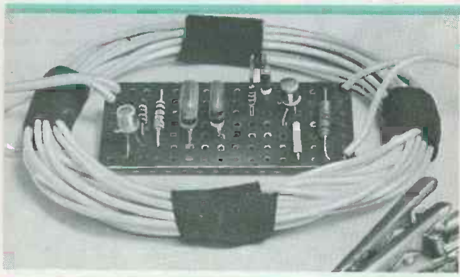
FREE VEROBOARD INSIDE

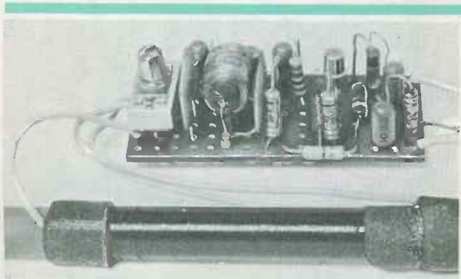
RADIO & ELECTRONICS CONSTRUCTOR

Vol. 26 No. 3 OCTOBER 1972 20p



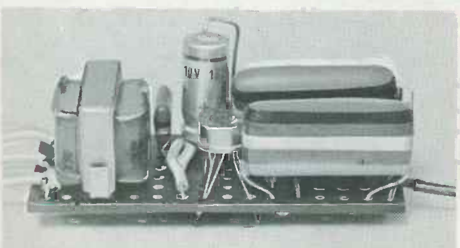
PROJECT 1

SIGNAL INJECTOR



PROJECT 2

RADIO 2 TUNER



PROJECT 3

INTEGRATED CIRCUIT AMPLIFIER

VEROBOARD PROJECT ISSUE

COMPONENTS

HOBBYIST - AMATEUR - DOMESTIC SURPLUS - 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

SEMICONDUCTORS

Full spec. marked by Mullard, etc. Many other types in stock

AF116	15p
AC127	17p
AC188	25p
AD149	45p
AD161	30p
AD162	30p
Matched pair	50p
BCY40	45p
BFY52	16p
ORP12	43p
2N3055	45p
2N2401	15p
Centercel Diodes	5p

6–110 volt, 0.6 amp. nominal bridge rect. encapsulated with built in Heat Sink .. 15p

T.O.3 Mica washers .. 2p

UNMARKED TESTED

BY127	8p
BC107-8-9	5p
2N2926	5p

1¼ 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, 1¼″ long, hollow centre	10p
Relay, P.O. 3000 type, 1,000 OHM coil, 4 pole c/o	60p

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

RESISTORS

⅛–¼–½ watt	1p
1 watt	1½p
Up to 10 watt wire	8p
15 watt wire wound	10p

SKELETON PRESETS

5K or 500K .. 3p

SAFETY PINS

Standard size, 10 for 4p

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 OTHERS	
EF183	40p	PL81	72p		
EF184	44p	PL83	56p		

RESETTABLE COUNTER

English Numbering Machines LTD.
MODEL 4436-159-989

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

DIE CAST ALLY BOX

4⅝ x 3⅝ x 2⅛ with lid .. 50p

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

BSR TD2 TAPE TRANSPORTER

With record-playback-erase heads .. £2.50

STEEL BOX WITH LID

10 x 5½ 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	
100	6	
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	5% 350V	3p each
0.061	5% 350V	3p each
0.066	5% 350V	3p each
0.069	5% 350V	3p each
0.075	5% 350V	3p each
0.08	5% 350V	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

30 PF Beehive, 12PF P.T.F.E., 2,500PF 750V — 10p each

WIREWOUND SLIDER

150 OHM, 250 OHM 5K 4p each

INDICATORS

12 volt red or mains neon amber, push fit round, chrome bezel
15p each

Rotor with neon indicator, as used in Seafarer, Pacific, Fairway depth finders
20p each

WIREWOUND POTS

250, 350 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 1⅜″ .. 2p

T.O.5 HEATSINKS

Style 154 high conductivity .. 5p

PAXOLINE

2⅜ x 4¾ x 1/16″ or 3 x 2½ x 1/16″	2p
4⅝ x ½ x ⅛″	2 for 1p
220K 3 watt resistors	2p
VALVE RETAINER CLIP, adjustable	2p

OUTPUT TRANSFORMERS

Sub-miniature .. 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 55L	21p	IS 021	10p
BY 128	15p	OA 10	35p	IS 951	6p

NEW COMPONENT PAK BARGAINS

Pack No.	Qty.	Description	Price
C 1	250	Resistors mixed values approx. count by weight	0.50
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
C 8	10	Reed Switches	0.50
C 9	3	Micro Switches	0.50
C10	15	Assorted Pots & Pre-Sets	0.50
C11	5	Jack Sockets 3—3.5m 2 — Standard Switch Types	0.50
C12	40	Paper Condensers preferred types mixed values	0.50
C13	20	Electrolytics Trans. types	0.50
C14	1	Pack assorted Hardware – Nuts/Bolts, Gromets, etc.	0.50
C15	4	Mains Toggle Switches, 2 Amp D/P	0.50
C16	20	Assorted Tag Strips & Panels	0.50
C17	10	Assorted Control Knobs	0.50
C18	4	Rotary Wave Change Switches	0.50
C19	3	Relays 6 – 24V Operating	0.50
C20	4	Sheets Copper Laminate approx. 10″×7″	0.50

Please add 10p post and packing on all component packs, plus a further 10p on pack Nos. C1, C2, C19, C20.
Component Lists for mail order available on request.

JUMBO COMPONENT PAKS

MIXED ELECTRONIC COMPONENTS
Exceptionally good value

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

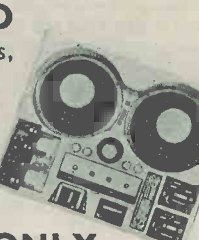
BRAND NEW POST OFFICE TYPE TELEPHONE DIALS

ONLY 35p each

THE NEW S.G.S. EA 1000 AUDIO AMP MODULE **Guar. 3 Watts RMS. Module Tested and Guaranteed.**
Qty. 1—9 **£2.63**; 10—25 **£2.28**. Price each.
Larger quantities quoted on request. Full hook-up diagrams and complete technical data supplied free with each module or available separately at **10p** each.

SYSTEM 12 STEREO

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.



ONLY £16.95 FREE P & P

NOW-TURN OVER FOR MORE FANTASTIC OFFERS

The largest selection

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

PIV	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	16A TO48	30A TO48
50	0.23	0.25	0.35	0.35	0.47	0.50	0.53	£1.15
100	0.25	0.33	0.47	0.47	0.50	0.58	0.63	£1.40
200	0.35	0.37	0.49	0.49	0.57	0.61	0.75	£1.60
400	0.43	0.47	0.56	0.56	0.67	0.75	0.93	£1.75
600	0.53	0.57	0.68	0.68	0.77	0.97	£1.25	—
800	0.63	0.70	0.80	0.80	0.90	£1.20	£1.50	£4.00

SILICON RECTIFIERS—TESTED

PIV	300mA £p	750mA £p	1A £p	1.5A £p	3A £p	10A £p	30A £p
50	0.04	0.05	0.05	0.07	0.14	0.21	0.60
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	—

TRIACS

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

FULL RANGE OF ZENER DIODES VOLTAGE RANGE 2-33V. 400mV (DO-7 Case) 13p ea. 1¼W (Top-Hat) 18p ea. 10W (SO-10 Stud) 25p ea. All fully tested 5% tol. and marked. State voltage required.

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

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NEW LINE

Plastic encapsulated 2 amp Bridge Rects.

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100 v RMS 37p each
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Size 15 mm x 6 mm

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Coded and Guaranteed

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T3	8 D1216	OC81D
T4	8 2G381T	OC81
T5	8 2G382T	OC82
T6	8 2G344B	OC44
T7	8 2G345B	OC45
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T9	8 2G399A	2N1302
T10	8 2G417	AF117

All 50p each pak

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ORP12 43p
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20 For	0.50	100 For	1.75
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Sil. trans. suitable for P.E. Organ. Metal TO-18 Eqvt. ZTX300 5p each. Any Qty.

SIL. G.P. DIODES £p

300mW	30	0·50
40PIV(Min.)	100	1·50
Sub-Min.	500	5·00
Full Tested	1,000	9·00

Ideal for Organ Builders.

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U3	75 Germanium Gold Bonded Sub-Min. like OA5, OA47	50p
U4	40 Germanium Transistors like OC81, AC128	50p
U5	60 200mA Sub-Min. Silicon Diodes	50p
U6	30 Sil. Planar Trans. NPN like BSY95A, 2N706	50p
U7	16 Sil. Rectifiers Top-Hat 750mA Vltg. Range up to 1,000	50p
U8	50 Sil. Planar Diodes DO-7 Glass 250mA like OA200/202	50p
U9	20 Mixed Voltages, 1 Watt Zener Diodes	50p
U10	20 BAY50 charge storage Diodes DO-7 Glass	50p
U11	25 PNP Sil. Planar Trans. TO-5 like 2N1132, 2N2904	50p
U12	12 Silicon Rectifiers Epoxy 500 mA up to 800 PIV	50p
U13	30 PNP-NPN Sil. Transistors OC200 and 2S 104	50p
U14	150 Mixed Silicon and Germanium Diodes	50p
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U16	10 3Amp Silicon Rectifiers Stud Type up to 1,000 PIV	50p
U17	30 Germanium PNP AF Transistors TO-5 like ACY 17-22	50p
U18	8 6Amp Silicon Rectifiers BYZ13 Type up to 600 PIV	50p
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U26	30 Fast Switching Silicon Diodes like IN914 Micro-Min.	50p
U27	12 NPN Germanium AF Transistors TO-1 like AC127	50p
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U31	20 Sil. Planar Plastic NPN Trans. Low Noise Amp 2N3707	50p
U32	25 Zener Diodes 400mW DO-7 case 3-18 volts mixed	50p
U33	15 Plastic Case 1 Amp Silicon Rectifiers IN4000 Series	50p
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U35	25 Silicon Planar Transistors PNP TO-18 2N2906	50p
U36	25 Silicon Planar NPN Transistors TO-5 BFY50/51/52	50p
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U41	25 RF Germanium Transistors TO-5, OC45, NKT72	50p
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Code Nos. mentioned above are given as a guide to the type of device in the Pak. The devices themselves are normally unmarked.

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Q3	4 OC 77 type transistors	50p
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Q5	4 OC 75 transistors	50p
Q6	5 OC 72 transistors	50p
Q7	4 AC 128 transistors PNP high gain	50p
Q8	4 AC 126 transistors PNP	50p
Q9	7 OC 81 type transistors	50p
Q10	7 OC 71 type transistors	50p
Q11	2 AC 127/128 Comp. pairs PNP/NPN	50p
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Q13	3 AF 117 type transistors	50p
Q14	3 OC 171 H.F. type transistors	50p
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Q16	2 GET880 low noise Germ. trans.	50p
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Q22	20 NKT transistors A.F. R.F. coded	50p
Q23	10 OA 202 Silicon diodes sub-min.	50p
Q24	8 OA 81 diodes	50p
Q25	15 IN914 Silicon diodes 75PIV 75mA	50p
Q26	8 OA95 Germanium diodes sub-min IN69	50p
Q27	2 10A 600 PIV Sil. rectifiers IS425R	50p
Q28	2 Silicon power rectifiers BYZ 13	50p
Q29	4 Silicon trans. 2 x 2N696, 1 x 2N697, 1 x 2N698	50p
Q30	7 Sil. switch transistors 2N706 NPN	50p
Q31	6 Sil. switch transistors 2N708 NPN	50p
Q32	3 PNP Sil. trans. 2x2N1131, 1x2N1132	50p
Q33	3 Silicon NPN transistors 2N1711	50p
Q34	7 Sil. NPN trans. 2N2369, 500MHz (code P397)	50p
Q35	3 Sil. PNP TO-5, 2x2N2904 & 1x2N2905	50p
Q36	7 2N3646 TO-18 plastic 300 MHz NPN	50p
Q37	3 2N3053 NPN Silicon transistors	50p
Q38	7 PNP trans. 4 x 2N3703, 3 x 2N3702	50p
Q39	7 NPN trans. 4 x 2N3704, 3 x 2N3705	50p
Q40	7 NPN trans. 4x 2N3707, 3 x 2N3708	50p
Q41	3 Plastic NPN TO-18 2N3904	50p
Q42	6 NPN transistors 2N5172	50p
Q43	7 BC 107 NPN transistors	50p
Q44	7 NPN trans. 4 x BC 108, 3 x BC 109	50p
Q45	3 BC 113 NPN TO-18 transistors	50p
Q46	3 BC 115 NPN TO-5 transistors	50p
Q47	6 NPN high grain trans. 3 x BC167, 3 x BC168	50p
Q48	4 BCY 70. PNP transistors TO-18	50p
Q49	4 NPN trans. 2 x BFY51, 2 x BFY52	50p
Q50	7 BSY 28 NPN switch trans. TO-18	50p
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Qty.	1-24	25-99	100 up
Price each	45p	40p	35p

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UIC03	12 × 7403	50p	UIC50	12 × 7450	50p	UIC92	5 × 7492	50p
UIC04	12 × 7404	50p	UIC51	12 × 7451	50p	UIC93	5 × 7493	50p
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Coded GP100. BRAND NEW TO-3 CASE. POSS. REPLACE.:—OC25-28-29-30-35-36. NKT 401-403-404-405-406-430-451-452-453. TI3027-3028, 2N250A, 2N456A-457A-458A, 2N511 A & B. 2G220-222, ETC. VCBO 80V VCEO 50V IC 10A PT. 30 WATTS Hfe 30-170.

PRICE	1-24	25-99	100 up
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SILICON High Voltage 250V NPN TO-3 case. G.P. Switching & Amplifier Applications. Brand new Coded R 2400 VCBO 250/VCEO 100/IC 6A/30 Watts. HFE type 20/fT 5MHZ.

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115 WATT SIL POWER NPN
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AD161/AD162 *NPN*
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OUR LOWEST PRICE
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SILICON 50 WATTS MATCHED NPN/PNP
BIP 19 NPN TO-3 Plastic.
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VCBO 100/VCEO 50/IC 10A. HFE type 100/ft 3mHZ.
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SN7401	0.15	0.14	0.12
SN7402	0.15	0.14	0.12
SN7403	0.15	0.14	0.12
SN7404	0.15	0.14	0.12
SN7405	0.15	0.14	0.12
SN7406	0.35	0.31	0.28
SN7407	0.35	0.31	0.28
SN7408	0.18	0.17	0.16
SN7409	0.18	0.17	0.16
SN7410	0.15	0.14	0.12
SN7411	0.25	0.24	0.23
SN7412	0.35	0.31	0.28
SN7413	0.29	0.26	0.24
SN7416	0.43	0.40	0.38
SN7417	0.43	0.40	0.38
SN7420	0.15	0.14	0.12
SN7422	0.50	0.48	0.45
SN7423	0.50	0.48	0.45
SN7425	0.50	0.48	0.45
SN7427	0.45	0.42	0.40
SN7428	0.70	0.65	0.60
SN7430	0.15	0.14	0.12
SN7432	0.45	0.42	0.40
SN7433	0.80	0.75	0.70
SN7437	0.64	0.62	0.60
SN7438	0.64	0.62	0.60
SN7440	0.15	0.14	0.12
SN7441	0.67	0.64	0.58
SN7442	0.67	0.64	0.58
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SN7453	0.15	0.14	0.12
SN7454	0.15	0.14	0.12
SN7460	0.15	0.14	0.12
SN7470	0.29	0.26	0.24
SN7472	0.29	0.26	0.24
SN7473	0.37	0.35	0.32
SN7474	0.37	0.35	0.32
SN7475	0.45	0.43	0.42
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SN7493	0.67	0.64	0.58
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SN7495	0.77	0.74	0.68
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SN74155	£1.40	£1.30	£1.20
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SN74157	£1.90	£1.80	£1.70
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SN74177	£2.50	£2.40	£2.30
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SN74181	£5.50	£5.00	£4.75
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SN74184	£3.50	£3.25	£3.00
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SN74193	£2.00	£1.80	£1.75
SN74194	£2.70	£2.60	£2.50
SN74195	£2.00	£1.90	£1.80
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SN74198	£5.50	£5.00	£4.50
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LINEAR I.C's— FULL SPEC.

Type No.	Price 1–24	25–99	100 up
BP 201C—SL201C	63p	53p	45p
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BP 702C—SL702C	63p	50p	45p
BP 702—72702	53p	45p	40p
BP 709—72709	36p	34p	30p
BP 709P—μA709C	36p	34p	30p
BP 710—72710	44p	42p	40p
BP 711—μA711	45p	43p	40p
BP 741—72741	75p	60p	50p
μA 703C—μA703C	28p	26p	24p
TA A263	70p	60p	55p
TA A293	90p	75p	70p
TA A350	170p	158p	150p

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

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

NUMERICAL INDICATOR TUBES

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

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

RTL MICROLOGIC CIRCUITS

Epoxy TO-5 case	Price each 1-24	25-99	100 up
uL900 Buffer	35p	33p	27p
uL914 Dual 2I/p gate	35p	33p	27p
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Date and Circuits Booklet for IC's Price 7p.

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TSO16 pin type	35p	32p	30p
Low Cost No.			
BPS 14	15p	13p	11p
BPS 16	16p	14p	12p

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50W pk 25w (RMS)

0.1% DISTORTION HI-FI AUDIO AMPLIFIER THE AL50

★ Frequency response 15Hz to 100,000 - 1dB.

★ Load - 3, 4, 8 or 16 ohms.

★ Distortion - better than .1% at 1KHz.

★ Signal to noise ratio 80dB.

★ Supply voltage 10 - 35 Volts.

★ Overall size 63mm x 105mm x 13mm.

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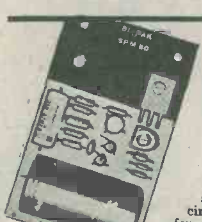

STABILISED POWER MODULE SPM80

AP80 is especially designed to power 2 of the AL50 Amplifiers, up to 15 watt (rms) per channel, simultaneously. This module embodies the latest components and circuit techniques incorporating complete short circuit protection. With the addition of the Mains Transformer MT80, the unit will provide outputs of up to 1·5 amps at 35 volts. Size: 62mm x 105mm x 30mm.

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PRICE £2·95

TRANSFORMER BMT80 £1.95 p. & p. 25p.

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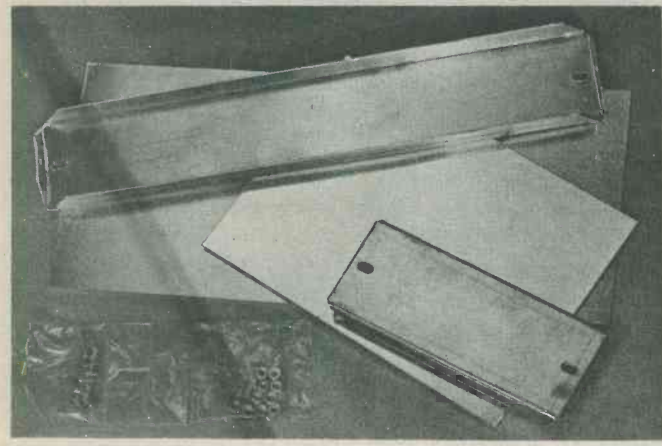

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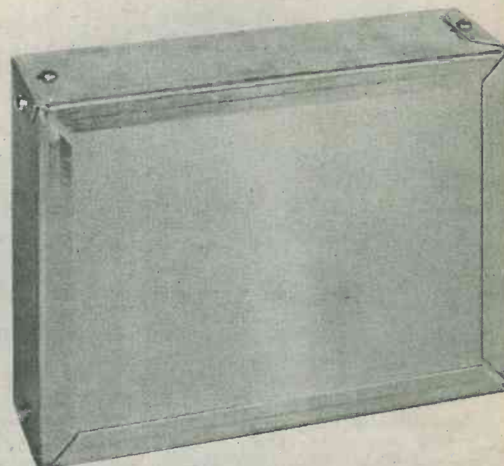

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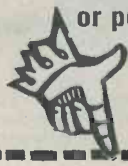

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CONTENTS

‘WIDE-BAND SIGNAL

This simple but very useful item of test equipment can be made up without difficulty on the Veroboard panel which is presented free with this month's issue.

IN THIS MONTH'S ISSUE OF *Radio & Electronics Constructor* WE are presenting free to readers a sizeable piece of Veroboard having a matrix, i.e. hole spacing, of 0.15 in. Many readers will already be aware of the unique properties of Veroboard as a constructional aid. If desired, any of the copper strips on the board can be cut at a hole by means of a Veroboard spot face cutter or an ordinary twist drill, thereby enabling sections of the strips to be isolated in the interests of circuit layout and design. The Veroboard has 7 strips, each with 16 holes, and this allows the construction of relatively quite advanced circuits, all of which occupy little space.

There are two simple basic rules to observe when working with Veroboard. First, use a small soldering iron with a rating of about 15 to 20 watts. Second, always employ a radio-type resin-cored solder such as Ersin Multicore or Savbit. *Never* use a paste or liquid flux. The Veroboard copper strips tin readily and it is an easy matter to solder to them reliably and quickly. It is slightly preferable to bend over a component lead-out before soldering, as in Fig. 1(a). If, however, this is difficult, it is still perfectly in order to simply pass a component lead through, cut it so that a little more than $\frac{1}{16}$ in. protrudes, as in Fig. 1(b), and then solder the lead to the copper strip. When all soldering on a particular project is completed, a visual check should be carried out to ensure that no two adjacent strips have been accidentally bridged together by stray solder or by solder 'blobs'.

Some constructors may find it helpful to provide a 'jig' on which the edges of the board may be rested, as shown in Fig. 2. A small cardboard box without a lid, or similar, can be employed here, and it enables the board to be kept in position more readily for soldering after the first few components have been fitted.

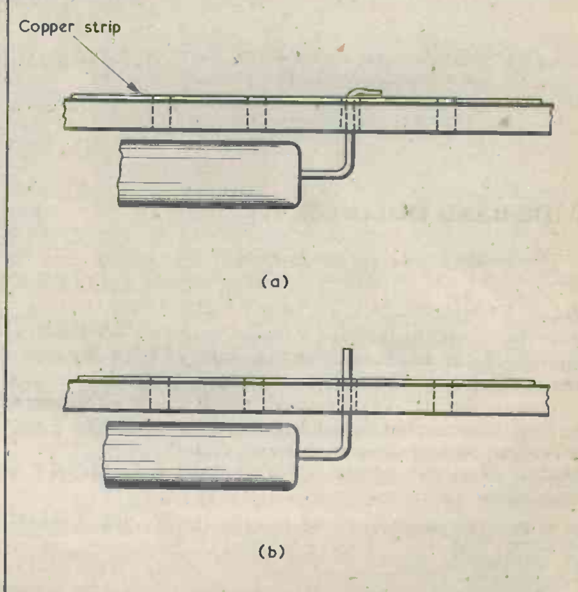
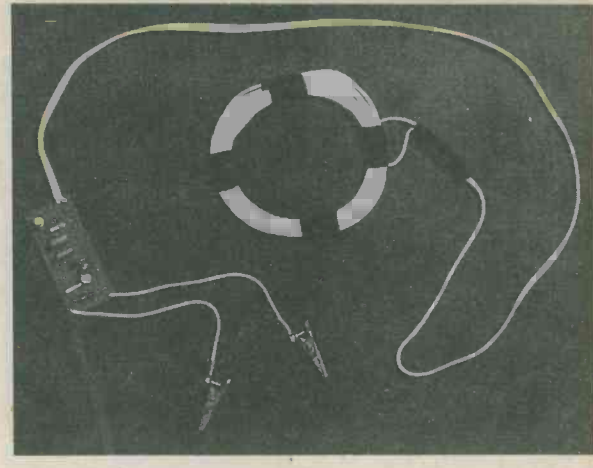


Fig. 1 (a). It is slightly preferable to bend a short length of a component lead-out along a Veroboard copper strip before soldering
(b). Perfectly sound solder joints will still be given, however, if the lead simply projects directly through the Veroboard hole

INJECTOR'



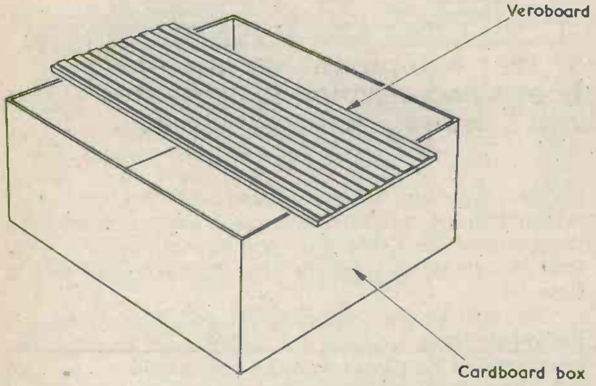


Fig. 2. Soldering is eased if the Veroboard edges are supported by the sides of a small empty cardboard box without its lid after the first few parts have been fitted

WIDE-BAND INJECTOR

The project now to be described, and which can be made up on the board, is quite simple and will be particularly attractive for newcomers. It consists of a wide-band signal injector which is capable of injecting an amplitude modulated signal into any medium and long wave receiver having a ferrite rod aerial. As such, it forms a useful and inexpensive item of test equipment.

The circuit of the signal injector is given in Fig. 3 and it comprises a multivibrator running at around 1kHz. Resistor R1 has the low value of 180Ω and it causes an abruptly starting pulse of around 22mA to flow in the injector coil each time, during the multivibrator cycle, that TR1 becomes conductive. The transistors employed are high frequency types, a factor which assists in the production of a sharp pulse front. A low bypass reactance across the supply lines is given by C3. To reduce battery current, the values of R2 and R3 are such that TR1 is conductive for only about a quarter of the multivibrator cycle. The total current drawn by the unit is approximately 10mA.

The pulses flowing in the injector coil constitute a basic waveform having a frequency of around 1kHz which is rich in harmonics. These harmonics extend well above 1.5MHz with the result that when the injector coil is held, outside the cabinet, in line with the ferrite rod aerial of a receiver, the basic tone can be heard at all points of the medium and long wave bands.

The four resistors fitted to the Veroboard are ¼ watt miniature, having a nominal body length of 8 mm (0.32 in.) and a nominal diameter of 2.8 mm (0.11 in.). It is, of course, quite in order to use 5% resistors instead of the 10% types specified in the Components List if these are easier to obtain. The two 0.1µF capacitors are Mullard Miniature Foil type C280 (available from Home Radio under Cat. No. 2EH49) and the 4µF capacitor is Mullard Miniature electrolytic (Home Radio Cat. No. 2CH12).

Construction commences with the assembly of the injector coil, which is illustrated in Fig. 4. This coil is not at all critical and simply consists of 20 turns of ordinary p.v.c. covered connecting wire, which may be either single or stranded, wound up in a round loop

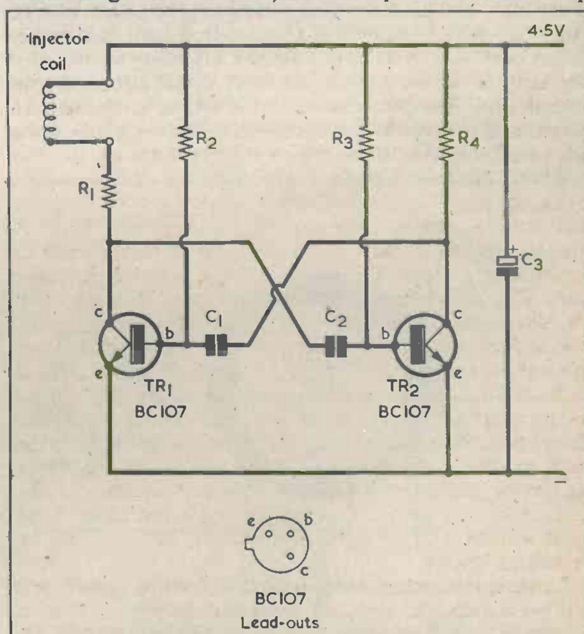


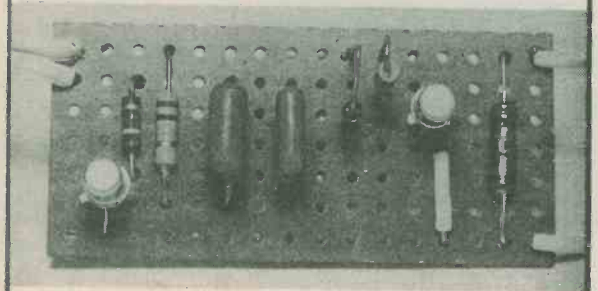
Fig. 3. The circuit of the wide-band signal injector

COMPONENTS

Resistors
(All ¼ watt miniature 10%)
R1 180Ω.
R2 10kΩ.
R3 2.7kΩ.
R4 1kΩ.

Capacitors
C1 0.1μF Mullard Miniature Foil type C280.
C2 0.1μF Mullard Miniature Foil type C280.
C3 4μF 10V Wkg. Mullard Miniature electrolytic.

Transistors
TR1 BC107.
TR2 BC107.
Miscellaneous
Veroboard, 0.15 in. matrix, 7 strips by 16 holes.
Injector coil (see text).
4.5 volt battery.



The component layout on the signal generator Veroboard

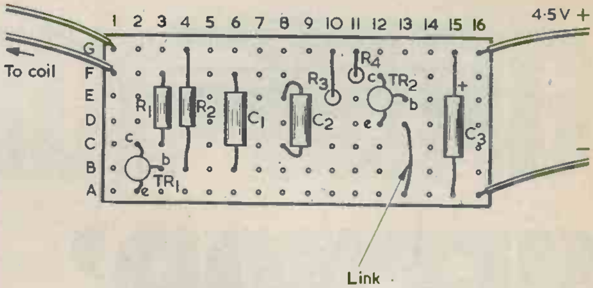


Fig. 5. Component and copper sides of the completed wide-band signal injector

having an internal diameter of about 3 in. An easy way of making the coil consists of winding the wire loosely around a glass jar having approximately the desired diameter and then sliding the turns off as one entity. About 20 ft. of wire are required for the coil, but it is safer to start with a slightly longer length than this and to cut off the excess after the coil has been wound.

The coil is made self-supporting by winding insulating tape round it at four points, as shown in Fig. 4. Its ends are connected to a piece of twin flex 2 ft. long.

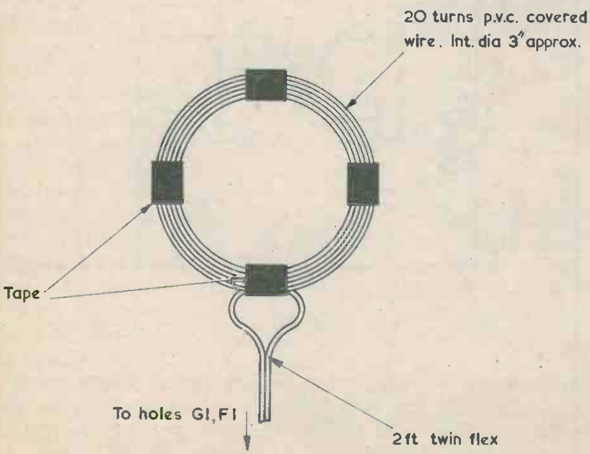


Fig. 4. Details of the injector coil

Next, take up the Veroboard and turn to Fig. 5, which shows its component and copper sides after completion. First, using a spot face cutter or a twist drill of suitable size, cut the appropriate copper strip at hole F4.

The resistors are fitted next. R1 and R2 are mounted flat on the board, whilst R3 and R4 are vertical. The lower lead of R3 passes through, and is soldered at, hole E10; its upper lead is bent down, passing through and being soldered at hole G10. R4 is similarly connected at holes F11 and G11.

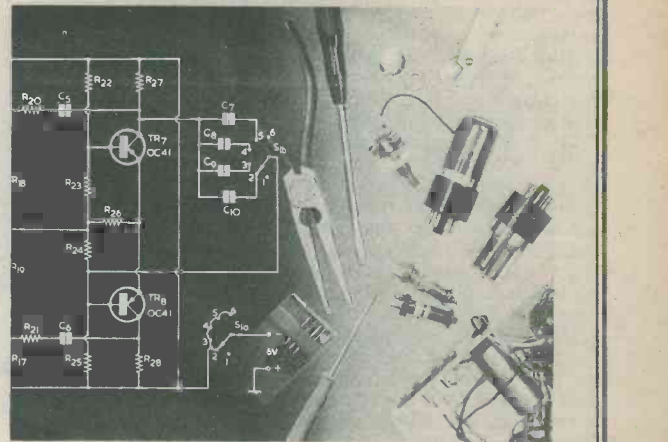
Capacitors C1, C2 and C3 are next wired to the board. Take care to connect C3 with correct polarity. Its negative lead-out is common with its can. The capacitors are followed by the link between holes D13 and A13. This is simply a length of bare tinned copper wire which couples strip D to the negative supply. The two battery leads are next soldered at holes A16 and G16, and the twin flex from the injector coil at holes G1 and F1. Finally, the transistors are soldered into circuit, with their emitter, base and collector leads connecting to the holes indicated.

The signal injector is now complete. A 4.5 volt battery should be connected to the battery leads, whereupon it will be found that a loud tone of around 1kHz is reproduced by any medium and long wave receiver when the injector coil is brought in line with its ferrite rod aerial.

The signal injector has a number of uses. With a superhet receiver it can first of all indicate oscillator failure or poor tracking over part of a range. It can also give a useful measure of receiver sensitivity. It is particularly helpful for oscillator padding adjustments at the low frequency end of a range, since there is no need for continual retuning, as occurs when a single fixed frequency signal is used. Finally, it can be employed to inject a strong signal into a receiver having no audible output, whereupon the signal can be traced through the r.f., i.f. and a.f. stages with a signal tracer.

A supply voltage greater than 4.5 volts should not be applied to the signal injector. ■

DUAL VOLTAGE POWER SUPPLY



by G. A. FRENCH

As the more experienced constructor will know, there are two basic rectifier circuits employed in d.c. power supplies, these being known respectively as the 'choke input' and the 'capacitor input' circuits. Fig. 1(a) illustrates the choke input circuit, and assumes that the rectifier arrangement is of the full-wave bridge type. When the choke in Fig. 1(a) has an adequate inductance, and if there is no resistance in the circuit or voltage drop in the rectifiers, the output voltage across the smoothing capacitor is always 0.9 times the r.m.s. value of the alternating voltage across the mains transformer secondary.

VOLTAGE REGULATION

The choke input power supply offers very good voltage regulation. In practice, output voltage drop due to increase in output current is caused by the inevitable resistance which appears in the circuit and which is given by the windings of the transformer and the choke, by voltage drop in the rectifiers and by the fact that the electromagnetic coupling between the primary and secondary of the mains transformer cannot be 100% efficient. With good design all these factors can be kept at a low level.

Fig. 1(b) illustrates the capacitor input arrangement. Here, rectified half-cycles are applied to the reservoir capacitor, causing it to charge up (in the absence of a load current) to their peak value, which is 1.414 times the r.m.s. value of the alternating voltage across the mains transformer secondary. When an output current is drawn the capacitor discharges between half-cycle peaks, with the result that output voltage falls to a value that is lower than the peak value of the alternating voltage half-cycles.

The output voltage regulation with the capacitor input circuit is poorer than with the choke input circuit. This

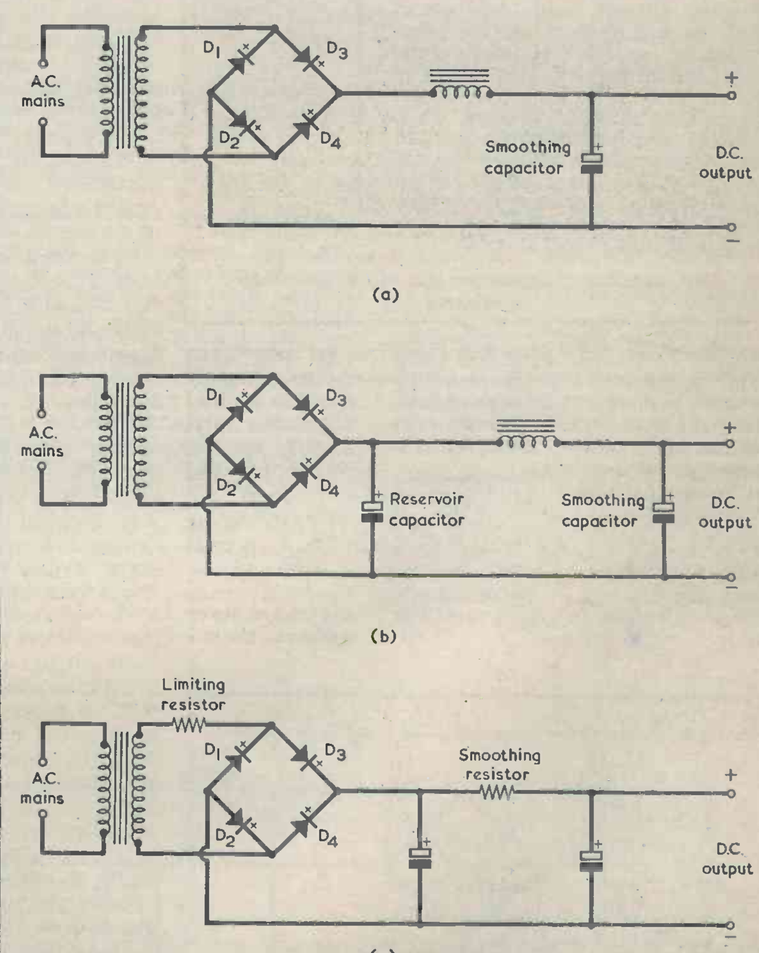


Fig. 1 (a). Choke input power supply incorporating a bridge rectifier
(b). The bridge rectifier followed by a capacitor input circuit
(c). The capacitor input circuit may have a current limiting resistor. Also, a smoothing resistor may be used instead of a choke

is inevitable because an increase in output current must cause the reservoir capacitor to discharge by a greater amount between half-cycle peaks, giving a consequent fall in average output voltage. On the other hand, the capacitor input circuit offers the advantage that the output voltage can, under low load current conditions, be at least 50% higher than is given by the choke input circuit for the same transformer secondary voltage. Also, the output voltage does not alter if the load current is constant.

In Fig. 1(b) the choke may be replaced, in practice, by a smoothing resistor. Also, a low-value limiting resistor can if necessary be inserted, at some point in the charging circuit to the reservoir capacitor, to limit switch-on current surges and ripple current in the capacitor. Fig. 1(c) illustrates a capacitor input circuit having both a smoothing resistor and a limiting resistor.

There are some classes of equipment in which it would be of advantage to feed the well regulated output given by a choke input supply to some of the stages and the higher voltage offered by the capacitor input circuit to others. A possible example is given by a transmitter, in which the v.f.o., r.f. and final stages could be run from the well regulated choke input supply, whilst some of the a.f. modulation amplifier stages could be run from the higher voltage capacitor input supply.

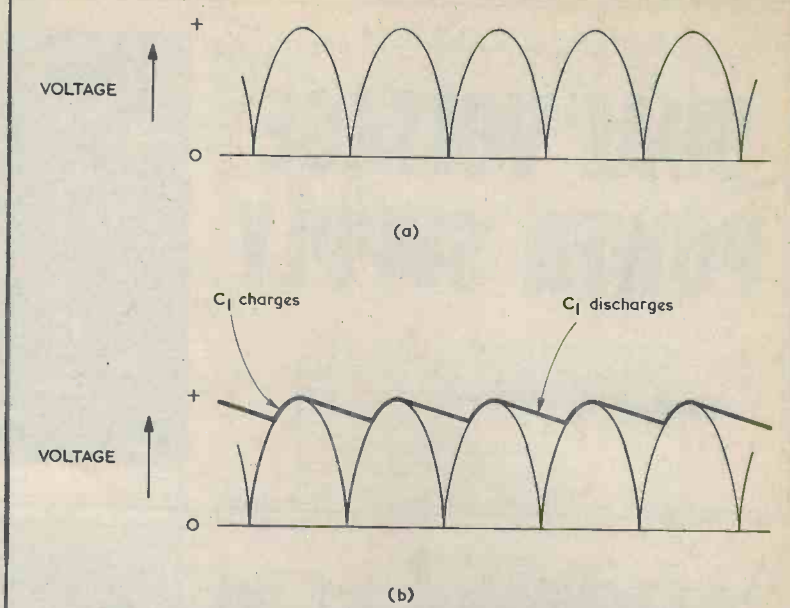


Fig. 3 (a). The rectified voltage at the junction of D3 and D4 which is applied to D5 consists of a series of rectified half-cycles
(b). The heavy line indicates the voltage across reservoir capacitor C1. This capacitor charges up on half-cycle peaks then discharges into the load in the periods between peaks

COMBINED CIRCUIT

Fig. 2 shows a power supply which enables both choke input *and* capacitor input circuits to be operated from a single mains transformer secondary. Output 1 is that from the choke input section whilst Output 2 is that from the capacitor input section.

In Fig. 2, rectifiers D1 to D4 form a standard bridge circuit which is identical to that illustrated in Fig. 1(a). This is then coupled in the same manner to choke L1 and smoothing capacitor C2, and it provides exactly the same output as was given in Fig. 1(a).

As may be seen from Fig. 3(a), rectified half-cycles appear at the junction of D3 and D4, and these are applied to rectifier D5. This causes reservoir capacitor C1 to charge up to their peak value whereupon, under no-load conditions, this capacitor charges to the peak value of the alternating voltage accross the transformer secondary. When a load current is drawn, the voltage across the reservoir capacitor falls between half-cycle peaks, as indicated by Fig. 3(b). The performance is, in consequence, similar to that of the circuit of Fig. 1(b).

It is assumed in Fig. 2 that the reservoir capacitor, C1, is followed by the smoothing choke L2. A smoothing resistor, as in Fig. 1(c), could be employed instead, if desired. If it is necessary to insert a limiting resistor in the D5 circuit, this may be fitted at the point indicated by a cross.

At first sight it might appear that the use of a single rectifier in the D5 position makes the capacitor input section of the circuit analogous with a half-wave rectifier arrangement. This is not so; *all* the half-cycles across the transformer secondary are applied to D5, and (assuming that the rectifier is a 'perfect' component) the performance is equal to that of the full-wave circuit of Fig. 1(b).

As with all bridge rectifier arrangements the peak inverse voltage applied to each of D1 to D4 is 1.414 times the r.m.s. value of the alternating voltage on the transformer secondary. The peak inverse voltage applied to D5 has the same value also, as can be seen by examining Fig. 3(a). Here, the voltage applied from the bridge to D5 varies from peak value to zero as the half-cycles proceed.

If it is desired to have output voltages that are negative with respect to chassis instead of positive, all the diodes, D1 to D5, have to be reversed. Similarly, all the electrolytic capacitors have to be reversed. The current rating of the mains transformer secondary must, of course, be equal to or greater than the sum of the two output currents.

The circuit of Fig. 2 can be employed at the high voltages associated with valve equipment or at the low voltages required by semiconductor devices. ■

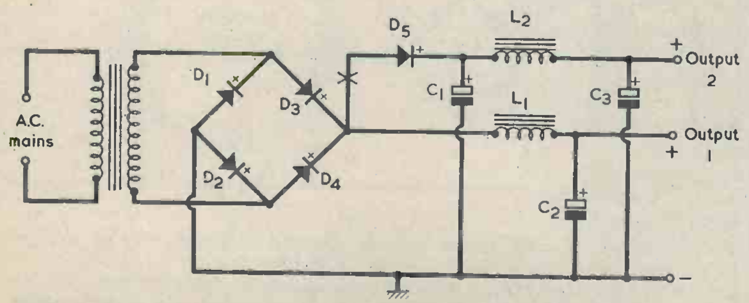


Fig. 2. A circuit which enables both choke and capacitor inputs to be employed with a single mains transformer winding

NOTES ON SEMICONDUCTORS

Further Notes—11

EARTH, GROUND OR COMMON?

by
Peter Williams

In this concluding note in the present series, our contributor describes a very simple amplifier which has a somewhat unexpected performance

It is easy to fall into a habit such as using two words interchangeably when both usually apply to the same situation. It may then be hard to use them properly on those occasions when only one applies. Such a pair of words is 'ground' and 'common'. For the purposes of this note, 'earth' and 'ground' may be taken as the U.K. and U.S. versions of the same concept, i.e. a true connection of low impedance to earth. A fourth word 'chassis' implies a low impedance connection to the conducting framework of the equipment under test. This too gets hopelessly mixed-up in meaning and it is quite 'common' to talk of 'grounding' a transistor when what is meant is ensuring a connection to a common line of the system which may or may not be connected to the 'chassis' which in turn may or may not be connected to 'ground' or 'earth'.

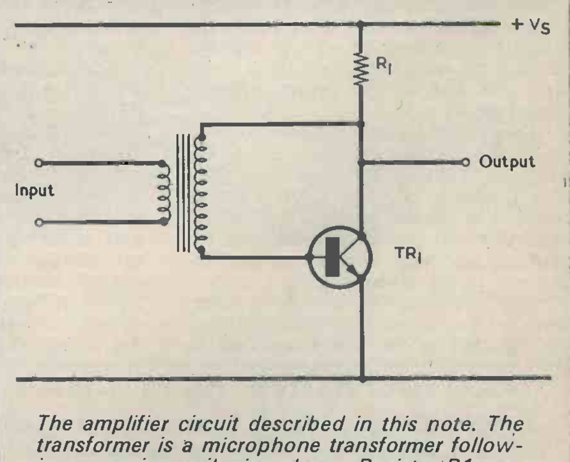
TRANSISTOR CIRCUITS

If any readers still remain at this point they may be encouraged to learn that out of this darkness may come light. We shall turn now to a particular problem in describing transistor circuits, the difference between a 'grounded' and a 'common' emitter circuit. For this purpose we shall use 'grounded' to mean 'connected to the ground line of the system' since this is accepted terminology, though riddled with the objections given above. A 'common emitter' amplifier on the other hand, is an amplifier in which the emitter is the transistor electrode common to the input and output circuits.

Now consider the circuit of Fig. 1. Firstly it is about the simplest microphone amplifier circuit that can be devised. A low impedance microphone requires a step-up transformer to raise the signal voltage as far above the amplifier noise voltage as possible (without raising the impedance level so high that other problems arise). There can hardly be fewer than one transistor, and a supply voltage and load resistor also seem pretty likely requirements! Beyond this no other components are required—except a coupling capacitor to the next stage—though even this may not be needed and is properly part of the following stage anyway.

The secondary of the transformer provides a low-resistance path that ensures Vcb is approximately equal to OV. This still holds TR1 in a region of reasonable current gain, and for signal excursions of only a few tens of millivolts the following assumptions are justifiable:

(i) The transformer is loaded only by the base current of TR1, while the collector supplies the output, i.e. the input impedance is high.
(ii) The output impedance is relatively low, since any current required by the load is readily supplied by the collector, only a small change in collector voltage reappearing at the base via the transformer.
(iii) The transformer secondary voltage is applied between base and collector with only a small portion between base and emitter, e.g. 1mV between base and emitter is enough to account for up to 100mV at the collector (in the opposite sense because of the amplifier inverting properties). Hence for 101mV in we have 100mV out.

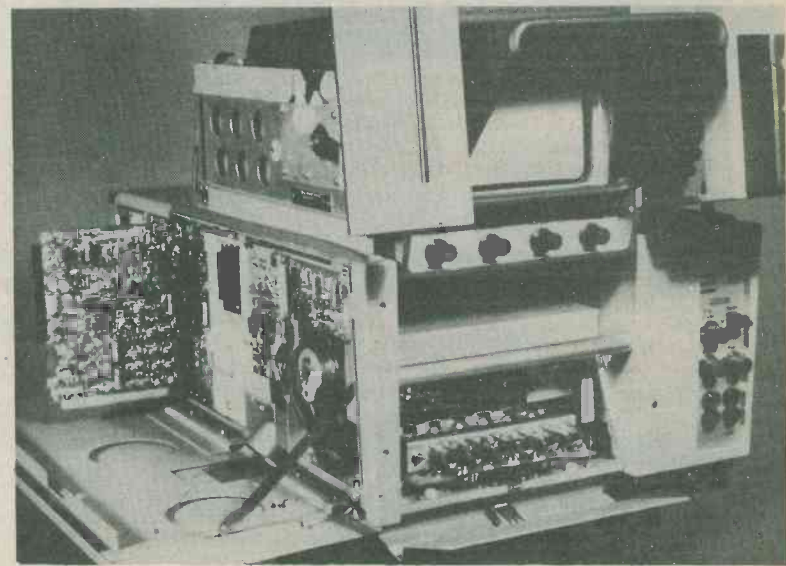


The amplifier circuit described in this note. The transformer is a microphone transformer following a moving-coil microphone. Resistor R1 may have a value which allows several milliamps of collector current to flow. TR1 is a high gain silicon component

See how similar these properties are to those expected of the emitter-follower or common-collector stage and then note, surprise surprise, that the *collector* is *common* to the input and output circuits. It is a common collector but grounded emitter amplifier with the former primarily determining the amplifier behaviour. ■

NEWS . . . . AND .

MARCONI MARK VIII CAMERA



Colour camera with fully automatic setting up of controls; a rear view of the Marconi Colour Camera Mark VIII

That world beater of a colour television camera, the Marconi Mark VIII, continues with its story of successful use and sales. You may recall that this is the camera which is fully self-adjusting. The operator presses a button and all the setting up is carried out by motor-controlled potentiometers. These motor-controlled potentiometers are manufactured by Portescap (U.K.) Limited, 204 Elgar Road, Reading, and offer a high level of compactness and reliability. Six of these are located in the camera head itself and you can just discern them in the photograph at the lower end of the camera back. Another seventeen are situated in the camera control unit. Each of the motor-controlled potentiometers is controlled by a digital servo loop and driven directly by TTL logic output signals to vary the adjustment of amplifier gains, beam deflections and similar parameters.

The manner in which the potentiometers carry out the setting up of the camera makes fascinating reading. The first stage in the process is the positioning of a capping shutter, driven by another of the motors, in front of the camera lens. A mirror is fitted to this shutter so that a slide in an internal diascope can be projected via the mirror directly into the three camera tubes through the light-splitting prism. The slide contains a test pattern, the essential features of which, for the setting up operation, are four white triangles and, at the centre, a white rectangle.

The first motor-driven potentiometer is then automatically adjusted to vary the light from the diascope lamp until the output from the green channel reaches a pre-set level. Two further motor-driven potentiometers then set the red and blue channel gains with respect to the green channel.

This is followed by automatic alignment of the beams of the picture tubes. One corner of the white rectangle in the test pattern is at the exact centre of the picture. The focus of each tube is rocked and any beam misalignment is detected by movement of the centre of the picture from any tube. The six motor-driven potentiometers, two for each tube, are controlled to adjust the horizontal and vertical alignment deflections of each tube until the movement ceases.

Registration of the red and blue pictures with the green picture is performed with the four white triangles. Mis-registration is revealed by misalignment of the diagonal edges of the triangles when the red and blue pictures are superimposed on the green. Misalignment is automatically detected and a set of fourteen motor-driven potentiometers, seven for each of the red and blue tubes, register the pictures by adjustment of horizontal centreing, vertical centreing, width, height, skew (i.e. tilting of vertical lines), twist (i.e. rotation of the complete picture) and horizontal linearity.

The capping shutter and mirror are then automatically withdrawn and the camera is ready for operation.

During operation of the camera a dynamic centreing system detects any drift in picture registration and controls two of the motor-driven potentiometers in the camera control unit to adjust the horizontal and vertical centreing of the red and blue tubes. Thus the red and blue pictures are continuously registered with the green picture, despite the long-term effects of temperature, mechanical shock or vibration.

The motors drive the potentiometers via Portescap type FM15 gearboxes with reduction ratios of 141:1 and 485:1. Slipping clutches fitted with thumb-wheels allow manual adjustments where required.

LUSTRAPHONE HI-FI CHAIR

Discriminating music lovers can now enjoy the ultimate in stereo listening – a personal music chamber which ensures excellent acoustics for stereo sound reproduction, regardless of the acoustics of the room. It enables the listener to enjoy music without disturbing other people or being disturbed by them.

The chamber is, in fact, a luxuriously comfortable fibre-glass armchair with back and sides extending upwards into a hood which forms a semi-anechoic (echo-free) cabinet with its own built-in speaker system. It can be placed anywhere – even outside on a patio or balcony – and is acoustically independent of its external environment

• • • COMMENT

NATIONAL AMATEUR EXHIBITION

The recently formed Amateur Radio Retailers' Association are staging an Exhibition entitled – National Amateur Radio & Electronics Exhibition.

The exhibition will be held at the Granby Halls, Leicester, from 26th-28th October. On the Thursday and Friday the show will be open from mid-day to 9.00 p.m. and on Saturday from 10.00 a.m. until 7.00 p.m. Admission 20p.

This exhibition should appeal to a substantial number of our readers, especially those interested in Amateur Radio. It is the first major show for Amateurs held outside London, and is well situated in the central part of the U.K. with easy access by road, rail and air.

CONSTRUCTION CONTESTS

● Otley Radio Society is holding an Open Construction Contest on 24th October commencing at 8.00 p.m.

Any type of working electronic equipment can be entered providing it has not been built from a kit, or built for commercial purposes.

Details and entry forms from D. G. Mott, G8BZY, 17 Newall Carr Road, Otley, Yorkshire. Entrance Fee 25p.

● Barking Radio & Electronics Society are holding an open contest on Thursday 9th November, commencing at 7.45 p.m., at Westbury Recreation Centre, Westbury School, Ripple Road, Barking, Essex.

There will be two sections, one for self designed and constructed equipment, and the other for self-constructed equipment.

Details and entry forms from Alan P. Foss, G8EAY, 73 Coolgardie Avenue, Chigwell, Essex. Entrance Fee 20p.

IN BRIEF

● The Radio Society of Great Britain have reported that, subject to audit, their accounts for the year to 30th June will show a surplus in the region of £4,000.

● The Microwave 1973 International Conference & Exhibition will be held at the Metropole Exhibition Centre, Brighton, from 19th to 21st June. Owing to extra demand, the exhibition space is being extended by 50 stand spaces.

● In readiness for its first colour transmissions scheduled for 1st March 1975, the Australian Broadcasting Commission is buying one of the latest Marconi colour outside broadcast units.

● The British Amateur Electronics Club have made a donation of £335.65p to the Cancer Research Campaign. The donation was from their, as usual, successful annual exhibition and the proceeds of a raffle held in conjunction therewith.

● A "Booster" course for those who have failed the Radio Amateurs' Examination and do not wish to take another complete course, is being held in Islington. Details from F. J. Barns, G3AGP, 60 Alvestone Avenue, East Barnet.

● An attendance of 5,000 and 1,200 cars in the car park marked the fifteenth Annual Mobile Radio Rally organised by the Derby and District Amateur Radio Society.

● AMF Venner Ltd., Kingston-By-Pass, New Malden, Surrey, are now offering their very versatile Model 728 Pulse Generator from stock: list price £215.

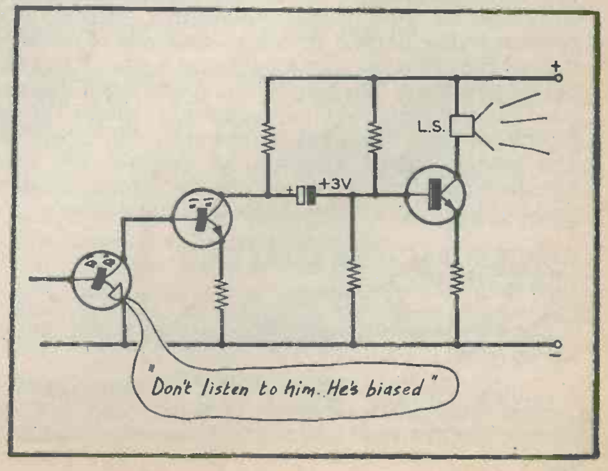
'CLANSMEN' ORDERS EXCEED £4M

Plessey Avionics & Communications, which has developed the PRC 320 HF Transceiver and all the frequency synthesisers for the British Army Clansman net radio system, has received production orders from the Ministry of Defence for both complete PRC 320 equipments and synthesisers, valued in excess of £4 million.

The company claims that the PRC 320 is the most technically advanced lightweight, high power HF SSB station radio available anywhere in the world and has a high export potential. The set is extremely versatile and can be used either in the manpack, ground station or clip-in vehicle roles.

Developed by Plessey under a MoD contract, the PRC 320 has received full approval following two years of extensive field trials conducted by the British Army. Fully sealed and of robust design it will operate in the most demanding environmental conditions likely to be encountered throughout the world.

In its basic form the PRC 320 is a manpack set carried on the operator's back and allowing full use of his weapons. Weighing approximately 20lbs (9kg) it is suitable for infantry, artillery, armoured and supporting forces and for installation in light aircraft and helicopters.



Oscilloscope Photography

by

A. Foord

Practical details on the photographing of static oscilloscope displays

WHEN USING AN OSCILLOSCOPE ONE DESIRABLE feature is to be able to photograph the display for comparison or record purposes. If it is essential that a print is immediately available, then a Polaroid camera is the most satisfactory approach. However the least expensive Polaroid camera which is designed especially for oscilloscope photography is the CR–9, and this costs over £50. While it is possible to modify one of the 'domestic' Polaroid cameras for this application, it is not a very satisfactory method. When prints are not immediately required and where a normal camera is available, the approach indicated in this article is both convenient and inexpensive.

We assume that the oscilloscope display is recurrent and not a single transient because the recurrent trace is the easiest to photograph and is that usually available.

There are two approaches to obtaining the correct film exposure. One is to measure the light intensity of the c.r.t., and the other is to maintain that intensity at a constant value. Several attempts were made to measure the intensity of a number of different c.r.ts., but without much success. The light level is too low and the spot size too small for conventional exposure meters to give a reliable reading, and spot photometers are expensive. The overall factors affecting the performance were therefore investigated to see how the screen intensity could be maintained constant for different displays.

GENERAL FACTORS AFFECTING PERFORMANCE

The energy density available to expose a film can be shown to be:

$$\text{available energy density} = \frac{a.b.c.d.P.t.}{A} \text{ watts/cm}^2,$$

where 'a' is the efficiency of the phosphor in converting the electrical energy to light,
'b' is the spectral transfer efficiency of the screen to film combination (the match of the screen colour to the film characteristics),
'c' is the efficiency of the optical system used, including the transmission loss of the glass in front of the screen,
'd' is the screen utilisation factor and depends on how much light is lost in the screen due to scattering, multiple reflections, etc.,
'P' is the exciting beam power, and is the product of the beam current and the total anode-to-cathode voltage,
't' is the time the spot spends over the area A, and
'A' is the scanning area.

In theory it would be possible to calculate a figure for each parameter, but in our practical approach an experimental technique can be used. For a given system many of the parameters are fixed, and one constant can be allocated to them. We then have:

$$\text{available energy density} = \frac{k.I.t.}{A} \text{ watts/cm}^2,$$

where I is the beam current and k is a constant. We can now show how specific changes of the oscilloscope parameters affect the film exposure we require.

SPECIFIC FACTORS AFFECTING PERFORMANCE

C.R.T. phosphors

The Table shows the different characteristics of the common phosphors; relative efficiencies vary from 1.00 to 0.25. (The information given in the Table can only be regarded as approximate, as each manufacturer has his own phosphors. Manufacturer's data sheets should be consulted for more accurate information on a specific tube.)

CHARACTERISTICS OF THE COMMON PHOSPHORS

Phosphur		P1	P2	P7	P11	P31
Colour	Initial Fluorescence	yellow–green	blue-green	purplish–blue	blue	green
	Afterglow	yellow–green	green	yellow-green	blue	green
	Spectral peak	520 nm.	510 nm.	450 nm.	450 nm.	530 nm.
Persistence		Medium	Medium–short	Long	Medium–short	Medium–short
Relative Photographic Efficiency		0.25	0.40	0.75	1.00	0.60
Application		General purpose, low voltage oscilloscopes.	General purpose, medium voltage oscilloscopes.	General purpose and long persistence work.	Ideal for recording high speed transients.	General purpose, higher voltage oscilloscopes.
Filters for separating fluorescence and afterglow		None	None	Blue filter removes yellow–green afterglow. Amber filter removes initial flash.	None	None
Comments		Not suitable for high speed transient displays		Relatively high photographic efficiency	Highest photographic efficiency	Comfortable to the eyes.

Filters

Filters of grey, blue, or green are often placed over the c.r.t. screen to enhance the visible trace contrast in the presence of ambient illumination. In recording applications such filters generally serve no useful purpose, since better photographs can be taken if ambient illumination is excluded by using a hood or by darkening the room. From two to seven times the light may be obtained if it is convenient to remove the filter. If a P7 phosphor is used, where the initial fluorescence and the afterglow have different colours, a filter may be employed to eliminate one or the other, as required.

Film exposure, development, printing.

Although it is possible to increase film speed and contrast by using an energetic developer, it is obviously of considerable advantage if a standard procedure can be used, especially if trade processing is required. It was found that by using HP4 with normal development and printing on a normal grade paper excellent results can be obtained.

The previous parameters remain constant, but the following may change.

Signal amplitude and waveform shape

The area 'A' which is scanned depends on the spot size, the waveform shape, and its amplitude. The minimum area (perhaps 8 cm. by 0.5mm.) would be given by a straight line, while the maximum area would be given by a waveform with many cycles on the screen.

As the amplitude of a specific trace increases, so the spot speed increases because it must travel further in the same time period, thereby reducing the brightness. Similarly, the number of cycles of waveform on the screen alters the brightness. However, it was found that these effects were small and it was not generally necessary to adjust the exposure with a change in signal amplitude or the number of cycles displayed on the screen. To be absolutely safe the signal amplitude and timebase speed could always be adjusted to give a full amplitude picture of (say) three complete cycles, and a separate note made of the absolute values.

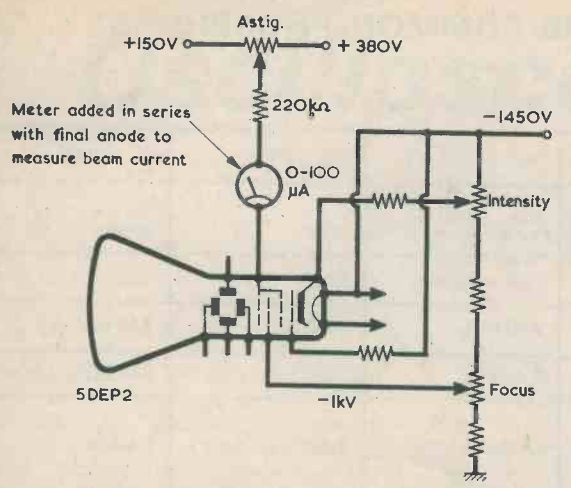
Timebase sweep speed and X magnifier

The time 't' that the spot spends over an area 'A' is not affected very much by the timebase sweep rate because an increase in sweep speed also results in an increase in the sweep repetition rate. The effective time per sweep would be reduced, but there would be more sweeps during a given period. To a first approximation 't' is independent of the sweep speed.

If a sweep magnifier is used this causes an increase in spot speed without a corresponding increase in sweep repetition rate. As a result a X5 sweep magnification calls for a X5 exposure increase.

Beam current

The final anode to cathode accelerating potential remains constant, and it is the beam current intensity setting which has the greatest single effect on the photo-



How the final anode beam current was measured in the writer's oscilloscope

graphic exposure. Even a slight change in intensity, almost unnoticeable to the eye, can have an effect equivalent to a change of one or two lens f-number settings. Generally, the intensity should be set to a low or medium value since an excessive intensity increases the spot size and reduces resolution. For the rather poor oscilloscope used by the author (the tube of which has a P2 phosphor) the beam current was set to 10μA.

The accompanying diagram shows how the final anode lead was broken into so that the beam current could be maintained constant over a wide range of signal conditions. Depending on the oscilloscope the final anode potential could be up to 20kV (simple 'scopes are up to 1kV), so check with the circuit diagram and be *very careful* with the insulation. Also, take all precautions against shock.

DETERMINATION OF CORRECT EXPOSURE

To determine the correct exposure for a given set of conditions a series of test exposures were made. The chosen beam current of 10μA could be maintained over both fast and slow timebase speeds. A shutter speed of one second was chosen because this covers several cycles of the timebase even at slow sweep speeds and is available on most cameras. A 50Hz sinewave signal from a heater transformer was displayed as three cycles of full screen amplitude and the beam current adjusted to 10μA.

Using HP4, test exposures at a 1 second shutter speed were given for lens f-number settings from 1.8 to 16. The negative was developed and printed to slightly larger than life size.

The results were as follows:

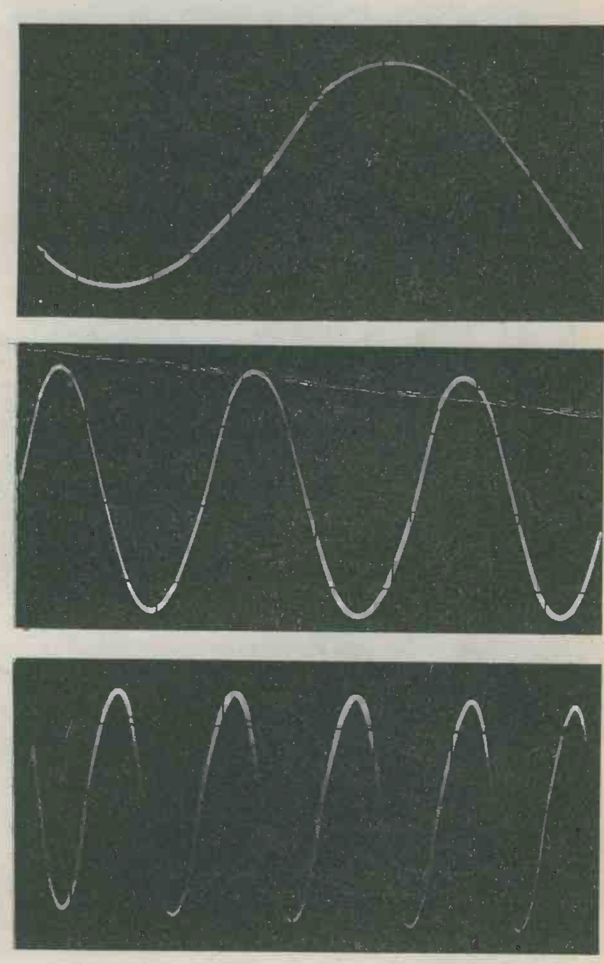
f-number 1.8: considerable overexposure, thick trace with halo, not satisfactory.

f-number 2.8: slight thickening of trace, excellent contrast, acceptable print.

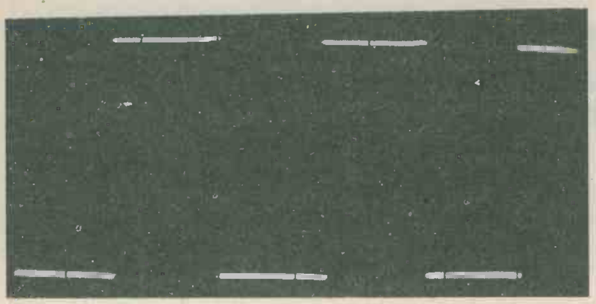
f-number 4: excellent negative, good contrast, printing very easy.

f-number 5.6: excellent negative, good contrast, printing very easy.

f-number 8: acceptable negative, printing and contrast satisfactory.



These three photographs, of a 50 Hz sine wave, were all taken at f 5.6 with 1 second exposure, and with final anode current at 10μA. All the other photographs were taken under similar conditions



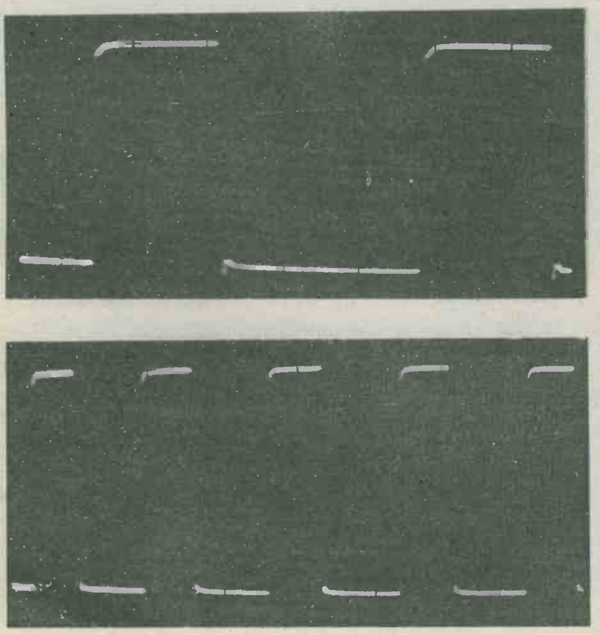
Several cycles of a 1 kHz square wave

f-number 11: thin negative, printing difficult; contrast just satisfactory.
f-number 16: very thin negative, printing difficult, contrast not satisfactory.

It is interesting to note that all the test exposures gave some form of result and that using an optimum exposure of 1 second at f 5.6 gave a latitude of one stop over which excellent results can be obtained.

CONCLUSION

To confirm that the exposure of 1 second at f 5.6 works for various frequencies and waveform shapes several more photographs were taken. The frequencies ranged from 25Hz to 100kHz. The basic parameters were left the same. Beam current was 10µA, adjusted to this level for each photograph. Exposure was 1 second at f 5.6 on HP4 film.



Two photographs of a 100 kHz square wave

The signal amplitude was adjusted to fill the screen each time but the timebase speed was adjusted so that from one to five cycles apeared on the screen. No X expansion was used. All the photographs were excellent and could be printed at the same enlarger settings. Some photographs showed intensity and amplitude modulation due to hum, but this was an oscilloscope characteristic rather than a photographic fault.

Some of the photographs accompany this article.

APPENDIX I

Development for HP4 was in Perceptol (diluted 1+1) for 12 minutes with 10 seconds agitation each minute. This gives a nominal film speed of 320 ASA and a G (average contrast) of 0.55.

The paper was Agfa 'Special' grade developed in D163 (diluted 1+3) for 2 to 3 minutes.

Fixing and washing were normal. If trade printing is used then instructions must be given to indicate that a white line on a black background is expected, because the automatic machines used for print exposure determination assume a normal range of print densities. Film development can be normal. For best results it might be better to develop and print your own films.

APPENDIX II

In order to obtain a reasonable image size on the film the camera will need to be focused closer than the 18 inches or so that is normally possible. This can be achieved by using extension tubes (if the camera has an interchangeable lens) or by attaching a supplementary lens on the front of the camera's normal lens. Even the simplest camera can usually be fitted with a push-on supplementary lens at a cost of about £2. The focusing can be checked by placing a ground glass screen in the film plane.

A visit to the local library or the local photographic dealer will indicate the approach required.

For the writer's oscilloscope a 4in. wide trace was to be recorded as a 1in. wide image on a 35mm. negative. This 1:4 reproduction ratio can be achieved by a *total* lens extension of between 10 mm. and 15mm. or by a supplementary lens of 4 dioptres (with the camera focused to 4ft.) for a 50mm. camera lens. 4 dioptres is quite a strong lens, and the writer was able to use a 10mm. extension tube.

The experimental procedure given in this article automatically allows for the increased exposure normally needed in close-up work. This would be about 2/3 of a stop for a 1:4 reproduction ratio. ■

RADIO 2

A pre-tuned Radio 2 tuner unit incorporating two transistors which may be assembled on this month's free sample Veroboard. Current consumption from the 9 volt battery is of the order of 2mA only.

THIS RADIO 2 TUNER UNIT REPRESENTS A FAIRLY complex assembly on the Veroboard, and it makes virtually full use of the options, in terms of connection points, that are offered by the board.

FUNCTIONING

The project consists of a 2-transistor tuner unit which is pre-tuned to the Radio 2 signal on 200kHz, or 1,500 metres. The Veroboard circuitry operates in conjunction with a ferrite aerial, the coils of which are home-wound. In areas where reception of the Radio 2 signal is reasonably good, the output of the tuner is of the same order of amplitude as is that offered by a ceramic or crystal pick-up, and the tuner may be coupled to any a.f. amplifier, having an input impedance of 20kΩ or more, which is capable of operating with an input of this level. The tuner may also be coupled to the integrated circuit a.f. amplifier described elsewhere in this issue, whereupon the two form a complete pre-tuned radio receiver driving a loudspeaker. The tuner output provides a signal at comfortable but not excessive level in a pair of 2,000Ω headphones, but is not at a sufficiently high power level to operate satisfactorily with a single ear-piece.

Naturally, the output of the tuner depends upon the strength of the Radio 2 signal in the particular locality where it is to be used, and it may not offer an adequate output in areas which are considerably removed from the transmitter at Droitwich. A further point is that the unit has only one sharply tuned circuit, with the result that it is impossible to guarantee freedom from break-through in areas where local signals, medium wave or otherwise, appear at considerably greater strength than the Radio 2 signal. The prototype gave satisfactory results in a location where the Radio 2 signal is picked up fairly well, and where the local medium wave signal is received at a significantly higher level. Some limitations in the performance of a radio tuner unit as relatively simple as the present one have, of course, to be accepted.

The circuit of the tuner unit appears in Fig. 1, and it demonstrates fairly conventional design approach. The ferrite aerial tuned winding, L1, is resonated at 200kHz by fixed capacitor C1 and trimmer C2, whilst winding L2 provides a low impedance coupling to the base of TR1. The letters 'X', 'Y' and 'Z' alongside the ferrite aerial windings are references to enable the correct connections to be made during assembly.

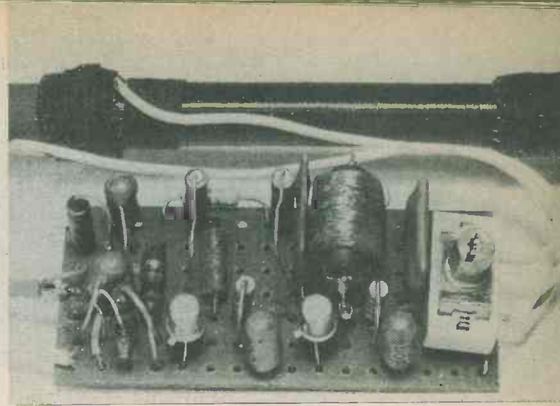
TR1 is a silicon n.p.n. transistor type BC107 offering a high level of gain at 200kHz, and its collector couples into the load given by R2, L3 and C6 in parallel. L3 is an r.f. choke whose main function, in the present design, is to offer an inductive coupling to the ferrite aerial to provide a small measure of regeneration. It is also caused to resonate, very broadly, at 200kHz by means of C6. The positive supply to the collector circuit of TR1 is decoupled by R3 and C4.

The amplified signal at TR1 collector is next fed, via C5, to the base of a second BC107, TR2. This further amplifies the signal and then passes it via C7 to the shunt diode detector D1. The detected signal is then passed to the output via a standard low-pass filter consisting of R7 and C8, and a d.c. blocking capacitor given by C9. Capacitor C10 provides a bypass across the supply lines.

The tuner unit is powered by a 9 volt battery. The current drawn from the battery is of the order of 2mA only.

The components on the board are standard types. The resistors are all miniature ¼ watt components of the same type as those employed in the Wide-Band Signal Injector, described elsewhere in this issue. Capacitors C3, C5, C7 and C8 are tubular ceramic, and

TUNER



COMPONENTS

Resistors
(All ¼ watt miniature 10%)
R1 1MΩ.
R2 2.2kΩ.
R3 470Ω.
R4 1MΩ.
R5 2.2kΩ.
R6 10kΩ.
R7 4.7kΩ.

Capacitors
C1 200pF, 2%, silvered mica, side wires.
C2 10-80pF, mica trimmer (Cat. No. VC29F, Home Radio).
C3 3,000pF, tubular ceramic.
C4 4μF, 10V Wkg., Mullard Miniature electrolytic.
C5 3,000pF, tubular ceramic.
C6 120pF, 2%, silvered mica, side wires.
C7 3,000pF, tubular ceramic.
C8 3,000pF, tubular ceramic.
C9 4μF, 10V Wkg., Mullard Miniature electrolytic.
C10 4μF, 10V Wkg., Mullard Miniature electrolytic.

Inductors
L1, L2 Ferrite aerial (see text).
L3 5mH r.f. choke type CH2 (Repanco).

Semiconductors
TR1 BC107.
TR2 BC107.
D1 OA91.

Miscellaneous
Veroboard, 0.15 in. matrix, 7 strips by 16 holes.
Ferrite rod, 8 in. by ⅜ in., R.S. Components Blue grade.
Enamelled wire, 34 s.w.g.
9 volt battery.
Flexible screened cable.

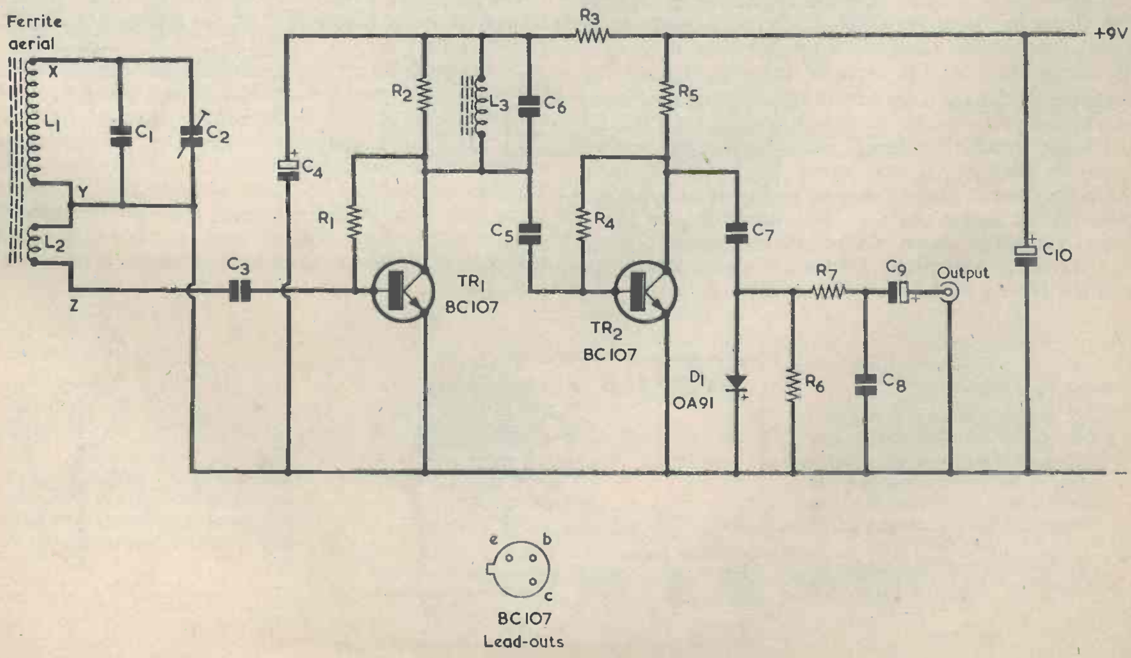


Fig. 1. The circuit of the Radio 2 tuner unit

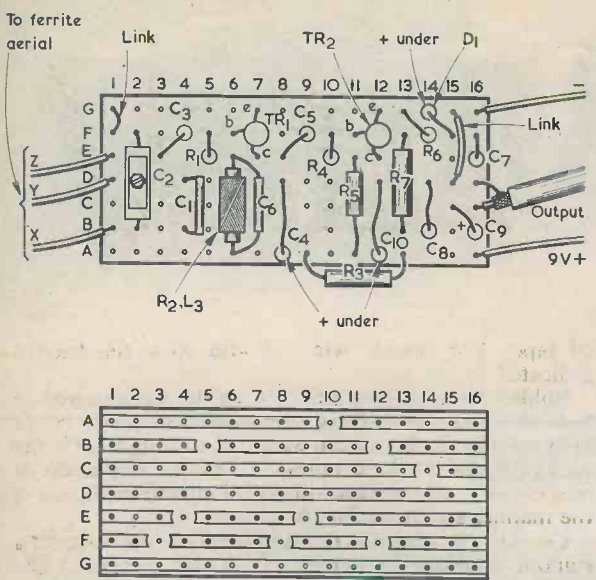


Fig. 2. Illustrating the component and copper sides of the completed tuner unit. Resistor R2 is under L3

they are all mounted vertically. For convenience, they are shown in the layout diagram, Fig. 2, as having the upper leads projecting from the end centres but, in practice, these capacitors have lead-outs which project from the sides. The ceramic capacitors are very nearly the last components to be mounted. The bottom lead-out of each is bent straight down and passed through its connection hole in the Veroboard, and the capacitor is then oriented such that the upper lead-out points in the general direction of the hole to which it is to connect. Thus, the body of each ceramic capacitor is slightly offset from the hole in which its bottom lead-out is inserted, and is not centrally disposed over that hole. It is important that the ceramic capacitors have the values specified in the Components List. Those employed in the prototype were Home Radio Cat. No. C79G. C1 and C6 are standard silvered mica components having side wires instead of end wires. Trimmer C2 is a Cyldon component type CAA/80 and is available from Home Radio under the Cat. No. given in the Components List. The three electrolytic capacitors are all 4μF, 10V Wkg., Mullard Miniature electrolytics, for which the Home Radio Cat. No. is 2CH12.

The ferrite aerial coils are wound with 34 s.w.g. enamelled wire (available on 2 oz. reels from Home Radio under Cat. No. ECW10). The ferrite rod is an 8 in. by $\frac{3}{8}$ in. Blue grade R.S. Components type. This rod is available from most component retailers and may be identified by the fact that its packing carries the R.S. Components trade mark and that one end of the rod is coded blue. It may be obtained directly from retailers of R.S. Components parts such as Chromasonic Electronics, 56 Fortis Green Road, London N10 3HN Other grades of rod will require a different number of turns in the windings. The tuner is capable of working with any ferrite rod having a length of 5 in. or more but, as is to be expected, performance improves as the length of the ferrite rod increases. It is for this reason that it was decided to employ an 8 in. rod.

Fig. 2 shows the component and copper sides of the Veroboard. The first process consists of cutting the copper strips at holes A10, B5, B12, C14, E4, E9, F3, F8 and F12. Then, on the component side of the board, fit a bare wire link between holes G1 and F1. Next, fit a link employing insulated wire between holes G15 and D15. This last link should be positioned such that free access is given to hole F15. Following Fig. 2, fit C1, R5 and R7. Fit, vertically, R6, D1, R4, R1, C4, C10 and C9. The positive lead-out of D1 connects to hole G14, the positive lead-out of C4 connects to A8, the positive lead-out of C10 connects to A12, and the positive lead-out of C9 connects to hole C15. The negative lead-outs of the electrolytic capacitors are common with their cans. Next, fit R3. This component is positioned on the outside of C10 and falls partly outside the board outline. Next, fit the two transistors, TR1 and TR2.

L3, R2 and C6 are mounted as a sub-assembly. First, bend L3 lead-outs in the manner illustrated in Fig. 3(a), and then solder R2 across these lead-outs as shown. Next solder C6 to the choke lead-outs, as illustrated in Figs. 3(a) and (b). Then insert the choke lead-outs into holes E6 and A6 and solder the assembly to the board. C6 is on the side of the choke that is remote from C1. Ensure that the lead-out at hole E6 does not touch the can of TR1.

Next come the tubular ceramic capacitors. Fit C5 and C8 in the manner described earlier. Similarly fit C7, ensuring also that its body allows access to hole D16. Fit C3, allowing a slightly longer length in the lead-out connecting to hole E3 than would normally be required. The longer length is necessary because the lead-out has to be later bent to clear trimmer C2 which, in practice, overhangs vertical lines 1 and 3. (For clarity, the trimmer is shown slightly smaller than actual size in Fig. 2.)

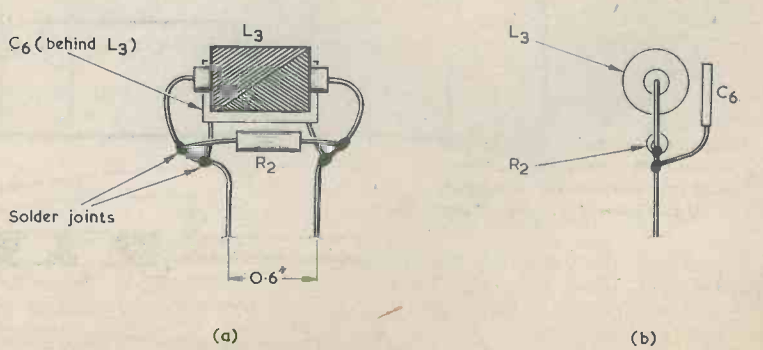
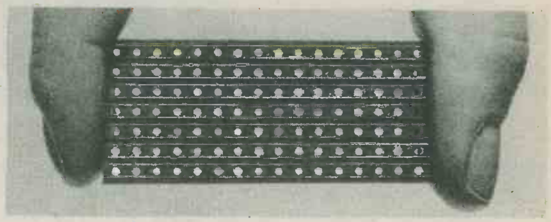


Fig. 3 (a). Choke L3, R2 and C6 form a sub-assembly which is made up as shown here. After the sub-assembly has been completed, the choke leads are soldered to the board
(b). Side view of the assembly given by L3, R2 and C6

Next, take up the trimmer, C2, and carefully file its tags so that they will pass through the Veroboard holes. It is quicker in practice to snip away the small amount of metal which needs to be removed from the tags, but this requires a pair of snips in good condition coupled with great care in their use, since there is the risk of accidentally snipping off the tags in their entirety. Ensure that the trimmer tags can pass through holes F2 and B2, but do not solder it into position yet. Ensure also that the lead from C3 to hole E3 will not foul the trimmer when the latter is fitted later.

Connect the braiding of a length of flexible screened wire to hole D16, and its inner conductor to hole C16. This screened lead carries the a.f. output of the tuner unit. Connect the negative battery lead to hole G16 and the positive battery lead to hole A16.

Take up the ferrite aerial rod and wind on L1 and L2, as shown in Fig. 4. L1 consists of 215 turns and L2 30 turns of 34 s.w.g. enamelled wire close-wound directly on the rod. Winding commences with end 'X' of L1, the wire being wound on in an anti-clockwise direction as viewed when the left-hand end of the rod (left-hand in Fig. 4) is pointed towards the eye. After the 215 turns for L1 have been fitted, the wire can be twisted on itself to form a loop for the tap 'Y', after which winding can proceed with the 30 turns required for L2. The winding ends are held in position with tape. The most convenient tape to employ here is black electrician's insulating tape split into a width of ¼ in. Connect thin flexible wires to points 'X', 'Y' and 'Z', anchoring these down and covering the solder joints with further lengths



of tape. The flexible wires should have the lengths indicated in Fig. 4.

Solder the lead from point 'X' of the ferrite aerial to hole B1 of the Veroboard, the lead from point 'Y' to hole D1 and the lead from point 'Z' to hole E1. Fit the tags of trimmer C2 to holes F2 and B2 and solder it into position. Place the ferrite rod alongside the board in the manner shown in Fig. 5.

Connect the screened output lead from the tuner to a suitable amplifier and connect a 9 volt battery to the supply leads. Adjust C2 for optimum strength of the Radio 2 signal. Experimentally move the ferrite rod both to and from the board and lengthwise as well. A position should be found where the Radio 2 signal is received at greatest strength. If the transistors employed have higher gain than average, some positions of the ferrite rod may cause oscillation, in which case the rod

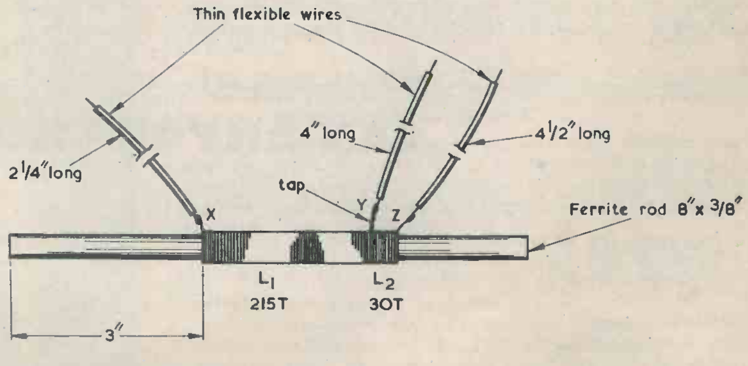


Fig. 4. Winding the ferrite rod aerial. The coil ends are secured with insulating tape. The soldered connections to the flexible wires are also covered with tape

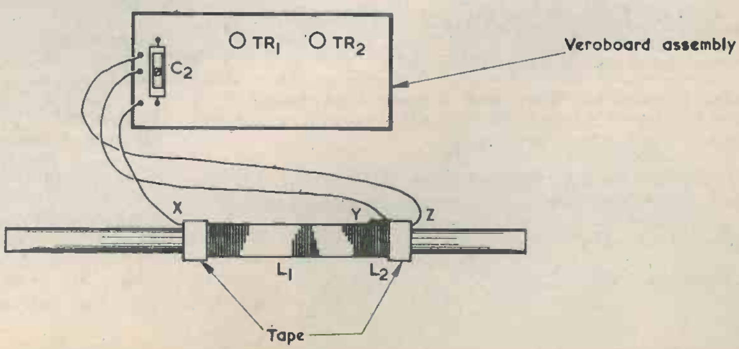
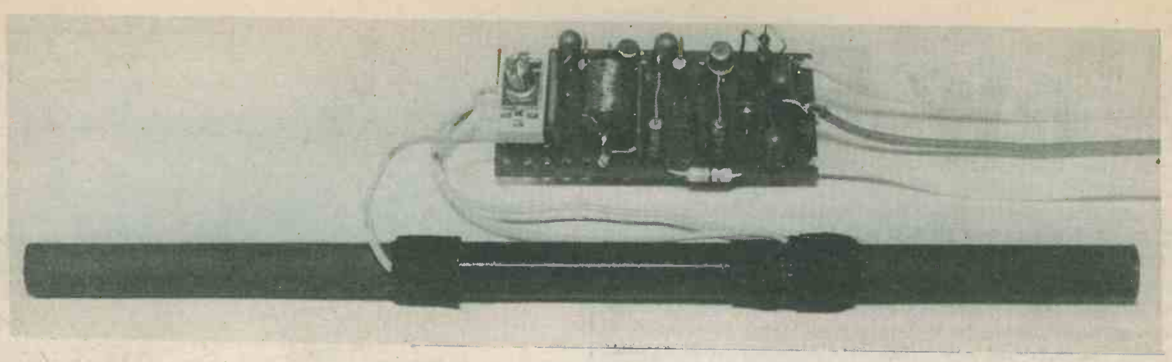


Fig. 5. The ferrite aerial should be positioned alongside the Veroboard assembly in the manner shown here



The Radio 2 tuner Veroboard assembly with the ferrite rod aerial alongside

should be moved to a position just outside that at which oscillation ceases. When the optimum position for the rod has been found the trimmer, C2, should be finally adjusted.

The writer has wound several ferrite rod aerials to the turn numbers shown in Fig. 4, and each has functioned satisfactorily. There is nevertheless a slight risk that some rods of the type specified may have slightly differing permeability, whereupon it may be necessary to add or take off a few turns from L1 to tune in the Radio 2 signal. The necessity for extra turns is indicated if signal strength increases as C2 is tightened, but C2 cannot be adjusted through the position of maximum signal strength. Similarly, the necessity for fewer turns is indicated if the same effect occurs at the minimum capacitance end of the range in C2. The number of turns to be added or taken off should only be in the order of 10 to 20.

The tuner may be overloaded in areas of extremely high signal strength. The solution here is to orient the ferrite rod to decrease signal input. Alternatively, the effective value of R2 may be reduced by adding parallel resistance on the copper side of the board, across holes E6 and A6.

Due to the simple filter provided by R7 and C8, a small amount of r.f. at 200kHz is present in the output from the tuner. This caused no trouble when the prototype tuner was connected to standard a.f. amplifiers and the design can, in consequence, be considered satisfactory for all conventional applications. The residual r.f. did, however, give rise to difficulties when the tuner was connected directly to the integrated circuit amplifier which is also described in this issue, the difficulties being due to the fact that an integrated circuit amplifier offers a high degree of gain, in an extremely small space, over a very wide band of frequencies. A simple additional filter to overcome this trouble (which could also arise with other integrated circuit amplifiers) is discussed in the article describing the amplifier. ■

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.

S.T.C. Triple Crystal Type 4434/A—L. J. Godfrey, 80 Clive Road, Dulwich, London, SE21 8BU – wishes to purchase.

Ex Ministry Receiver, DRAW 62E, AP67907, GEC 170—R. J. Langdon, 5 Princes Park Close, Hayes, Middlesex – Conversion details to 2 metres wanted.

Radio Constructor June and August 1964 issues—J. F. Glavin, North Lodge, Northlands, Salthill, Chichester, Sussex – To purchase or borrow.

UHF Booster for 2 Metre Reception—J. D. Noble, 3 Barden Road, Eastmoor, Wakefield, Yorkshire – Circuit wanted.

Bush Radio AC-DC Mains Receiver Type DAC 90—R. Batty, 2 Manor View, Halfway, Sheffield, S19 5GG – Circuit diagram, loan or purchase.

Erskine Oscilloscope Model II W—C. Calvert, 34 Renwick Road, Blyth, Northumberland – Circuit or manual or both, loan or purchase.

Capacitance-Resistance Bridge, Model 34A, Thrush Electrical—A. E. Lelgveld, 2 New Road, Chalfont St. Giles, Bucks – Instruction book (loan or purchase) or any information.

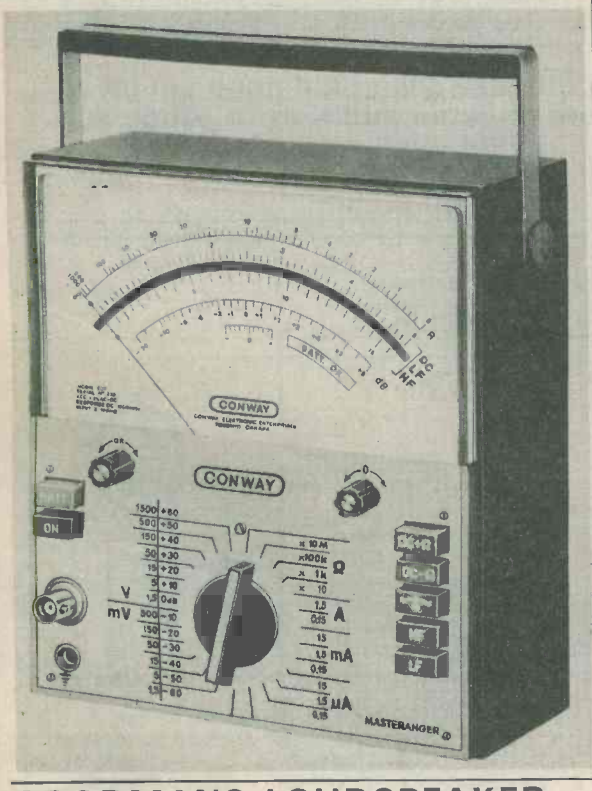
"Crystella" Crystal Controlled F.M. Tuner, Radio Constructor, February and March 1963—B. Hayes, 31 Beverley Crescent, The Headlands, Northampton, NN3 2PY – Loan or purchase.

Transistors Type OM 100 TO 5 can. 10 leadout wires, Type FU 5B 771239/722 TO5 can. 8 leadout wires—H. L. Hammatt 42 Park Avenue, Sittingbourne, Kent – Information required.

New Products

F.E.T. MULTIMETER

This unique 6″ mirror scale solid state F.E.T. Multimeter has a most comprehensive specification, and yet is most competitively priced. The outstanding features of this instrument include: 100 M ohms input impedance on all AC/DC Volt and Millivolt ranges (10 Megohms on AC Millivolts) covering *1.5 mV* to *1,500 volts* in 26 ranges. 150 Nanoamps to 1.5 A self contained in 16 ranges. External shunts to 150 A. F.R. Voltage to *1,000 MHZ* with probe. Taut band suspension. 13dB ranges from –80 to ×66 dBM. Accuracy × or –1.5%. Centre zero switch. "Floating" input facility. Overload protection to 1,200 V on All M.V. & V. ranges. Further details and comprehensive specification from exclusive distributors: Pambry Electronics Ltd., One Chimney, Blackpool Lane, Farnham Royal, Bucks. SL2 3EA.



BATTERY OPERATED SOLDERING INSTRUMENT

A lightweight thermally controlled soldering instrument has been introduced by Adcola Products to operate from a standard car battery.

The new model features a pencil-slim handle moulded in Noryl plastic. The complete tool weighs less than 2oz and features a simple plug in element which can be replaced in 90 seconds.

Two models are available with soldering bit diameters of $\frac{3}{16}$in and $\frac{1}{4}$in, rated at 23 and 27 watts respectively to provide an operating bit temperature of 360°C.

The time taken to heat up to soldering temperature is dependent upon the condition of the battery used as a power source, but the Invader battery model will normally melt solder in a couple of minutes and will reach full operating temperature in less than five minutes.

Crocodile clips are provided at the end of 12ft of pvc cable – impervious to oil, grease and water – for connection to the battery terminals.

The tool is supplied with a fire resistant tubular sleeve which fits over the element and bit. This allows the user to safely replace the soldering instrument in a tool box after use without having to wait for the tip to cool – the sleeve also protects the element in transit.

The Invader $\frac{3}{16}$in diameter bit model BL 646 retails at £2.37 and the larger model BL 1076 for £2.47. Both are available with a red or blue handle. A wide range of standard copper and iron plated long life bits are also available.

GOODMANS LOUDSPEAKER 8/1119

Mullard Ltd., approve and are recommending Goodmans model 8/1119 for use with their UNILEX audio modules, and are publicising this with their booklet "Screwdriver Electronics".

The Model 8/1119, which also usefully serves as a replacement loudspeaker, is available now, supplied with no-solder lead in an attractive display pack designed to match Mullard's UNILEX styling.

Recommended retail price for this speaker is £2.89 including Purchase Tax of £0.49.

The model 8/1119 is an 8 inch full-range loudspeaker with 15 ohm impedance and a magnet with flux density of 10,000 gauss.

SIMPLE RECEIVER MODIFICATION

by

M. J. Powell, B.Sc. (Eng.), GW3IJE

Applying mainly to valve receivers, the idea described here can be fitted as a modification to some sets or as an addition to others.

THE COMMONEST ITEM OF EQUIPMENT TO BOTH THE experimenter and the listener is a receiver. Few experimenters do not possess one of some kind and to the listener it is the focus of his hobby, whether it be a much-modified wartime relic or the latest all-transistor Super DX-Sniffer. The idea to be described can greatly improve the usefulness of many receivers and also increase their flexibility.

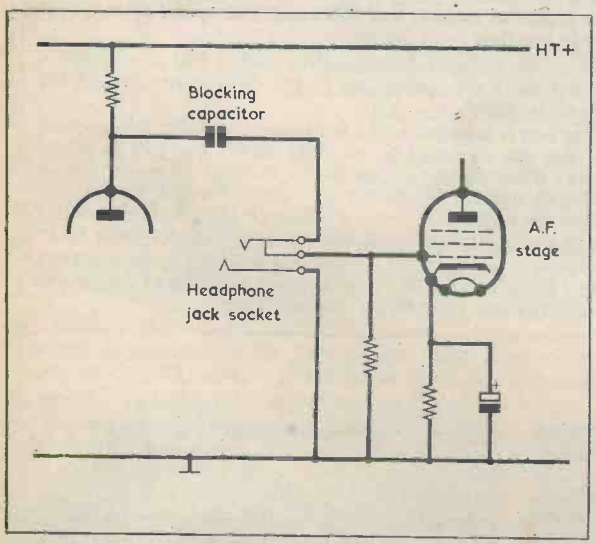


Fig. 1. A commonly encountered headphone output circuit

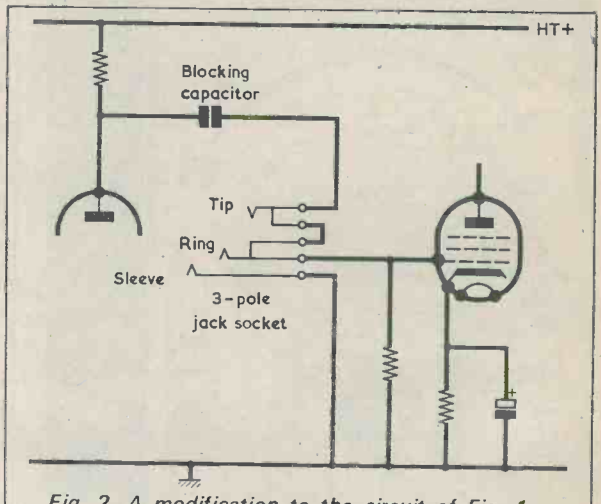


Fig. 2. A modification to the circuit of Fig. 1. A 3-pole socket with break contacts is now added

A.F. ACCESS

Briefly, the scheme makes accessible the input to the a.f. amplifier section of the receiver and allows a number of useful external units to be plugged in when required. Fig. 1 shows a very common method of feeding headphones from a valve receiver. The feed to the grid of the a.f. valve (usually the output valve) is broken by the insertion of the headphone plug, thus muting the loudspeaker and routing the audio signal to the headphones. A 2-pole (unbalanced) socket is normally fitted.

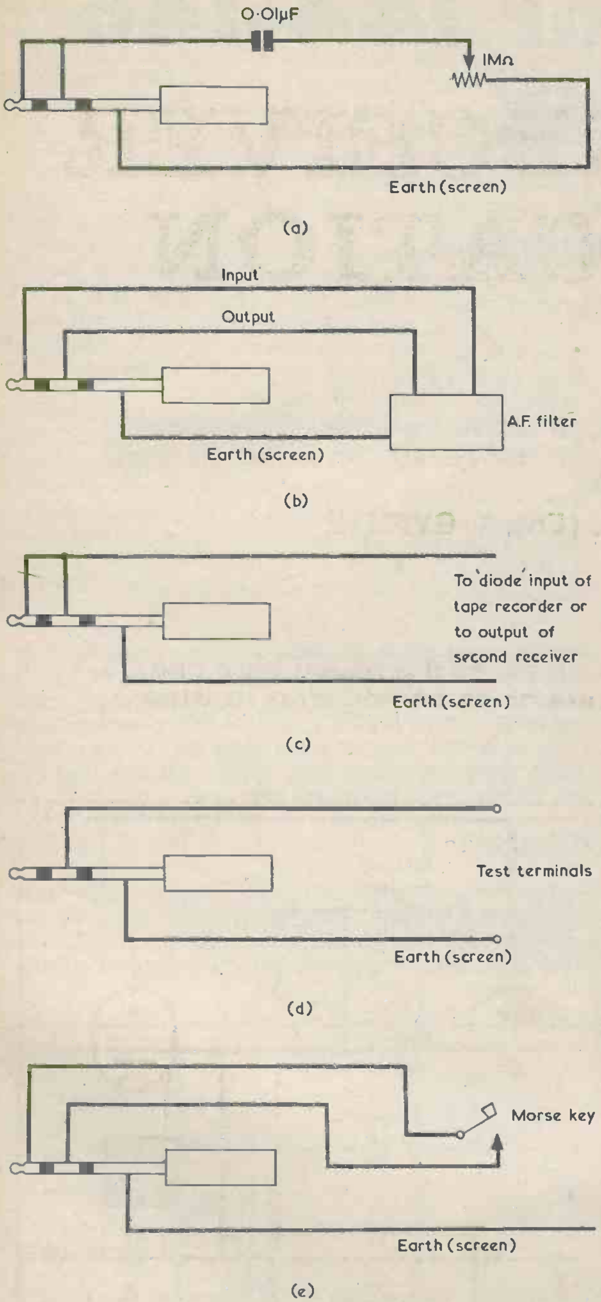


Fig. 3 (a) to (e). Illustrating the facilities offered by the modification. These are all described in the text

Receivers having a headphone socket wired in this manner may be modified by replacing the existing socket with a 3-pole socket and wiring this as shown in Fig. 2. The 3-pole socket can, also, be added to receivers which have alternative headphone output circuits. If the process is one of modification only, it is possible that no drilling will be required as both types of socket fit the same ⅜in. hole, but some cutting may be necessary with some types of war-surplus receiver. All the wires needed are already connected to the existing socket and only a further half-inch of hook-up wire is needed. The live feed is connected to the moving 'tip' contact and the grid to the moving 'ring' contact. The live feed wire is connected at its other end to the existing blocking capacitor and it can be found by inspection. The fixed 'tip' and fixed 'ring' contacts are connected together with the half-inch of hook-up wire. Earth (or chassis) is connected to the moving 'sleeve' contact as before. This completes the changes required when a straightforward modification is involved.

The connections to the new socket are: '*tip*', a.f. output at high impedance; '*ring*', input to an a.f. amplifier at high impedance; '*sleeve*', earth.

EXTERNAL UNITS

A number of useful external units can now be plugged into the receiver, as illustrated in Figs. 3(a) to (e).

1. A simple top-cut tone control, as in Fig.3(a).
2. An a.f. filter, either fixed or adjustable, as in Fig. 3(b).
3. The a.f. output at the jack socket can be applied to a tape recorder, whilst still allowing use of the receiver loudspeaker for monitoring. See Fig. 3(c). This will give better quality recording than is given by connecting the recorder to the receiver loudspeaker terminals.
4. The output of a second receiver monitoring another band or channel can be fed into the receiver for reproduction over the receiver loudspeaker. Fig. 3(c) applies here as well.
5. By switching on the b.f.o. and tuning to an unmodulated carrier a source of tone (available between the jack plug 'tip' and 'sleeve') can be obtained for testing or gain measurement.
6. An a.f. amplifier feeding a loudspeaker is available for bench experiments, the testing of gramophone pick-ups or microphones, and for a.f. probing. In the last case a 0.01μF blocking capacitor should be inserted in the non-earthy test lead. See Fig. 3(d).
7. A morse key for c.w. practice can be plugged in, as in Fig. 3(e). The receiver b.f.o. should be turned on for this application, as with item 5.

A.F. GAIN CONTROL

Most receivers will have their a.f. gain controls fitted before the headphone socket, and this will not be available for use with item 6, although one could easily be provided on the external unit.

The receiver headphones should now be fitted with a 3-pole plug, with the phones connected between 'tip' and 'sleeve'.

All other plugs used with the receiver should be the 3-pole type also. It is sometimes possible to push a 2-pole plug into a 3-pole socket but contact is intermittent and damage to the socket can result. Items 1 and 2 may require headphone operation, in which case a headphone jack socket can be fitted to the external unit itself, wired to break the feed to the a.f. amplifier when a plug is inserted.

Screened wire should be used for all items, particularly for those which feed back into the a.f. amplifier of the receiver.

3-pole plugs and sockets are available from most suppliers of Hi-Fi equipment. ■

Superhet for 144-146 MHz

by

D. F. W. Featherstone

Intended for the more experienced experimenter, this article describes an interesting approach to the reception of v.h.f. a.m. signals.

This superhet was built for listening on the 144–146MHz amateur band. Its actual coverage is a little in excess of 120 to 146MHz, which means that the 144–146MHz band appears with tuning capacitor near the minimum capacitance end of its travel. Constructors may reduce the coverage by employing low values of tuning capacitance but it will probably be better to initially build the receiver with the relatively wide range and then reduce this, if felt desirable, after it has been brought into full working order.

No attempt was made to produce a particularly neat or small receiver, as the prototype was purely experimental. Instead, it was made in three bolt-on sections comprising r.f. stage and local oscillator, i.f. amplifier, and a.f. stage. Even so, the overall size was only 12in. by 4½in, with a maximum height of 3in. It could therefore be housed in a reasonably small case. The total current is 20mA, so it is best powered from a mains-driven source when possible. It was built mainly from the spares box, which indicates that the cost of construction can be kept low.

THE CIRCUIT

The r.f. and local oscillator stages incorporate transistors TR1 and TR2, both functioning in the common base configuration. See Figs. 1 and 2. The value of R1 gives reasonable matching for 75Ω coaxial

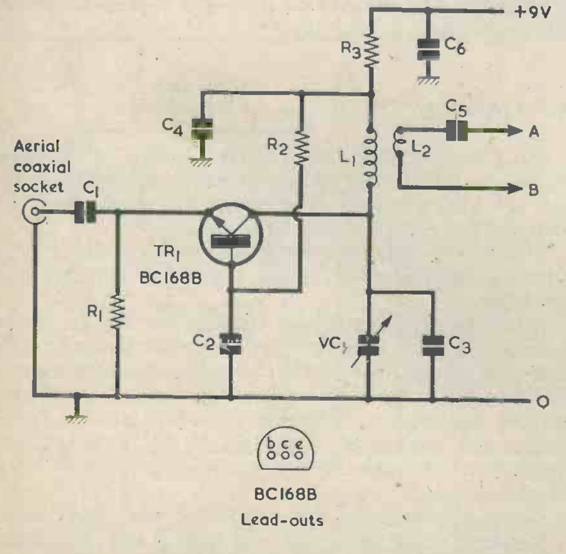


Fig. 1. The r.f. amplifier stage of the receiver

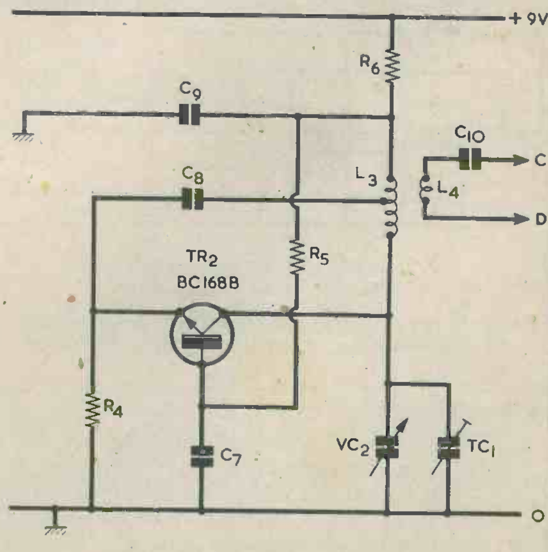


Fig. 2. The oscillator circuit.

cable from a dipole or quarter-wave aerial. The supply current to the r.f. stage is decoupled by R3 and C4, and that to the oscillator by R6 and C9. The values of C4 and C9 are fairly critical as they form part of the associated tuned circuit. The tuned circuit for TR1 is given by L1 and VC1 plus C3 and C4. A secondary coil, L2, couples the signal from TR1 to the mixer via C5.

The local oscillator has a circuit somewhat similar to that of the r.f. stage, with positive feedback from the tapping on L3 applied to the emitter of TR2 via C8.

Both the outputs from the r.f. stage and the oscillator are fed to the mixer in the manner shown in Fig. 3. The pairs A and B, and C and D, each consist of parallel wires about ¼in to ⅜in. apart, and each having a run of about 2¼in. They are earthed to the braiding of a piece of coaxial cable about ¾in. long, which takes their common connection up to the base of the mixer transistor, which is mounted under the i.f. chassis. The short length of coaxial cable provides screening and improves stability.

The circuit of the mixer and i.f. amplifier is very simple, and is given in Fig. 4. Again, the supply to individual stages is decoupled, the decoupling components being R8 and C11, R10 and C14, and R12 and C18. The diode detector develops the audio signal

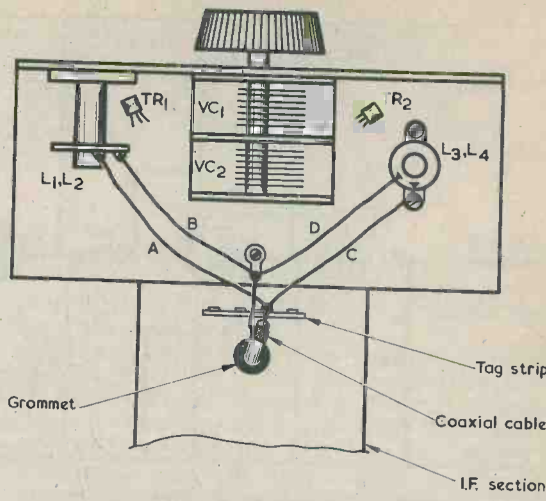


Fig. 3. Practical detail illustrating the manner in which the r.f. amplifier and oscillator are coupled to the mixer transistor in the i.f. section of the receiver

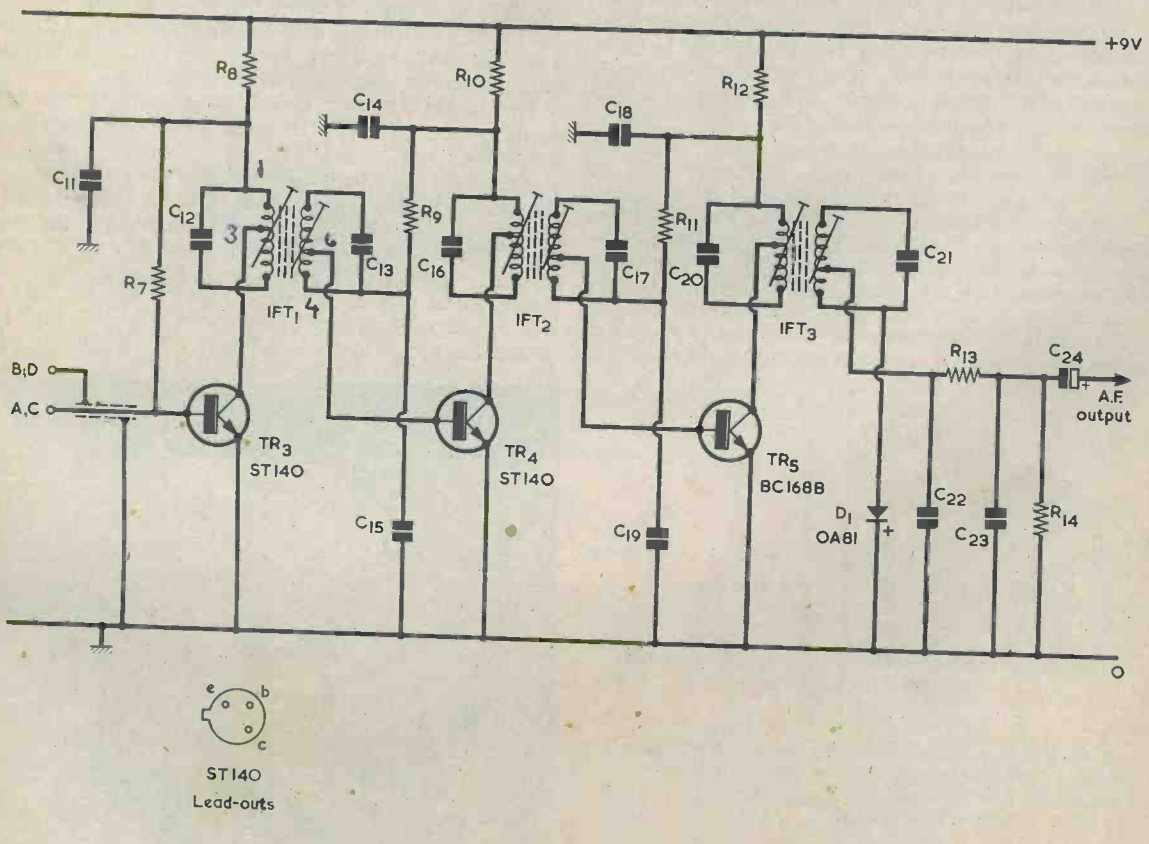


Fig. 4. The i.f. amplifier. All the i.f. transformers are home-wound

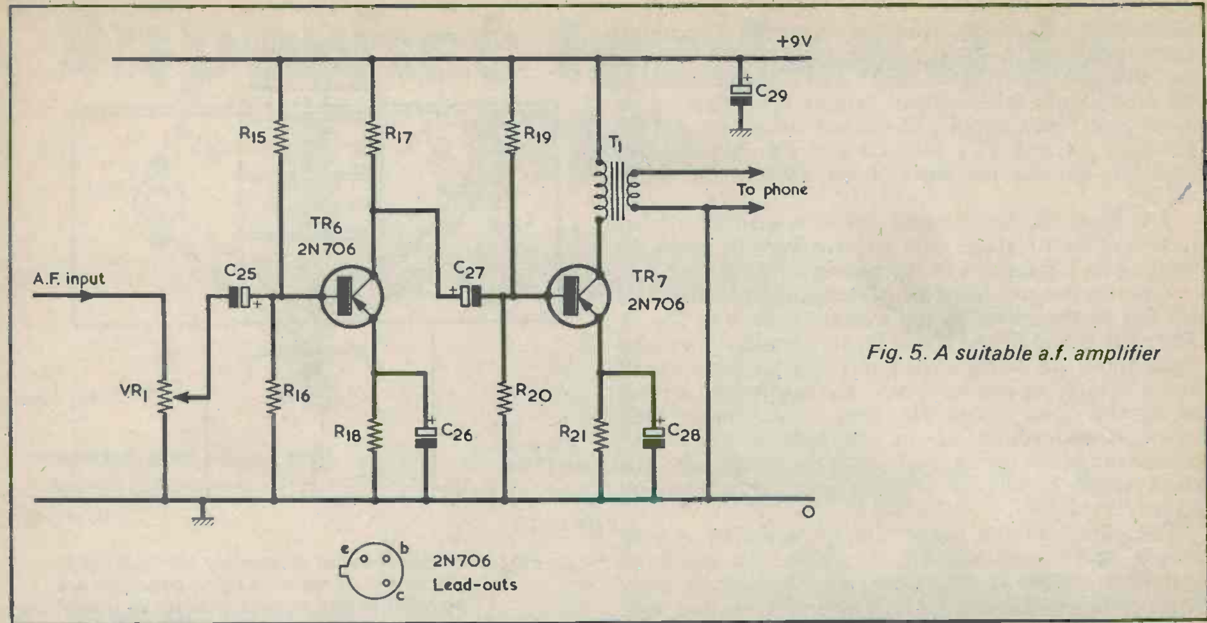


Fig. 5. A suitable a.f. amplifier

across R14. This signal can then be passed to the a.f. amplifier of Fig. 5 for earphone output, or to a more powerful amplifier if a loudspeaker is to be used. In the i.f. amplifier it may be necessary to vary the values of the bias resistors to suit the particular transistors employed. These resistors are R7, R9 and R11. Their values should be such that the voltage drop across the associated decoupling resistor (R8, R10 and R12 respectively) is around 1 to 1.5 volts.

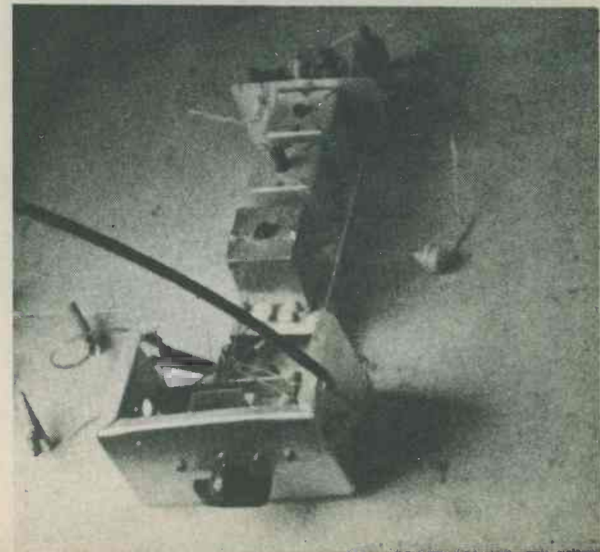
COMPONENTS

In the prototype the tuning capacitor, VC1 and VC2, was salvaged from a transistor medium-wave and v.h.f. f.m. radio. It has two gangs for v.h.f. and two for medium-wave, and the v.h.f. sections only were employed in the receiver with the other sections earthed to the chassis. The capacitor also had two v.h.f. trimmers, but it was found that keeping both in circuit resulted in instability, and only the one in the oscillator section was retained. This is TC1 in Fig. 2. Equivalent results would be given by a 10+10pF 2-gang capacitor with a small 10pF air-spaced concentric trimmer in the TC1 position.

The BC168B transistors specified for TR1, TR2 and TR5 are available from Amatronix Ltd., 396 Selsdon Road, South Croydon, Surrey, CR2 0DE.

Output transformer T1 can be any small type such as the Eagle LT700. It couples into a low impedance earphone.

The coils are home-wound. L1 and L2 can be wound on Denco formers Ref. 450, each fitted with a Denco tag-ring Ref. 6LT/2 for anchoring the wire ends. These coils are not screened and do not have dust cores. L1 consists of 3 turns and L2 of $1\frac{3}{4}$ turns. L3 has $3\frac{1}{2}$ turns, tapped at $\frac{3}{4}$ turn from the R6 end, and L4 has $1\frac{3}{4}$ turns. Spacing is wire width for L2 and L4, and twice wire width for L1 and L3. A suitable wire



The prototype receiver. The r.f. and oscillator section is to the front.

COMPONENTS

Resistors

(All fixed values ¼ watt 10%)

R1	150Ω
R2	470kΩ
R3	1kΩ
R4	390Ω
R5	47kΩ
R6	1kΩ
R7	100kΩ (see text)
R8	1kΩ
R9	100kΩ (see text)
R10	1kΩ
R11	220kΩ (see text)
R12	1kΩ
R13	1.2kΩ
R14	10kΩ
R15	75kΩ
R16	22kΩ
R17	4.7kΩ
R18	1kΩ
R19	22kΩ
R20	8.2kΩ
R21	270Ω
VR1	20kΩ potentiometer, log

Capacitors

C1	100pF ceramic
C2	5,000pF ceramic
C3	4.7pF ceramic (see text)
C4	200pF ceramic
C5	10pF ceramic
C6	5,000pF ceramic
C7	5,000pF ceramic
C8	6.8pF ceramic
C9	100pF ceramic
C10	8.2pF ceramic
C11	0.05μF plastic foil
C12	47pF ± 1pF silvered mica
C13	47pF ± 1pF silvered mica
C14	0.05μF plastic foil
C15	0.05μF plastic foil
C16	47pF ± 1pF silvered mica
C17	47pF ± 1pF silvered mica
C18	0.05μF plastic foil
C19	0.05μF plastic foil
C20	47pF ± 1pF silvered mica
C21	47pF ± 1pF silvered mica
C22	100pF ceramic
C23	500pF ceramic
C24	4μF electrolytic, 4 V.Wkg.
C25	4μF electrolytic, 4 V.Wkg.
C26	10μF electrolytic, 6 V.Wkg.
C27	4μF electrolytic, 10 V.Wkg.
C28	20μF electrolytic, 6 V.Wkg.
C29	50μF electrolytic, 10 V.Wkg.
VC1	VC2 2-gang capacitor (see text)
TC1	Trimmer (see text)

Inductors

See text for details of all inductors.

Semiconductors

TR1	BC168B	TR5	BC168B
TR2	BC168B	TR6	2N706
TR3	ST140	TR7	2N706
TR4	ST140	D1	OA81

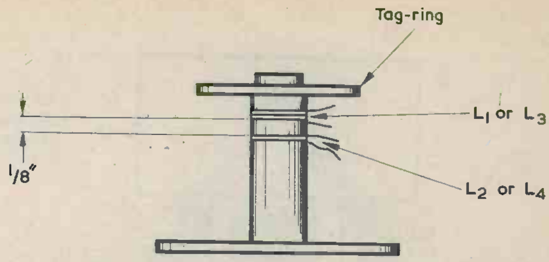


Fig. 6. General appearance of the r.f. and oscillator coils

for all windings is 20 s.w.g. enamelled. A general view of the coils is given in Fig. 6.

The i.f. transformers may be wound on Denco formers Ref. 5007/4PL fitted with insulated top plate Denco Ref. 5001 and screened by Denco screening cans Ref. 5. This type of can is larger than would normally be employed with the former Ref. 5007/4PL and ensures that the inside surface of the can does not too closely approach the transformer windings. Each winding consists of 22 turns of 26 s.w.g. enamelled wire, close-wound with a tap at 5 turns from the earthy end. The earthy ends of each winding are on the inside (i.e. closer to the other winding) and the spacing between windings is 5/16in. See Fig. 7 All windings are tuned by 47pF close-tolerance silvered mica capacitors, which are situated inside the cans. Each winding has a standard 6mm. dust core.

Chassis dimensions and layout are left to the constructor, who may prefer to adopt a more conventional approach than that used by the author. For interest, the basic layout of i.f. stages in the prototype is given in Fig. 8. The components are above the chassis in the r.f. and oscillator section, and below the chassis in the i.f. section. L1, L2 and L3, L4 are mounted at right angles to each other. C6 is mounted in the r.f. and oscillator section. In the i.f. section it is advisable to use one earthing point for all the components of each stage, and to avoid cramping the components too much so that each component can be placed near the chassis.

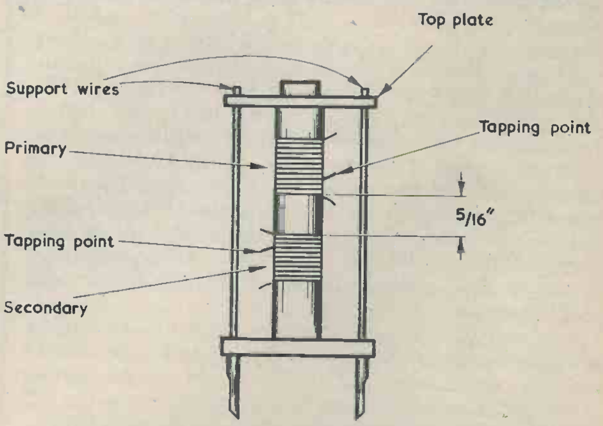


Fig. 7. All three i.f. transformers are wound in the same manner. Also included in each can are two 47pF silvered mica capacitors (not shown here)

ALIGNMENT

Once construction has been completed, circuit checks and alignment can be carried out. Current consumption

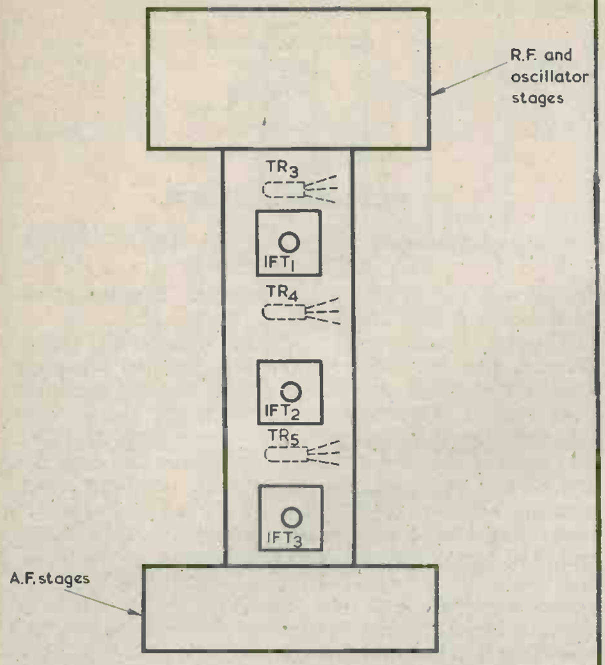


Fig. 8. Stage layout of the i.f. section. All components except the i.f. transformers are below the chassis

from the 9 volt supply should be around 20mA. If the amplifier of Fig. 5 has been incorporated, a finger applied to the non-earthy end of VR1 track should produce a hum at a readily audible level.

The i.f. stages are next aligned, with the aid of a modulated signal generator. Alignment may be carried out aurally or, preferably, by connecting a testmeter switched to read 50μA full-scale across R14. Final adjustments should be made with the signal generator attenuator adjusted such that a low audio output is given or such that the testmeter indicates about 5μA. The signal generator output is applied, via a capacitor of around 300pF, to the base of TR5 for tuning IFT3, next to the base of TR4 for tuning IFT2, and then to the base of TR3 for tuning IFT1. With the signal generator coupled to the base of TR3, all the i.f. transformers are also given a final trim. The i.f. transformers are designed to operate at 10.7MHz, but the actual final frequency is not critical and may be anywhere between 10 and 11.5MHz. The frequency should be one at which the transformers offer a good performance.

The oscillator stage comes next and this should be adjusted such that the 144–146MHz band appears near the low-capacitance end of the travel of the tuning capacitor. This adjustment is carried out with the aid of TC1.

The r.f. stage is next adjusted. Tune in a signal at or near 144 to 146MHz and bring a small dust core in line with L1, L2. If signal strength increases, the value of C3 needs to be made larger. If the dust core causes the signal strength to decrease, reduce the value of C3 and check again. When it is felt that the value for C3 is about correct, 'rock' the tuning capacitor back and forth through the signal, adjusting TC1 slowly until the signal is received at maximum strength. ■

ROAD

by
D.P. Newton, B.Sc.

ENGLISH WINTERS CANNOT BE SAID TO BE SEVERE, and even a midwinter's day may be mild and several degrees above freezing. In many countries with colder climates the weather can be said to be less of a problem than ours as large fluctuations are not the rule. Here, these fluctuations are a hazard in themselves. Driving in daylight may present no problems but, as evening approaches, the temperature can drop rapidly and any thin film of water present on the road turn to ice. Those who drive for long periods of time may begin their journeys in comparative warmth, drive for some time in heated compartments and then fail to notice the rapid change and the ensuing danger.

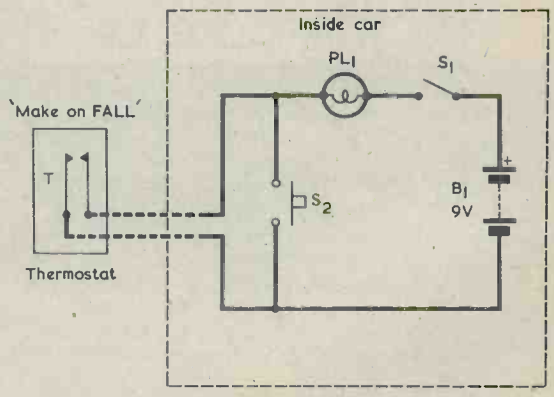


Fig. 1 The simple circuit employed for the warning device

-ICE WARNING

A device which forewarns the driver of the presence of road-ice

TEMPERATURE WARNING

A warning of a fall in temperature is useful and a detector need not be too complex to make. Fig. 1 shows the circuit of an adjustable thermostat which operates a warning light as the temperature falls below a predetermined level.

S1 is the operating switch, T the thermostat connected in the 'make on fall' mode, whilst S2 is a push-button testing switch to guard against failure of battery or bulb. Naturally, the device could be operated from the 12V car battery, in which case a suitable bulb would replace PL1. Since many users may wish to remove the device for the eight ice-free months of the year, the circuit shown is more suitable.

MOUNTING

Some care must be taken in mounting the detector. The thermostat is best fitted remote from the engine and radiator, but it must be accessible to the cold air outside the car. There are various possibilities, such as window mounting, as with parking lights, or mounting behind a bumper. One successful method used by the author was to place the thermostat in the car boot near a drain-hole, remove the plug and insert a rubber tube to deflect air forward as shown in Fig. 2.

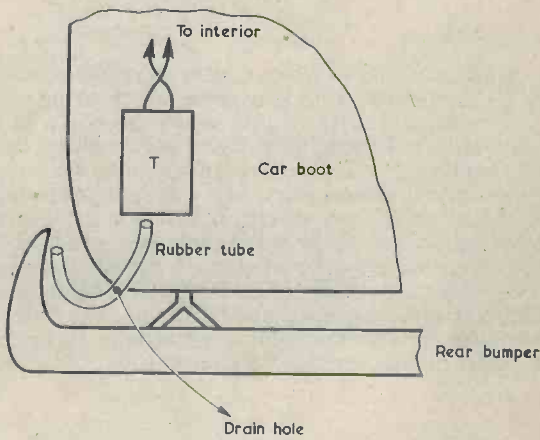


Fig. 2 How the thermostat was installed in the writer's car

COMPONENTS

Thermostat
T Teddington Room Thermostat (see text)
Lamp
PL1 9V bulb and holder (see text)
Switches
S1 s.p.s.t. toggle
S2 push-button
Battery
B1 9V battery (see text)

SETTING THE THERMOSTAT

Adjustment is made by means of a knob on the case side. The thermostat is detecting air temperature which can be about 5 or 6°C *above* road surface temperature so it must be set to operate at say 6°C. Watch for a day when the temperature is falling and adjust the thermostat to operate at ambient temperatures to suit the requirements of the driver.

Together with common sense, this device should prove to be a useful aid.

COMPONENTS

If any difficulty is experienced in obtaining a 9V bulb, a 6V bulb may be employed instead, with a consequent change in battery voltage.

The thermostat is a Teddington Room Thermostat, 0-15°C, Model A4, Code ZG, and is available by mail-order from London Wholesale Warehouse, 165-169 Queens Road, Peckham, S.E.15. ■

DIODE AND HEATER TESTER

by
T. Samuel

A low-cost servicing aid with a surprisingly large number of applications.

MANY BUSY SERVICE WORKSHOPS HAVE ON HAND A home-made continuity tester for checking valve heaters. Testers of this nature employ a series combination of battery, resistor and milliammeter, these being connected to the most commonly used heater pin tags of several valveholders, and they are particularly useful for finding an open-circuit heater in a TV series heater chain. Each valve in the chain is inserted in the appropriate valveholder, whereupon the milliammeter at once indicates whether or not its heater is continuous. This check is much quicker and far less fiddling than the alternative procedure of holding testmeter prods against the heater pins of individual valves in turn.

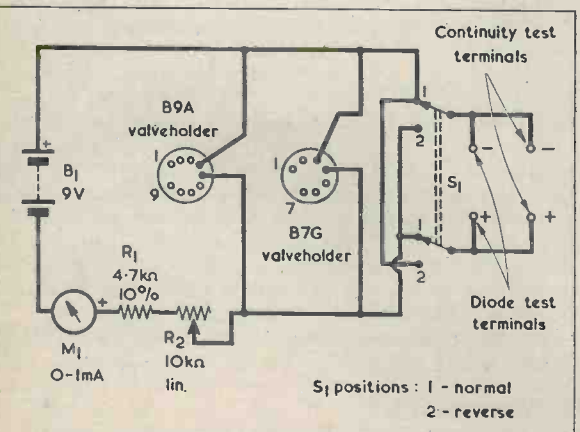


Fig. 1. The circuit of the continuity tester. The additional circuitry resulting from adding switch S1 and the four test terminals allows the tester to check diodes, to measure resistance, and to test for continuity

DIODE TEST

Fig. 1 shows the basic heater test circuit. Here, pins 4 and 5 of a B9A valveholder and pins 3 and 4 of a B7G valveholder are coupled into the series continuity test circuit given by battery B1, resistors R1 and R2 and 0–1mA meter M1. As was just explained, valves to be tested are inserted in either the B7G or B9A valveholder, whereupon the meter gives an indication if the valve heater is continuous and no indication if the heater is open-circuit. There are a few B7G and B9A valve types whose heaters do not appear at the pins indicated, but one soon learns to look out for these when using the heater tester, and to then check against their heater pins with the testmeter prods.

The tester of Fig. 1 offers further facilities, since the test circuit also couples via switch S1 to two sets of test terminals. The first of these are the Diode Test Terminals. The Diode Test Terminals are used for checking germanium or silicon diodes of any type. If the polarity of the diode being checked is known it is applied to the terminals with its cathode (+) end to the positive terminal. If it is a good germanium diode the meter will then give an indication of around 0.97mA. If it is a good silicon diode the meter will read about 0.93mA. S1 is then put to the 'Reverse' position. A good germanium diode will cause either no deflection or a slight deflection in the meter, the latter being a measure of the leakage resistance in the diode. A good silicon diode should cause no deflection at all. If the device is a zener diode with a zener voltage lower than 9 volts, the meter will give a reading corresponding to the zener voltage dropped in the diode at the current flowing. Thus, a diode offering 6.3 volts zener voltage at the current flowing in the circuit will give a reading of around 0.3mA. This is because the diode allows only 2.7 volts to be applied to the effective voltmeter given by M1, R1 and R2 whereupon, since the full-scale deflection of this voltmeter corresponds to 9 volts, it gives a reading of 2.7/9 of f.s.d. A small table, such as that given in

Meter reading (mA)	'Voltmeter' (R_1,R_2,M_1) voltage	Zener diode voltage
0·1	0·9	8·1
0·2	1·8	7·2
0·3	2·7	6·3
0·4	3·6	5·4
0·5	4·5	4·5
0·6	5·4	3·6
0·7	6·3	2·7
0·8	7·2	–
0·9	8·1	–
1·0	9·0	–

Fig. 2. Table showing meter readings for different zener diode voltages, the latter appearing in the third column. The zener diode voltages are equal to 9 volts minus the voltage in the centre column

Fig. 2, enables the meter readings to be translated to volts for evaluating zener diode performance.

If, when S1 is put to the 'Reverse' position with a diode connected the meter continues to show a reading near (or at) f.s.d., the diode under test is short-circuited and should be discarded. The operator's fingers should, incidentally, be kept away from the Diode Test Terminals when the switch is in the 'Reverse' position, as they may cause excessively high leakage current indications to be given.

The tester is particularly useful for checking the polarity and serviceability of unknown 'surplus' diodes. If a diode, when connected, causes little or no reading with S1 at the 'Normal' position but gives a reading in excess of 9.2mA when S1 is in the 'Reverse' position, it is a serviceable diode with its cathode connected to the negative Diode Test Terminal. The tester will also indicate whether the diode is a germanium or silicon device by the magnitude of the meter reading which is given when the diode conducts.

RESISTANCE TEST

The Continuity Test Terminals also appear after switch S1, and these may have two test leads and prods fitted to them, whereupon standard continuity tests can be carried out in normal fashion. The prods may also be used to give an accurate measurement of resistance, using the conversion chart given in Fig. 3. If, when the test prods are applied to a component, the meter gives a reading of 0.75mA, the chart indicates that that component has a resistance of 3kΩ. It should be pointed out that this chart is only accurate when battery B1 gives 9 volts, and should not be relied upon if the battery voltage falls considerably below this level. As a further point, the continuity test prods can be used to check a germanium or silicon diode whilst it is connected in a working circuit, provided that the circuit in which the diode appears does not allow current to flow when the test prods are applied with reverse polarity.

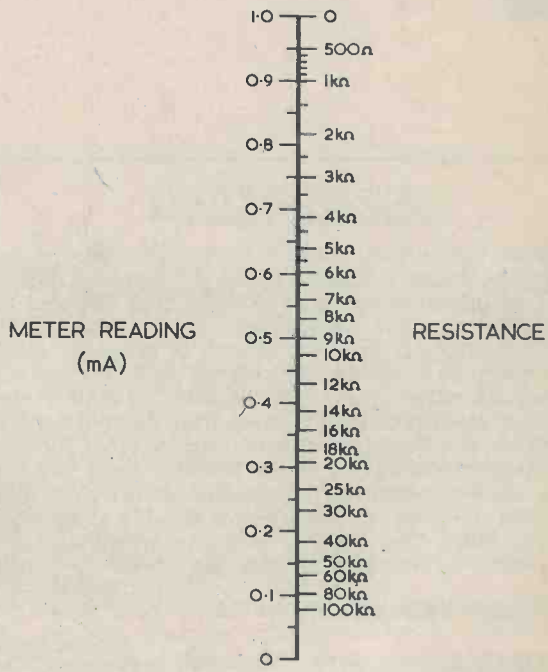


Fig. 3. Chart indicating resistance values corresponding to meter readings

The components for the tester can all be housed in a small wooden case, with the meter, the two valveholders, S1 and R2 mounted on the front panel. S1 may be a d.p.d.t. toggle switch, but it is preferable to use a d.p.d.t. push-button if this can be obtained, the push-button being in the 'Normal' position when released. R2 is fitted with a pointer knob. Before each testing session is commenced, R2 is adjusted to give f.s.d. in the meter when the two continuity test prods are short-circuited together. ■

BACK NUMBERS

For the benefit of new readers we would draw attention to our back number service.
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.
Before undertaking any constructional project described in a back issue, it must be borne in mind that components readily available at the time of publication may no longer be so.
We regret that we are unable to supply photo copies of articles where an issue is not available.
Libraries and members of local radio clubs can often be very helpful where an issue is not available for sale.

INTEGRATED CIR

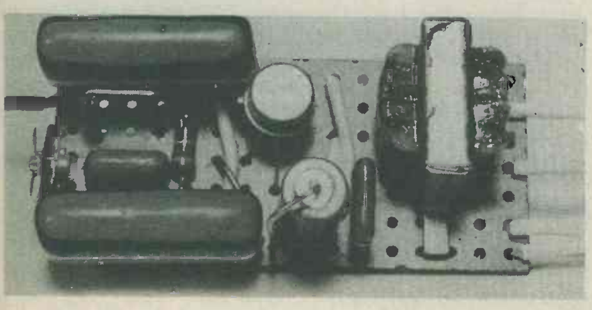
Designed around the readily availa
amplifier is built up on the free V
It offers a high level of perform
ponents are needed in

THE VEROBOARD PROJECT TO BE DESCRIBED IN THIS article is an integrated circuit a.f. amplifier offering an output in excess of 300 mW. It is intended for coupling to a 3 Ω loudspeaker. The input impedance of the amplifier is 50k Ω and it is primarily suited for use as an amplifier following the diode detector of a transistor radio tuner. In fact, it offers the same level of amplification as do the a.f. stages, from diode detector to speaker, of a standard transistor radio receiver. It can be coupled to the output of the Radio 2 tuner which is described elsewhere this month, whereupon the two units form a complete receiver which is capable of driving a loudspeaker. The amplifier may also be coupled to a crystal or ceramic pick-up cartridge.

INTEGRATED CIRCUIT

The integrated circuit employed in the amplifier is the R.C.A. CA3020. This is in a T05-type can and has 12 lead-outs equi-spaced in a circle. The amplifier is fed by a 9 volt battery, from which it draws a quiescent current of slightly in excess of 20mA. The current rises, in usual Class B fashion, on a.f. peaks.

To understand how the amplifier works it is first of all necessary to quickly examine the internal circuit of the CA3020. This is illustrated in Fig. 1. The input to



The i.c. a.f. amplifier. Few components are required external to the integrated circuit

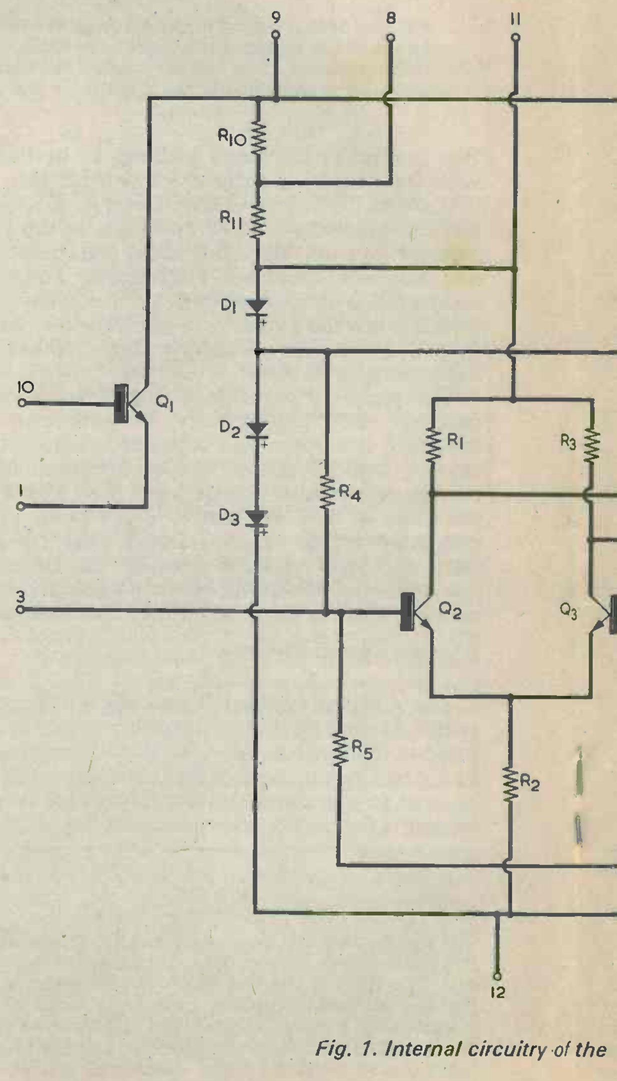


Fig. 1. Internal circuitry of the

NTEGRATED CIRCUIT A

Designed around the readily available R.C.A. CA3020 i.c., this a amplifier is built up on the free Veroboard presented this mont It offers a high level of performance, and relatively few com ponents are needed in its construction.

ESCRIBED IN THIS
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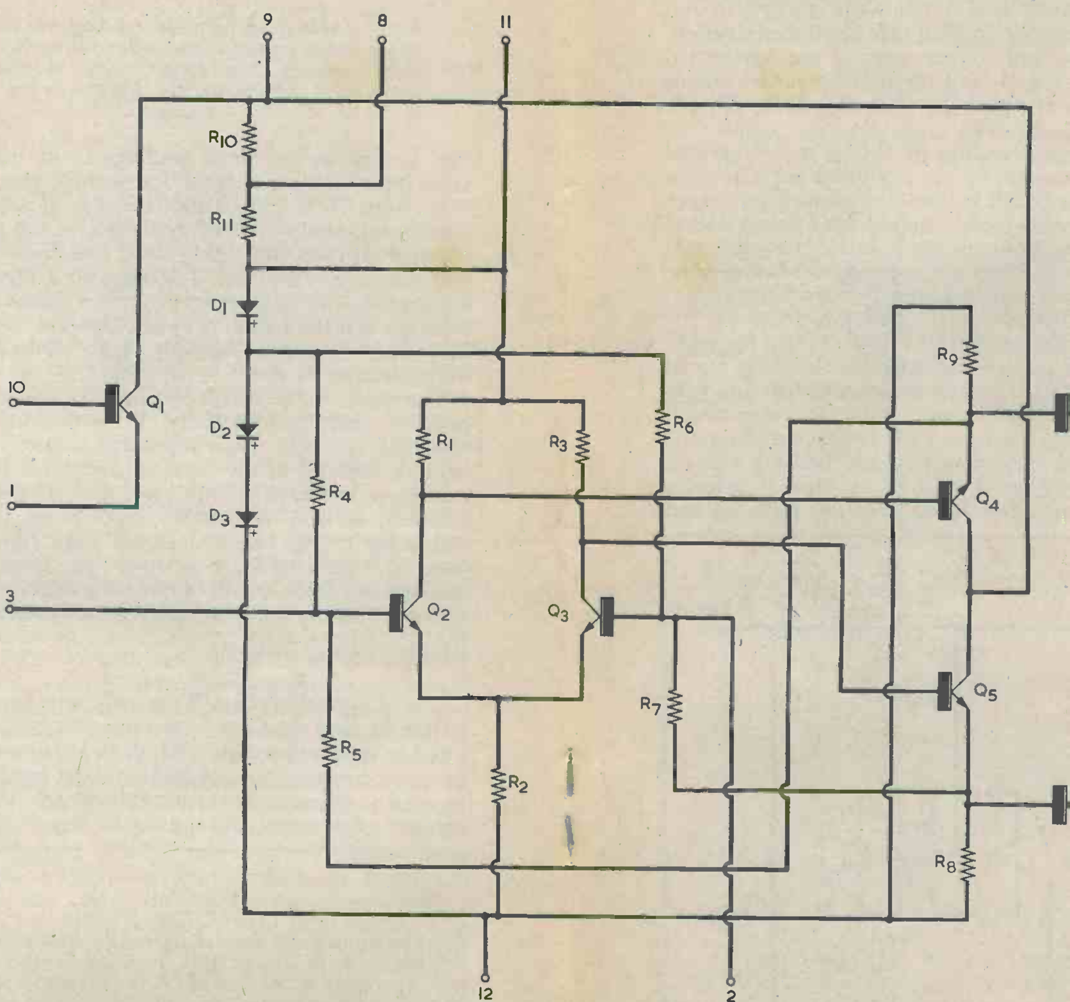
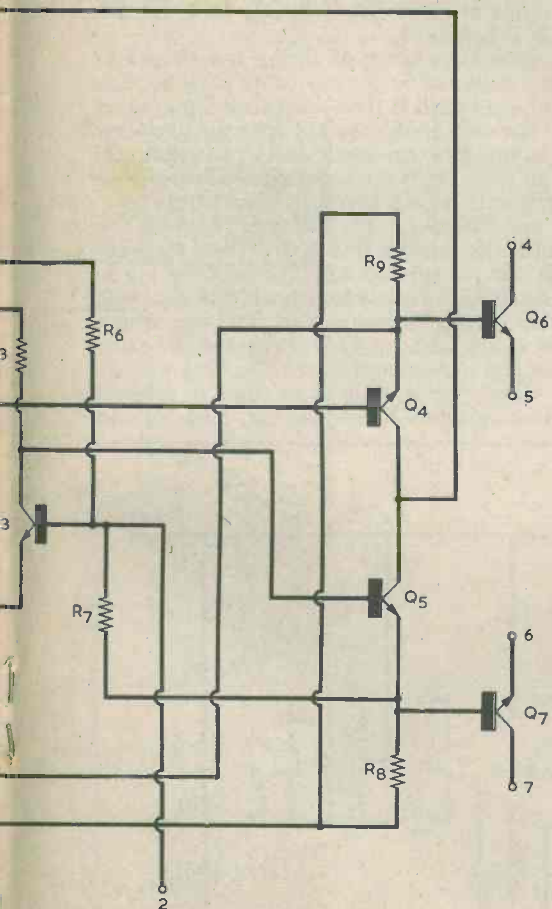


Fig. 1. Internal circuitry of the CA3020 integrated circuit

RCUIT AMPLIFIER

ailable R.C.A. CA3020 i.c., this a.f. e Veroboard presented this month. ormance, and relatively few com- in its construction.



the CA3020 integrated circuit

COMPONENTS

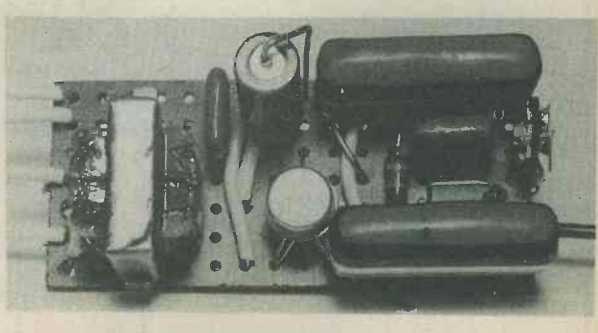
Resistors
R1 470kΩ ¼ watt miniature 10%
R2 270Ω ¼ watt miniature 10%.
VR1 5kΩ miniature skeleton preset potentiometer (Home Radio Cat. No. VR100B) or standard potentiometer, log track.

Capacitors
(All non-electrolytic capacitors Mullard Miniature Foil type C280)
C1 1μF.
C2 0.1μF.
C3 0.01μF.
C4 1μF.
C5 125μF 10V Wkg., Mullard Miniature electrolytic.

Transformer
T1 Output transformer type T/T2 (R.S. Components)

Integrated Circuit
IC1 Integrated circuit type CA3020 (R.C.A.).

Miscellaneous
Veroboard, 0.15 in. matrix, 7 strips by 16 holes.
3Ω speaker.
9 volt battery.
Flexible screened cable.



The integrated circuit amplifier, photographed from the other side of the board the i.c. amplifying section proper appears at terminal 3, which couples to the base of transistor Q2. This transistor and Q3 form a differential pair. If the base of Q3, at terminal 2, is held at earth potential for a.f., Q2 and Q3 provide phase-splitting. Their collectors are coupled to two driver transistors, Q4 and Q5, the latter coupling, in turn, to the output transistors Q6 and Q7. Negative feedback, both at d.c. and at a.f., is provided by way of R5 and R7. The output transistors should feed, at terminals 4 and 7, into a load of approximately 130Ω.

The input impedance at terminal 3 is 700Ω only. Since this is too low for most applications a separate emitter follower, Q1, is included in the i.c. package. An input may then be fed in at terminal 10, and an output taken from terminal 1 for application to terminal 3. The input impedance at terminal 10 is the 50kΩ figure mentioned earlier.

In the Veroboard amplifier the CA3020 appears in the circuit shown in Fig. 2. Here, the input signal is applied via C1 to terminal 10, whereupon it reappears, at lower impedance, at terminal 1. After passing through the volume control circuit around VR1, the signal is fed to terminal 3 and, thus, to the main amplifying section of the CA3020. The output, from terminals 4 and 7 feed a 6.6:1 centre-tapped output transformer which, when a 3Ω speaker is connected to its secondary, presents a calculated primary impedance of 131Ω

Terminal 2 of the i.c. is taken to the negative supply line via the large-value capacitor C4. This holds the base of Q3, inside the i.c., at earth potential for audio frequencies. The emitters of Q6 and Q7, at terminals 5 and 6, connect directly to the negative supply line, as also does terminal 12. Terminals 9 and 8 connect to the positive supply line. No connection is made to terminal 11.

A high value electrolytic capacitor, C5, connects across the supply lines. This prevents distortion which would otherwise occur if the internal resistance of the supply battery were to rise to a high value as it aged.

As will be seen, the overall amplifier circuit requires very few components as compared with an amplifier of similar performance incorporating discrete semiconductor components. It is desirable for the two 1μF capacitors, C1 and C4, to be non-electrolytic types. These are Mullard Miniature Foil capacitors type C280, and they can be accommodated quite comfortably on the Veroboard. C2 and C3 are also type C280, whilst C5 is a Mullard Miniature electrolytic. (The Home Radio Cat. Nos. are 2EJ04 for the 1μF capacitors, 2EH49 for 0.1μF, 2EH43 for 0.01μF and 2CH60 for the 125μF capacitor.) The two fixed resistors are miniature ¼ watt components of the same type as are employed in the other Veroboard projects described this month. VR1 may, as in the prototype illustrated, be a miniature preset skeleton potentiometer (Home Radio Cat. No. VR100B), or it can be an external standard-size knob-operated log track potentiometer mounted separate from the board and coupled to it by short leads. The choice here rests with the constructor.

CONSTRUCTION

Before commencing details of construction the reader is warned that the threading of the CA3020 lead-outs through the appropriate holes in the Veroboard is rather a ticklish task, especially for those who are not used to carrying out fine work. If the instructions to be given shortly are followed carefully, the i.c. lead-outs can be fitted correctly in less than a minute or two, but the operation does require both care and concentration.

The component and copper sides of the Veroboard are illustrated in Fig. 3, and the first operation entails cutting the strips at holes C3, C13, D8, D14, E3, E8, E11, F8, F14, G4 and G8.

The next process consists of fitting the integrated circuit. This is mounted before any other parts because the surface of the board is then uncluttered and easier to work on. The only tools required are a small pocket screwdriver having a narrow blade and a rule graduated in tenths of an inch. Pliers are not needed because none of the i.c. lead-outs is bent abruptly. Apart from lead-out 11, they are all *eased* to the positions required.

The i.c. should be held, as in Fig. 4(a), with the lead-outs towards the reader and with the locating lug at the left. Lead-out 12 is exactly in line with the lug, with lead-outs 1, 2, 3, etc., following it in clockwise order. (If any doubt exists, lead-out 12 is connected internally to the i.c. can and may be verified by checking with an ohmmeter.) Gently bend lead 11 so that it projects outwards. No connection is made to this lead-out and

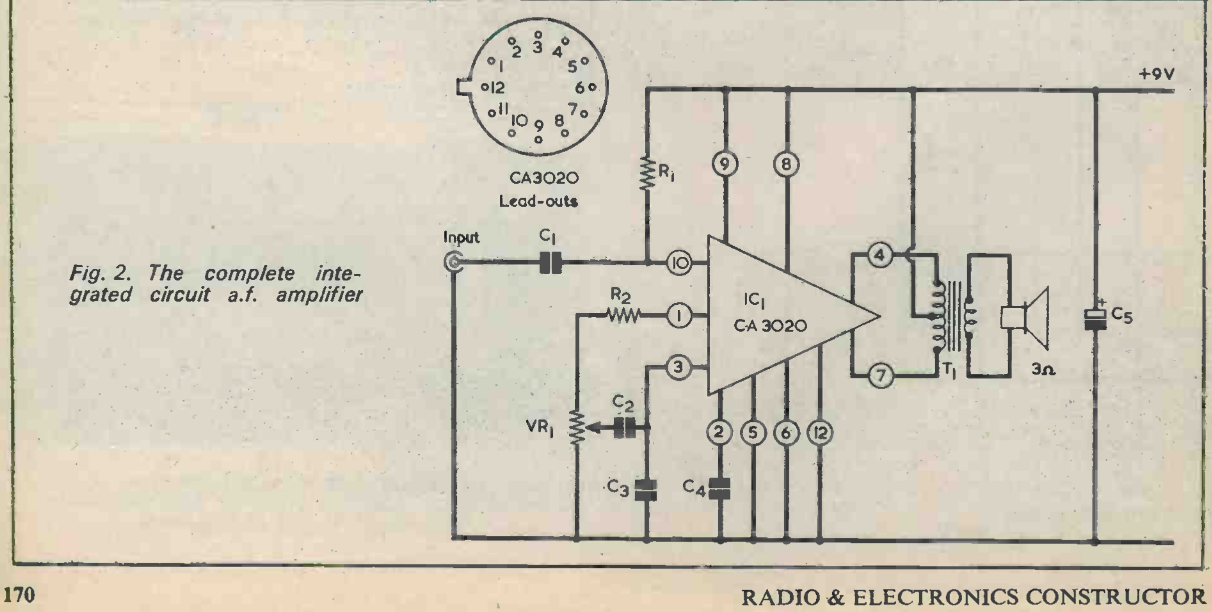


Fig. 2. The complete integrated circuit a.f. amplifier

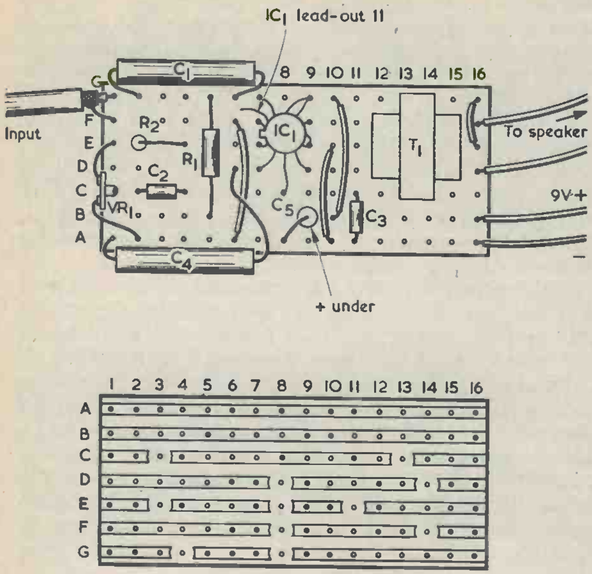


Fig. 3. The component and copper sides of the amplifier board

it does not pass through the board. When bent outward it provides a useful 'marker' for identifying the remaining lead-outs. Next, *gently* splay out the remaining lead-outs so that their *ends* take up, approximately, the positions shown in Fig. 4(a). The ends then conform with the hole positions in the Veroboard through which the wires will pass. Note that lead-outs 5 and 6 will both pass through a single hole, as will lead-outs 8 and 9.

Next examine Figs. 4(b) and (c). Fig. 4(b) shows the i.c. connections below the board whilst Fig. 4(c) illustrates the connections above. As will be noted, the i.c. lead-outs straddle vertical line 8, with the exception of lead-out 3 which passes through hole C8. Working from Fig. 4(c) and keeping the flat top of the i.c. parallel with the plane of the board, apply the i.c. lead-out ends very lightly to the non-copper side of the board, which should be spaced off from the surface of the bench. Once again, lead-out 11 proves helpful here and acts as a 'marker'. The lead-out ends should already be in approximately the correct positions for the holes through which they will pass. Gently ease into their holes the lead-outs which first come into contact with the board, these being lead-outs 1, 12, 7, 5 and 6. Help these into their holes with the aid of the screwdriver blade. Then bring the i.c. body fractionally closer to the board, easing in lead-outs 10, 8, 9, 4 and 2. With all these lead-outs in their correct holes, the i.c. is brought fractionally closer again and lead-out 3 is finally passed through its hole. As soon as every lead-out has been passed through its correct hole, bend over the ends of lead-out 1 (or 12) and 7 (or 5, 6) on the copper side of the board so that the i.c. is prevented from coming out again.

An important point to bear in mind whilst carrying out the insertion of the i.c. lead-outs is that at no time must the i.c. body be pressed down so hard that one of the lead-outs gets bent. The i.c. case should be held down with feather-light pressure. The final spacing between the upper surface of the board and the under surface of the i.c. body is such that just sufficient of lead-out 3 passes through hole C8 to enable a satisfactory solder joint to be achieved at this point.

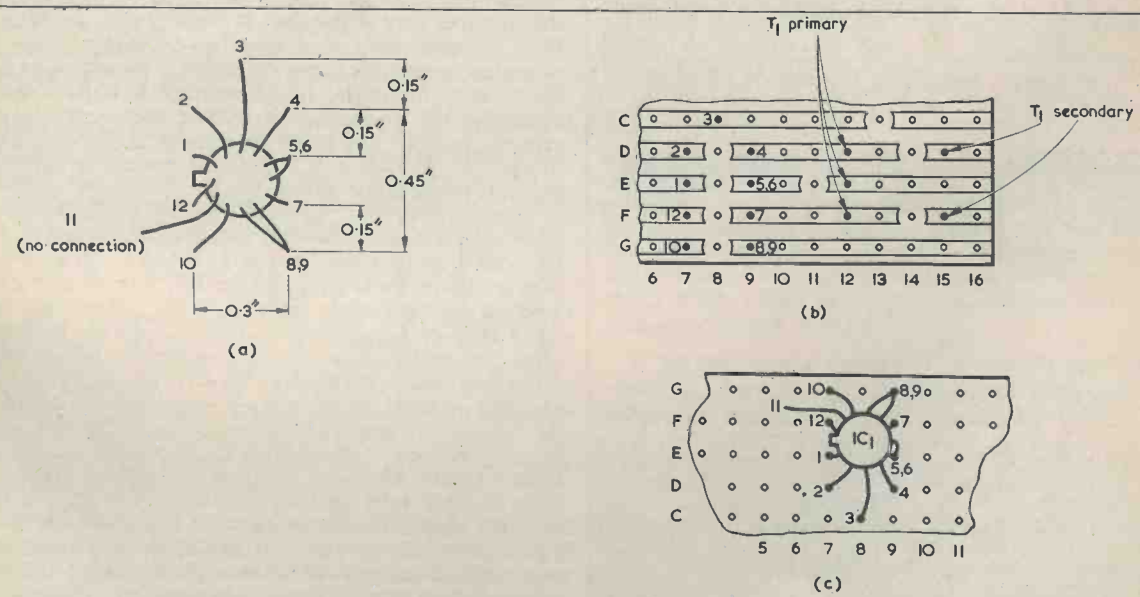


Fig. 4 (a). Before insertion, the lead-outs of the i.c. are gently splayed out so that their ends take up approximately the positions shown here
(b). Connections on the copper side of the board for both the i.c. and the output transformer
(c). Integrated circuit lead-outs above the board

All the i.c. lead-outs may now be soldered to the appropriate copper strips.

Next, take up transformer T1 and refer to Fig. 4(b). This diagram also shows the connection points for T1 primary and secondary. First, bend out the mounting lugs of this transformer and then check that it can be fitted to the board by passing its primary spills through holes D12, E12 and F12 and its secondary spills through holes D15 and F15. It will probably be found that it is necessary for the spills to be bent in slightly to enable them to pass through the appropriate holes. Pass the spills through the Veroboard holes just sufficiently far to enable satisfactory solder joints to be made, then solder all five spills to the appropriate copper strips.

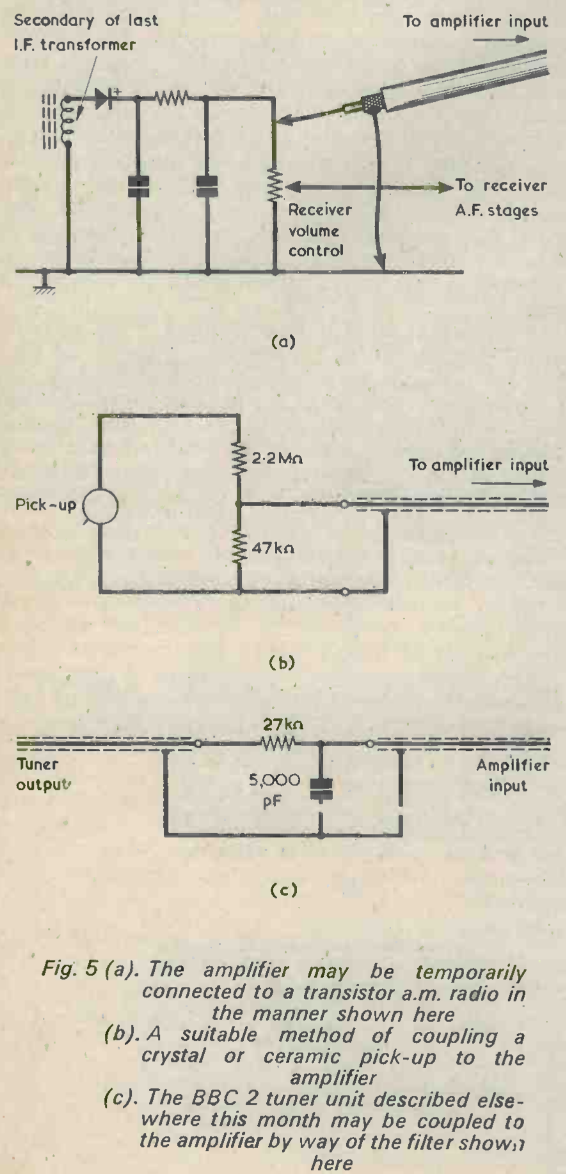


Fig. 5 (a). The amplifier may be temporarily connected to a transistor a.m. radio in the manner shown here
(b). A suitable method of coupling a crystal or ceramic pick-up to the amplifier
(c). The BBC 2 tuner unit described elsewhere this month may be coupled to the amplifier by way of the filter shown here

The transformer is not pushed up tight against the Veroboard and it will be held quite securely by the solder joints at its spill ends. Take care, whilst handling the transformer, not to damage the fine winding wire which connects to the upper ends of the spills.

For the rest of the assembly we return to Fig. 3. Fit an insulated link wire between holes G16 and E16, positioning this so that hole F16 is left clear. Similarly fit an insulated link wire between F6 and A6, leaving access free to hole D6. Fit insulated links between G10 and B10, and between E10 and A10. Fit R1, C2 and C3, then R2 (vertical) and C5 (vertical). The positive lead-out of C5 connects at hole B9.

If the preset skeleton potentiometer volume control is to be used, fit and solder its central slider tag to hole C1. Its two outside tags then project over the edge of the board. Using thin bare wire and following Fig. 3, connect one of the outside tags to hole E1 and the other to hole A2. Ensure that there is no risk of short-circuit between the outside tags and the ends of strips B and D. Should an external standard potentiometer be used, connect its slider to hole C1, the outside tag at the minimum volume end of its track (spindle fully anti-clockwise) to the hole A2 and the other outside tag to hole E1. An external volume control should be connected to the board with short leads. The skeleton potentiometer mounted on the board gives full volume, incidentally, when it is rotated fully *anti*-clockwise.

Next fit C1 and C4. Their positions are best adjudged from the photographs since, for clarity, Fig. 3 shows them displaced slightly outwards. At this stage, check that lead-out 11 of the CA3020 is not making contact with any other wire or conductor. There is plenty of space for this lead-out to project sideways and there is no necessity to cut it off.

Take up a length of screened cable and connect its central wire to hole G1 and its braiding to F1. Connect the two speaker wires to F16 and D16, the positive supply wire to B16 and the negative supply wire to A16.

Assembly is now complete and, after a visual check, the amplifier may be tried out, preferably with the output from a tuner unit. If a superhet transistor radio is available, a suitable input signal may be obtained by temporarily connecting the screened cable to its volume control in the manner shown in Fig. 5(a). A crystal or ceramic pick-up has to be connected to the amplifier by way of a matching attenuator circuit, a suitable example being given in Fig. 5(b).

The amplifier may be employed with the Radio 2 tuner which is also described this month. However, the integrated circuit offers greater gain to r.f. signals than does a conventional a.f. amplifier and it is necessary to insert a filter between the two units. Otherwise, the small level of r.f. present in the tuner output receives excessive amplification by the integrated circuit and distortion results. A suitable filter circuit is illustrated in Fig. 5(c). In most instances it will be possible to operate the tuner and the amplifier from the same battery, and this can be done by connecting the two positive battery leads together. The tuner negative battery lead need not then connect into circuit because it will receive its negative supply via the braiding of the screened leads joining the tuner output to the amplifier input. In instances where the tuner receives a weak signal and the amplifier gain control has to be turned to a high level it may be found that the lack of decoupling between the two results in slight distortion. Under such circumstances the two units require separate batteries. ■

Trade News . . .

FLAME RETARDENT CASE FOR TV DELAY LINE

The need to build safety into television sets at every possible level is being increasingly recognised. A hazard demanding particular attention is fire, and components enclosed in flame retardent cases make a valuable contribution to fire prevention. A typical example is ITT's TAU 40 delay line for colour television.

This miniature glass delay line is used to eliminate colour distortion in PAL colour receivers. It has been approved by major colour television manufacturers throughout Europe and is in large scale production at ITT Components Group Europe's Quartz Crystal Division at Harlow, Essex.

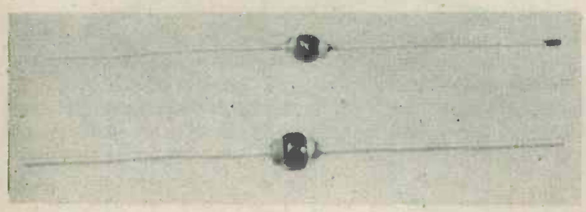
The TAU 40 meets all manufacturers, specifications and is in a specially-designed flame retardent encapsulation. In the device an electrical signal is transformed into a mechanical vibration through a transducer.

The mechanical vibration passes through a 1 mm thick piece of glass, is reflected five times and then passes out through another transducer as an electrical signal. The signal takes exactly 63,943 μs to travel through the glass.

Weighing only 17g compared to its 120g predecessor, the TAU 40 is also only one tenth the volume of the previous model of delay line.

For further information contact ITT Components Group Europe, Quartz Crystal Division, Edinburgh Way, Harlow, Essex.

SOLID-DIELECTRIC DIODES



Solidev Ltd., have just announced the types BF4, BF5 and BF6 solid-dielectric diodes in their "Solitrode" series of rectifiers. The three types provide current ratings of 1, 2 and 3 A and are each available in eight versions for peak-inverse-voltages of 50 to 1200V, and they can withstand current surges as high as 40, 60 and 80 A (of 8.3-msec duration).

The devices exhibit a leakage current at the rated p.i.v. of only 5 μA at 25°C, derating to 100 μA at 100°C. Fan cooling at 25°C can increase the maximum average d.c. current ratings from 1 to 1.5 A, 2 to 3 A and 3 to 4.5 A.

The Solitrode diodes are available in stud packages measuring less than 6.5 mm (0.25 in.) long by 3.5 mm (0.14 in.) in diameter and fitted with silver leads.

Further details from: Solidev Ltd., Tubs Hill House, North Entrance, London Road, Sevenoaks, Kent.

COUTANT ELECTRONICS EXPAND AUTOMATIC TEST FACILITIES FOR POWER SUPPLIES.

Coutant Electronics have expanded the automatic power supply test facility at their Ilfracombe, North Devon, manufacturing plant with the construction of a unique system which tests all main parameters of a power supply. Known as DAPHNE 2, it complements the earlier DAPHNE 1 automatic tester which is still in use.

The automatic equipment is used to test all standard and special custom-designed power units as well as to test the reliability and main operating parameters of new units under development. The tests applied check the output voltage, regulation of voltage and current for load and input voltage changes, and the overload current trip. Overvoltage protection can also be tested and the ripple is displayed on an oscilloscope.

Test results are printed out while the tests are being performed, the print-out constituting a validated record of the quality of the unit which is acceptable by many customers as a test certificate.

Tests are applied under worst case conditions and in a manner which detects faults which are not normally detected by manual methods. For example, on load and line current and voltage regulation tests, the load resistance is switched abruptly from zero to 100% and the in-

line current and voltage regulation tests, the load resistance is switched abruptly from zero to 100% and the in-**put voltage is switched abruptly from –10 to +10%. the transients and step waveforms generated in this manner detect any tendency to oscillation of the control circuit and the sharp rise in voltage can cause the breakdown of faulty joints which could otherwise remain undetected until after the unit is in service.**

A further unique feature is a built-in backing-off circuit which produces an output voltage and current to balance the output from the power unit under test.

ELECTRIC ART MOBILE

Make your own mini-psychedelic light display with the aid of a few low-cost components.

by
D. P. Newton, B.Sc.

BIMETALLIC OR 'FLASHER' LIGHT BULBS HAVE EXISTED for some time. Their uses range from warning lights to Christmas tree lights but, where any accuracy in time of flash is required, their dependency on ambient conditions precludes their use. This device is often scorned, therefore, in favour of more complex circuitry, but its unpredictability can be put to use. A simple, attractive 'art mobile' is one example.

BRIDGE NETWORK

The basic unit consists of four bulbs in a Wheatstone bridge network as in Fig. 1. The galvanometer is replaced by a short-circuit, XY, which carries no current when all bulbs are lit and the bridge is 'balanced'. Suppose A goes out, then B carries an increased current via XY so it goes out and consequently C and D go out. However, A re-establishes itself, bringing C and D back on and from here, individual variations in resistance and structure make the bulbs flash in an unpredictable manner.

The bulbs are most easily available as the control 'flasher' for Christmas lights. Various colours can be made or bought and this adds to the attraction. The effect is improved when the bulbs are behind a trans-

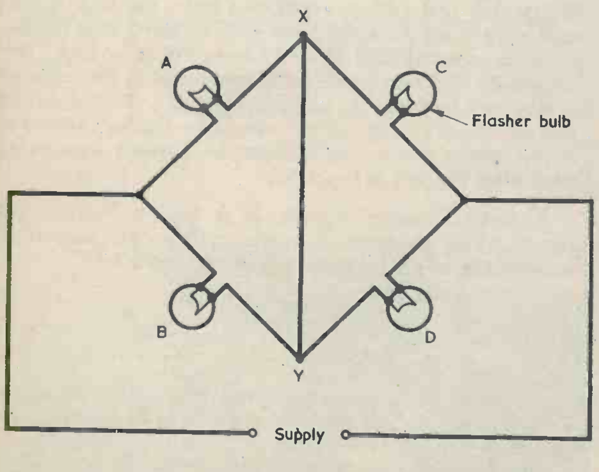


Fig. 1. The circuit of the electric art module. The four bulbs light up in a random and unpredictable manner

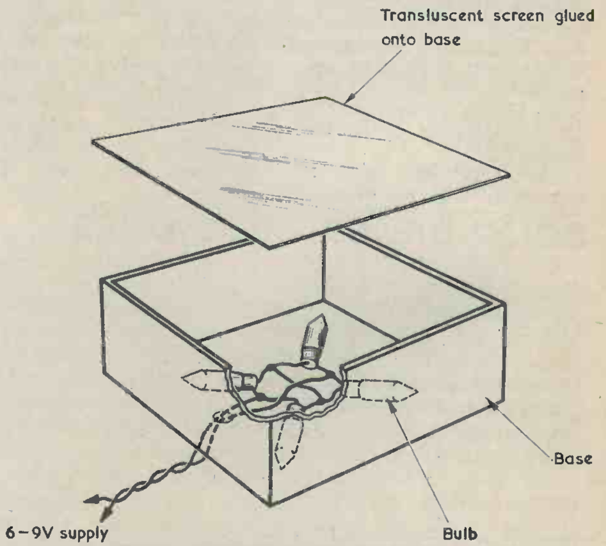


Fig. 2. How the bulbs may be arranged to allow diffused colour overlap

lucent, light-diffusing screen such as 'frosted' glass or clouded Perspex or plastic. If the unit is enclosed as in Fig. 2, the overlap of colour becomes apparent and attractive.

Larger displays are made by connecting in parallel units wired as in Fig. 1. Sometimes one bulb may differ radically in resistance from the rest. In this case it is best to replace it as it can become a controlling bulb which does not allow the rest to warm up. Before any change is made, however, the unit should be allowed to operate for a few minutes as it may take time for the 'randomness' to begin.

The components required for the circuit of Fig. 1 are four 6 volt flasher bulbs, together with a supply offering 6 to 9 volts.

The writer obtained his bimetal lamps at a Halford's store, where they are sold, on individual cards, as flasher lamps for Christmas tree lights. The type he employed is specified as '6 volt' and is intended for use with a 40-light set. The bulbs are available in various colours and the author is assured that they are on the standard stock list of all Halford's shops as well as many others. ■

Notes for Newcomers

Compiled by our Editorial Staff, these notes provide information on on points which tend to puzzle readers who are just embarking on the hobby of radio construction.

As is evident from the correspondence received by the Editorial Staff of *Radio & Electronics Constructor*, we continually attract new readers who are interested in the hobby we represent, but who are not aware of some of the more basic details which form an essential part of that hobby. These notes should assist in providing the background required.

RESISTORS

A component which causes quite a little confusion is the humble fixed resistor. This is a component whose function is to present a fixed resistance having a value measured in *ohms* (Ω), in *kilohms* (kΩ) or in *megohms* (MΩ). Kilohms are thousands of ohms, and megohms are millions of ohms. The value of 1MΩ may also be referred to as 1,000kΩ or 1,000,000Ω; but it is most convenient to use the term '1MΩ' as this is shortest. It is similarly more convenient to refer to 1kΩ than to 1,000Ω. If necessary, we use the term 'fixed' to differentiate a fixed resistor (whose value is not supposed to alter) from a 'variable resistor' or 'potentiometer' (whose value can be deliberately made to alter). The symbol for a fixed resistor is shown in Fig. 1(a), that for a variable resistor in Fig. 1(b), and that for a potentiometer in Fig. 1(c). A preset variable potentiometer is shown in Fig. 1(d). Commonly, the term 'potentiometer' is used for the component represented by Fig. 1(b) because this device will, in practice, almost certainly have a solder tag or other form of terminal at the unused end of its track, even if no connection is made to that tag. The 'track', as indicated in Figs. 1(b) and (c), is the resistive path along which the 'slider' travels, and the quoted value of the variable resistor or potentiometer is the total resistance of this track. In some instances, the track offers a change of resistance which is proportional to slider rotation; this is described as a 'linear' track. In other instances, the track resistance has a 'tapered' characteristic, the resistance changing relatively slowly per degree of slider rotation at the anticlockwise end of the track and relatively quickly per degree of slider rotation at the clockwise end of the track. This is known as a 'log' (short for 'logarithmic') track. Log track potentiometers are commonly used for volume controls, since the sensitivity of the ear to audible sound level follows a logarithmic law.

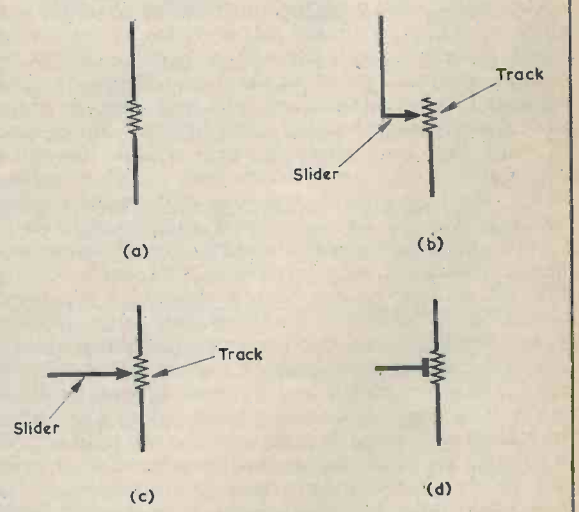


Fig. 1. Circuit symbols for (a) a fixed resistor, (b) a variable resistor, (c) a potentiometer and (d) a preset potentiometer

The term 'fixed' is very frequently omitted when referring to fixed resistors. These are almost always simply referred to as 'resistors'.

A resistor cannot be made to have an *exact* value of resistance. If, for instance, we were to refer to a resistor as having a value of *exactly* 10Ω, this would infer that the resistance should be 10.000000 . . .Ω, which is clearly impossible to achieve in practice. Instead, we refer to a resistor by its nominal value together with a tolerance on that value, the common tolerances being ±20%, ±10%, ±5%, ±2% and ±1%. The term '±' stands for 'plus or minus'. The most usual resistance tolerances encountered in home constructional projects are ±10% and ±5%. The '±' is quite often omitted, whereupon we refer to a '10% resistor', or '5% resistor', and so on.

If a circuit design specifies that a particular resistor should be, say, 100Ω ±10%, this means that the circuit will work satisfactorily if the actual value of the resistance offered by the resistor lies anywhere between 110Ω and 90Ω. If the constructor should happen to have on hand a 100Ω ±5% resistor this could be used in place of the 100Ω ±10% type specified because its value must obviously lie within the limits of 110Ω and 90Ω. It is always in order to use a resistor having a closer tolerance than that specified. On the other hand a resistor having a wider tolerance should not be employed. Thus, a 100Ω ±20% resistor should not be used if 100Ω ±10% is specified. In general, resistors become more expensive as the tolerance becomes closer, and the circuit designer specifies tolerances that are as wide a circuit operation allows.

One of the most common functions of a resistor is to allow a voltage to appear across it due to the current which is made to flow through it. Because of this the resistor dissipates power in the form of heat. Power is measured in watts (watts are volts multiplied by amps) and resistors have a wattage rating to specify the number of watts they may safely dissipate without becoming overheated. Large-size resistors have a higher wattage rating than small-size resistors. Common wattage ratings are $\frac{1}{10}$ watt, $\frac{1}{8}$ watt, $\frac{1}{4}$ watt, $\frac{1}{2}$ watt, 1 watt, 2 watts, 3 watts and 5 watts. Unfortunately, it is difficult to give precise details of actual physical dimensions for the different wattage ratings because these vary somewhat according to different manufacturers and different types of resistor, and also because engineering wattage specifications can themselves be interpreted in different ways. The newcomer to radio is best advised to assign to a resistor the wattage rating under which it is sold by the retailer. After a little experience, he will soon be able to adjudge the lower wattage ratings automatically. For very nearly all circuits in which resistors appear – in particular those handling direct current and audio frequencies – it is in order to use a resistor having a higher wattage rating than that specified, provided that the higher wattage resistor is not so bulky that it will not fit into the circuit layout. Usually, the situation resolves itself down to employing the next higher wattage rating, e.g. employing a 1 watt resistor instead of a $\frac{1}{2}$ watt resistor.

In many radio circuits resistors dissipate extremely low powers, these being in the order of one-thousandth of a watt or even considerably less. Resistors dissipating these low powers may still, nevertheless, be specified as $\frac{1}{4}$ watt. This is done simply because the $\frac{1}{4}$ watt type of resistor is cheap and readily obtainable. Resistors having dissipations of $\frac{1}{8}$ watt and $\frac{1}{10}$ watt most commonly appear in circuit designs where physical space has to be kept low.

The resistor colour code is illustrated by Fig. 2 and the Table.

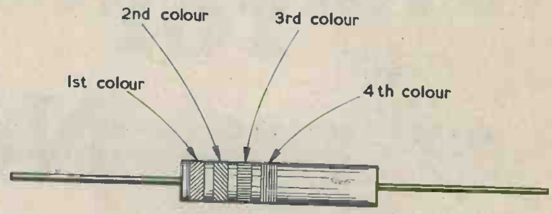


Fig 2. With present-day resistors, four coloured bands at one end of the body indicate the value and tolerance. The accompanying Table gives the figures corresponding to the colours

TABLE

THE RESISTOR COLOUR CODE

Colour	*Significant Figure (First two colours)*	*Multiplier (Third colour)*	*Tolerance (Fourth colour)*
Black	0	1	—
Brown	1	10	1%
Red	2	10^2	2%
Orange	3	10^3	3%
Yellow	4	10^4	4%
Green	5	10^5	5%
Blue	6	10^6	6%
Violet	7	10^7	7%
Grey	8	10^8	8%
White	9	10^9	9%
Gold	–	0.1	5%
Silver	–	0.01	10%
No colour	–	–	20%

Example: Yellow, Violet, Brown, Gold: 470Ω ±5%

CAPACITORS

Capacitors have a capacitance value together with a working voltage. There is a tolerance on the capacitor value, although this may not be marked on the component itself. If a circuit design does not specify a tolerance for a capacitor, it is quite in order to employ any capacitor of the type quoted, since it will automatically have the tolerance required by the circuit.

A very wide range of capacitors from around 0.001μF to 1μF, are available in what can generally be referred to as 'paper or plastic foil'. Up to some 15 years or so ago these capacitors were most commonly made as paper types only, but subsequent developments have resulted in a number of plastic alternatives to the paper dielectric, notable amongst these being polyester. There are also 'mixed dielectric' capacitors, which employ a combination of paper and polyester for the dielectric.

Any of these capacitor types may be used where a 'paper or plastic foil' component is specified. Several particularly useful ranges of capacitors are made by Mullard, these consisting of Mullard Polyester, Mullard Miniature Foil, and Mullard Metallised Foil, all of which have the advantages of relatively small physical size and robust construction. Because of this, these particular types of capacitor are sometimes specified directly by manufacturer and type number.

Silvered mica capacitors are available from around 5pF to 12,000pF, and are very suitable for r.f. (radio frequency) circuits. They are also made to close tolerances and even the standard ranges are around ±1% to ±2%. An advantage with silvered mica capacitors is that they exhibit very low change in capacitance for change in temperature and are, in consequence, particularly suited for home-constructed r.f. oscillator tuned circuits.

Ceramic capacitors are available from around 0.5pF to 10,000pF. So far as the newcomer is concerned they have the slightly confusing complication of being available in different grades of ceramic which have widely varying dielectric constants and temperature coefficients. (Temperature coefficient defines the change in capacitance for change in temperature). They are very suitable for r.f. circuits and those with a temperature coefficient of NPO or P100 may be used in home-constructed oscillator tuned circuits. If, as is often the case, the temperature coefficient cannot be reliably ascertained, it is preferable to employ silvered mica capacitors in such circuits instead. The lower value ceramic capacitors – below some 150pF or so – are most commonly available in tubular construction, and are normally ±5% or less in tolerance. There is a very useful range of disc ceramic capacitors, from around 1,000pF to 10,000pF, which are small in size and have tolerances of the order of +50% to –25% on nominal value together with very high temperature coefficients. These are excellent for the main purpose for which they are intended, this being as r.f. bypass capacitors in short-wave and v.h.f. circuits, where the wide tolerance and change of capacitance with temperature is unimportant.

Electrolytic capacitors are available from around 1μF to 10,000μF. These capacitors require a direct voltage across them to enable the dielectric to 'form' and the capacitance to be exhibited, and this direct voltage is almost always automatically provided by the circuits in which they appear. An electrolytic capacitor must always be connected into circuit with correct polarity (i.e. capacitor positive to circuit positive and capacitor negative to circuit negative). If it is connected with incorrect polarity it will exhibit a low resistance or even become fully short-circuited with, in some cases, disastrous results in the circuit in which it is fitted.

With home-constructor designs it is safest to ensure that the direct voltage across any capacitor never exceeds its working voltage. (With some Mullard electrolytic capacitors the voltage rating quoted is, in any case, the maximum voltage specified by the manufacturer.) As is to be expected, the physical size of a capacitor in any range and type tends to increase as the working voltage rating becomes higher. Unless a particular make and type of capacitor is quoted for a home-constructor design it is always safe, if a capacitor having the working voltage stated is not available, to employ a capacitor having a higher working voltage than that specified provided that there is space in the layout to accommodate it. This applies to electrolytic as well as non-electrolytic types. Thus, a 5,000pF disc ceramic capacitor having a working voltage of 500 may be employed where a 5,000pF disc ceramic capacitor with a working voltage of 350 is specified. If no working voltage is specified, then any capacitor of the type required may be used since it will automatically have an adequate working voltage rating. This situation often arises in low voltage transistor circuits where it is only necessary to ascribe working voltages to the electrolytic capacitors.

There is a range of very small disc ceramic capacitors (from around 0.01 to 0.5μF) available in the trade which employ a ceramic that allows a leakage current to flow. These are normally used by set manufacturers and should be avoided by the newcomer to radio. They may be recognised by the fact that they have low working voltages (usually below 20 volts). Ordinary disc ceramic capacitors, which may be safely used, have working voltages in excess of 150.

The circuit symbol for a non-electrolytic capacitor appears in Fig. 3(a) and that for an electrolytic capacitor in Fig. 3(b). The symbol in Fig. 3(b) has a 'plus' sign to indicate the positive connection. A variable capacitor is shown in Fig. 3(c) whilst a trimmer (which is a variable capacitor that may be preset to a particular value) is shown in Fig. 3(d).

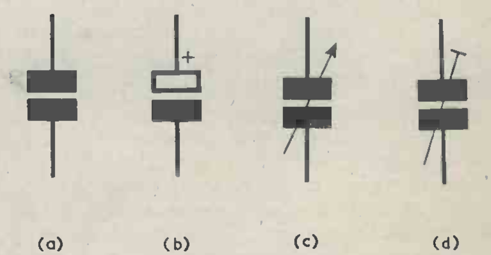


Fig. 3. The circuit symbols employed for (a) a non-electrolytic capacitor, (b) an electrolytic capacitor, (c) a variable capacitor and (d) a trimmer

Capacitance values are given in microfarads (μF) and picofarads (pF), one million picofarads being equal to one microfarad. Values around 0.001μF are quoted either in μF or in pF, and it is a simple matter here to remember that 0.001μF is the same as 1,000pF. There is another capacitance unit, the nanofarad (nF) which is equal to 0.001μF or 1,000pF. This unit is not used in *Radio & Electronics Constructor*.

SOLDERING

Many early attempts at home construction fail because of poor soldering. The ability to solder is essential for satisfactory results, and it is one that is quite easy to acquire. The newcomer should practice on a few odd components and tagstrips before tackling a constructional project.

The basic theory behind soldering is very simple. Solder will flow over two parts suitable for soldering together provided, first, that both parts are raised, by

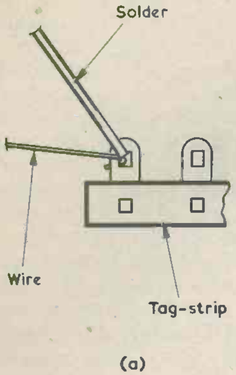


Fig. 4 (a). When soldering a wire to a tag, as here, it is helpful to initially place the end of a length of solder against the wire and tag (b). The soldering iron tip is then placed against the end of the solder

the soldering iron, to a temperature which is just above the melting point of the solder. A flux is necessary in the soldering process, this being a chemical which breaks down the oxides that form on the parts to be soldered and which then allows the solder to come into intimate contact with their surfaces. Always employ a radio-type resin-cored solder such as 'Multicore' or 'Savbit', in which the resin itself forms the flux. Never use a paste or liquid flux. The tip of the soldering iron should always have a shiny tinned finish.

A good approach is to lay the end of a length of resin-cored solder on to the parts to be joined, as in Fig. 4(a), and then apply the soldering iron, as in Fig. 4(b). The solder will melt at once, releasing flux and allowing the iron to rest on the parts to be joined, after which a little more solder may be fed in. A good solder joint can be recognised as it is being made, since the solder runs smoothly over the surfaces to be joined. As soon as this has occurred remove the iron, and do not disturb the joint until the solder has solidified.

COMPONENT AVAILABILITY

A final point concerns component availability. There are many towns in the U.K. which do not have shops offering a wide range of radio components, and readers who are so situated make their purchases by mail-order. It is a very helpful move, when starting the hobby, to obtain the catalogues of mail-order houses, as these catalogues not only assist in the task of tracing particular parts but also have the incidental advantage of being instructive, since they introduce the reader to the appearance and characteristics of present-day components. As may be gathered from the advertisements in this issue, the cost of a catalogue can in some instances be considerably reduced due to the presence of repayment vouchers in the catalogue itself. ■

Building

by
Arthur C. Gee, G2UK

THE NEXT TIME YOU WANT TO PUT THE SHORT WAVE set on to a shelf, and find that it fits nicely but there just isn't room to accommodate the separate speaker usually used with this type of receiver, don't despair! Just have a look through some of the component suppliers' catalogues and see if you can find something in the speaker line which will fill the bill. Then fit it into a cabinet of your own construction which just fits into the available space. Making up a cabinet is not nearly so difficult as you might imagine!

The speaker cabinet is made so as to comfortably fit the available space

a Speaker Cabinet

How to construct a presentable speaker cabinet which just fits into the space available for it.

AVAILABLE SPACE

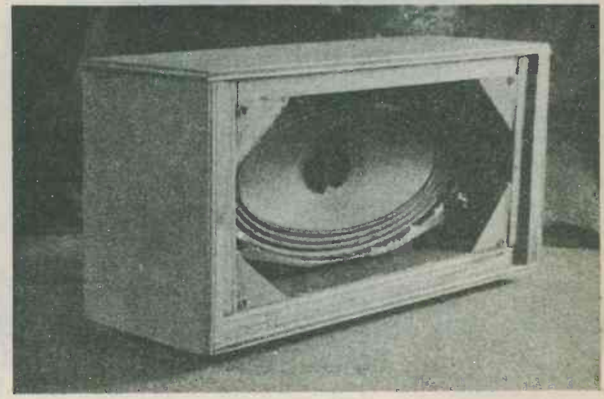
In the writer's case, there was a space of $4\frac{3}{4}$ ins. between the top of the receiver and the bottom of the shelf above. In the Home Radio components catalogue he found listed an elliptical speaker, 5 by $2\frac{3}{4}$ ins. in size, under Cat. No. LS87C. He also found listed plastic speaker grilles, $6\frac{3}{4}$ by $3\frac{1}{2}$ ins. in size, which were available in black, cream, grey or white, all of these being under Cat. No. LS1A. Further items, listed under Cat. No. ZA35, were $\frac{1}{2}$ in. rubber feet with steel pin fixing. It was decided to make up a small wooden cabinet around these parts which would just fit into the available space.

You do not have to here the ability or facilities of a skilled cabinet maker to make up quite a presentable little speaker cabinet. Provided you can use a wood saw, a drill and sandpaper with a little care and patience, and are prepared to carry out a lot of sandpapering, you can easily make a presentable job.

For a small cabinet of this type, first make the back and sides of the same wood, say 5-ply plywood. The dimensions must be such as to accommodate the speaker, to fit the space available—remembering to allow for the rubber feet on the bottom—and to take the grille so that it fits neatly into the front of the cabinet. The photographs make the arrangement clear.

Cut the back and the side pieces to the required size. Then fix the side pieces to the back with wood tacks and glue. Now, temporarily fit the speaker to the back with lengths of studding and spacers cut from Paxolin tube or similar. The front of the speaker frame should be so positioned that it will be just behind the grille when the latter is fitted. When a satisfactory speaker mounting has been achieved, the speaker may be removed.

Next cut pieces of thinner plywood—say 3-ply—to form the top and bottom of the cabinet. Make the top and bottom a little longer and a little wider than the back and sides, so that there is an overhang at the sides and front. Pieces of the same plywood can then be glued to the sides of the cabinet to give the appearance of veneer and cover up the cut ends of the back piece of wood. The top, bottom and two glued-on side pieces should project forward sufficiently to form an edging when the grille is fitted. Drill a hole in the bottom, or back, to take the loudspeaker lead.

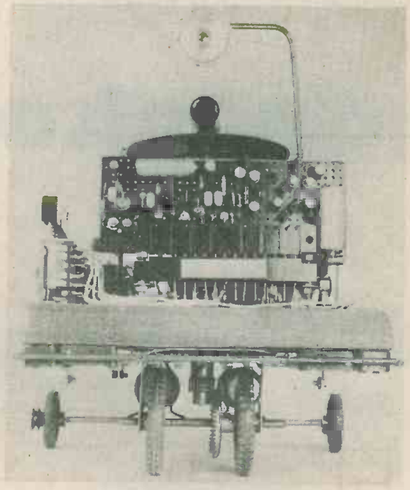


Details of the assembly of sides, top and bottom just before the grille is fitted

Cut out some triangular pieces of wood. These are glued to the inside corners of the cabinet at the front to support the grille. Glue on the thinner pieces of plywood to the sides to finish off, and then leave to set hard. Next sandpaper down. The better you do the sandpapering the better the cabinet will look. You can now stain, paint, polish or leave the cabinet white, as per your fancy. Connect a lead to the speaker, take this through the hole in the bottom or back, and finally mount the speaker in place. Fix the grille and attach four rubber feet to the bottom.

And you'll have a very nice looking little speaker housing. ■

CYCLOPS



PART FOUR

by

L. C. Galitz

In this fourth article describing the construction of Cyclops, the basic reflex and motor circuitry are dealt with.

Fig. 17 shows the component layout on the main chassis. First, the Veroboard edge connector, the three relays, the two batteries, the power supply socket and the switches are mounted. Also, the touch sensors are attached to the underside of the chassis, and details of these are given in Fig. 18(a) and (b). Two microswitches are screwed to each corner, and metal bumper bars are attached between the microswitches on each side. If the microswitches have metal operating levers the metal bars may be soldered to these. Should the microswitches have operating buttons only, then the bars are supported by a loop of wire at each switch, this loop being soldered to one of the contact tags or secured in any other convenient manner. Pieces of Sellotape wrapped round the bars prevent them sliding out of the wire loops. All the microswitches are wired in parallel, and one wire from them passes through hole 1 in the chassis (see Fig. 17) and the other through hole 3. The Veroboard edge connector is screwed into position, using two spacing pillars to keep the tags clear of the chassis, and the main switch, S1-S4, is secured down by means of two of the holes in the switch metalwork. If there is no way of screwing the switch down, or if independent switches are used, then a separate panel must be made up. In the prototype part of the chassis was cut away as shown in Fig. 19, to accommodate the projecting sections of the switch. Also, S5 was secured directly to the main switch.

MOUNTING BRACKETS

A Perspex bracket was made up to mount relays RLB and RLC, this being illustrated in Fig. 20(a). Another Perspex bracket, shown in Fig. 20(b), was employed for mounting the power supply socket. A special bracket, consisting of a Meccano part 6a bent to shape, was used for mounting relay RLA, this being shown in Fig. 20(c). A Ripmax Tank Clip is fitted under the chassis, as in Fig. 20(d), and secures the Deac battery, BY1. Leave sufficient space for a second Deac battery of the same type, which will be fitted later. The photograph of the chassis underside which accompanied Part 2 of this series shows both batteries in position. A clamp for accumulator BY2 is shown in Fig. 21. Finally, a 2-way connector block having screw terminals is mounted near BY2 in order to take the accumulator leads.

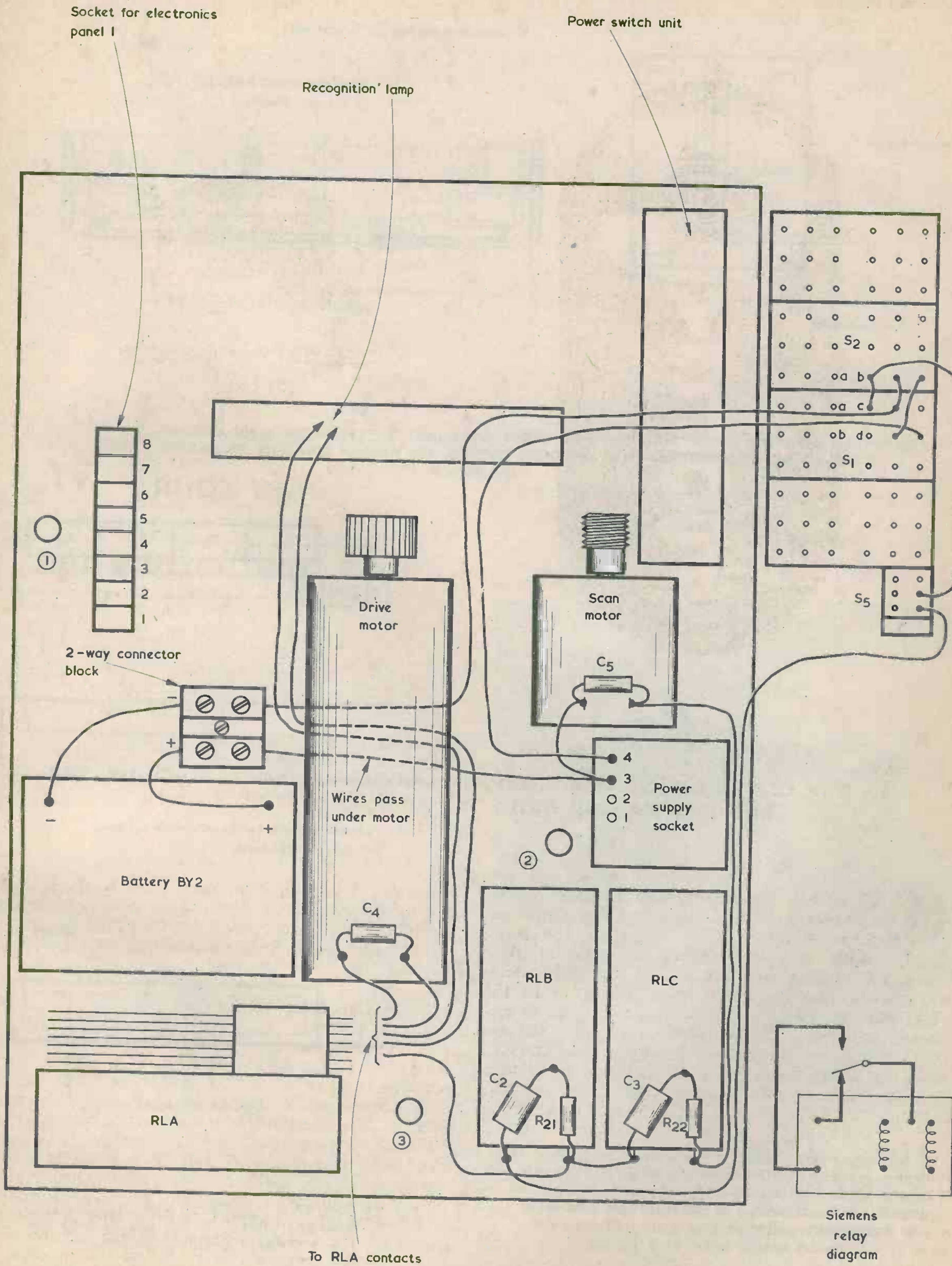


Fig. 17. Component layout and motor wiring above the chassis

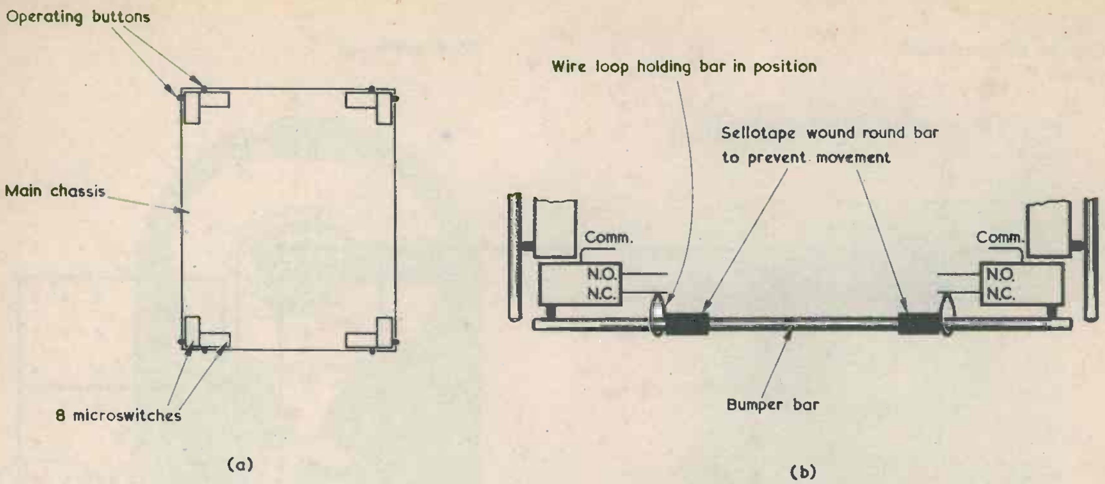
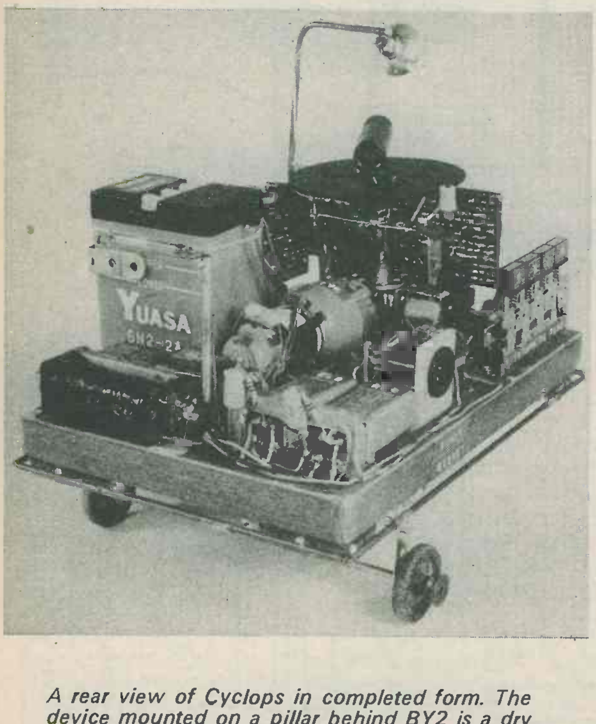


Fig. 18 (a). How the touch sensor microswitches are positioned under the main chassis (b). If the microswitches have operating buttons, the bumper bars may be held in position in the manner shown here



A rear view of Cyclops in completed form. The device mounted on a pillar behind BY2 is a dry reed switch. This is added for the extra circuits which will be described in the next two articles. The Veroboard panel at the front will also be discussed in the next two issues

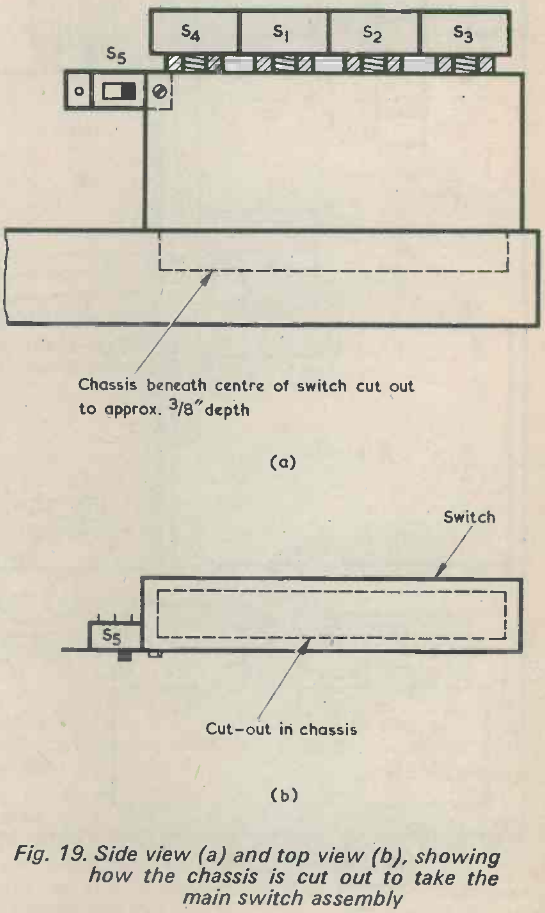


Fig. 19. Side view (a) and top view (b), showing how the chassis is cut out to take the main switch assembly

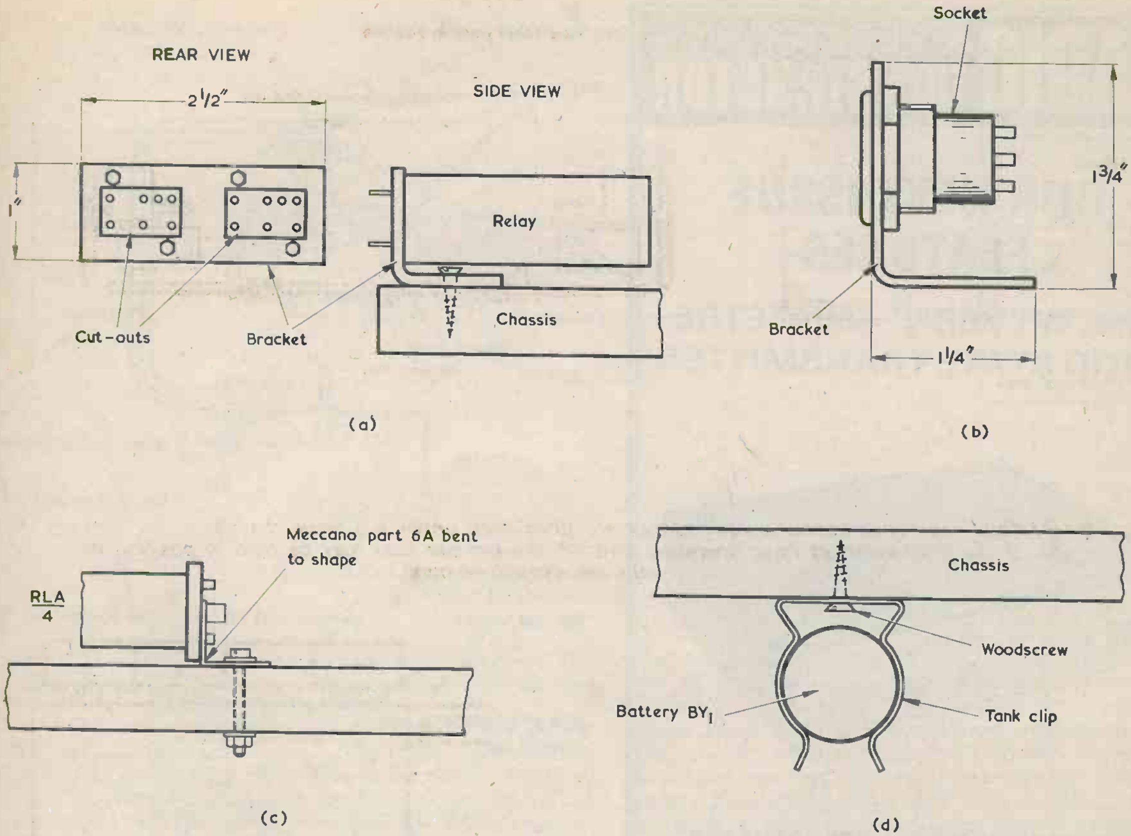


Fig. 20 (a). The Perspex bracket on which relays RLB and RLC are mounted
(b). The power socket is also mounted on a Perspex bracket
(c). A Meccano part is used for securing relay RLA
(d). The Deac battery is secured to the chassis underside by a Ripmax Tank Clip

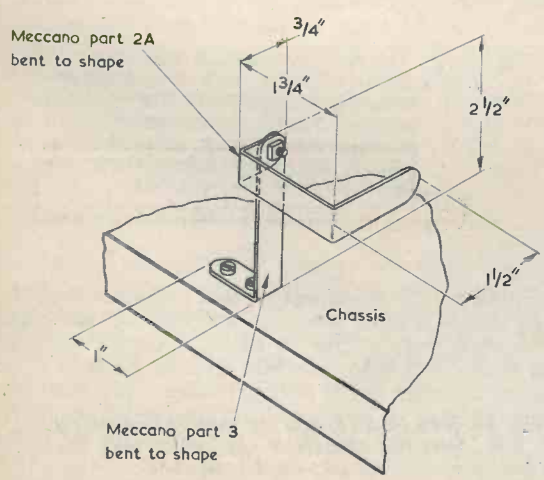


Fig. 21. The clamp which holds accumulator BY2 in position

PHOTOCELL ASSEMBLY

The ORP12 photocell is mounted in a tube whose diameter, approximately $\frac{1}{2}$ in., provides a snug fit. In the prototype the tube was made of glass painted matt black on the inside and the outside. The front end of the tube was left clear whilst the back, after suitable lengths of insulated wire had been soldered to the ORP12 lead-outs, was sealed with sealing wax and then painted black, the leads passing through the sealing wax. Alternatively, a metal tube could be used, this being sealed off at one end and painted matt black on the inside. In either case the length of the tube should be about 2 in. The tube may be secured to the large gear wheel by means of a clamp or by any other convenient means. As was described in Part 2, the leads from the photocell are wired to the jack socket underneath the eye assembly.

The recognition light assembly consists of a Meccano coupling, part 63, screwed to the eye unit support, as in Fig. 22(a) and (b). This holds a brass rod bent into the shape shown, the lamp being soldered at the other end. A reflector taken from a torch is mounted behind the lamp and is secured by adhesive. This method of

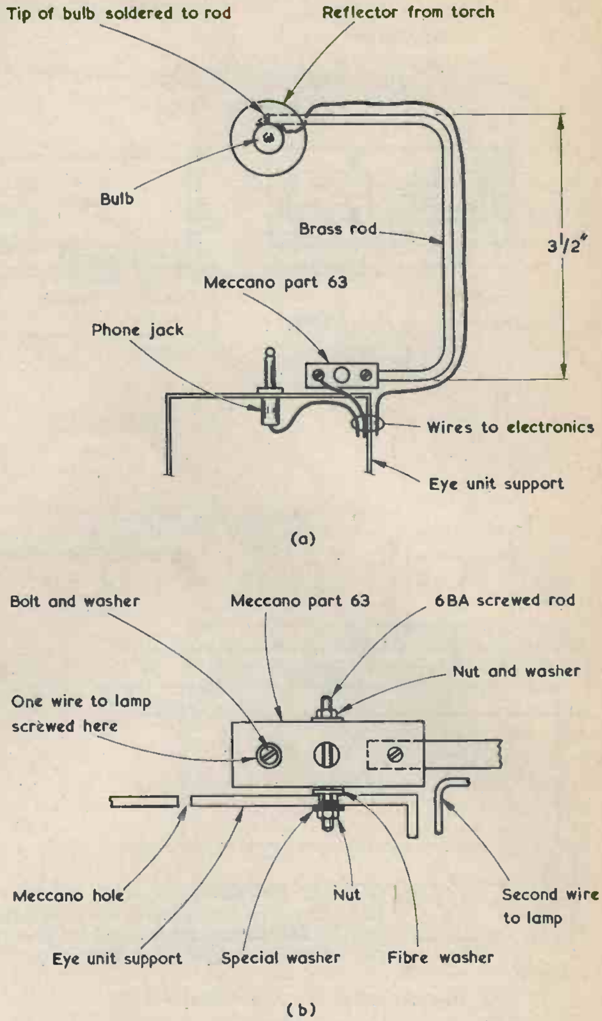


Fig. 22 (a). The recognition lamp assembly
(b). Detail showing how the Meccano coupling is secured to the eye unit support. The 'special washer' is of the type employed for mounting power transistors when these are insulated from the heat sink

mounting has the disadvantage that replacement of the lamp, should it burn out, is a little fiddling, and some constructors may prefer to devise a combination of bulb holder and reflector which enables the bulb to be screwed in or out in the normal manner. The Meccano coupling has to be insulated from the eye unit support, and this was accomplished in the prototype by using insulating washers, as shown in Fig. 22(b). This insulation is of considerable importance because if, when the learn circuits are added later, there is a short-circuit between the lamp circuit and the eye unit support, damage would result to both power supplies and circuitry. Some constructors may prefer to use a

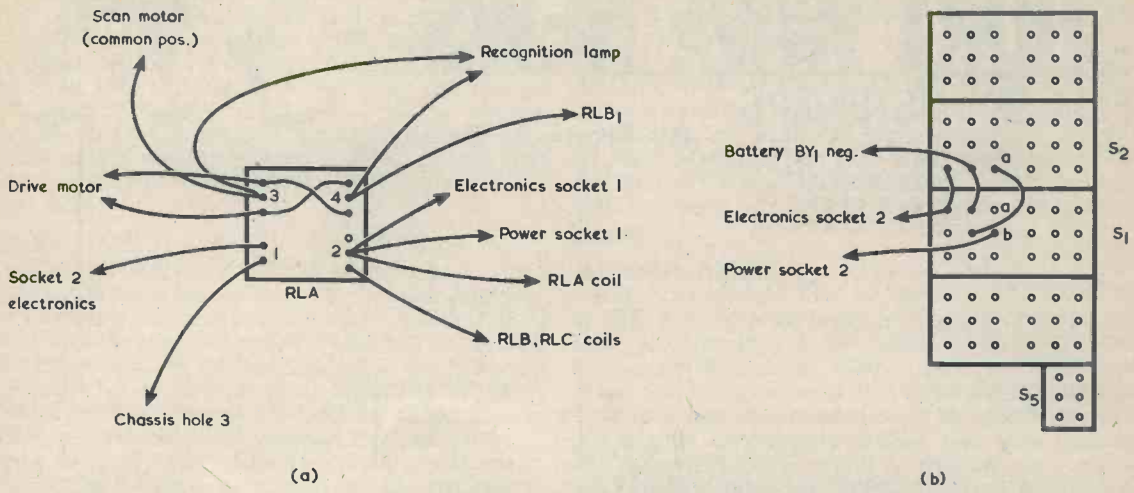


Fig. 23 (a). Connections to the contacts of relay RLA
(b). Wiring to switches S1 (a) and (b) and to S2 (a)

different and more positive method of insulating the lamp rod from the eye unit support, incorporating, say, a bracket made of insulating material.

At this stage, wiring up can commence. The motor wiring is illustrated in Fig. 17. The reflex circuit wiring should be carried out by following the circuit diagram, Fig. 14, which was published last month. In Fig. 14 the numbers 1 to 8 alongside the dotted line correspond to the same numbers on the edge socket shown in Fig. 17. The lead from the microswitches which passes through hole 1 connects to tag 6 of the edge socket, and that which passes through hole 3 connects to relay contact set RLA1. The wires from battery BY1 pass through hole 2. Figs. 23(a) and (b) give details of the wiring at relay RLA and at switches S1(b), S1(a) and S2(a).

The eye unit support is connected to tag 2 of the Veroboard socket, thereby automatically providing one of the connections to the photocell jack plug. The tip of the jack plug connects to tag 3 of the Veroboard socket. The Meccano coupling mounted on top of the eye support unit, and electrically isolated from it, takes one of the wires connecting to the bulb. The other wire to the bulb passes up the brass rod and is connected to its remaining terminal. All wiring should be kept well clear of mechanical moving parts.

TESTING AND SETTING UP

Firstly, the insulation between the recognition light assembly and the eye support unit, if it is of the type employed in the prototype, should be carefully checked. If this check proves satisfactory, the sliders of VR1, VR2 and VR3 should all be set at the bottom (positive) ends of their tracks, and the power should be applied. Then, Cyclops should be placed 1 ft. away from a suitable light source and VR2 adjusted so that relay RLB cuts in. The lamp should then be moved away, and RLB should cut out before the lamp is more than about 1 ft. 3 in. away. VR1 should be set at maximum unless the ambient light conditions are such that relay RLC cuts in; in which case VR1 should be set to the maximum possible before this happens. Cyclops is really a nocturnal animal, and he is happiest when his habitat is in pitch darkness apart from the lights he is required to 'feed' on. VR3 is set to a position such that relays RLB and RLC cut out when a lamp is held about 1 in. from his eye.

At this stage, TR1, R1 and D1 are mounted on the Veroboard panel. Also, a capacitor should be soldered in the C1 position which has a value such that relay RLA operates for a period of duration equal to the time that the front drive unit takes to rotate through 180°. In the author's case this value was 50μF.

In order to achieve maximum drive efficiency, the horizontal contrate wheel, i.e. the one above the chassis, should rotate in the *opposite* direction to that in which the eye unit and front drive unit rotate. Then, the very slight rotational motion imparted to the front wheels by the scanning system is in the same direction as the main drive power under normal conditions.

If the motors are connected with the requisite polarity, Cyclops will now exhibit basic reflexes. He will speculate for light and, upon finding it, will home into the source and then 'feed' on it. He will also avoid obstacles and, when confronted with his reflection in a mirror, will execute a highly personalised version of the tango!

In the next article, the Conditioned Reflex in animals will be discussed, and constructional details of a Conditioned Reflex for Cyclops will be given.

(To be continued)

SHORT WAVE NEWS

FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT   *Frequencies* = kHz

● CLANDESTINE

Most readers of these columns are aware that such stations exist and radiate programmes on the short waves, such stations as Radio Euzkadi (Basque Freedom Movement) on **13200** signing-on at 2230 in English, Spanish, French and Basque, and usually jammed or partly so. Or Radio Portugal Livre (Free Portugal) on **11507** from 1857 onwards in Portuguese and also on **15483**. However, what about Voice of the Malayan Revolution on **15789**, heard opening in Chinese at 1400, then into Tamil; or Voice of the Thai People on **9423** signing-on at 1100 in a Thai dialect or Radio Sparks signing-on in Chinese at 0945 on **9600**? Have a go and log some of the Clandestines.

● AROUND THE DIAL

African stations continue to be of interest and reception of them here in the U.K. on the 60 metre band can provide some worthwhile listening periods.

● MALAWI

Blantyre, the capital city, can be heard on **3380** (88.76m) where it was recently logged at 1935 when radiating a drama in dialect, probably Chichewa.

● CONGO

Brazzaville in the form of R.TV Congolaise may be logged on **3264** (91.91m) around 2055, when we heard the very rythmic African drums in an apparently endless session.

● MALI

Bomako on 4783 (62.72m) often provides typical African fare, we heard it at 2125 with drums, chants and other percussion native instruments. This is the Home Service, the evening schedule of which opens at 1800 and extends through to 2300.

● MAURITANIA

With the dial set at **4850** (61.87m), one can often receive Radio Mauritania free of interference around 2200. We logged it 2203 when the Home Service (evening schedule from 1700 to 2300) was carrying a programme of typical African music.

● DAHOMEY

Cotonou has a 30kW transmitter on **4870** (61.60m) which radiates the Home Service throughout the evening up to 2300. It was logged recently at 2220 with the usual drums and chants but this time interspersed with shrill female cries – quite impressive.

● CAMEROON

On **4972** (60.33m) the Radio Yaounde 30kW transmitter can often be heard during the evening. We logged the Home Service (1700 to 2230) at 2210 when, surprisingly for a change, a programme of recorded English "pops" was heard.

● LATIN AMERICA

Late night and early morning sessions often provide some additions to the log in the form of LA stations, although I should add that equally often, one can return dejectedly to bed having ascertained that conditions for LA receptions are anything but good – or even impossible.

● BRAZIL

PRC5 Radio Clube do Para, Belem, on **4865** (61.66m) with its 2kW transmitter can often be heard during the late evening if conditions are right. We logged it here at 2216 when a sports commentary in Portuguese was being broadcast, schedule 0900 to 0300.

Radio Brazil Central, Goiania, on **4995** (60.60m) has a 5kW transmitter that operates throughout the evening right up to sign-off at 0400. This Brazilian can often be heard quite early in the evening here in the U.K., around 2100 or so. We logged ZYX2 at 2130 when the station identification in Portuguese was clearly heard.

Radio Relogio, Rio, is another 5kW Brazilian that can often be logged early on in an LA session. Listen on **4905** (61.16m) for ZYZ20, we heard it at 2235 when a talk in Portuguese was being radiated.

● ECUADOR

HCHE4 La Voz de Esmeraldas operates on **4875** (61.54m) from 1000 through to 0600 with a 5kW transmitter and it can sometimes be heard through interference from other LA transmitters. A programme of LA songs and station identification were heard at 0330.

● COLOMBIA

One of the easiest ways to log this country is to tune to **4955** (60.54m) for the 25kW signal of HJCO Radio Nacional, Bogota; we heard it at 0207 when a talk in Spanish on Colombiana was being featured.

● VENEZUALA

Then, of course, we have the myriad Venezualans. YVOA Radio Sucre on **4960** (60.48m) 1 kW with identification and LA music at 0200; YVKB Nueva Radio Dif on **4890** (61.35m) 5 kW at 0210 with LA "pops" and YVLA La Voz de Carabobo on **4780** (62.76m) 1kW with identification and LA music at 0230.

● ISRAEL

Kol Yisrael, Tel Aviv, has been using various experimental channels over the past few weeks, presumably in an effort to locate clear channels for its external service. Initially, it was heard on **11760** (25.51 metres) but has recently (at the time of writing) been logged on **11715** (25.61m) at 2042 with the news in English and also on **11790** (25.45m) at 1800 in Spanish – the last logging according to BADX (British Association of Dx-ers). By the time this appears in print, Kol Yisrael may well be experimenting with channels differing from those quoted here.

● INDIA

The General Overseas Service of All India Radio from Delhi may be heard here in the U.K. on many channels, some of those noted here recently were – **9530** (31.48m) at 2102 with the news in English; **9912** (30.27m) at 2045 with a programme in English directed to the U.K. and also in parallel on **7260** (41.32m) and **11740** (25.55m); and on **11620** (25.82m) at 1845 with a programme in English, complete with Indian musical items.

● MOZAMBIQUE

Radio Clube de Mozambique, Lourenco Marques, may be heard on **4855** (61.79m), where it was recently logged by us at 2155 when radiating a programme of Portuguese songs and guitar music. Announcements in Portuguese, 4 chimes followed by station identification at 2200 were heard.

Radio Clube de Mozambique radiates its "A" programme on **4855** (25kW) from 0400 to 0530 and from 1600 to 2210 daily, all programmes being in Portuguese. Other channels used are **15295** (19.62m), **11820** (25.38m) **9620** (31.19m), **6115** (49.06m) and **3210** (93.44m). However, the **4855** channel offers the best chance of hearing Lourenco Marques here in the U.K.

● NIGERIA

A station not very often heard here in the U.K. is Benin City on **4932** (60.38m). Owing to the activities of a utility station right on this frequency, Benin City signals are, more often than not, completely obliterated. A lucky chance recently presented the writer with the opportunity to log the 10kW transmitter, the utility station being off the air for once. The Mid-West State Programme was heard at 2225, the African drums and chants being "in the clear".

● CHINA

The Fukien Front station operates on many channels but two of these have been recently logged here, these being **3400** (88.24m) at 2010 when radiating a programme of military music and choral marching songs and **3900** (76.92m) at 2017 with a talk in dialect.

The schedule of Fukien is rather large to reproduce in these pages but readers may like to listen on the following channels during the time periods quoted.

From 2010 to 2230 on **2600** (115.4m), **2800** (107.1m), **3200** (93.75m), **3400**, **3535** (84.87m), **3900** and on **4380** (68.49m). From 2230 to 2300 on **2600**, **2800**, **3200**, **3400**, **3900**, **4380**, **5170** (58.03m) and on **5240** (57.25m).

● FALKLAND ISLANDS

The Falkland Islands Broadcasting Service operate a 0.5kW transmitter on **3942** (76.10m), their schedule in the summer months being from 2230 to 0130 (Saturdays from 2130) and in the winter months from 2230 to 0200 (Saturdays from 2030). They have however been noted recently signing-off as early as 0100 or just after – all according to BADX. All programmes are in English and the frequency given here is approximate.

● ZAIRE

Radio National du Zaire lists its operational frequencies as **4880** (61.48m), **7115** (42.16m), **9770** (30.71m), **11720** (25.60m), **11795** (25.43m), all 10kW and **15245** (19.68m) 100kW, all located at Kinshasha. The Lubumbashi transmitters operate on **5955** (50.39m), **7865** (38.13m), **9540** (31.45m) and **11865** (25.28m). Bukuvu operates on **4839** (62.00m), Mbandaka on **5995** (50.04m), Luluabourg on **6125** (48.98m), Kisangani on **6085** (49.30m), Mbujimayi on **7295** (41.12m), Fikwit on **7255** (41.35m) and Matadi on **7205** (41.64m), all according to BADX. Zaire – formerly Democratic Republic of Congo.

● BANGLADESH

Radio Bangladesh may be heard on **17935** (16.73m) at 1230 with its programme in English directed to the U.K., at which time it was recently logged by us. Prior to the identification at 1230, a plaintive melody was heard, this being followed by a newscast. Have the tape recorder ready for the melody, it is well worth recording.

● HAITI

This country is rather difficult to log here in the U.K. and the reception of 4VEH on **15280** (19.63m) from midnight to 0100 is no mean feat considering the low power involved – just 0.1kW. Our old friend B. Walsh of Romford, Essex did just that and he tells me that the programming was in English. If you do manage to log this one, the address is Box 1, Cap Haitien.

● GHANA

In addition to the often heard **4980** (60.25m) channel, Ghana can be logged on other frequencies. Readers may like to try the **21545** (13.93m) channel around 1445 when a programme in English is radiated, according to BADX

● NICARAGUA

YNHC Radio Hernandez de Cordoba on **6100** (49.18m) has an observed schedule from 1600 to 1900 and from 2200 to 0000 daily.

YNCA Radio Atlantico has been logged on **6120** (49.02m) at 2210.

● SRI LANKA

Radio Ceylon is reported by BADX on **9719** (30.86m) at 1700 with a programme in English to sign-off at 1730 with identification "All Asia Service of Radio Ceylon from Republic of Sri Lanka".

● SOUTH AFRICA

Radio RSA has an English Service beamed to the U.K. from 1900 to 1950 on **15175** (19.77m).

The SABC has been recently logged by us on **3320** (90.34m) with a programme of light music and announcements in Afrikaans at 2050 and also on **4945** (60.67m) at 2232 with dance music in the All Night Service.

● KUWAIT

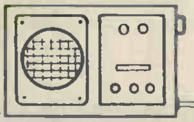
The English Service from Radio Kuwait may be heard from 1730 to 1900 on **11825** (25.37m).

● LIBERIA

Radio ELWA ("Eternal Love Winning Africa"), the Radio Voice of the Sudan Interior Mission, Monrovia, operates on the following frequencies in a variety of African languages, and English, **3227** (93.03m), **4770** (62.89m), **9555** (31.40m), **9640** (31.12m), **11940** (25.13m), **11950** (25.10m), **11975** (25.05m), **15095** (19.87m) and on **15170** (19.78m). ■

This month Dick encounters an unusual fault in a cassette tape recorder. Its repair enables both him and Smithy to discuss a tape motor speed control circuit which is widely used in these recorders.

In your workshop



Dick carried the small cassette recorder over to his bench and regarded it thoughtfully. He selected 'Playback' and switched it on. A low hiss from the speaker indicated that some form of life was extant in the amplifier stages, but there was no response from the tape motor. He switched to 'Record' whereupon the speaker became silent, but the motor still refused to operate. He scratched his head, then took the back off the recorder.

There were five 'high power' 1.5 volt cells inside, and he applied his testmeter prods to the end terminals of the holder in which they were fitted. The testmeter needle indicated 7.5 volts exactly. Dick next peered inside the recorder chassis, looking for obvious faults and disconnections; but of these there were none.

Dick scratched his head once more, then reached a decision. Rising from his stool he walked purposefully over to the filing cabinet in which the service manuals were kept.

CASSETTE RECORDER SNAG

Smithy looked up, startled, from the work on his bench.

"What on earth," he queried, "are you up to?"

"Me? Why, nothing," replied Dick. "I'm just going to get out the service sheet for this cassette recorder I'm fixing."

"Wonders will never cease." commented Smithy, in an agreeably surprised tone. "It looks as though all my advice over the last few years has actually started to bear fruit. It must be *months* since you last got a service manual out."

"Ah yes," said Dick airily, "but don't forget that I don't need to rely too much on manuals, because I can usually fix the jobs I get without having to look them up."

"Can you?" commented Smithy accusingly. "I would have said, instead, that you are quite prepared to spend ages digging around in a set in the hope that you'll stumble on what's gone wrong rather than devote a few minutes sitting down with its service sheet and trying to locate the trouble in a logical manner."

"I like that." retorted Dick, stung at the unexpected indictment. "I bet there's *nobody* can repair a set quicker than I can."

"I'm not talking about the *repair* of a set," replied Smithy sternly, "I'm talking about the tracing of the fault that *needs* repairing. Pretty well all service engineers will take about the same time to replace, say, a short-circuited capacitor. But the service engineer who's worth his salt is the one who locates the particular capacitor which has gone short-circuit in the shortest possible time."

Smithy turned back to his bench, then chuckled as a thought occurred to him.

"I don't know why I'm going on at you like this," he grinned, "seeing that you *are*, for once, setting about things the right way."

"Don't worry about it, Smithy," replied Dick soothingly, as he searched further in the filing cabinet. "You're probably just at that difficult age where you tend to be irrational and find fault with things. They say we all have to go through it."

Smithy threw a suspicious glance at his assistant, but that worthy had by now obtained the service manual he required and was already returning to his bench with it.

As Dick reached his bench, he opened

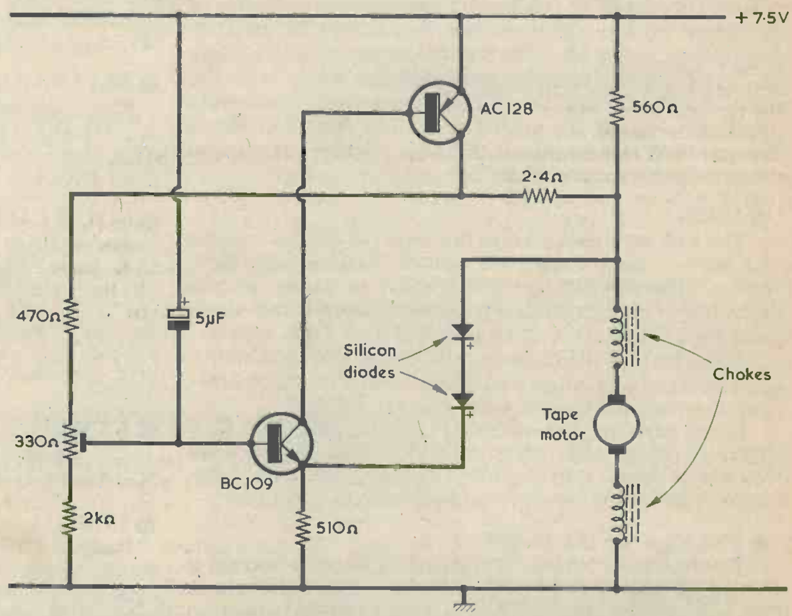


Fig. 1. Basic cassette tape motor speed control circuit. The values and transistor types shown are representative of current practice and do not apply to a specific model. A silicon transistor of similar rating may be employed instead of the germanium AC128

the manual at its circuit diagram and examined the circuitry around the motor. (Fig. 1). Tentatively, he set the recorder to "Playback" and switched on again. He next applied the prods of his testmeter to chassis and the positive supply rail at the upper end of the 560Ω resistor in the motor circuit. (Fig. 2(a).) The meter indicated 7.5 volts. Dick next moved his positive test prod to the lower end of the 560Ω resistor. (Fig. 2(b).) The testmeter needle remained at zero.

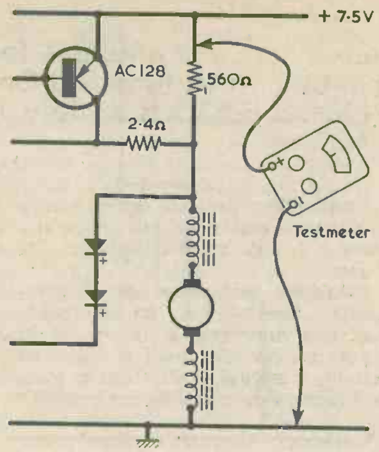
Hardly able to believe his good fortune at finding a fault condition as early as this, Dick checked again. There was quite definitely no discernable voltage between the lower end of the 560Ω resistor and chassis. There must, he decided next, be a dead short-circuit between the lower end of the resistor and chassis. Quickly, he switched off the recorder, set his testmeter to an ohms range and reapplied it between the lower end of the 560Ω resistor and chassis. The testmeter indicated a resistance of about 4Ω.

Dick frowned. This was not *quite* a dead short-circuit. Admittedly, the reading of 4Ω was so much lower in value than 560Ω that it could quite readily be the reason for an apparent zero voltage indication in the testmeter. On the other hand, though, a resistance of 4Ω could just simply be the combined resistance of the motor windings and the series chokes, whereupon it could represent a perfectly satisfactorily state of affairs. On an impulse, Dick shifted the testmeter prods so that they bridged the 560Ω resistor. (Fig. 2(c).) The meter indicated a resistance of around 6kΩ.

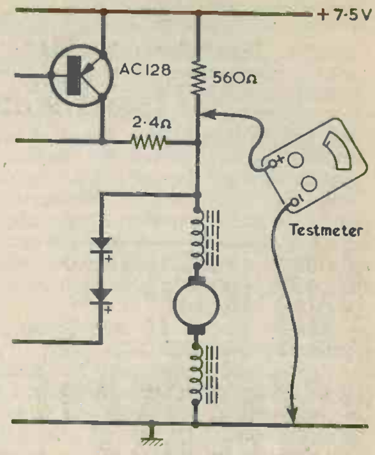
Dick checked again. 6kΩ. This was a much better lead towards the fault. It was obvious that fixed potential divider networks between the positive and negative supply rails elsewhere in the recorder could present a resistance of this order across the 560Ω resistor. But that 560Ω resistor should, if it was doing its job properly, then pull an overall resistance of 6kΩ down to its own value and below. The 560Ω resistor had an appreciable length of lead-out on each side of its body before either of these descended below the printed circuit board. With a trembling hand, Dick snipped one of the lead-outs and measured the value of the resistor on its own and divorced from the remainder of the circuit. His testmeter indicated that the resistor was completely open-circuit.

Dick experienced for several luxurious moments the sense of intense gratification that is achieved by those who, on visiting a friend's club, get the three bars up after inserting one single coin in the bandit. Then he set to work and proceeded to solder in a new 560Ω resistor on the board.

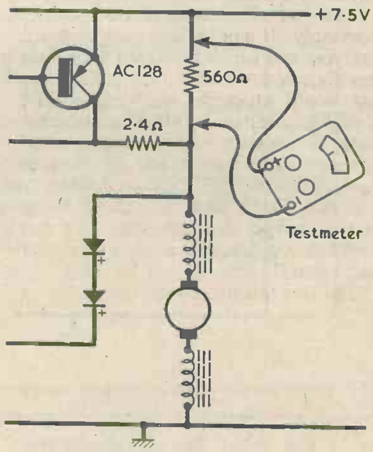
When all was complete he put down his soldering iron and switched the recorder on. Its little motor whirred immediately to life.



(a)



(b)



(c)

Fig. 2 (a). Dick's first test on his cassette tape recorder was to check the voltage at the upper end of the 560Ω resistor
(b). He next checked the voltage, and then the resistance, between the lower end of the 560Ω resistor and chassis
(c). The final test was a resistance measurement across the 560Ω resistor

SWITCH-ON RESISTOR

"Hey, Smithy," called out Dick cheerfully. "Perhaps you're right about consulting service manuals after all. The manual has certainly helped me to locate the fault in this battery cassette recorder quickly."

"You should know by now," replied Smithy over his shoulder, "that I am always right about *everything*. What was the snag?"

"The motor in this recorder wouldn't run," announced Dick. "It obtains its current via a 560Ω resistor, which had gone open-circuit. I've just fitted a new one and the motor's going like a bomb now"

"The motor obtains its current via a *what* did you say?"

"A 560Ω resistor."

Smithy rose from his stool and walked over to Dick's bench.

"This," he announced, "I must see for myself. Dash it all, Dick, a 560Ω resistor in a standard battery cassette recorder can't pass as much as 20mA with the full battery voltage across it, so it can hardly be in the supply lead to the motor."

"Well, it is," retorted Dick defiantly, pointing to the 560Ω resistor in the service manual circuit diagram. "You can't have a resistor which is more in series with the motor than that one is."

Smithy peered at the diagram.

"You're right about the resistor being in series," he agreed. "But you're wrong if you think it's meant to supply current to the motor."

"Then what does it do?".

"It's the switch-on resistor for the two transistors which govern the motor speed."

"Well," conceded Dick. "I did think that those two transistors in the circuit *could* be involved in the operation of the motor. But I was so pleased at being able to find that the resistor was faulty after my first few checks that I didn't bother about the rest of the circuit. How do those two transistors work, anyway?"

"In a very simple manner," replied Smithy. "Their function is to keep the motor speed as constant as possible both for changes in supply voltage and for variations in mechanical loading on the motor. Under running conditions the main current for the motor passes through the AC128 at the top and the 2.4Ω resistor between its collector and the motor. Forget about the two chokes in series with the motor for the time being. They have no effect on motor operation and both have a very low resistance."

Smithy paused for a moment to collect his thoughts.

"Now." he continued, "the circuit is set up such that something like 2 to 4 volts appears between the emitter and the collector of the AC128. Let's see what happens now if the supply voltage drops. This voltage drop appears at the junction of the 2.4Ω resistor and the 560Ω resistor you replaced, and it is passed in its entirety to the emitter of the BC109. The drop is passed in its entirety because of the two silicon diodes in series; these are both forward conducting and there is a constant voltage of about 1.2 volts across them. The voltage drop will also be applied to the base of the BC109 by way of the 470Ω resistor, the 330Ω pre-set potentiometer and the 2kΩ resistor. Because of potential divider action in this chain of resistors the voltage drop at the base of the BC109 will be less than that at the emitter."

Dick frowned.

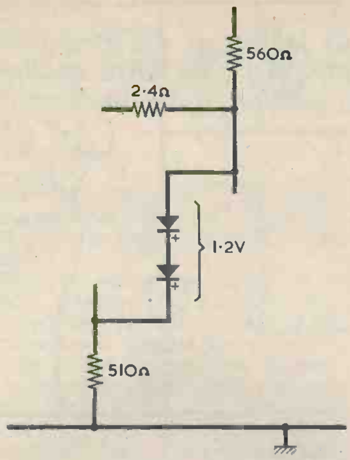
"I don't get that."

Smithy sighed and pulled a pen from his pocket. He drew two simple sketches in the margin of the service manual. (Figs. 3(a) and (b).)

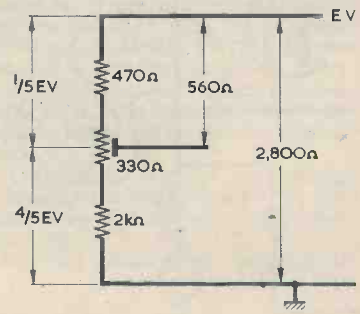
"The first of these sketches," he announced, "gives you the situation with the two silicon diodes. These are forward biased, which means that about 1.2 volts appears across the two of them in series. Now if the upper supply point at the top of the diodes is, say, 5 volts above the chassis, then 5 minus 1.2, or 3.8 volts, appears at the lower end of the two diodes. If, next, the upper supply point drops to 4 volts, you still have 1.2 volts across the diodes, with the result that 4 minus 1.2 volts, which is equal to 2.8 volts, appears at the lower end of the two diodes. So, a drop of 1 volt at the top of the diodes causes a drop of 1 volt at the bottom of the diodes. Okay?"

"Yes," confirmed Dick "I get that bit."

"Right," said Smithy briskly. "Now let's turn to the chain of resistors. Their total value comes to 2,800Ω and we can, for the sake of argument, adjust the potentiometer so that the resistance above its slider is 560Ω. This is one-fifth of 2,800Ω, with the result that one-fifth of the voltage applied to the chain appears above the slider and four-fifths of the voltage appears below the slider. Do you



(a)



(b)

Fig. 3 (a). The voltage at the lower end of the two silicon diodes in Fig. 1 is always 1.2 volts lower than that at the top
(b). On the other hand, the voltage at the slider of the pre-set potentiometer (assuming no direct connection to the lower transistor) is always a fraction of the voltage at the top

follow things so far?"

"Yes," replied Dick. "This seems pretty well okay up to now."

"Good," commented Smithy. "Now, as with the diodes let's start off by applying 5 volts to the chain of resistors. We will then get four-fifths of this, or 4 volts, between the pot slider and chassis. What happens when we reduce the 5 volts to 4 volts?"

"Why," replied Dick, slightly taken aback at this sudden question, "we'll have four-fifths of 4 volts between the pot slider and the chassis."

"And what's that?"

"Four-fifths of 4? Blimey now, this needs a spot of mental arithmetic! It's 4 times 4 over 5, which is 16 over 5. And that comes out to—let me see now—3 and a fifth."

"Good," said Smithy. "Or, if we work in decimals, we can say that four-fifths of 4 is 3.2. Assuming that the chain of resistors is not connected to the transistor base, a fall of 1 volt at the top would result in a drop of only 0.8 volt at the slider of the pot. At the same time, a drop of 1 volt, passed via the silicon diodes, causes a fall of 1 volt at the emitter of the BC109."

"I see what you're getting at now," said Dick excitedly. "You've shown that a voltage change at the top of the resistors is reduced due to potential divider action in the resistors. In the present instance the pot slider connects to the forward biased base-emitter junction of the BC109 and so we should think also of the current drawn from the pot slider by the transistor base. Since the voltage drop at the pot slider, when no current is drawn from it, is less than the voltage drop at the bottom of the two silicon diodes, it follows that when the pot slider *is* connected to the transistor base the voltage drop at the top causes that base to become marginally more positive with respect to the emitter than it was before. The result is that the transistor draws an increased collector current when the voltage applied to the motor falls."

Smithy gazed at his assistant benignly.

"There are moments." he said fondly, "when you exhibit a level of intelligence which raises you head and shoulders above the common rut of your own mediocrity."

Dick polished his finger nails on the lapel of his overall jacket.

"I'm not just a pretty face, you know," he replied modestly. "I've got brains I haven't even started using yet."

"I have little doubt of it." commented Smithy. "Anyway, let's get back to the transistor motor speed control circuit. We have now seen that, if the supply voltage falls, the collector current in the BC109 increases. This increasing collector current flows in the base of the AC128, and it turns this transistor harder on. The result is that a lower voltage appears across the emitter and collector of the AC128, this counteracting the original drop in supply voltage. The circuit will similarly counteract *rises* in supply voltage. These will cause reduced base current in the BC109 and, in consequence, the AC128. The latter will be turned less hard on, thereby allowing a higher voltage to appear across it and compensate for the rise in supply voltage."

VARYING MOTOR LOAD

"It seems to be," remarked Dick, "quite a neat little circuit. Are there any other things it can do?"

"As I mentioned earlier," replied Smithy, "it can also counteract changes in motor voltage due to varying mechanical load on the motor."

"How does it do that?"

"In rather the same manner as it counteracts supply voltage variations. If the load on the motor increases, the motor draws a larger current. This results in a bigger voltage drop across the series 2.4Ω resistor, and this voltage drop is passed to the emitter of the BC109 via the silicon diodes in the same way as before. The BC109 draws more current, thus turning the AC128 harder on, and so raising the voltage applied to the motor and causing it to maintain a constant speed."

"I suppose." suggested Dick, "that you initially set up the pot for the correct motor motor speed."

"That's right," agreed Smithy. "You check motor speed by running a test tape which has a tone of known frequency recorded on it. The pot is then adjusted such that the tone is reproduced at the correct frequency. Alternatively, you can check the time taken for a known length of tape to pass the capstan."

Smithy paused momentarily and scribbled some figures in the manual margin.

"Now, these cassette recorders," he resumed, "are usually 1⅞ inches per second, and so you can expect 56¼ inches of tape to take 30 seconds to pass through. After a few timed test runs it should be possible to arrive at a final pot setting which is quite accurate."

"I see," replied Dick. "Incidentally, is this motor speed control circuit used fairly widely in battery cassette recorders?"

"Yes, it is," said Smithy. "There are a number of British and European manufacturers who use the basic circuit. The values of individual resistors and the transistor types vary between different makes, of course, but those are the only major differences you'll encounter. I've also seen the circuit, in slightly more altered form, in a Japanese cassette recorder. In this case there are two silicon diodes in parallel instead of in series. This version of the circuit also has a thermistor in the lower end of the resistor chain." (Fig. 4.)

"Why have two diodes in parallel?" queried Dick. "Wouldn't one do?"

"The two diodes are dissimilar types," explained Smithy, "and they will be chosen to give the required overall forward characteristic. They may also assist in providing a level of temperature compensation. However, the thermistor will be the main component which looks after that particular department."

"Why do you need temperature compensation?"

"To guard against changes in the resistance of the motor windings as ambient temperature varies," explained Smithy. "This winding resistance will increase with temperature. When there is a thermistor in the lower part of the resistor chain, the

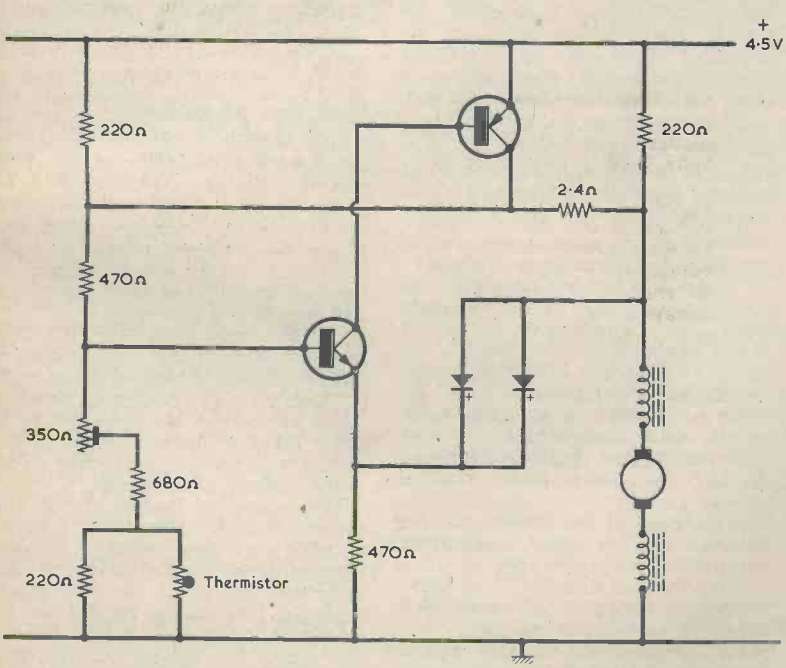


Fig. 4. An alternative version of the motor speed control circuit, as used in the Sanyo M508 cassette recorder. Both transistors here are silicon types

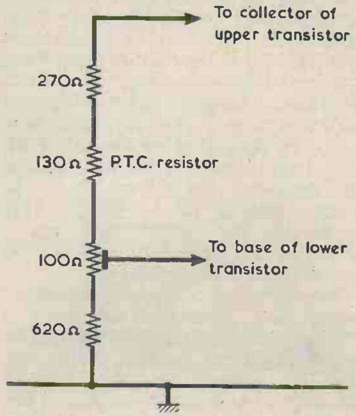


Fig. 5. Obtaining temperature compensation by means of a positive temperature coefficient resistor in the resistor chain. Component values shown are typical

resistance inserted by this component decreases as temperature goes up. This reduces the bias current in the lower transistor, the transistor passes less current and the circuit stabilizes with the upper transistor offering an increased effective resistance to compensate for the increased resistance of the motor windings. Another way of achieving the same effect, which is encountered in some European designs, consists of inserting a positive temperature coefficient resistor in the resistor chain *above* the pot. Its resistance increases with ambient temperature, thereby giving the same effect as a thermistor below the pot. Normally, the resistor is a wire-wound job using the same type of wire as is employed in the motor. This can result in very accurate temperature compensation." (Fig. 5.)

"Are there any other means of compensating for temperature changes?"

"The only other one I can think of at the moment," said Smithy, "consists quite simply of relying on the silicon diodes themselves. Normally, the forward voltage of a silicon diode falls slightly as its temperature goes up, which is just what is required in the circuit. The manufacturer chooses diodes which have the desired forward voltage and temperature characteristic."

With these words, Smithy put his pen back into his pocket, preparatory to returning to his own bench.

"Hey, hang on a minute," said Dick, recognising the signs, "I've still got a few more questions to ask you."

"Oh, all right then," replied Smithy resignedly, "but I hope they aren't ones that require long answers, I can't stay gassing away here all day long."

"What." asked Dick, "are the two chokes in series with the motor for?"

"They're to stop commutator noise from the motor getting onto the supply rails," said Smithy. "You may sometimes find capacitors of the order of 0.02μF in the motor supply circuit as well, these assisting in filtering out the noise. Some recorders seem to get by without either chokes or capacitors. Any more questions?"

FINAL QUESTION

"Yes," replied Dick, "there's just one final one. You haven't yet told me what that 560Ω resistor I changed actually does."

"As I said at the time," replied Smithy, "it's a switch-on resistor. Its function is simply to cause a small bias current to flow in the lower transistor when the circuit is switched on. This bias is sufficient to allow both transistors to start conducting and come up to their full operating condition. If you didn't have that resistor, both transistors would simply remain in the cut-off condition after the circuit had been turned on."

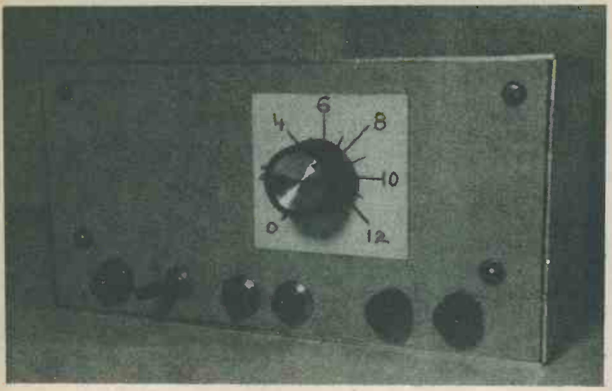
"Stap me," remarked Dick elegantly. "Then all that resistor does is merely turn the stabilizing circuit on!"

"That's right," confirmed Smithy. "And as soon as it's done that little job it takes no further interest in the proceedings and has no further effect in the working of the circuit."

Dick gazed at the resistor in the cassette recorder with newly aroused respect, whereupon Smithy took advantage of his silence to quietly slip away and return to his own much neglected labours. As he did so, he wondered how long it would be before, yet again, he would be standing alongside his assistant and explaining some further points in electronics.

Smithy sighed.

Life in the Workshop tended to be rather like that. ■



SWITCHED EARTH SUPPLY UNIT

by
Vincent S. Evans, G8EDM

THE AVERAGE ELECTRONIC HOBBYIST NEEDS A TABLE top power unit which he can use to supply whatever project or gadget he has in hand at the moment. It requires to be something better than a simple transformer and rectifier arrangement, but at the same time should not be too sophisticated and expensive to build. Nevertheless it must have a variable voltage output, and this voltage should be reasonably stable over a wide range of loadings.

STABLIZATION

Perhaps it should be explained for the beginner that a simple unstablized mains unit is usually designed to supply a specified voltage at a fixed load current. For example, a power supply unit of this type could provide 9 volts at 20mA for a small transistor receiver which requires this voltage and current. However, should an amplifier requiring, say 200mA at 9 volts be connected to the same power supply unit, its output voltage may well drop dramatically. The object of having a stabilized unit is to prevent this drop in voltage as the load current is increased.

The stabilized supply unit to be described will fulfil the requirements of the average constructor and is fairly easy to build. The output voltage is continuously variable from zero to 12 volts, and voltage stability is good for load currents up to 250mA. At 400mA loading there is a drop of 1 volt when the output is set to 12 volts off-load, and the voltage drop at this current is less than 1 volt when the output is adjusted for lower voltages. This performance is adequate for general purposes and, in addition, the output is to a considerable extent unaffected by fluctuations in mains voltage. It should be added that an output current of 400mA is the maximum that should be drawn from the supply unit.

The particular project to be supplied with power will have either a positive or negative common (or chassis) supply line. It is often advantageous, and in some instances necessary, for the power supply chassis line to be of the same polarity, and earthed. In other cases it is desirable that neither the positive nor negative output terminals of the supply unit be earthed so that they are, instead, 'floating'. Provision for all three requirements is made in the present design, which includes a 3-way switch capable of earthing either output terminal or of leaving both floating. To ensure that no mistakes are made when using the unit, the operating state is indicated visually by two pilot lights.

This stabilized power supply unit has an output that is continuously variable up to 12 volts. Either the positive or negative output terminal, or neither, may be earthed as desired.

THE CIRCUIT

The general configuration is a well-tried one, and incorporates a mains transformer with a secondary rated somewhat higher than the maximum stabilized output voltage and current figures required. The transformer employed by the author has a secondary rated at 15 volts r.m.s., 0.5 amp, and it is available from J. Bull (Electrical) Ltd., 7 Park Street, Croydon, CR0 1YD

The transformer is shown in the circuit diagram given in Fig. 1 as T1, and its secondary connects to a silicon bridge rectifier. This is specified in the Compo-

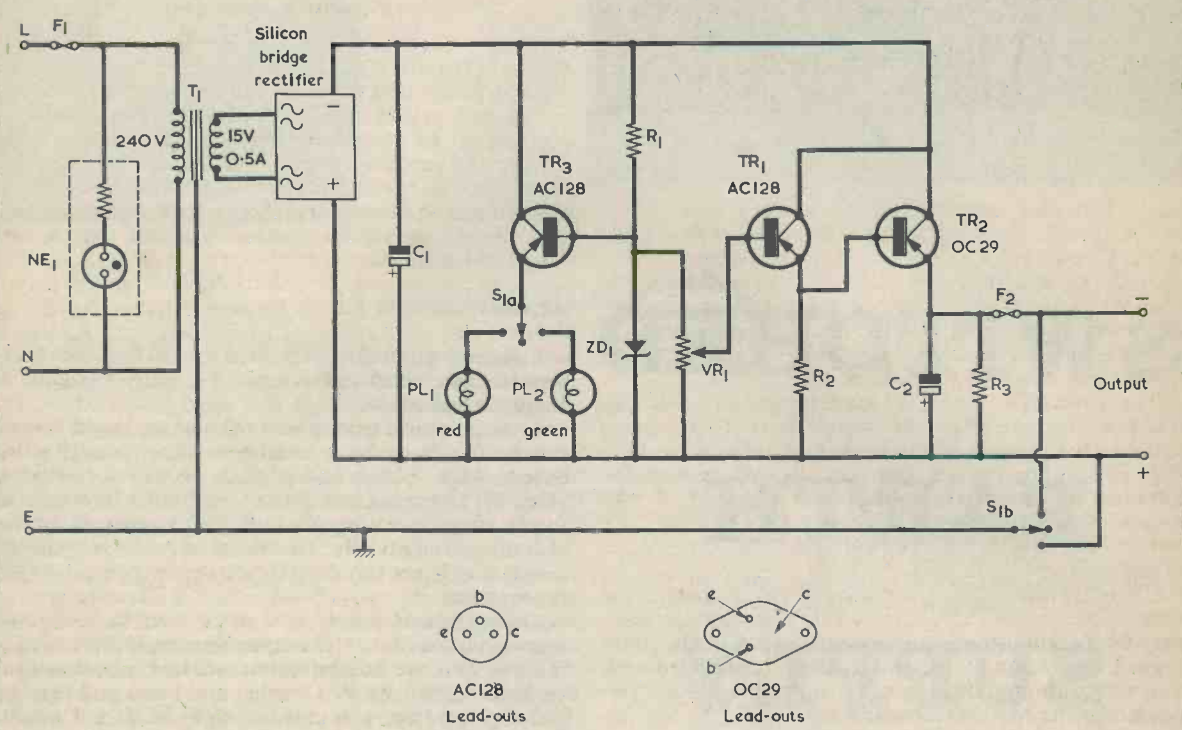


Fig. 1. The circuit of the stabilized power supply unit

COMPONENTS

Resistors
(All fixed values ½ watt 10%)

R1	680Ω
R2	1.2kΩ
R3	820Ω
VR1	20kΩ potentiometer, linear

Capacitors

C1	1,000μF electrolytic, 25 V. Wkg.
C2	500μF electrolytic, 15 V. Wkg.

Transformer

T1	Mains transformer, secondary 15V at 0.5A (see text)

Semiconductors

TR1	AC128
TR2	OC29
TR3	AC128
ZD1	13 Volt zener diode, 1 watt

Silicon bridge rectifier, 1A 25V (see text)

Pilot Lights

PL1, 2	14V 0.75 watt, l.e.s. (R.S. Components)

Neon

NE1	240V neon assembly, with integral series resistor, panel-mounting

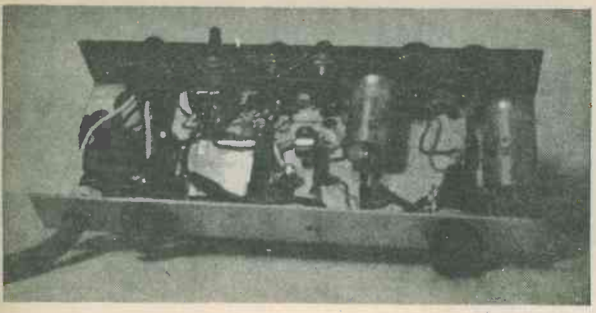
Switch

S1(a)(b)	d.p.d.t. centre-off, miniature, toggle

Fuses

F1, 2	500mA fuses, 30mm.

Miscellaneous
Panel-mounting l.e.s. bulb holder, red lens
Panel-mounting l.e.s. bulb holder, green lens
2 Fuseholders, panel-mounting, miniature (see text)
Pointer knob
Mica washer and insulating bushes (for TR2)
Wander plug socket, red
Wander plug socket, black
Materials for chassis and panel
3-core mains lead
Grommets, solder tags, etc.



A view of the chassis underside

nents List as 1 amp 25 volt. In practice, any silicon bridge rectifier rated at 1 amp (or more) and with a p.i.v. (peak inverse voltage) of 25 volts or more may be employed. (In general, the lowest p.i.v. rating likely to be encountered is 50 volts.) Modern small-sized electrolytic capacitors are used for the reservoir capacitor, C1, and the final smoothing capacitor, C2, to keep the overall unit small in dimensions.

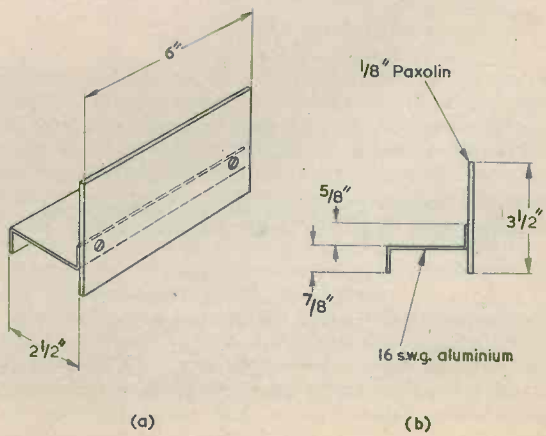
Transistors TR1 and TR2 are arranged as a Darlington pair d.c. amplifier, the overall current gain being equal to the product of the individual gains of the two. TR1 is a high gain type. The variable voltage output is obtained by varying the voltage on the base of TR1 by means of potentiometer VR1. Since TR1 and TR2 are both in the emitter follower configuration, the voltage at the emitter of TR2 is just a little lower than that on the base of TR1. The zener diode ZD1 maintains the voltage across VR1 at a fixed level. The potentiometer may be a carbon-track component instead of the more rugged wire-wound type, and its knob is provided with a scale calibrated in terms of output voltage. The potentiometer requires a linear track in order to provide even spacing in the scale calibration.

No heat sink is required for TR1. TR2, on the other hand, needs a large heat sink, to which it should be well coupled, since it can dissipate a significant amount of power when the supply unit is providing a high output current at low voltage. The heat sink, here, is provided by the chassis. Resistor R3, across C2, provides a discharge path for the capacitor, allowing it to discharge rapidly when the unit is switched off or when VR1 is adjusted to provide a lower voltage.

Two fuse points are provided, one at the mains input and one at the negative output terminal. The author employed miniature Eagle single-hole mounting fuseholders (available as Type 125 from Henry's Radio) fitted with 500mA 30mm. fuses. The mains input fuse protects against component breakdown, and the fuse in the output gives some protection against overload. Nevertheless, short-circuiting of the output should be avoided at all times.

S1 is a double-pole double-throw centre-off toggle switch. This is available in several makes, including the Bulgin Type S780 (Home Radio Cat. No. WS81). Section S1(b) connects either of the output terminals to chassis or it leaves them floating. S1(a) connects PL1 or PL2 to the emitter follower TR3 to indicate the state of the circuit. When PL1 is illuminated, the positive output terminal is earthed; when PL2 is illuminated, the negative output terminal is earthed; and when neither lamp is illuminated, the output terminals are floating. PL1 and PL2 are fitted in miniature l.e.s. panel-mounting holders, that for PL1 having a red lens and that for PL2 a green lens. The author employed R.S. Components 14V 0.75 watt lamps as it was found that 12V lamps of higher wattage tended to damage the plastic lenses of the miniature holders. These bulbs are available from any supplier of R.S. Components parts, including Chromasonic Electronics, 56 Fortis Green Road, London, N10 3HN. It is not advisable to employ bulbs drawing a higher current since excessive dissipation will then occur in TR3. The envelope of this transistor is clipped to the chassis by means of a small metal clamp to provide heat dissipation.

Fig. 2. (a) The assembled chassis and front panel
(b) Illustrating how the chassis is bent



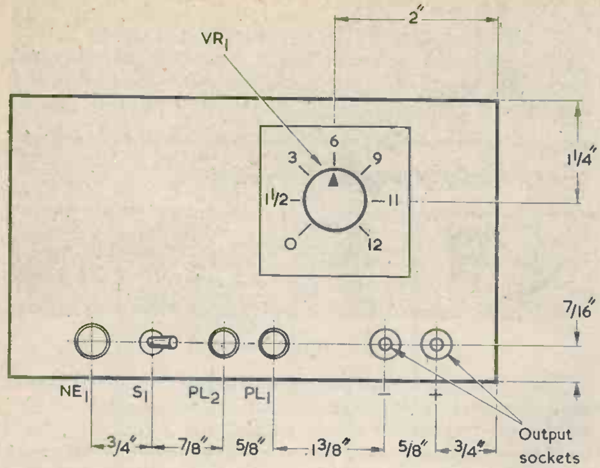


Fig. 3. The components mounted on the front panel

No mains on-off switch is shown in Fig. 1, and none was provided in the prototype. If such a switch is required, it may consist of a d.p.s.t. toggle type, and is inserted in the live and neutral mains input leads. It may be positioned at any convenient point on the front panel.

CONSTRUCTION

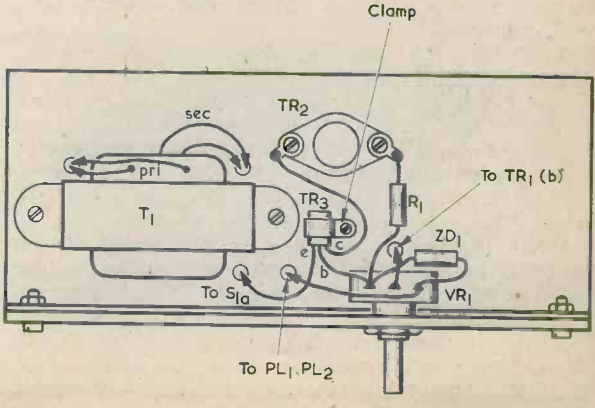
As will be gathered, the author went to some pains to obtain miniature components and thereby enable the whole unit to be reasonably small in size. It was possible, in consequence, to assemble the prototype in a case measuring 6 by 3½ by 2½in. Many readers may prefer to obtain standard sized components, where applicable, whereupon the chassis dimensions will need to be enlarged to suit. Even if miniature components are used, it is a wise precaution to obtain all of these before commencing on the front panel and metalwork. A check can then be made to see that the components will fit into the intended space. If not, the chassis dimensions can be enlarged as necessary.

The chassis and front panel are made up as shown in Figs. 2(a) and (b). The chassis is a piece of 16 s.w.g. aluminium with two folds, to which is bolted the front panel consisting of a sheet of ⅛in. Paxolin. Three holes are required at the chassis rear, these being for the fuseholders and the mains input lead. The latter must be fitted with a grommet. Three corresponding holes will be required in the back of the power supply case when this is fitted later. Fig. 3 shows the front panel layout and indicates the positioning of the front panel components. Wiring above the chassis is shown in Fig. 4, whilst Fig. 5 illustrates the below chassis connections and the positioning of the fuseholders.

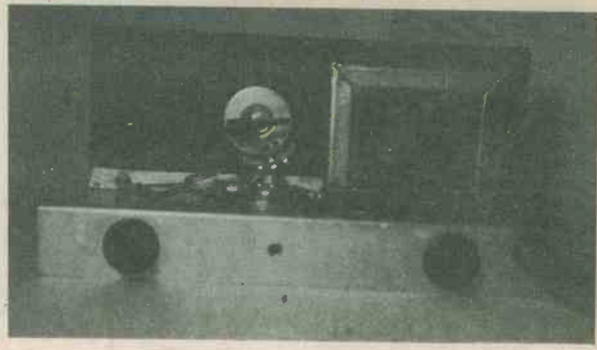
TR2 is insulated from the chassis and must be mounted with a mica washer and two insulating bushes. Care must be taken to ensure that the chassis surface presented to this transistor is flat, and that the mounting and lead-out holes for it are free from burrs. Note that a number of connections are made, both above and below the chassis, to solder tags secured under the bolts and nuts which hold TR2 in position. As was mentioned earlier, TR3 is held against the chassis by a small metal clamp.

It is possible that the primary and secondary tags of the transformer for T1 may be positioned differently to those shown in Fig. 4. The transformer tags should be identified before this component is wired in so that connections agree with the circuit diagram of Fig. 1. The same remarks apply to the bridge rectifier, the tags of which may have positioning different to that shown in Fig. 5. The 2-way terminal block in Fig. 5 may be cut from a flexible plastic terminal strip of the type available from radio and electrical retailers, or from the electrical counter of popular stores. A number of leads pass

Fig. 4. Wiring above the chassis. Connect the zener diode with the polarity shown in Fig. 1



The chassis as seen from the rear



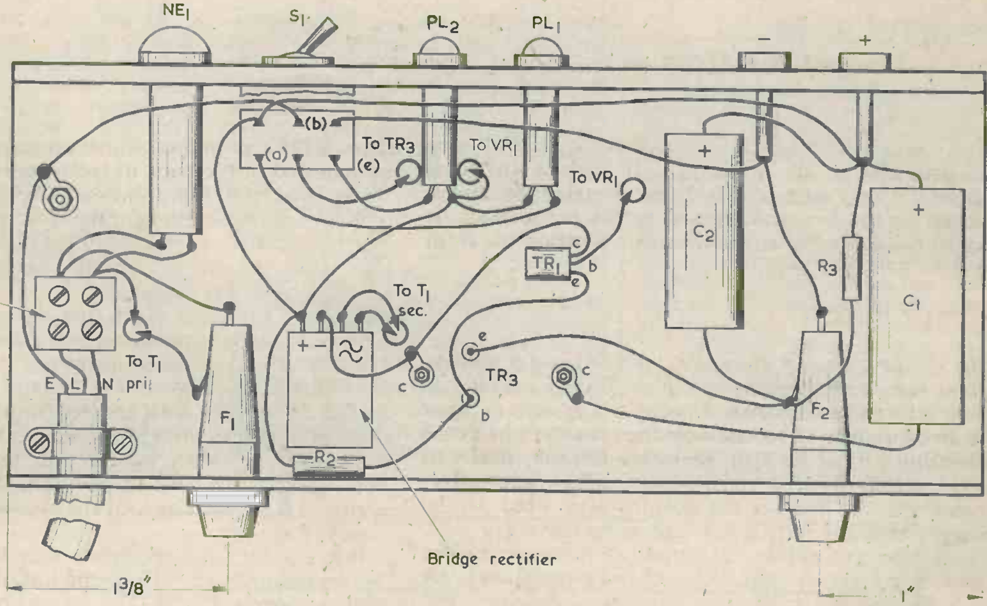


Fig. 5. Components and wiring underneath the chassis

through holes in the chassis. These holes should be fitted with grommets.

The mains lead must be a 3-core type, preferably terminated in a 3-way mains plug with an earth pin. It is a sensible precaution, when wiring is complete and before testing commences, to check that any exposed mains connections or joints are properly covered or taped to prevent accident. Also, all internal wiring should, be carefully checked, as an incorrect connection could damage one or more of the transistors.

When the unit is switched on and tested, it will probably be found that the maximum output voltage given by the unit will differ somewhat from the nominal voltage of the zener diode. This is due to spread, within tolerance, in the zener voltage plus the fact that a small voltage is dropped in the base-emitter junctions of TR1 and TR2. The author employed a zener diode with a nominal voltage of 13 and found that the maximum output available was 12 volts exactly. If several zener diodes are to hand, it may be found advantageous to check these in turn in the circuit, finally incorporating the one which gives best results, as indicated by a voltmeter connected across the output terminals. The mains supply must, of course, be switched off when changing diodes. It should be remembered that it is possible to use two lower voltage zener diodes in series, the effective total voltage being the sum of the two.

Calibration of the voltage scale, which consists of a disc or square of white card glued to the panel behind the knob of VR1, may finally be carried out, this being done with a reliable voltmeter connected across the output terminals. The scale is afterwards protected by painting with clear varnish. ■

Radio Topics

By Recorder

SEQUENTIAL TIMER

The accompanying diagram, issued by Motorola Semiconductors Limited, York House, Empire Way, Wembley, Middlesex, illustrates an ingenious method of obtaining sequential timing operations with the aid of unijunction transistors. The circuit automatically switches from one independent time delay to the next. Three time delays are shown in the diagram but the system can be expanded to include any number of time delays. If the final stage is coupled back to the first the system gives continual recycling.

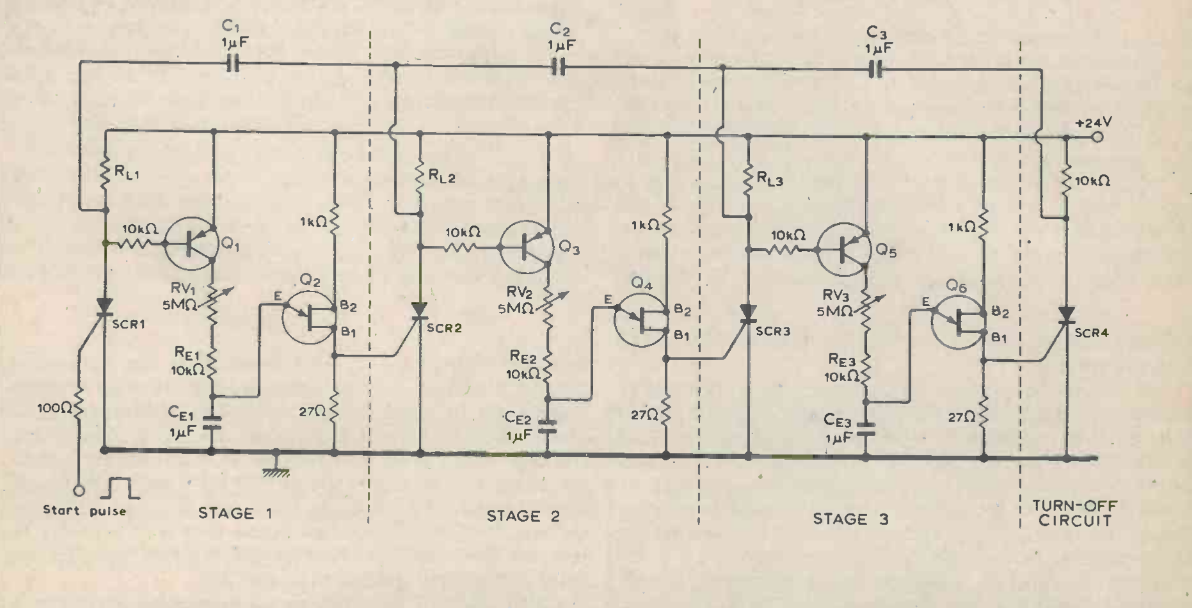
The circuit is started by applying a positive pulse to the gate of thyristor SCR1. This fires, drawing current through the first load resistor RL1 and biasing transistor Q1 into conduction. Q1 draws collector current through RV1 and RE1, charging timing capacitor CE1 in the process. The voltage across CE1 increases until it reaches the peak-point voltage for the unijunction transistor Q2. Q2 fires and causes a relatively large current to flow between its base 1 and base 2. The consequent positive pulse at the base 1 is fed to SCR2 which, in its turn, also fires, causing current to flow in the second load resistor RL2 and biasing transistor Q3 into conduction.

When SCR2 fires, the lower end of RL2 goes suddenly negative, and a negative pulse is fed back, via C1, to SCR1. This pulse turns off SCR1, with the result that the bias current to Q1 is removed and this transistor cuts off. Capacitor CE1 discharges into the emitter and base 1 of Q2 and the first section of the circuit reverts to its original state.

At the same time, the now conductive Q3 is causing the voltage across capacitor CE2 to rise. This, when it is sufficiently high, triggers the unijunction transistor Q4, and the process just described is repeated in the second and third stages of the circuit. The timing sequence comes to an end when the final thyristor, SCR4 in the diagram, fires and turns off SCR3. If the base 1 of Q6 is returned to the gate of SCR1 instead of to the gate of SCR4 the circuit continually recycles.

The time delays of each section are set by the values of RV, RE and CE, being adjustable by means of RV. With the components shown, the delays available are from 16 milliseconds to 8 seconds.

The circuit is designed around Motorola semiconductors, these being



A simple sequential timing circuit designed by Motorola Limited. Any number of sequential stages may be incorporated type BC350 for the transistors, MCR106–1 for the thyristors and 2N4871 for the u.j.t.'s. The type 2N4871 operates with a typical peak-point emitter current of only 1uA and the reverse emitter current at voltages below the peak-point level is typically as low as 0.005uA. The device is, in consequence, very suitable for timing applications where the charging capacitor couples directly to the emitter, since the emitter current prior to the peak-point is low enough to be negligible compared with the capacitor charging current.

SOLDER RISK

Although it is always wise to employ a heat shunt on the lead-outs when soldering transistors into circuit, there are plenty of occasions when many of us do not observe this simple and sensible precaution. Even when in such instances the soldering iron is applied and removed quickly, there is still a risk of damage to the transistor for a reason which is rarely mentioned.

If, due to previous connections or to excessive zeal in applying the solder, there is a large mass of solder at the connection point for the transistor, that mass of solder will retain its heat for a surprisingly long period after the removal of the iron. This heat can travel up the lead-out wire of the transistor and it may cause internal damage. It should be noted that it is not the heat which is present at the joint when the iron is applied that results in the damage, it is the heat remaining in the large mass of solder after the iron has been taken away.

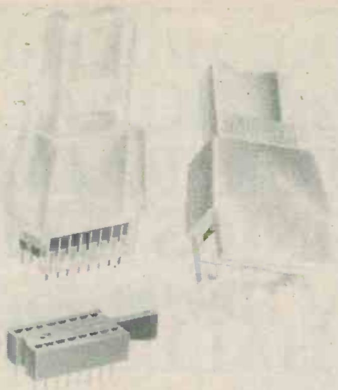
Methods of avoiding this trouble are, of course, obvious. First, try to prevent the appearance of excessively large quantities of solder at the points to which transistors connect. Second, play it safe in any case by using a heat shunt.

I.C. INSERTER

My photograph illustrates the type A23-2050 integrated circuit insertion tool which is now available from Jermyn Manufacturing, Vestry Estate, Sevenoaks, Kent. This enables 14 and 16 lead d.i.p.'s to be rapidly and safely inserted into sockets and printed circuit boards. The letters 'd.i.p.', incidentally, indicate dual-in-line for plastic-encapsulated integrated circuits.

Using the device is simplicity itself. An integrated circuit is loaded into the base of the tool, which automatically adjusts its leads to the correct pitch of 0.3 in. The i.c. leads are then located over the socket or printed circuit board, whereupon the tool's plunger is operated to insert the i.c. by applying light finger pressure only.

The base of the tool is made of a transparent material, thus facilitating visual alignment of the i.c. leads. Furthermore, no metal parts are used in its construction, so that i.c.'s can be



The Jermyn Manufacturing Division's A23-2050 and A23-2050P integrated circuit insertion tools

inserted into live sockets if required without danger of causing short-circuits.

A special gold-plated version of the tool (the type A23-2050P) is also available. This is employed for inserting MOS devices, where it is essential for the i.c. leads to be short-circuited together during insertion.

AUTOMATIC SIGNAL GENERATOR

In our last May issue we published an article under the title 'Automatic Signal Generator'. This described an experimental signal generator whose output was always at the aerial input frequency of the receiver being aligned. The effect was achieved by extracting an output from the receiver oscillator and mixing this, in the signal generator, with an oscillator running at the receiver intermediate frequency. We added an introduction to the article which referred to it as being an original idea.

We should have known that almost all claims to originality in electronics are liable to result in the production of evidence that the idea has been thought of before! So it has turned out with the automatic signal generator principle, and several readers have kindly pointed out to us that a similar type of signal generator was described during World War II in the *R.S.G.B. Bulletin*. The material concerned appeared under the title 'The Synthescope' in the December 1943 and February 1944 issues of the *Bulletin*, and was written by R. H. Hammans G2IG. We are only too happy to bring the record straight and give credit for the idea to G2IG. ■

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(Continued on page 203)

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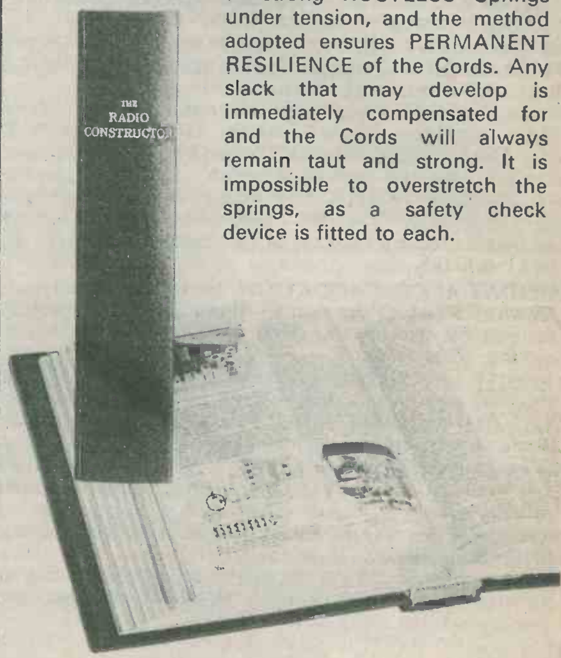

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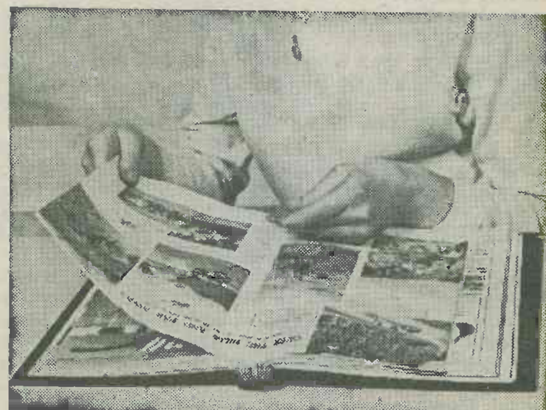

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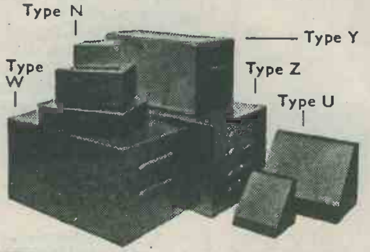
Type N has removable bottom, Type U removable bottom or back, Type W removable front, Type Y all screwed construction, Type Z removable back and front. *Plus p.&p.*



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Size	Price	Base	Size	Price	Base
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7x4x1½"	33p	18p	12x7x2½"	66p	33p
7x5x2"	40p	19p	12x9x2½"	76p	38p
8x4x2"	38p	19p	13x8x2½"	76p	38p
8½x5½x2"	44p	21p	14x7x3"	80p	36p
9x7x2"	50p	26p	14x10x2½"	88p	47p
10x4x2½"	50p	21p	15x10x2½"	92p	50p
12x4x2½"	55p	22p	17x10x3"	£1.10	55p
12x5x3"	66p	26p	*Plus post and packing*		

TO FIT OUR CASES

Size	Price	Base	Size	Price	Base
7x5¾x1½"	38p	21p	12x6¾x2"	60p	33p
7x5¾x2"	43p	21p	14x8¾x2"	74p	44p
11x6¾x1½"	48p	30p	15¾x9¾x2½"	94p	52p
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PANELS: Any size up to 3ft. at 36p sq. ft. 16 s.w.g. (18 s.w.g. 32p). *Plus postage and packing*

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A TOTAL OF 610 RESISTORS

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SMALL SCREENED WIRE, 10 yds. ⅛" DIA. ..	50p
MIN. GEN. PURPOSE SWITCHING DIODE	25 for 25p
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	3.75" x 3.75" ..	25p
	2.5" x 1"	2 for 12p
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	2.5" x 3.75" ..	17p
	3.75" x 5" ..	30p
	3.75" x 3.75" ..	25p
	2.5" x 1"	2 for 12p
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	2.5" x 3.75" ..	11p
	5" x 3.75" ..	20p

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Meter Shunts II

The Table lists shunt values, to 3 significant figures, for meter resistances from 25Ω to 1,500Ω. Multiplying factors are in the series 2.5×5×25, and may be used in conjunction with the 10, 100 and 1,000 factors given in Data Sheet No. 66. As an example, the shunt required to cause a 1,250Ω 0-100μA meter to read 5mA f.s.d. is 25.5Ω.

Meter Resistance	X2.5	X5	X25	X50	X250	X500	X2,500
25Ω	16.7Ω	6.25Ω	1.04Ω	0.510Ω	0.100Ω	0.0501Ω	0.0100Ω
50Ω	33.3Ω	12.5Ω	2.08Ω	1.02Ω	0.201Ω	0.100Ω	0.0200Ω
75Ω	50.0Ω	18.8Ω	3.13Ω	1.53Ω	0.301Ω	0.150Ω	0.0300Ω
100Ω	66.7Ω	25.0Ω	4.17Ω	2.04Ω	0.402Ω	0.200Ω	0.0400Ω
250Ω	167Ω	62.5Ω	10.4Ω	5.10Ω	1.00Ω	0.501Ω	0.100Ω
500Ω	333Ω	125Ω	20.8Ω	10.2Ω	2.01Ω	1.00Ω	0.200Ω
750Ω	500Ω	188Ω	31.3Ω	15.3Ω	3.01Ω	1.50Ω	0.300Ω
800Ω	533Ω	200Ω	33.3Ω	16.3Ω	3.21Ω	1.60Ω	0.320Ω
850Ω	567Ω	213Ω	35.4Ω	17.3Ω	3.41Ω	1.70Ω	0.340Ω
900Ω	600Ω	225Ω	37.5Ω	18.4Ω	3.61Ω	1.80Ω	0.360Ω
950Ω	633Ω	238Ω	39.6Ω	19.4Ω	3.81Ω	1.90Ω	0.380Ω
1,000Ω	667Ω	250Ω	41.7Ω	20.4Ω	4.02Ω	2.00Ω	0.400Ω
1,100Ω	733Ω	275Ω	45.8Ω	22.4Ω	4.42Ω	2.20Ω	0.440Ω
1,200Ω	800Ω	300Ω	50.0Ω	24.5Ω	4.82Ω	2.40Ω	0.480Ω
1,250Ω	833Ω	313Ω	52.1Ω	25.5Ω	5.02Ω	2.51Ω	0.500Ω
1,300Ω	867Ω	325Ω	54.2Ω	26.5Ω	5.22Ω	2.61Ω	0.520Ω
1,400Ω	933Ω	350Ω	58.3Ω	28.6Ω	5.65Ω	2.81Ω	0.560Ω
1,500Ω	1,000Ω	375Ω	62.5Ω	30.6Ω	6.02Ω	3.01Ω	0.600Ω