RADIO & ELECTRONICS CONSTRUCTOR

DECEMBER 1973 20p

THE 'WYVERN' 30 WATT STEREO AMPLIFIER

ALSO FEATURED

DIRECT READING TRANSISTOR CHECKER

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

MAINS POWER SUPPLY UNIT. 400m/A, 6-7.5-9-12 VOLT MADE TO SELL AT £5.25 OUR PRICE £3.50

VALVE BASES

Chassis or printed circuit B9A – B7G	3p
Chassis UX7 – UX5 – B9G	3p
Shrouded chassis B7G – B9A	4p
B11A chassis (relay)	8p
B8A chassis	5p

TAG STRIP 6 way **2p** Single **1p**

WRIST COMPASS 20p with Needle Lock

TO3 Mica Washer 2p
3" Standard Tape - Boxed 15p
GP91-1 Cartridge. turnover stylii 65p
GC10/4B Cold Cathode £5.00
Brand New Boxed 6K7G 25p

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, 2¼" long, hollow centre	10p
Relay, P.O. 3000 type, 1,000 OHM coil, 4 pole c/o	60p
R.S. 12 way standard plug and shell	50p

SWITCHES

Pole	Way	Type	
4	2	Sub. Min. Slide	10p
6	2	Slide	15p
4	2	Lever Slide	10p
6	4	Wafer Rotary	12p each
4	3	Wafer Rotary	12p each
3	7	Wafer Rotary	12p each
2	5	Wafer Rotary	12p each
1	3	+ off Sub. min. edge	10p
1	3	13 amp small rotary	12p
2	2	Locking with 2 to 3 keys	£1.50
2	1	2 Amp 250V A.C. rotary	20p
1	2	Toggle	10p

COMPUTER AND AUDIO BOARDS

HOST OF QUALITY, REASONABLE LEAD TRANSISTORS, SOME POWER. SILICON, GERMANIUM, ZENER DIODES, POT CORES HI-STAB RESISTORS, SOME WIREWOUND, CONDENSERS, CHOKES, TRIMPOTS, ELECTROLYTICS, ETC.
3lb. for **75p** + **25p** post and packing
7lb. for **£1.50** + **40p** post and packing

SUBMIN VERTICAL SKELETON PRESET 100, 220, 470, 680 OHM 1, 2.2, 4.7, 6.8, 10, 15, 22, 47, 68, 100, 220 K OHM. ONLY 1½p EACH

KNOBS

SILVER METAL PUSH ON WITH POINTER, OR WHITE PLASTIC, GRUB SCREW, WITH POINTER AND SILVER CENTRE 5p EACH.

ZM1162A INDICATOR TUBE

0-9 Inline End View. Rectangular Envelope 170V 2.5M/A £1.70

RESETTABLE COUNTER

English Numbering Machines LTD.
MODEL 4436-159-989
6–14 volt, 6 digit, illuminated, fully enclosed. £2.50

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

WIREWOUND POTS

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

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

THERMISTORS

VA1040, VA1055, VA1066, VA1100 10p each
VA1077 13p

STEEL BOX WITH LID

10 x 5½ x 3" grey hammer finish £1

RELAYS

6 volt, 2 pole c/o heavy duty contacts 50p
Mains 3 pole c/o heavy duty contacts ex equipment 35p

ELECTROLYTICS

Mullard C426, TCC, CRL, CCL, Cullins, Hunts, STC Subminiature, etc.
MFD/VOLT 2p 100/6, 6/3, 8/6, 200/3, 25/3.
3p 25/6.4, 500/6, 250/6.
4p 20/12, 100/25, 100/12, 100/15, 64/10, 125/10, 50/50, 50/10, 100/18, 6/25, 2/350.
9p 8/500, 100/200. 400/40, 100/250-275.
5p 8/50, 8/20, 8/40, 2.5/64, 12/50, 12/20, 10/20, 16/50, 16/40, 25/25, 50/25, 150/12, 150/25, 260/12, 4/60, 15/35.
6p 250/18, 400/16, 250/30, 550/12.
50p 8/800, 12,000/12.
20p 100-100/150, 100-100/275.

INDICATORS

Arcolectric green, takes M.E.S. bulb	10p
Bulgin D676 red, takes M.E.S. bulb	15p
12 volt red, small pushfit	15p
Mains neon, amber, green or red, pushfit	15p

CAPACITORS

Mixed type **PFDS, 2p.** 3.3, 4.7, 10, 16, 18, 22, 24, 25, 27, 30, 37, 39, 47, 50, 56, 68, 88, 100, 110, 150, 200, 220, 250, 270, 300, 350, 470, 500, 600, 680, 800, 1000, 2200, 3000, 3300, 5000.
Poly, met., film, paper, etc. MFD/Volt, **3p.** .001/1250, .03/350, .022/70, .03/12, .033/100, .0068/70, .056/350, .061/350, .069/350, .075/350, .08/350, .1/350, .1/500, .13/350, .25/150.
4p. 1500, 1800, 2200, 3000, 3300, 6800, 8200 PFD. .01/350, .013/350, .02/250, .05/125, .25/350.
5p. .033/100, .1/250, .25/500, .5/350.
6p. .1/600, .1/1500, .22/250.
10p. .01/1000, 1/350, 2/150, 2/200, 2/250.
40p. 5/150, 9/275AC, 10/150, 15/150, 40/150.

TRIMMERS, 10p each

100PF Ceramic, 30PF Beehive, 12PF PTFE, 2500PF 750 volt, 33PF MIN. AIR SPACED.

CONNECTOR STRIP

Belling Lee L1469, 12 way polythene. **5p each**

CAN CLIPS

1" or 1⅜" or ¾" 2p

LABGEAR MAINS DROPPER

36 ohm 25 watt + 79 ohm 9 watt 15p

TUNING CONDENSERS 33 or 50PF, **20p**

PAXOLINE

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 Transistor Type 20p

3 pin din to open end, 1½yd twin screened lead 35p

10 mtrs loudspeaker extension lead fitted 2 pin din plug and socket **40p** (retail 80p)

THE RADIO SHACK

161 ST. JOHNS HILL, BATTERSEA, LONDON S.W.11
Open 10 a.m. till 7 p.m. Monday to Saturday Phone 01-223 5016
If payment by cheque allow time for clearance, otherwise by return.

SEMICONDUCTORS

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

AC127	12p	BCY70	13p	BF183	28p
AC187/8	12p	BCY71	20p	BF184/5	17p
AD149	35p	BCY72	8p	BF194/5/6/7	12p
AD161/2	26p	BD115	62p	BF262/3	22p
AF116/7	12p	BD131	40p	BFX29/30	25p
AF139	31p	BD132	50p	BFX84	24p
AF178	32p	BD135	33p	BFX88	20p
AF180	40p	BD203	£1.00	BFY50/1/2	13p
AF239	37p	BD232	65p	BSV64	40p
BC107A or C	10p	BD234/5	48p	BSX21	20p
BC107/8/9	7p	BF115	20p	BU105/01	£1.30
BC147/8/9	8p	BF167	20p	OC35	34½p
BC148B/9B	10p	BF173	20p	TAA570	1-50p
BC157/8/9	11p	BF178	25p	2N706	10p
BC178	14p	BF179	30p	2N2219	20p
BC186/7	22p	BF180	20p	2N2401 (ASY26-27)	25p
BCY40	25p	BF181/2	32p	2N2904	18p
2N2905	22p	2N3053	15p		
2N2906	18p	2N3055	35p		
2N2907	20p				

THYRISTORS

Amp	Volt		
1	240	BTX18-200	30p
1	240	BTX30-200	30p
6.5	300	BT102-300R	42p
6.5	500	BT102-500R	60p
6.5	500	BT107	90p
6.5	500	BT108	90p
6.5	500	BT101-500R	68p
6.5	500	BT109-500R	90p
20	600	BTW92-600RM	£3.00
15	800	BTX95-800R Pulse Modulated	£12

BRIDGE RECTIFIERS

Amp	Volt RMS		
½	1,600	BYX10	30p
1	140	OSH01-200	25p
1.4	42	BY164	35p
		Plastic types	
2	30	LT120	30p
0.6	6-110	EC433 Encapsulated with built-in heat sink	15p

OTHER DIODES

Centercel	5p
IN916	4p
BA145	15p
BA182	24p

5 pin and 6 pin 240° (Type B) Metal Chassis Din Sockets 6p

TRIACS

Amp	Volt		
6	400	BT110-400 Plastic	75p
25	900	BTX94-900	£6.50
25	1200	BTX94-1200	£9

DIAC BRI00 30p

CQ11B Infra red transmitter £4

WESTINGHOUSE 28TIO 30 AMP 1000 VOLT THYRISTER WITHOUT NUT £5

PHOTO SILICON CONTROLLED SWITCH

BPX66 PNPN 10 amp £1

1 AMP RECTIFIERS

IN4002	100 volt	4p
IN4003	200 volt	5p
IN4004	400 volt	6p
IN4005	600 volt	7p
IN4006	800 volt	8p
IN4007	1,000 volt	8p

HIGH POWER RECTIFIERS

	Amp	Volt	
LT102	2	30	10p
BYX38-600	2.5	600	25p
BYX38-300	2.5	300	20p
BYX38-900	2.5	900	28p
BYX38-1200	2.5	1,200	30p
BYX49-600	2.5	600	25p
BYX49-300	2.5	300	20p
BYX49-900	2.5	900	28p
BYX48-300	6	300	27p
BYX48-600	6	600	32p
BYX48-900	6	900	40p
BYX48-1200	6	1,200	60p
BYX72-150R	10	150	24p
BYX72-300R	10	300	35p
BYX72-500R	10	500	43p
BYX42-300	10	300	40p
BYX42-600	10	600	45p
BYX42-900	10	900	55p
BYX42-1200	10	1,200	75p
BYX46-300*	15	300	£2.50
BYX46-400*	15	400	£2.90
BYX46-500*	15	500	£3.20
BYX46-600*	15	600	£3.80
BYX20-200	25	200	35p
BYX52-300	40	300	£1.75
BYX52-1200	40	1,200	£2.25

*Avalanche type

N50 ohm free plug (UG21D/U) 50p
N50 ohm square socket (UG58A/U) 50p

1" Terryclips black plastic coated, or chrome finish 4p

Cinch 10-way terminal block 15p

Pair of LA2407 Ferrox cores with adjuster 25p

Chrome Car Radio facia 15p
Rubber Car Radio gasket 10p

DLI Pal Delayline £2.00

Relay socket 12p
Take miniature 2PCO relay

B9A valve can 2p

0–30 in ·5 segments, black pvc, 360° dial, silver digits, self adhesive, 4½" dia. 15p

OPTO ELECTRONICS

ORP12	48p
BPX40	25p
BPX42	£1
BPY10	£1.50
BPY68	75p
BPY69	£1
BPY77	75p
Diodes	

Photo transistor
BPX29 80p
OCP71 £1

RED L.E.D.
2v 50m/A max.
4½ mm diam. 25p

PNPN PROGRAMMABLE UNIJUNCTION

BRY39 30p

F.E.T's

BFW10	25p
BSV79	90p
BSV80	80p
N. Channel	
BSV81 M.O.S.T.	£1
BFS28 Dual M.O.S.T.	90p

Plastic, Transistor or Diode Holder 1p
Transistor or Diode Pad 1p

PAPER BLOCK CONDENSER

0.25MFD	800 volt	30p
1MFD	400 volt	15p
2MFD	250 volt	20p
2MFD	1.5 kv	50p
15MFD	150 volt	25p

ALL ORDERS OVER £3 POST FREE OVER £6 V.A.T. FREE

TAA300 T0-74 1 Watt A.F. AMPLIFIER I.C. 4·5 to 9v £1.62½

WIREWOUND SLIDER

150 Ohm, 250 Ohm 5K 4p each

HANDLES

Rigid light blue nylon 6¼" with secret fitting screws 5p

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

DEE PLUG

McMurdo DA15P 15 way chassis plug 20p

Fairway 18009 Coax. socket 5p

TIE CLIPS

Nylon self locking 3½" 1p; 7" 2p

CINCH 150

12 way edge socket 10p

Phillips Iron Thermostat 15p

Bulgin 2-pin flat plug and socket 10p

McMurdo PP108 8 way edge plug 15p

300 ohm moving coil insert 4103D 1¾" diameter. Make ideal mike or speaker for communication work 25p

8 way Cinch standard 0.15 pitch edge socket 20p

U.E.C.L. 10 way pin connector 2B6000 OA1P10 20p

U.E.C.L. 20 way pin connector 2A60000A1P20 30p

U.E.C.L. 10 way pin socket 2B606001R10 20p

U.E.C.L. 20 way pin socket B260800A1R20 30p

BELLING LEE L1354 TV Aerial diplexer 10p

Tested unmarked or marked ample lead ex new equipment

AC128	6p	OC71/2	6p
ACY17-20	8p	OC200-5	6p
ASY28/9	8p	2G302	6p
ASZ21	8p	2N2926	5p
BCY70/1/2	8p	2N598/9	6p
BCY30-34	10p	2N1091	8p
BY127	8p	2N1302	8p
BZY88 series	6p	Germ. diode	3p
OA5/7/10	10p	GET111	20p
OA47/81	4p	GET120 (AC128 In 1" sq. heat sink)	20p
OA200-5	5p		
OC23	20p		
OC29	25p	100v 1 amp	
OC44	6p	diode	3p

SMALL ORDERS, ENCLOSE SUITABLE STAMPED ADDRESSED ENVELOPE
LARGE ORDERS, ADD SUFFICIENT FOR POSTAGE, INSURANCE, ETC.
TOTAL GOODS PLUS CARRIAGE, ADD 10% V.A.T.

THE RADIO SHACK

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

BRAND NEW FULLY GUARANTEED DEVICES

Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price	Type	Price
AC107	0.22	AD161 &		BC150	0.20	BD131	0.55	BF182	0.44	MAT121	0.22	2G304	0.27	2N2148	0.63	2N3055	0.55	2N4060	0.13
AC113	0.20	AD162(MP)	0.75	BC151	0.22	BD132	0.66	BF183	0.44	MJE2955	0.95	2G306	0.44	2N2160	0.66	2N3391	0.16	2N4061	0.13
AC115	0.22	ADT140	0.55	BC152	0.19	BD133	0.72	BF184	0.28	MJE3055	0.62	2G308	0.39	2N2192	0.39	2N3391A	0.18	2N4062	0.13
AC117K	0.32	AF114	0.27	BC153	0.31	BD135	0.44	BF185	0.33	MJE3440	0.55	2G309	0.39	2N2193	0.39	2N3392	0.16	2N4284	0.19
AC122	0.13	AF115	0.27	BC154	0.33	BD136	0.44	BF187	0.30	MPF102	0.46	2G339	0.22	2N2194	0.39	2N3393	0.16	2N4285	0.19
AC125	0.19	AF116	0.27	BC157	0.20	BD137	0.50	BF188	0.44	MPF104	0.41	2G339A	0.18	2N2217	0.24	2N3394	0.16	2N4286	0.19
AC126	0.19	AF117	0.27	BC158	0.13	BD138	0.55	BF194	0.13	MPF105	0.41	2G334	0.20	2N2218	0.22	2N3395	0.19	2N4287	0.19
AC127	0.20	AF118	0.39	BC159	0.13	BD139	0.61	BF195	0.13	OC19	0.39	2G345	0.18	2N2219	0.22	2N3402	0.23	2N4288	0.19
AC128	0.20	AF124	0.33	BC160	0.50	BD140	0.66	BF196	0.16	OC20	0.70	2G371	0.18	2N2220	0.24	2N3403	0.23	2N4289	0.19
AC132	0.16	AF125	0.33	BC161	0.55	BD155	0.88	BF197	0.16	OC22	0.52	2G371B	0.13	2N2221	0.22	2N3404	0.31	2N4290	0.19
AC134	0.16	AF126	0.31	BC167	0.13	BD175	0.66	BF200	0.50	OC23	0.54	2G373	0.19	2N2222	0.22	2N3405	0.46	2N4291	0.19
AC137	0.16	AF127	0.31	BC168	0.13	BD176	0.66	BF222	£1.05	OC24	0.62	2G374	0.19	2N2368	0.19	2N3414	0.17	2N4292	0.19
AC141	0.20	AF139	0.33	BC169	0.13	BD177	0.72	BF257	0.50	OC25	0.42	2G377	0.33	2N2369	0.16	2N3415	0.17	2N4293	0.19
AC141K	0.32	AF178	0.55	BC170	0.13	BD178	0.72	BF258	0.66	OC26	0.32	2G378	0.18	2N2369A	0.16	2N3416	0.31	2N5172	0.13
AC142	0.20	AF179	0.55	BC171	0.16	BD179	0.77	BF259	0.94	OC28	0.55	2G381	0.18	2N2411	0.27	2N3417	0.31	2N5294	0.60
AC142K	0.28	AF180	0.55	BC172	0.16	BD180	0.77	BF262	0.61	OC29	0.55	2G382	0.18	2N2412	0.27	2N3525	0.83	2N5457	0.35
AC151	0.17	AF181	0.55	BC173	0.16	BD185	0.72	BF263	0.61	OC35	0.46	2G401	0.33	2N2646	0.52	2N3614	0.74	2N5458	0.35
AC154	0.22	AF186	0.55	BC174	0.16	BD186	0.72	BF270	0.39	OC36	0.55	2G414	0.33	2N2711	0.23	2N3615	0.82	2N5459	0.44
AC155	0.22	AF239	0.41	BC175	0.24	BD187	0.77	BF271	0.33	OC41	0.22	2G417	0.28	2N2712	0.23	2N3616	0.82	2N6211	0.75
AC156	0.22	AL102	0.72	BC177	0.21	BD188	0.77	BF272	0.88	OC42	0.27	2N388	0.39	2N2714	0.23	2N3464	0.10	2S301	0.55
AC157	0.27	AL103	0.72	BC178	0.21	BD189	0.83	BF273	0.39	OC44	0.17	2N388A	0.61	2N2904	0.19	2N3702	0.13	2S302A	0.46
AC165	0.22	ASY26	0.28	BC179	0.21	BD190	0.83	BF274	0.39	OC45	0.14	2N404	0.22	2N2904A	0.23	2N3703	0.13	2S302	0.46
AC166	0.22	ASY27	0.33	BC180	0.27	BD195	0.94	BFW10	0.66	OC70	0.11	2N404A	0.31	2N2905	0.23	2N3704	0.14	2S303	0.61
AC167	0.22	ASY28	0.28	BC181	0.27	BD196	0.94	BFX29	0.30	OC71	0.11	2N524	0.46	2N2905A	0.23	2N3705	0.13	2S304	0.77
AC168	0.27	ASY29	0.28	BC182	0.11	BD197	0.99	BFX84	0.24	OC72	0.16	2N527	0.54	2N2906	0.17	2N3706	0.13	2S305	0.86
AC169	0.16	ASY50	0.28	BC182L	0.11	BD198	0.99	BFX85	0.33	OC74	0.16	2N598	0.46	2N2906A	0.20	2N3707	0.14	2S306	0.86
AC176	0.22	ASY51	0.28	BC183	0.11	BD199	£1.05	BFX86	0.24	OC75	0.17	2N599	0.50	2N2907	0.22	2N3708	0.09	2S307	0.86
AC177	0.27	ASY52	0.28	BC183L	0.11	BD200	£1.05	BFX87	0.27	OC76	0.17	2N696	0.14	2N2907A	0.24	2N3709	0.10	2S321	0.62
AC178	0.31	ASY54	0.28	BC184	0.13	BD205	0.88	BFX88	0.24	OC77	0.28	2N697	0.15	2N2923	0.16	2N3710	0.10	2S322	0.46
AC179	0.31	ASY55	0.28	BC184L	0.13	BD206	0.88	BFY50	0.22	OC81	0.17	2N698	0.27	2N2924	0.16	2N3711	0.10	2S322A	0.46
AC180	0.22	ASY56	0.28	BC186	0.31	BD207	£1.05	BFY51	0.22	OC81D	0.17	2N699	0.39	2N2925	0.16	2N3819	0.31	2S323	0.62
AC180K	0.32	ASY57	0.28	BC187	0.31	BD208	£1.05	BFY52	0.22	OC82	0.17	2N706	0.09	2N2926(G)	0.14	2N3820	0.55	2S324	0.77
AC181	0.22	ASY58	0.28	BC207	0.12	BDY20	£1.10	BFY53	0.19	OC82D	0.17	2N706A	0.10	2N2926(Y)	0.12	2N3821	0.39	2S325	0.77
AC181K	0.32	ASY73	0.28	BC208	0.12	BF115	0.27	BPX25	0.94	OC83	0.22	2N708	0.13	2N2926(O)	0.11	2N3823	0.31	2S326	0.77
AC187	0.24	ASZ21	0.44	BC209	0.13	BF117	0.50	BSX19	0.17	OC139	0.22	2N711	0.33	2N2926(R)	0.11	2N3903	0.31	2S327	0.77
AC187K	0.25	BC107	0.12	BC212L	0.12	BF118	0.77	BSX20	0.17	OC140	0.22	2N717	0.39	2N2926(B)	0.11	2N3904	0.33	2S701	0.46
AC188	0.24	BC108	0.12	BC213L	0.12	BF119	0.77	BSY25	0.17	OC169	0.28	2N718	0.27	2N3010	0.77	2N3905	0.31	40361	0.44
AC188K	0.25	BC109	0.12	BC214L	0.16	BF121	0.50	BSY26	0.17	OC170	0.28	2N718A	0.55	2N3011	0.16	2N3906	0.30	40362	0.50
ACY17	0.28	BC113	0.11	BC225	0.28	BF123	0.55	BSY27	0.17	OC171	0.28	2N726	0.31	2N3053	0.19	2N4058	0.13		
ACY18	0.22	BC114	0.17	BC226	0.39	BF125	0.50	BSY28	0.17	OC200	0.28	2N727	0.31	2N3054	0.51	2N4059	0.11		
ACY19	0.22	BC115	0.17	BC301	0.30	BF127	0.55	BSY29	0.17	OC201	0.31	2N743	0.22						
ACY20	0.22	BC116	0.17	BC302	0.27	BF152	0.61	BSY38	0.20	OC202	0.31	2N744	0.22						
ACY21	0.22	BC117	0.20	BC303	0.35	BF153	0.50	BSY39	0.20	OC203	0.28	2N914	0.16						
ACY22	0.18	BC118	0.11	BC304	0.40	BF154	0.50	BSY40	0.31	OC204	0.28	2N918	0.33						
ACY27	0.20	BC119	0.33	BC440	0.34	BF155	0.77	BSY41	0.31	OC205	0.39	2N929	0.23						
ACY28	0.21	BC120	0.88	BC460	9.40	BF156	0.53	BSY95	0.14	OC309	0.44	2N930	0.23						
ACY29	0.39	BC125	0.13	BCY30	0.27	BF157	0.61	BSY95A	0.14	OCP71	0.48	2N1131	0.22						
ACY30	0.31	BC126	0.20	BCY31	0.29	BF158	0.61	BU105	£2.20	ORP12	0.48	2N1132	0.24						
ACY31	0.31	BC132	0.13	BCY32	0.33	BF159	0.66	C111E	0.55			2N1302	0.16						
ACY34	0.23	BC134	0.20	BCY33	0.24	BF160	0.44	C400	0.33			2N1303	0.16						
ACY35	0.23	BC135	0.13	BCY34	0.28	BF162	0.44	C407	0.28	P20	0.55	2N1304	0.19						
ACY36	0.31	BC136	0.17	BCY70	0.16	BF163	0.44	C424	0.28	P21	0.50	2N1305	0.19						
ACY40	0.19	BC137	0.17	BCY71	0.22	BF164	0.44	C425	0.55	P346A	0.22	2N1306	0.23						
ACY41	0.20	BC139	0.44	BCY72	0.16	BF165	0.44	C426	0.39	P397	0.46	2N1307	0.23						
ACY44	0.39	BC140	0.33	BCZ10	0.22	BF167	0.24	C428	0.22	ST140	0.14	2N1308	0.26						
AD130	0.42	BC141	0.33	BCZ11	0.28	BF173	0.24	C441	0.33	ST141	0.19	2N1309	0.26						
AD140	0.53	BC142	0.33	BCZ12	0.28	BF176	0.39	C442	0.33	TIS43	0.33	2N1613	0.22						
AD142	0.53	BC143	0.33	BD115	0.68	BF177	0.39	C444	0.39	UT46	0.30	2N1711	0.22						
AD143	0.42	BC145	0.50	BD116	0.88	BF178	0.33	C450	0.24	ZN414	£1.20	2N1889	0.35						
AD149	0.55	BC147	0.11	BD121	0.66	BF179	0.33	MAT100	0.21	2G301	0.21	2N1890	0.50						
AD161	0.39	BC148	0.11	BD123	0.72	BF180	0.33	MAT101	0.22	2G302	0.21	2N1893	0.41						
AD162	0.39	BC149	0.13	BD124	0.76	BF181	0.33	MAT120	0.21	2G303	0.21	2N2147	0.79						

DIODES AND RECTIFIERS

AA119	0.09	BY128	0.17	OA70	0.08
AA120	0.09	BY130	0.18	OA70	0.08
AA129	0.09	BY133	0.23	OA81	0.08
AAY30	0.10	BY164	0.55	OA85	0.10
AAZ13	0.11	BYX38/30	0.46	OA90	0.07
BA100	0.11	BYZ10	0.39	OA91	0.07
BA116	0.23	BYZ11	0.33	OA95	0.08
BA126	0.24	BYX12	0.33	OA200	0.07
BA148	0.16	BYZ13	0.28	OA202	0.08
BA154	0.13	BYZ16	0.44	SD10	0.06
BA155	0.16	BYZ17	0.39	SD19	0.06
BA156	0.15	BYZ18	0.39	1N34	0.08
BA173	0.16	BYZ10	0.31	1N34A	0.08
BY100	0.17	CH62		1N914	0.06
BY101	0.13	(OA91Eq)	0.06	1N916	0.06
BY105	0.19	CG651 (OA70–		1N4148	0.06
BY114	0.13	OA79)	0.07	1S021	0.11
BY124	0.13	OA5	0.39	1S951	0.07
BY126	0.16	OA10	0.15		
BY127	0.17	OA47	0.08		

LINEAR I.C's—FULL SPEC.

Type No.	Case		1	25	100 +
72702	DIL	14	0.50	0.48	0.45
72709	DIL	14	0.35	0.33	0.30
72710	DIL	14	0.45	0.43	0.40
72741	DIL	14	0.40	0.38	0.35
72741C	TO–5	8	0.45	0.43	0.40
72741P	DIL	8	0.38	0.36	0.34
72748P	DIL	8	0.38	0.36	0.34
SL201C	TO–5	8	0.50	0.45	0.40
SL701C	TO–5	8	0.50	0.45	0.40
SL702C	TO–5	8	0.50	0.45	0.40
TAA263	TO–72	4	0.80	0.70	0.60
TAA293	TO–74	10	£1.00	0.95	0.90
TAA350A	TO–5	10	£1.85	£1.80	£1.70
µA703C	TO–5	6	0.28	0.26	0.24
µA709C	TO–5	8	0.35	0.33	0.30
µA711	TO–5	10	0.45	0.43	0.40

DTL 930 SERIES LOGIC I.C's

Type	1	25	100 +
BP930	0.15	0.14	0.13
BP932	0.16	0.15	0.14
BP933	0.16	0.15	0.14
BP935	0.16	0.15	0.14
BP936	0.16	0.15	0.14
BP944	0.16	0.15	0.14
BP945	0.30	0.28	0.25
BP946	0.15	0.14	0.13
BP948	0.30	0.28	0.25
BP951	0.70	0.65	0.60
BP962	0.15	0.14	0.13
BP9093	0.45	0.43	0.40
BP9094	0.45	0.43	0.40
BP9097	0.45	0.43	0.40
BP9099	0.45	0.43	0.40

NUMERICAL INDICATOR TUBES

Type	Description	
3015F	Minitron 7 Segment Indicator	£1.50
MAN 3M	L.E.D. 7 Segment Display 0.127" High Characters	£1.90
CD 66	Side Viewing 'Nixie Type' Tube 16 m/m	£1.87
GR 116	Side Viewing 'Nixie Type' Tube 13 m/m	£1.70

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µA7812	12V (Equiv. to MVR12V)	£1.76

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BPS14	14 pin type (low cost)	0.16	0.14	0.12
BPS16	16 pin type (low cost)	0.17	0.15	0.13

74 Series T.T.L. I.C's

Type	Quantities 1	25	100 +	Type	Quantities 1	25	100 +	Type	Quantities 1	25	100 +
7400	0.18	0.17	0.16	7453	0.18	0.17	0.16	74153	£1.30	£1.20	£1.10
7401	0.18	0.17	0.16	7454	0.18	0.17	0.16	74154	£1.98	£1.90	£1.75
7402	0.18	0.17	0.16	7460	0.18	0.17	0.16	74155	£1.50	£1.45	£1.35
7403	0.18	0.17	0.16	7470	0.32	0.29	0.27	74156	£1.50	£1.45	£1.35
7404	0.18	0.17	0.16	7472	0.32	0.29	0.27	74157	£2.00	£1.90	£1.80
7405	0.18	0.17	0.16	7473	0.41	0.39	0.35	74160	£2.10	£2.00	£1.90
7406	03.9	0.34	0.31	7474	0.41	0.39	03.5	74161	£2.10	£2.00	£1.90
7407	0.39	0.34	0.31	7475	0.50	0.48	0.46	74162	£4.40	£4.15	£3.85
7408	0.20	0.19	0.18	7576	0.44	0.43	0.42	74163	£4.40	£4.15	£3.85
7409	0.20	0.19	0.18	7480	0.74	0.71	0.64	74164	£2.20	£2.10	£2.00
7410	0.18	0.17	0.16	7481	£1.30	£1.25	£1.20	74165	£2.20	£2.10	£2.00
7411	0.28	0.27	0.26	7482	0.96	0.95	0.94	74166	£3.20	£3.10	£3.00
7412	0.39	0.34	0.31	7483	£1.20	£1.15	£1.05	74174	£2.50	£2.40	£2.30
7413	0.32	0.31	0.30	7484	£1.10	£1.05	£1.00	74175	£1.75	£1.65	£1.55
7416	0.48	0.44	0.42	7485	£3.50	£3.40	£3.30	74176	£1.85	£1.75	£1.65
7417	0.48	0.44	0.42	7486	0.35	0.34	0.33	74177	£1.85	£1.75	£1.65
7420	0.18	0.17	0.16	7489	£4.00	£3.75	£3.50	74180	£1.50	£1.40	£1.30
7422	0.55	0.53	0.50	7490	0.74	0.71	0.64	74181	£5.00	£4.50	£4.00
7423	0.55	0.53	0.50	7491	£1.10	£1.05	£1.00	74182	£2.00	£1.90	£1.75
7425	0.55	0.53	0.50	7492	0.74	0.71	0.64	74184	£3.20	£3.10	£3.00
7426	0.50	0.46	0.44	7493	0.74	0.71	0.64	74190	£2.15	£2.10	£2.00
7427	0.50	0.46	0.44	7494	0.85	0.82	0.75	74191	£2.15	£2.10	£2.00
7428	0.55	0.53	0.50	7495	0.85	0.82	0.75	74192	£2.15	£2.10	£2.00
7430	0.18	0.17	0.16	7496	0.96	0.93	0.86	74193	£2.15	£2.10	£2.00
7432	0.50	0.46	0.44	74100	£1.50	£1.45	£1.40	74194	£2.98	£2.86	£2.75
7433	0.75	0.73	0.70	74104	£1.07	£1.04	£1.00	74195	£2.00	£1.95	£1.90
7437	0.70	0.68	0.65	74105	£1.07	£1.04	£1.00	74196	£1.95	£1.90	£1.85
7438	0.70	0.68	0.65	74107	0.44	0.42	0.40	74197	£1.95	£1.90	£1.85
7440	0.18	0.17	0.16	74110	0.60	0.55	0.50	74198	£5.00	£4.75	£4.50
7441	0.74	0.71	0.64	74111	£1.38	£1.27	£1.21	74199	£5.00	£4.75	£4.50
7442	0.74	0.71	0.64	74118	£1.10	£1.05	£1.00				
7443	£1.20	£1.15	£1.10	74119	£1.50	£1.40	£1.30				
7444	£1.20	£1.15	£1.10	74121	0.50	0.48	0.45				
7445	£1.98	£1.95	£1.90	74122	£1.50	£1.45	£1.40				
7446	£1.20	£1.15	£1.10	74123	£3.00	£2.90	£2.80				
7447	£1.10	£1.07	£1.05	74141	0.85	0.82	0.79				
7448	£1.10	£1.07	£1.05	74145	£1.65	£1.55	£1.45				
7450	0.18	0.17	0.16	74150	£2.90	£2.80	£2.70				
7451	0.18	0.17	0.16	74151	£1.10	£1.05	£1.00				

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400mW (DO-7 Case). range 2–33V. 12p each. 1.5W (Top-Hat). range 2–33V. 18p each. 10W (SO-10 Stud). range 2–33V. 32p each.

INTEGRATED CIRCUIT PAKS

Manufacturers' "Fall Outs" which include Functional and Part Functional Units. These are classed as 'out-of-spec' from the maker's very rigid specifications, but are ideal for learning about I.C.'s and experimental work.

Pak No. Contents	Price	Pak No. Contents	Price	Pak No. Contents	Price
UIC00=12×7400	0.55	UIC46=5×7446	0.55	UIC86=5×7486	0.55
UIC01=12×7401	0.55	UIC47=5×7447	0.55	UIC90=5×7490	0.55
UIC02=12×7402	0.55	UIC48 5×7448	0.55	UIC91=5×7491	0.55
UIC03=12×7403	0.55	UIC50=12×7450	0.55	UIC92=5×7492	0.55
UIC04=12×7404	0.55	UIC51=12×7451	0.55	UIC93 5×7493	0.55
UIC05=12×7405	0.55	UIC53=12×7453	0.55	UIC94=5×7494	0.55
UIC06=8×7406	0.55	UIC54=12×7454	0.55	UIC95 5×7495	0.55
UIC07=8×7407	0.55	UIC60=12×7460	0.55	UIC96=5×7496	0.55
UIC10=12×7410	0.55	UIC70=8×7470	0.55	UIC100=5+74100	0.55
UIC13=8×7413	0.55	UIC72=8×7472	0.55	UIC121=5×74121	0.55
UIC20=12×7420	0.55	UIC73=8×7473	0.55	UIC141=5×74141	0.55
UIC30=12×7430	0.55	UIC74=8×7474	0.55	UIC151=5×74151	0.55
UIC40=12×7440	0.55	UIC75=8×7475	0.55	UIC154=5×74154	0.55
UIC41=5×7441	0.55	UIC76=8×7476	0.55	UIC193=5×74193	0.55
UIC42=5×7442	0.55	UIC80=5×7480	0.55	UIC199=5×74199	0.55
UIC43=5×7443	0.55	UIC81=5×7481	0.55		
UIC44=5×7444	0.55	UIC82=5×7482	0.55	UICX1=25 Assorted 74's	1.65
UIC45=5×7445	0.55	UIC83=5×7483	0.55		

Paks cannot be split, but 25 assorted pieces (our mix) is available as PAK UIC X1.

2 Amp. BRIDGE RECTS.

50 v RMS	35p each
100 v RMS	41p ,,
400 v RMS	51p ,,

Size 16 mm × 16 mm

D1699 NPN SILICON DUAL TRANSISTOR (Similar to 2N2060)

1	25	100 +
0.28	0.26	0.23

B1P 19/20 TO3 NPN PLASTIC SILICON
Vcbo = 100V. Vceo = 50V I.C. = 10 amps. Ptot5 = 0W. hfe = type. 100 fT3 = MHz

1	25	100 +
0.38	0.35	0.32

B1P 19/20 Matched Pair.

1	25	100 +
0.66	0.61	0.55

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

PIV	1A TO5	3A TO66	5A TO66	5A TO64	7A TO48	10A TO48	10A TO48	30A TO48
50	0.22	0.27	0.39	0.39	0.52	0.55	0.58	£1.27
100	0.27	0.27	0.52	0.52	0.55	0.63	0.62	£1.54
200	0.27	0.32	0.54	0.54	0.62	0.67	0.67	£1.76
400	0.32	0.42	0.50	0.62	0.67	0.83	0.77	£1.93
600	0.42	0.52	0.75	0.75	0.84	£1.07	0.97	—
800	0.63	0.70	0.88	0.88	0.99	£1.32	£1.50	£4.40

F.E.T.'S

2N3819	31p	2N5458	35p
2N3820	55p	2N5459	44p
2N3821	39p	MPF105	41p
2N3823	31p		

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100	0.05	0.07	0.06	0.10	0.17	0.23	0.75
200	0.06	0.10	0.07	0.12	0.22	0.25	£1.00
400	0.08	0.15	0.08	0.15	0.30	0.38	£1.35
600	0.09	0.17	0.10	0.18	0.36	0.45	£1.90
800	0.12	0.19	0.11	0.20	0.38	0.55	£2.10
1000	0.14	0.30	0.12	0.25	0.48	0.65	£2.50
1200	—	0.35	—	0.30	0.58	0.75	£3.00

DIACS
FOR USE WITH TRIACS BR100 (D32) 41p each

TRIACS

VBOM	100V £	200V £	400V £
2 Amp	0.33	0.55	0.77
6 Amp	0.55	0.66	0.83
10 Amp	0.83	0.99	1.21

10 amp POTTED BRIDGE RECTIFIER on heat sink. 100PIV. 99p each

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BA3	4"	x	2¼"	x	1½"	41p
BA4	5¼"	x	4"	x	1½"	47p
BA5	4"	x	2¼"	x	2"	41p
BA6	3"	x	2"	x	1"	34p
BA7	7"	x	5"	x	2½"	68p
BA8	8"	x	6"	x	3"	84p
BA9	6"	x	4"	x	2"	54p

(each complete with ½" deep lid)
Please add 10p postage and packing for each box.

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De Luxe Groov-Kleen
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Ref. 56	Hi-Fi Stereo Hints and Tips ..	32p

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1020	For model G240 3/32" ..	38p
1021	For model G240 1/8" ..	38p
1022	For model G240 3/16" ..	38p
50	For model X25 3/32" ..	38p
51	For model X25 1/8" ..	38p
52	For model X25 3/16" ..	38p

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C 3	50	Precision Resistors .1%, .01% mixed values ..	0.55
C 4	75	⅛th W Resistors mixed preferred values ..	0.55
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C 6	2	Tuning Gangs, MW/LW VHF	0.55
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C 8	10	Reed Switches ..	0.55
C 9	3	Micro Switches ..	0.55
C10	15	Assorted Pots and Pre-Sets ..	0.55
C11	5	Jack Sockets 3×3.5m 2× Standard Switch Types ..	0.55
C12	40	Paper Condensers preferred types mixed values ..	0.55
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C14	1	Pack assorted Hardware – Nuts/Bolts, Grommets etc.	0.55
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C19	3	Relays 6–24V Operating ..	0.55
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Please add 10p post and packing on all component packs, plus a further 10p on pack Nos. C1, C2, C19 and C20.

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PS39	Jack 2.5mm Switched ..	0.09
PS40	Jack 3.5mm Switched ..	0.10
PS41	Jack ¼" Switched ..	0.17
PS42	Jack Stereo Switched ..	0.26
PS43	Phono Single ..	0.06
PS44	Phono Double ..	0.10
PS45	Car Aerial ..	0.09
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PS47	Co-Axial Flush ..	0.14

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PS22	DIN 3 Pin ..	0.17
PS23	DIN 5 Pin 180° ..	0.17
PS24	DIN 5 Pin 240° ..	0.17
PS25	Jack 2.5mm Plastic ..	0.10
PS26	Jack 3.5mm Plastic ..	0.12
PS27	Jack ¼" Plastic ..	0.24
PS28	Jack ¼" Screened ..	0.28
PS29	Jack Stereo Plastic ..	0.22
PS30	Jack Stereo Screened ..	0.32
PS31	Phono Screened ..	0.14
PS32	Car Aerial ..	0.15
PS33	Co-Axial ..	0.17

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PS 2	DIN 3 Pin ..	0.12
PS 3	DIN 4 Pin ..	0.15
PS 4	DIN 5 Pin 180° ..	0.14
PS 5	DIN 5 Pin 240° ..	0.15
PS 6	DIN 6 Pin ..	0.15
PS 7	DIN 7 Pin ..	0.15
PS 8	Jack 2.5mm Screened ..	0.10
PS 9	Jack 3.5mm Plastic ..	0.09
PS10	Jack 3.5mm Screened ..	0.12
PS11	Jack ¼" Plastic ..	0.13
PS12	Jack ¼" Screened ..	0.18
PS13	Jack Stereo Screened ..	0.29
PS14	Phono ..	0.06
PS15	Car Aerial ..	0.15
PS16	Co-Axial ..	0.10

CABLES

CP 1	Single lapped screen ..	0.06
CP 2	Twin Common Screen ..	0.08
CP 3	Stereo Screened ..	0.08
CP 4	Four Core Common Screen ..	0.23
CP 5	Four Core individually Screened	0.30
CP 6	Microphone Fully Braided Cable	0.10
CP 7	Three core mains cable ..	0.07
CP 8	Twin oval mains cable ..	0.06
CP 9	Speaker Cable ..	0.04
CP10	Low Loss Co-Axial ..	0.10

CARBON POTENTIOMETERS

Log and Lin 4.7K, 10K, 22K, 47K, 100K, 220K, 470K, 1M, 2M.

VC1	Single less Switch ..	0.14
VC2	Single O.P. Switch ..	0.26
VC3	Tandem Less Switch ..	0.44
VC4	1K Lin Less Switch ..	0.14
VC5	100K Log anti-Log ..	0.44

HORIZONTAL CARBON PRESETS

0.1 watt 0.06
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8 Books comprising:
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138	How to make FM & TV Aerials, Bands 1, 2 & 3 ..	18p
141	Radio Servicing for Amateurs ..	20p
146	High Fidelity Loudspeaker Enclosures ..	37p
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175	Transistor Test Equipment and Servicing Manual	25p
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ACOS	GP91 1SC	200mV at 1.2cms/sec	£1.16
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	GP96 1	100mV at 1cm/sec ..	£2.65
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	J-20 10C	Crystal/Hi Output Compatible ..	£1.10
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The E12 Range of Carbon Film Resistors, ⅓th watt available in PAKS of 50 pieces, assorted into the following groups:

R1	50 Mixed 100ohms – 820ohms ..	40p
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AL10 AL20 AL30
AUDIO AMPLIFIER MODULES

The AL10, AL20 and AL30 units are similar in their appearance and in their general specification. However, careful selection of the plastic power devices has resulted in a range of output powers from 3 to 10 watts R.M.S.

The versatility of their design makes them ideal for use in record players, tape recorders, stereo amplifiers and cassette and cartridge tape players in the car and at home.

PARAMETER	CONDITIONS	PERFORMANCE
HARMONIC DISTORTION	Po=3 WATTS f 1 KHz	0.25%
LOAD IMPEDANCE	—	8 - 16Ω
INPUT IMPEDANCE	f =1KHz	100 KΩ
FREQUENCY RESPONSE ±3 dB	Po 2 WATTS	50 Hz - 25 KHz
SENSITIVITY for RATED O/P	Vs 25V. RL 8Ω f 1KHz	75mV. RMS
DIMENSIONS	—	3"×2½"×1"

The above table relates to the AL10, AL20 and AL30 modules.
The following table outlines the differences in their working conditions.

PARAMETER	AL10	AL20	AL30
Maximum Supply Voltage	25	30	30
Power output for 2% T.H.D. (RL 8Ω f 1 KHz)	3 watts RMS Min.	5 watts RMS Min.	10 watts RMS Min.

AUDIO AMPLIFIER MODULES

AL10	3 Watts	£2.19
AL20	5 Watts	£2.59
AL30	10 Watts	£3.01

PRE-AMPLIFIERS

PA 12	(Use with AL10 & AL20)	£4.35
PA100	(Use with AL30 & AL50)	£13.15

POWER SUPPLIES

PS12	(Use with AL10 & AL20)	88p
SPM80	(Use with AL30 & AL50)	£3.25

TRANSFORMERS

T461	(Use with AL10) p&p 15p	£1.38
T538	(Use with AL20) p&p 15p	£1,93
BMT80	(Use with AL30 & AL50) p&p 25p	£2.15

FRONT PANELS PA 12 With knobs £1.00

PA 12. PRE-AMPLIFIER SPECIFICATION

The PA12 pre-amplifier has been designed to match into most budget stereo systems. It is compatible with the AL10, AL20 and AL30 audio power amplifiers and it can be supplied from their associated power supplies. There are two stereo inputs, one has been designed for use with *Cramic cartridges while the auxiliary input will suit most †Magnetic cartridges. Full details are given in the specification table. The four controls are, from left to right: Volume and on/off switch, balance, bass and treble. Size 152mm × 84mm × 35mm.

Frequency response
20Hz–50KHz (–3dB)
Bass control
±12dB at 60Hz
Treble control
±14dB at 14 KHz
*Input 1.
Impedance 1 Meg. ohm.
Sensitivity 300 mV
†Input 2.
Impedance 30 K ohms
Sensitivity 4 mV

EA1000 AUDIO AMP MODULE

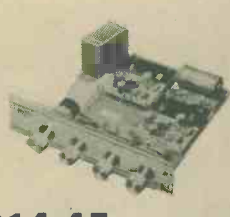
Module Tested and Guaranteed.
Full hook-up diagrams and complete technical data supplied free with each module or available separately at 10p each.

SPECIAL OFFER £2

The STEREO 20

The 'Stereo 20' amplifier is mounted, ready wired and tested on a one-piece chassis measuring 20 cm x 14 cm x 5.5 cm. This compact unit comes complete with on/off switch, volume control, balance, bass and treble controls. Transformer, Power supply and Power Amps. Attractively printed front panel and matching control knobs. The 'Stereo 20' has been designed to fit into most turntable plinths without interfering with the mechanism or, alternatively, into a separate cabinet.

Output power 20w peak	Input 1 (er.) 300mV into 1M
Freq. res. 25Hz–25kHz	Input 2 (Aux.) 4 mV into 30K
Harmonic distortion	Bass control ±12bB at 60 Hz.
typically 0.25% at 1 watt	Treble con. ±14bB at 14 kHz



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50W pk 25w (RMS)
0.1% DISTORTION
HI-FI AUDIO AMPLIFIER
THE AL50

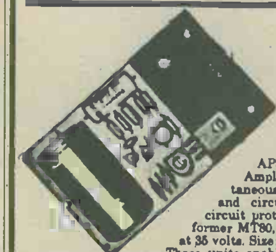
★ Frequency response 15Hz to 100,000 - 1dB.
★ Load - 3, 4, 8 or 16 ohms.
★ Distortion - better than .1% at 1KHz.
★ Signal to noise ratio 80dB.

ONLY **£3.58** each

★ Supply voltage 10 - 35 Volts.
★ Overall size 63mm x 105mm x 13mm.

Tailor made to the most stringent specifications using top quality components and incorporating the latest solid state circuitry and ALSO was conceived to fill the need for all your A.F. amplification needs. FULLY BUILT - TESTED - GUARANTEED.

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.

These units enable you to build Audio Systems of the highest quality at a hitherto unobtainable price. Also ideal for many other applications including: Disco Systems, Public Address, Intercom Units etc. Handbook available 10p.

PRICE £3.25

TRANSFORMER BMT80 £2.15 p. & p. 25p.

STEREO PRE-AMPLIFIER, TYPE PA100

Built to a specification and NOT a price, and yet still the greatest value on the market, the PA100 stereo pre-amplifier has been conceived from the latest circuit techniques.

Designed for use with the AL50 power amplifier system, this quality made unit incorporates no less than eight silicon planar transistors, two of these are specially selected low noise NPN devices for use in the input stages.

Three switched stereo inputs, and rumble and scratch filters are features of the PA100, which also has a STEREO/MONO switch, volume, balance and continuously variable bass and treble controls.

SPECIFICATION

Frequency Response	20Hz — 20KHz ± 1dB
Harmonic Distortion	better than 0.1%
Inputs: 1. Tape Head	1.25 mV into 50KΩ
2. Radio, Tuner	35 mV into 50KΩ
3. Magnetic P.U.	1.5 mV into 50KΩ

All input voltages are for an output of 250mV. Tape and P.U. inputs equalised to RIAA curve within ± 1dB, from 20Hz to 20KHz.

Base Control ± 15dB @ 20Hz — Treble Control ±15dB @ 20KHz
Filters: Rumble (High Pass) 100Hz
Scratch (Low Pass) 8KHz
Signal/Noise Ratio better than — 65dB
Input overload + 26dB — Supply + 35 volts @ 20mA
Dimensions 292mm × 82mm × 35mm

Price **£13.15**

SPECIAL COMPLETE KIT COMPRISING 2 AL50's, 1 SPM80, 1 BMT80 and 1 PA100. ONLY **£25.30** FREE p & p.

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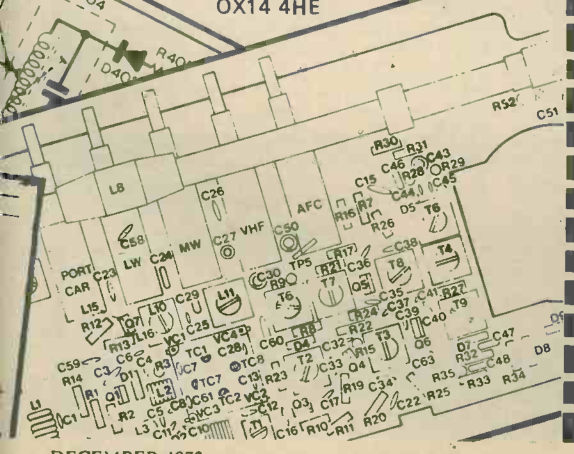

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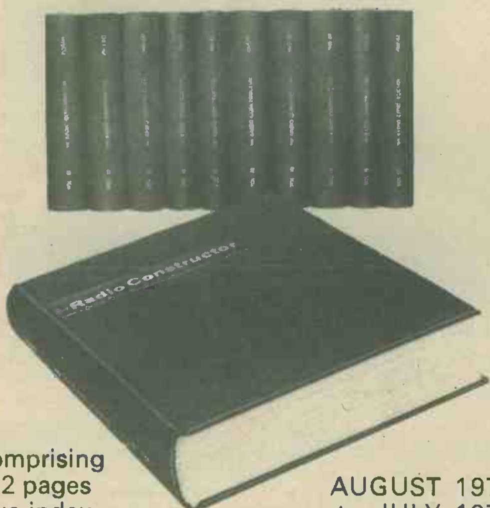

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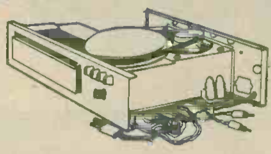

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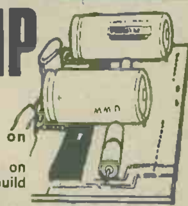

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Vol. 27 No. 5

Published Monthly (1st of Month)
First Published 1947

Incorporating The Radio Amateur

Editorial and Advertising Offices
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Published in Great Britain by the Proprietors and Publishers, Data Publications Ltd, 57 Maida Vale, London, W9 1SN

The *Radio & Electronics Constructor* is printed by Carlisle Web Offset.

JANUARY ISSUE WILL BE PUBLISHED ON JANUARY 2nd

RADIO RECEIVERS

We have not yet arrived at the stage where a single integrated circuit connected to an aerial, a battery and a speaker comprises a radio receiver, but we can make up such a receiver with two i.c.'s and a few discrete components. In this article the integrated circuit type ZN414 is discussed in detail, and next month's concluding article will illustrate how it may be employed in conjunction with the Sinclair IC-12 and the Plessey SL402D/403D a.f. amplifier integrated circuits to form a complete receiver operating a speaker.

ALMOST ALL TRANSISTOR RADIO RECEIVERS EMPLOY superheterodyne circuits, since such circuits confer the advantages of good selectivity and high gain. However, superhet circuits have certain disadvantages, especially from the point of view of the amateur constructor. These disadvantages include the alignment problems involved in obtaining satisfactory bandwidth, the moderate circuit complexity and the spurious 'whistles' which are generated when the local oscillator in the receiver forms a beat note with an incoming signal.

ZN414 RECEIVERS

The Ferranti Company announced a new type of integrated circuit in January 1973 which is designated by the coding ZN414. The use of this device makes it possible to design simple, high gain radio receivers for the medium and long wave bands without employing the superheterodyne principle. Only one tuned circuit is used in ZN414 receivers and this avoids all alignment troubles and tedious coil design. The device is very suitable for use by both the amateur constructor and also by designers of commercial radio receivers.

Although the selectivity of receivers employing the ZN414 may not be so good as that of most superheterodyne receivers, the greater bandwidth usually results in better audio reproduction than that obtainable from typical medium and long wave superhets. In addition, tuning may not be so critical. Automatic gain control can be incorporated in ZN414 circuits and this renders their performance more like that of superhet circuits.

The ZN414 itself is an integrated circuit containing ten transistors and other components in a miniature TO18 encapsulation of the type used for transistor cases. There are only three connecting leads, these being shown in Fig. 1.

If the ZN414 device is suitably connected to a tuned circuit incorporating a ferrite rod aerial, two capacitors, one resistor and a low voltage supply (1.1 to 1.6. volts), one has a complete radio receiver which can drive an earpiece.

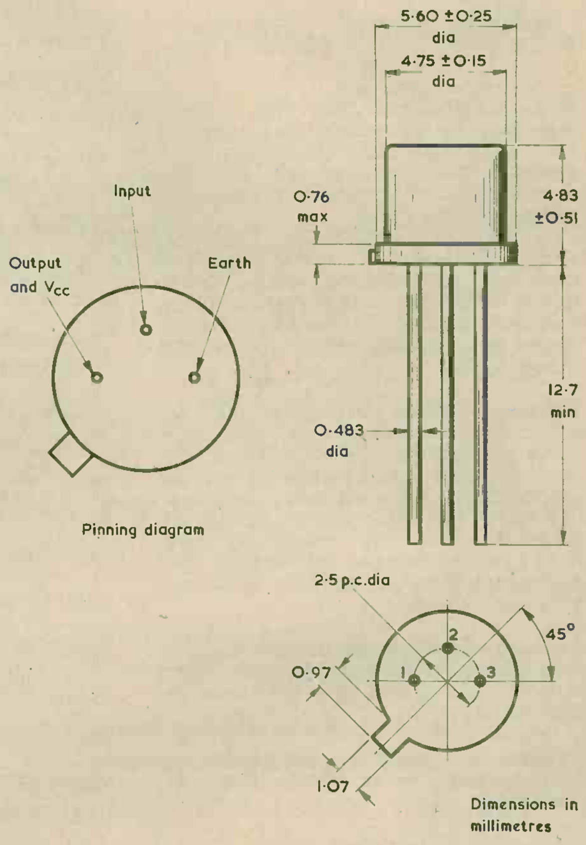


Fig. 1. The connections and dimensions of the ZN414

USING TWO INTEGRATED CIRCUITS

Part 1 **by M. J. Darby**

The output of the ZN414 circuit must be fed into an audio amplifier if the signal is to be used to operate a loudspeaker. Many of the circuits which have been published for use with the ZN414 have employed an audio amplifier with discrete components. This and next month's articles will describe the use of the ZN414 with integrated circuit audio amplifiers in medium and long wave receivers, since these enable a complete receiver to be constructed using only the two integrated circuits and a number of passive components. No other signal-handling semiconductor devices are required. It should be added, however, that the use of two diodes or a single transistor in the power supply circuit will enable a much more consistent performance to be obtained as the battery voltage changes with use.

The receivers to be described are intended mainly for the reception of U.K. stations which provide a reasonably high signal level. However, the writer has found that reasonable reception of various European stations can be obtained after dusk using only a ferrite rod aerial.

The ZN414 enables much simpler circuits to be used than some of the earlier types of integrated circuit radio receivers designed for use in superhet circuits (such as the dual-in-line 14 pin TAD100). In addition, it is a much smaller device.

COLLECTOR DIFFUSION ISOLATION

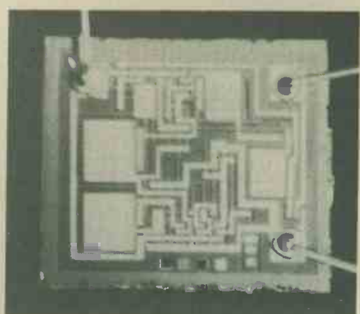
A manufacturing process known as 'collector diffusion isolation' is employed in fabricating the ZN414; this process is described in detail in reference 1. The collector diffusion isolation technique was first developed at the Bell Telephone Laboratories, U.S.A (reference 2). However, the Ferranti Company have made great improvements to the process in the past few years, especially by increasing the breakdown voltage from 3 volts to 8 volts and by developing p-channel f.e.t. devices.

The collector diffusion isolation technique offers the advantages of high component density combined with simplicity of manufacture, which in turn permits low costs. Silicon transistors in the integrated circuits manufactured by this technique have the advantage that their high current gain is maintained over a wide range of operating currents, even at collector currents of less than one microamp. In addition they can operate at high frequencies (f_T is typically 1GHz), have a low leakage and can operate from power supplies of 1 volt. However, p.n.p. transistors cannot be made by this technique.

Integrated circuits produced by the collector diffusion isolation process have a wide variety of applications in digital, linear and in the hybrid 'Digilin' circuits. Such circuits are employed in calculating machines, in telephone repeaters, etc., as well as in the ZN414 device. All of these offer the advantage of large scale integration.

THE ZN414 CIRCUIT

The ZN414 circuit itself will be discussed first. The use of this circuit for feeding two different types of integrated circuit audio amplifier will be described in next month's concluding article.



The ZN414 – chip area enlarged more than 30 times. Photo: Courtesy Ferranti Ltd.

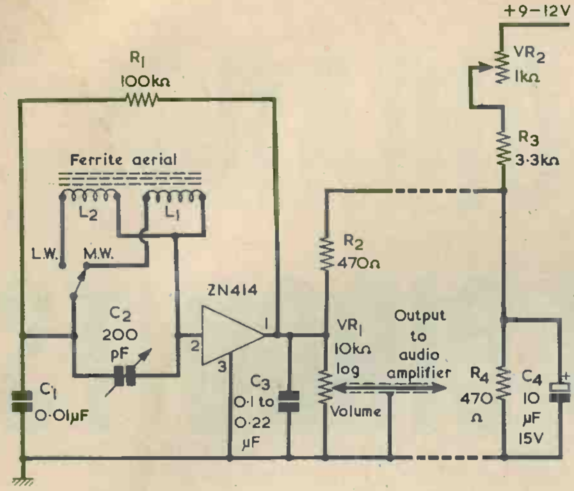


Fig. 2. Receiver circuit incorporating the ZN414

A circuit suitable for the ZN414 is shown in Fig. 2. The tuned circuit is formed by the variable capacitor C2 in parallel with either the medium wave coil L1 or the long wave coil L2, these coils being placed on a ferrite rod. The long wave coil may be omitted if reception on this waveband is not required.

The resistor R2 acts as the load resistor for the ZN414 output and it also provides an automatic gain control voltage. When the circuit is tuned to a strong signal the ZN414 passes more current; this results in a greater voltage drop across R2 and less voltage across the ZN414. The gain of the device therefore falls and this tends to keep the audio output signal at a fairly constant level. The value of R2 should be between 470 and 1,000Ω, the lower values giving rather better selectivity.

If the input to the ZN414 exceeds a certain level, the output becomes almost independent of the input level provided that overloading does not occur. For optimum a.g.c. action, the signal input should reach this limiting level on local signals, but should not greatly exceed it. The voltage applied to the ZN414 can be adjusted for optimum a.g.c. action. Alternatively, overloading can usually be avoided by rotating the receiver for minimum pick-up by the ferrite rod aerial.

POWER SUPPLY

If the low voltage supply required by the ZN414 is to be derived from the higher voltage required by the following audio amplifier, a potential divider circuit of the type shown on the right hand side of Fig. 2 may be employed. The current passing through R3 should not be less than about 2mA in order to preserve normal a.g.c. action. The current required by the ZN414 itself is only about 0.3mA (maximum 0.5mA).

The manufacturer suggests a value of 1.1 to 1.6 volts for the power supply to the upper end of R2 in Fig. 2. The writer has used the circuit about 10 miles from one of the B.B.C. medium wave transmitters and feels that it is best to use a voltage at the lower end of this range to avoid overloading of the detector stage of the ZN414. The device gives quite a high gain even at supply potentials of a little less than 1 volt.

The value of R3 shown in Fig. 2 is suitable for use with a supply voltage of about 9 to 12V. If a higher voltage is to be employed in order to obtain more power output from the audio amplifier, the value of R3 should be increased in order to keep the voltage supply to the ZN414 at a suitable value.

It is not essential to include VR2, but the writer has found that its presence in the circuit is well worth-while. VR2 can be used to reduce the gain of the ZN414 when a strong signal is being received or to increase the gain for a weak signal. If VR2 is omitted. R3 should be increased to about 4.7kΩ.

The resistor R1 provides a bias current to the input of the ZN414. The *moving vanes* of the tuning capacitor, C2, must be connected to the junction of R1 and C1; the latter capacitor ensures that these vanes are kept at about earth potential with respect to radio frequency voltages. The capacitor C3 returns any radio frequencies at the output to chassis, whilst leaving the audio output voltages almost unaffected.

The performance of the circuit of Fig. 2 is sensitive to the applied voltage; and this can cause difficulties as the battery ages, especially if VR2 is not included. Troubles with supply voltages can be avoided by the use of either of the power supply circuits shown in Figs. 3 and 4. It is strongly recommended that one of these two circuits be employed unless a power supply

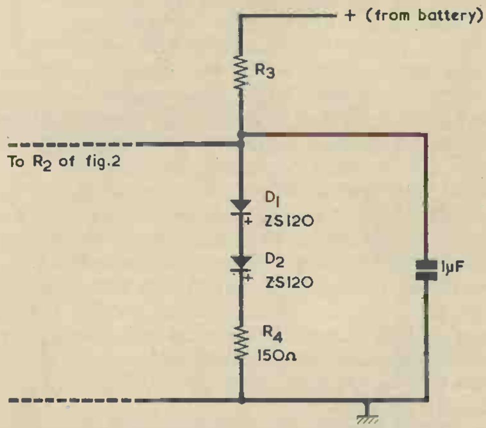


Fig. 3. A suitable power supply circuit

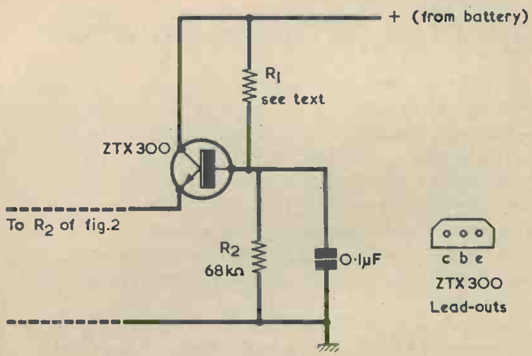


Fig. 4. A power supply circuit incorporating a transistor

giving a reasonably constant voltage (such as a mains power supply) is used.

In Fig. 3 the voltage across the two forward biased diodes remains fairly constant as the current passing through them varies. An additional voltage drop is produced across R4; this resistor can be replaced by a potentiometer of value about 250Ω if one wishes to be able to vary the voltage applied to the ZN414. The recommended values for R3 in reference 3 are 12kΩ and 8.2kΩ for supplies of 12 volts and 9 volts respectively. The whole circuit of Fig. 3 requires a current of about 1mA.

The transistor circuit of Fig. 4 consumes less than 0.5mA, almost all of which passes to the ZN414. The value of R1 may be 220kΩ when a 9 volt supply is employed or 330kΩ when a 12 volt supply is used. R2 may be replaced by a 56kΩ fixed resistor in series with a 25kΩ variable resistor if one wishes to be able to adjust the ZN414 operating voltage.

(The diodes shown in Fig. 3 are general purpose silicon junction types and it would be possible to use other diodes of similar type, such as the 0A200 in their place. – Editor.)

OUTPUT

The output from the circuit of Fig. 2 contains not only the audio signal, but also a fraction of the steady power supply voltage. However, the audio amplifiers to be described include a series capacitor at their inputs and therefore only the audio voltage will be able to reach the amplifier itself.

The output from Fig. 2 may also be connected directly to a crystal earphone, but it may then be desirable to employ the maximum supply voltage available in order to obtain the requisite gain.

The audio output voltage from the circuit of Fig. 2 is typically about 30mV r.m.s. The total harmonic distortion is about 1%, but as it consists mainly of second harmonc distortion, it is not of a type which is very objectionable to the ear. However, if a strong signal overloads the detector, the distortion becomes very much greater. In this case, the voltage applied to the ZN414 should be reduced and/or the aerial rotated to the point where it produces the minimum signal strength.

TUNING METER

If desired, a 0–1mA meter may be fitted in series with the upper end of R2 and used as a tuning meter. It will indicate a current of about 0.3mA when no signal is applied, increasing to about 0.6mA when a strong signal is received.

The ZN414 itself consists of four cascaded radio frequency amplifier stages followed by a two-transistor detector stage. It has a very high overall gain (typically 72db at a supply voltage of 1.5 volts), and this results in a typical threshold sensitivity at the input terminal of about 50μV in the medium wave band. The gain falls at frequencies in the long wave band and also at short wave frequencies, but the device gives a good performance over the range of 200kHz to 3MHz. Satisfactory operation may be obtained outside these limits.

The input impedance of the ZN414 is very high, being typically 4MΩ. The load on the tuned circuit is therefore negligible. This enables much better selectivity to be obtained than one would normally expect from a t.r.f. receiver.

The output signal from a ZN414 for various input voltages is shown in Fig. 5 (reference 3). These measurements were made without a tuned circuit, so in a practical receiver the sensitivity will be multiplied by the Q factor of the tuned circuit used. If the Q factor is 100, a 30μV signal will become a 3mA signal to the ZN414 and this will drive the device to the point where its gain is limited by a.g.c. action. It must be emphasised that Fig. 5 shows the gain at various frequencies and not the bandwidth of a receiver.

AERIAL

The medium wave coil consists of about 80 turns of insulated copper wire wound as a single layer on the ferrite rod. See Fig. 6. The exact number of turns is not at all critical and may be adjusted to obtain the desired frequency coverage. The wire may be about 30 s.w.g., but again this is not critical provided that one does not depart from the suggested values so much that the Q of the circuit is significantly affected. Litzendraht (Litz wire) is ideal for this coil and should produce a high Q with somewhat greater selectivity. The bandwidth of the receiver (that is, the selectivity) can be considered as

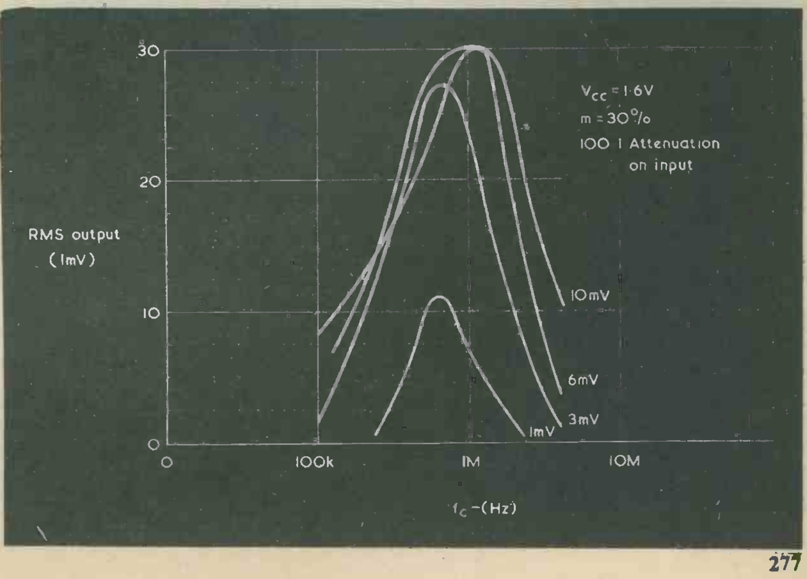


Fig. 5. The output of the ZN414 at various input frequencies and amplitudes

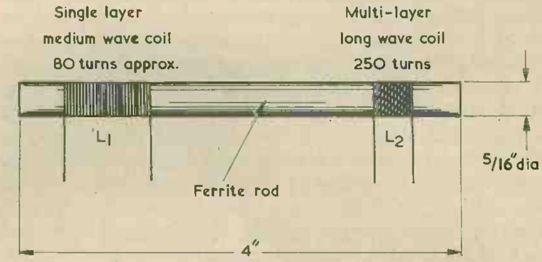


Fig. 6. The ferrite rod aerial used by the author

being equal to the signal frequency divided by the Q factor of the tuned circuit. Thus a Q factor of 100 will produce a 10kHz bandwidth at 1MHz, whilst a Q factor of 180 will produce a bandwidth of 5.5kHz at the same frequency.

The long wave coil may consist of a multi-layer winding containing 250 turns. This wire should have a smaller diameter than that used for the medium wave coil, and about 38 s.w.g. is suitable. The number of turns on the long wave coil can, in fact, be adjusted so that the position of the tuning capacitor is the same for the reception of the Droitwich long wave station as for a chosen medium wave station. One then has switched tuning between these two stations.

The length, diameter and the material of the ferrite rod affect the inductance of the coils somewhat, but the number of turns can be varied to obtain the required tuning range.

CIRCUIT CONSTRUCTION

The ZN414 is a very high gain device. This automatically implies that unwanted feedback (and, hence, instability) can occur if the circuit is not assembled in a reasonable way.

The leads from the ZN414 should be kept as short as possible and it is especially important that the output decoupling capacitor, C3 of Fig. 2, should be soldered as near as possible to the device. The value of this capacitor together with the value of the a.g.c. load resistor, R2, should cause the response to roll off at about 4kHz (reference 3).

The ferrite aerial should be kept more than one inch away from the ZN414 if instability occurs. The positioning of the tuned circuit leads may also be altered to reduce instability. If Veroboard is employed, it is recommended that the ZN414 leads are soldered directly to the *copper* side of the board.

If instability still persists after all precautions have been taken, the voltage applied to the upper end of R2 may be reduced in order to lower the gain of the device.

BOOKLET

A detailed booklet (reference 3) is available from the manufacturers of the ZN414. It gives practical circuits for earpiece radio receivers, a low cost 3 volt personal radio, a high quality 9 volt radio, an a.m. superhet radio receiver employing the ZN414 as an i.f. amplifier, a 27MHz radio control receiver using the ZN414 as an i.f. amplifier and a frequency standard using the ZN414 to receive the 200kHz Droitwich station.

(To be concluded)

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2. B. T. Murphy, V. J. Glinski, P. A. Gary and R. A. Pedesen, 'Collector Diffusion Isolation Integrated Circuits', Proc.I.E.E.E., Vol. 57, No. 9, p.1523 (September 1969).
3. 'ZN414 The One Chip Receiver', Ferranti publication AR/121, March 1973. (Available from Ferranti Ltd., at the same address as reference 1.)

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.

FITTING FEED-THROUGH CAPACITORS

by K. Harker

How to fit solder-mounting feed-through capacitors to an aluminium chassis

THE AUTHOR HAD EMBARKED ON A CONSTRUCTIONAL project which specified a brass chassis, into which a number of 1,000 pF solder-mounting feed-through capacitors were to be fitted. The recommended method of fixing the capacitors involved the combined use of a soldering iron and blowlamp, thus soldering the capacitors directly to the brass.

ALUMINIUM CHASSIS

Not having a blowlamp or brass sheet to hand, it was decided to make the chassis from aluminium, in the belief that nut-fitting feed-through capacitors would be readily available. When these could not be obtained easily, the problem then arose of fitting solderable capacitors to the aluminium chassis.

This was overcome by using 2 B.A. solder tags, but with the functions of the two holes reversed. The hole intended for the wire connection was used to fasten the tag down to the chassis so that its 2 B.A. bolt hole coincided with the hole already drilled in the aluminium chassis for the capacitor.

The tags were fastened to the chassis with $\frac{3}{16}$ in. 8 B.A. bolts and nuts. Extra 8 B.A. clearance holes had, of course, to be drilled in the chassis but, fortunately, the additional space required by the tags was not too great. Also, the small hole in each tag had to be opened out to 8 B.A. clearance. All the 8 B.A. clearance holes in the chassis and the tags were made with a No. 41 drill.

It was found that the drilling of the tags was best carried out by packing a wad of the required number in a vice, and running the drill through them all together, as illustrated in Fig. 1.

The 2 B.A. clearance hole in each tag was just right for the capacitor to sit in and be soft-soldered into position. Soldering is best done before the tag is fixed to the chassis. It is helpful too if the tag is scraped first with a file or penknife, and care should be taken not to get too much solder on the underside where it might prevent a flush mounting to the chassis. If this does happen, it may be necessary to open out the capacitor hole in the chassis a little. The flush mounting can be improved if the tag is bent very slightly (convex side uppermost) before bolting down. See Fig. 2. Tightening up the 8 B.A. bolt and nut then flattens the tag on to the chassis, as in Fig. 3.

A firmer mounting could perhaps be obtained by using double-sided solder tags; but these will need extra space, incur extra drilling, and double the number of 8 B.A. nuts and bolts needed. Double-sided solder tags are probably unnecessary if care is taken to get a good flush-mounting with a single-sided tag.

The author found the single-sided tag method quite satisfactory, and it provided a quick and reliable solution to the problem of fitting feed-through capacitors to an aluminium chassis. ■

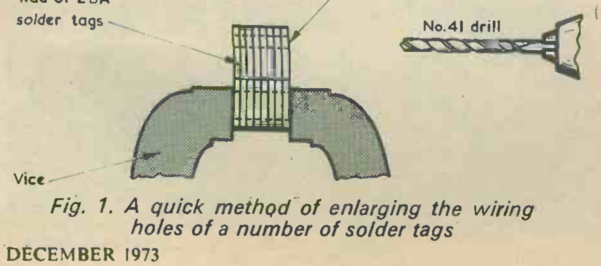


Fig. 1. A quick method of enlarging the wiring holes of a number of solder tags

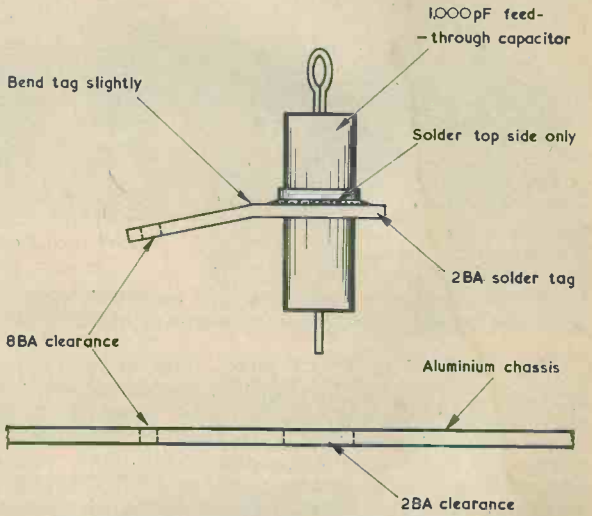


Fig. 2. The feed-through capacitor is soldered to the tag before being mounted on the chassis

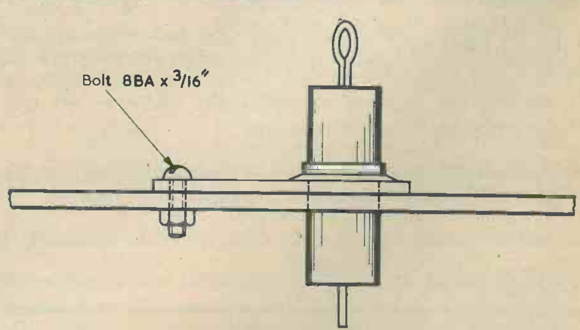


Fig. 3. The solder tag flattens and becomes flush with the chassis surface when the 8 B.A. bolt is tightened up

NEWS . . . AND .

COMBINED RADIO/STEREO PLAYER FOR CARS, BOATS, AND CARAVANS

A competitively priced, combined radio and stereo cassette player has been introduced by Stellar components of Maldon, Essex.

Taking advantage of the small dimensions of standard compact cassettes, the Selmar unit fits the radio aperture of most modern cars, so that the hazard and unsightly appearance of 'hang-on' fittings are avoided. The space occupied is also kept to a minimum in boats or caravans. Features of the stereo player (which will also accept mono cassettes) include a fast forward-wind button and an output of 7 watts per channel – far more than is usually needed, or offered by most competitive makes. The high output, Selmar claim, keeps distortion to a very low level even when the volume is turned up for fast driving, and will serve an additional pair of speakers if required.

Medium- and long-wave band reception on the radio is manually controlled, with a moving-light pointer for easy selection by day or night. Tone and balance controls operate on both radio and cassette player. Inserting the cassette automatically switches off the radio and a light indicates which system is in use.

Twin speakers are supplied in pods which may be fitted on the rear shelf or, by undoing four screws, mounted in the doors.

Recommended price, including speakers, is £54.10, plus VAT.

All Selmar products were displayed at the London Motor Show.

SWISS BROADCASTING CORPORATION'S CHRISTMAS COMPETITION

Christmas is such an important event that undoubtedly everybody knows its significance in the Christian religion, but does everybody know how Christmas is spent by innumerable families all over the world? Does a Christian know what a non-Christian's idea of Christmas is? Have we still the true spirit of Christmas?

These are the fundamental points of a competition organized by the Swiss Broadcasting Corporation. An unusual competition in which all listeners of SBC's English programme are invited to take part. All one has to do is write down a personal experience of Christmas, how this holiday is spent in one's country, a personal opinion of Christmas – be it Christian or not –, and so on. Written or tape-recorded text must be in English, no longer than four minutes to read and accompanied by a short biography of the author.

A special SBC jury will select the stories or comments which will be broadcast on Christmas Day and Boxing Day. Listeners to the programme will then vote for the three final winners. First prize is 350 Swiss francs, second prize 250 Swiss francs and third prize 150 Swiss francs. All entries to the Swiss Broadcasting Corporation, Christmas Competition, 3000 Bern 16, Switzerland, not later than 10th December.

THE 'SAFE' FIRST AID KIT - Universal safety aid

The SAFE First Aid Kit is housed in a strong, clearly marked ABS plastic cabinet measuring approximately 9 x 4 inches. It houses, clipped in the bottom compartment, an SGM Fire Extinguisher in a simple-to-operate aerosol can.

Inside the main cabinet is a full stock of plasters, medicated dressings, bandage, gauze, cotton wool and lint, Savlon cream and TCP liquid antiseptic, together with medical scissors, tweezers and safety pins. The stock is completed by a booklet on First Aid Treatment.

The SAFE First Aid Kit is attractively finished and will fit into virtually any type of decor.

It is available from Twyford Auto Conversions, Bassingbourne Hall, 22nd Street, Stansted Airport, Essex.

. . . COMMENT

THE MIDLAND NATIONAL AMATEUR RADIO AND ELECTRONICS EXHIBITION

The Midland National Amateur Radio and Electronics Exhibition, was held for the second year in succession at the Granby Halls, Leicester, on 25th, 26th and 27th October.

It seemed generally agreed, that this effort by the Amateur Radio Retailers Association, to provide the Midland enthusiast with an exhibition along the lines of the London exhibitions, was an even greater success than the first one last year. The attendances were better and the trade gave good support as before. The accommodation was spacious, and there really was 'plenty of room to move around' and see everything.

There was a good balance between stands showing new equipment and those selling a great variety of surplus. Latest techniques were represented by working exhibits of Slow Scan TV from SPACEMARK; the new FT 101 B, looking more beautiful than ever; an example of the new, compact, MOONBOUNCE beam from J BEAMS; the new K. W. ELECTRONICS KW108 MONITORSCOPE and the new DRAKE R-4C Receiver. Many of the AMTRON kits were also on display producing much interest.

The Radio Society of Great Britain, Short Wave Magazine, Ham Radio and VHF Communications had books and magazines on display and sale. There was a pre-release copy of the new 'Teleprinter Handbook', now available, on show at the RSGB Stand, this looked a particularly attractive volume. There were several RTTY demonstrations on different stands to be seen, as well as Amateur TV.

Altogether a very good exhibition for which the organisers deserve much credit.

3 AND 5W AUDIO AMPLIFIERS

Plessey have introduced two new integrated circuit audio amplifiers, types SL414 and SL415, which replace the earlier, popular SL402 and SL403. The amplifiers, which are held in stock by the Portsmouth-based electronic component distributors, SDS Components Ltd., will deliver 3 and 5 W r.m.s. respectively into a 7.5 ohm load. Designed for operation from a 20V (SL414) and 25V (SL415) supply rail, distortion is quoted as 0.1% r.m.s. (SL414) and 0.3% (SL415) with a power output of 1W at a frequency of 400Hz.

Each amplifier has a built-in pre-amplifier consisting of a triple Darlington stage, thereby ensuring high input impedance.

SOUND IDEAS FOR CHRISTMAS

With more than two-million cassette recorders regularly operating in Britain, the gift of a blank cassette is sure to be a welcome one at Christmas time. Trebly acceptable will be the new presentation packs from 3M United Kingdom Ltd., each of which contains three Scotch Dynarange cassettes, plus a gift card for personal greetings.

There are three versions of the pack, which contain either three C.60 cassettes (each with 30 minutes recording a side); three C.90s (45 minutes a side), or three C.120s (one hour a side). Recommended retail prices, including VAT, are £2.44, £3.20 and £5.12 respectively – but look out for bargains in the form of special offers in your local dealers' windows.

IN BRIEF

■ Marconi black-and-white and colour cameras supplied by Marconi Communication Systems Ltd., took part in the Australian Broadcasting Commission's coverage of the opening of the Sydney Opera House by Queen Elizabeth II on 20th October 1973. This outside broadcast was one of the most comprehensive ever undertaken in Australia by the ABC.

■ The Council of The Royal Television Society has awarded an Honorary Fellowship to Mr. Robert W. Sarnoff, Chairman of the Board and Chief Executive Officer of RCA Corporation, in recognition of his 25 years of outstanding service to the Television industry.

■ Readers who were unable to obtain copies of our Special October issue, because their newsagent had sold out, will be glad to know that we have a limited supply available containing the Free Veroboard. Cost 20p plus postage 6p.

The moral is, of course, to place a regular order with your newsagent.

■ Thorn Colour Tubes Ltd. one of Europe's largest colour television picture tube manufacturers, have opened new warehouse facilities at Winsford, Cheshire.

The installation of additional machinery under the current £4½ million extension programme at Skemersdale has made it necessary for additional warehousing facilities to be obtained elsewhere.

Thorn Colour Tubes have therefore rented 90,000 sq. ft. of warehouse space from British Tissue Ltd., at Winsford, Cheshire. It is expected that approximately 15 people will be employed at this new depot.

"This is my husband's workshop, Vicar. He's trying to make something with a Kit, but he's not very good at it!"

DIRECT READING TRANSISTOR CHECKER

by R. L. Shaw

A low-cost unit which offers comparative checks on transistors

TRANSISTORS ARE LIKE CARBON COMPOSITION RESISTORS: you don't know what performance to expect until they've been made. With resistors the variable factor is resistance, and the resistors are sorted out into their various values after they have been made. With transistors the unknown quantity (or at least one of the unknown quantities) is current gain, and it is accepted practice to allow an exceptionally wide tolerance on this. A typical hFE 'spread' for a standard transistor is from 100 to 300, and some transistors do not even have a maximum hFE figure quoted, the appropriate data specifying a minimum value only.

MEASUREMENT ACCURACY

The transistor checker described in this short article has been designed from the viewpoint that transistors are essentially very wide tolerance devices. In consequence, the checker employs circuit simplifications and economies which allow measurements of hFE to be taken at quite an approximate level. The unit is still, nevertheless, capable of making precise comparisons between transistors of the same type, and it thereby enables two or more matched devices to be selected from a batch. Also, it is more than adequate for the quick checking of transistors in an amateur or professional workshop.

The circuit of the checker is given in the accompanying diagram and, in this, it is assumed that battery B1 gives a voltage of exactly 9 volts and that the 0–10mA meter M1 has zero internal resistance. In practice, 0–10mA meters normally have internal resistances of the order of 2Ω only, and such a resistance is negligibly low compared with the other resistances in the circuit.

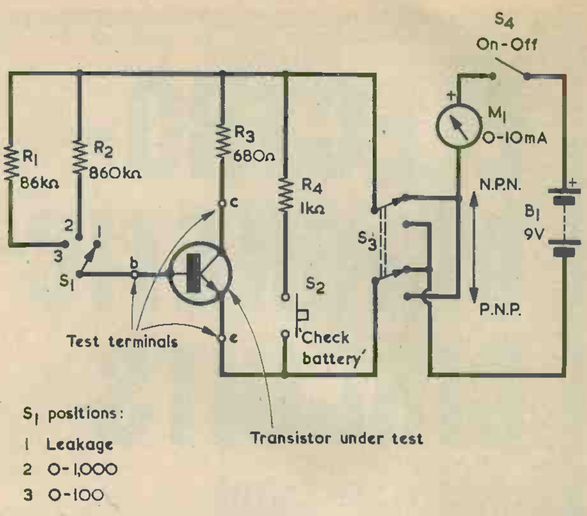
Switch S3 selects supply rail polarity to suit the transistor under test. When S3 is in the upper position the top supply rail is positive, and the unit is capable of checking n.p.n. transistors. When S3 is in the lower position the top supply rail is negative, allowing the unit to check p.n.p. transistors. In the diagram, an n.p.n. transistor is shown connected to the test terminals for purposes of illustration. A p.n.p. transistor would be connected in the same manner, and S3 would then be in the lower position. The transistor is connected as a common emitter amplifier.

R3, in series with the collector, is a limiting resistor and, in the event of a collector-emitter short-circuit in the transistor being tested, restricts the maximum current which can flow to about 13mA. There is, in consequence, no risk of damage to the meter should such a short-circuit exist.

When S1 is in position 2, the 860kΩ resistor, R2, is connected between the top supply rail and the base of the transistor under test. This resistor allows a nominal base current of 0.01mA to flow. Its value is actually a compromise between the requirements for germanium and for silicon transistors. With germanium transistors the voltage drop in the forward biased base-emitter junction is about 0.2 volt, and with silicon transistors it is about 0.6 volt. To give a base current of precisely 0.01mA, R2 would require a value of 880kΩ with germanium transistors and a value of 840kΩ with silicon transistors. The value actually used is midway between these two figures and introduces an error of a little less than 2% with either type of transistor. R1 is intended to allow a nominal base current of 0.1mA to flow, and this resistor again has a value which is central between the ideals for germanium and silicon test transistors.

With certain qualifications, meter M1 gives a direct read-out of the hFE of the transistor under test. When S1 is in position 2, a reading of 10mA (i.e. 0.01mA multiplied by 1,000) in the meter indicates that the transistor under test has an hFE of 1,000. A reading of 9mA denotes an hFE of 900 and so on. When S1 is in position 3, a reading of 10mA in the meter corresponds to an hFE of 100, a reading of 9mA to an hFE of 90, and so on down the scale. To take an example, let us assume that the transistor under test has an hFE of 500.

The circuit of the transistor checker. This tests for leakage and gives approximate indications of transistor current gain.



With S1 in position 2, a base current of 0.01mA will then result in a collector current of 5mA. Both the base and the collector currents pass through the meter and the total current here becomes 5.01mA. However, the base current is negligibly small compared with the collector current and the meter will indicate, so far as visual inspection is concerned, a current of 5mA, this corresponding to the hFE of 500 in the transistor.

It will be seen that the meter actually reads hFE + 1. But the '+1' factor, given by the base current, is of little importance with hFE figures of 50 or more and the unit is in any case only intended to give approximate indications of hFE.

COLLECTOR VOLTAGE

The presence of R3 causes the voltage at the collector of the transistor being checked to vary with collector current. If a transistor passes a collector current of 2mA (corresponding to an hFE of 200 with S1 in position 2, or an hFE of 20 with S1 in position 3) a voltage of 1.36 volts is dropped in R3, causing the collector voltage to be 7.64 volts. At the same time, a collector current of, say, 8mA would result in a drop of 5.44 volts in R3 and a collector voltage of 3.56 volts. Measurements of hFE are not in consequence taken at a fixed collector voltage, and this fact is accepted. If the Ic/Vc curves for any transistor are checked for voltages of the order of 2 to 9 volts, as are given here, it will be found that the increase of collector current with collector voltage is not very great. When comparing transistors of the same type for matching purposes, two transistors of the same hFE will also receive the same collector voltage.

A final point which has not yet been mentioned is the function of S2. This switch is pressed to check the battery voltage and it causes a resistance of 1kΩ to appear across the supply rails. M1 then functions as a voltmeter with a full-scale deflection of 10 volts, and a reading of 9mA indicates a battery voltage of 9 volts. No transistor should be connected to the test terminals when S2 is pressed.

Turning to practical matters, the switches S3 and S4 may be toggle types. S1 is a 3-pole rotary switch and S2 is a standard push-to-close press-button. The test terminals can have short lengths of flexible wire connected to them, these being terminated in miniature insulated crocodile clips for connection to the lead-outs of the transistor under test. Accidental short-circuits between test terminals can cause no damage as the meter current is limited by R3 to about 13mA. R1 has the non-preferred value of 86kΩ, and may be made up of a 39kΩ and a 47kΩ resistor in series. Similarly, R2 may be 390kΩ and 470kΩ in series. R3 may have a tolerance of 5%, whilst R4 should be 2% or 1% so that the battery voltage indications given when S2 is pressed are accurate. It is left to the constructor to decide whether to use 5%, 2% or 1% resistors for R1 and R2. All the resistors are ¼ or ½ watt. Any convenient size of 9 volt battery may be employed for B1.

To check a transistor, S1 should be set to position 1, S4 to 'Off' and S3 to the position which corresponds to the type of transistor to be checked. The transistor is then connected to the test terminals and S4 is closed.

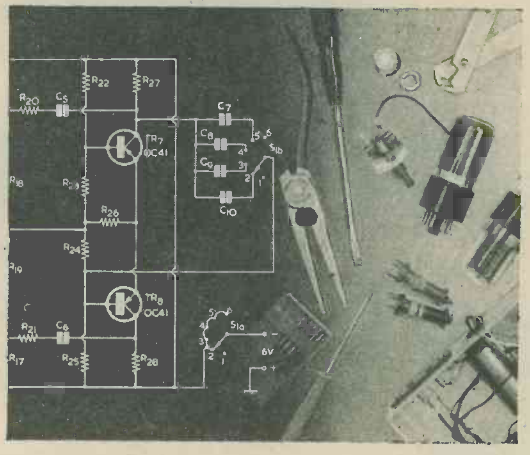
The meter will now indicate the collector-emitter leakage current of the transistor under test. With silicon devices, this current should be very low and there will in most cases be no movement of the meter needle. Germanium transistors may give readings of the order of 0.1mA or so. A faulty transistor will give a reading in the order of milliamps. Checking the leakage current of the transistor before measuring its hFE weeds out devices which have high leakage current. Without this check, the leakage current could be misconstrued as an hFE value.

S1 is next set to position 2. The deflection of the needle of M1 then gives an indication of hFE with 10 on the scale corresponding to 1,000. If the meter reading is lower than 1mA (corresponding to an hFE of 100), S1 is set to position 3, whereupon the meter reads hFE figures from 0 to 100. Because of varying collector voltages resulting from the presence of R3, some transistors having an hFE of less than 100 will give a slightly different indication when S1 is at position 3 than when it is at position 2.

Before periods of use, the battery voltage should be checked by pressing S2. Any battery voltage between 8.5 and 9.5 volts will, in practice, be satisfactory.

Despite its extremely simple design and the fact that approximations are purposely allowed to exist, this transistor checker can prove to be surprisingly useful in the workshop. It can be quickly assembled in a small insulated case and will be invaluable to anyone who handles a large amount of transistors. ■

ELECTRO-MAGNETIC CIRCUITS



by G. A. FRENCH

WE NOWADAYS TEND TO LOOK upon counting circuits in terms of t.t.l. logic, employing neon or l.e.d. read-out devices. The speed at which t.t.l. circuits can operate is, of course, very high.

When considerably slower speeds are acceptable it is possible to use much more elementary counting devices, these carrying out the counting process by mechanical rather than electronic means. Particularly suitable for such applications are Post Office electromagnetic counters of the type which are employed for metering subscribers' telephone calls. These counters, which are readily available on the home-constructor market, are capable of operating at speeds of up to some 5 counts per second. They are, in consequence, quite suitable for monitoring many industrial processes, batch counting and similar applications.

This month's 'Suggested Circuit' article will deal with suitable circuits in which an electromagnetic counter can be actuated by the closure and opening of two contacts. It is hoped to describe more sophisticated means of operating a counter in next month's issue.

ELECTROMAGNETIC COUNTER

The type of counter employed in the circuits to be discussed has the external appearance illustrated in Fig. 1. Four digits appear in the window at the end of the unit's removable cover, the four-digit number increasing by 1 each time the armature inside is energised and released. When the digits have reached 9999, the next actuation of the armature brings them to 0000. The digits cannot be manually reset to 0000, with the result that it is necessary to note the number indicated at the start of a counting operation and subtract this from the number given at the end of the operation.

The internal construction of the counter, with its cover removed, is shown in Figs. 2(a), (b) and (c). In all these diagrams, two strengthening panels at the sides have been omitted for simplicity of presentation. Fig. 2(a) shows the mechanism as seen from the top, illustrating in particular the digit wheels. These are geared together in the same way as are the digit wheels in a car mileometer. When, for instance, the 'units' wheel increases from 9 to 0 (as seen through the front window of the cover) it moves the 'tens' wheel one digit further so that the number the latter displays increases by 1.

Fig. 2(b) gives a side view and illustrates the armature action. In this diagram the coil is energised and the armature is pulled down to the core, against the tension imposed by the armature restoring spring. The operating pawl is attached to the armature,

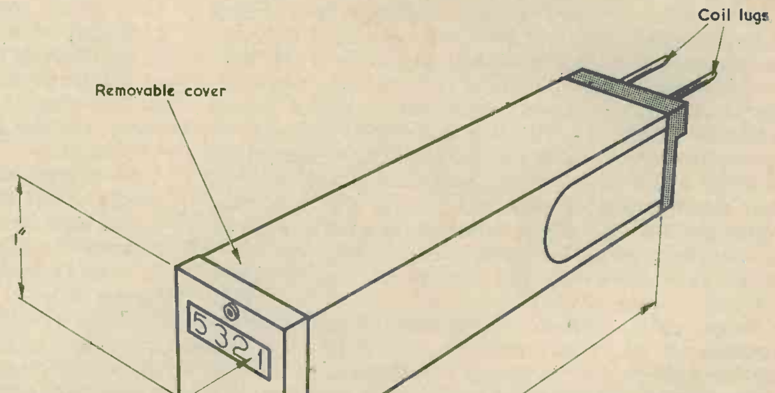


Fig. 1. The electromagnetic counter has the external appearance and dimensions shown here

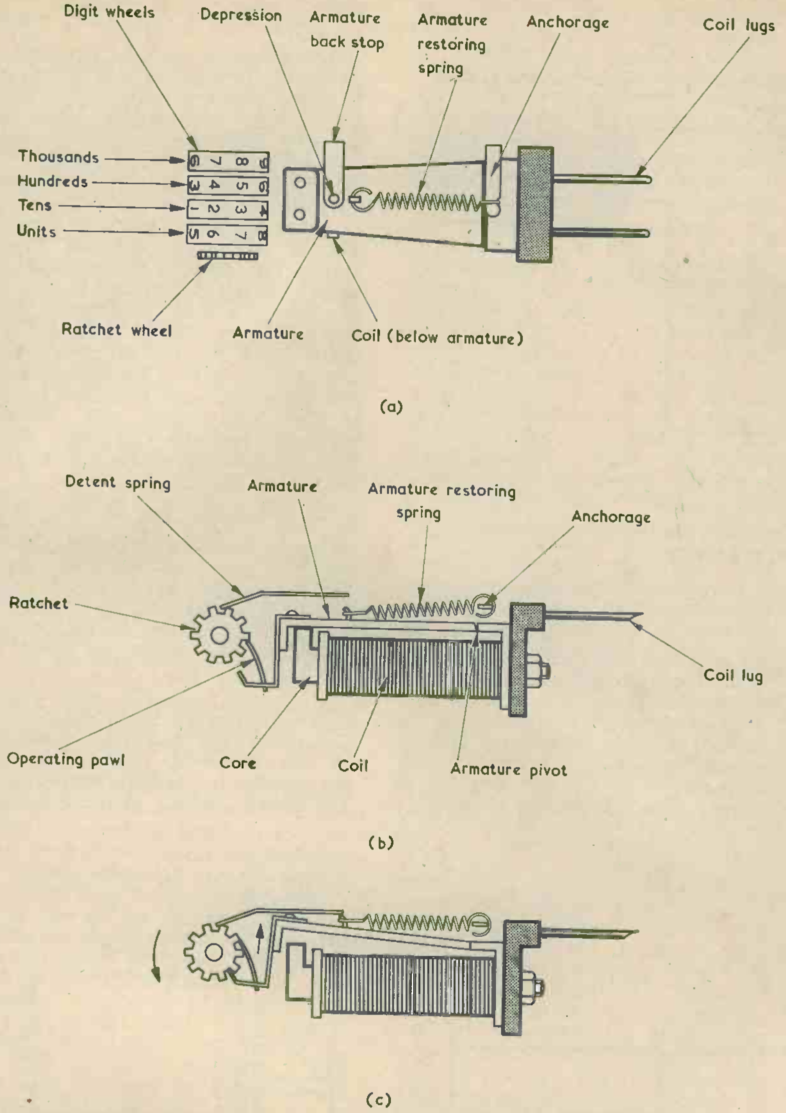


Fig. 2 (a). Top view of the counter mechanism, showing in particular the digit wheels
(b). Side view of the counter in the energised condition, with the armature pulled down to the core
(c). When the armature releases it moves up, and the operating pawl turns the ratchet wheel through one tooth

and when the latter moves down the pawl passes over one tooth of the 10-tooth ratchet wheel. The wheel is prevented by the detent spring from turning in the same direction as the pawl. In Fig. 2(c) the energising current in the coil has been removed, and the end of the armature moves upwards in the direction of the arrow. The operating pawl turns the ratchet wheel round such that one tooth passes under the detent spring, whilst a further extension under the operating pawl rests between two of the ratchet wheel teeth, holding the ratchet wheel steady in its new position.

Thus, if an energising current is passed through the coil and is then removed, thereby causing the armature to move into the energised position towards the core and then release, the ratchet wheel is turned round by one tooth. The ratchet wheel is mechanically coupled to the 'units' digit wheel whereupon, after each energising and release cycle, the number this wheel displays increases by 1. The 'units' wheel is coupled to the remaining digit wheels by means of the gearing which causes actuation of a successive wheel on passing from 9 to 0.

The energising power required by an electromagnetic counter is much higher than that needed by a standard relay. This is partly because the gap distance between the armature and the core in the de-energised condition is greater than occurs in a normal relay, with the result that a high coil current is required for initial pull-in. Also, the armature restoring spring applies a relatively large tension to the armature because this spring has to provide the force which turns the digit wheels. The greatest force needed here occurs when all four wheels have to be moved, as is given, for example, when changing from 1999 to 2000. A typical electrical power requirement for reliable energising of the counter is of the order of 3 to 6 watts. An adjustment which reduces the power requirement for the counter is available at the armature restoring spring anchorage, and this can be gently bent to a position which reduces the armature restoring tension. But the constructor is strongly advised not to make any adjustment here if the counter is working satisfactorily, as the adjustment may result in erratic operation or even damage. The energising power needed by the counter is such as to warrant a mains supply, or an accumulator, whether or not the power required is reduced by adjustment, and so there is little point in making the adjustment.

Electromagnetic counters of the type under discussion are available with various coil resistances, and the unit which was employed by the writer in checking out the present circuits had a coil resistance of 2300Ω. Counters with 2300Ω coils are available from Henry's Radio Ltd., in whose catalogue they are referred to as counters Type 14B. The coil energising voltage should be around 80 to 100 volts.

SIMPLE CIRCUIT

A simple circuit for operating the counter is given in Fig. 3. This incorporates a small mains transformer having a centre-tapped secondary giving 125–0–125 volts at a maximum current of 50mA. Full-wave rectification is provided by silicon rectifiers D1 and D2, the rectified voltage at their cathodes being applied to the voltage dropping resistor R1. When the actuating contacts at the left of the diagram are closed the rectified output of the power supply is applied across R1 and the counter coil in series, and the resultant current in the counter coil causes its armature to move to the energised position. It was found in practice that there was no need to provide any reservoir or smoothing capacitors.

In the prototype circuit, the voltage between the lower supply rail and the upper terminal of the counter coil, as measured by a moving-coil voltmeter, was 115 volts when the actuating contacts were open. It dropped to

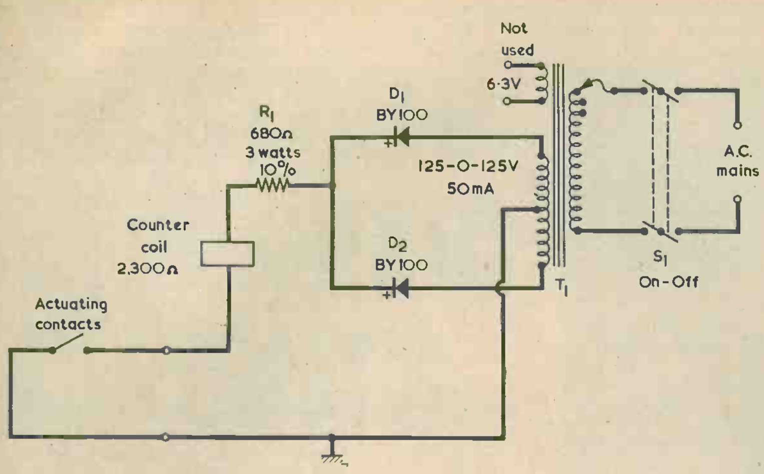


Fig. 3. A simple counting circuit in which the energising supply is obtained from the mains

85 volts when they were closed. The counter coil energising current was, in consequence, 37mA.

So far as components in the simple circuit of Fig. 3 are concerned, D1 and D2 were BY100's, as these happened to be on hand. However, any other silicon rectifiers rated at at least 0.5 amp and with a p.i.v. of 350 volts or more will be satisfactory. The mains transformer is an R.S. Components 'Midget Mains 250V' item having the 125–0–125 volt secondary already referred to, and a 6.3 volt 1.2 amp secondary. The 6.3 volt winding is unused. This transformer is available from retailers of R.S. Components parts.

The actuating contacts may consist of a switch or relay contacts capable of handling 40mA at around 175 volts peak. This requirement takes in virtually all microswitches, toggle switches and the like. It has to be borne in mind that the coil load switched by the contacts is inductive and that significant sparking may be evident when the contacts open, despite the fact that the unsmoothed supply voltage falls to zero at the end of each rectified half-cycle. The relatively high voltage precludes the use of small dry reed switches, which are rated typically at 100 volts or less, and some wafer and miniature rotary switches. The counter adds 1 to the number previously indicated each time the actuating contacts close and then open again.

The circuit of Fig. 3 is reliable and its only disadvantage is that the voltage at the actuating contacts when these are open is relatively high. *The circuit should not be used if there is any risk that the actuating contacts or their connections can be touched by people, as the danger of shock is then too high.*

LOW VOLTAGE CIRCUIT

A circuit which causes the voltage at the actuating contacts to be considerably reduced is given in Fig. 4. The current flowing in the actuating

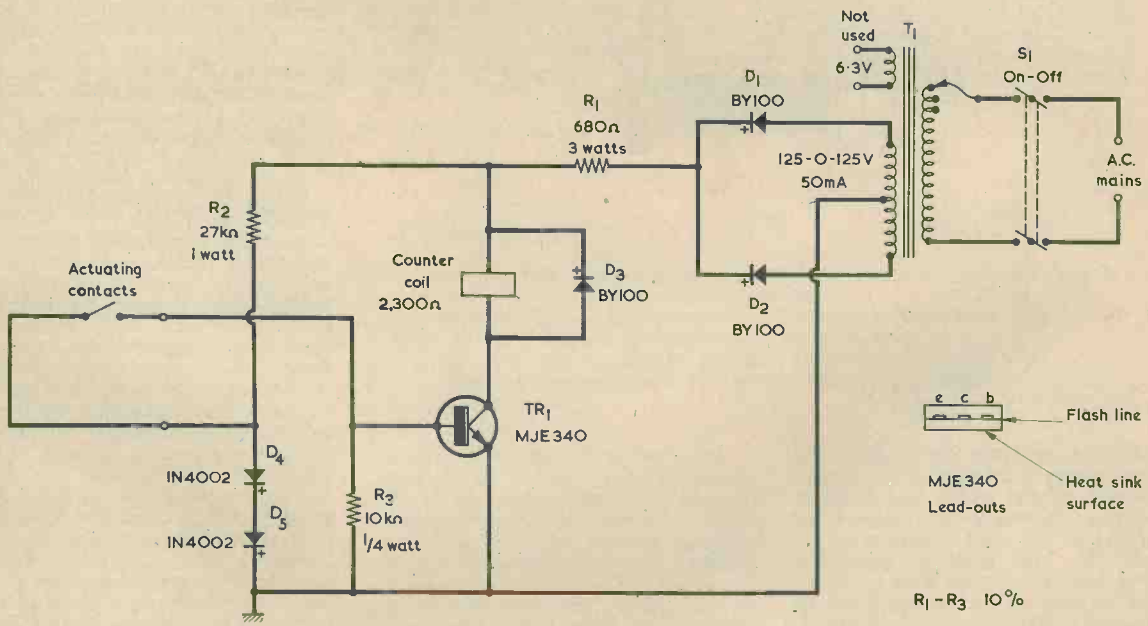


Fig. 4. The addition of a transistor allows both the voltage and the current at the actuating contacts to be considerably reduced

contact circuit is also made smaller, being of the order of 3mA only.

This reduction in voltage and current is achieved by the addition of a switching transistor between the actuating contacts and the counter coil. The transistor is a Motorola high voltage power device type MJE340, and its emitter and collector take the place of the actuating contacts of Fig 3.

When, in Fig. 4, the actuating contacts are open, no bias current flows in the base of TR1. This base is held at the same potential as the emitter via R3, and the transistor is cut off. At the same time, a current of around 3mA flows through R2 to the two forward-biased silicon rectifiers, D4 and D5, causing a voltage of 1.2 volts (as measured) to appear across them. When the actuating contacts are closed the lower end of R2 is connected to the base of the transistor, with the result that the base assumes a voltage of 0.65 volt (again as measured) with reference to chassis. This voltage also appears across D4 and D5, but is below that at which these diodes pass forward current. In consequence, all the current flowing through R2 is now fed to the base of the transistor. This turns hard on and energises the counter. When the actuating contacts are opened again the transistor once more becomes cut off, and the counter armature releases.

With this circuit the voltage appearing across the actuating contacts, when these are open, is only 1.2 volt. The contacts are not, in this instance, at chassis potential but are slightly removed from it. If it is desirable to have one of the contacts at chassis potential, the chassis connection may be transferred from the lower supply rail to the negative end of D4. This will not affect circuit operation.

Due to the small extra current drawn by R2 the voltage across the counter coil, when energised, is now 80 volts, as read by a moving-coil meter.

Diode D3 is connected across the counter coil to prevent the appearance of high reverse voltages when the transistor cuts off. These voltages could damage the transistor. The addition of a diode across a relay coil frequently causes the release time to be slightly extended, because the diode slows down the collapse of the magnetic field around the core. In the present case, however, the presence of the diode did not cause any noticeable reduction in the speed of operation of the counter.

Transistor TR1 has a maximum collector-emitter voltage rating of 300 volts and is used well within its limits here. It is a small component having a metal area on one surface which is common with the collector and which is intended for coupling to a heat sink. The transistor can be secured to the sink with a single 6BA bolt and nut. The lead-outs are as indicated in the inset when the flash line (the line where the two halves of the plastic mould met) is positioned as shown. The flash line is not easy to see, but any doubts about transistor orientation can be dispelled by checking with an ohmmeter between the central collector lead-out and the two outside lead-outs. Continuity will be indicated (with the ohmmeter connected one way round) between collector and base lead-outs only. The MJE340 is available from Henry's Radio Ltd.

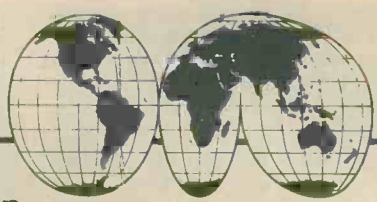
If the supply to the circuit consisted of a smoothed direct voltage, the dissipation in TR1 could be almost negligibly low. This is because it would then either be in the condition where it is fully cut off or in the condition where it is turned hard on and has a very low voltage across it, with very quick transition from one condition to the other. But in the present circuit the supply consists of rectified half-cycles of voltage which fall to zero at the end of each half-cycle. This means that, when the actuating contacts are closed, the transistor will be cut off at the start of each half-cycle and will then gradually go into full conduction as the half-cycle voltage increases, reaching the full conduction state at a half-cycle voltage level which depends on the hFE of the particular transistor employed. The same thing will happen, in reverse, near the end of each half-cycle. There is in consequence a small amount of dissipation at the end and start of each half-cycle which would not be evident with a smoothed d.c. supply. In the prototype, the measured voltage across TR1, when this was hard on, was only 0.3 volt and so the periods of extra dissipation must be short. The writer mounted the transistor on a small heat sink measuring $1\frac{1}{2}$ by $\frac{1}{2}$ in. only, and it ran quite cool. There is a very slight risk that the extra dissipation resulting from the unsmoothed supply may be higher with transistors having a low hFE. If a transistor in the TR1 position runs warm, this may be due to low hFE and the effect can be cleared by reducing the value of R2. Quite low values, down to around 6kΩ, are permissable here. The heat sink, must not, of course, be touched to check its temperature when the mains supply is switched on as it might have a high voltage on it with respect to chassis.

Diode D3, in Fig. 4, is shown as a BY100, since this type happened, as with D1 and D2, to be on hand. Any other silicon rectifier rated at around 0.5 volt and with a p.i.v. of 200 volts or more may be used here. Great care must be taken to connect the diode into circuit with correct polarity as, otherwise, the mains transformer may be damaged. Diodes D4 and D5 are shown as 1N4002. Any other small silicon rectifiers would be equally suitable here.

The circuit of Fig. 4 worked satisfactorily and was not, so far as could be judged subjectively, slower in operation than that of Fig. 3. ■

We wish all our readers a very Happy Christmas and a Prosperous New Year

SHORT WAVE NEWS
FOR DX LISTENERS



By Frank A. Baldwin

Times = GMT   *Frequencies* = kHz

For some weeks past, a signal on a measured **4877** (61.51 metres) has drawn the attention of the writer most evenings from around 2200, the transmission only being audible to any degree when conditions are favourable for Far East reception, only the carrier being apparent on other occasions. Now **4877** is an old channel of Saigon and this is indeed the answer to the puzzle, Saigon has reactivated the frequency. The best time for listening to this one is around 2230 when the signal tends to peak if conditions are good for reception of this area here in the U.K.

There are several pointers for good conditions on the 60 metre band, listen for R. Peking on **4800** (62.50m) or Lanchow (listed but actual location uncertain) on **4865** (61.66m), R. Peking on **4905** (61.16m), all around 2100 or so. For superb conditions, which do not occur very often, listen for Penang on **4985** (60.18m) or Singapore on **5010** (59.88m) around 2210. A word of warning about the latter channel however, this is occupied by R. Garoua, Cameroon, until sign-off at 2200 and by HIMI R. Cristal, Dominican Republic on a 24 hour schedule, although the time is somewhat early for reception of this 1kW transmitter. However, there are always surprises in store on the short waves and HIMI has been logged around 2230 when conditions for Latin America are good. A further pointer for the Far East would be Foochow (actual location uncertain) on **4975** (60.30m) but this one would be rather difficult in normal circumstances.

CURRENT SCHEDULES

● AUSTRIA

The Short Wave Service of Radio Austria broadcasts in English to Europe from 0830 to 0900 a "Report from Austria" on **6155** (48.74m), **15410** (19.46m), **17850** (16.80m) and on **21720** (13.81m). From 1230 to 1300 on **6155**, **9770** (30.70m), **11860** (25.29m) and on **17780** (16.87m). From 1830 to 1900 on **6155**, **15200** (19.73m), **15335** (19.56m) and on **17780**.

● ETHIOPIA

"Radio Voice of the Gospel – ETLF", Addis Ababa, programmes in English as follows – to East Africa from 0400 to 0425 on **7165** (41.87m); to West Africa from 0530 to 0610 on **11890** (25.23m); to Sri Lanka and India from 1255 to 1325 on **15320** (19.58m); to North India from 1330 to 1345 on **11945** (25.11m); to South India from 1330 to 1400 on **15400** (19.48m); to Ethiopia from 1655 to 1710 on **6065** (49.46m); to East Africa from 1755 to 1810 on **9705** (30.91m); to South Africa from 1830 to 1910 on **7255** (41.35m) and to West Africa from 1930 to 2015 on **11810** (25.40m).

● BELGIUM

The "International Service of the Belgian Radio", Brussels, does not radiate to Europe in English but does provide a service to the Americas from 2255 to 2315 on **9655** (31.07m) and on **11920** (25.16m) and also from 0040 to 0100 on the same channels.

● BANGLADESH

Radio Bangladesh, Dacca, at the time of writing, has a schedule in English for Europe as follows – from 1230 to 1300 on **15455** (19.41m) and on **17690** (16.95m), although measured by us on **17691.5** (16.95m); from 1845 to 1900 on **9495** (31.59m) and on **4890** (61.34m) and from 2100 to 2200 on the two latter channels.

● JORDAN

Jordan does not now have an external service but a relay of the home service programme in English is directed to Europe from 1100 to 1230 on **7155** (41.92m) and from 1600 to 1730 on **9560** (31.38m) the latter transmission being best received here in the U.K.

● LEBANON

The Overseas Service from Radio Beirut is directed to Europe and Africa in English, Arabic and French from 1830 to 2030 on **11840** (25.33m).

● AFGHANISTAN

Radio Afghanistan broadcasts to Europe in English from 1800 to 1830 on **9575** (31.33m) but the channel is occupied during this period by a jamming transmitter rendering the broadcast inaudible! Kabul can be heard in Pushtu and Dari from 1200 to 1300 on **15195** (19.74m) and on **21695** (13.82m).

● BRAZIL

"Radio Nacional de Brasilia" radiates a programme in English from 2300 on **9665** (31.03m), **11720** (25.59m) and on **15445** (19.42m).

AROUND THE DIAL

● CHINA

The P.L.A. (People's Liberation Army) Fukien Front station may be heard around 2030 (when logged by us) on **6400** (46.87m). Most of the programme content is of talks in Standard Chinese, which is a pity, for the writer finds their music rather appealing. However, for those who are interested in logging this station, sign-on is at 2010 and thence through to 2300 on **2430** (123.45m), **2600** (115.38m) **2800** (107.14m) all unlikely to be heard here in the U.K. and, more likely, **3200** (93.75m), **3400** (88.23m), **3535** (84.86m), **3900** (76.92m), **4380** (68.49m) and on **6400**.

At 2300, according to the schedule, Fukien relays the Taiwan Service in Standard Chinese until 2330 on **3200, 3400, 3900, 4380, 4840, 5170, 5240, 5900** and on **6400**. However, the **4840** (61.98m) transmission has been logged here as early as 2150, that on **3900** at 1923!

Chinese regional transmitters may also be heard, recent loggings have included Lanchow at 2150 on **4865** (61.66m); Foochow at 2216 on **4975** (60.30m) and even Nanning with YL in Chinese under Singapore on **5010** (59.88m) at 2303. The locations of the Chinese regional stations are shown here as listed but the actual locations are uncertain.

Lhasa can be heard on **9395** (31.93m) from 1600 at which time we heard them carrying the External Service of R. Peking in Hindi.

● BRAZIL

There are several Brazilian stations operating on the 15MHz band, some logged recently have been –

ZYK33 R. Journal de Commercio, Recife, at 2050 on **15145** (19.80m) 10kW schedule from 1900 to 0100.

ZYB9 R. Dif. de Sao Paulo, at 2032 on **15155** (19.79m) 10kW, schedule from 1500 to 0300.

PRK9 R. Inconfidencia, Belo Horizonte, at 2026 on **15190** (19.74m) 5kW schedule 0900 to 0300.

● ZAIRE

Kinshasha operates throughout a 24-hour schedule and may be heard on **15245** (19.67m), being logged at 1818 when radiating a programme of typical African chants accompanied by drums and local musical instruments.

● U.S.A.

WINB (World Inter-National Broadcasters) Red Lion, Pennsylvania, is to be heard on **15185** (19.75m) where, according to schedule, they operate in English to Europe, from 1745 to 2245. The programmes are of evangelical content, one such being logged here at 2046 after station identification.

● SWITZERLAND

Berne may be logged on **9535** (31.46m) with a programme in English during the evenings, we heard them at 2120 and were informed about the Swiss economic scene.

● AUSTRALIA

We pommies usually hear Australia in the early mornings or mid-afternoons but the musical box rendition of "Waltzing Matilda", together with the sounds of side-splitting laughter, can be aurally apparent in the evenings if conditions permit. Try **9535** (31.46m) at 2126, but note from the above paragraph that your ears may Berne (oh dear).

● AUSTRIA

Vienna can be heard in English around 1830, we logged them at 1835 during a discussion about local natural history on **15335** (19.56m). According to later announcements, Vienna was also on the parallel channels of **15200** (19.73m) and **6155** (48.74m).

● YUGOSLAVIA

Belgrade radiates a programme in English from 1830 to 1900. We logged them at 1830 with the news after station identification, listen on **6100** (49.18m).

● NETHERLANDS

Radio Nederland is to be heard, with a newscast in English, at 1830 on **6085** (49.30m); we also located them soon after on **6020** (49.83m).

● ALBANIA

Tirana, with comment on world affairs in English from the Albanian point of view, can be heard at 1830 on **7065** (42.46m).

● NIGERIA

Lagos operates on 15185 (according to the schedule) but recently, when featuring the news in English at 0700 after station identification, they were actually on a measured **15182** (19.76m).

● CANADA

Tune to **17820** (16.83m) at 1230 for Radio Canada in English, programmes from Sackville are always worth hearing.

● ISRAEL

Jerusalem can be tuned in on **9625** (31.16m) at 2000, news in English, identification at 2014 then comment on world affairs; on **11700** (25.64m) at 2042 with news in English after identification and on **15105** (19.86m) at 2000 with identification, time-check and news in English.

● FINLAND

OIX2 Pori on **9550** (31.41m) may be heard at 2030 with news of Finnish internal affairs in English.

● SPAIN

R. Nacional, Madrid, on **7105** (42.22m) at 1955 with the music and songs of Andulasia, announcements in Spanish.

● GHANA

Tema may be heard from 1500 in English on **21545** (13.92m), logged by us when they were radiating a programme about local sport and training facilities.

● PAKISTAN

Karachi can be heard on **9460** (31.71m), we logged them at 1610 when an internal affairs commentary in English was featured. Sign-off is at 1620.

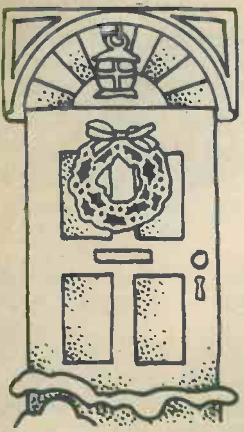
Radio Pakistan, for 60 metre band devotees, can also be heard on **4877** (measured) but listed on **4875** (61.53m) at 1804, when we logged station identification, the news in English and sign-off at 1809.

● BANGLADESH

Dacca on **4890** (61.34m) at 2130 with a programme of local music and songs, identification is in English at 2137.

● GAMBIA

Banjul (formerly Bathurst) is to be heard on **4820** (62.24m) around 2130. We logged them at 2128, listening to the talking drum and identification in English at 2129.



A Christmas Drama!

TOTAL HARMONIC DISTORTION

by D.P.S.T. Toggle, A/C, D/C, Bar

A SWITCHED ON STORY—

Based on a well known carbon film

REG VOLTAGE LOOKED ACROSS AT HIS WIFE ZENER AND wondered if there was any chance left for him to transformer. Their shelf life was so full of high tension these days and neither had the capacity any more to maintain a bistable state.

Suddenly there was a centre tap on the window and when Reg looked out he saw a longtailed pair of eyes belonging to Ivor Gauss, his wife's ex-lover. In Gauss' hand was an electron gun and as Reg watched he inserted a cartridge, took Shure aim and pulled the trigger. The single shot reverberated and Reg dropped rapidly to the deck, his life cut dead short at its most positive peak.

Ivor leaped in just as Zener grabbed the phono to DIL the binary code and call the fuzz. He quickly took hold of her and taped her loudspeaker to avoid any audio breakthrough and having established a low-noise state he stopped to ponder. He had to rectify the situation in some way and smooth things over; he was afraid that the DIN would have upset the next-door neighbour L.C. Bridge and lead to interference.

He listened – no noise, not even hums or rumbles – all was well. Walking to the nearby cabinet he removed a bottle, filled the mixer and oscillated it vigorously as I.F. his life depended on it. He poured out the potential juice through a filter, added a small current and drank Watt he could in the timebase available. He then decided to visit his transistor and brother across the channel while allowing things a while to Coulomb off and so executed a quick thermal runaway.

Zener by this time had broken the tape and although very shocked knew she had to contact her friend Meg Ohm and tell her all that had happened. Ivor she realised was terribly unstable and had to be caught and defluxed before he caused any more Gunn effects. She picked up the phono and DILed Meg; she heard the decibel ringing but it seemed a decade before it was answered and she could discharge her load to Meg, who immediately said "I.C." and being very logical insisted on calling the fuzz on the 625 line.

Feeling all wirewound up Zener eased her tension by having a smoke of pot but nanoseconds later the Law arrived at the Voltage threshold to collector. Meg was with them and they all shifted into the force vehicle which was a fast four pole motor; with the driver using full choke they sped away down the bypass to try and short circuit the kiloVolt Ivor. While driving along Detector Schmitt asked Zener to Verofy all the facts and to be as unbiased as possible so he could relay the data to other units and switch the entire force output on to the problem.

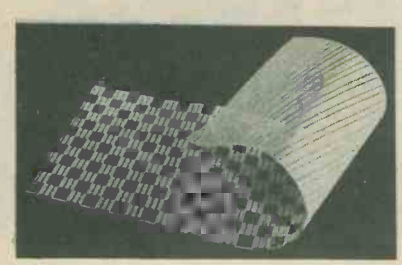
Reports quickly avalanched in as to Ivor Gauss' position – he had been detected near a gate into a field effect by the AFC shore and it was not long before the motor reached the spot and they could all see Ivor running away very fast. Despite a loose bootstrap he ran on until he reached a unijunction where he was momentarily quiescent before dashing off down a low resistance path that LED to the Darlington Pair.

When he got to the end he stopped and just stood, caught in the modulated light beam of the motor's lamps. The atmospherics were electrolytic and pulses quickened as Detector Schmitt ordered him to drop his electron gun and have the sensitivity to respond to higher power levels but instead Gauss just made bipolar digital signals and gave a sawtoothy grin. He had obviously realised that push or pull he had no means of escape and as they watched him it was suddenly very apparent that he was going to commit sinusoid; before anyone could be galvanised into action he had given a half wave and emitting an over-modulated screech come howl jumped straight off Darlington Pair into the waves of the AFC.

The effect of all this high frequency drama on Zener was that she broke down but Schmitt quickly took control and assured her that the reaction was quite normal and that all had worked out for the best. This brought her down to earth before long and Schmitt asked if she and Meg would Dyne with him at the 'Auxiliary In' the next day so they could engage in some crosstalk about other things less harmful to the memory systems. The reply was positive and that very day a firm friendship was fused that was to produce a phase change in all their lives by degrees and Zener could see that despite the recent flux in events she would somehow solder on regardless. ■

New Products

STANDARD BACK WIRING AID



Vero Electronics Limited have now introduced a standard Back Wiring Aid for use with single and double sided .1″ pitch mini wrap Edge Connectors up to the maximum length which can be fitted into a Vero Card Frame. The Vero Back Wiring Aids have been designed to speed the back wiring of printed circuit Card Frames and reduce the number of faults which occur. The wiring panels more readily identify each connector termination and thus simplify both the initial wiring operation and the subsequent inspection procedure. They are also extremely useful when any servicing is necessary. The standard Back Wiring Aids are printed with a red and white checkerboard pattern for contact identification but in production applications they can also be printed with individual connector and terminal identification.

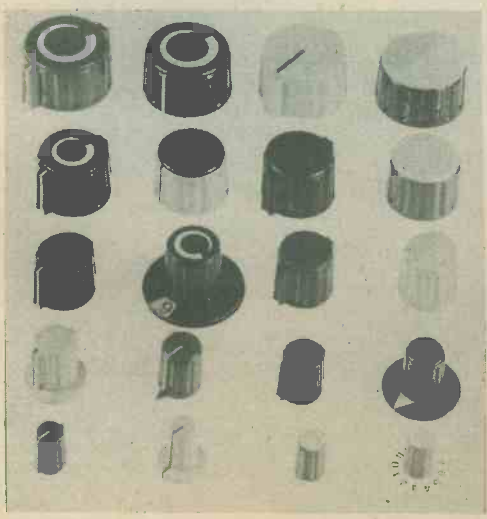
LONG LIFE CASSETTE CLEANER

By using a BASF cleaning cassette for just a couple of seconds each week, you will be able to keep the tape contact parts of your cassette machine clear of deposits for up to 12 years without buying another cleaner.

Each cassette holds over 180 feet of chrome oxide (not to be confused with chromium dioxide tape which is chemically a different substance altogether) tape which gives approximately 600, two-second bursts of cleaning. BASF technicians consider two seconds to be ample time to clean away normal deposits. To get the best results at each cleaning session an unused length of tape should be used.

Failure to clean tape heads, capstans and other parts in contact with tape is considered to be the most common single cause of poor tape performance and damage. Deposits on the magnetic heads, for example, reduce head-to-tape contact which in turn can cause loss of high frequencies, and drop-outs. Deposits also mis-shape capstans which can lead to poor transportation of and possible damage to the tape.

The recommended retail price of the cleaning cassette is £1.62 excluding VAT. BASF United Kingdom Ltd., 197 Knightsbridge, London SW7 1SA.



MULTI-RANGE INSTRUMENT CONTROL KNOBS

Announcing the Sole Agency appointment of A. F. Bulgin & Co., Ltd., for the Swiss manufactured range of 'RITEL' Collet fixing Control Knobs to be known as 'BULGIN MULTI-RANGE'.

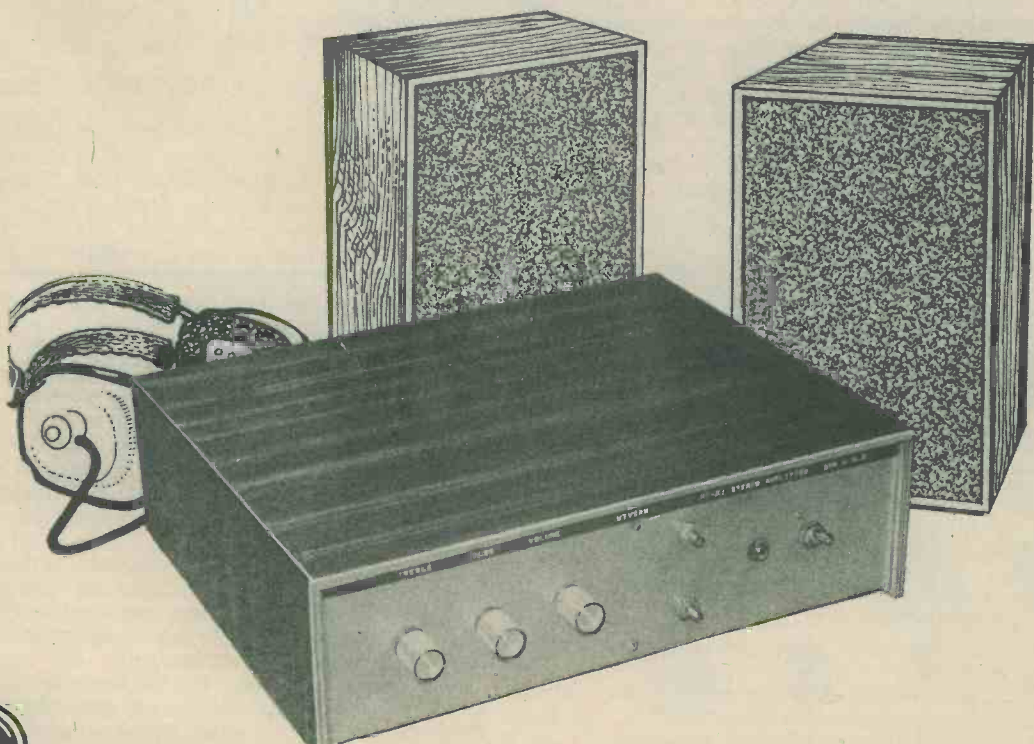
These Control Knobs cover four basic styles of which there is five sizes in each style, all conforming to accepted standards of modern 'matched family design' and manufactured to the highest specifications in order to meet Bulgin quality standards.

This range will further extend the coverage of sizes and styles already available from the existing Bulgin catalogue and will no doubt prove of great interest to the engineer responsible for matched front of panel controls. Further details from: A. F. Bulgin & Co. Ltd., Bye-Pass Road, Barking, Essex.

The 'WYVERN'

Part 1 By John R. Green B.Sc., G3WVR

This is the first of a 3-part series which describes the construction and operation of a fully solid state stereo amplifier. A comprehensive circuit design is employed, with emphasis on the use of low-cost transistors



Cover Feature

30 watt Stereo Amplifier

THIS SHORT SERIES OF ARTICLES DESCRIBES A STRAIGHT-forward and conventional solid state stereo amplifier design which delivers 15 watts r.m.s. per channel into a 3Ω load. The name 'Wyvern' is chosen, as with a transmitter design previously described,[1] since its first, third and fifth letters coincide with the author's call-sign.

The performance of the amplifier over the four years since the first version was built has shown it to be a reliable design, versatile in application, and capable of an excellent and repeatable performance which is indistinguishable by ear from expensive manufactured designs claiming low distortion figures.

The modular construction and simple chassis work make the amplifier an ideal project for the hi-fi enthusiast.

A detailed theoretical section on the design of the power amplifier stage is also incorporated in the series.

The block diagram for the complete amplifier system is illustrated in Fig. 1.

Each channel incorporates Mullard designed circuits for magnetic cartridge equalisation and active tone

1. John R. Green, B.Sc., 'The "Wyvern" 160 Metre Solid State Transmitter', *Radio & Electronics Constructor*, November, December 1972, January 1973.

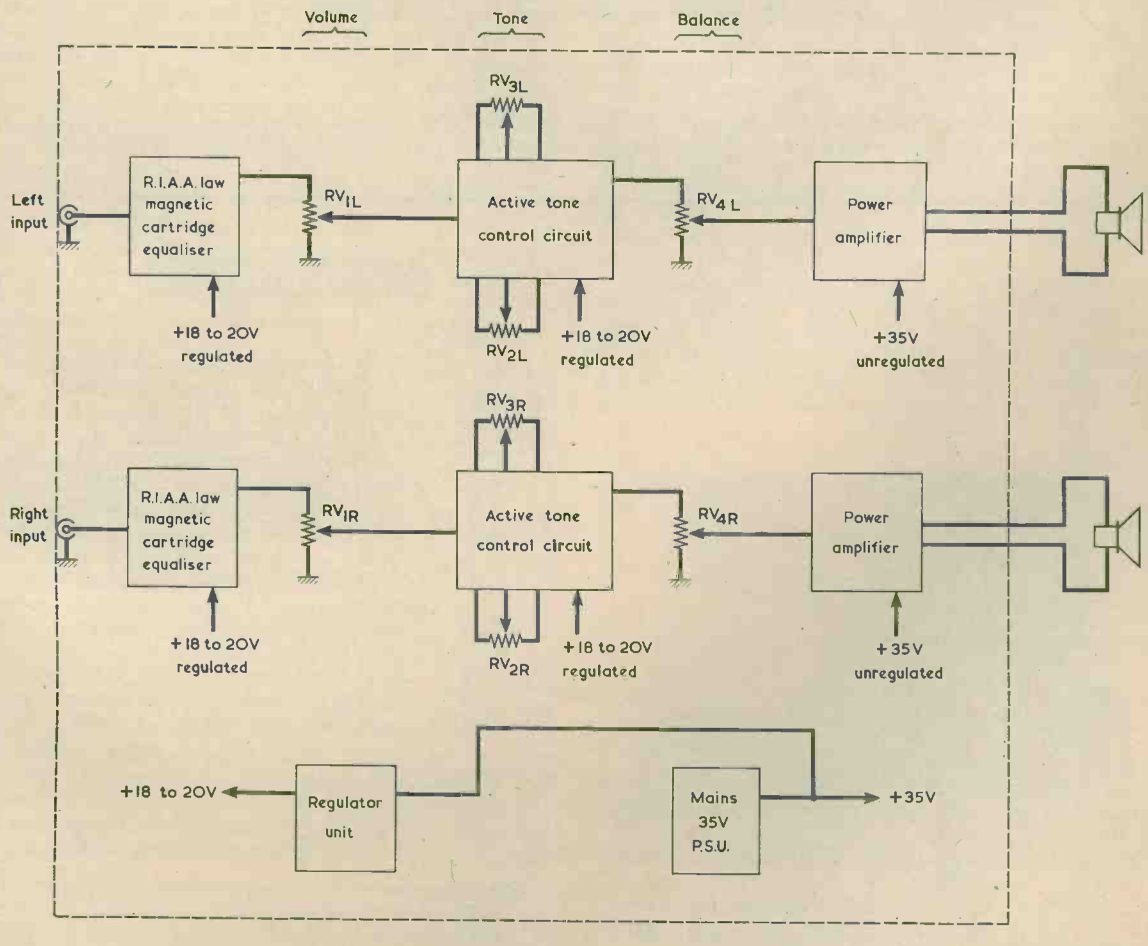


Fig. 1. Block diagram for the complete stereo amplifier

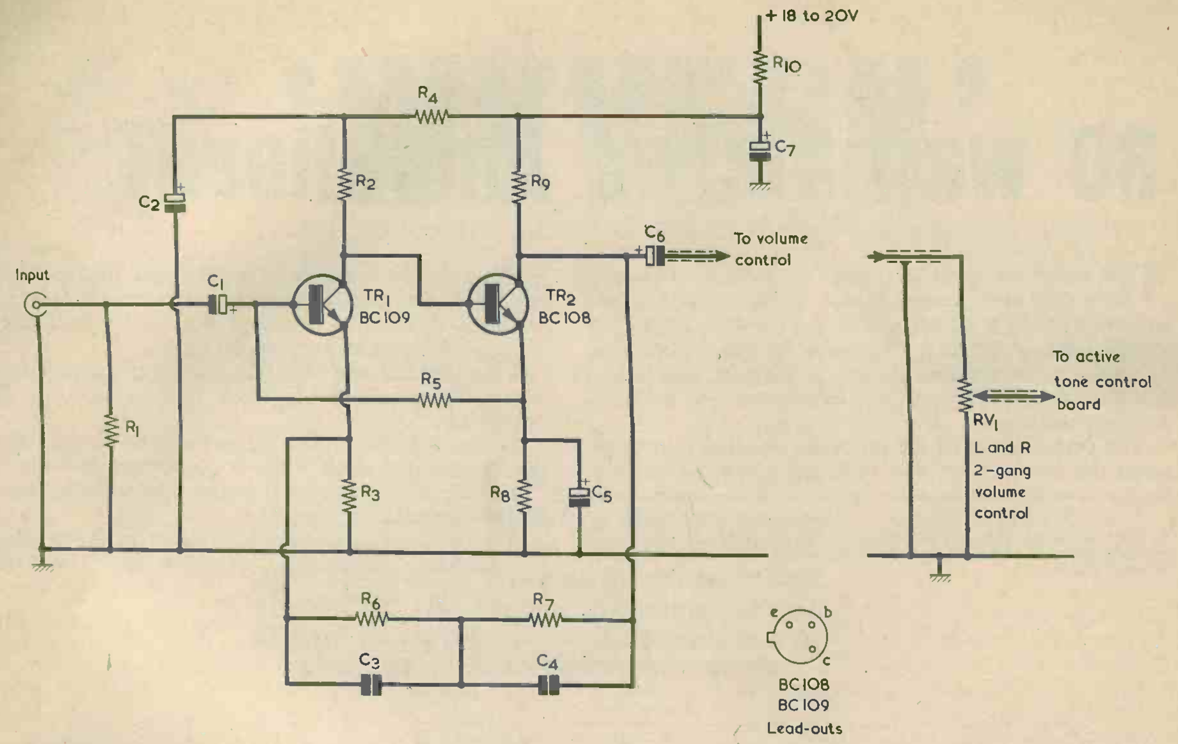


Fig. 2. Circuit of the R.I.A.A. law magnetic cartridge equaliser. Two of these are required and the outputs connect to the two sections of the 2-gang volume control RV1. This circuit is based on a Mullard design

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)

R1	2-off 56kΩ
R2	2-off 220kΩ
R3	2-off 680Ω
R4	2-off 220kΩ
R5	2-off 220kΩ
R6	2-off 10kΩ
R7	2-off 150kΩ
R8	2-off 820Ω
R9	2-off 18kΩ
R10	2-off 1kΩ
R11	2-off 4.7kΩ
R12	2-off 4.7kΩ
R13	2-off 39kΩ
R14	2-off 5.6kΩ
R15	2-off 180kΩ
R16	2-off 33kΩ
R17	2-off 3.9kΩ
R18	2-off 1kΩ
R19	2-off 330Ω
RV1	1-off 10kΩ potentiometer, log, 2-gang
RV2	1-off 100kΩ potentiometer, linear, 2-gang
RV3	1-off 100kΩ potentiometer, linear, 2-gang
RV4	2-off 10kΩ potentiometer, log, panel-mounting pre-set (or 1-off 2-gang log/antilog – see text)

Capacitors

C1	2-off 12μF electrolytic, 25 V.Wkg.
C2	2-off 50μF electrolytic, 25 V.Wkg.
C3	2-off 0.0068μF plastic foil
C4	2-off 0.022μF plastic foil
C5	2-off 400μF electrolytic, 6 V.Wkg.
C6	2-off 25μF electrolytic, 25 V.Wkg.
C7	2-off 25μF electrolytic, 25 V.Wkg.
C8	2-off 2,200pF plastic foil or silvered mica
C9	2-off 2,200pF plastic foil or silvered mica
C10	2-off 8μF electrolytic, 25V.Wkg.
C11	2-off 0.047μF plastic foil
C12	2-off 50μF electrolytic, 25 V.Wkg.
C13	2-off 50μF electrolytic, 6 V.Wkg.
C14	2-off 25μF electrolytic, 25 V.Wkg.

Semiconductors

TR1	2-off BC109
TR2	2-off BC108
TR3	2-off BC108

Miscellaneous
Perforated board (see text)
Perforated board pins (see text)

controls, and the author's design for the power amplifier stage.[2]

An 18 volt regulated supply is incorporated for running the pre-amplifier stages, whereas the power amplifier stages are run from an unstabilized 30–35 volt supply.

PICK-UP EQUALISER CIRCUIT

The amplifier was intended to be used solely with a magnetic cartridge and for this purpose the R.I.A.A. law equaliser shown in Fig. 2 is used. (As is explained shortly, this may be easily modified for a ceramic or crystal cartridge.)

Since the magnetic cartridge works on the principle of electro-magnetic induction, its output rises with frequency. This may be deduced from the formula $V = L\frac{di}{dt}$, where V is the induced e.m.f.; L is the coil inductance and $\frac{di}{dt}$ is the rate of change of current in the coil, which in turn is related to the frequency of the recorded signal exciting the stylus.

A suitable device for converting the output response of the magnetic cartridge to a flat response would appear to be an equaliser whose frequency response falls off at the same rate as the cartridge response rise. But this is not the only consideration involved, since the actual disc recording incorporates bass cut (below 1kHz) and treble lift (above 1kHz) in order to maintain a sensible dynamic range, to give a good signal-to-noise ratio (by treble boost) and to prevent the necessity of increased groove separation which full amplitude, unattenuated, bass frequencies would require. The increased groove separation would cause a consequent reduction in the length of the recording.

In addition to compensating for the cartridge characteristic and the recording characteristic, the equaliser must also provide sufficient gain to amplify the pick-up signal to a level suitable for driving the power amplifier. (The tone control circuits following the equaliser offer approximately unity gain when in the 'flat' response condition.) The equaliser must also incorporate a low noise first stage so as to yield a good signal-to-noise ratio.

The circuit shown in Fig. 2 satisfies these requirements. The first stage uses a low noise transistor type BC109 running at very low current to give a low noise performance, whilst TR2 provides further gain. The overall gain and response are controlled by negative feedback via R7, C4, R6 and C3.

For use with a ceramic or crystal pick-up the network R7, C4, R6, C3 is replaced by a series combination of a 10µF 20 V.Wkg. electrolytic capacitor and a 4.7kΩ resistor. The positive terminal of the 10µF capacitor connects to the collector of TR2 and the free end of the 4.7kΩ resistor connects to the emitter of TR1. Also, R1 is removed and a potential divider given by a 1.8 MΩ and a 220kΩ resistor in series fitted instead. The 220kΩ resistor is wired in the position occupied in Fig. 2, by R1, and the 1.8MΩ resistor is in series with the upper end of the 220kΩ resistor and the non-earthy output from the pick-up. This potential divider reduces the higher output given by a ceramic or crystal pick-up to a level suitable for application to the equaliser, although this level may vary somewhat depending on the output of the cartridge used.

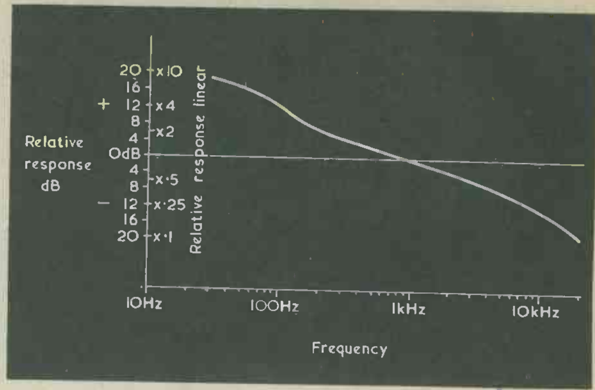
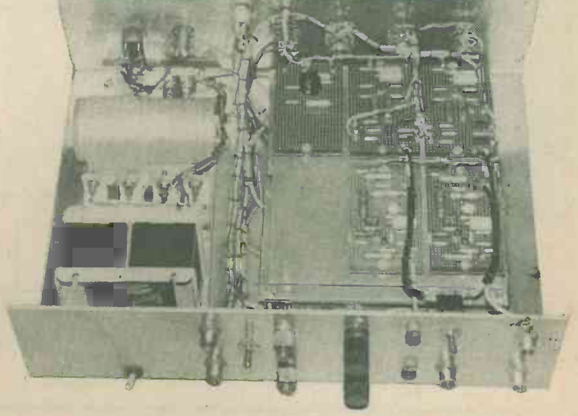


Fig. 3. Response of the equaliser circuit for magnetic cartridge input. (Courtesy Mullard Limited.)

The response of the equaliser, using the components for magnetic cartridge equalisation, is shown in Fig. 3.

The layout of the R.I.A.A. equalisers on a plain perforated panel is illustrated in Fig. 4. This diagram shows the board from the component side, the wiring under the panel being illustrated in dashed line. The equaliser boards may also be seen in the accompanying photographs, in which they are the two units nearer the rear and further away from the 2-gang potentiometers. (In the photographs each equaliser board has a resistor and capacitor in addition to the components shown in Fig. 4. These were fitted temporarily to provide an extra input to the following tone control stage at the time when the photographs were taken. They are not necessary for normal operation of the amplifier and need not be included by the constructor.)

The perforated board employed by the author is the R.S. Components Matrix Board type 186, which is available in pieces measuring 104 by 65 mm. (4.1 by 2.6 in.) and has a hole spacing of 0.1 in. This board is available from suppliers of R. S. Components parts. Five of the R.S. Components boards are required for



The inside of the amplifier as viewed from the rear. The five perforated boards are mounted on a panel above the power amplifier stages

2. The circuits given in Figs. 2 and 5 are based on designs appearing in 'Transistor Audio and Radio Circuits', Second Edition, published by Mullard Limited. The curves of Figs. 3 and 6 are also taken from this source. These diagrams and the relevant circuit information are reproduced by kind permission of Mullard Limited.

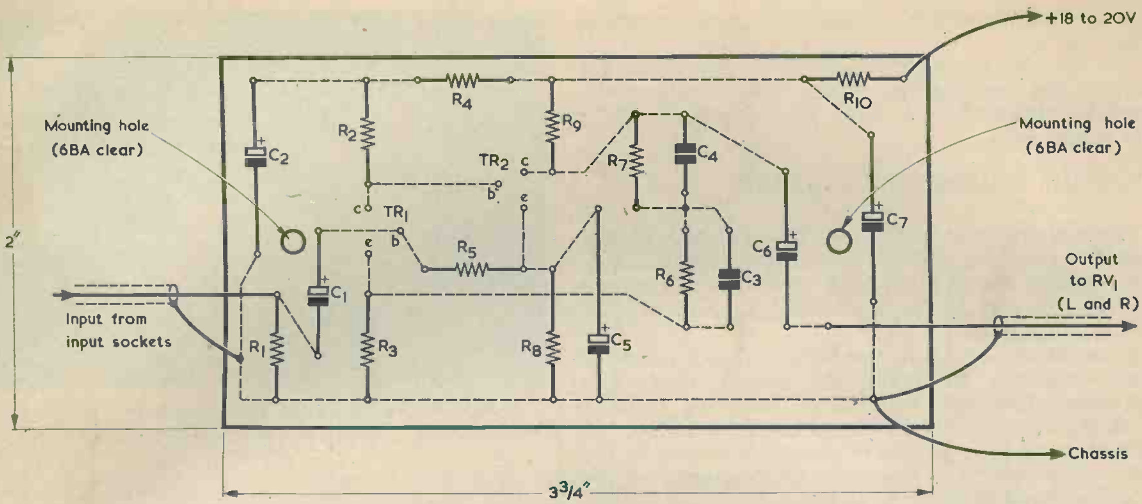


Fig. 4. Layout and wiring of components for the equaliser on perforated board. This is viewed from the component side and is reproduced full size.

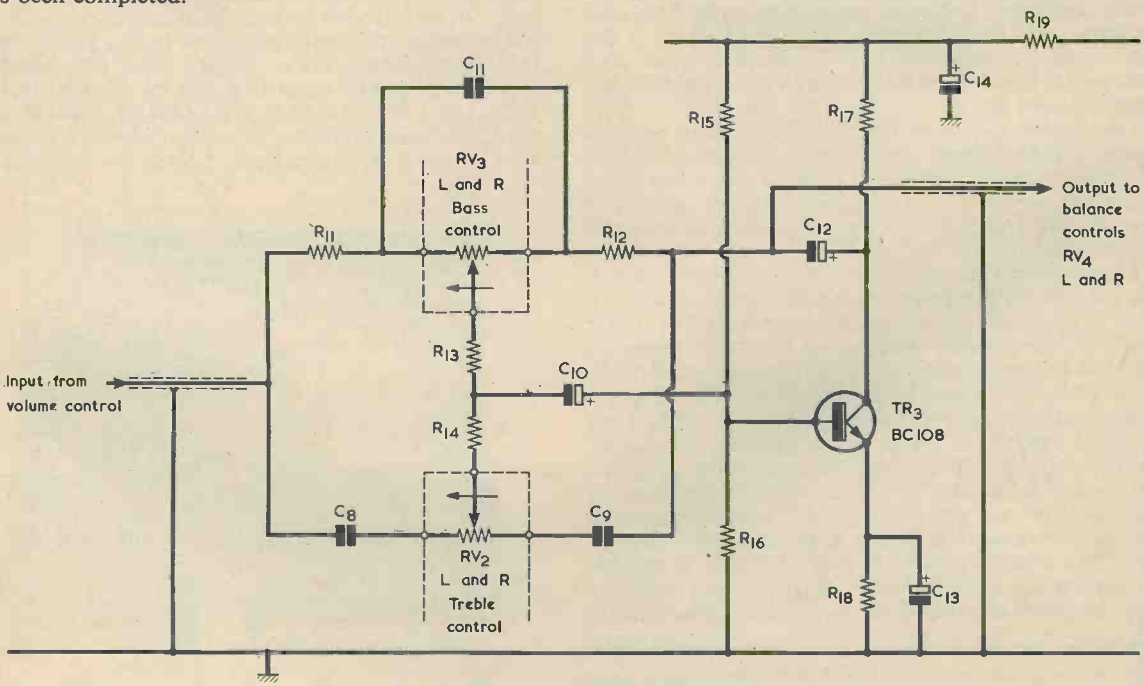
the complete amplifier. Alternatively, standard plain Veroboard with a hole matrix of 0.15 in. can be employed. Input and output connections for the 0.1 in. board may be provided by R. S. Components terminal pins type DS. If 0.15 in. Veroboard is used, standard Vero pins may be employed.

As an aid to assembly, Fig. 4 is reproduced full-sized, and may be traced, if desired. However, precise component positioning is not critical and slight variations in lead-out placing dictated by such things as component dimensions are permissable. RV1, the dual-gang 10kΩ log volume control shown in Fig. 2, is fitted and wired in later, after chassis construction has been completed.

ACTIVE TONE CONTROL

The active tone control circuit is shown in Fig. 5, and the response graph at various tone control settings in Fig. 6.

The circuit of Fig. 5 operates with a frequency dependent feedback network between the collector and base of the transistor. The tone characteristics of Fig. 6 show the range of control, which extends from —22 to +19.5dB at 30Hz, and from —19 to +19.5dB at 20kHz. (These figures represent linear boost and cut equal to a multiplication and division by about 10 at 30Hz and 20kHz.)



Tone controls are linear 2-gang

Fig. 5. The active tone control circuit, also based on a Mullard design. Two are required

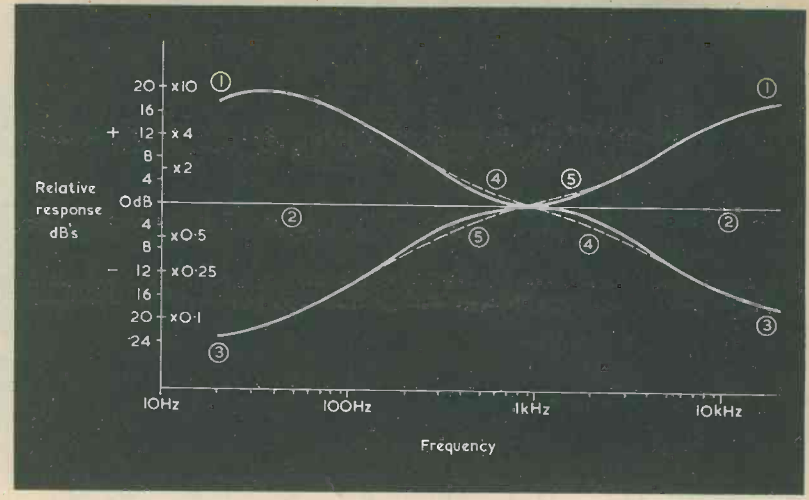


Fig. 6. Curves showing active tone control response. Curve 1 shows maximum bass boost, maximum treble cut; curve 2 shows linear frequency response (controls flat); curve 3 shows maximum bass cut, maximum treble cut; curve 4 shows maximum bass boost, maximum treble cut; curve 5 shows maximum bass cut, maximum treble boost. (Courtesy Mullard Limited.)

The flat frequency response is obtained when the variable resistors are in the physically central position. The voltage gain then given is 0.91.

The potentiometers used for the tone control RV2 and RV3, are of the ganged type, and are both 100kΩ linear. The arrows alongside the tracks correspond to clockwise rotation for maximum bass and maximum treble. When they are wired in later, after the appropriate chassis construction has been completed, R11 is connected to the track end of RV3 at which the slider rests after complete clockwise rotation of the spindle. C8 connects to the corresponding track end of RV2.

The outputs of the two active tone controls pass to two separate panel-mounting pre-set potentiometers, RV4, each having a value of 10kΩ log. These appear in Fig. 12, to be published next month, and they are mounted on the front panel. Alternatively, a single ganged log/antilog 10kΩ potentiometer could be used, this being connected as shown in Fig. 7, where the

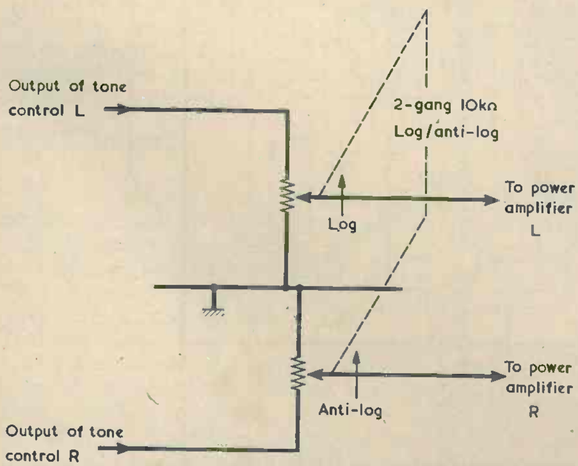
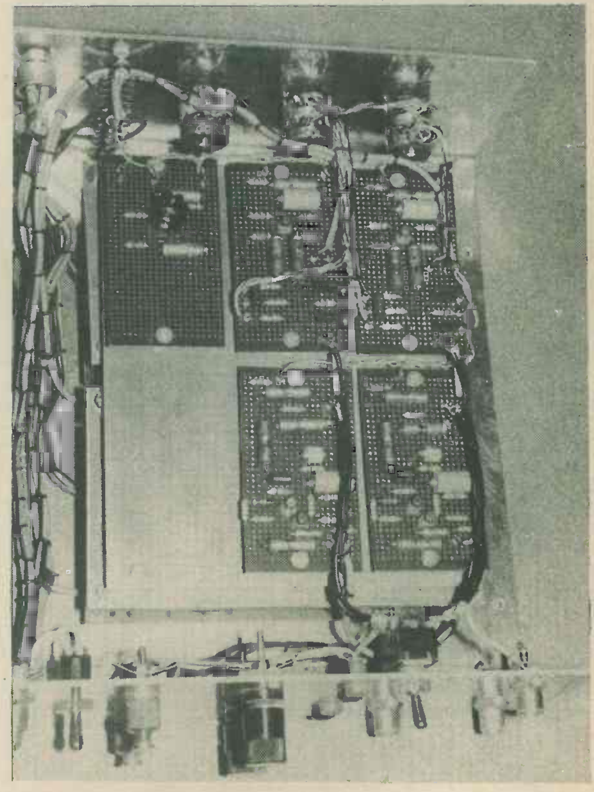


Fig. 7. A single 2-gang log/antilog potentiometer may be used as a balance control, whereupon it is connected in the manner shown here. Signal wire screening is omitted for simplicity



A closer view of the perforated boards. The two similar boards closer to the two-gang potentiometers at the front are the active tone control boards, with the supply voltage regulator board alongside. The two boards nearer the rear are the R.I.A.A. equalisers

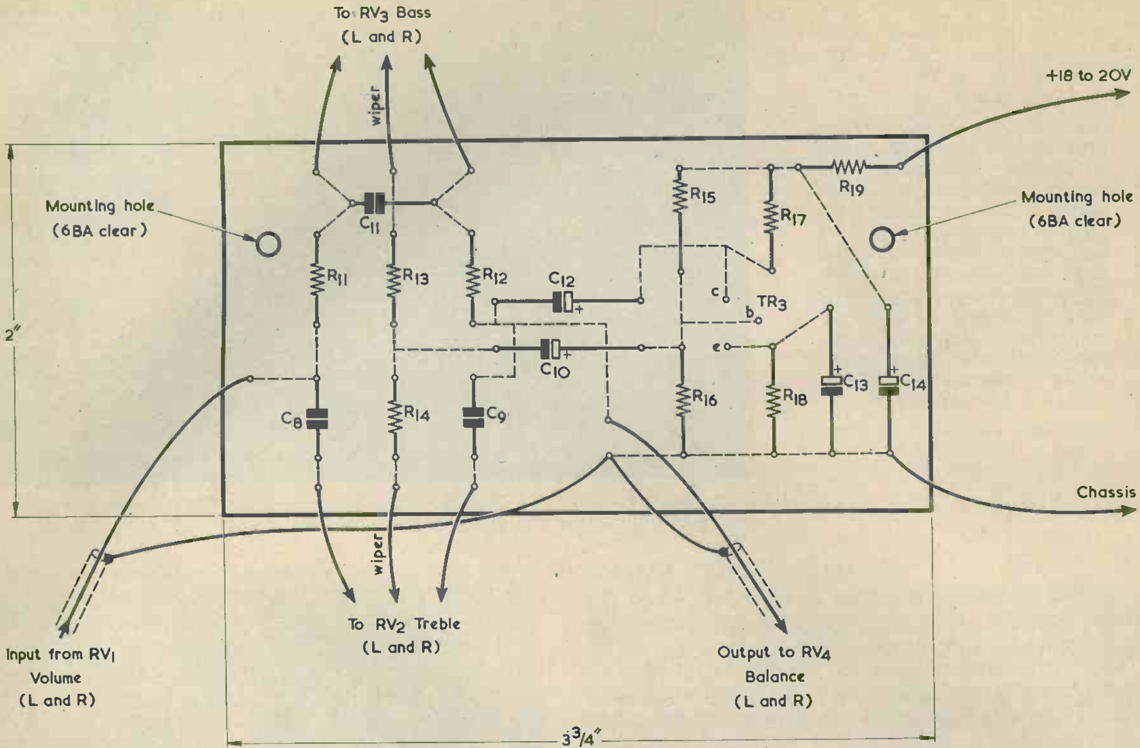


Fig. 8. Component side of the active tone control board. This is also reproduced full size

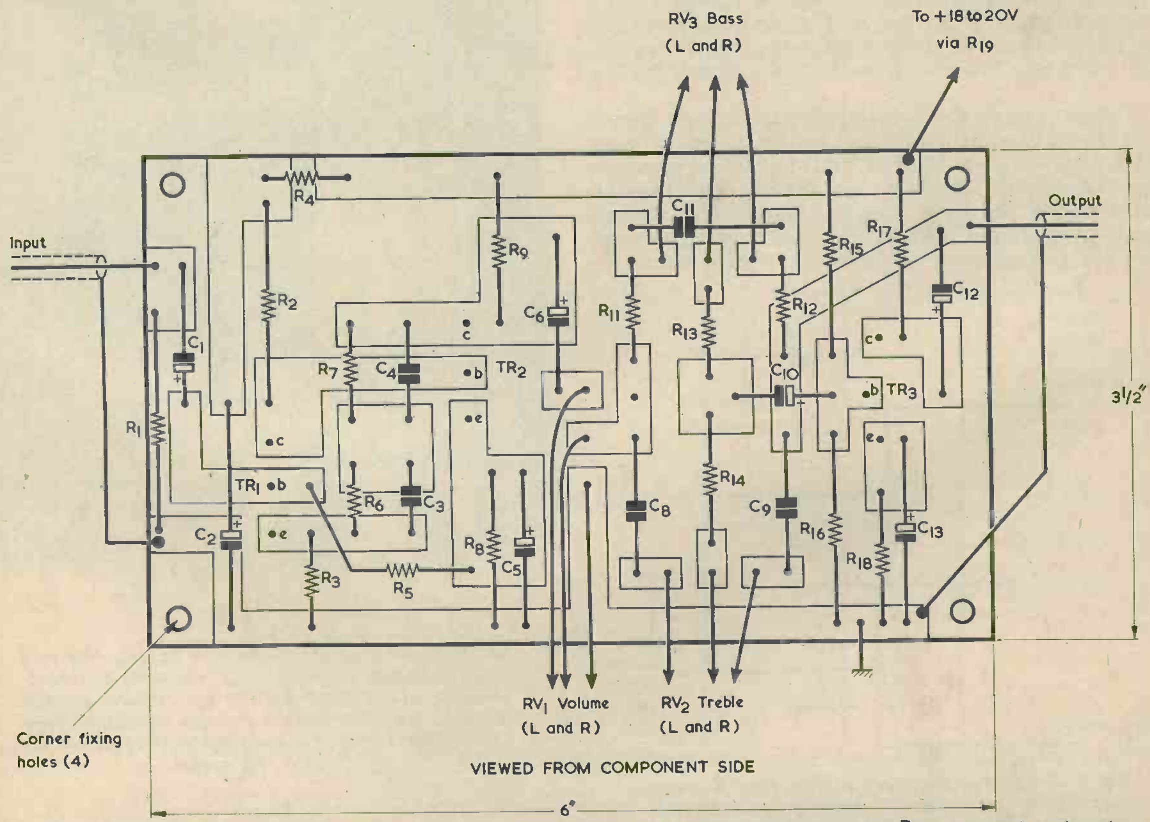
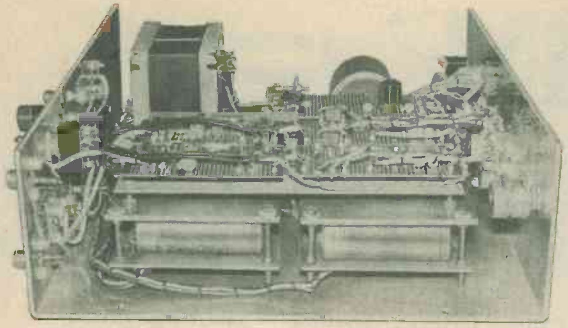


Fig. 9. If desired, both the equaliser and the active tone controls may be assembled on a single printed circuit board. A suitable board layout is shown here. This is viewed from the component side



A side view illustrating the manner in which the perforated boards are mounted above the power amplifier stages

arrows at the potentiometer sections indicate clockwise spindle rotation.

The perforated board layout for the active tone control circuit is shown in Fig. 8. The same remarks as for the equaliser assembly apply here with respect to board material and the fitting of components. The board is reproduced full size, and the view is from the component side. In the photographs, the tone control boards are immediately forward of the two equaliser boards.

For those who would prefer to use a printed circuit layout, a suitable board, viewed from the component side, is shown in Fig. 9. This incorporates both the R.I.A.A. equaliser *and* the active tone control circuit for one channel on the one board. Two of these may be accommodated easily enough on the pre-amplifier plate (to be described in more detail later). If these boards are used, an alternative position is required for the power supply regulator unit components which, in the photograph, appear on a board alongside the two tone control boards. The question of repositioning the regulator unit is left to the constructor and is not dealt with in the present articles.

R19 and C14 do not appear on the board of Fig. 9 and these two components are fitted externally. Also, R10 and C7 of Fig. 2 are omitted.

The board of Fig. 9 is shown smaller than full-size. However, the copper layout is quite simple and should not be difficult to reproduce. This printed circuit layout has been used successfully by the author in another piece of his equipment.

NEXT MONTH

In part 2 of this series, to be published next month, details will be given of the voltage regulator unit which supplies the pre-amplifier boards. This unit is assembled on a fifth perforated board which can be identified, in the accompanying photographs of the interior, by the fact that it incorporates a transistor fitted with a TO5 heat sink.

The five perforated board assemblies are mounted on a flat aluminium sheet, referred to as the pre-amplifier plate, which is positioned above the power amplifier section. The mounting is achieved by nuts, bolts and spacers and is clearly illustrated in one of the accompanying photographs.

After dealing with the voltage regulator unit, Part 2 will carry on to the power amplifier section.

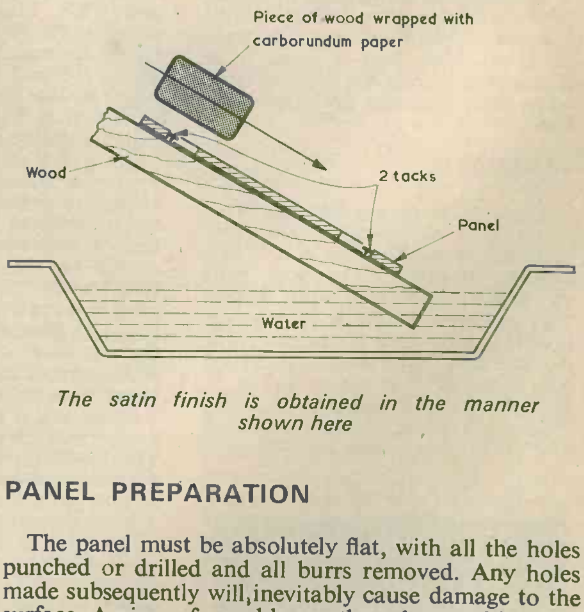
(*To be continued*)

SATIN FINISH FOR CONTROL PANELS

by James Kerrick

How to obtain a professional finish with home-built equipment

AN EXCELLENT SATIN FINISH CAN BE APPLIED TO aluminium control panels without the use of etching chemicals and at little cost. The process involves the smoothing of the panel by fine grade carborundum paper of the 'Wet or Dry' type. It is, however, only suitable for flat panels of reasonable size.



The satin finish is obtained in the manner shown here

PANEL PREPARATION

The panel must be absolutely flat, with all the holes punched or drilled and all burrs removed. Any holes made subsequently will inevitably cause damage to the surface. A piece of wood larger than the panel has two tacks in it to hold the panel firmly. The tacks are positioned so that they bear against opposite edges of two of the panel holes, as shown in the accompanying diagram. Their heads must not protrude above the surface of the panel. The diagram gives an indication of the manner in which the process operates.

A piece of 300 grade 'Wet or Dry' paper is wrapped around a piece of wood and rubbed down the panel in a direction parallel to its longer side. The movement must always be in the same direction and is continued until the panel has the same textured finish all over. The paper is kept lubricated and free of aluminium particles by the continual immersion in water. If required a final finishing may be given with 400 grade paper. ■

THE 'DUALINE' M.W.-V.H.F. PORTABLE

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

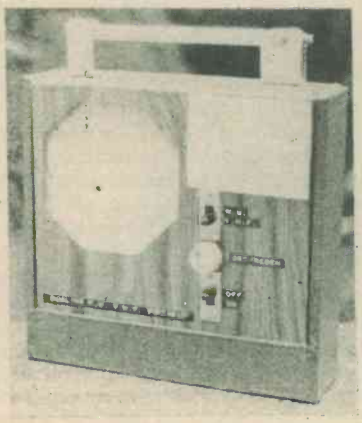
PART 2

This concluding article completes the constructional information for this receiver and also gives details for setting up

In this concluding article we continue the constructional details published last month in Part 1. The diagrams preceding Fig. 4 were published with Part 1, and it is necessary to turn to the previous issue when these diagrams are referred to here.

TAGBOARD

Take up the 18 way tagboard. This is an R.S. Components 'Standard' tagboard, available from R.S. Components stockists. Cut five pairs of tags away from this board. This will clearly leave a 13 way tagboard! Remove one tag by drilling it out and fit a 1⅝ in. 4BA countersunk bolt in the hole, as shown in Fig. 2, with the end of the bolt pointing towards the reader. Screw the tagboard to the main panel, using two 4BA nuts as spacers to keep the underside of the board just clear of the panel. Fit S1, S2 and VR2. Make a U-bracket for securing the PP3 battery, and screw this to the main panel in the position shown in Fig. 2. Next, make the aerial swivel bracket and aerial hook bracket, as shown in Figs 3(d) and (e). The material can be aluminium of around 18 s.w.g., but the exact thickness is not important provided the hook is strong enough to enable the telescopic aerial to be employed as a carrying handle. Drill a 4BA clear hole through the outside section of the aerial near its base and fit the aerial to the swivel bracket using a 4BA bolt as shown in Fig. 3(d). Mount the swivel bracket to the top panel of the chassis with a 4BA screw. There is a spring washer between the bracket and the panel, and a solder tag, a plain washer and two lock nuts on the screw under the panel. This allows the bracket to be rotated. Fit the aerial hook bracket also. The relative positions are shown in Fig. 2.



Another view of the receiver

Mount small components and wire up as shown in Fig. 4. There are many connections to the tag which carries the negative supply rail and it will be found convenient to solder a ½ in. length of tinned copper wire to this tag and to solder the various leads to this. The end of each lead should be turned into a small loop before being passed over the ½ in. wire. T1 should be glued into position with its tags pointing upwards. T2 is fitted by bending over the feet of its clamp and soldering 4BA tags to them. To facilitate connections to this transformer, it is helpful to fit a small 5-way tagstrip to the top of its clamp, connecting its five leads to the tags. A section is cut from an R.S. Components 'Miniature' 6-way tagboard (Home Radio Cat. No. BTS13) and it will be found that two of the holes in this board will fit exactly the two lugs on the top of the transformer clamp. The scheme is shown in Fig. 5. For reasons of clarity, the 5-way tagstrip is not shown in Fig. 4. All wiring should be short and direct, particularly in the r.f. circuits. The connection between the emitter of TR3 and the collector of TR4 to S2 should be of a temporary nature only at this stage, as also should the connections to T2 primary.

Note that the lead in Fig. 4 which is shown as passing to the aerial connects to the solder tag under the nuts which secure the telescopic aerial swivel bracket. When all other wiring has been completed, the speaker is fitted, over a piece of speaker fabric, and is connected into circuit.

The v.h.f. coil, L4, comes next. Take a piece of Fablon or Contact measuring 2½ by 4 in., and using the same method as for the previous sleeve, make a sleeve 2½ in. long which is a loose enough fit on the 1¼ in. ferrite rod to enable the latter to slide easily inside, but without wobbling. A 2-turn coil of 28 s.w.g. enamelled wire is wound and fixed in place with tape, as shown in Fig. 3(a). A piece of ⅜ in. wooden dowelling ½ in. long, and covered with a turn or two of Sellotape to make a good fit, is fitted to the end of the sleeve. The sleeve and dowelling are then drilled to take a 4BA bolt. This hole is drilled such that, when the coil assembly is mounted, the coil lead-outs project to the right, as in Fig. 3(a).

The coil assembly is fitted over the 1⅝ in. bolt on the 13-way tagboard, the open end of the sleeve being towards the spindle of VC1. Two 4BA nuts are fitted on either side of the coil assembly to hold this firmly. The rear projection of the spindle of VC1, which is already threaded 4BA, has a large plain washer

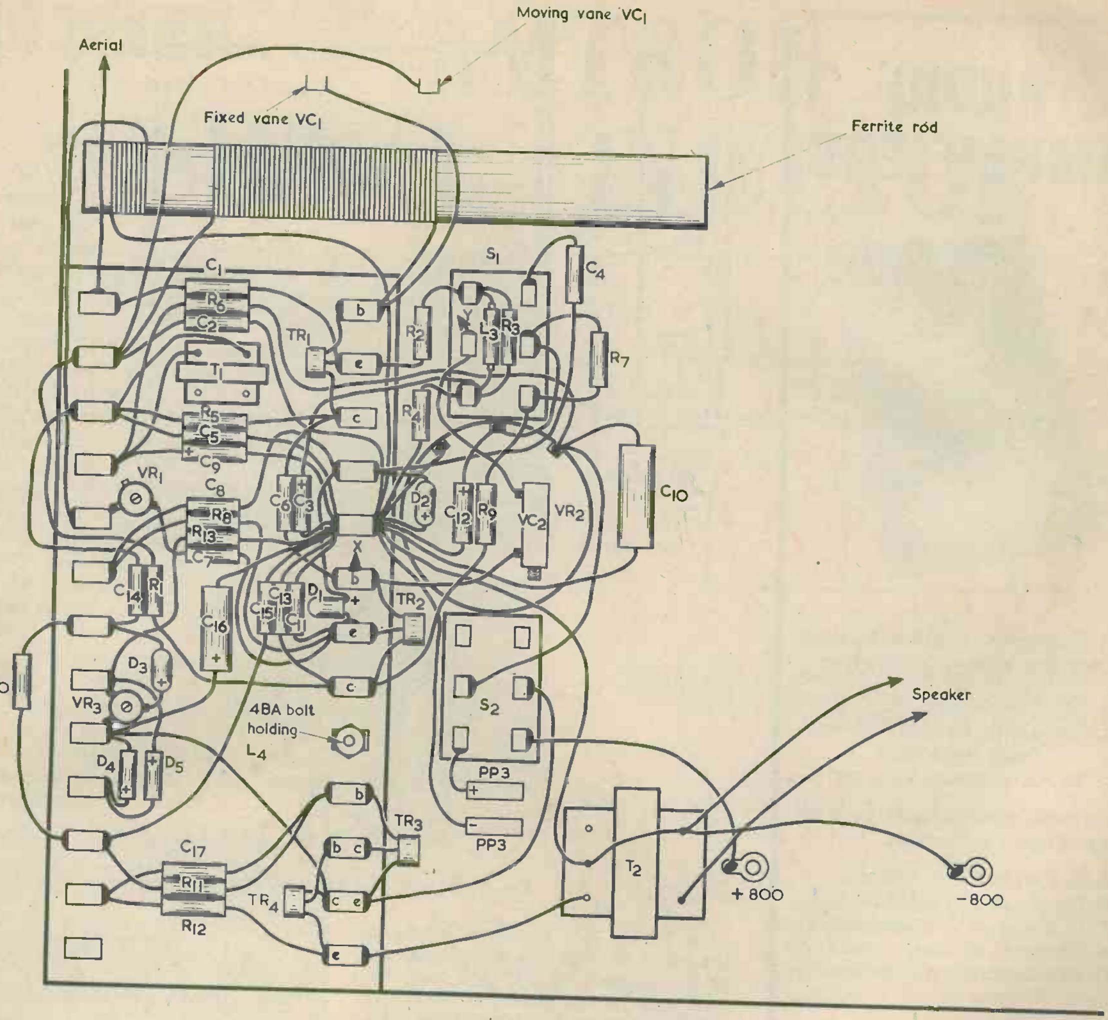


Fig. 4. Main wiring diagram for the receiver

and a 4BA nut fitted to it, so as to make a small 'pulley' of which the centre is the 4BA nut already fitted by the makers. A length of nylon cord is trapped under the extra washer and nut fitted by the constructor, and a turn or two of this is taken round the 'pulley'. The other end of the cord is passed through a grommet which is fitted over the end of the 1½ in. ferrite rod. See Figs. 3(b) and (c). The grommet should be a tight fit on the rod. The length of the cord is adjusted, at the grommet, such that the vanes of VC1 are fully enmeshed when the rod is fully inserted into the coil. When VC1 is turned anti-clockwise the rod should be withdrawn smoothly from the coil. Gravity is helped, when VC1 is turned clockwise, by a rubber band passed over the grommet at the top of the rod and the bottom end of the coil sleeve. The top lead of the 2-turn coil is connected to the centre tag on S1 marked 'Y' in Fig. 4, and the bottom lead to the tag marked 'X' on the 13 way tagboard.

SETTING UP

The receiver may now be set up – a simple business. Set VR1 slider at the disconnected end of its track. Set VR3 slider to the end of its track which connects to the positive lead-out of C16, and adjust VC2 so that about ⅜ in. of its screw is projecting. Disconnect the lead from the emitter of TR3 and the collector of TR4 to S2, and insert a current-reading meter switched initially to a high current range. Switch on and, if the meter indication shows that it is safe to do so, select a range which allows a clear reading of 8mA. Adjust VR3 to give such a reading. (The high current range is selected at first to protect the meter in case a wiring error causes excessive current to flow.) Rejoin the disconnected lead. Some extra useful life may be given to the 3 volt battery if this process is repeated once again after about 20 hours use.

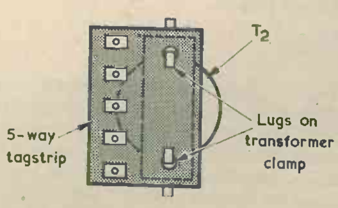


Fig. 5. A 5-way tagstrip is fitted to the output transformer

Next, set S1(a)(b) to medium waves and adjust VR1 until oscillation starts, throughout the whole travel of VC1, with VR2 set fairly near to maximum. VR1 will probably need to insert about 1kΩ resistance to obtain this effect. Finally, set SI(a)(b) to v.h.f., and set VC1 with most of its moving vanes enmeshed. Advance VR2 until there is an increase in background noise in the form of a not very loud hiss. Using a screwdriver or trimming tool made of insulating material – or even a sharpened match-stick – turn the screw of VC2 one way or the other

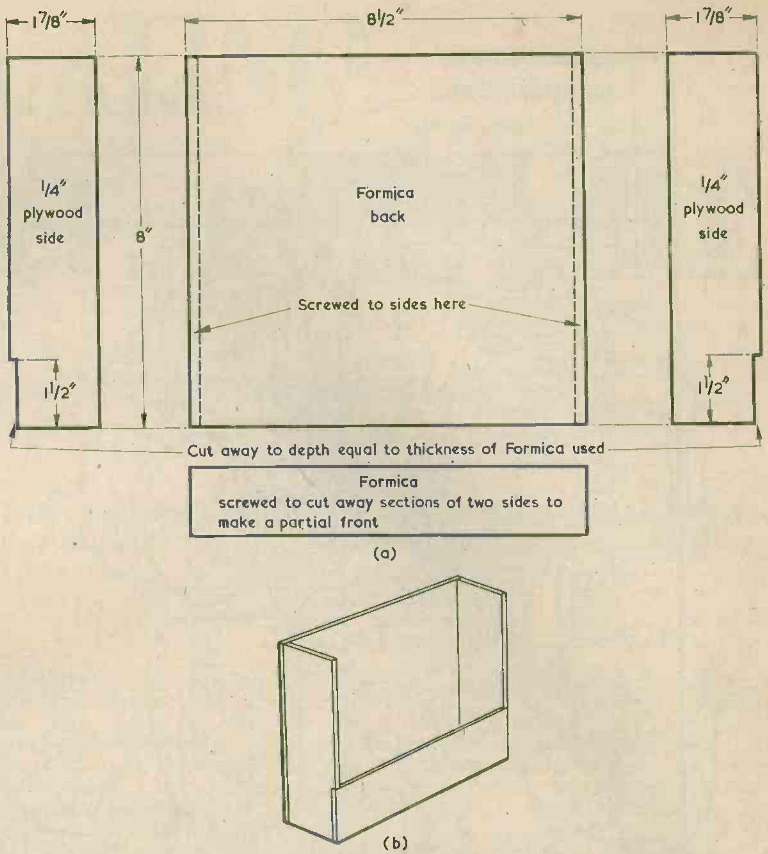


Fig. 6. Details of a case for the receiver

until Radio 2 is tuned in. Also, try the effect of reversing the connections to the primary of T2. One way may give better results than the other.

When tuning in stations on v.h.f. the receiver must be kept in a constant state of gentle oscillation by adjustment of the panel control, VR2, as necessary. Orientate the aerial and adjust its length for best results. Often it should be fully extended. In weak reception areas it can be tuned by careful adjustment of its length to give maximum pick-up. When, on the other hand, the receiver is used very near to a transmitter it may be necessary to close the aerial right up for most satisfactory reception.

On the medium wave band VR2 should be used to keep the receiver just short of oscillation for the most sensitive results.

CABINET

Fig. 6 shows a suggestion for a simple case, using Formica and plywood. The dimensions in this diagram should be looked upon as a guide and the actual dimensions of the case should be checked against the receiver chassis as made, since sections of the latter may not have been accurately cut out. Note that the chassis and case dimensions assume that the depth of the speaker will not be greater than $1\frac{3}{4}$ in. If it is, the top and bottom of the chassis, as well as the case, will require revised dimensions to accommodate it.

An efficient speaker is important. If possible, choose one having a flux density of not less than 10,000 gauss. A sensitive speaker makes a very big difference with a small portable receiver where there is not much acoustic power to spare.

A tuning scale can be added, pointers being made from stiff wire affixed to the epicyclic tuning drive flange. The scale can be marked up for the three B.B.C. stations or v.h.f., together with the local station if one is available. The medium wave band may be calibrated in terms of wavelength.

It is important to use the specified components and to make sure that the transistors are first-grade components. Do not be fobbed off with re-marked seconds, some of which are useless. Use the specified diodes. Follow the layout, and do not on any account try to employ a laminated board instead of the 13-way tagboard specified. Then, if care is taken to see that there are no faulty connections or dry joints, really good results will be obtainable on both wavebands.

(*Concluded*)

KIT REVIEW . . . AMTRON SIGNAL INJECTOR

THE ACCOMPANYING PHOTOGRAPH ILLUSTRATES THE Amtron Signal Injector kit, Ref. No. UK220, as received by the purchaser before assembly. All the parts required for construction of the injector, as well as the assembly instructions, are securely packed in a plastic 'blister' which is backed with foam plastic and fitted to a stout card.

The signal injector consists of a 500Hz multivibrator which, when completed, is housed in a cylindrical tube with a probe at one end. There is also a flexible lead terminated in a crocodile clip which connects to the chassis of the equipment into which the signal is being injected. Useful harmonics are given up to approximately 30MHz.

This is one of the simpler kits available from Amtron, whose current catalogue lists more than 130 items. These include power supplies, hi-fi amplifiers, musical instrument accessories, short wave equipment, capacitor ignition systems for cars, burglar alarms and test gear. The range is exceptionally wide and covers virtually all the interests likely to be exhibited by the keen electronics enthusiast. A photograph is given in the Amtron catalogue for each item, together with technical information.

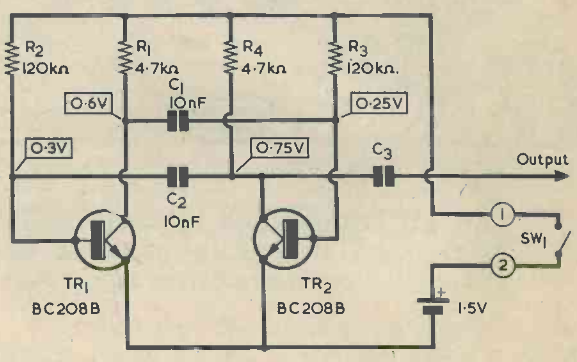


Fig. 1. This circuit diagram is reproduced from the assembly instructions for the Amtron signal injector

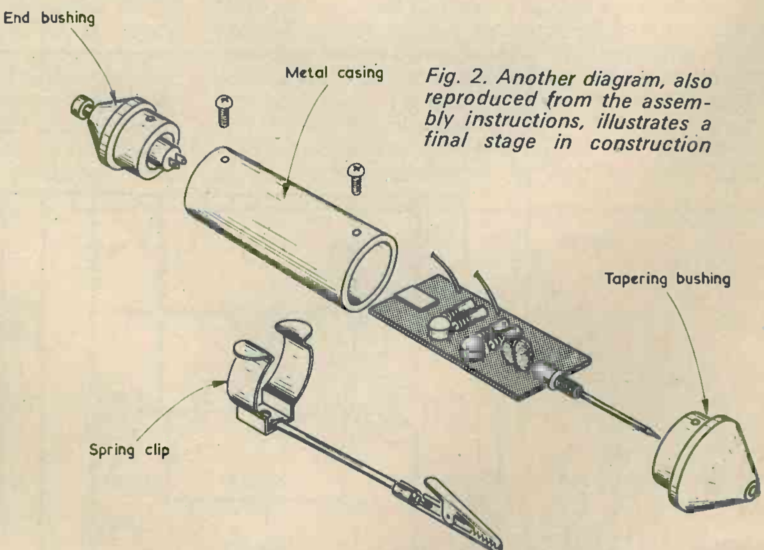


Fig. 2. Another diagram, also reproduced from the assembly instructions, illustrates a final stage in construction

CLEAR PRESENTATION

The accompanying diagrams, which are reproduced from the assembly instructions for the signal injector kit, demonstrate the clarity with which the constructional information is given.

One diagram shows the circuit of the injector, and is accompanied in the text by a description of its operation. The value shown for C1 and C2, 10nF, is equivalent, incidentally, to 10,000pF. Test voltages appear in the rectangles alongside the appropriate circuit points.

The second diagram gives details of a final stage in the assembly of the injector, in which the various parts are being fitted to the cylindrical metal casing.

These are only two of the eight diagrams in the instructions and they are included in this review to enable readers to judge for themselves the manner in which constructional details are presented.

As already mentioned, the signal injector kit is one of the simpler projects available from Amtron. Further details on Amtron kits may be obtained from Amtron U.K., 4–7 Castle Street, Hastings, Sussex. ■

LIGHT FLASHER CIRCUIT

by P. L. Fleming

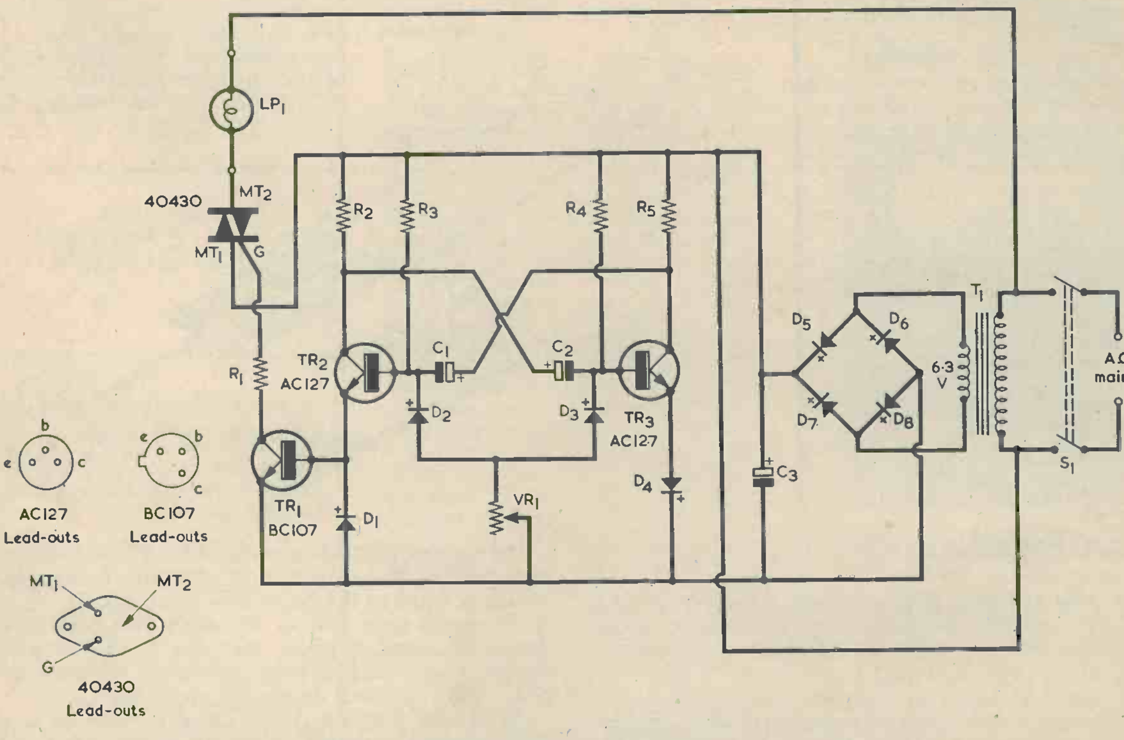
An all solid-state circuit which provides continual flashing of a 100 watt mains lamp. The speed of operation is continuously variable from about 50 to 110 flashes per minute

THE CIRCUIT DESCRIBED IN THIS ARTICLE CAUSES A 100 watt domestic mains bulb to be continually switched on and off, and it can in consequence be used as a means of attracting attention, as an advertising aid or for visual effects in a discotheque. There are no mechanical contacts in the circuit controlling the lamp and switching is carried out entirely by semiconductor devices.

TRIAC SWITCHING

The circuit of the switching unit is given in the accompanying diagram, in which it will be seen that the lamp is controlled by a triac type 40430.

The a.c. mains is turned on by switch S1, and is then applied to the primary of transformer T1. The 6.3 volt secondary of this transformer connects to the bridge



The circuit of the light flasher unit. This causes the 100 watt bulb, LP1, to be continually turned on and off at the frequency selected by VR1 rectifier comprising D5 to D8 inclusive, and a rectified voltage of about 7.5 to 8 volts appears across capacitor C3. This voltage is applied to the multivibrator based on transistors TR2 and TR3.

Germanium transistors are employed for TR2 and TR3 as these have a higher reverse base-emitter voltage rating than do the more commonly encountered silicon types. VR1, in company with D2 and D3, provides a control of multivibrator frequency. If VR1, D2 and D3 were not in circuit, the multivibrator would run in conventional fashion. Immediately after the change-over in the multivibrator cycle which causes TR2 to turn off, for instance, the base of this transistor would be taken negative of the negative supply rail by the charged capacitor C1, after which C1 would discharge through R3 until the base of TR2 acquired a sufficiently high positive potential to initiate the next change-over and turn this transistor on again. The length of the period during which TR2 is turned off would then be controlled by the values of C1 and R3. With D2, D3 and VR1 in circuit there is a second discharge path. When the base of TR2 goes negative, diode D2 becomes conductive, allowing a second discharge path for C1 via VR1. D3 is non-conductive under these conditions. On the alternate half-cycles, when the base of TR3 goes negative, D3 becomes conductive, giving the second discharge path for C2 via VR1, and it is D2 which is now non-conductive.

It follows that VR1 is capable of varying the lengths of the alternate periods when either TR2 or TR3 is turned off. The multivibrator is symmetrical, offering a 50:50 waveform. The control circuit incorporating D2, D3 and VR1 is also symmetrical, and the result is that the frequency of oscillation of the multivibrator can be varied by adjusting VR1 without upsetting the 50:50 relationship. The frequency increases as the resistance inserted into circuit by VR1 decreases, since a lower resistance in this component causes quicker discharge of the cross-coupling capacitors. In the author's unit the frequency of oscillation was 52 cycles per minute when VR1 inserted minimum resistance, and 112 cycles per minute when VR1 inserted maximum resistance. There will be some variance from these figures in units built up to the circuit due to the relatively wide tolerance on value in the electrolytic capacitors specified for C1 and C2, but the differences should not be serious.

The emitter of TR2 does not connect direct to the lower negative rail but is, instead, coupled to that rail via the base-emitter junction of TR1. This is a silicon transistor with a maximum reverse base-emitter rating of 6 volts only. However, diode D1 ensures that the base of TR1 cannot be taken more than 0.6 volt negative of its emitter during the periods in the multivibrator cycle when TR2 is off. Diode D1 is reverse biased and does not conduct during the periods when TR2 is turned on. During these periods the emitter current of TR2 flows in the base-emitter junction of TR1.

D4 is included in the emitter circuit of TR3 and is conductive when TR3 is turned on. It offers about the same voltage drop as that given by the base-emitter junction of TR1, and thereby balances the circuit. In practice D4 is not really essential, and it was included mainly because it provided a marginal increase in frequency when VR1 inserted zero resistance into circuit.

The collector of TR1 connects, via current limiting resistor R1, to the gate of the triac. One side of the mains input connects to the positive supply line for the multivibrator and thence to the Main Terminal 1 of the triac. The Main Terminal 2 of the triac couples to the controlled 100 watt bulb, LP1, the remaining terminal of which connects to the other side of the mains input.

As already stated, the emitter current of TR2 flows in the base-emitter junction of TR1 during the periods, in the multivibrator cycle, when TR2 is on. This base-emitter current causes TR1 to be turned hard on during these periods, and it draws a collector current from the positive supply rail for the multivibrator through the gate and Main Terminal 1 of the triac and through resistor R1. The current flowing in the triac between its gate and Main Terminal 1 causes it to be turned on and thereby light up the bulb.

In consequence, the circuit allows the 100 watt bulb to be illuminated during the periods when TR2 is

COMPONENTS

Resistors
(All fixed values ¼ watt 10% unless otherwise stated)

R1	220Ω
R2	4.7kΩ
R3	47kΩ 5%
R4	47kΩ 5%
R5	4.7kΩ
VR1	100kΩ potentiometer, log.

Capacitors
C1–3 32μF electrolytic, 10V Wkg.

Transformer
T1 6.3 volt heater transformer

Semiconductors

TR1	BC107
TR2	AC127
TR3	AC127
D1–8	1N4002
Triac	40430

Switch
S1 d.p.s.t. toggle

Lamp
LP1 240 volt 100 watt lamp

Miscellaneous
Lampholder
Knob for VR1
Material for housing
Wire, etc.

turned on.

PRACTICAL POINTS

No difficulty should be experienced in obtaining the parts required. T1 can be any small heater transformer offering a secondary voltage of 6.3 volts at 0.5 amp or more. The triac type 40430 is obtainable from a number of suppliers. This was mounted on a small flat heat sink about 2 in. square in the author's unit and it ran quite cool.

All eight diodes are silicon, and are type IN4002. The on-off switch, S1, can be a standard toggle component. VR1 is a log potentiometer and it is wired such that the resistance it inserts into circuit increases as its spindle is turned clockwise. This means that the speed of flashing decreases with clockwise spindle rotation. Some constructors may prefer to have frequency increase with clockwise rotation, and this could be achieved by using an anti-log potentiometer of the same value. If an anti-log potentiometer is used, it should be wired so that it inserts decreasing resistance into circuit as its spindle is turned clockwise.

The controlled lamp, LP1, can be mounted some distance away from the remainder of the components. The main unit may have a mains socket into which a plug connecting to the lamp could be fitted. Lamps rated higher than 100 watts should not be used in the circuit, but it is in order to employ lower power bulbs.

Construction should be simple to carry out and layout is not critical. *It is most important to bear in mind that all components in the circuit are close to, or at, mains potential and that all precautions against accidental shock must be observed.* Apart from LP1, all the parts should be housed in a box made of insulating material, this being assembled such that the components are inaccessible when the back has been screwed on. A wooden case would be suitable. A few small holes for ventilation may be provided, but virtually the only heat-producing component is the mains transformer and a high degree of ventilation is not in consequence necessary. VR1 and S1 can be mounted on the front panel of the housing. If VR1 has a metal spindle it should be fitted with a plastic control knob.

Care must be taken to prevent shock when the completed unit is being checked. Particularly hazardous in this respect is the heat sink for the triac. Since this is in contact with the Main Terminal 2 its potential changes alternately from that of one side of the mains to that of the other as the multivibrator oscillates. *One of these potentials can be dangerous, especially if there are earthed objects in the vicinity.*

The author's unit worked satisfactorily and gave the desired flashing effect with the 100 watt bulb. The periods during which this was turned off were approximately the same in length as were those when it was turned on, this condition being given at all settings of the speed control VR1.

As a final point it would appear, at first sight, that a second triac and bulb could be operated by TR3, this being achieved by removing D4 and connecting to the emitter of TR3 the same BC107 and triac circuit that is connected to the emitter of TR2. The two bulbs would then flash alternately. In practice, however, a modification of this nature does not work successfully since there is a high level of overall current gain due to the added transistor, and the circuit becomes unstable. The unit should, in consequence, be employed to switch a single bulb on and off only, as indicated by the diagram. ■

Radio Topics

By Recorder

INFRA-RED C.C.T.V.

I see that a Water Board in the Thames Valley area has been supplied with a low cost and very effective night security system using an infra-red television camera designed and installed by Marconi-Elliott Avionic Systems Limited, a GEC-Marconi Electronics company. This allows the night operators at the pumping station to maintain a complete watch on the site without interrupting their work or exposing themselves to possible danger. Costing less than £4,500, the complete system operates at a fraction of the cost of normal floodlighting, yet it provides a more effective surveillance. The television screen and system control are located in the pumping station control room.

The system employs a Silicon Diode Array target vidicon sensor tube which is particularly sensitive to infra-red radiation. The camera is mounted with a pair of infra-red searchlights on either side and is virtually undetectable from the outside. At the first sign of intruders, the night operator at the plant has only to telephone for the police, who can be on their way long before the intruders even know they have been detected.

JUNK BOX PARTS

In company with most followers of our hobby, I have amassed a fair quantity of odd components over the years. These include such things as resistors with short lead-outs, antiquated electrolytics and similar examples of the items which tend to collect and which, somehow, never find their way into the rubbish bin.

In other words: junk.

Junk can, nevertheless, be very useful, this being particularly true if you are trying out an experimental circuit or are building an item of equipment and are not sure of one or two of the component values that will be required. Suppose, for instance, that you don't know what value of resistance you require for a particular point in a circuit but are fairly certain that it will lie somewhere between 10 and 100kΩ. If fairly long leads to the mystery resistor are acceptable, the thing to do here is to assemble the circuit without it and then connect a 10kΩ fixed resistor and a 100kΩ potentiometer in series across the points where the resistor will eventually connect. The potentiometer can then be adjusted until the desired performance is obtained, after which it, and the series 10kΩ resistor, can be taken out of circuit and their resistance measured. A fixed resistor of the requisite value can then be inserted in the circuit position.

If a new resistor is not available, the junk box may more than probably provide a single used resistor of the desired value, or two resistors which, in series or parallel, give that value. The single resistor, or the two resistors, may next be temporarily soldered into circuit, allowing the equipment to be brought into operational use. A nice new resistor of the required value can then be bought on your next component shopping spree and this can be soldered permanently into the equipment, whereupon the latter is complete and in its final form.

The ability of the junk box to furnish components for temporary use more than often justifies its existence, but you have to take a few precautions. Fixed resistors of the carbon composition type should, in particular, be looked upon with a certain amount of suspicion. These resistors have a sneaky habit of occasionally shifting in value after long periods even if they have been left undisturbed, and this tendency is increased considerably if they are continually soldered into and then removed from experimental circuits. So, if you find a carbon resistor in your junk box which falls into the venerable category, or which looks as though it has had more than its fair share of the soldering iron, quickly check its value with the testmeter before fitting it into circuit. If you take the resistor at its face value, and its resistance *has* shifted, you may later have some head-scratching fault symptoms in the equipment in which it has been wired.

LEAKAGE RESISTANCE

Old tubular paper capacitors are another item to suspect, the trouble in this case being leakiness. A resistance check with the testmeter is not always good enough here, as the leak could be of the order of several megohms, a value which may not show up on the average testmeter when switched to read ohms. An old dodge here is to temporarily apply the leads of the capacitor to a d.c. voltage source of around 200 volts or so, remove the capacitor and, after a short wait, apply its lead ends against a shiny metal surface. If the capacitor is good, there will be a noticeable spark as its leads short-circuit against the surface. The spark is given even with capacitors as small as 0.001μF.

The efficacy of this last test is surprisingly high. Let's say that we are checking an 0.01μF capacitor and find we get a spark from it five seconds after removing it from the 200 volt charging points. The fact that we get a spark after five seconds means that the time constant of 0.01μF and the parallel leakage resistance of the capacitor will, at worst, hardly be much lower than five seconds and, at best, may be considerably more. Time constant, in seconds, is the product of megohms and microfarads, and so we can say that the leakage resistance of our 0.01μF capacitor is, at worst, of the order of 500MΩ and may be considerably higher. Not bad for a test which requires no test gear!

Of course, the capacitor should be held at the centre of its body during the test and the lead-outs must at no time be touched, or you could get a nasty shock. And this short-circuit test must *never* be carried out with electrolytic capacitors because they can be damaged by the high surge currents which would flow when they are short-circuited.

Electrolytic capacitors can be checked for leakage with an ohmmeter. An electrolytic capacitor will cause the meter needle to swing over initially towards zero ohms, after which the meter needle will fall back to indicate the leakage resistance as the capacitor charges from the ohmmeter battery. Most testmeters, when switched to read ohms, have a positive potential on the *negative* test prod and a negative potential on the *positive* test prod. So the positive test prod should connect to the negative end of the electrolytic capacitor, and the negative test prod to its positive end. If the test prods are connected the other way round, some capacitors will show a resistance much lower than the leakage resistance which is given with correct polarisation.

The only snag with this type of test is that some of the larger capacitors, of around 1,000μF, which are common these days, take a long time to charge up sufficiently from the ohmmeter battery to give a final leakage reading. But this is, alas, an imperfect world, and we have to accept such aggravations.

Finally, of course, a junk box is an invaluable source of nuts and bolts and associated hardware. And we all know that, as soon as a *single* nut or bolt is thrown out, that will be the precise size which will be required on the following day. ■

RECENT PUBLICATIONS

FUN WITH HI-FI. By Gilbert Davey.
64 pages, 195 x 250 mm. ($7\frac{1}{2}$ x 10 in.) Published by Kaye & Ward Ltd. Price £1.15.

This title is the latest in the Kaye & Ward 'Learning With Fun' series, and is the fifth contributed to the series by Gilbert Davey. It is edited by Jack Cox.

The book is intended mainly for the newcomer to high fidelity listening and little technical knowledge is assumed. After a short introductory chapter on the progress of sound reproduction from the Edison phonograph, the second chapter discusses the growth of electronic means of reproduction. The following chapter deals with the amplifiers which were described in the Mullard publication 'Circuits For Audio Amplifiers', stressing that, although these are valve designs, many of the overall principles involved are applicable to present-day equipment.

The next chapter is devoted to modern hi-fi units, whilst subsequent chapters describe gram decks and cartridges, radio tuners, amplifiers and loudspeakers. Two further chapters cover the home construction of tuners, amplifiers and loudspeaker cabinets, and the final chapter in the book discusses modern headphones and the future of hi-fi. An appendix lists periodicals and books connected with hi-fi and gives the addresses of component and equipment suppliers.

The book is attractively presented with clear print, photographs and diagrams.

* * *

UNDERSTANDING ELECTRONIC CIRCUITS. By Ian R. Sinclair, B.Sc., M.I.E.E., A.Inst.P.
213 pages, 135 x 215 mm. ($5\frac{1}{4}$ x $8\frac{1}{2}$ in.) Published by Fountain Press. Price £3.50.

This book is stated to be intended for the middle-of-the-road reader who has some knowledge of the properties of electronic components and the elementary laws of electrical circuits. As such, it works from an assumption of knowledge which is somewhat elevated above that of the complete beginner and takes the subject to quite an advanced level. Points dealt with cover a very extensive range and are illustrated by circuits incorporating valves, discrete semiconductor devices and integrated circuits.

The contents include chapters on amplification and amplifiers, oscillators, pulse circuits, logic and counting circuits, power supplies, and oscilloscope operation and use. The author has a readable and economic style which allows much hard information to be encompassed in a small space. The treatment is practical and mainly non-mathematical, and individual topics are discussed at significant depth. The book will be of particular help to the amateur who is just starting to feel his way into electronics, the service engineer and the student who desires an overall picture of present-day electronic design.

* * *

SEMICONDUCTORS FROM A TO Z. By Phillip Dahlen.
278 pages, 130 x 215 mm. (5 x $8\frac{1}{2}$ in.) Published by Foulsham-Tab Ltd. Price £1.50.

This title is in the Foulsham-Tab list of American texts having an added introductory chapter for the guidance of the English reader.

'Semiconductors From A to Z' originally appeared as a series of articles in the American journal ***Electronic Technician,*** where they proved to be very popular with readers. The book deals extensively with semiconductor devices and circuits, describing these at a sufficiently advanced level for the technician and without entering into abstruse detail. Discrete semiconductor devices discussed include diodes, transistors, f.e.t's, m.o.s.f.e.t's, tunnel diodes, varicap diodes, unijunction transistors, field-effect diodes, zener diodes, diacs and triacs. There are also six chapters on integrated circuits and three chapters on light-sensitive and light-emitting devices, the principles of optic lenses and the principles of fibre optics.

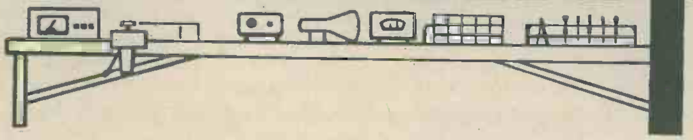
* * *

INSTALLING & SERVICING ELECTRONIC PROTECTIVE SYSTEMS. By Harvey F. Swearer.
262 pages, 130 x 215 mm. (5 x $8\frac{1}{2}$ in.) Published by Foulsham-Tab Ltd. Price £1.30.

A further title in the Foulsham-Tab list of American texts, this book covers a very extensive range of burglar alarm and similar anti-theft systems, as employed in the United States. Apart from vibration detectors and different directly operated switches, there are photoelectric alarms, ultrasonic detection systems, microwave systems, proximity alarm systems, audio and visual alarms, and even seismic and stress intrusion systems. The book is written for the engineer who intends to set up a business installing and monitoring the systems, and it describes their methods of operation and effectiveness.

Virtually all the systems are of American manufacture, but similar products are, in many instances, available in Britain. This point apart, the book offers much of interest in its descriptions of system operation and will give many useful ideas to those who are interested in burglar alarms.

In your workshop



This month Smithy the Serviceman, in concert with his able assistant Dick, starts Christmas in his own individual accident-prone manner. He is, nevertheless, still able to look into some of the less generally appreciated aspects of variable capacitor functioning.

IT WAS CHRISTMAS EVE.

The street lamps shone eerily on a thin early morning blanket of snow as Smithy trudged along the deserted pavements towards the Workshop. He and Dick had ceremoniously closed down for the Festive Season on the preceding Saturday and the Serviceman had been looking forward to a quiet period free of worrying electronic matters until at least the 27th of December. But fate is not kind to service engineers and his own television receiver had suddenly broken down on the previous evening. An irritated Smithy was now on his way to the Workshop to pick up his testmeter and a few spare parts.

INTRUDER

As he turned the corner which led to the Workshop his step faltered.

A torch flickered weakly inside the darkened workshop, occasionally casting its beam towards one of the windows. Somebody must have made his way in. Smithy's mind at once cast itself back to recent episodes concerning one Jason King, and he flattened himself against the wall. Staying in the shadows he proceeded sideways soundlessly until he was within several yards of the workshop door. At this distance he was able to discern, through an adjacent steel-framed window, a furtive shadowy figure holding the torch, a figure which was at that very instant busily investigating the drawers of his own bench. Smithy held his breath and inched cautiously forward.

His foot slipped in the snow.

Grasping blindly for support he grabbed quickly at a drain pipe alongside him. This, unaccustomed to the sudden weight imposed upon it, unexpectedly became detached from the wall and Smithy found himself clinging tightly to a ten foot length of four inch metal pipe. Smithy continued to fall and the pipe, extending over his head by some six feet, fell sharply and with deafening clangour against the side of the workshop dust-bin. The bin toppled over and its lid clattered sonorously against the door of the workshop, after which its contents crashed noisily onto the stone door step. Smithy saw with horror that these contents consisted mainly of old mild steel radio and TV chassis which he and his assistant Dick had deposited in the bin during a pre-Christmas clear-out.

The section of drain pipe above that inadvertently removed by Smithy now hung downwards without support. As Smithy carefully picked himself up and then leaned cautiously back against the wall his shoulder touched its lower end. The pipe at once fell free, dropping in a direction which caused its upper end to rattle resoundingly against the steel-framed window, breaking one of the panes in the process. A section of the guttering above the pipe descended below the horizontal by some thirty degrees. Smithy looked up and a small avalanche of snow fell on his face.

The Serviceman stood still for some moments to collect his wits. Once again he peered cautiously through the window, but there was now no light or movement inside the workshop whatsoever. Steeling himself, he made his way to the door, placing his hand tentatively on the knob. He turned it soundlessly and found that the door was free to open. Carefully avoiding the discarded chassis on the step he suddenly flung the door wide open, entered and darted to one side.

"Right," he yelled out sharply, "just stay where you are!"

"Not me, mate," came a trembling voice from the opposite end of the workshop. "You just stay where *you* are."

There was silence for a moment.

"Hey," came the tremulous voice from the dark, "is that Smithy?"

Smithy snorted furiously.

"Ye gods," he growled through clenched teeth. "Don't say I've gone through all that performance because of you, you great steaming nit!"

There was an audible sigh of relief from the dark recesses of the workshop and the torch once more lit up.

"Thank goodness for that," said the voice, in an obviously relieved tone. "Judging from the noise outside I thought we were starting World War III!"

"I should be so lucky," stated Smithy bitterly, "as to have an assistant like you. What on earth are you doing here when you're supposed to be away on Christmas holiday?"

"I just popped in," explained Dick, "to do a little job, but unfortunately I blew the main fuse. Since then I've been hunting around looking for fuse wire."

"Well, you'll find it in the spares cupboard," snapped Smithy shortly. "It's on the second shelf down from the top."

Dick quickly found the fuse wire and, within minutes, the workshop lights were blazing brightly. Smithy found a piece of cardboard, taped it up over the broken window pane and then sat down on the stool alongside Dick's bench. He mopped his face with his handkerchief and allowed himself to calm down.

After some moments he glanced over the surface of his assistant's bench, on which stood a small medium and long wave transistor radio. Dick had already removed its back and taken out the battery. Alongside the radio was Dick's soldering iron. A badly scorched section of its frayed lead indicated the cause of the burnt-out main fuse.

"You shouldn't let your soldering

iron lead get into as bad a condition as this," grunted Smithy peevishly. "And what's this set doing on your bench?"

"It belongs to one of my aunts," explained Dick. "I was hoping to get it fixed by tomorrow."

"What's wrong with it?"

"The 2-gang tuning capacitor's gone for a burton," replied Dick. "It's an air-spaced capacitor and she accidentally bent the vanes on the outside gang whilst replacing the battery. The outside gang's short-circuit over most of the capacitor's rotation."

"In that case," responded Smithy positively, "you probably won't be able to fix that set until after Christmas."

"Why on earth not?"

"Because it will be necessary to order a new tuning capacitor from the set-maker's service department. Changing a tuning capacitor isn't like changing a resistor, you know. These tuning capacitors are usually tailor-made for the particular set-maker who uses them."

Dick frowned.

"Well," he said. "I did at least manage to find the service sheet for this particular radio. It quotes the value of the 2-gang as being 266pF per section."

Smithy's eyebrows rose.

"That's mildly surprising," he remarked. "Set-makers don't always give a value for tuning capacitors in their service manuals. What they do instead is just quote a part number for ordering a replacement."

"Do they?" said Dick. "What makes them so cagey about giving information on these capacitors?"

"It's because the replacement problem is so difficult," replied Smithy. "To take an example, let's look at the situation with that set you've got there. You do at least know that the capacitance of each section of the 2-gang is 266pF, and so let's say that you're extremely lucky and that you happen to have a replacement 2-gang capacitor with the same values in stock. But it won't be a *true* replacement unless it has the same framework and the same positioning for the mounting holes. Again, if the faulty capacitor has integral trimmers mounted on it then the replacement capacitor will similarly require integral trimmers. Yet another point, should you want to make a proper replacement, is that if the faulty capacitor has a screen between the two sets of fixed vanes the replacement capacitor should also have a screen." (Fig. 1.)

"There certainly," remarked Dick, "seem to be a lot of permutations so far as tuning capacitors are concerned."

"There are," confirmed Smithy, "and we're only dealing with 2-gang capacitors intended for medium and long wave sets and having the same value in each section. As you know, some 2-gang capacitors for medium and long waves have a lower value in the oscillator section. When you get on to ganged capacitors for a.m.–f.m. sets you get a whole set of further variations. Ganged capacitors of this type will have two high capacitance sections for medium and long waves, and two low capacitance sections for the f.m. band, all operating with the one spindle." (Fig. 2.)

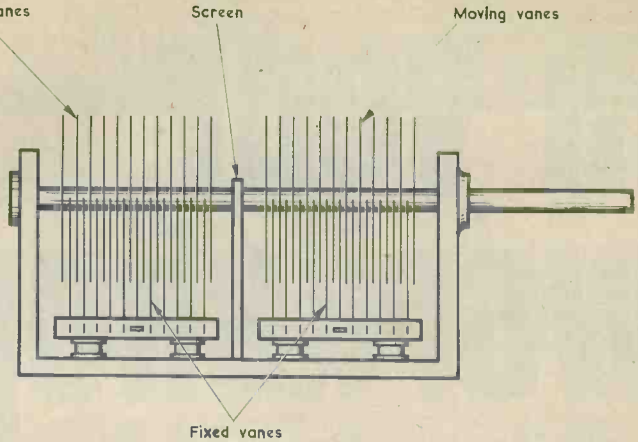


Fig. 1. Some 2-gang capacitors are fitted with a screen between the two sets of fixed vanes

VARIABLE CAPACITOR REPLACEMENT

"Blimey," said Dick, impressed at these revelations. "This tuning capacitor replacement business is a lot more involved than I'd realised. Still, I'm certain that, so far as medium and long wave sets are concerned, quite a few amateur service types would be prepared to fit a new 2-gang to a set even if it wasn't exactly the correct replacement."

"I have no doubt they would," agreed Smithy. "But this would almost certainly entail drilling new mounting holes in the printed circuit board, and things like that, which simply couldn't be entertained by the professional engineer. Another factor is that the values for 2-gang capacitors employed in manufactured sets are nearly all off-beat figures like the 266pF value quoted for the capacitor in the set on your bench, and they're not nice round numbers like, say, 200pF or 250pF. So, if the new 2-gang was one of the round figure value

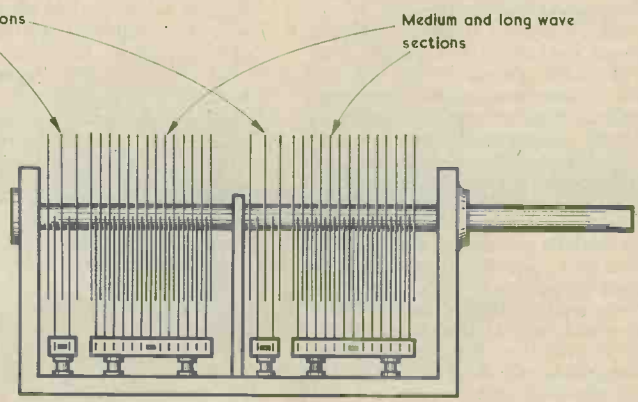


Fig. 2. A tuning capacitor intended for an a.m.-f.m. receiver. The medium and long wave sections have a relatively high maximum capacitance and the f.m. sections have a low maximum capacitance Representative minimum and maximum values are 8 and 250pF for the medium and long wave sections, and 4 and 10pF for the f.m. sections

types, as are offered on the home constructor market, you would almost certainly end up with a different tuning range."

"Well," commented Dick, "just for argument let's say that I had the good fortune to have a replacement 2-gang on hand which had the same capacitance per section as the faulty one and also had the same mounting holes and so on. Wouldn't I be out of trouble then?"

"Not necessarily," replied Smithy. "The replacement capacitor might have a different law!"

Dick threw up his hands in despair.

"Stone me," he said disgustedly. "With a geyser like you around I simply cannot win. I don't even know what this law business is, but if I did fit a new capacitor with correct values but a wrong law what would happen?"

"The receiver tuning dial calibration would be correct at the low and high frequency ends of the band," responded Smithy, "but it would be incorrect over much of the range between."

He stopped as a sudden thought crossed his mind, then he turned and glared at his assistant.

"Why, you conniving devil," he snorted accusingly. "You've gone and done it again!"

"Done what?"

"Conned me into a long and involved discourse on technical matters," returned Smithy aggrievedly. "Dash it all, I only came here to get a few odds and ends and what happens? I find myself holding forth on the subject of variable capacitor laws! And this is happening *after* I thought this place was being burgled and went through the business of creeping up to it stealthily so that I could catch the thief."

"Stealthily?" repeated Dick astoundedly. "*Stealthily?* Corluvaduck, the racket you made just now sounded as though ten dozen corrugated iron roofs had been dropped on the workshop all at once. If you call that stealthy I should hate to be near you when you're *really* doing things quietly. I'd be deafened for life."

"It so happens," said Smithy stiffly, "that I happened to slip a little."

"I'll say you did," returned Dick, "and in the process you just about scared the living daylights out of me. I must have secreted half a gallon of adrenalin just then."

"That's not half as much as I must have secreted outside" retorted Smithy, stung at his assistant's claim. "Don't forget that I started secreting long before you even knew I was there. But what really gets my goat is that, after having been through all this, and before I've even had a chance to let my shattered nerves recover, you calmly set about getting me involved in a technical discussion. At least you could have done something more constructive, like getting a spot of tea made or something like that."

"Fair enough, Smithy," responded Dick, as he moved towards the workshop sink. "I'll get the kettle boiling in no time at all."

"Well, that's better," said Smithy, mollified. "I can perhaps now think of normal things, like getting my overcoat off."

VARIABLE CAPACITOR LAW

The Serviceman hung his overcoat on the peg behind the door then returned to Dick's bench. He glanced idly at the medium and long wave radio and then rotated the tuning knob. The tuning capacitor had a relatively open construction and Smithy was able to observe most of the moving vanes when these were set to give minimum capacitance. A sudden glint appeared in his eyes and he leaned over and examined the moving vanes more closely. He next picked up a small screwdriver and proceded to make an adjustment, after which he again turned the tuning knob. A satisfied grin flickered momentarily across his face, then he resumed the expression appropriate to one who, after desperate rigours, justly awaits sustenance.

"Hey, how much longer is that tea going to be?"

"It's nearly ready," returned Dick soothingly. "Ah, the kettle's just beginning to boil."

And, indeed, the kettle was already giving vent to its preliminary splutters preparatory to producing a full and continuous whistle. It took Dick very little time to fill the teapot and to carry Smithy's mug over to him. The Serviceman sipped at the steaming liquid.

"Ah, that's more like it," he said cheerfully. "If nothing else, Dick, you do know how to make decent tea."

"Do I?" repeated Dick, startled at this unexpected praise. "You certainly know how to get rid of it, anyway. Now what's all this about variable capacitor law?"

"Oh, that," replied Smithy. "Well, the law of a variable capacitor defines the change of capacitance with rotation of the moving vanes."

"I don't quite see that," remarked Dick, frowning. "Surely, all that happens with a variable capacitor is that its capacitance increases as the two sets of vanes get more and more enmeshed."

"That's true enough, of course," said Smithy, putting the mug down, "but things are a bit more complicated than that."

Glancing round, he saw Dick's note-pad on the bench. He pulled it towards him, drew a ball-point pen from his pocket, and drew several sketches. (Figs. 3(a) and (b).)

"Now to start off with," he announced, "I've just sketched out a variable capacitor having semicircular moving vanes. You see plenty of variable capacitors like this in electronics and they're normally employed as trimmers. The Jackson Brothers 'Air Trimmers' type C803 and C804 are typical examples of variable capacitors having semicircular moving vanes, and these are very well-known amongst amateurs and experimenters."

"I've bumped into them quite a bit myself," concurred Dick. "They're just the job for home-constructor applications."

"Exactly," said Smithy. "Let's next take a general look at basic variable capacitor functioning. If, for the moment, we ignore the inevitable minimum capacitance of the capacitor, we can say that the capacitance of a variable capacitor is proportional to the area of overlap of its sets of vanes. If the area of overlap doubles, so does the capacitance. All right so far?"

"Sure," replied Dick, enthusiastically. "Go on, Smithy."

"Right," said Smithy. "Well now, when the moving vanes are semicircular the capacitance increases in linear fashion with spindle rotation. With variable capacitors, spindle rotation is expressed in degress from zero to 180, zero degrees applying to the position of minimum capacitance and 180 degrees to the position of maximum capacitance. In a variable capacitor having semicircular moving vanes, the area of overlap is proportional to the number of degrees of rotation. For instance, the area of overlap at 60 degrees rotation will obviously be twice the area of overlap at 30 degrees."

"Does that mean," put in Dick quickly, "that the capacitance at 60 degrees rotation will be twice the capacitance at 30 degrees rotation?"

"It would," replied Smithy, "if, as I said just now, we ignored the minimum capacitance which is given at zero degrees rotation. However, in practice we have to take this minimum capacitance into account. So your statement has to be changed by saying that at 60 degrees rotation the *increase* in capacitance over minimum capacitance is double the *increase* in capacitance over minimum capacitance at 30 degrees. Got it?"

"Ah yes, I see what you're driving at now."

"The minimum capacitance is usually very small," continued Smithy, "but it still has to be borne in mind, because it affects the swing of the variable capacitor."

"That's a funny word," commented Dick. "What do you mean by 'swing'?"

"With variable capacitors," explained Smithy, "'swing' simply means the difference between the maximum and minimum capacitances. Now, if you look at the second of the two sketches I did just now, you'll see that it consists of a graph showing capacitance against spindle rotation for a variable capacitor having semicircular moving vanes. The vertical capacitance axis of the graph is marked up in terms of percentage of the maximum capacitance. As you can see, the curve is a straight line drawn between the minimum value of the capacitor at zero degrees rotation and 100 per cent capacitance at 180 degrees rotation. Because of this characteristic, variable capacitors with semicircular moving vanes are said to follow a 'straight-line capacitance' law."

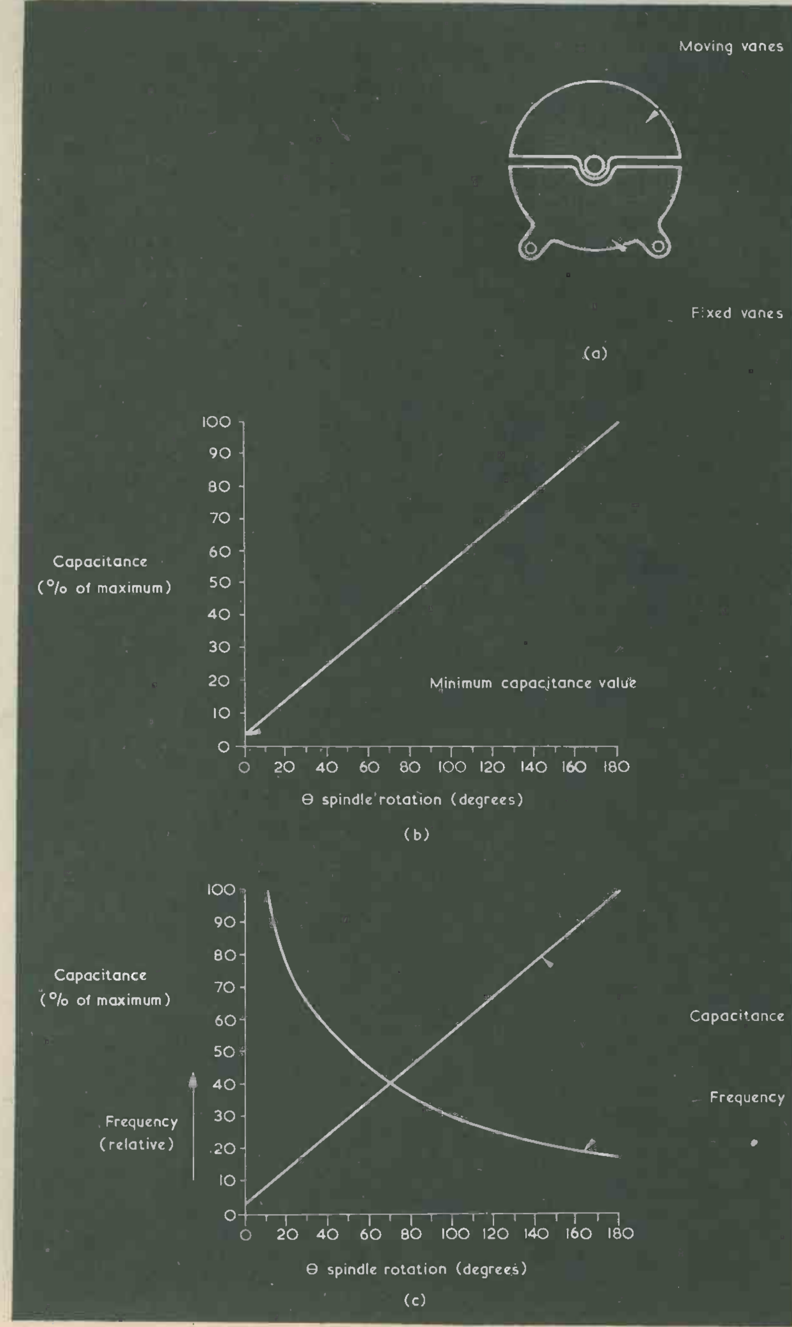


Fig. 3 (a). A variable capacitor with semicircular moving vanes exhibits a straight-line capacitance law
(b). Curve illustrating the relationship between spindle rotation and capacitance in a variable capacitor with semicircular moving vanes. It is assumed that the minimum capacitance is approximately 2.5% of the maximum value
(c). When a variable capacitor with semicircular moving vanes is connected across a coil, resonant frequency with spindle rotation has the characteristic shown here

"That seems pretty straightforward," said Dick. "What's that little oval with the line through it alongside the rotation axis?"

"It's the Greek letter 'theta'," explained Smithy. "That's the letter which is normally used to represent variable capacitor spindle rotation. Let's turn to a further point. If we use our variable capacitor with semi-circular moving vanes to tune a coil, and then plot the resulting resonant frequency against spindle rotation, we'll obtain a curve something like this."

FREQUENCY COVERAGE

Smithy added a further line to his graph. (Fig. 3(c).)

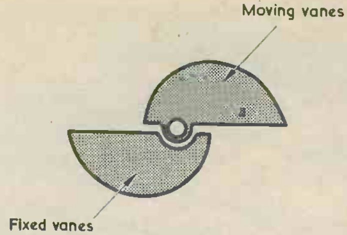
"This curve," he resumed, "is anything but linear. As the tuning capacitor spindle is turned from zero degrees to around 20 to 30 degrees there is an extremely large change in resonant frequency, and the change in resonant frequency per degree of rotation becomes progressively smaller as the rotation carries on up to 180 degrees. If a capacitor with semi-circular vanes is used as the main tuning control of a receiver, the stations at the high frequency end of the range covered will be packed together far more closely than those at the low frequency end."

"I can visualise that," remarked Dick. "Is that why the moving vanes of normal tuning capacitors are never semicircular?"

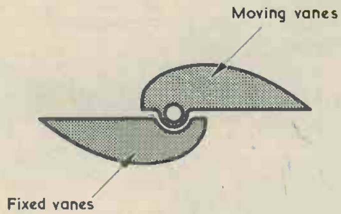
"It is," confirmed Smithy. "If you take any normal tuning capacitor which is set to minimum capacitance and then turn its spindle so that the vanes start to enmesh, you'll see that there is at first a relatively small area of overlap, this becoming larger and larger as the vanes get more and more enmeshed. The result is that the rate of increase in capacitance against rotation at the low capacitance end is smaller than that at the high capacitance end. Because of this, stations at the high frequency end of the band being tuned by the capacitor are by no means as cramped together as they would be with a capacitor having semicircular moving vanes. The shape of tuning capacitor moving vanes is such that the high frequency end of the range is effectively opened out."

"Is it possible," asked Dick, "to have a tuning capacitor moving vane shape which gives a linear effect with wavelength and with frequency?"

"Oh yes," replied Smithy. "Although, I should add that the wavelength and frequency requirements cannot be met by a single shape. The wavelength to which a tuned circuit esponds is proportional to the square root of the product of its inductance and capacitance. In a receiver tuned circuit the inductance will be fixed, so that wavelength then becomes proportional to the square root of capacitance. The moving vanes of a variable capacitor in which the square root of the capacitance is proportional to spindle rotation takes up a shape like this."



(a)



(b)

Fig. 4 (a). Vane shape for a variable capacitor with a straight-line wavelength law (b). A variable capacitor having a straight-line frequency law

Smithy started to sketch out a further diagram on Dick's note-pad. (Fig. 4(a).)

"Such a capacitor," he stated as he drew, "is described as having a 'straight-line wavelength' law."

Smithy put his pen down and indicated the moving vane shape to Dick.

"Now, frequency differs from wavelength," he went on, "because it's proportional to the *reciprocal* of the square root of the product of inductance and capacitance. The moving be proportional to vane shape which causes frequency to spindle rotation is like this, and it corresponds to a 'straight-line fre-quency' law."

Smithy drew a second capacitor vane shape. (Fig. 4 (b).)

Dick studied the two sketches.

"Most of the tuning capacitors I've seen," he remarked, "seem to have a moving vane shape which falls between those two shapes you've just drawn."

"In general, that's true," confirmed Smithy. "Most practical tuning capacitors do indeed have vane shapes which come somewhere between the straight-line wavelength and straight-line frequency shapes."

He paused.

"Hang on a minute," he said thoughtfully, "I think I've got a chart knocking around which gives a typical law for a practical variable capacitor."

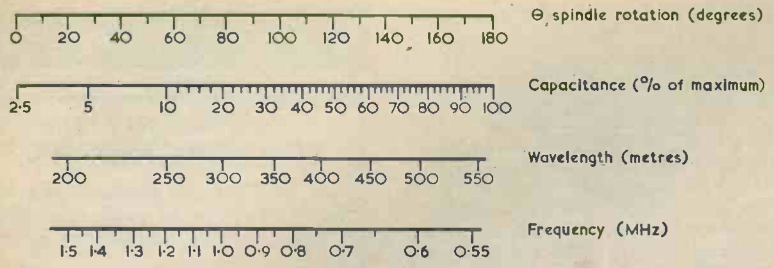


Fig. 5. Chart showing a typical law for a variable capacitor intended for tuning the medium and long wave bands. The third line shows wavelengths in the medium wave band when the capacitor is connected to a suitable coil and the fourth line shows the corresponding frequencies

He walked over to his bench and rummaged in one of the drawers.

"Ah, here we are," he said, as he returned with a sheet of paper in his hand. "Take a look at this."

Smithy placed the sheet on Dick's bench, and the latter gazed at it closely. (Fig. 5.)

"This chart," continued Smithy, "not only shows capacitance values for spindle rotation but it also shows the medium wave wavelengths and frequencies which are given when the variable capacitor having this particular law tunes the medium wave band. The capacitance doesn't reach 10 per cent of maximum value until the spindle has passed through at least 50 degrees of rotation, whereupon the low wavelength end of the medium wave band is opened out quite a lot. I should mention that this particular law is only one of quite a few that are encountered in practical variable capacitors."

"Blow me," said Dick excitedly. "I've just cottoned on to something!"

"What's that?"

"The spacing along the wavelength line in that law chart will be the same as the spacing along the medium wave tuning scale of the receiver in which the capacitor is fitted!"

"Exactly," confirmed Smithy. "And this leads on to the fact that you can get a good idea of the law of the tuning capacitor in any receiver covering medium waves simply by looking at the wavelength spacing along the medium wave tuning scale. You'll find that there are quite high variations in tuning capacitor law between receivers of different makes and types. You can also get a good idea of tuning capacitor law by looking at the v.h.f. tuning scales of f.m. receivers, provided of course that these don't use permeability tuning. Only in this case the tuning scale graduations will be in terms of frequency instead of wavelength, and will extend from around 88 to 108MHz."

END VANE SEGMENT

"You've certainly opened my eyes on this variable capacitor business," remarked Dick. "I can see myself taking an added interest in medium wave and f.m. tuning scales from now on!"

Smithy picked up his mug and drank deeply. Dick's eyes fell on his aunt's receiver.

"It's a pity that I won't be able to get that set fixed in time for Christmas, though."

"Are you *sure* the tuning capacitor is faulty?"

"Definitely," averred Dick. "The outside section of the 2-gang is the oscillator section and it has a padding capacitor in series with it. Because of this I was able to check it with an ohmmeter; and the vanes are short-circuit over two-thirds of spindle rotation."

"Nevertheless," said Smithy mildly, "it might just be worth your connecting up the battery and trying the set out once again."

"I can't see that doing any good," commented Dick reluctantly. "Still, I'll do it if only to please you."

Dick clipped on the battery connector, turned on the receiver, selected medium waves and swung its tuning knob. The little set at once gave an extremely lively performance, reproducing stations at all sections of the medium wave band. Dick stared at it incredulously.

"Your aunt," chuckled Smithy, "hadn't done as much damage to that 2-gang capacitor as you'd imagined. All she'd done was to bend in one of the adjustable segments of the outside end vane. I spotted this whilst you were making the tea and so I simply bent it out again." (Fig. 6.)

"Blimey, Smithy, you're marvellous. This has really made my Christmas!"

"I'm glad you're pleased," said Smithy. "Let's see if we can find a bit of suitable music."

He carefully tuned in a station on the radio, to be rewarded with Bing Crosby's rendering of 'I'm Dreaming of a White Christmas'.

"Stap me," remarked Dick. "He gets in every year, doesn't he?"

But Smithy had left him and was now engaged on some mysterious errand elsewhere. Dick turned round to see the Serviceman delving into the rear of the spares cupboard. Smithy returned, accompanied by the pleasant chink of glass against bottle, and placed two glasses on Dick's bench. He proceeded to fill them, then handed one to his assistant.

"Here we are, Dick. And let me now wish you a very Merry Christmas."

"And the same to you, too," returned Dick warmly. "In fact, let me wish you the very best Christmas you've ever had."

"Thank you," said Smithy gravely. "We'd better now be upstanding."

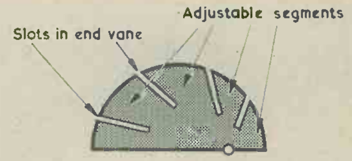


Fig. 6. The outside vanes of each section of multi-vane air-spaced ganged tuning capacitors are slotted as shown here. If necessary, the individual segments can then be bent out to ensure that the capacitor presents the correct capacitance over all its spindle rotation

They both rose and held up their glasses.

"Let us next," pronounced Smithy, "wish a very Merry Christmas and a truly happy and prosperous New Year to all the readers who've put up with our antics over the last twelve months."

They drank.

"And," concluded Dick, "let us finish, as we have done on so many earlier Christmasses, by saying 'God bless us, every one'!" ■

"That's funny! I don't remember there being a fire in the book"

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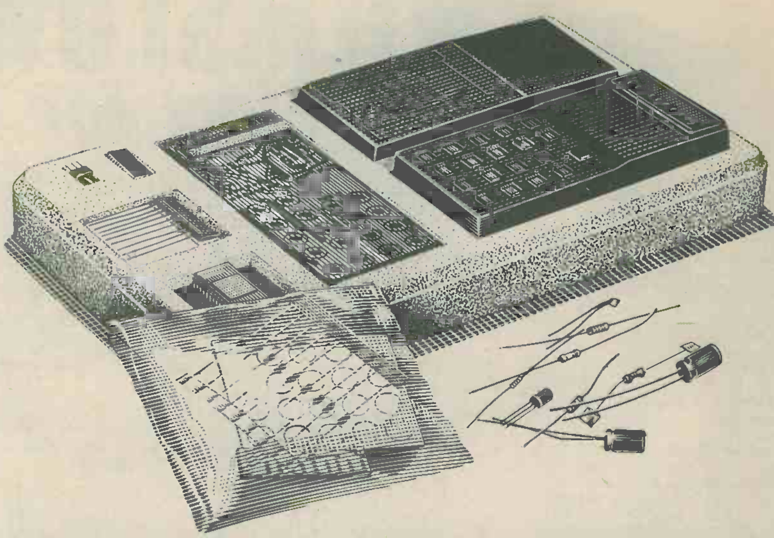

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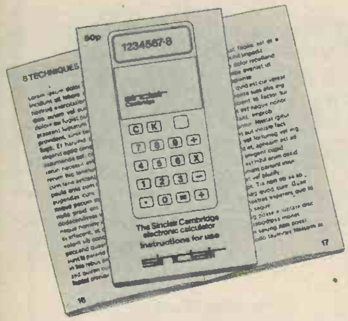

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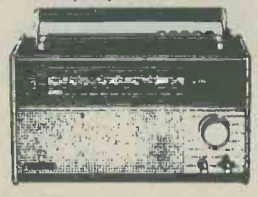

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(Continued on page 321)

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(Continued on page 323)

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(Continued from page 321)

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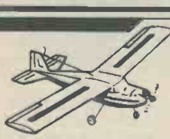

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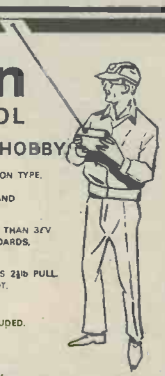

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CONSTRUCTOR'S DATA SHEET 81

FREQUENCY—WAVELENGTH II

The Table lists wavelengths of radio frequencies from 5.3MHz to 10MHz and completes the information which commenced in the previous Data Sheet. Use the appropriate factor for frequencies in other decades; thus, 67MHz corresponds with 4.47 metres.

Frequency (MHz)	Wavelength (metres)	Frequency (MHz)	Wavelength (metres)	Frequency (MHz)	Wavelength (metres)	Frequency (MHz)	Wavelength (metres)
5.3	56.6	6.5	46.1	7.7	38.9	8.9	33.6
5.4	55.6	6.6	45.5	7.8	38.4	9.0	33.3
5.5	54.5	6.7	44.7	7.9	37.8	9.1	33.0
5.6	53.5	6.8	44.0	8.0	37.5	9.2	32.6
5.7	52.6	6.9	43.5	8.1	37.0	9.3	32.2
5.8	51.7	7.0	42.9	8.2	36.6	9.4	31.9
5.9	50.8	7.1	42.2	8.3	36.1	9.5	31.6
6.0	50.0	7.2	41.7	8.4	35.7	9.6	31.3
6.1	49.1	7.3	41.1	8.5	35.2	9.7	30.9
6.2	48.4	7.4	40.5	8.6	34.9	9.8	30.6
6.3	47.6	7.5	40.0	8.7	34.5	9.9	30.3
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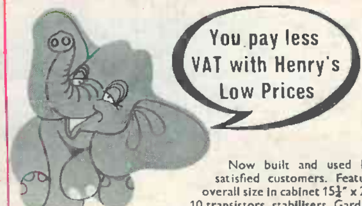

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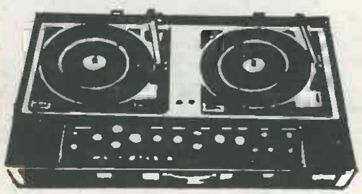

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