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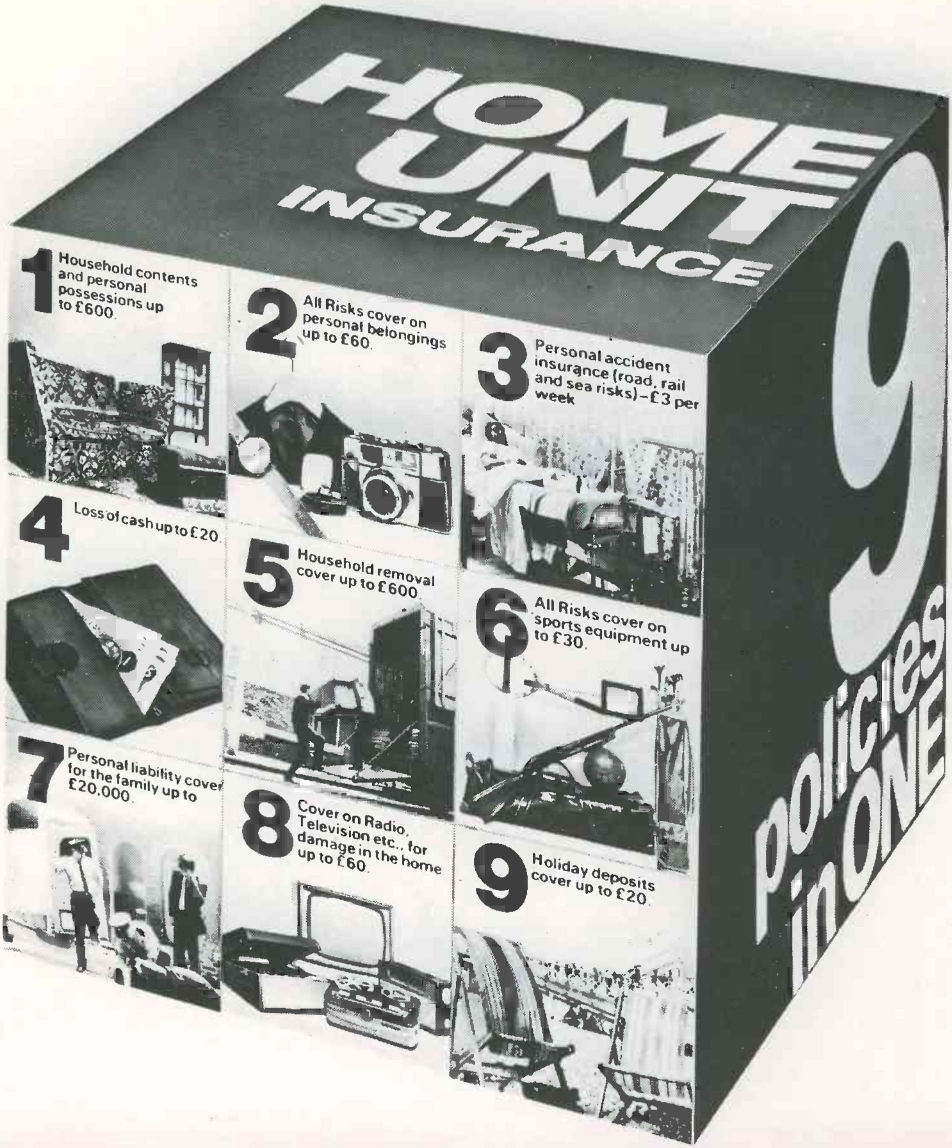

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20/9468

The largest selection

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Type	Price	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	MJE2955	0.95	2G308	0.39	2N2192	0.39	2N3391	0.16	2N4060	0.13
AC113	0.20	AD162(MP)	0.75	BC151	0.22	BD132	0.66	BF183	0.44	MJE3055	0.62	2G309	0.39	2N2193	0.39	2N3391A	0.18	2N4061	0.13
AC115	0.22	ADT140	0.55	BC152	0.19	BD133	0.72	BF184	0.28	MJE3440	0.55	2G339	0.22	2N2194	0.39	2N3392	0.16	2N4062	0.13
AC117K	0.32	AF114	0.27	BC153	0.31	BD135	0.44	BF185	0.33	MPF102	0.46	2G339A	0.18	2N2217	0.24	2N3393	0.16	2N4284	0.19
AC122	0.13	AF115	0.27	BC154	0.33	BD136	0.44	BF187	0.30	MPF104	0.41	2G344	0.20	2N2218	0.22	2N3394	0.16	2N4285	0.19
AC125	0.19	AF116	0.27	BC157	0.20	BD137	0.50	BF188	0.44	MPF105	0.41	2G345	0.18	2N2219	0.22	2N3395	0.19	2N4286	0.19
AC126	0.19	AF117	0.27	BC158	0.13	BD138	0.55	BF194	0.13	OC19	0.39	2G371	0.18	2N2220	0.24	2N3402	0.23	2N4287	0.19
AC127	0.20	AF118	0.39	BC159	0.13	BD139	0.61	BF195	0.13	OC20	0.70	2G371B	0.13	2N2221	0.22	2N3403	0.23	2N4288	0.19
AC128	0.20	AF124	0.33	BC160	0.50	BD140	0.66	BF196	0.16	OC22	0.52	2G373	0.19	2N2222	0.22	2N3404	0.31	2N4289	0.19
AC132	0.16	AF125	0.33	BC161	0.55	BD155	0.88	BF197	0.16	OC23	0.54	2G374	0.19	2N2368	0.19	2N3405	0.46	2N4290	0.19
AC134	0.16	AF126	0.31	BC167	0.13	BD175	0.66	BF200	0.50	OC24	0.62	2G377	0.33	2N2369	0.16	2N3414	0.17	2N4291	0.19
AC137	0.16	AF127	0.31	BC168	0.13	BD176	0.66	BF222	£1.05	OC25	0.42	2G378	0.18	2N2369A	0.16	2N3415	0.17	2N4292	0.19
AC141	0.20	AF139	0.33	BC169	0.13	BD177	0.72	BF257	0.50	OC26	0.32	2G381	0.18	2N2411	0.27	2N3416	0.31	2N4293	0.19
AC141K	0.32	AF178	0.55	BC170	0.13	BD178	0.72	BF258	0.66	OC28	0.55	2G382	0.18	2N2412	0.27	2N3417	0.31	2N5172	0.13
AC142	0.20	AF179	0.55	BC171	0.16	BD179	0.77	BF259	0.94	OC29	0.55	2G401	0.33	2N2646	0.52	2N3525	0.83	2N5294	0.60
AC142K	0.28	AF180	0.55	BC172	0.16	BD180	0.77	BF262	0.61	OC35	0.46	2G414	0.33	2N2711	0.23	2N3614	0.74	2N5457	0.35
AC151	0.17	AF181	0.55	BC173	0.16	BD185	0.72	BF263	0.61	OC36	0.55	2G417	0.28	2N2712	0.23	2N3615	0.82	2N5458	0.35
AC154	0.22	AF186	0.55	BC174	0.16	BD186	0.72	BF270	0.39	OC41	0.22	2N388	0.39	2N2714	0.23	2N3616	0.82	2N5459	0.44
AC155	0.22	AF239	0.41	BC175	0.24	BD187	0.77	BF271	0.33	OC42	0.27	2N388A	0.61	2N2904	0.19	2N3644	0.10	2N6221	0.75
AC156	0.22	AL102	0.72	BC177	0.21	BD188	0.77	BF272	0.88	OC44	0.17	2N404	0.22	2N2904A	0.23	2N3702	0.13	2S301	0.55
AC157	0.27	AL103	0.72	BC178	0.21	BD189	0.83	BF273	0.39	OC45	0.14	2N404A	0.31	2N2905	0.23	2N3703	0.13	2S302A	0.46
AC165	0.22	ASY26	0.28	BC179	0.21	BD190	0.83	BF274	0.39	OC70	0.11	2N524	0.46	2N2905A	0.23	2N3704	0.14	2S302	0.48
AC166	0.22	ASY27	0.33	BC180	0.27	BD195	0.94	BFW10	0.66	OC71	0.11	2N527	0.54	2N2906	0.17	2N3705	0.13	2S303	0.62
AC167	0.22	ASY28	0.28	BC181	0.27	BD196	0.94	BFX29	0.30	OC72	0.16	2N598	0.46	2N2906A	0.20	2N3706	0.13	2S304	0.77
AC168	0.27	ASY29	0.28	BC182	0.16	BD197	0.99	BFX84	0.24	OC74	0.16	2N599	0.50	2N2907	0.22	2N3707	0.14	2S305	0.86
AC169	0.16	ASY50	0.28	BC182L	0.16	BD198	0.99	BFX85	0.33	OC75	0.17	2N696	0.14	2N2907A	0.24	2N3708	0.09	2S306	0.86
AC176	0.22	ASY51	0.28	BC183	0.16	BD199	£1.05	BFX86	0.24	OC76	0.17	2N697	0.15	2N2923	0.16	2N3709	0.10	2S307	0.86
AC177	0.27	ASY52	0.28	BC183L	0.16	BD200	£1.05	BFX87	0.27	OC77	0.28	2N698	0.27	2N2924	0.16	2N3710	0.10	2S321	0.62
AC178	0.31	ASY54	0.28	BC184	0.22	BD205	0.88	BFX88	0.24	OC81	0.17	2N699	0.39	2N2925	0.16	2N3711	0.10	2S322	0.46
AC179	0.31	ASY55	0.28	BC184L	0.22	BD206	0.88	BFY50	0.22	OC81D	0.17	2N706	0.09	2N2926(G)	0.14	2N3819	0.31	2S322A	0.46
AC180	0.22	ASY56	0.28	BC186	0.31	BD207	£1.05	BFY51	0.22	OC82	0.17	2N706A	0.10	2N2926(Y)	0.12	2N3820	0.55	2S323	0.62
AC180K	0.32	ASY57	0.28	BC187	0.31	BD208	£1.05	BFY52	0.22	OC82D	0.17	2N708	0.13	2N2926(O)	0.11	2N3821	0.39	2S324	0.77
AC181	0.22	ASY58	0.28	BC207	0.12	BDY20	£1.10	BFY53	0.19	OC83	0.22	2N711	0.33	2N2926(R)	0.11	2N3823	0.31	2S325	0.77
AC181K	0.32	ASY73	0.28	BC208	0.12	BF115	0.27	BSX19	0.17	OC139	0.22	2N717	0.39	2N2926(B)	0.11	2N3903	0.31	2S326	0.77
AC187	0.24	ASZ21	0.44	BC209	0.13	BF117	0.50	BSX20	0.17	OC140	0.22	2N718	0.27	2N3010	0.77	2N3904	0.33	2S327	0.77
AC187K	0.25	BC107	0.14	BC212L	0.14	BF118	0.77	BSY25	0.17	OC169	0.28	2N718A	0.55	2N3011	0.16	2N3905	0.31	2S701	0.46
AC188	0.24	BC108	0.14	BC213L	0.14	BF119	0.77	BSY26	0.17	OC170	0.28	2N726	0.31	2N3053	0.19	2N3906	0.30	40361	0.44
AC188K	0.25	BC109	0.15	BC214L	0.18	BF121	0.50	BSY27	0.17	OC171	0.28	2N727	0.31	2N3054	0.51	2N4058	0.13	40362	0.50
ACY17	0.28	BC113	0.11	BC225	0.28	BF123	0.55	BSY28	0.17	OC200	0.28	2N743	0.22	2N3055	0.55	2N4059	0.11		
ACY18	0.22	BC114	0.17	BC226	0.39	BF125	0.50	BSY29	0.17	OC201	0.31	2N744	0.22						
ACY19	0.22	BC115	0.17	BC301	0.30	BF127	0.55	BSY38	0.20	OC202	0.31	2N914	0.16						
ACY20	0.22	BC116	0.17	BC302	0.27	BF152	0.61	BSY39	0.20	OC203	0.28	2N918	0.33						
ACY21	0.22	BC117	0.20	BC303	0.35	BF153	0.50	BSY40	0.31	OC204	0.28	2N929	0.23						
ACY22	0.18	BC118	0.11	BC304	0.40	BF154	0.50	BSY41	0.31	OC205	0.39	2N930	0.23						
ACY27	0.20	BC119	0.33	BC440	0.34	BF155	0.77	BSY95	0.14	OC309	0.44	2N1131	0.22						
ACY28	0.21	BC120	0.88	BC460	0.40	BF156	0.53	BSY95A	0.14	OCP71	0.48	2N1132	0.24						
ACY29	0.39	BC125	0.13	BCY30	0.27	BF157	0.61	BU105	£2.20	ORP12	0.48	2N1302	0.16						
ACY30	0.31	BC126	0.20	BCY31	0.29	BF158	0.61	C111E	0.55	ORP60	0.44	2N1303	0.16						
ACY31	0.31	BC132	0.13	BCY32	0.33	BF159	0.66	C400	0.33	ORP61	0.44	2N1304	0.19						
ACY34	0.23	BC134	0.20	BCY33	0.24	BF160	0.44	C407	0.28	P20	0.55	2N1305	0.19						
ACY35	0.23	BC135	0.13	BCY34	0.28	BF162	0.44	C424	0.28	P346A	0.22	2N1306	0.23						
ACY36	0.31	BC136	0.17	BCY70	0.16	BF163	0.44	C425	0.55	P397	0.46	2N1307	0.23						
ACY40	0.19	BC137	0.17	BCY71	0.22	BF164	0.44	C426	0.39	ST140	0.14	2N1308	0.26						
ACY41	0.20	BC139	0.44	BCY72	0.16	BF165	0.44	C428	0.22	ST141	0.19	2N1309	0.26						
ACY44	0.39	BC140	0.33	BCZ10	0.22	BF167	0.24	C441	0.33	TIS43	0.34	2N1613	0.22						
AD130	0.42	BC141	0.33	BCZ11	0.28	BF173	0.24	C442	0.33	UT46	0.30	2N1711	0.22						
AD140	0.53	BC142	0.33	BCZ12	0.28	BF176	0.39	C444	0.39	ZN414	£1.20	2N1889	0.35						
AD142	0.53	BC143	0.33	BD115	0.68	BF177	0.39	C450	0.24	2G301	0.21	2N1890	0.50						
AD143	0.42	BC145	0.50	BD116	0.88	BF178	0.33	MAT100	0.21	2G302	0.21	2N1893	0.41						
AD149	0.55	BC147	0.11	BD121	0.66	BF179	0.33	MAT101	0.22	2G303	0.21	2N2147	0.79						
AD161	0.39	BC148	0.11	BD123	0.72	BF180	0.33	MAT120	0.21	2G304	0.27	2N2148	0.63						
AD162	0.39	BC149	0.13	BD124	0.76	BF181	0.33	MAT121	0.22	2G306	0.44	2N2160	0.66						

DIODES AND RECTIFIERS

Type	Price	Type	Price	Type	Price
AA119	0.09	BY128	0.17	OA10	0.15
AA120	0.09	BY130	0.18	OA47	0.08
AA129	0.09	BY133	0.23	OA70	0.08
AAY30	0.10	BY164	0.55	OA79	0.08
AAZ13	0.11	BYX38/30	0.46	OA81	0.08
BA100	0.11	BYZ10	0.39	OA85	0.10
BA116	0.23	BYZ11	0.33	OA90	0.07
BA126	0.24	BYZ12	0.33	OA91	0.07
BA148	0.16	BYZ13	0.28	OA95	0.08
BA154	0.13	BYZ16	0.44	OA200	0.07
BA155	0.16	BYZ17	0.39	OA202	0.08
BA156	0.15	BYZ18	0.39	SD10	0.06
BA173	0.16	BYZ19	0.31	SD19	0.06
BY100	0.17	CG62		1N34	0.08
BY101	0.13	(OA91Eq)	0.06	1N34A	0.08
BY105	0.19	CG651 (OA70-		1N914	0.06
BY114	0.13	79)	0.07	1N916	0.06
BY124	0.13	OA5	0.39	1N4148	0.06
BY126	0.16	OA5 short		1S021	0.11
BY127	0.17	leads	0.23	1S951	0.07

LINEAR I.C's—FULL SPEC.

Type No.	Price 1	25	100 +
72702	0.50	0.48	0.45
72709	0.35	0.33	0.30
72709P	0.33	0.31	0.29
72710	0.45	0.43	0.40
72741	0.40	0.38	0.35
72741C	0.45	0.43	0.40
72741P	0.38	0.36	0.34
72748P	0.38	0.36	0.34
SL201C	0.59	0.45	0.40
SL701C	0.50	0.45	0.40
SL702C	0.50	0.45	0.40
TAA263	0.80	0.70	0.60
TAA293	£1.00	0.95	0.90
TAA350A	£1.85	£1.80	£1.70
μA703C	0.28	0.26	0.24
μA709C	0.35	0.33	0.30
μA711	0.45	0.43	0.40
TBA800	£1.50	—	—

NUMERICAL INDICATOR TUBES

CD66	£1·87
GR116	£1·70
3015F Minitron	£1·50
MAN 3M. L.E.D. 7-segment 0·127"	£1·90

All indicators 0·9 + Decimal point.
All side viewing. Full data for all types available on request.

ZN414 .. .. £1·20 each
I.C. Radio Rec. incl. full cir. data.

TRIPLE 66-bit DYNAMIC SHIFT REGISTER EDSR 3166

Comprises three 66-bit 2 O dynamic shift registers with independent inputs and outputs. TTL compatibility and buffered clock lines to reduce the capacitive load presented at the clock pins. A boot-strapped buffer ensures a full logic swing at the output.
£2·50 each

DTL 930 SERIES LOGIC I.C's

Type	Price 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

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

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μA.7805/L129 5V (Equiv. to MVR5V)	£1·76
μA.7812/L130 12V (Equiv. to MVR12V)	£1·76
μA.7815/L131 15V (Equiv. to MVR15V)	£1·76

DUAL-IN-LINE SOCKETS

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

PROF. TYPE No.	1-24	25-99	100up.
TSO 14 pin type	33p	30p	27p
TSO 16	38p	35p	32p
LOW COST No.			
BPS 14	16p	14p	12p
BPS 16	17p	15p	13p
BPS 8 spin type	15p	13p	11p

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

BI-PAK STILL LOWEST IN PRICE. FULL SPECIFICATION GUARANTEED. ALL FAMOUS MANUFACTURERS

Type	Quantities 1	25	100 +	Type	Quantities 1	25	100 +	Type	Quantities 1	25	100 +
7400	0.18	0.17	0.16	7448	£1.10	£1.07	£1.05	74122	0.88	0.86	0.84
7401	0.18	0.17	0.16	7450	0.18	0.17	0.16	74123	£1.58	£1.54	£1.50
7402	0.18	0.17	0.16	7451	0.18	0.17	0.16	74141	0.85	0.82	0.79
7403	0.18	0.17	0.16	7453	0.18	0.17	0.16	74145	£1.58	£1.54	£1.50
7404	0.18	0.17	0.16	7454	0.18	0.17	0.16	74150	£2.50	£2.40	£2.30
7405	0.18	0.17	0.16	7460	0.18	0.17	0.16	74151	£1.10	£1.05	£1.00
7406	0.39	0.34	0.31	7470	0.32	0.29	0.27	74153	£1.20	£1.10	£1.00
7407	0.39	0.34	0.31	7472	0.32	0.29	0.27	74154	£1.98	£1.90	£1.75
7408	0.25	0.24	0.23	7473	0.41	0.39	0.35	74155	£1.20	£1.15	£1.10
7409	0.25	0.24	0.23	7474	0.41	0.39	0.35	74156	£1.20	£1.15	£1.10
7410	0.18	0.17	0.16	7475	0.60	0.58	0.56	74157	£1.20	£1.15	£1.10
7411	0.28	0.27	0.26	7476	0.44	0.43	0.42	74160	£1.73	£1.70	£1.65
7412	0.30	0.29	0.28	7480	0.74	0.71	0.64	74161	£1.73	£1.70	£1.65
7413	0.32	0.31	0.30	7481	£1.30	£1.25	£1.20	74162	£1.73	£1.70	£1.65
7416	0.40	0.39	0.38	7482	0.90	0.85	0.80	74163	£1.73	£1.70	£1.65
7417	0.40	0.39	0.38	7483	£1.20	£1.15	£1.05	74164	£2.20	£2.10	£2.00
7420	0.18	0.17	0.16	7484	£1.10	£1.05	£1.00	74165	£2.20	£2.10	£2.00
7422	0.30	0.29	0.28	7485	£2.00	£1.90	£1.80	74166	£2.35	£2.30	£2.25
7423	0.40	0.39	0.38	7486	0.35	0.34	0.33	74174	£2.00	£1.95	£1.90
7425	0.40	0.39	0.38	7489	£4.00	£3.75	£3.50	74175	£1.40	£1.35	£1.30
7426	0.40	0.38	0.36	7490	0.74	0.71	0.64	74176	£1.60	£1.55	£1.50
7427	0.40	0.38	0.36	7491	£1.10	£1.05	£1.00	74177	£1.60	£1.55	£1.50
7428	0.45	0.42	0.40	7492	0.74	0.71	0.64	74180	£1.60	£1.55	£1.50
7430	0.18	0.17	0.16	7493	0.74	0.71	0.64	74181	£5.00	£4.50	£4.00
7432	0.40	0.38	0.36	7494	0.85	0.82	0.75	74182	£1.50	£1.45	£1.40
7433	0.42	0.40	0.38	7495	0.85	0.82	0.75	74184	£2.40	£2.30	£2.20
7437	0.45	0.42	0.40	7496	0.96	0.93	0.86	74190	£2.15	£2.10	£2.00
7438	0.45	0.42	0.40	74100	£1.50	£1.45	£1.40	74191	£2.15	£2.10	£2.00
7440	0.18	0.17	0.16	74104	0.70	0.68	0.66	74192	£2.15	£2.10	£2.00
7441	0.74	0.71	0.64	74105	0.70	0.68	0.66	74193	£2.15	£2.10	£2.00
7442	0.74	0.71	0.64	74107	0.44	0.42	0.40	74194	£1.90	£1.80	£1.70
7443	£1.20	£1.15	£1.10	74110	0.60	0.55	0.50	74195	£1.60	£1.50	£1.40
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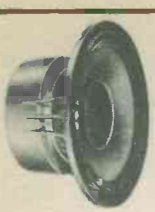

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6.5	500	BT102-500R	75p
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15	500	BT107	90p
6.5	500	BT101-500R	83p
6.5	500	BT109-500R	90p
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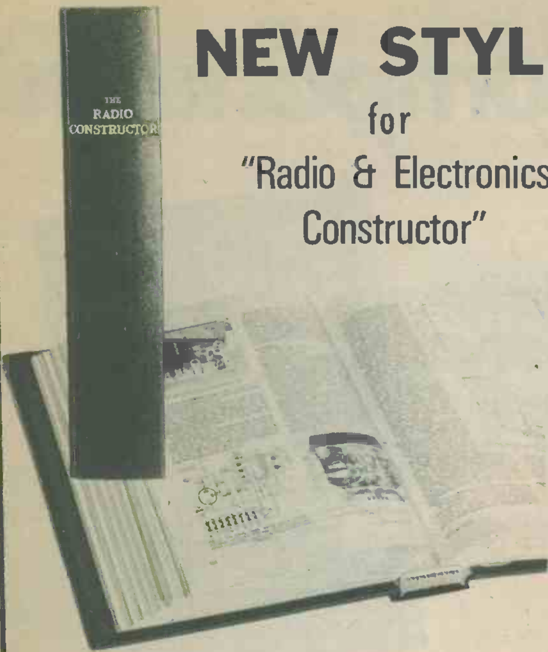

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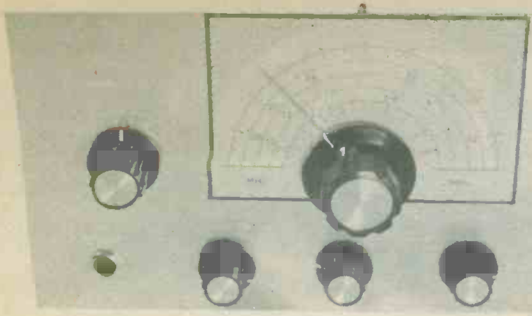


REFLEX

By R. A. Penfold

Intended for a crystal earphone or crystal headphones, this simple receiver can be initially constructed in the form of a single transistor circuit. If desired, a 1-transistor a.f. amplifier may then be added on the same chassis.

THIS LITTLE RECEIVER HAS A FREQUENCY COVERAGE extending from around 1.5 to 36MHz in three bands, and it thus covers virtually the complete short wave frequency spectrum. The approximate coverage for Range 3 is 1.5 to 5.5MHz (200 to 54.5 metres), for Range 4 5.0 to 17MHz (60 to 17.5 metres), and for Range 5 10 to 36MHz (30 to 8.5 metres). These Range numbers correspond to the Denco Blue plug-in coils type 3T, 4T and 5T respectively, and the band required is selected by merely plugging the appropriate Denco coil into its holder. The complications which would arise if bandswitching were used are thus avoided.

The basic receiver employs only a single transistor in a reflex circuit having controlled regeneration. An optional single transistor a.f. amplifier can be added to give the set a degree of extra gain. The output, either with or without the a.f. amplifier, is intended for a crystal earphone or crystal headphones. As with any small short wave receiver, an efficient outdoor aerial is required to obtain good results.

THE CIRCUIT

The circuit diagram for the basic single transistor version of the receiver is shown in Fig. 1. Signals received by the aerial are coupled via L1 to the tuned winding, L2. This is tuned by VC1 and VC2 and selects signals at the desired frequency, these being coupled to the base of the transistor by way of coupling winding L3. C2 bypasses the earthy end of L3 to chassis for r.f. signals. Of the two tuning capacitors, VC1 is the main tuning control, whilst the lower value VC2 is the bandspread control.

TR1 operates as an r.f. amplifier, and the amplified r.f. signals appear at its collector. The r.f. choke, L4, presents a high impedance to r.f. signals whilst C4 offers a low impedance at these frequencies. In consequence, the r.f. signals pass via C4 and D1 back to the base coupling winding, L3. Although it has no d.c. return, diode D1 functions in practice as a non-linear device and the signal now passed to L3 consists of the detected r.f. signal.

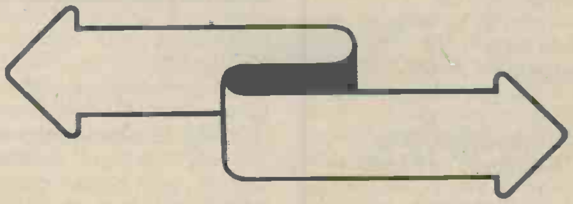
TR1 functions this time as an a.f. amplifier. L4 offers a low impedance at audio frequencies and the amplified a.f. signal passes through this choke and the d.c. blocking capacitor to the volume control, VR3. The signal from this control is then fed to the jack socket SK4 and thence to the earphone or headphones. C5 filters out any residual r.f. component in the output signal which is still present after the r.f. choke. R2 is the collector load for the transistor, both at r.f. and at a.f., and R1 is the base bias resistor.

Two aerial sockets are provided, one coupling direct to L1, and the other coupling to that winding via C1. The aerial is normally plugged into SK2, but it can be plugged into SK1 under conditions of high signal strength which could cause overloading of the receiver.

In order to increase gain and selectivity, regeneration, or r.f. positive feedback, is incorporated in the circuit. The signals at the collector of the transistor and the non-earthy end of L2 are in phase, whereupon C3 and VR1 are employed to provide a controllable level of r.f. feedback. VR1 functions as a coarse control of regeneration, fine control being given by VR2 which varies the supply voltage applied to the transistor. This arrangement enables an extremely smooth control of regeneration to be provided.

It will be noted that the ends of winding L3 are designated '5 or 7' and '7 or 5'. This is because it was found that the coils for Ranges 3 and 4 had this winding

SHORT WAVE RECEIVER



connected one way round to its pins in relation to L2, whilst the Range 5 coil had the winding connected the other way round. The two methods of connection are accommodated by providing two coil holders, one for the Ranges 3 and 4 coils, and the other for the Range 5 coil.

Of the components, the only ones that require special comment are VC1 and VC2. VC1 can be any small air-spaced capacitor having a maximum capacitance of around 365pF and a Jackson type '0' or '00' would be suitable. VC2 requires a maximum capacitance of 50pF and can be a Jackson type C804. VC1 is provided with a scale taken from 'Panel Signs' Set No. 5, and this causes its spindle to be $2\frac{1}{4}$ in. from the top of the front panel. Before cutting out the front panel ascertain that there will be sufficient space above the chassis to accommodate the body of the particular component used for VC1. If not, the height of the panel should be increased or a capacitor of smaller size employed. 'Panel Signs' are available from the publishers of this journal.

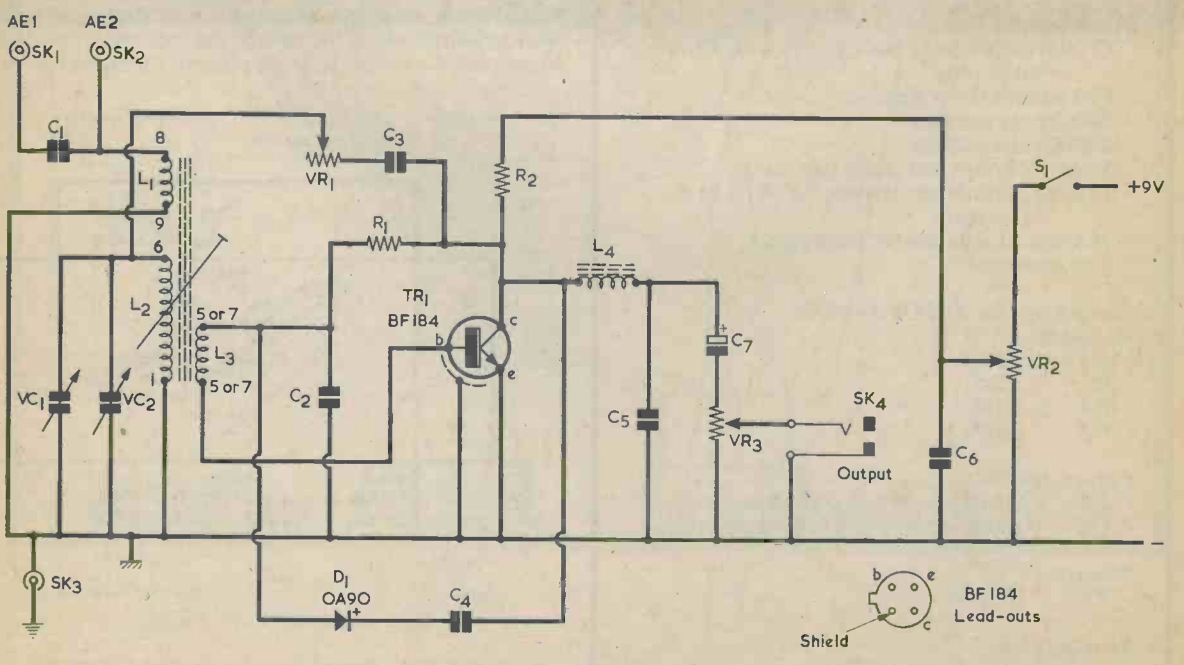


Fig. 1. The circuit of the single transistor reflex short wave receiver

COMPONENTS

Resistors

R1	470kΩ, ¼ watt 10%
R2	4.7kΩ, ¼ watt 10%
VR1	100kΩ potentiometer, linear
VR2	25kΩ potentiometer, linear
VR3	25kΩ potentiometer, log, with switch S1

Capacitors

C1	10pF ceramic or silvered mica
C2	0.01μF plastic foil
C3	8.2pF ceramic or silvered mica
C4	0.022μF plastic foil
C5	0.01μF plastic foil
C6	0.01μF ceramic or plastic foil
C7	2 or 2.2μF electrolytic, 16 V. Wkg.
VC1	365pF variable (see text)
VC2	50pF variable (see text)

Inductors

L1, 2, 3	Miniature Dual Purpose coils, Blue, transistor usage, Ranges 3T, 4T and 5T (Denco)
L4	2.5mH r.f. choke, type CH1 (Repanco)

Semiconductors

TR1	BF184
D1	0A90

Switch

S1	s.p.s.t., part of VR3

Sockets

SK1	Wander plug socket, red
SK2	Wander plug socket, red
SK3	Wander plug socket, black
SK4	3.5mm jack socket

Miscellaneous

Crystal earphone or headphones with 3.5mm jack plug
PP3 battery (Ever Ready)
Battery connector
2 B9A valveholders
5 control knobs and scales (see text)
16 s.w.g. aluminium chassis, 7 by 4 by 1½ in. (see text)
18 s.w.g. aluminium for front panel
¼ in. grommet

Components for Add-On Amplifier

Resistors
(All ¼ watt 10%)

R3	2.2kΩ
R4	3.3MΩ
R5	6.8kΩ

Capacitors

C8	0.1μF plastic foil, side wires
C9	150pF polystyrene or silvered mica

Transistor

TR2	BC169C

Miscellaneous

0.1 in. matrix Veroboard.

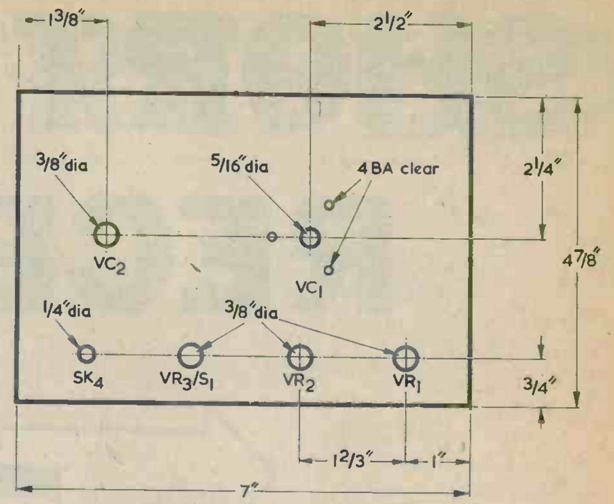


Fig. 2. Dimensions and drilling details for the front panel

CHASSIS AND PANEL

The front panel is home-made from 18 s.w.g. aluminium sheet and it has the dimensions shown in Fig. 2. This diagram also gives drilling details.

If the capacitor employed for VC1 is a Jackson type '0' or '00' component, it is mounted to the front panel by three 4BA countersunk bolts which pass into tapped holes in the front plate of the capacitor. Spacing washers, which could consist of 2BA nuts, are fitted between the panel and the capacitor front plate to provide clearance for the raised centre section. The bolts must be short and their ends must not pass beyond the inside surface of the capacitor front plate or they may damage the fixed or moving vanes. The capacitor is mounted so that its fixed vanes are towards VC2, as illustrated in the photograph showing the rear of the receiver. A piece of paper placed against the front plate of the capacitor can

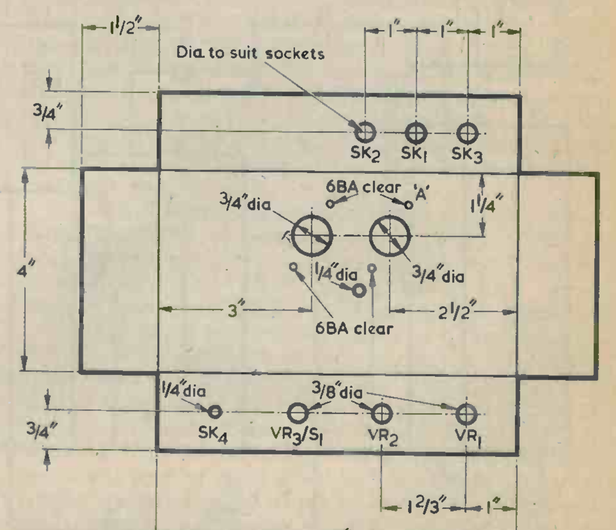


Fig. 3. Top view of the chassis. The flanges are shown opened out for clarity

be marked with the positions of the three holes. The paper can then be used as a template to mark out the corresponding holes on the front panel.

The aluminium chassis measures 7 by 4 by 1½ in., and can be obtained ready-made from H. L. Smith & Co. Ltd., 287-289 Edgware Road, London, W2 1BE. Fig. 3 gives a top view of the chassis, with flanges opened out for clarity, and shows the drilling details.

The two ¾ in. holes on the deck of the chassis are for the two B9A valveholders which take the coils. These are most easily cut out with the aid of a chassis punch or cutter. Alternatively, a series of small closely spaced holes may be drilled inside the periphery of the cut-out, and the centre piece then snipped or punched out. The rough edges of the holes can be finally smoothed out to the correct diameter with the aid of a small half-round file. The positions of the two 6BA clear holes for each valveholder are marked out with the aid of the valveholder itself. When they are mounted, the valveholders should have the orientation shown in the wiring diagram of Fig. 4.

The front flange of the chassis and the front panel are held together by the bush mounting nuts of SK4, VR3, VR2 and VR1. It is therefore important that the mounting holes for these components are drilled accurately in the correct positions in both the chassis and the front panel. The ¼ in. hole in the deck of the chassis in front of the valveholder holes will later allow several leads to pass through, and should be fitted with a rubber or p.v.c. grommet. Its precise positioning is not important.

Once all the drilling has been completed the chassis and panel can be assembled, and the controls, sockets and valveholders mounted in the appropriate positions. A solder tag is secured, below the chassis, under the valveholder mounting nut at the hole marked 'A' in Fig. 2. Make sure that the lower fixed vane tag of VC1 does not touch the upper surface of the chassis deck.

WIRING

The wiring below the chassis is shown in Fig. 4. Valveholder tags which do not connect to coil pins are used as anchoring tags. This assists in easing the process of wiring.

Make sure that the lead-outs of TR1 do not touch each other (except for the emitter and shield lead-outs which are both connected to chassis) and if necessary insulate the lead-outs with short lengths of sleeving. A lead from pin 6 of the right-hand valveholder in the diagram passes through the ¼ in. hole in the chassis to the fixed vane tag of VC1. This lead should be kept short. Above the chassis, the fixed vane tag of VC1 is connected to the fixed vane tag of VC2. Also passing through the ¼ in. hole are the two leads to the battery connector. There is no other wiring above the chassis, and the moving vanes of VC1 and VC2 take their chassis connection by way of the front panel.

As stated earlier, one valveholder is used for the Range 3 and 4 coils, whilst the other is used for the Range 5 coil. When the set is viewed from above the chassis and from the front, the Range 3 or 4 coil

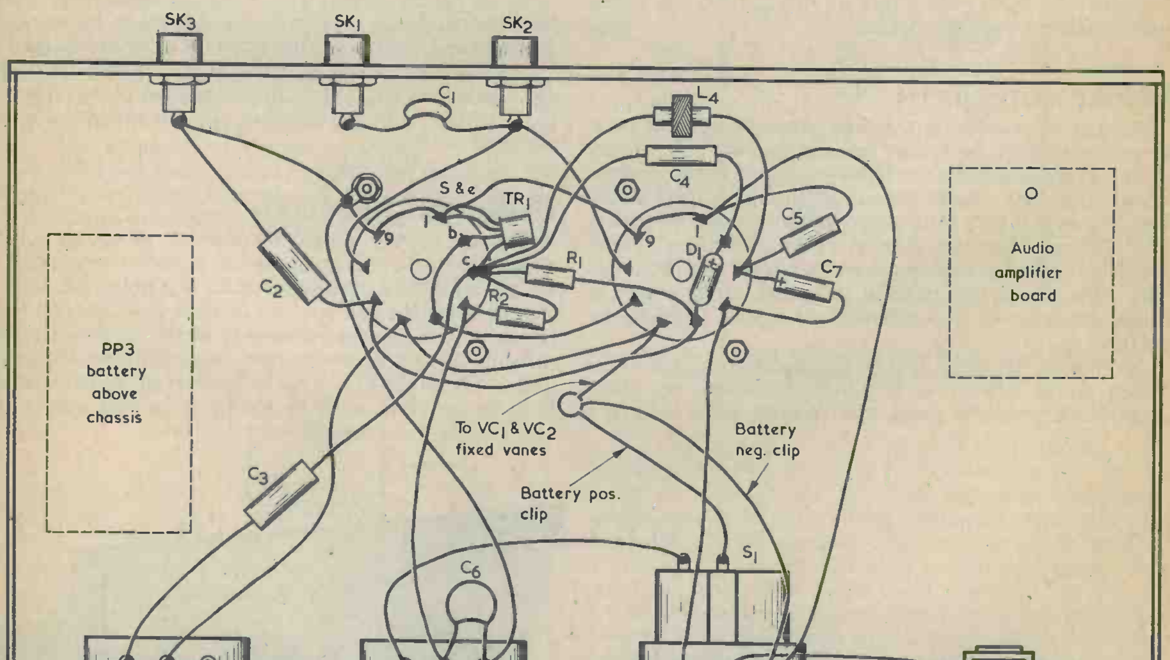
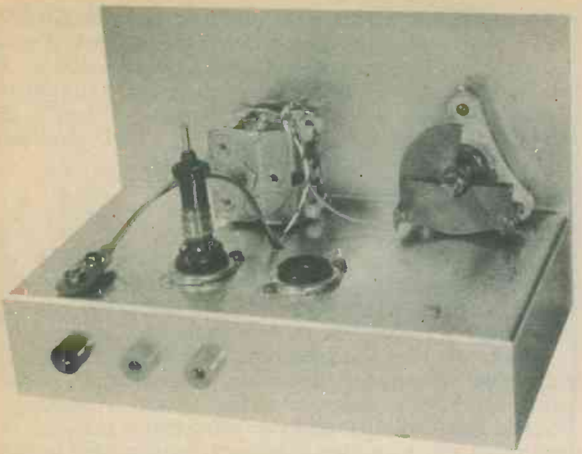


Fig. 4. Wiring and component layout under the chassis. The few connections needed above the chassis are discussed in the text



Rear view of the receiver with a coil inserted

occupies the holder on the right and the Range 5 coil occupies the holder on the left-hand side. It should be mentioned that the regeneration circuit used in this receiver is not one for which the coils are specifically designed, and it is possible that the connections to pins 5 and 7 may differ in some coils. Whilst this would not upset operation when the coil is used in its normal circuit application it could prevent regeneration taking place in the present receiver. The coils should be initially fitted to the valveholders in the manner just described. Should it be found that a coil does not allow regeneration to take place, the effect of fitting it to the other valveholder should be checked.

AERIAL AND EARTH

A long wire aerial is required, and this should be a proper outdoor type as very few stations will be received under average conditions when using a short indoor aerial. For best results the aerial should consist of 50 feet or more of wire strung between any two convenient points which place the aerial at a reasonable height, and preferably clear of buildings or other large obstructions. The wire should be reliably insulated at its securing points in order to prevent received signals from being earthed.

Normally, the aerial will be plugged into socket SK2. When using a very long aerial, however, or when conditions are very good, the receiver may be overloaded. Overloading will result in stations in parts of the band being inseparable, together with a loud hissing sound in the background. This is due to cross-modulation.

Under these conditions it is necessary to reduce the signal input from the aerial, and this is achieved by plugging the aerial into SK1.

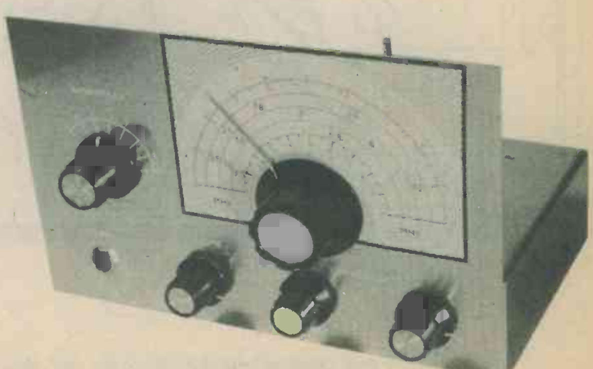
An earth connection can be plugged into SK3, but this will probably have little effect on the performance of the set except, perhaps, on the 80 metre and, more particularly, on the 160 metre amateur bands.

An earth can consist of a length of metal pipe with a lead connected to it. The pipe is buried in moist earth, and the lead taken to the receiver. The earth lead-in should be as short as possible. The effectiveness of the earth is largely dependent upon the area of metal which is in contact with the ground, and therefore the larger the pipe the better.

USING THE RECEIVER

The set is very simple to operate, although a little experience with the regeneration controls may need to be gained before optimum results are obtained. VC1 is the main tuning control, but as each coil covers a wide range of frequencies, tuning is likely to prove rather difficult using this on its own, especially on Ranges 4 and 5. Therefore VC1 is set to the part of the band which is to be covered, and the tuning is carried out by the

Another view of the receiver as seen from the front



bandspread control, VC2. This has a much lower value than VC1, and so covers only a small portion of the band.

VR3 is the combined a.f. volume control and on-off switch, and in the single transistor version of the receiver will need to be kept at maximum all the time.

The settings of VR1 and VR2 are very critical if maximum sensitivity is to be obtained. Start with VR1 adjusted fully anti-clockwise, and VR2 advanced about two-thirds to three-quarters of full travel in the clockwise direction. If VR1 is now advanced there should be a small increase in sensitivity. Continuing to advance VR1 will cause the sensitivity to steadily increase until a point is reached where the set breaks into oscillation. This will be heard as a reduction in background hiss and as whistles when the set is tuned across transmissions.

VR1 should be backed off to a point just below that at which oscillation occurs. VR2 is then advanced in a clockwise direction as far as is possible without the set oscillating. It is at the setting just below the oscillation point that the sensitivity and selectivity of the receiver are at their greatest. In order to obtain good results it is important to ensure that the regeneration controls are adjusted accurately to this setting.

Do not try to obtain fine adjustment of regeneration by means of VR1 as this is only the coarse control. A much more precise setting can be obtained by using VR2. Always ensure that VR2 is well advanced in a clockwise direction, as if this control is advanced less than about half-way a serious loss of gain may result. The required settings for VR1 and VR2 will vary with the settings of the tuning controls and the coil which is in use.

The specific coverage of each coil depends upon the position of its adjustable core, and this should be set so that about $\frac{3}{8}$ in. of its metal thread protrudes from the top of the coil former. The Range 4 coil is likely to prove of most use since this range contains most of the popular broadcast bands. It also contains the 40 metre amateur band. The Range 5 coil gives coverage of the h.f. broadcast bands and amateur bands. Coverage with the Range 3 coil includes the 80 and 160 metre bands, as well as numerous maritime transmissions.

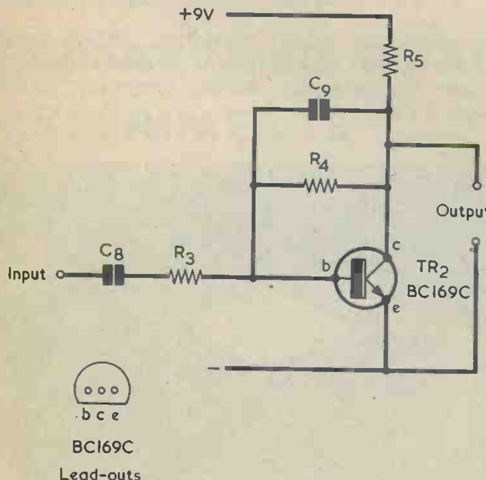


Fig. 5. Circuit of the add-on amplifier stage

The front panel has one of the medium size tuning scales in 'Panel Signs' Set No. 5 affixed to it, and this appears behind VC1 control knob. It may be marked up in terms of the main frequency bands after these have been located and identified. A home-made cursor is fitted to the control knob by means of adhesive. A small scale, also taken from 'Panel Signs' Set No. 5, is positioned behind the knob for VC2. With the prototype, white wording, taken from 'Panel Signs' Set No. 3, was positioned alongside the controls to indicate their functions.

ADD-ON STAGE

The maximum volume and gain of the basic receiver are not very high, and results are considerably enhanced by the addition of an a.f. amplifier stage. The circuit of a suitable amplifier is shown in Fig. 5. This is a straightforward high gain common emitter stage.

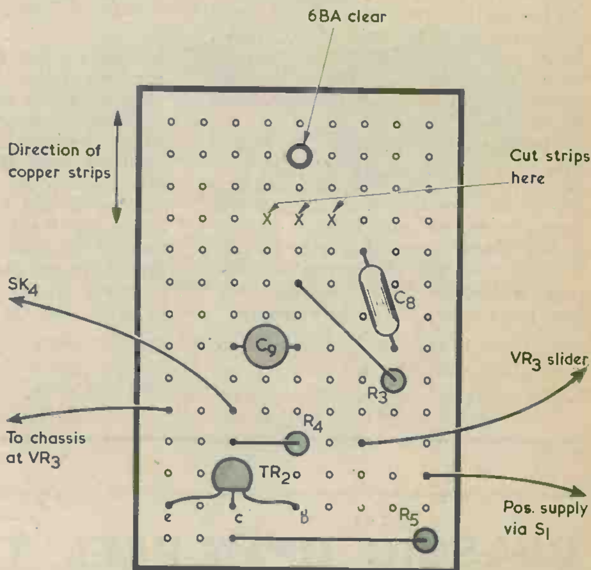


Fig. 6. Component side of the Veroboard panel on which the amplifier stage is assembled

It is assembled on a 0.1 in. matrix Veroboard panel having 9 by 14 holes. Fig. 6 shows the layout on this panel as viewed from the component side. The copper strips have to be cut at three points, as indicated in the diagram. The only major wiring modifications required to the single transistor version consist of disconnecting the lead from VR3 slider to SK4 and of making the alternative connections between these circuit points and the amplifier which are shown in Fig. 6. A 6BA clear hole has also to be drilled in the chassis to take a bolt for mounting the amplifier board. Its position, under the chassis, is indicated in Fig. 4. The board is mounted by means of a single 6BA bolt $\frac{1}{2}$ in. long, an insulated spacing washer about $\frac{1}{4}$ in. thick being placed over this between the chassis and the board.

As a final point, the current consumption of the receiver is very low. It is approximately 2mA for the single transistor version, and 2.6mA for the two transistor version. ■

NEWS . . . AND .

DE LUXE DIGITAL ELECTONIC ALARM CLOCK

Like any dependable alarm clock, the new Heathkit GC-1092AE keeps accurate time and wakes you up in the morning. But that's where its similarity to conventional clocks end. For instance, when the distinctive intermittent electronic "beep" wakes you in the morning, there are no switches or buttons to fumble for. Instead, the slightest touch of the Heathkit "logo" on top of the case, turns off the alarm . . . electronically. And, if you like a lie-in you may activate the "snooze cycle" the night before to give yourself another 7 minutes catnap (repeatable up to an hour).

Emergency Power Supply: If you've ever been late for work because your alarm woke you an hour late due to a power-cut, you'll appreciate this feature: it has its own built-in battery power supply that takes over in case of power failure – keeping accurate time (without the lighted display, however) and wakes you in the morning . . .

on time! When AC power is restored the correct time is once again displayed eliminating the need to reset the clock.

Deluxe Features: Switch-selection of 12 or 24-hour time format; on an indicator-light that lets you set the alarm in correct 24-hour cycle so you can go to bed at 9 p.m. and set the alarm for 10 a.m. without being awakened in an hour; an automatic light sensor control that gives a consistently readable display – bright in brightly lit areas, dim in dark areas – and a battery-saver switch that keeps batteries from discharging when the clock is unplugged for extended periods of time.

Big Orange Digits: Hours, minutes and seconds are displayed on the front panel with big ½ in-high 7-segment Beckman Planar gas discharge tubes for easy, across-the-room viewing. Switches on the bottom panel make setting the time and alarm quick and easy – allow you to hold seconds for correction to a time standard or time an interval and hold the final displayed time. Plug-in IC's and colour coded wiring make the GC-1092AE an enjoyable and rewarding kit building experience.

Kit K/GC-1092AE £50.80. Assembled A/GC-1092AE £72.40 (including 8% VAT and delivery within United Kingdom).

FREE Catalogue available from: Heath (Gloucester) Ltd., Gloucester, GL2 6EE.

CLASSIC OPEN-REEL TAPE FROM 3M

Hi-fi enthusiasts preferring the open-reel format are promised tape performance with more brilliant high frequencies, according to 3M, which has just introduced its new range of Scotch Classic tapes.

Classic tapes use a new proprietary low-noise ferric oxide, giving them a high-frequency performance 3 db higher than Scotch high output low-noise professional tape (206 and 207). Classic tape's signal-to-noise ratio is 8 db higher than standard recording tape.

It is available on 7 inch plastic reels in standard-play (1,200 ft.) long-play (1,800 ft.) and double-play (2,400 ft.) lengths and on reels with NAB-type hubs in 2,400, 3,600- and 4,800 foot lengths. The box for both reel sizes is an innovative book style with a padded front. It has attractive point-of-sale black and silver embossed lettering. The technical and performance data information on the removable sleeve is repeated inside for permanent reference, and the tape is protected in a poly bag cradled in a premoulded plastic tray. Pressure sensitive index and spine labels are also provided.

Suggested list prices for 7 inch reels, excluding VAT, are: standard-play, £4.02; long-play, £5.00; double-play, £6.78. On 10½ inch reels, the recommended retail prices are: standard-play, £9.63; long-play, £11.58; double-play, £15.23.

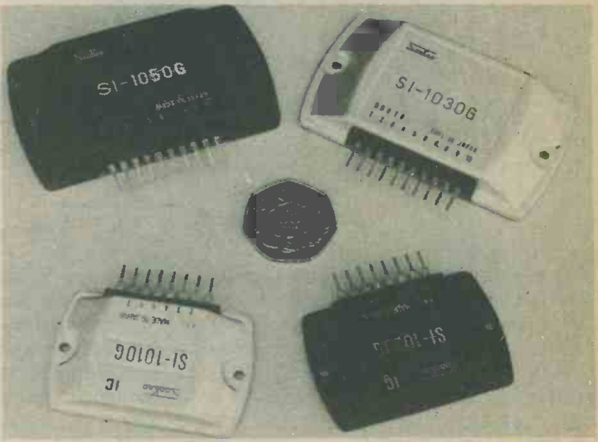
. . . COMMENT

SANKEN HYBRID AUDIO AMPLIFIERS LAUNCHED IN U.K.

The appointment of Armon Products Ltd. of 54 George Street, London W1, as U.K. agents for Sanken Electric Company of Tokyo means that the range of Sanken hybrid audio amplifiers is now available to U.K. electronics hobbyists and hi-fi enthusiasts. Four models are offered, all at short delivery times: SI–1010G (10 watts max, r.m.s.), SI–1020G (20 W), SI–1030G (30 W) and SI–1050G (50 W). All are of compact flat unitary construction, and all have quasi-complementary Class B outputs.

These easy-to-use self-contained hybrid power amplifiers have been designed for use in high-fidelity equipment, musical instruments, public address and other audio applications. Sanken claim $\pm\frac{1}{2}$ dB response from 20 to 100,000 Hz, and less than 0.5% harmonic distortion at full power. Passivated chip transistors are used at the power output end; all others are flip-chip high-reliability types.

The two larger circuits have built-in current limiting and differential input stages, and will feed out into 4 or 8Ω loads. The two smaller do not have differential input, and are for a 8Ω loads only. All four can operate from single or dual (split) power supplies, and all have 40,000Ω input impedance, typically. Design input voltages vary from 0.3 to 0.7, throughout the range. Retail prices of these units are: 10 W, £3.30 each; 20 W, £6.60; 30 W £8.40; and 50 W, £13.00 (all prices subject to VAT). Delivery within 10 to 14 days.



Armon Products are offering four new hybrid audio amplifiers from 10 to 50 watts r.m.s., made by the Japanese Sanken Electric Company.

HOME SECRETARY APPROVES CEEFAX AND ORACLE EXPERIMENTS

The Home Secretary has approved the introduction for a two year experimental period, of the broadcasting of live information on television by means of the technique known as CEEFAX (BBC) and ORACLE (IBA).

The purpose of the experiment, whereby those in possession of the necessary receivers will be able to receive printed up-to-date information over a wide range of topics on their television screens, is to enable an assessment to be made of the demand for the service, to determine what form it should take and to estimate the scope for the manufacture of the equipment. It is assumed that the Annan Committee on the Future of Broadcasting will consider the technique involved against its review of broadcasting policy as a whole.

The regular transmission of live broadcasts by the BBC started in September, when the equipment was shown at the opening conference of the International Broadcasting Convention by both the BBC and IBA.

The United Kingdom leads the field in the development both of the technique and the hardware, and there are good prospects for industrial production both for home and overseas, if the service becomes established.

"Sorry, Doctor. We do not stock your sort of transformer."

BATTERY MISER

By V. S. Evans, G4AVT

An unusual and individual approach to the problem of battery economy

BATTERIES FOR DOMESTIC PORTABLE RADIOS ARE NOW expensive items, which brings very much to the fore the question of battery life and current drain. Unfortunately this aspect of economics is not always given the importance we should like by commercial designers and manufacturers. As a consequence, there are transistor portables on the market which are quite ravenous in consumption of replacement batteries.

CURRENT DRAIN

It is fairly usual for the current consumption of a portable radio to be expressed as a 'no signal' current and as a current figure 'at average volume, rising on peaks'. Specifications of this nature may appear reasonable but the reality can be very different as there are other important data relative to battery life which must be considered.

Current consumption at 'average volume' may be doubled or even more at three-quarters to full volume. Also, assuming the portable works on a 9 volt battery, the drain is less as the voltage drops so that the quoted figures may be based on something less than 9 volts, e.g, the average voltage for the battery's working life of say 8.5 volts. A further wasteful factor occurs with a new battery which can be well in excess of 9.5 volts. This means that the current drain can be really high for the first part of the battery's life. Another relevant aspect is the lowest voltage the battery can reach before distortion or other shortcomings in receiver performance become unacceptable. This voltage can be higher than one would expect, resulting in early discard of the battery.

VOLTAGE REGULATION

Providing the basic 'no signal' current is reasonable, a solution to the wide variables can be found in a simple voltage regulator. This is the purpose of the Battery Miser described in this article. The Miser is placed in circuit between the receiver and the battery. It receives the battery voltage (which is varying with age and use) but puts out a steady fixed voltage to the radio. This fixed voltage is designed to be the minimum voltage at which the radio will work efficiently. Ideally for this purpose the optimum working voltage of the radio should be 2 or 3 volts below the nominal rated voltage of the battery. Thus a radio can be designed to give its best performance at a voltage of 6 volts. The 6 volt supply will be supplied and maintained via the Miser from a 9 volt battery throughout that battery's working life, and that life should be longer than we are accustomed to. The longer life is due to the fixed receiver voltage confining the current drain to fixed designed limits.

A 'hungry' commercial 6 volt portable could be powered in this manner, provided there is room in the case for the 9 volt battery and the Miser.

A 9 volt portable which is heavy on batteries can also be helped by the Miser, providing the minimum voltage at which it will work efficiently is 8 volts or less. This can be ascertained either by observation, i.e. by checking the battery voltage at the first sign of fall off in performance or, better, with the aid of a variable voltage power supply. It is important that the voltage checking should be carried out under load conditions with the receiver switched on.

CIRCUIT DIAGRAM

The Battery Miser has only three components and its layout is unimportant. The circuit is shown in Fig. 1, and it will be seen that it is simply a standard zener regulated emitter follower. The zener diode should have a voltage rating slightly in excess of the voltage it is intended to apply to the receiver. It should be a 5% component with a dissipation rating between 200 and 250mW. Resistor R1 should have a value which causes about 0.5 to 1mA to flow in the zener diode when the

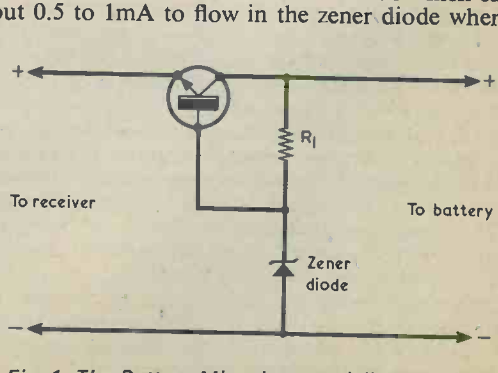


Fig. 1. The Battery Miser is essentially an emitter follower voltage regulator

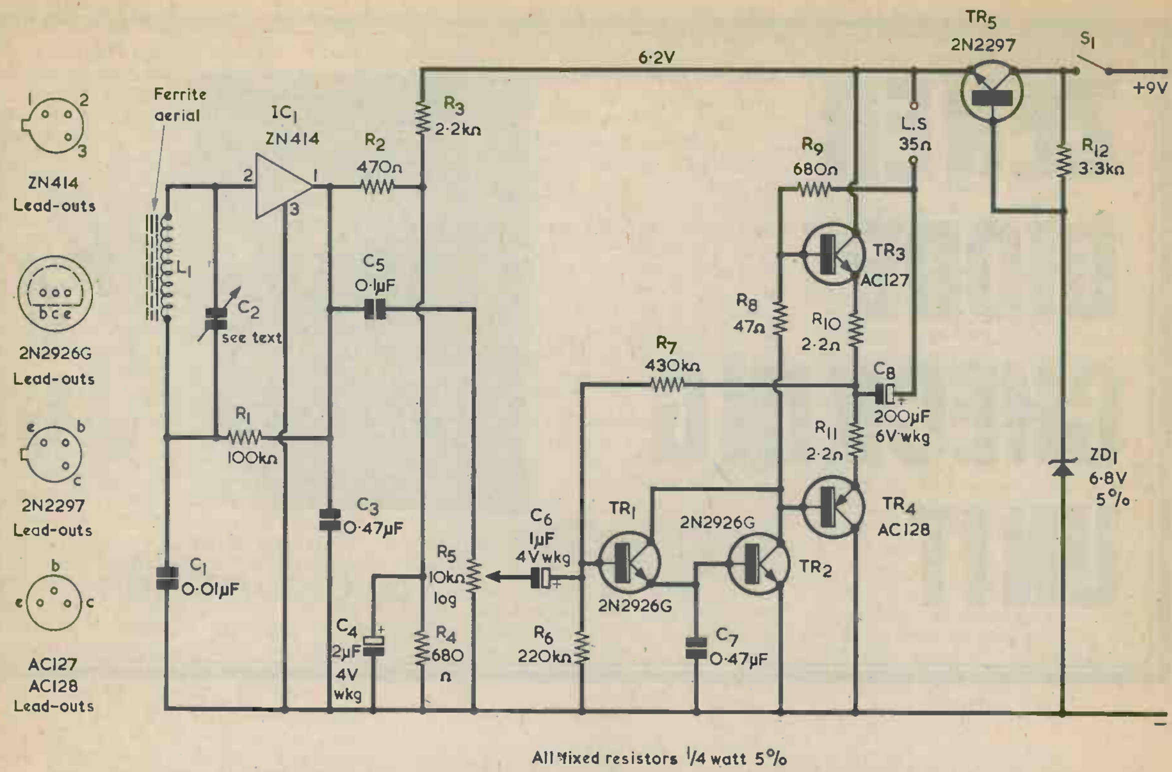


Fig. 2. A simple medium wave portable receiver incorporating the Battery Miser. Current consumption is virtually unchanged throughout the useful life of the 9 volt battery

battery is at its nominal voltage. The transistor may be any small power transistor having a wattage rating in excess of the maximum power it is required to dissipate. If, for instance, it is required to give a 6 volt output from a 9 volt battery then it will have to drop 3 volts. Should the peak current of the receiver be 50mA, then the dissipation in the transistor is 3 times 50, or 150mW. The author uses a silicon transistor type 2N2297 in his version of the circuit. This is in a TO-5 can and has a maximum power rating of 800mW. A slight disadvantage with a silicon transistor is that the 0.6 volt drop between its base and emitter means that the battery voltage, near the end of battery life, has to be at least 0.6 volt higher than the receiver voltage for the circuit to function as intended. A small germanium power transistor, with a base to emitter voltage drop of about 0.15 volt, would allow the battery voltage to fall a little further than does a silicon transistor.

DESIGN PROJECT

To demonstrate the usefulness of the Battery Miser, the author constructed a small portable receiver based on the Ferranti ZN414 integrated circuit. The circuit of the receiver is shown in Fig. 2. The provision of a stabilized supply voltage, given here at the emitter of the 2N2297, is particularly desirable both for the ZN414 and for the following a.f. amplifier. The simple potential divider consisting of R3 and R4 is all that is required for supplying the ZN414, and the potential at the junction of these two resistors does not alter despite widely varying battery voltage. Also, the two output transistors can be set up for optimum operating conditions with respect to both quiescent current value and the obtaining of half-supply voltage at the output emitters.

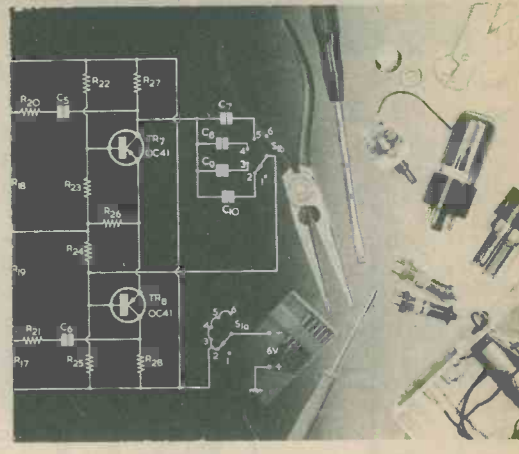
So far as operation of the ZN414 is concerned, it is particularly important to ensure that C3 connects to lead-outs 1 and 3 of the i.c. by short leads. L1 is a medium wave ferrite rod aerial coil and is tuned by a suitable value of tuning capacitance in the C2 position. In general, a value around 300pF should give more than adequate coverage.

The AC127 and AC128 output transistors should be matched if a low value of R8 is to be achieved with minimal distortion. They are available as a matched pair from Home Radio. Mis-match can be compensated to some extent by increasing the value of R8, but at the expense of increased current drain. If desired, R8 may be replaced by a pre-set 200Ω potentiometer, this being adjusted for minimum quiescent current consistent with crossover distortion. Such a potentiometer should be set initially to insert zero resistance into circuit. The resistance should then be gradually increased until the desired setting is obtained. The quiescent current may be measured by inserting a current-reading meter in the collector circuit o the AC127.

R7 fixes the standing boltage at the junction of R10 and R11, which should be approximately half the regulated voltage. If the voltage at the junction of these resistors is a little too high, slightly reduce the value of R7, and vice versa.

As a guide, the quiescent current of the amplifier should be about 10mA. This rises to 15mA with speech, and to 20 to 25mA with loud music, peaking at 30mA. These current figures will, of course, remain constant throughout the useful life of the 9 volt battery. ■

ZENER DIODE CHECKING UNIT



by G. A. FRENCH

Zener diodes are nowadays obtainable with voltage ratings ranging from 2.4 to no less than 100 volts. A large proportion of the diodes available consists of manufacturers' surplus. Zener diodes in this class tend to appear in a variety of shapes and sizes, and are liable to have defaced or confusing type numbers and markings. In addition, it is not always an easy matter to determine the polarity of the diode leads, and some devices have actual zener voltages which do not conform with those indicated on their cases.

THIS MONTH'S ARTICLE IN THE 'Suggested Circuit' series is devoted to a simple piece of test equipment for checking zener diodes. The unit may readily be home-constructed and, since it will in most cases be used only occasionally, particular emphasis has been placed on economy. There is only one expensive component, this being a mains transformer having a secondary voltage lying between 125 and 250 volts. It is anticipated that many constructors will be able to salvage a suitable transformer from an old valve radio receiver or that they may have such a component in stock from their earlier valve days. A voltmeter is also needed, but this is merely a multimeter coupled to a pair of terminals mounted on the unit. The only requirement here is that the meter should have a sensitivity of 10kΩ per volt, or better, on its voltage ranges.

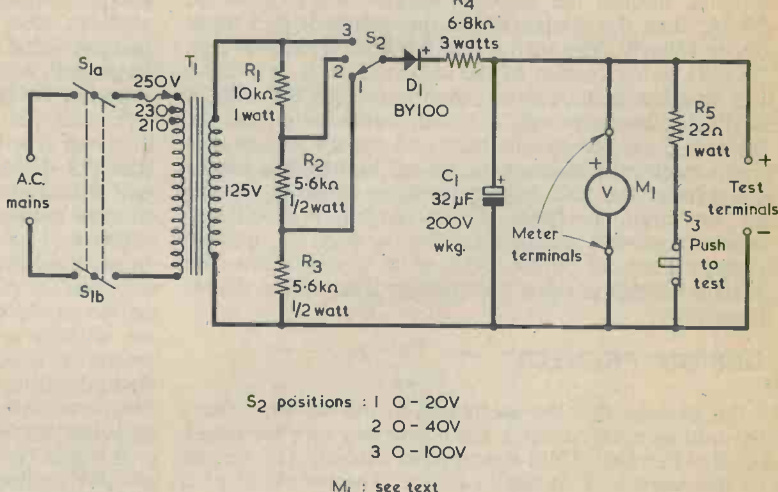


Fig. 1. The circuit of the zener diode checking unit. When push-button S3 is pressed the voltage across C1 rises to the zener value of the test diode

THE CIRCUIT

The circuit of the zener diode checking unit appears in Fig. 1. Here, the a.c. mains supply is applied, via on-off switch S1(a)(b), to the primary of transformer T1. The transformer shown in the diagram has a 125 volt secondary and this couples to the potential divider given by R1, R2 and R3. The standing current flowing through these resistors is approximately 6mA, and a voltage of about 66 volts with respect to the lower rail appears at the junction of R1 and R2, and a voltage of about 33 volts at the junction of R2 and R3. Thus, switch S2 can select either of these voltages or the full 125 volts which is available from the secondary.

The voltage selected by S2 is rectified by D1 and is then passed to current limiting resistor R4. Normally, push-button S3 is closed, but when it is pressed (and assuming that no component is connected across the test terminals) its contacts take the short-circuit off C1 and allow this capacitor to charge up to the peak value of the alternating voltage selected by S2. When S3 is released, capacitor C1 is quickly discharged again by way of the low value resistor R5, this last component being included to limit the capacitor discharge current and prevent sparking at the push-button contacts. It is quite in order for S3 to be in the closed condition when the mains supply is switched on, as all that happens is that a limited rectified current flows through R4.

It will be seen that the three positions of S2 correspond to diodes having zener voltages of 0 to 20, 0 to 40 and 0 to 100 respectively.

When the unit is used to check a zener diode a multimeter switched to a voltage range is connected to the meter terminals, S2 is set to position 1 and the test zener diode is connected to the test terminals with its cathode to the positive terminal. S3 is then pressed, whereupon C1 charges at once to a voltage which is limited by the zener diode. This voltage will be the zener voltage of the diode and will be indicated by the multimeter. If the voltage is in excess of 20 volts, S3 is released, S2 is set to position 2 and the process repeated. Should the zener voltage be higher than 40 volts S3 is released, S2 set to position 3 and S3 pressed once more. At each check, the multimeter should be initially set to a voltage range higher than the maximum figure in the range selected by S2, to guard against the case where the test diode is a high voltage device. This precaution ensures that voltages considerably in excess of f.s.d. value are not passed to the meter.

It is possible to obtain unpleasant shocks from both the test and the meter terminals, particularly when S2 is set to position 3. The operator's hands must be kept away from both sets of terminals whenever S3 is pressed.

If the test diode is connected to the test terminals wrong way round it will function as an ordinary silicon diode, and the voltage reading given when S3 is pressed will be about 0.6 volt only. This factor is useful in determining the polarity of an unmarked diode.

The maximum possible dissipation in the test diode is of the order of 15mW when S2 is in position 1, 60mW for position 2 and 300mW for position 3. Diodes with zener voltages of 6 volts or less may read a little low on the unit because these low voltage diodes have a much greater initial slope in their characteristic. All other diodes should be brought well on to the flat part of their characteristic.

COMPONENTS

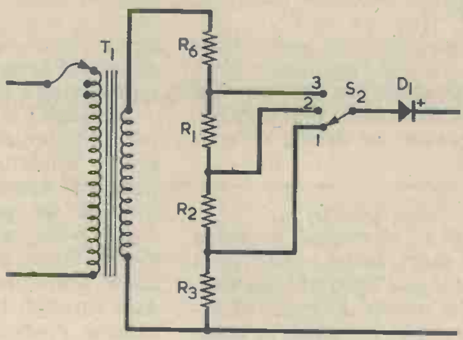
The components employed in the unit are all quite standard items. The four terminals should be of the insulated type in order to reduce the risk of accidental shock.

Switch S2 should, ideally, be of the break-before-make type. In practice, however, it will be quite in order to employ an inexpensive make-before-break switch here. This will allow two of the fixed contacts to be momentarily short-circuited together as the switch is changed from one position to the next, but the result will only be a relatively small increase in the current drawn from the mains transformer secondary. Switch S3 is a push-button whose contacts break when it is pressed.

It is essential that capacitor C1 should have a low leakage current. Any good quality modern component will be satisfactory here. Its working voltage can, of course, be higher than the figure indicated in Fig. 1. The wattage ratings of the resistors are shown in the diagram. R4 may have a higher rating than 3 watts if it is found difficult to obtain a 6.8kΩ component with that rating. All the resisors may be 5% or 10% components.

Diode D1 can be any silicon rectifier having a p.i.v. of 350 volts or more. (This figure applies to a capacitor and not a resistor input circuit but, although D1 works into R1, it is still possible for C1 to charge to peak level.) The author used a BY100, which happened to be on hand.

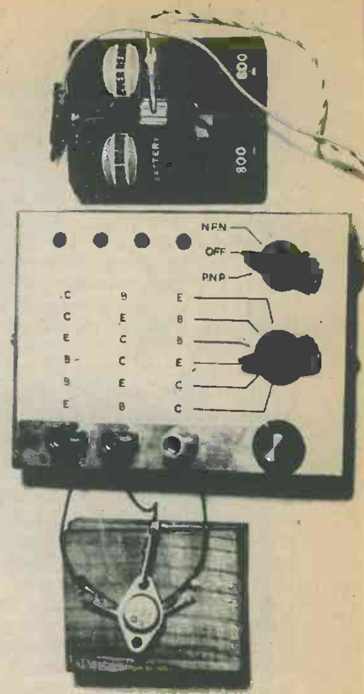
The transformer employed by the author was an R.S. Components 'Midget Mains 250 Volt' transformer. This has a 125–0–125 volt 50mA secondary, of which one 125 volt section was employed in the circuit. Any other mains transformer offering a secondary voltage in excess of 125 volts and, preferably, not greater than 250 volts can also be used, but it is necessary to insert an additional resistor between one end of the secondary and the potential divider given by R1, R2 and R3 to ensure that the voltage across these three resistors is maintained at approximately 125 volts. Three of the most common secondary voltages likely to be encountered are 200, 230 and 250 volts, and Fig. 2 gives details of the manner of connection and the value of the additional resistor, which is shown as R6. In most cases, the transformers will be valve receiver types having centre-tapped h.t. secondaries of 200–0–200 volts, 230–0–230 volts and 250–0–250 volts. One half of any of these secondaries is used in the present application. The current requirement of the circuit is less than 20mA, and this should be readily available from transformers of this type. Such transformers will also have low voltage heater secondaries, to which no connections are made. ■



Secondary voltage	R6
200V	12kΩ 1watt
230V	18kΩ 2watts
250V	22kΩ 2watts

Fig. 2. If a mains transformer having a secondary voltage higher than 125 volts is used an additional resistor, R6, is inserted into circuit in the manner shown here

TRANSISTOR LEAD-OUT LOCATER



Part 2

This concluding article describes the construction and setting up of the transistor lead locater. The locater is capable of identifying the lead-outs of any normal bipolar transistor, and also of indicating whether it is p.n.p. or n.p.n.

By J. R. Davies

In last month's issue we examined the circuit and operation of the transistor lead locater. We carry on, in this month's concluding article, to details of construction and setting up.

COMPONENTS

The layout of the unit is not at all critical provided that wiring is kept reasonably short. Some constructors may prefer to assemble the unit in a case of their own choice, working only from the circuit diagram. However, it is probable that most readers intending to make up the unit would prefer to use the case and follow the layout employed in the author's prototype, whereupon details of these are given in the present article.

The case employed by the author is an aluminium box type AB10, and can be obtained from Home Radio or Electrovalue. The dimensions of the box are $5\frac{1}{4}$ by 4 by $1\frac{1}{2}$ in., and it is provided with a lid. This lid forms the front panel of the unit, and all the small components are mounted on tagstrips fitted on its inside surface. The 3 volt battery is external to the case, connection to it being made by way of two flexible leads terminated in crocodile clips. An excellent choice for the 3 volt supply is the Ever Ready No. 800 cycle lamp battery, and it is an easy matter to connect the unit to such a battery whenever it is required.

Constructors who prefer to have the battery self-contained inside the unit case will need to employ a box that is sufficiently deep to accommodate it. If the front panel of such a box measures $5\frac{1}{4}$ by 4 in., the same front panel layout as is employed in the prototype can be followed. The alternative case could be home-made and it is necessary for it to be made of metal and not an insulating material.

S1 is a 4-pole 3-way rotary switch, and the component employed here should be of the 'miniature wavechange' type having a body diameter of about $1\frac{1}{4}$ in.

Switch S2 is 3-pole 6-way rotary, and it is made up from Miniature Maka-Switch parts. The parts required are a Miniature Maka-Switch shafting assembly, a packet of ten miniature spacers (of which only four are used in the present application) and two miniature 2-pole 6-way wafers. When assembled, this constitutes a 4-pole 6-way switch in which only 3 of the poles are used. Miniature Maka-Switch kits are generally available through the larger home constructor mail order houses. Potentiometer VR1 needs to be a small component and it should have a body diameter of approximatley $\frac{3}{4}$ in. The potentiometer used by the author was a type P20, less switch, available from Electrovalue Ltd., and having a value of 22kΩ. The two switches will be fitted with small pointer knobs, and the potentiometer with a small round knob having a skirt diameter of around $\frac{3}{4}$ in.

The spindles of all three controls should be cut to a length suitable for the knobs to be employed. The spindle of the Maka-Switch shafting assembly obtained by the author did not have a flat on it. A flat is essential here to ensure that the knob cannot rotate on the spindle, and a flat was in consequence filed out on the spindle. The flat can have any angular position on the spindle. If S1 also does not have a flat, one should be filed out on it.

The three terminals can be any insulated types which give reliable and robust connections. The appearance of the unit is enhanced if terminals of different colours are employed, but this is not, of course, essential. Final items in the 'hardware' category are the six 5-way tagstrips on which the smaller components are wired. The tagstrips used in the prototype were Lektrokit type LK-2231.

FRONT PANEL DRILLING

As was explained in the preceding article, a piece of stiff card is affixed to the front panel of the unit and it provides a scale which denotes switch functions. The scale is shown full size in Fig. 8, and this diagram may be traced directly. It is necessary to draw up and cut out at least a rough copy of the scale before drilling the front panel, this copy having marked on it the three radial lines from switch S1, the six radial lines from switch S2, and the centres of the holes in which the l.e.d.'s will appear.

Drilling details for the front panel are given in Fig. 9. All the holes shown here may be drilled out with the exception of the four $\frac{1}{4}$ in. holes for the l.e.d.'s. The six 6BA clear countersunk holes will later take countersunk 6BA bolts which secure the six tagstrips on the inside of the panel. The scale which has been copied from Fig. 8 is positioned on the panel in such a manner that its top edge is just below the top edge of the panel and the holes for S1 and S2 are centralised in the U-cuts at the right of the scale. Using the Fig. 8 scale as a template, mark out the centres of the four $\frac{1}{4}$ in. holes and then drill out these holes.

Next, assemble the Maka-Switch assembly to provide S2. This requires one spacer on each length of studding between the indent plate and the first wafer, and another spacer between the first wafer and the second. Make certain that the wafers are fitted such that they function correctly as the switch spindle is rotated. Excess studding and actuating shaft at the rear is cut off.

The indent plate of the shafting assembly has a locating lug at the front which is intended to pass through a corresponding anchor hole drilled in the front panel. This ensures that the body of the switch cannot rotate even if the mounting bush nut becomes loose.

COMPONENTS

Aluminium box type AB10, $5\frac{1}{4}$ by 4 by $1\frac{1}{2}$ in.
6-off 5-way tagstrips, Lektrokit type LK-2231
3 insulated terminals
2 pointer knobs
Round knob
2 crocodile clips
Sleeving
$\frac{3}{8}$ in. grommet
Miniature Maka-Switch assembly for S2 (see text)

Remove the bush mounting nut and washer, pass the switch bush through the panel and temporarily fit the pointer knob to it. With the aid of the Fig. 8 scale, find the orientation of S2 body which is required to ensure that its knob is correctly aligned with the six radial lines on the scale. Carefully mark out the point required for the anchor hole in the front panel, remove the switch and then drill out the anchor hole. Switch S1 will also have a locating lug. Repeat the process with this switch to ensure that its pointer knob is correctly aligned with the three radial lines on the Fig. 8 scale and then drill the anchor hole in the appropriate position.

The final piece of metalwork consists of cutting and filing out a U-cut on the side of the aluminium box near the point where S1 will appear, in the manner shown in Fig. 10. This will later take a $\frac{3}{8}$ in. grommet through which pass the two battery leads, the grommet being held in position when the front panel is secured in place.

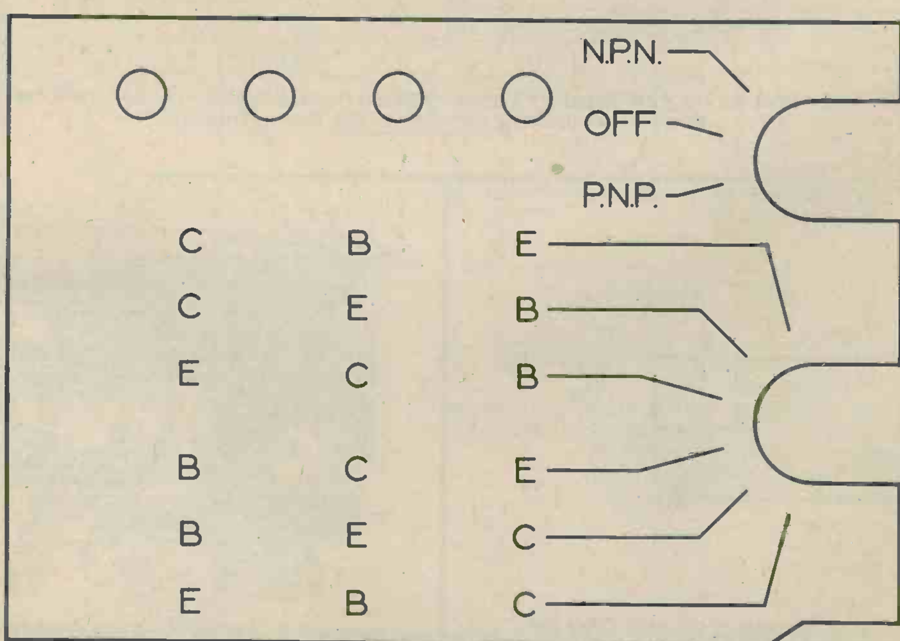


Fig. 8. The scale which is affixed to the front panel of the transistor lead locater. The mounting bush nuts of S1 and S2 fit into the two cut-outs at the right. The scale is reproduced full size and the diagram may be traced

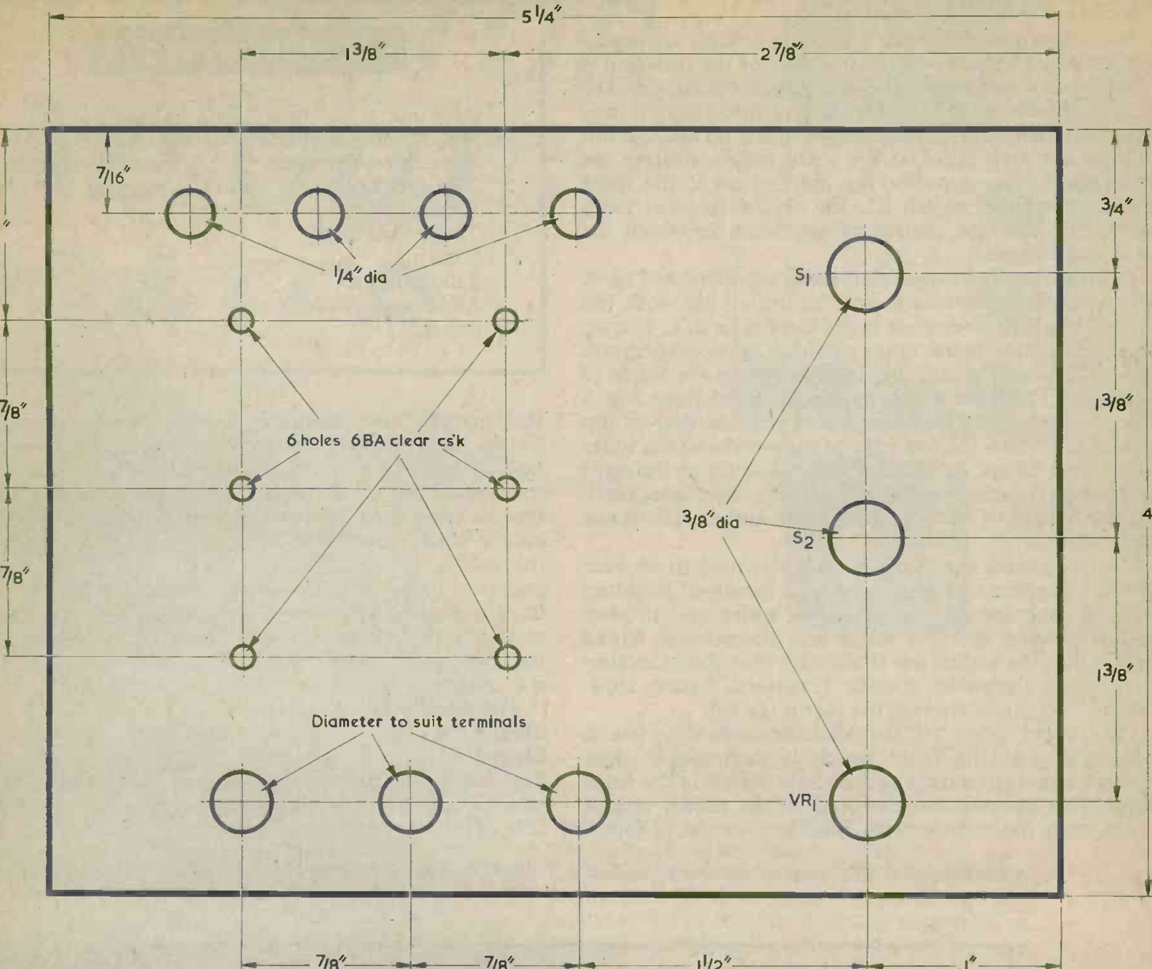


Fig. 9. Drilling details for the front panel. To ensure optimum registration, the four ¼ in. holes at the top are marked out by using the scale of Fig. 8 as a template

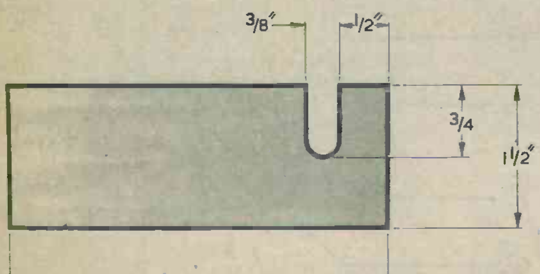
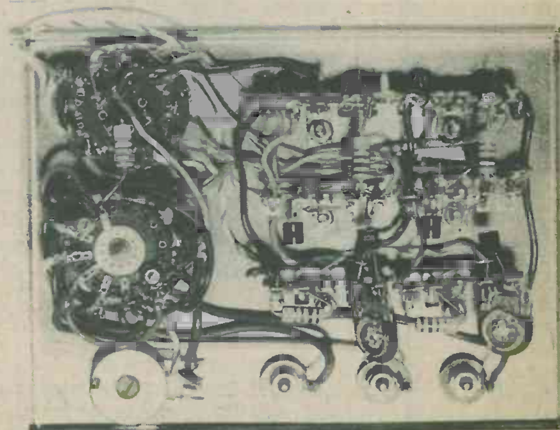


Fig. 10. A U-cut at one side of the case takes the grommet through which the battery leads pass. The grommet slides out when the front panel is removed, enabling the panel to be positioned clear of the case, when required, without any difficulty



All the small components are fitted to tagstrips mounted on the rear of the front panel. This enables a compact layout to be achieved without cramping of parts

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WIRING

Next mount VR1, S2 and the three terminals, fitting a pointer knob to S2. The first component to wire up is S2, but details of the wiring required here are not shown in the wiring diagram of Fig. 11, because it is easier to work from the circuit than from a wiring diagram. The wiring circuit for S2 is given in Fig. 7, which appeared in last month's issue. It is unimportant which poles of the switch are employed for S2(a), (b) and (c). A continuity tester is virtually essential when it is being wired up.

First connect a wire to the arm of one pole of the switch, baring its other end so that a continuity tester may be connected to it. This is the arm of S2(a), or point 'X'. Connect the arm of another pole of the switch to the centre tag of VR1. This is point 'Y', the arm of S2(b). Finally, connect R4 to the arm of a third pole of the switch, to give point 'Z', which corresponds with the arm of S2(c). The other end of R4 will later connect to a tag on S1.

Working from Fig. 7, and using the continuity tester to make certain of identifying the correct switch tags, wire up S2(a). Fig. 7 has purposely been drawn so that the arms move in the same direction as they do when the switch is viewed from the rear, and this should assist in wiring up. The position of the switch arms in Fig. 7 is that given when the knob, as viewed from the front, is fully clockwise. Three wires, corresponding to terminals 1, 2 and 3, should now be available from S2(a). Transferring the continuity tester to the arm of S2(b), proceed to wire this section of the switch, taking up the wires 1, 2 and 3 from S2(a). When S2(b) has been wired up a further three wires, 1, 2 and 3, should be available from this for S2(c). The continuity tester is then transferred to the arm of S2(c), and this is then wired up, taking in the wires 1, 2 and 3 from S2(b). The three wires 1, 2 and 3 from S2(c) are then taken to the correspondingly numbered terminals.

The writer must apologise to the more experienced constructor for putting what is, perhaps, excessive emphasis on the procedure required for wiring up S2. However, it is extremely easy to make a mistake here and an error in wiring can cause mysterious shortcomings in performance which are very difficult to remedy later. Indeed, to make quite sure that all is well, the constructor is advised to check the switch wiring with the aid of the continuity tester and Fig. 7 after wiring has been completed. If the continuity tester is connected to the arm of S2(a) there should be continuity to terminal 1 only on the first two positions of the switch, to terminal 2 only on the next two positions, and to terminal 3 only on the final two positions. The continuity tester should then be transferred to the arm of S2(b), which should connect to the terminals indicated in Fig. 7, and then finally to the arm of S2(c) and the process repeated.

General wiring up may then follow, as illustrated in Fig. 11. S1 and the six tagstrips are mounted, the central mounting lug of each of the latter being below

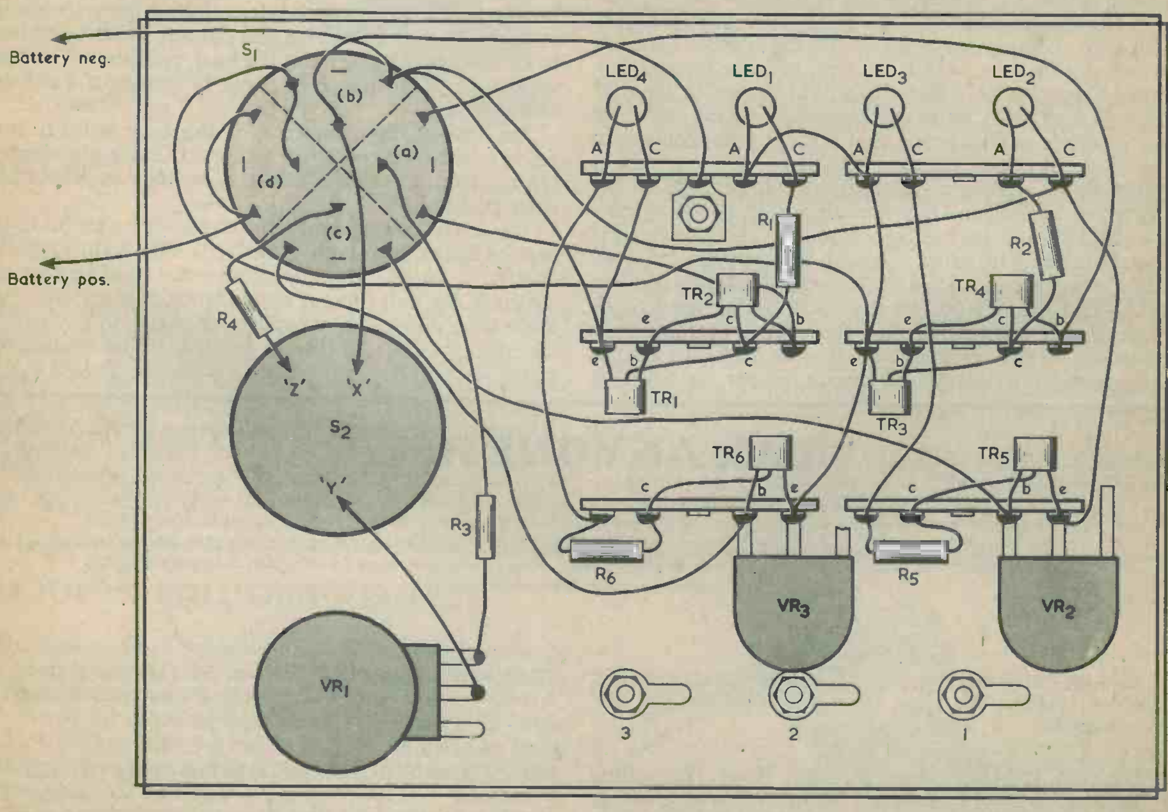
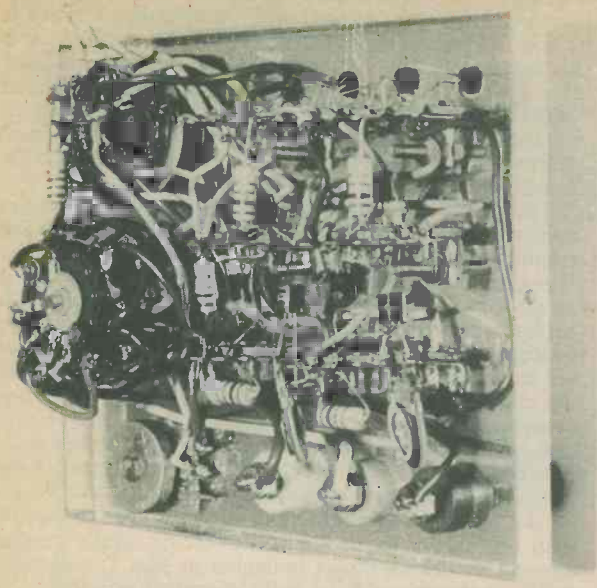


Fig. 11. Wiring diagram for the components mounted behind the front panel. The wiring at switch S2 is carried out with the aid of the circuit diagram which was published last month



Another view of the components mounted on the rear of the front panel

the strip as indicated in the diagram. Note that the four sections of S1 do not appear, round the switch, in alphabetical order. Although less essential than when S2 was wired, a continuity tester will still be found helpful when making connections to S1. It is quite possible with some components that the centre contact for each switch section may have a position, relative to the three outside tags, which differs from that shown in the diagram. A continuity tester eliminates any wiring errors on this score. It will be noted that there is a connection to chassis from the centre tag of S1(b).

The four l.e.d.'s are soldered to the lower tags on the Lektrokit tagstrips. They are supported by their lead-outs and should be positioned so that their bodies are central in the ¼ in. holes in which they appear. 'Mid-air joints' may be needed for the collector lead-outs of TR1, TR3, TR5 and TR6. The lead-outs of R3 need to be covered with sleeving. It may be necessary to solder an extension lead to this resistor if its own lead-outs are not long enough to reach the circuit points to which it connects. The two skeleton potentiometers, VR2 and VR3, each have two tags soldered to the adjacent tagstrips. No connection is made to the third tag of each potentiometer.

SETTING UP

When construction is completed it is necessary to set up VR2 and VR3. First set these two potentiometers to insert maximum resistance into circuit, adjust VR1 to insert minimum resistance into circuit (i.e. fully anti-clockwise), then connect a known p.n.p. *silicon* transistor to the test terminals. Put S1 to 'PNP' and adjust S2 to the setting which corresponds to the transistor lead-outs. Both LED1 and LED4 should light up. Slowly decrease the resistance inserted into circuit by VR3 until the brightness of LED4 *just* commences to reduce.

Next connect a known n.p.n. *silicon* transistor to the test terminals and adjust S2 accordingly. Put S1 to 'NPN' and gradually reduce the resistance inserted into circuit by VR2 until the brightness of LED3 *just* starts to reduce. Both VR2 and VR3 are then set up and the unit is ready for use.

When employing the unit, remember that VR1 knob must always be initially set fully anti-clockwise. If a test transistor causes S2 to give two positions where two l.e.d.'s are illuminated, VR1 is then advanced clockwise until the incorrect reading is eradicated. This adjustment of VR1 will be occasioned mainly by germanium transistors. The required setting in VR1 is normally not at all critical and can be found very quickly.

When the unit is completed and has been checked for satisfactory operation a final version of the scale shown in Fig. 8 may be drawn up and cut out. Four holes need to be cut out in the scale at the l.e.d. positions. The scale is then affixed to the front panel by means of a suitable adhesive.

The current consumption of the unit is fairly low, being of the order of 20mA with two l.e.d.'s illuminated. On no account should a battery voltage in excess of 3 volts be used.

The circuit is earthed by the chassis connection to the arm of S2(a). Although some fairly high gain amplifier chains, in which the test transistor can itself appear, are set up in the unit there is no evidence of instability, and there is no necessity for bypass capacitors in any part of the circuit. The prototype proved to be completely stable with all transistors which were checked on it. ■

CAN ANYONE HELP?

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

Trio 9R-59DS Receiver – T. C. Falconer, 112 Parkhead Drive, Edinburgh, 11 – Details of modifications and re-aligning.

Ex W.D. 2 Valve (Mark II) Short Wave Transmitter/Receiver W 17/11/219 – A. Willis, 9 Victoria Street, Cornholme, Todmorton, Lancs, OL14 8LR – Any data, circuit or wiring diagrams.

R109 at RX – R. L. Morrison, 58 Derryboye Road, Crossgar, Co. Down, N. Ireland – Power pack Voltage/Current Outputs, also alignment data required.

C.T. 373 Test Set-Oscillator/Distortion Meter – D. Kerr, 9 Mckellar Avenue, Ardrossan, Ayrshire KA22 7AS – Handbook, Service Manual or Diagram required. Purchase or borrow.

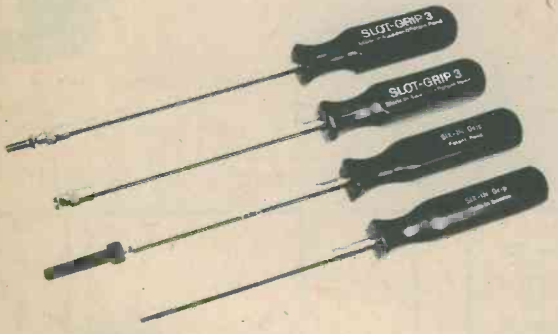
New Products

BATTERY STATUS INDICATOR

New from Litronix is the RLC-400 battery status indicator, a T1 miniature-sized LED lamp with red diffused lens, incorporating a voltage-sensing integrated circuit.

Designed to indicate battery status in small portable equipment, such as calculators and cameras, the RLC-400 features a sharp turn-on characteristic, having zero luminous intensity at 2.0V and better than 0.2 mcd at 3.0V. Maximum forward voltage is 5.0Vdc. Development quantities are available now at unit prices ranging from 30p, according to volume. For further information contact: Watts, Steadman & Partners, 34 High Street, Saffron Walden, Essex, CB10 1EP.

SLOT-GRIP SCREWDRIVERS FOR EASY POSITIONING



At Internepcon/UK 74, the international micro electronics exhibition held in Brighton from 15th–17th October 1974, Compass Electronics introduced a patented new range of Swedish screwdrivers, designed to end the time wasting and frustration involved in locating screws in assemblies where access is restricted. Available in three patterns to cater for Allen and Phillips-type heads as well as conventional slot head screws, the tips of these screwdrivers will hold the screw firmly in place without the risk of dropping, regardless of the difficulties of the mounting position.

Made of highest quality non magnetic Swedish steel, these new products carry a twelve month manufacturing guarantee. The Allen and Phillips screwdrivers have one face of the tip sprung to provide a tight fit into the screw, whilst the slot head driver employs a split tip which serves the same purpose.

Known as Six-in Grip, the Allen type screwdrivers are available in eleven combinations of length and tip width, including five with insulated handles intended for use in the electric and electronic industries.

The Star-Grip Phillips range is made in five lengths covering point sizes 1, 2 and 3, whilst the standard Slot Grip is sold in two blade lengths of 150mm and 175mm, having tips of 6mm and 8mm wide respectively.

All these screwdrivers have the same turning power as ordinary drivers the Six-in Grip being provided with flats at the top of the blade, enabling a spanner to be used to give additional leverage. The Slot Grip is held in place by a sliding sleeve which enables the tip to be replaced if it should be damaged, instead of replacing the whole tool.

Prices range from 97p up to £1.68 dependent upon size, and further details may be obtained from Compass Electronics, 150 Tooley Street, London SE1 2XE.

MODERN SOLDERING IRONS

A unique range of Soldering Irons is being introduced by Colstar Limited, who have just announced the Single-Handed Soldering Pistol type KL 3000.

The solder is fed through a reel direct to the tip of the pistol, so that soldering can be carried out with one hand, leaving the second hand free to hold components, wires, etc.

This system is widely used by major manufacturers on the Continent, and is patented in most countries.

Further information may be obtained from Colstar Limited, 233/243 Wimbledon Park Road, London SW18.

DIRECT READIN

Employing three integrated circuits, this instrument measures the values of both non-electrolytic and electrolytic capacitors up to 10uF. A built-in meter gives direct indication of the capacitor values.

By Alan C. Ainslie

Constructors often need to measure the values of capacitors; for example in fault finding or as a check during construction. Also one needs to find 'matched pairs' for such circuits as 'Twin Tee' or to evaluate a component for a precise application. The latter can be especially important if small electrolytic capacitors are used in critical circuits as the actual capacitance can vary considerably from that marked on the component. Large electrolytic capacitors (say over 25μF) are rarely used in critical circuits as they are not as stable as the smaller values.

Traditionally capacitors have been measured using bridge techniques to cover a wide range of values. However, to construct a wide range bridge is difficult, the calibration is awkward and, as it is not usually direct reading, it can be slow to use.

The instrument to be described measures from 100pF to 10μF f.s.d. (with useful indications at 10pF) in 6 ranges. The capacitance value is directly displayed on a panel meter with a '÷2' facility for small deflections.

CIRCUIT OPERATION

The full circuit of the capacitance meter is shown in Fig. 1.

The capacitor under test is connected to pins 10 and 11 of the SN74121 monostable. The output of the monostable will be low (about 0.3 volt) normally until a negative-going pulse is applied to pins 3 and 4. The output then goes high for a period solely dependent on the value of the capacitor and the resistance, between pin 11 and the 5 volt positive rail, which is selected by S3(b).

The high output level of the 74121 is clamped to 3.3 volts by zener diode D3. R7 ensures a satisfactory zener current in the high state. Thus the output at pin 6 of the 74121 is a pulse of defined height whose duration is controlled by the unknown capacitor.

A repetitive pulse train (clock) is fed to pins 3 and 4 of the monostable. As this pulse train has a constant period for each range the mark-space ratio or duty cycle of the monostable output is governed solely by the unknown capacitor.

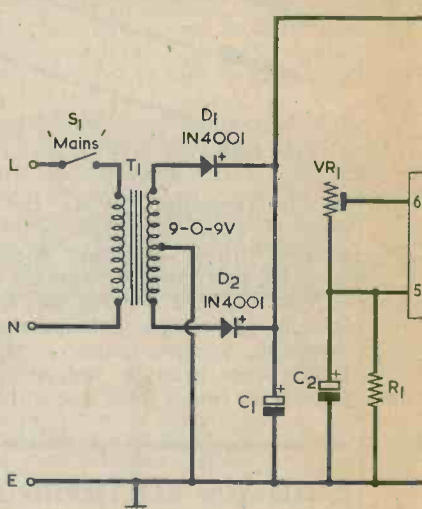
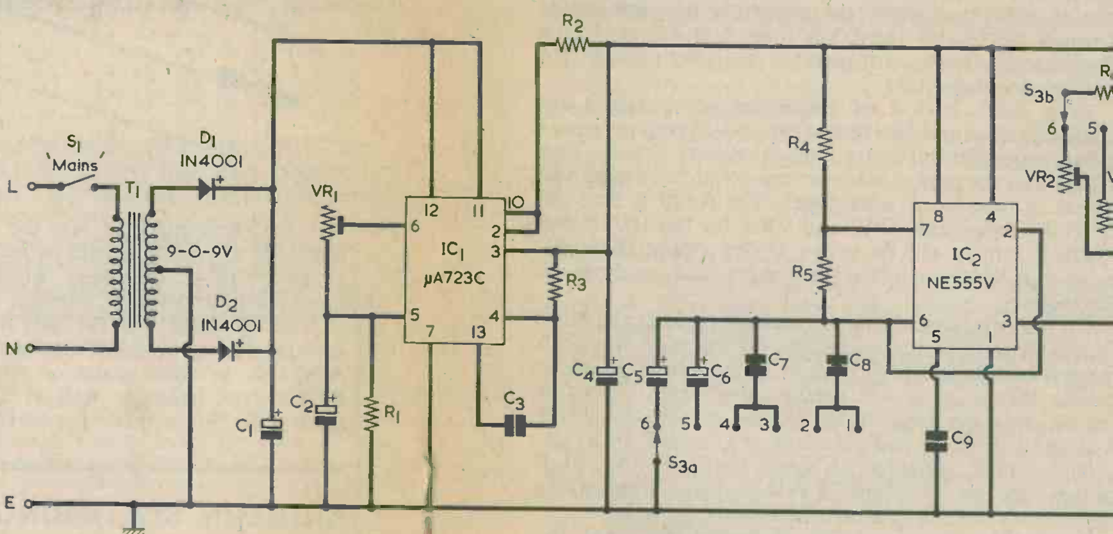


Fig. 1. Th

CT READING CAPACI…

METER

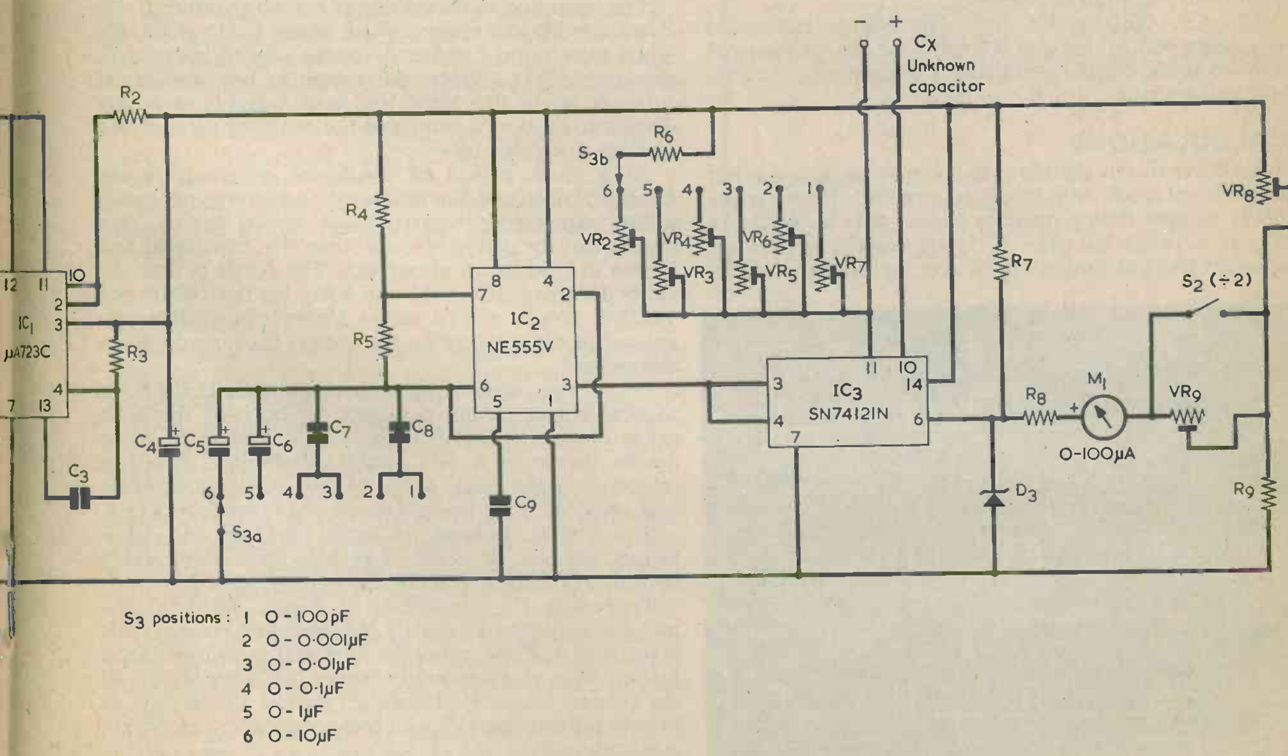
By Alan C. Ainslie



S3 positions:
1 0 - 100pF
2 0 - 0·001μF
3 0 - 0·01μF
4 0 - 0·1μF
5 0 - 1μF
6 0 - 10μF

Fig. 1. The circuit diagram of the direct reading capacitance meter. This is capab… values up to 10μF

G CAPACITANCE METER



...e circuit diagram of the direct reading capacitance meter. This is capable of measuring capacitance values up to 10µF

A simple voltmeter connected to the output pulse train takes the average of the waveform and gives a deflection proportional to the mark-space ratio, i.e. proportional to the capacitance.

Fig. 2 shows the principle of operation diagrammatically. The range under consideration is the 1μF f.s.d. range. With a 1μF external capacitor the mark period is shown as half the clock period. This corresponds to a mark-space ratio of 1:1. The mean of a 1:1 pulse train is one half of the peak value, i.e. 1.5 volt. Thus the voltmeter would read 1.5 volt f.s.d.

With a 0.5μF external meter the mark-space ratio is reduced to 1:3, i.e. the mark is one quarter of the whole period. The mean voltage is now 0.75 volt, giving a meter deflection of 0.5 f.s.d. Similarly with an external capacitor of 0.25μF we find that the mean would be 0.375 volt, corresponding to 0.25 f.s.d.

From these examples it is quite obvious that the scale is perfectly linear.

The voltmeter multiplier resistance is made up of R8 and VR9. Switch S2 short-circuits VR9 to halve the multiplier resistance and double the deflection when the meter reads below half full sale. This helps to improve the accuracy of the readings.

In order to offset the 0.3 volt that exists at the monostable output when it is low (and which would cause a zero error) the negative end of the voltmeter is returned to a potential developed across the potential divider, R10, VR8, the latter being the 'set zero' pre-set control.

The clock is formed by an astable 555 oscillator which offers the high stability required. The 555 output is t.t.l. compatible when the device is powered from a positive 5 volt rail as in this application.

C5, C6, C7 and C8 form the charge capacitors selected by S3(a). R4 and R5 form the charge resistors and R5 is the discharge resistor. C9 decouples the control voltage point, which is unused.

CALCULATIONS

To cover the six decade ranges it may be thought that six different clock rates would be required. However the 74121 accepts timing resistors from 1.4kΩ to 40kΩ. As this is a range of over 10:1 the switching between adjacent pairs of ranges can be accomplished merely by changing the 74121 timing resistors, which have to be switched anyway to allow calibration of each individual range. Thus the expense of a couple of capacitors can be saved.

Choosing the 74121 timing resistors to be pre-set at about 1.75kΩ and 17.5kΩ gives ranges separated by a factor of 10. The period of the monostable is given by

$$T = 0.7Ct.Rt,$$

and so the period will be 1.2 × 1,000Ct and 12 × 1,000 Ct for the 1.75kΩ and 17.5kΩ values of Rt respectively.

Thus for the 0.01μF range the period will be 120μS with Rt at 17.5kΩ and for the 0.1μF range the period will again be 120μS with Rt at 1.75kΩ. The one clock period to cover both these ranges should be twice the monostable period, i.e. about 240μS.

The 555 timer has two separate timing equations, one for charge through R4 and R5 and another for discharge through R5 only. These equations are:

$$T1 = 0.7Cc(R4 + R5)$$

$$\text{and } T2 = 0.7Cc(R5).$$

The total period is T1 + T2 and

$$T1 + T2 = 0.7Cc(R4 + 2R5).$$

With R4 and R5 equal,

$$T1 + T2 = 0.7Cc(3R).$$

The value of T1 + T2 that we require is 240μS. With Cc at 0.1μF this period is given when 3R is 3.3kΩ, so both R4 and R5 could be 1kΩ.

For the 100pF range the monostable period is 1.2μS with Rt at 17.5kΩ and for the 1,000pF range a 1.2μS monostable period is obtained with Rt at 1.75kΩ. With a Cc of 1,000pF timing, the clock period is calculated to be the required 2.4μS.

The operation of the 555 timer is such that pins 6 and 2 are comparator inputs which cause Cc to discharge when pins 6 and 2 are at a voltage slightly more than two thirds Vcc. When the capacitor has discharged through R5 to one third Vcc pins 6 and 2 cause the discharge process to stop and the charging through R4 and R5 to commence.

At a clock period of 2.4μS the comparators are relatively slow and the discharge and charge processes extend considerably past the calculated limits. This means that the period is longer than that calculated and comes in practice to about 4μS. The result is that the calibration resistors, VR7 and VR6, for the 100pF and 1,000pF ranges will be set to higher values than calculated in order to obtain the correct f.s.d. readings on the meter.

On the two largest ranges the clock period calculated to enable one timing capacitor to be used for both ranges would be 24mS. This is long enough to cause needle flicker in a few meter movements. For this reason only the 10μF range is used at this clock rate with the 1μF range being clocked at a faster 2.4mS rate.

The timing resistors on both the 1μF and 10μF ranges are set at about 1.8kΩ to give monostable periods of 1.2mS and 12mS respectively.

To reduce the possibility of needle flutter at the possible expense of linearity the discharge resistor, R5, is specified as 820Ω rather than the 1kΩ value mentioned earlier. This gives generally higher clock speeds on all the ranges. Linearity difficulties should not intrude as even at a duty cycle of 3:2 an error of only 5% maximum is introduced.

The combinations of clock speeds and full scale monostable periods are summarised in the accompanying table. The values given should be taken as a nominal guide only, as component tolerances can cause significant changes to the calculated values.

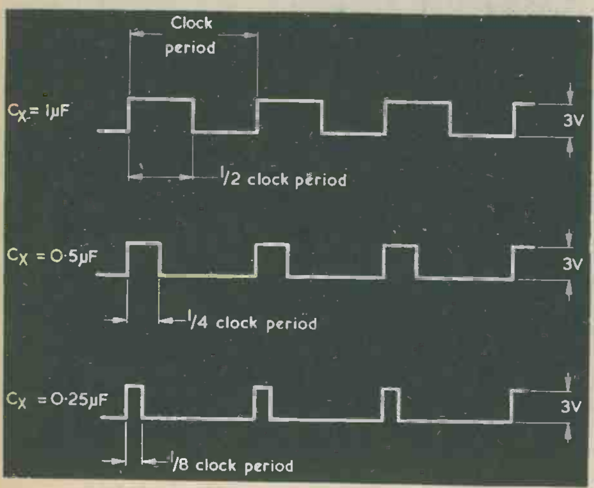


Fig. 2. The length of the positive pulse at the output of the SN74121N varies in linear fashion with the value of the test capacitance

TABLE
Clock and Monostable Periods

Range	Clock Period	Monostable Timing Resistor (Non-adjusted Value)	Monostable Period at Full Scale
100pF	4μS	50kΩ (VR7)	1.5μS
0.001μF	4μS	5kΩ (VR6)	1.5μS
0.01μF	240μS	50kΩ (VR5)	120μS
0.1μF	240μS	5kΩ (VR4)	120μS
1μF	2.4mS	5kΩ (VR3)	1.2mS
10μF	24mS	5kΩ (VR2)	12mS

POWER SUPPLY

The 555 and 74121 both give timing periods which are reasonably independent of the power supply voltage, but to ensure good short and long term stability a power supply regulator is incorporated for the positive 5 volt rail.

The current required by the unit is about 50mA or so and a μA723 regulator chip is able to supply this current without an external emitter follower.

At pin 6 a stable reference of just over 7 volts is produced. This is divided by R1 and VR1 and fed to pin 5, the non-inverting input of the comparator. The inverting input, pin 4, is connected to the output of the device via R3 to equalise the differential input resistance and reduce thermal effects. R2 produces a voltage drop which, when it exceeds 0.6 volts, causes the regulator overcurrent limit to function, thereby protecting the devices in the event of a fault. C3 is necessary to provide frequency compensation.

The μA723 is fed by about 11 volts or so from a centre tapped 9–0–9 volt transformer, with D1 and D2 as rectifiers.

COMPONENTS

The timer and monostable integrated circuits are available from most mail order suppliers dealing in components of this type. The regulator is a type μA723C in 14 pin d.i.l., and an equivalent is the Texas SN72723N. Another equivalent is listed by Electrovalue Ltd., as LIC723C14.

The mains transformer employed in the author's unit was a small component offering 9–0–9 volts at 100mA, and having fixing centres at approximately 1½ in. This is not listed by the larger mail-order houses and a suitable, but somewhat bigger, alternative is the Osmabet transformer retailed by Home Radio under Cat. No. TMM9. The Osmabet transformer secondary current rating is 0.3 amp. Any other small 9–0–9 volt transformer with a current rating of 100mA or more can also be used.

The holes in the author's printed circuit board for the tags of VR2 to VR8 inclusive are intended for miniature horizontal mounting skeleton pre-set potentiometers. Components having the requisite tag spacing are potentiometers type PN, horizontal mounting, obtainable from Electrovalue Ltd. VR1 and VR9 may similarly be Electrovalue type PN, vertical mounting.

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)

R1 4.7kΩ
R2 4.7Ω
R3 2.2kΩ
R4 1kΩ
R5 820Ω
R6 1kΩ
R7 680Ω
R8 4.7kΩ
R9 10Ω
VR1 5kΩ
VR2 5kΩ
VR3 5kΩ
VR4 5kΩ
VR5 50kΩ
VR6 5kΩ
VR7 50kΩ
VR8 1kΩ
VR9 10kΩ

Capacitors

C1 640μF electrolytic, 16 V. Wkg.
C2 10μF electrolytic, 12 V. Wkg.
C3 100pF
C4 10μF electrolytic, 12 V. Wkg.
C5 10μF electrolytic, 12 V. Wkg.
C6 1μF plastic foil or electrolytic, 12 V. Wkg.
C7 0.1μF
C8 0.001μF
C9 0.047μF

Integrated Circuits

IC1 μA723 or equivalent
IC2 NE555V or equivalent
IC3 SN74121N

Diodes

D1 1N4001
D2 1N4001
D3 3.3 volt zener diode, 400mW

Transformer

T1 Mains transformer, secondary 9–0–9V (see text)

Meter

M1 Moving-coil meter, 0–100μA

Switches

S1 s.p.s.t. toggle
S2 single pole push-button, press to close
S3 2-pole 6-way rotary

Miscellaneous

1 red socket
1 black socket
1 knob
Printed circuit board
Materials for case and panel

CONSTRUCTION

The electronics can be built on a small printed circuit board. In the prototype the board was secured to the two terminals of the meter, this being a Japanese model MR-65P having the same outside dimensions as The Henelec 65 Series retailed by Henry's Radio Ltd. The mains transformer was also mounted on this board. The component and copper sides of the board are illustrated in Figs. 3 and 4, the latter being reproduced full size. In Fig. 4, the two holes 'X' are for the meter terminals and the two holes 'Y' are mounting holes for the mains transformer. The positions of these holes will vary for different meters and transformers and should be marked out with the aid of the components themselves. It will also probably be necessary to make the board slightly larger than is shown in Fig. 4 to take alternative transformers, and the board should not be cut out until the transformer has been obtained and the modified dimensions determined. It will merely be necessary to make the board a little wider and longer.

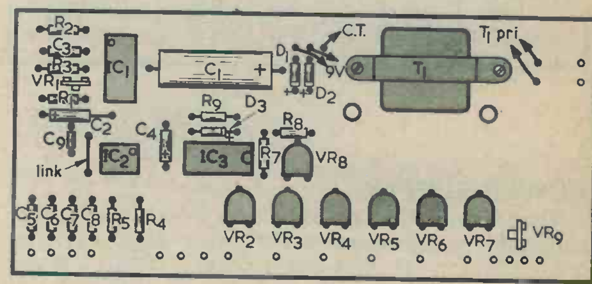


Fig. 3. The component side of the printed circuit board

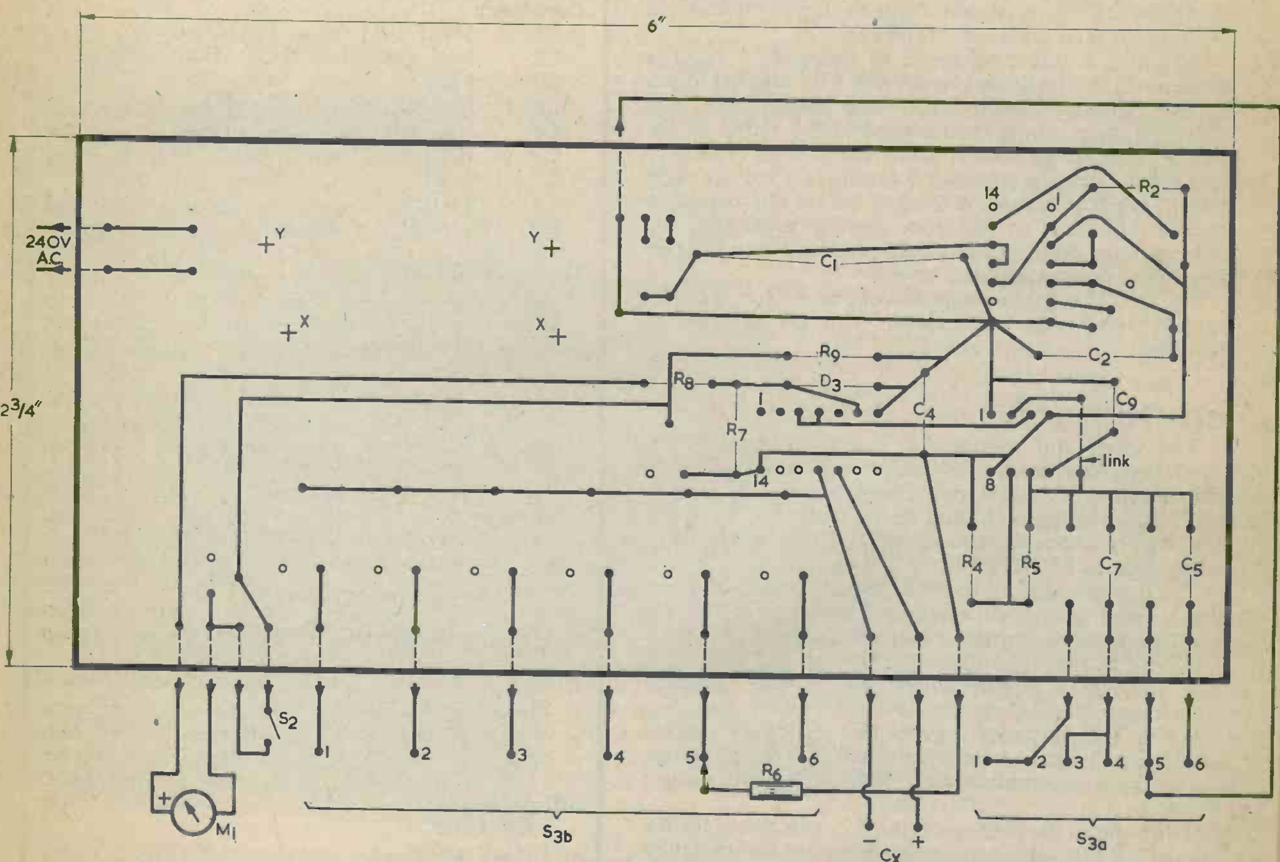
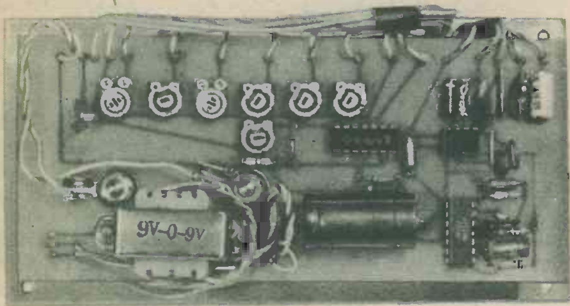


Fig. 4. The copper side of the board. To assist in positioning components, the end pins of the integrated circuits are indicated as also are some of the capacitors and resistors. The negative rail connection to pin 8 of IC1 is in order as this is an 'NC' pin. The board dimensions, but not the basic copper pattern, may need to be modified for different mains transformers and meters

The copper pattern for all the remaining components remains unaltered and can be traced from Fig. 4.

The design can be marked out onto the clean copper board with one of the many p.c.b. resist pens now available. There is no location for R6, which can be mounted on the range switch.

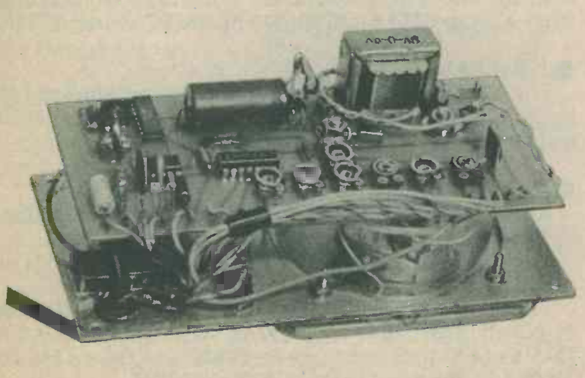
The author recommends that the project be constructed on fibre glass board for stability. This is available from Home Radio Ltd., in varying sizes, including 4 by 16 in. under Cat. No. BTS53. To ensure even etching of the panel it can be floated copper side down on top of the etchant. In this way the copper removal is more even and etching is quicker.



The printed panel with the components mounted. This corresponds to Fig. 3

The etched board can now be drilled. A No. 60 drill (0.040 in.) is suitable for most of the component leads, although the pre-set potentiometers will require slightly larger holes. The components are inserted on the board as in Fig. 3, taking particular note of diode polarities and i.c. orientation.

The next stage is to prepare the cabinet and front panel, and the photographs should give a guide as to a suitable panel layout. The dimensions of the panel and case should suit the particular meter employed and allow the printed circuit assembly to be comfortably housed. A number of commercial cabinets of about the required size are available. On the front panel one of the sockets for the test capacitor should be red to indicate the positive connection and the other black. The author employed a mains on-off push-button switch whose contacts close and then open on successive pushes, but a normal toggle switch could also of course be used.



The printed circuit board is mounted by the two connecting bolts of the meter movement

As already mentioned, the completed printed circuit board is supported at the two holes marked 'X' through which pass the terminals of the meter. The wiring from the controls to the board can now be completed using neat short leads as this is in fact a fairly high frequency circuit. It was found with the prototype that the stray capacitances in the 'Cx' leads was of the order of 6 to 7pF. This small capacitance could be reduced slightly, if desired, by spacing the leads to the test sockets away from other wiring.

The author also fitted a small bulb inside the meter to illuminate its scale, the bulb being powered from one half of the mains transformer secondary. The bulb is not included in the Components List.

CALIBRATION

The completed unit is now ready for testing and calibration. VR1 is set to maximum resistance and the mains supply switched on. VR1 is then adjusted to give a reading of 5 volts on pin 8 of the 555.

With S2 closed, a high capacitance range selected and no external capacitor connected, VR8 is adjusted to bring the meter pointer exactly to zero.

A capacitor of about 0.047μF is next connected to the test terminals. With the range switch at the 0.1μF position VR4 is adjusted so that with S2 closed the meter reads full scale. S2 is then opened and VR9 adjusted so that the meter reads exactly half full scale.

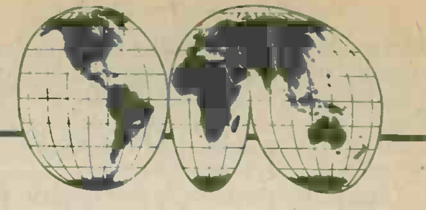
The voltmeter part of the instrument is now set up and the ranges can next be set for full scale deflection, starting with the 100pF range and adjusting VR7, and finishing with the 10μF range and adjusting VR2. Obviously, good 'standard' capacitors should be used but the average of a batch of reputable capacitors should not be too far off.

As explained earlier the 10μF range may be subject to needle flutter. If this is the case then R5 can be reduced, say to 680Ω. However, the circuit has been used with several meter movements and all have shown less than 1% flutter.

If an oscilloscope is available the waveform at pin 6 of the 74121 can be checked. The mark-space ratio at f.s.d. should not be significantly in excess of 1:1 otherwise linearity may suffer. Poor linearity with the correct waveform can be directly attributable to the 74121. Checking with a digital period meter shows very good linearity with the majority of devices.

All components in the Components List are rated for continuous operation and, with reasonable care in assembly and calibration, the constructor will have a reliable capacitance meter of high accuracy and good stability. ■

SHORT WAVE NEWS



FOR DX LISTENERS

By Frank A. Baldwin

Times=GMT

Frequencies=kHz

Stepping off once again on the left foot (like all ex-service types) we commence with the subject of clandestines – and why not, the vast majority of them are left anyway, and extremely left at that!

On **9422.5** one afternoon at 1543 we had the pleasure of hearing one of our old friends, none other than "Voice of the Thai People". This one had previously been reported inactive but has obviously now been reactivated. Programme format is the usual OM and YL alternate harangue in Thai until 1600 when there is a marching song by male chorus, military music at 1608, slogans and off at 1610. The transmission is thought to be a Chinese operation from Yunnan Province.

A little earlier in the afternoons, if you are around, set the dial on **9988.5** from 1400 onwards and you may log the Voice of the United National Front of Cambodia. Logged several times recently, the last entry shows that signal strength peaked from 1420 onwards when the usual format emerged. Yes, you guessed aright, OM and YL in Cambodian (Khmere) alternately, each vying to out-harangue the other apparently. Sign-off was at 1432, suddenly and without any military music etc.

For listeners here in the U.K. the best chances of hearing VUNFC would be from 1330 sign-on to 1430 sign-off and from 2300 sign-on to 2400 sign-off on **9988, 10080, 10120** and on **12005** (all variable by plus or minus 5kHz). They also transmit on **4675** and **7015** as above but these channels are unlikely to be heard here.

CURRENT SCHEDULES

● TANZANIA

Radio Tanzania, Dar es-Salaam, operates an External Service mainly in English from 0330 to 0530 on **6105**; from 0900 to 1600 on **9750** and from 1600 to 2015 on **15435** and **4785**. R. Tanzania can also be currently heard, in Swahili and English, on **4825** and on **5050** during the early evenings. For 90 metre band hunters, listen on **3339** around 1700 for Zanzibar (See Around the Dial).

● SPAIN

Spanish National Radio (RNE), Madrid, has an External Service to Europe, Africa, North and South America. English is only used in the North American Service from 0100 to 0345 on **6065** and **11925**.

● AUSTRALIA

Radio Australia currently offers a programme in English to the U.K. from 0645 on **7280** and **9570** and an evening transmission to the U.K. from 1800 to 2100 on **7270, 9745** and on **9755**. When checked by us at 1900 (newscast) only the latter channel was audible and even that was marred by co-channel QRM.

● NETHERLAND

Radio Nederland, Hilversum, presents an External Service in English to Europe from 0930 to 1050 on **6045** and **7210**; from 1400 to 1520 on **6045, 11740** (Madagascar relay), **15415, 15425** and **21570** (both transmissions also on **6020** on Sundays only). From 1830 to 1950 on **6020, 6085** and **11950**; from 2000 to 2120 on **11730** (Madagascan relay).

● BELGIUM

An External Service from Brussels in English is directed to the Americas from 2255 to 2315 and to the Americas and Far East from 0040 to 0100 on **6055, 9655** and on **11855**.

● PAKISTAN

Radio Pakistan has a World Service directed to the U.K. from 0830 to 1100 in Urdu on **15115** and **17910** and from 1915 to 2115 in Urdu, Sylheti and English on **7085** and on **9463**.

● SOUTH AFRICA

Radio RSA, Johannesburg, currently directs a programme in English to Europe and West Africa from 2100 to 2150 on **5980, 7270, 9525** and on **11900**.

● MEXICO

Radio Mexico operates an External Service in Spanish but identification is sometimes given in both French and English. The transmissions are from 1325 to 1535 and from 2255 to 0305 on **9705, 11770, 15125** and on **21705**.

● NIGERIA

The Voice of Nigeria, Lagos, beams a programme in English to Europe from 0555 to 0735 on **7275, 11770** and on **15185**.

● BANGLADESH

Radio Bangladesh, Dacca, now broadcasts in English to Europe from 1230 to 1300 on **17680**.

● EGYPT

The Overseas Service from Cairo radiates in English to North America from 0200 to 0330 on **9475**; from 1315 to 1430 to South Asia on **17920** and from 2145 to 2300 to Europe (newscast at 2200) on **9805**.

Broadcasts to Africa ("Voice of Africa") in English to West Africa is from 2030 to 2200 on **17725**.

AROUND THE DIAL

On the higher frequency bands we have –

● **EGYPT**
Cairo at 0942 on **17745** with a programme of Arabic music and songs by both male and female singers.

● **PAKISTAN**
Radio Pakistan at 1615 on **9460** when presenting a programme in English about recent events in Mozambique. Sign-off without National Anthem at 1619.

● **MONACO**
Trans World Radio at 1520 on Sundays with a religious programme. Identification at 1530 then news of church affairs here in the U.K. Listen on **9685**.

● **CHINA**
Radio Peking at 1239 on **11650** when featuring a programme in English describing the Chinese industrial scene and achievements, future plans and endeavours.

● **FINLAND**
Helsinki at 1424 on **9550** with an informative presentation of Finnish theatre history and recent productions.

● **TANZANIA**
Radio Tanzania, Dar es-Salaam, at 1800 on **15435** when we heard the 6 pips time signal, identification "Radio Tanzania, Dar es-Salaam", the world news in English with a further identification at 1804.

● **CONGO**
R.TV Congolaise, Brazzaville, at 2301 on **4765** when signing-off after the National Anthem, revealing two Latin American stations on the same channel.

● **INDIA–1**
All India Radio, Delhi, at 1000 on **17775**, with a newscast of local events in English until 1010 when a pleasant-voiced YL presented news of recent proceedings within the Indian parliament. Very informative.

On the LF bands a whole host of stations have been logged and we first present a few which could be heard by the beginner listener, leaving the Dx till last.

● **IRAQ**
Baghdad at 2021 on **3240**, Arabic music and songs, OM announcer.

● **GHANA**
Accra at 2002 on **4915** with a newscast in English read by OM announcer.

● **MALAWI**
Blantyre at 2139 on **3380** religious programme in English. Also at 1810 with world news in English, time check at 1815 and into vernacular programme.

● **TANZANIA**
Zanzibar at 1721 on **3339** with a programme in Swahili to 1733 sign-off, heard often.

● **BURUNDI**
Bujumbura at 1827 on **3300**, African music, drums, chants, channel suffers from heavy QRM at times.

● **ANGOLA**
CR6RZ Emisora Official, Luanda, with a programme of dance music records at 2005 on **3375**

● **INDIA–2**
AIR Delhi at 1820 on **3905 YL** with song in Hindi, local music.

For the Dxer, the following may be of some interest.

● **PERU**
OAX8F Radio Atlantida at 0452 on **4788** station identification and Euro-style dance music records, announcements in Spanish, sign-off 0601.

OAX8X Radio Samaren at 0315 on **4815**, identification, local pops, ads. At 0330 after identification, programme of Andean flute and drum music with 'noticias'.

OAZ4C Radio Andina at 0410 on **4995**, plaintive Andean songs and music by OM, identification at 0414.

OAX8V Radio Eco at 0423 on **5010**, songs in Spanish, LA music with frequent identifications preceded by two chimes.

● **COLOMBIA**
HJLZ La Voz del Cinaruco at 0436 on **4865**, OM in Spanish, local music, identification 0437, newscast.

HJKC Em. Nuevo Mundo at 0500 on **4755** OM with identification then local news in Spanish.

● **ECUADOR**
HCRQ1 Radio Quito at 0323 on 4923 local music, guitar, OM with song, announcements with identification at 0326.

HCAJ2 C.R.E. Guayaquil at 0347 on **4765**, OM with song and guitar, hetro QRM.

● **SRI LANKA**
Colombo at 1703 on **4902**, commencement of Buddhist chants on full moon day.

Colombo at 1705 on **4870**, OM and YL with duet in vernacular, local music, off with choral National Anthem at 1731.

● **INDIA**
AIR Delhi at 1653 on **4800**, OM with song in Hindi, local music, sign-off without National Anthem after announcements by YL at 1700.

● **PAKISTAN**
Peshewar at 1749 on **3330**, YL's in chorus with local song, 6 pips at 1800 and identification in English.

Radio Pakistan on **4835** at 1611, YL with talk in Urdu, sign-off at 1628 with National Anthem after identification in English.

R. Pakistan at 2027 on **4734** YL with song in Urdu, local music, announcements in French.

● **SINGAPORE**
R. Singapore at 1603 on **5010** with Euro-style dance music records and announcements in English, also in parallel on **5052**. Sign-off at 1628 with National Anthem after series of announcements in English.

● **MALAYSIA**
Kuching at 2235 on **5005**, YL with announcements in vernacular, light music local style.

● **HONDURAS**
HRPL3 Radio Progresso, LA music at 0358 on **4920**, OM with identification then sign-off without National Anthem at 0400.

● **S. YEMEN**
Aden at 1719 on **5060**, OM with songs in Arabic, local music, hetro QRM.

SELECTIVE

Part 3

In this final article of our 3-part series, details are given of three optional stages which may be added to the basic receiver.

THE FIRST TWO ARTICLES IN THIS SERIES DESCRIBED THE basic receiver. This concluding section will deal with three additional optional stages which may be installed in the receiver after it has been completed. Any one of these can be used, and they all require the fitting of a B7G valveholder to the chassis hole which was marked 'For Extra Stage' in Fig. 4.

PRE-AMPLIFIER

The pre-amplifier is an untuned r.f. booster stage designed to raise the signal level when a telescopic aerial fitted to the cabinet is relied upon for reception, or when a *very short* aerial is in use. The circuit for this stage is shown in Fig. 7.

Wiring should be short and direct, with grid and anode leads kept well separated. The primary of L1, originally used for aerial coupling, is disconnected from the chassis and its pin 9 is taken to the h.t. positive line via R4, with C4 functioning as an r.f. bypass capacitor. The valve should be fitted in a skirted valveholder with screening can, and the central spigot of this valveholder is earthed to the chassis.

This stage will give a substantial increase in signal strength. It is *not* suitable for use with a long aerial, and will only introduce cross-modulation and other troubles if such an aerial is connected.

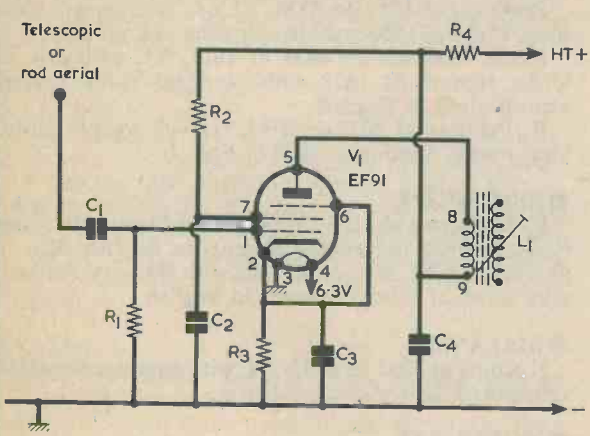


Fig. 7. An optional aerial pre-amplifier. This is intended for use with very short aerials only

COMPONENTS

Resistors
(All 10%)

R1	470kΩ ¼ watt
R2	470kΩ ¼ watt
R3	680Ω ½ watt
R4	5.6kΩ ½ watt

Capacitors

C1	20 to 30pF (see text)
C2	0.01μF
C3	0.01μF
C4	0.25μF

Valve

V1	6C4

Valveholder

B7G	skirted valveholder

RECEIVER FOR THE L. F. BANDS

By F. G. Rayer, T.Eng. (C.E.I.) Assoc. I.E.R.E.

CRYSTAL MARKER

The circuit of the crystal marker is given in Fig. 8. It employs a 100kHz crystal, giving harmonic 'pips' at 100kHz or 0.1MHz points. Its primary use is to provide exact calibration of Amateur bands. As an example, it will give marker 'pips' at 1.8, 1.9 and 2.0MHz in the 160 metre band, and at 3.5, 3.6, 3.7 and 3.8MHz in the 80 metre band.

For the low frequency short wave range, one frequency can be established by tuning in the standard frequency transmission from MSF on 2.5MHz. All the other 0.1MHz points can then be marked by counting up and down from this known frequency.

TC1 allows the crystal frequency to be varied slightly to permit zero beating with the 2.5MHz transmission, or with the B.B.C. Radio 2 200kHz signal tuned in on the long wave band of another receiver. An error in crystal frequency will be heard as a very low audio tone or as a flutter on reception, but even if this is not corrected the accuracy will be far higher than is usually needed for the present purpose. Suitable 0.1MHz crystals are available from many suppliers of short wave components.

The crystal harmonic will operate the tuning indicator or may be heard when the b.f.o. is switched on. The oscillator valve is not screened and the location of this stage should give sufficient stray coupling into the receiver r.f. circuits. If it is wished to increase the coupling for higher frequency bands, run an inch or so of insulated wire from tag 5 of the oscillator valveholder close to VC7.

The oscillator is controlled by a rotary on-off switch mounted between VR1 and VR2, and the crystal is positioned below the chassis.

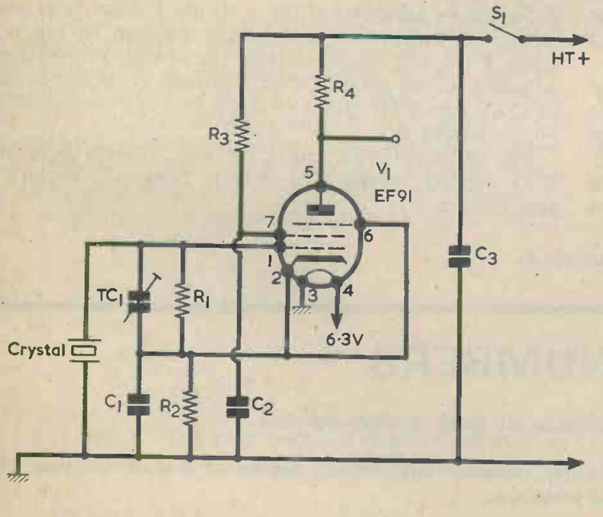


Fig. 8. The 0.1MHz crystal marker. This provides harmonics of crystal frequency over all the ranges covered

COMPONENTS

Resistors
(All 10%)

R1	470kΩ ¼ watt
R2	10kΩ ½ watt
R3	100kΩ ½ watt
R4	22kΩ ½ watt

Capacitors

C1	1,000pF silvered mica
C2	0.01μF
C3	0.01μF
TC1	100pF trimmer

Valve

V1	EF91

Switch

S1	s.p.s.t. rotary

Crystal

0.1MHz quartz crystal with holder

Valveholder

B7G	plain valveholder

ELECTRONIC MUTING

When the receiver is used in conjunction with a transmitter, some means of change-over is necessary when the transmitter is turned on. This frequently consists of transferring the aerial from the receiver to the transmitter, and of muting the receiver to avoid acoustic feedback from its loudspeaker to the microphone.

The circuit in Fig. 9 causes the change-over to be depends on the aerial impedance and transmitter power, but can be expected to be of the order of 30 to 100 volts. C26 and R22 in Fig. 9 are the existing capacitor and resistor in the receiver a.f. stages.

Should the receiver be used with a transmitter without the muting stage, the usual care must be taken to avoid a high level of r.f. reaching L1, whose windings may be destroyed. A relay or switch may be needed to short-circuit the primary of L1, unless only low power is run.

C1 in Fig. 9 may be 20pF to 30pF, and needs to be of

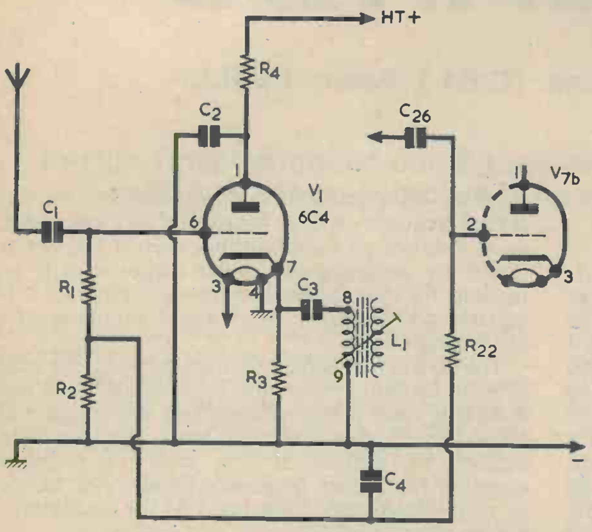


Fig. 9. The electronic muting circuit, which disables the receiver when an accompanying transmitter is in use. Resistor R22 was previously returned to chassis

COMPONENTS

Resistors
(All 10%)

R1	470kΩ $\frac{1}{4}$ watt
R2	470kΩ $\frac{1}{4}$ watt
R3	680Ω $\frac{1}{2}$ watt
R4	5.6kΩ $\frac{1}{2}$ watt

Capacitors

C1	20 to 30pF (see text)
C2	0.01μF
C3	0.01μF
C4	0.25μF

Valve

V1	6C4

Valveholder

B7G	skirted valveholder

accomplished automatically. Capacitor C1 is connected to the transmitting aerial circuit. During reception the 6C4 acts as a cathode follower, and signals across R3 are coupled to L1 in the receiver via C3.

During transmission, the large r.f. signal voltage applied to C1 develops a high negative voltage at the valve grid due to grid rectification. This negative voltage cuts off the stage, preventing the high level r.f. from reaching L1. A high negative bias is also applied to the a.f. output stage, cutting this off. The actual bias high voltage rating. With 75Ω and similar aerial loads, it should be adequate if the working voltage is at least twice the transmitter h.t. supply voltage to the p.a. stage. C1 is positioned outside the chassis immediately adjacent to the aerial socket. Ceramic capacitors rated at 12kV and with values of 22pF or 27pF are listed by Home Radio.

The valve in the electronic muting circuit is fitted in a B7G skirted valveholder, but it does not require a screening can. ■

(*Concluded*)

TRANSFORMER RATIO ANALYSER

By S. L. Martin

An inexpensive item of test gear which measures the turns ratios of small a.f. transformers

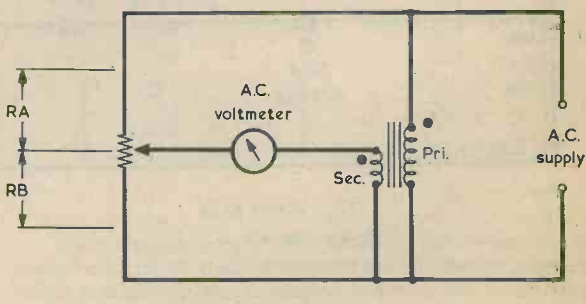
SADDLED RECENTLY WITH A LARGE BATCH OF SMALL unmarked transistor a.f. amplifier transformers, the writer devised the item of test equipment described here to sort them out in terms of turns ratio. The circuit to be described has its limitations and would not qualify as an item of laboratory equipment. On the other hand it gives reasonably accurate measurements of turns ratio as well as determining the phase relationship between two windings on a transformer. The components needed are standard types and the more experienced constructor may well have all that is required already to hand in his spares box. A 0-50μA meter movement is employed, and this is provided by a multi-testmeter switched to read this range of current.

BASIC OPERATION

The basic mode of operation is illustrated by the circuit given in Fig. 1. Here, an a.c. supply is applied to the primary of a step-down transformer. Also connected across the supply is a potentiometer, the slider of which connects via an a.c. voltmeter to the upper end of the secondary. The two large dots alongside the upper ends of the primary and secondary indicate similar winding ends. That is to say, the two ends indicated by the dots could both be winding 'starts' or could both be winding 'finishes'. In consequence the induced alternating voltage at the upper end of the secondary is in phase with the applied alternating voltage at the upper end of the primary.

The potentiometer is adjusted for a null, or zero, reading in the a.c. voltmeter. The voltage tapped off by the potentiometer slider will also be in phase with that at the upper end of the primary so that, when the voltage at the potentiometer slider is equal to that at the upper end of the secondary winding, the a.c. voltmeter gives the null reading. At all other settings of the potentiometer there will be an alternating voltage difference between the potentiometer slider and the upper end of the secondary winding, and this will be indicated by the a.c. voltmeter. As may be seen, the circuit is one step removed from the familiar Wheatstone bridge.

The alternating voltages across the primary and secondary windings are proportional to the turns ratio. If the transformer has a turns ratio of 2:1 the alternating voltage at the upper end of the secondary, with respect to the lower circuit rail, will be half that at the upper end of the primary. The voltage at the slider will similarly be half that at the upper end of the primary when the potentiometer slider is half-way up the track. So, a 2:1 transformer ratio will be indicated, after



$$\frac{\text{Pri. turns}}{\text{Sec. turns}} = \frac{RA + RB}{RB}$$

Fig. 1. Illustrating the basic mode of operation of the transformer ratio analyser

adjustment for a null reading in the a.c. voltmeter, by a 2:1 ratio between the total track resistance and the track resistance below the potentiometer slider.

If the transformer has a turns ratio of 4:1, then the null indication will be given when the potentiometer slider is quarter-way up the track. Other turns ratios will have corresponding track resistance ratios in the potentiometer, and the overall situation is indicated by the equation which appears below the circuit in Fig. 1. It is an easy matter to provide the potentiometer with a scale calibrated in terms of turns ratio, whereupon the circuit becomes suitable for measuring this property of an a.f. transformer.

Finally, it should be noted that the circuit will not give a null reading if the secondary of the transformer is connected with opposite phase to that shown in Fig. 1, or if it is connected as a step-up transformer. Also, the potentiometer slider can only approach, but not pass through, a null indication if the transformer has a turns ratio of 1:1.

WORKING CIRCUIT

A practical working circuit is shown in Fig. 2. Comparing this with Fig. 1, the primary of the transformer being checked connects to terminals B and C, and the secondary to terminals D and E. This method of connection is illustrated in Fig. 3(a). The a.c. supply of Fig. 1 is now the alternating voltage appearing across the 10Ω resistor, R3, in Fig. 2. Due to the presence of R2, this voltage is approximately one-tenth of the 6.3 volts obtained from transformer T1, which is a standard 6.3 volt heater transformer. Thus, the alternating frequency applied to the transformer being checked is that of the a.c. mains supply, i.e. 50Hz. The voltage across R3 is only 0.63, whereupon there is little risk of damage to a small transistor a.f. transformer.

The a.c. voltmeter incorporates the rectifying and smoothing circuit given by D1 and C1, whilst the meter proper is the 0-50μA movement shown as M1. In practice this is a multimeter switched to read 50μA f.s.d., and connected to the circuit by way of two suitably positioned terminals. The limited capabilities of the circuit do not really warrant the expense of a permanently installed panel-mounting meter. Normally S1, a push-to-close press button, is left in the open condition. This allows R1 to remain in series with the meter, whereupon it limits the current input which can flow when VR1 slider is away from the zero voltage setting. VR1 is initially adjusted to give a rough zero indication, after which S1 is pressed and a final fine setting in VR1 can then be achieved.

To use the device, the transformer being checked is connected to terminals B, C, D and E with on-off switch S2 open. S2 is then closed and VR1 adjusted for a null reading in the meter, remembering that meter indication is a little sluggish due to the presence of C1. If a null indication cannot be obtained, the connections to the transformer are changed to obtain correct phasing or to ensure that it is functioning as a step-down instead of a step-up component. As soon as a rough null indication is obtained in the meter, S1 is pressed and a final null setting obtained in VR1. The transformer turns ratio is then read from a scale fitted to VR1.

The circuit will also check tapped transformer windings, these being connected to terminals B, C and D as shown in Fig. 3(b). The turns ratio found is then the ratio between the turns in the total winding and the turns in the section connected to terminals D and C. This facility is helpful when dealing with components such as driver transformers which may have a centre-tapped winding and an overall 1:1 ratio. The presence of the centre-tap may be found with the circuit of Fig. 3(b), and the overall ratio determined by checking the

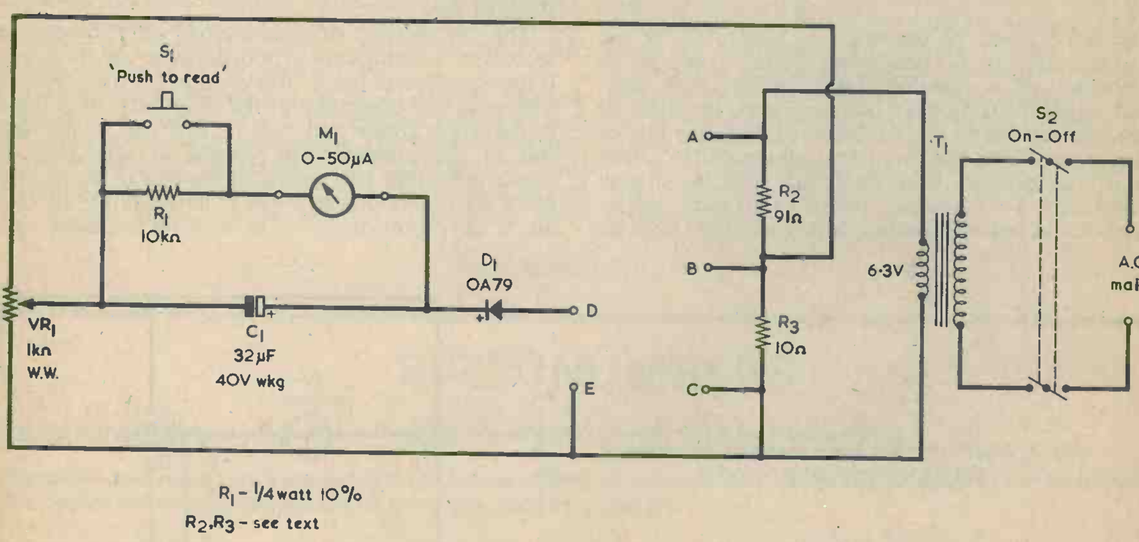
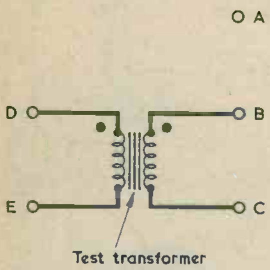
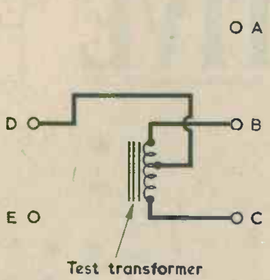


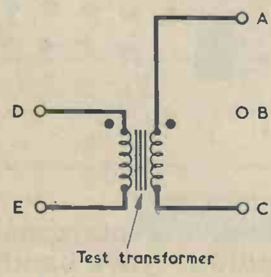
Fig. 2. The practical circuit of the ratio analyser



(a)



(b)



(c)

Fig. 3 (a). Transformers having ratios of 10:1 or less are connected in the manner shown here (b). Circuit connections for a tapped transformer winding (c). Transformers having ratios in excess of 10:1 are connected to test terminal 'A'

remaining winding against half the centre-tapped winding. During checks, any windings which are not connected to the test terminals are left open-circuit.

In Fig. 1 reference was made to the 'primary' and 'secondary' of the transformer. This was for convenience in explanation and, so far as using the test device is concerned, the 'primary' is the winding having the greater number of turns. A few small transistor transformers may give a balance null reading which is not zero but is a little above zero. This is due to losses in the transformer which result in a small phase shift at 50Hz, and the effect is not important.

Valve speaker transformers having step-down ratios from some 30:1 to 90:1 can also be checked, and they are connected to terminals A, C, D and E, as illustrated in Fig. 3(c). The alternating voltage across terminals A and C is about 10 times that across terminals B and C, and the ratio indicated at the null setting of VR1 is then multiplied by 10. Thus, a ratio of 4:1 on VR1 scale corresponds to a transformer ratio of 40:1. Before checking, the primary of the valve speaker transformer can be identified by an ohmmeter, and it will have much higher resistance than the secondary. It is this high resistance winding which connects to terminals A and C.

When checking any unknown transformer which may have a high turns ratio, initially set the testmeter to read 0-1mA, or similar. This gives an additional protection against possible excess current in the meter.

COMPONENTS

As mentioned, the components are all standard types. T1 is any 6.3 volt heater transformer having a secondary current rating of 0.5 amp or more. R2 and R3 may have ratings of ½ watt or more. For precise readings with valve output transformers, R2 should be exactly 9 times the value of R3, but in practice the nearest preferred value of 91Ω will be satisfactory. Both R2 and R3 should, preferably, be 2% or 1% in tolerance on value. Incidentally, the combined value of R3 and VR1 in parallel is only marginally lower than the value of R3 on its own.

D1 is specified as an OA79, but most germanium diodes of similar type could be employed in its place. A 0-100μA meter could be used, if desired, for M1, but the null sensitivity will, of course, be somewhat lower. Since D1 becomes nearly non-conductive at forward voltages below about 0.1 volt, the null obtained when checking efficient transformers which give a true null zero may be determined by swinging VR1 slightly on either side of the central null position.

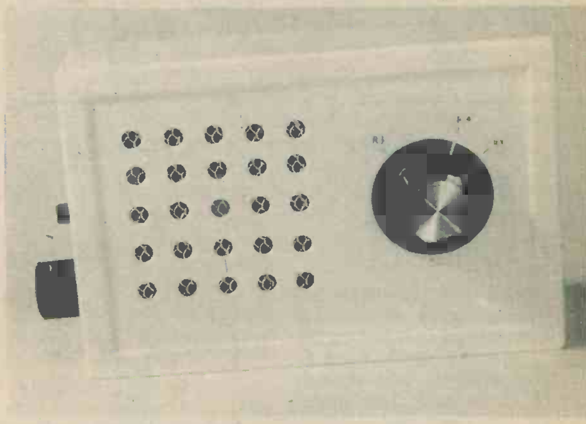
VR1 is wire-wound since components of this type are normally capable of a high level of resolution. An important point here is to ensure that when the slider is at the end-stops there is very little resistance between the slider and the adjacent end-of-track terminal. This is a function of potentiometer mechanical design and the ideal condition is given when there is very nearly zero resistance at the track ends. A few wire-wound potentiometers, particularly in the lower resistance values, have quite high 'end-hop' resistances, and a potentiometer of this type would not enable the higher turns ratios to be indicated. It is for this reason that the potentiometer consists of VR1 connected across R3, instead of using a 10Ω potentiometer to carry out the function of both components.

TABLE

RB (Ω)	Turns Ratio
100	10:1
125	8:1
167	6:1
200	5:1
250	4:1
333	3:1
500	2:1
667	1.5:1
833	1.2:1
1,000	1:1

The potentiometer is calibrated by disconnecting the ower end of its track from the rest of the circuit, and then connecting an ohmmeter between the track lower end and the slider. Calibration in terms of turns ratio may then be carried out with the aid of the accompanying Table. ■

THREE TRANSISTOR REGENERATIVE RECEIVER



By

A. P. Roberts

A self-contained transistor portable giving loudspeaker or earphone reception on the medium wave band.

THIS IS A SIMPLE PORTABLE 3-TRANSISTOR RECEIVER covering the medium wave band, and providing loudspeaker reception. Due to the simplicity of the circuit the available volume is not great, but the set makes a good bedside receiver. An output socket is provided for a magnetic earphone.

CLASS A OUTPUT

A Class A output stage is used, and the total current consumption of the receiver is approximately 12mA. This is economically provided by four 1.5 volt cells connected in series to give 6 volts. The set is completely self-contained, having an internal ferrite aerial, and it can be made up in reasonably compact form. The author's receiver was housed in a case measuring approximately 6 by 4 by 2 in.

With the prototype a number of stations can be received at a reasonable volume level, including B.B.C. Radios 1, 3 and 4 during daylight. Additionally, Radio Luxembourg and several other Continental stations can be received after dark.

The circuit diagram of the receiver is shown in Fig. 1. The circuit consists of a single transistor regenerative detector, TR1, feeding a 2-stage audio amplifier incorporating TR2 and TR3.

VC1 is the tuning capacitor and L1 is the tuned winding on the ferrite aerial. L2 is a coupling winding, and it couples the received signals into the low input impedance of TR1 base via the d.c. blocking capacitor, C1. TR1 is biased by R1, and has L3 and VR1 as its collector load for r.f., whilst R2 acts as its a.f. collector load. C2 is an r.f. bypass capacitor.

The way in which this type of circuit detects the signal is quite simple. The transistor is biased so that it is conducting only a low current between its emitter and collector. Negative r.f. half-cycles at the base cause a larger collector current to flow. The gain of the transistor increases with increasing collector current, and so these half-cycles receive a higher degree of amplification.

Positive r.f. half-cycles have the opposite effect, and cause a smaller collector current to flow with, in consequence, a lower degree of amplification. The overall non-linear amplification thus given by the transistor results in detection of the received signal.

The use of controllable regeneration, or positive feedback, increases the level of the input r.f. signal, and also the difference in the amplification which is given to half-cycles of opposite polarity. Detection is therefore more efficient as also is the amplification provided by the transistor.

In Fig. 1, L3 is the regenerative feedback winding, and it couples the amplified r.f. signal at TR1 collector back to its base by way of L2. Potentiometer VR1 controls the level of feedback. If VR1 is set to insert minimum resistance into circuit, L3 on its own forms the r.f. collector load for TR1. There will be a relatively high r.f. current in this winding and a similarly high r.f. signal fed back via L2 to the base. The feedback, under these conditions, will be such as to cause the stage to oscillate. If VR1 is next adjusted to insert an increasing resistance into circuit, there will be a lower r.f. current flowing in L3 and the level of feedback will reduce. At a certain setting of VR1 the feedback will be insufficient to maintain oscillation in TR1, although the feedback

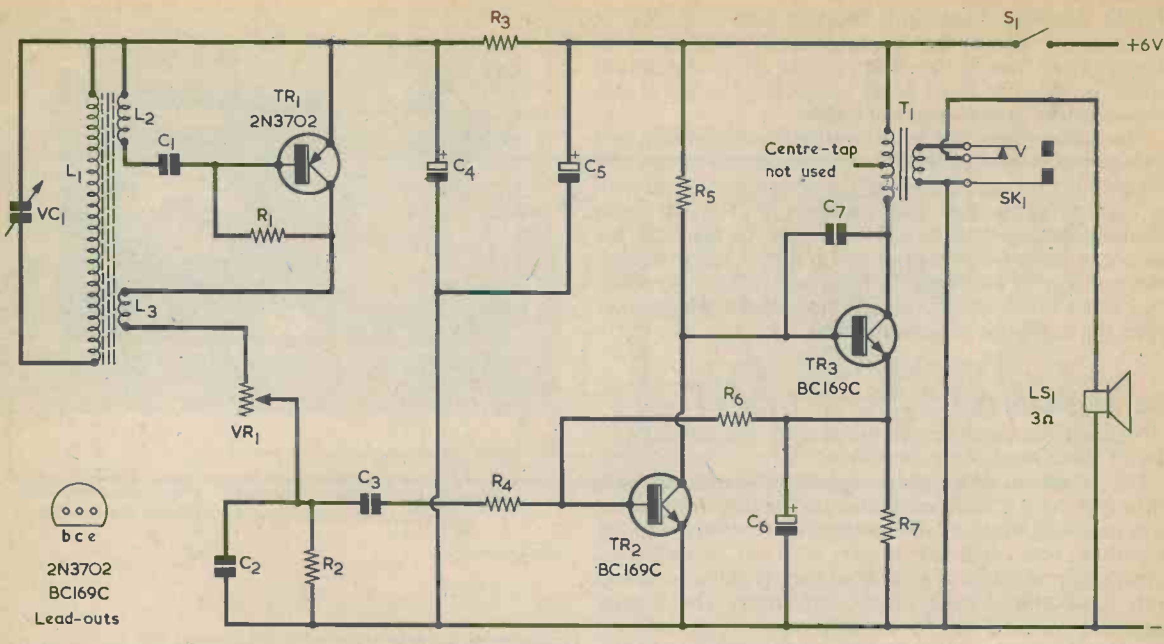


Fig. 1. The circuit of the 3-transistor regenerative receiver

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)
R1 1.5MΩ (see text)
R2 5.6kΩ
R3 1kΩ
R4 2.7kΩ
R5 4.7kΩ
R6 150kΩ
R7 82Ω
VR1 5kΩ potentiometer, linear

Capacitors
C1 0.022μF plastic foil
C2 0.015μF plastic foil
C3 0.22μF plastic foil, side wires
C4 100μF electrolytic, 10 V. Wkg.
C5 100μF electrolytic, 10 V. Wkg.
C6 400μF electrolytic, 4 V. Wkg.
C7 1,000pF disc ceramic
VC1 Value to suit ferrite aerial (see text)

Inductors
L1, 2, 3 Medium wave ferrite aerial (see text)
T1 Output transformer type LT700 (Eagle)

Transistors
TR1 2N3702
TR2 BC169C
TR3 BC169C

Switch
S1 Slide switch

Socket
SK1 3.5mm jack socket with break contact

Speaker
LS1 3Ω speaker, 3 in. square

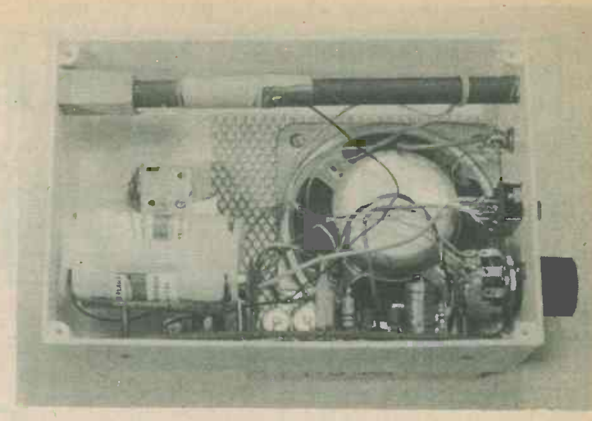
Miscellaneous
8Ω magnetic earphone with 3.5mm jack plug (if required)
Plain Veroboard, 0.15 in. matrix
4 cells, 1.5 volt type HP7 or equivalent (Ever Ready)
Battery holder (see text)
PP3 connector clip for battery holder
Case (see text)
Speaker mesh material
2 knobs

will still boost the signal applied to TR1 base. The feedback reduces further as VR1 inserts yet more resistance into circuit. Normally, VR1 is adjusted such that the feedback is just below the point at which oscillation takes place.

C2 has a low impedance at r.f. and a high impedance at audio frequencies. In consequence it bypasses the r.f. signal at the junction of VR1 and R2 but allows the appearance of the detected a.f. signal across R2.

The value of bias resistor R1 is a little critical as it has to enable TR1 to have a collector current which is sufficiently low to allow non-linear amplification, and hence detection, to take place, but which is not so low as to give too small an overall amplification. Some transistors of the type specified may function better with a slightly different value in the R1 position. The receiver should be assembled and checked out with R1 at 1.5MΩ, as specified. Experimentally-minded constructors can then, if they wish, try the effect of different values in place of the 1.5MΩ component to see if any improvement in performance results.

The audio stages are quite straightforward, using two high gain silicon transistors in a d.c. coupled circuit. C7 is a stablilizing capacitor which gives negative feedback at higher frequencies and prevents the circuit from breaking into oscillation. Transformer T1 provides the necessary impedance step down to allow a low impedance speaker or earphone to be driven from the output. SK1 has a break contact which disconnects the speaker when the earphone plug is inserted.



The layout inside the case. There is adequate space for the components without crowding

COMPONENTS

Most of the components are readily available, but a few of these need some comment.

The ferrite aerial can be any ready-made medium wave type with a 5 in. ferrite rod and having a transistor base coupling winding. The component employed in the prototype was obtained as part of a set of inductors intended for a medium wave superhet. It came complete with a suitable 2-gang tuning capacitor. The 2-gang capacitor is used in the present receiver, connection being made to the aerial section of the capacitor only. The author tried other ready-made medium wave ferrite aerials with complete success, these including the Denco ferrite aerial type MW/5FR. If the Denco ferrite aerial is employed, VC1 should have a value of 208pF. A single gang 208pF capacitor (Jackson type 01), or the 208pF section of a 208 + 176pF 2-gang capacitor can be used. In some cases, and particularly if a 2-gang component is employed, the tuning capacitor may be fitted with an integral trimmer. This trimmer is initially left at about half maximum capacitance.

It is important to ensure that the lead-outs of the aerial are connected properly, and Fig. 2 shows the correct connections. It also gives details of the additional winding, L3, which is made from a length of thin p.v.c. insulated single core wire. L3 is positioned away from L1 and L2, as illustrated.

Most ready-made aerials have a base coupling winding consisting of about four or five turns of wire. Ideally, this receiver should have a coupling winding with about ten turns. It is an easy matter to use one of the lead-outs of the coil (the one furthest from the tuned winding) to add another five or six turns to the winding, the extra turns being taped to the coil former. A piece of thin insulated wire is then used to extend the lead-out back to its original length.

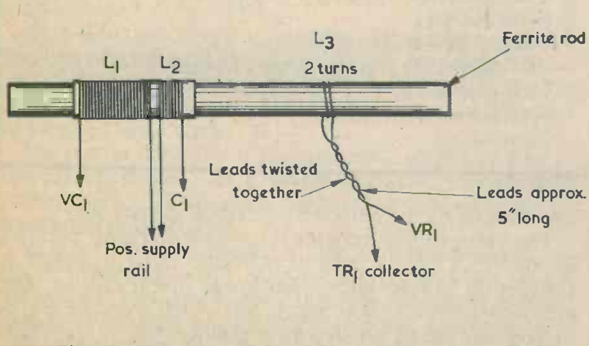


Fig. 2. Illustrating how the ferrite rod aerial windings are connected into circuit

It is by no means essential to alter the ferrite aerial in this way, but the modification will give a worth-while increase in sensitivity.

The speaker in the prototype was a 3 in. square type with an impedance of 3Ω. Smaller speakers of the same impedance could be used, but these will probably have a lower efficiency.

The four 1.5 volt cells are fitted in a battery holder of the type illustrated in the photograph of the interior. This is an Eagle type BH4N or, alternatively, the Bulgin type 2/CB/4U7 can be used.

The author's receiver was housed in a plastic case measuring 6 by 4 by 2 in. Any non-metallic case of similar dimensions may be used, or could be constructed from plywood, but first make sure that it will be large enough to take the particular speaker and variable capacitor employed, in company with the Veroboard assembly and the other components. The space needed by the Veroboard assembly will be apparent from Fig. 3 and the photograph of the case interior.

CONSTRUCTION

Construction starts with the preparation of the main component panel. This is a piece of plain Veroboard (i.e. without copper strips) having a matrix of 0.15 in. and 33 by 10 holes. This takes all the small components, and a component layout and wiring diagram is given in Fig. 3.

First drill out the two 6BA clear mounting holes in the positions shown. Next drill out two $\frac{3}{16}$ in. holes to take the mounting lugs of T1. In Fig. 3 these holes appear in the first and fifth row of holes from the top. If the transformer does not fit comfortably into holes with this spacing, drill out the lower hole in the sixth row of holes from the top.

The components are then mounted in the positions indicated in the diagram, which shows the board from the component side. The underside wiring is illustrated in broken line. In many instances, the component lead-

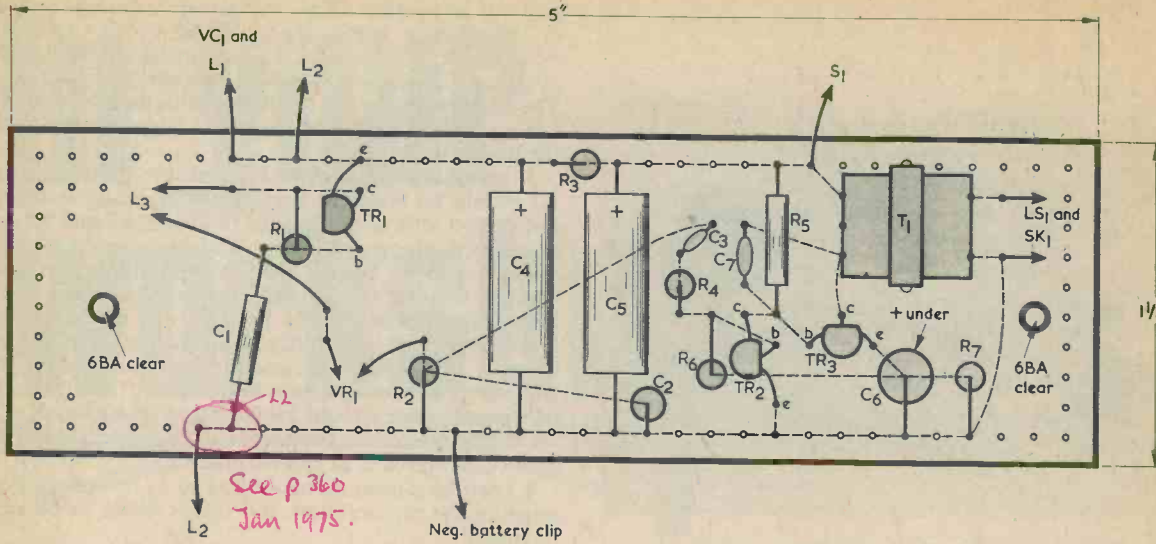


Fig. 3. The smaller components are assembled on a plain Veroboard panel, shown here as viewed from the component side

outs will be long enough to reach their connection points. Additional lengths of wire carry the positive and negative supply connections, and it will be found helpful to carry out this part of the wiring first. Where adjacent leads pass very close to one another, one of these is insulated with sleeving. When connecting L3 to the board it should be borne in mind that its connections may have to be transposed during the setting up procedure.

The finished panel is later mounted on the inside bottom of the case by means of two 1 in. 6BA countersunk screws, with suitable spacing washers between the underside of the board and the inside surface of the case. T1 is near the left hand end of the case, as seen from the front. The board may be used as a template to mark out the positions of the two countersunk holes required in the case. The panel will be mounted when the connections between it and the other components have been made.

The general layout inside the case can be seen from the photographs. With the author's receiver, a matrix of 25 $\frac{1}{4}$ in. diameter holes, with $\frac{1}{2}$ in. spacing, was drilled on the left front side of the case, after which a square of speaker mesh material was glued behind this. The speaker was, in turn, glued to the mesh. Alternatively, the speaker could be mounted to the front panel by four bolts and nuts, with the mesh sandwiched in between. The ferrite aerial is mounted at the top of the case, as far away from metal objects such as the speaker, VC1 and the battery, as possible. A piece of $\frac{3}{8}$ in. square wood was glued to one end of the rod to give a total length equal to the inside width of the case, and both were then glued in position in the case.

VC1 is mounted on the front panel next to the speaker, whilst VR1, S1 and SK1 are mounted on the left hand side of the case, as seen from the front. VR1 is at the bottom, S1 in the centre and SK1 at the top. Ensure that clearance exists between VR1 and the Veroboard panel. VC1 will probably have a construction which allows it to be mounted by three 4BA bolts passing through tapped holes in its front plate. A piece of paper can be used as a template for marking out these holes on the front panel by initially pressing it against the capacitor front plate. The 4BA bolts used to secure the capacitor must be short. If their ends pass beyond the inside surface of the capacitor front plate they can damage the fixed or moving vanes.

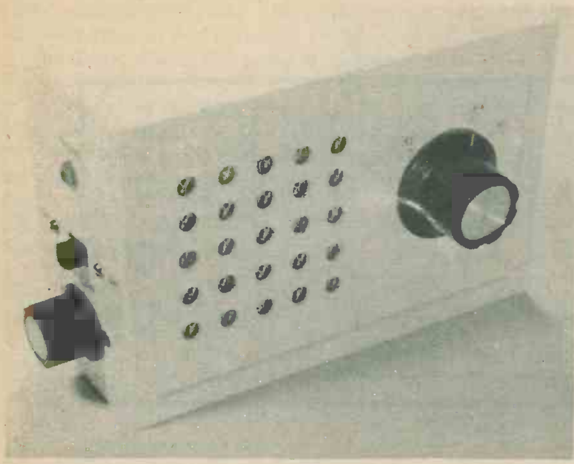
When all these parts have been mounted, the remaining wiring can be completed. Most of the wiring is illustrated in Figs. 2 and 3, and the few connections which are not are shown in the circuit diagram. VR1 is wired so that the resistance it inserts into circuit decreases as it is turned clockwise. (When the photographs were taken it was wired to insert increasing resistance.) All the interconnecting leads must be insulated.

The battery holder fits behind VC1 and can be held in position by a piece of foam rubber or plastic glued to the inside of the cabinet back.

SETTING UP AND USE

Before switching on the completed receiver, set L1 and L2 towards one end of the ferrite rod, and L3 at about the centre. VR1 should be adjusted to insert maximum resistance into circuit.

Upon switching on the set, a rushing sound should be heard from the speaker. Adjusting VC1 will probably not cause any stations to be received until VR1 is advanced clockwise. If VR1 should be advanced too far the set will break into oscillation, and proper reception



This view shows the regeneration control, the on-off switch and the earphone socket, all of which are mounted on the left side of the case

will not be possible. The most sensitive setting for VR1 is immediately below the point at which oscillation occurs, and not when it is fully advanced. For all but the strongest signals VR1 will need very careful adjustment. The best setting for VR1 will vary with the setting of the tuning control, and it will need readjustment each time the tuning is altered.

If oscillation cannot be obtained, the connections to L3 should be reversed. Should the frequency coverage not extend fully to the ends of the band, L1 and L2 can be moved along the ferrite rod to alter the range covered and so correct this. If VC1 has an integral trimmer this can be adjusted to control coverage at the high frequency end of the band. In the unlikely event that there is any tendency towards instability at the extreme high frequency end of the range when the trimmer is set for minimum capacitance, then the trimmer capacitance should be increased to avoid this. If VC1 does not have a trimmer, a 10pF capacitor may be connected across it in this eventuality.

L3 can be moved along the rod so as to find the best position for regeneration, but this is likely to be very uncritical.

As a finishing touch, legends from 'Panel Signs' Set No. 4 can be added at VR1, S1 and SK1, together with suitable indications of station positions behind the control knob of VC1. ■

NEXT MONTH'S ATTRACTIVE ISSUE

Features

PULSE COUNTING F. M. TUNER

By employing the pulse counting method of discrimination, this f.m. tuner performs as a superhet receiver having an i.f. amplifier which requires no tuned circuits at all. The tuner may be powered by a 9 volt power supply unit.

The following month's concluding article will give details of construction and of setting up.

OSCILLOSCOPE AMPLITUDE CALIBRATOR

This unit provides a.c. or d.c. voltages from 10mV to 10 volts for calibration or test purposes, and consists of a multivibrator followed by an accurate attenuator.

* * *

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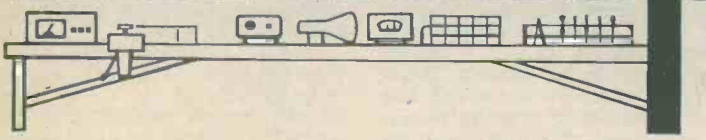
In your workshop



This month Smithy the Serviceman ostensibly sets out to explain to Dick how simple a matter electronics really is. But he ends by having his assistant far more confused than he had been at the start.

DICK SCRATCHED HIS HEAD, THEN turned back the volume control knob on the medium and long wave transistor radio on his bench.

The radio reproduced the music from the local station at reasonable quality level. Once more Dick slowly advanced the gain control. The sound from the receiver increased in amplitude until it filled the Workshop. The music suddenly reached a peak, the receiver became momentarily silent, and then it commenced to play once more. There was another peak in the music, followed by a further momentary silence from the receiver.

The irritated clattering of a soldering iron on its rest became audible from Smithy's side of the Workshop.

Dick turned down the volume and scowled at the receiver. Then he turned up the volume again.

LOW BATTERY

"Ye gods," yelled out Smithy irately. "Am I going to be subjected to that racket all morning?"

"I'm *trying*," retorted Dick in a pained tone, "to find out what's wrong with this set. Every time there's a loud sound from the speaker it cuts out."

"You don't need to tell me that," snorted Smithy. "I've been hearing nothing else but that set cutting out on loud sounds for the last quarter of an hour. For goodness' sake put a new battery in it and get on with some useful work."

"The very first thing I did was to check battery voltage."

Smithy's reply was short and to the point.

"Put in a new battery."

Shrugging his shoulders, Dick switched off the receiver and walked over to the spares cupboard. Returning he peeled off the cardboard which covered the battery terminals, removed the existing battery and fitted the new one to the set. He switched on and listened to the receiver.

It gave a perfect performance at all volume levels.

Perplexed, Dick stared at the old battery then applied the test prods of his meter to its connectors. The meter registered 8.5 volts.

"How the heck," he called out, "did you know that this set wanted a new battery, Smithy? Why, you haven't even looked at it."

"I didn't need to," replied the Serviceman over his shoulder. "It was sufficient just to hear it. I was almost 100% certain that the battery was causing the trouble."

"But it couldn't have been," persisted Dick. "It's only half a volt below its proper voltage of 9 volts."

Smithy sighed, rose from his stool and walked over to his assistant.

"Show me."

Obligingly, Dick connected his testmeter to the battery and indicated the reading of 8.5 volts.

"Now connect it to the set and measure its voltage whilst the set is playing."

Dick removed the new battery, reconnected the old one and clipped on the testmeter leads. He switched on the receiver. The battery voltage at once dropped to less than 8 volts. Dick turned the volume up, whereupon the meter needle danced in sympathy with the level of the reproduced music. The music rose to a crescendo, the meter reading dropped to 5 volts, and the receiver became silent for a short period until the battery voltage rose and it resumed working. Hastily, Dick switched the set off.

"There you are," pronounced Smithy. "That battery had developed a high internal resistance. The Class B output stage of the set draws increased current as the volume level goes up, and loud sounds were causing so much current to be drawn that there wasn't enough battery voltage to keep the oscillator running. So the set ceased to work for a very short period after the start of a loud sound until the voltage on its supply rails increased to a level which allowed the oscillator to come on again." (Fig. 1).

Ruefully, Dick took out the faulty battery and put back the new one.

"Stap me," he remarked forlornly. "I certainly made a mess of this job. I remember now that I measured the voltage of the old battery with the set switched off."

"You should never do that," advised Smithy sternly. "Always measure battery voltage on load."

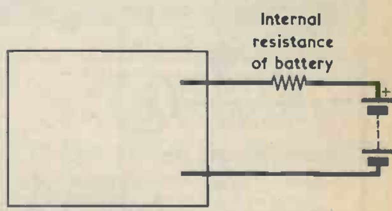


Fig. 1. The internal resistance of a battery may be represented as a physical resistor in series with it. In the instance shown here, the voltage applied to the receiver circuits drops as the receiver current increases

"There are times," stated Dick desolately, "when I think I'm not cut out for this servicing lark. That's the second silly mistake I've made this morning."

"Go on," said Smithy, intrigued. "What else have you done?"

"I wasted nearly half an hour with another set replacing a transistor base bias resistor that I thought had gone low in value. After I'd put the new one in I found it showed the same low resistance as the old one did."

"How was the resistor connected?"

"Between the collector and base of the transistor." (Fig. 2(a)).

"I can guess what happened here," commented Smithy. "You connected the testmeter so that it passed forward current through the base-collector juntion of the transistor." (Fig. 2(b)).

"That's what I must have done," agreed Dick dejectedly. "Anyway, I next checked the new resistor with the testmeter leads the other way round and it showed the correct resistance. If I'd thought of doing that with the first one I needn't have gone to the bother of changing it." (Fig. 2(c)).

METER POLARITY

"Well, you know now," pronounced Smithy heavily, "As a matter of principle, whenever you're checking the value of a resistor which is connected in a transistor circuit it's often a good plan to apply the meter leads one way round and then the other way round. There are so many effective diodes given in transistor circuits, due to base-emitter and base-collector junctions, that it's quite easy to obtain a low resistance reading by mistake. Another thing to remember when using a testmeter switched to an ohms range is that the positive test lead in most cases carries the negative voltage from the testmeter battery whilst the negative test lead carries the positive voltage. That's because nearly all testmeter resistance reading circuits rely on an internal series battery in the meter. This is a useful thing to remember when checking electrolytics for leakage and things like that."

"I tell you, Smithy," said Dick morosely. "This electronics business is really getting too much for me. This positive is negative and negative is positive thing is just the final sting in the tail so far as I'm concerned."

"Do you mean," queried the startled Serviceman, "that you're actually thinking of giving up servicing? Of leaving the Workshop and going for another job?"

"Well, yes," confessed Dick. "Something in the open air for a change. Like on the milk round, for instance."

"If you're going to deliver milk you've got to get up . . . " started Smithy, then checked himself. Dick's passing reference to a "sting" had caused memories of a recent cinema visit to suddenly flood his mind. He abruptly turned his head away so that his assistant could not see the expression of almost Stygian cunning that was now emblazoned across his face.

"Hey, what's up with you?" asked Dick. "What are you looking away like that for?"

With an effort, Smithy composed his features, then faced his assistant.

"It's nothing," he stated bravely. "Just a tic I'm afflicted with."

"Humph," grunted Dick suspiciously. "I thought it was only cattle that had ticks."

"I didn't mean that sort of tick," grated Smithy. "Let's get back to this electronics business which, you say, is getting too much for you."

"So it is, too," repeated Dick. "I reckon I'm going to find myself a job where things are a lot simpler."

"Now I'm certain you don't mean that," commented Smithy reprovingly. "Tell you what, let's take a bit of time off so that I can show you how simple, basically, electronics is."

He walked over to the spares cupboard, then returned with a small mains transformer.

"Here we are," he said comfortingly. "This is a nice simple mains transformer with a 240 volt primary which has a 220 volt tap in it. We shan't worry about the secondary windings. Now, take up your soldering iron, connect a bit of 2-core flex to the zero and 240 volt tags, then connect the other end of the flex to the mains. Okay?"

"Fair enough," said Dick reluctantly. "But I don't quite see what this is leading up to."

Dick quickly wired up the transformer, then looked up at Smithy enquiringly. (Fig. 3(a)).

"Right," said that worthy. "Set up your testmeter to a high a.c. volts range, switch on the mains to that transformer and measure the voltage across the primary. As I said just now, we won't worry about the transformer secondaries."

"I'm switching on the mains now," announced Dick, "and I'll see what voltage we've got between the zero and 240 volt tags on the primary. Here we are, it's spot on at 240 volts." (Fig. 3(b).)

"Good. Now check the voltage between the zero volt point and the 220 volt tap."

"This is just a waste of time," grumbled Dick. "It's bound to be 220 volts. And so it is!" (Fig. 3(c).)

"Fair enough," continued Smithy. "Next check the voltage between the 240 and the 220 volt taps."

"Blimey, Smithy," complained Dick. "This has just got to be 20 volts. And – let's see now – that's exactly what it is." (Fig. 3(d).)

"Very good," commended Smithy. "Now did you find that at all hard to understand?"

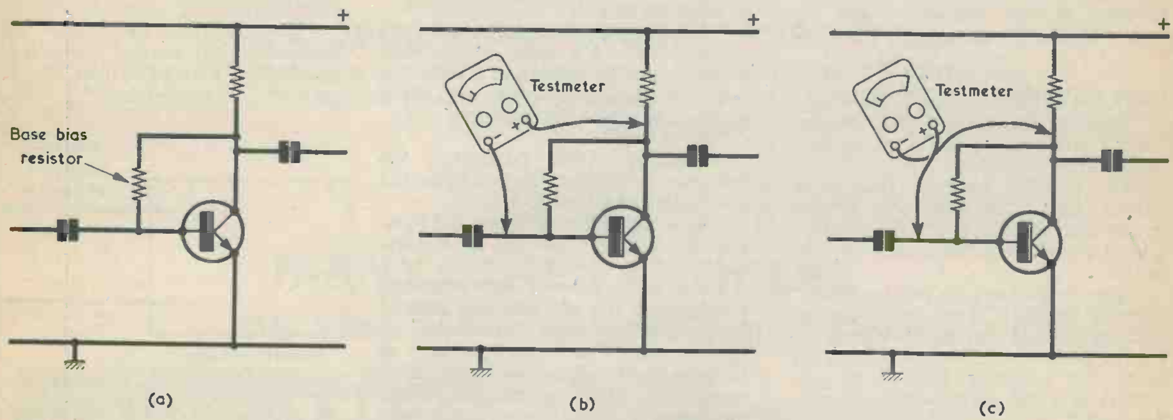


Fig. 2(a). A typical amplifier stage with a base bias resistor between collector and base. An n.p.n. transistor is assumed
(b). Applying a testmeter switched to an ohms range to the bias resistor can cause the base-collector junction of the transistor to be forward biased. The meter then gives a false low resistance reading
(c). If the testmeter leads are transposed the base-collector junction is reverse biased and a reasonably accurate resistance measurement can be made

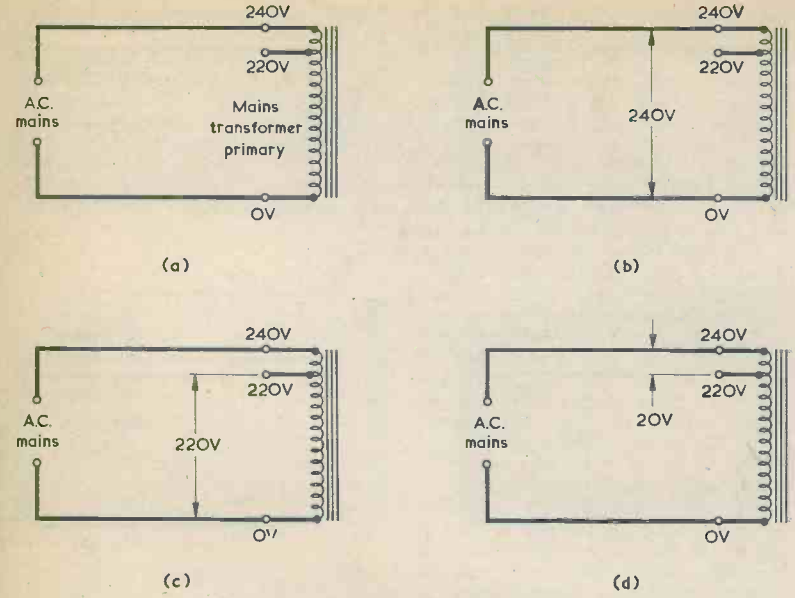


Fig. 3(a). Applying the a.c. mains to the primary of a standard 240 volt transformer having a tap at 220 volts. No connections are made to the secondary or secondaries
(b). The applied voltage is 240 volts
(c). As is to be expected, a voltage of 220 volts is given at the tap
(d). A voltage of 20 volts appears between the 220 and 240 volt points

"It was dead easy," replied Dick scornfully. "We just had what was, in effect, a 240 volt autotransformer with a tap at 220 volts."

"And could we assume," queried Smithy, "that the current in the 240 to 220 volt part of the transformer winding was flowing in the same direction as the current in the 220 to zero volt section?"

"Of course we could assume that. It must be."

"Excellent," said Smithy, rubbing his hands together. "Switch off the mains and remove the lead from the 240 volt point and connect it to the 220 volt tap."

Dick picked up his soldering iron and carried out the Serviceman's instructions. (Fig. 4(a).)

"All finished, lad?" asked Smithy heartily. "That's fine. Will you now measure the a.c. voltage between the zero volt point and the 220 volt tap"

"Dear, oh dear," muttered Dick rebelliously. "Talk about wasting time. Well, the voltage is 240 volts, which is what you'd expect it to be." (Fig. 4(b).)

"Good," commented Smithy. "And now the voltage between the zero and 240 volt points."

Dick carried out the voltage test. (Fig. 4(c).)

"It's just above 260 volts," he announced. "It's bound to be higher than the mains voltage at the 220 volt tap because the transformer is now acting as a step-up autotransformer."

"Good, good," purred Smithy. "Could you next check the voltage between the 220 volt tap and the 240 volt point?"

"Corluvaduk," said the mutinous Dick. "I've done some daft things in my time but this is plain ridiculous. Anyway, the voltage is round about 22 volts." (Fig. 4(d).)

"Excellent," said Smithy. "It's slightly more than the 20 volts we had previously because we're applying the mains voltage to a lower tap in the winding."

WINDING CURRENTS

"What," asked Dick, "comes next"

"We start to think," replied Smithy, "about current in the transformer as it's now connected. Would you say that the current induced in the section of the winding between the 240 volt point and the 220 volt tap is flowing in the same direction as the current in the 220 volt to zero volt section?"

"Oh, definitely," stated Dick emphatically. "We've got the same voltage polarities that we had in the previous case, so the current in the top part must be flowing in the same direction as the current in the lower section. In terms of voltage this means that during half-cycles when the 220 volt tap is positive the 240 volt point is positive also, but more so because of the autotransformer step-up effect."

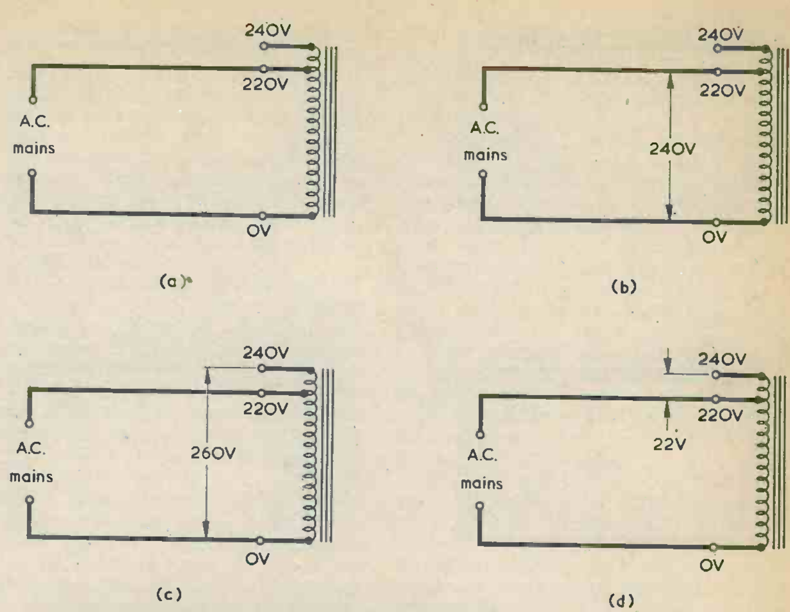


Fig. 4(a). This time the a.c. mains is applied to the zero and 220 volt points
(b). Once again the input voltage is 240 volts
(c). Due to step-up effect, the voltage at the 240 volt point is in excess of 240 volts
(d). A slightly increased voltage is also given between the 220 and 240 volt points

"Very good," said Smithy silkily. "Now switch the mains off from that transformer and let's draw its symbol on some paper. Have you got a piece of paper anywhere?"

Dick reached forward and produced a grubby note-pad from the back of his bench. Smithy fastidiously tore off several sheets until he encountered one which was reasonably free of the patina of sticky grime which, mysteriously, clung to all of the more permanent items on his assistant's bench.

"I will now," announced Smithy, as he took out his ball-point pen, "draw out the circuit of our mains transformer primary. I'll use larger loops than usual for the winding symbol so that I can add little arrows to indicate current flow. And I'll also add a resistor across the 220 and 240 volt points to act as a load. If there wasn't a load here there wouldn't, in practice, be any current in this part of the winding. All right?" (Fig. 5(a).)

"Sure."

"Will you," continued Smithy, "be happy if I refer to 'conventional current', which is assumed to flow from positive to negative?"

"Suits me," replied Dick carelessly.

"Right," said Smithy briskly. "Then I'll start off with the mains half-cycle you referred to just now where the 220 volt tap is positive and where the zero volt point is, consequently, negative. Our conventional current flows from positive to negative down the winding, so I'll add some arrows to show this." (Fig. 5(b).)

"That seems all right to me," commented Dick. "Now add the arrows to the top part of the winding."

"In the same direction?"

"In the same direction."

Carefully, Smithy added the arrows. (Fig. 5(c).)

"There we are," he pronounced. "Now what could you have simpler than that?"

With a gesture of finality, Smithy put the cap on his pen and returned it to his pocket. Dick gazed at the circuit on his note-pad.

"It could be I was wrong about this electronics scene after all," he commented after a moment's thought. "Perhaps I was letting myself get put down too much just because I flumped a few simple faults."

His countenance brightened.

"I think," he continued, "I'll stay on in the servicing game after all."

Smithy looked at him amiably.

"I'm glad to hear it," he stated warmly. "I was certain you'd realise that things aren't as difficult as you've been making out."

The Serviceman walked over to his bench, leaving his assistant gazing raptly at the diagram on his note-pad.

A MATTER OF POLARITY

The Serviceman waited a little, then glanced round. His assistant was still engrossed with the diagram.

The time, Smithy decided, was just right. He cleared his throat.

"Ahem."

Dick continued to look at the diagram.

"Ahem," said Smithy, in a louder tone.

Surprised, Dick turned round.

"What did you say?"

"I said 'ahem'."

"What on earth did you say that for? I've never heard you say 'ahem' before."

"People say 'ahem'," explained Smithy tetchily, "when they want to catch other people's attention. I was trying to catch your attention."

"Well, I don't dig this 'ahem' bit. You're really *weird* this morning, Smithy. First of all, you've been all kind and considerate towards me, and now you've started saying 'ahem'."

"For the love of Pete," exploded Smithy furiously, "just forget I darned well said 'ahem'. All I want to do is flaming well say something to you, you steaming great hairy-nostrilled nit."

"Ah now," said Dick in a relieved tone of voice, "that's more like it. I was getting quite worried about you. What did you want to talk about?"

"That transformer we've just been discussing," replied Smithy, forcing himself into a calmer state. "I've just remembered that we haven't *quite* finished our examination of it."

"Haven't we?"

"There's one final thing outstanding," stated Smithy. "We forgot to look at the current which flows in the load resistor connected across the top part of the transformer winding."

"Fair enough," said Dick equably. "Let's press on and do that right now."

Smithy walked back to Dick's bench and pulled out his pen once more.

"When we left this transformer," he said, "it was receiving a half-cycle from the mains which caused the 220 volt tap to be positive. We then added the arrows which indicate the flow of conventional current."

"Agreed."

"So let's next look at the top part of the winding on its own."

Smithy pulled Dick's pad towards him and drew out a further diagram. (Fig. 6(a).)

"We now," he continued, "have the top winding feeding conventional current into the load resistor. We already know the current direction in the winding and this current obviously flows through the resistor. In consequence, we can add a further arrow alongside the resistor to indicate the current direction inside it."

Smithy added the arrow. (Fig. 6(b).)

"This seems reasonable enough," commented Dick assuredly. "The conventional current follows the same direction through the resistor as it did in the transformer winding, and so it goes from the bottom of the resistor up to the top."

"As you say," concurred Smithy gently. "Now, conventional current flows from positive to negative. The result, so far as the resistor is concerned, is that the voltage from the transformer winding is such that the bottom of the resistor is positive and the top of the resistor is negative."

Smithy added a positive and a negative sign to his sketch. (Fig. 6(c).) He glanced expectantly at his assistant.

Dick looked worried.

"Just a minute," he said unhappily. "Let's get this straight. We're examining the transformer during the half-cycle when the 220 volt tap is positive. But what we've now found out is that this causes the 240 volt point to go *negative* of the 220 volt tap."

His brow creased in anguish.

"But that *can't* be true," he wailed. "We know that the 240 volt point goes *positive* of the 220 volt tap. Blimey, we've just *measured* the voltages and we've found that the 240 volt point has a higher voltage than the 220 volt tap, which means that when the 220 volt tap goes positive the 240 volt point goes more positive. And yet when you look at the circuit in basic form this tells us that the 240 volt point goes *negative* of the 220 volt tap!"

He glowered at the diagram, then gave a gesture of utter despair.

"That's it," he remarked with certitude. "Milk round, here I come!"

"Come, come," remonstrated Smithy. "You mustn't be too hasty."

"Too hasty? Who's being too hasty when he's leaving a job where, before your very eyes, positive becomes negative and negative becomes positive? From now on, all I'm going to worry about is how to keep the gold tops separate from the silver tops."

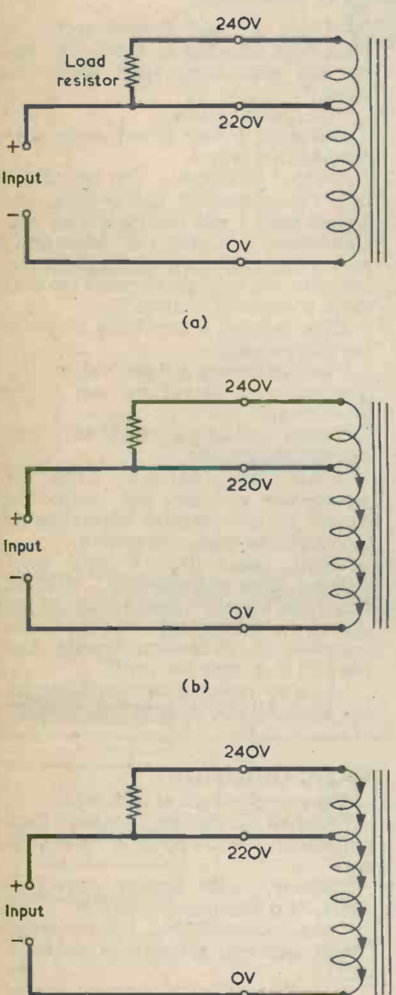


Fig. 5(a). The circuit situation which exists on half-cycles when tne upper input terminal is positive
(b). The arrows indicate the direction of current flow in the lower section of the winding
(c). Current in the upper section of the winding if it is assumed that this flows in the same direction. In practice a load resistance is required across the upper section to allow tne current to flow

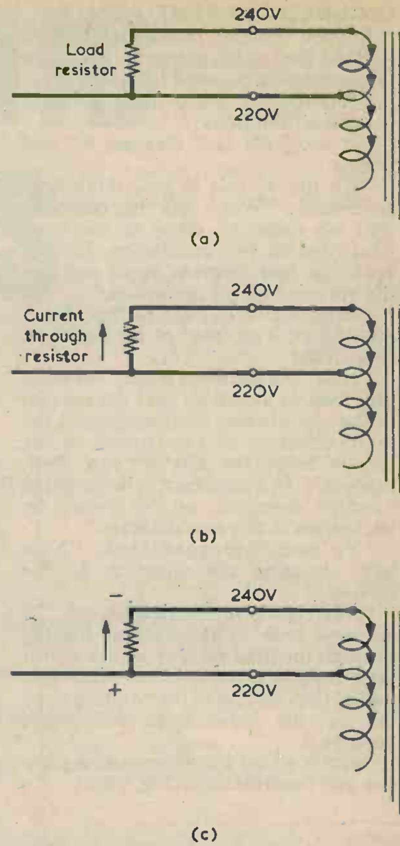


Fig. 6(a). The situation at the upper section of the transformer winding of Fig. 5(c) is shown in detail here
(b). The direction of the current in the load resistor
(c). the consequent polarity of the voltage across the resistor

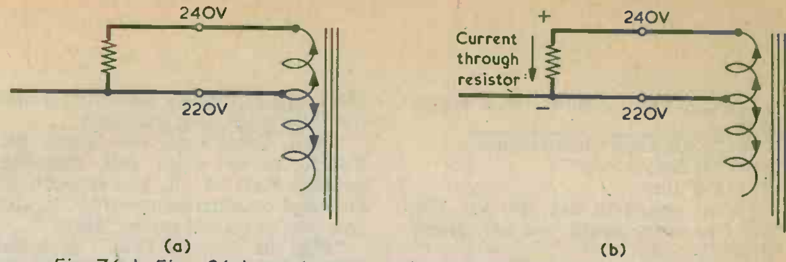


Fig. 7(a). Fig. 6(a) re-drawn, with the current arrows pointing upwards
(b). The current through the load resistor and the voltage polarity is then as shown here

INDUCED CURRENT

Smithy glanced down at the anguished face of his assistant. A tremor of compassion touched his heart.

"Perhaps," he murmured, "I should get you off this hook."

He took the last diagram he had drawn.

"It's not as bad as you think," he continued. "What has happened is that we made an error in the steps which led to this conclusion. Let me draw the last diagram again and put the correct current arrows in."

Smithy scribbled out a further sketch and placed it in front of his assistant. (Fig. 7(a).)

"Now, the error we made," he went on, "was in assuming that the current in the top winding section flows in the same direction as the current in the section below the 220 volt tap. Well, it doesn't. In actual fact, it flows in the opposite direction, as I've shown by the arrows in this new diagram."

"Ye gods," groaned Dick. "Now he's changing the direction of the *current*."

"And rightly so," stated Smithy. "If we now look at the current flowing through the load resistor we see that it goes from top to bottom. And that means that the top of the winding is, so far as the resistor is concerned, positive."

Smithy added the arrow and a positive and negative sign. (Fig. 7(b).)

"Well," remarked Dick doubtfully. "That does at least tie in with the observed facts about the winding voltages. When the 220 volt tap goes positive, the 240 volt point goes more positive."

He examined the sketch again.

"But this means," he went on, "that the current induced in the winding between the 220 and 240 volt points flows in the opposite direction to that which flows in the 220 to zero volt section. Can that be true, Smithy?"

"It is," confirmed Smithy. "In fact, the current *has* to flow in the opposite direction if only to satisfy the known facts about voltage addition which are given when you connect one winding of a transformer in series with another winding. The current induced in the upper section of our transformer winding or in the secondary of any transformer flows, inside the winding, in the opposite direction to the current which flows in the primary winding."

"But how can this be possible?"

"It arises," said Smithy, "from the basic property of an inductor, which is to oppose any change in the current which flows through it. Say we have an iron-cored smoothing choke and we start to pass a current through it. The current causes an expanding magnetic field to be set up, and that expanding field in turn produces a back e.m.f. in the choke winding which opposes the flow of the current. If we add another winding to the choke and connect a resistor across that winding so that current can flow in it, the winding will function like the secondary in a transformer, and it will have induced in it a current which flows in the same direction as that corresponding to the back e.m.f. produced in the original winding."

"Stap me," said Dick. "That idea takes a bit of getting used to."

"I'll agree," said Smithy, "that it's a bit of a pill to swallow, but it makes sense when you give it some consideration. What I've said about current direction in primary and secondary windings applies to all transformers, and it must obviously be true because of the readily measurable voltages which are obtained when we connect transformer windings in series."

There was silence for some moments as Dick absorbed this information.

"Do you know, Smithy," he said eventually, "the trouble with electronics is that it's so darned *interesting*. Perhaps I won't give up servicing after all."

"There is," said Smithy softly, "a milk float standing at the dairy. And it's got your name right across the front."

"Oh, I don't know."

Suddenly, a flash of comprehension crossed Dick's face.

"Why," he gasped, "you set all this up! You conniving old twister, you waited until I was feeling fed up with electronics, and then you deliberately set up this business about transformer currents and voltages to make me even more cheesed off with it."

Dick pointed a trembling finger at the Serviceman.

"You're trying to get rid of me. You're trying to get me out of the Workshop!"

Smithy spread his hands in a self-deprecating gesture.

"Dick, lad," he said. "I'm not getting any younger, you know. The idea of a quiet peaceful Workshop all to myself has many attractions."

"Well, that's nice, I must say," retorted Dick indignantly. "After all these years you're now trying to get shot of me. Casting me out like a worn-out glove or a sucked-out orange. And after all I've done for you!"

"You've never done anything for me, ever. All you do is impede things."

BASIC QUESTION

The pair glowered at each other.

"And if I do go," asked Dick ominously, "who's going to make your tea?"

"Blimey," said Smithy apprehensively, "I'd forgotten about that."

"Aha," crowed Dick triumphantly. "Who wants to get shot of me now, eh?"

"I never said I wanted to get shot of you," replied Smithy hastily. "At least not in so many words. Besides, it was you who started off all this talk about the milk round."

They faced each other belligerently. The ridiculous aspect of the situation suddenly occurred to Dick and he grinned. It was not long before Smithy joined him and the Workshop was soon filled with howls of laughter.

And so, disapprovingly, we must take our leave of Smithy and his assistant as they fall about with most unseemly hilarity, when they should have been engaged in the serious pursuits that are becoming to a professional servicing establishment.

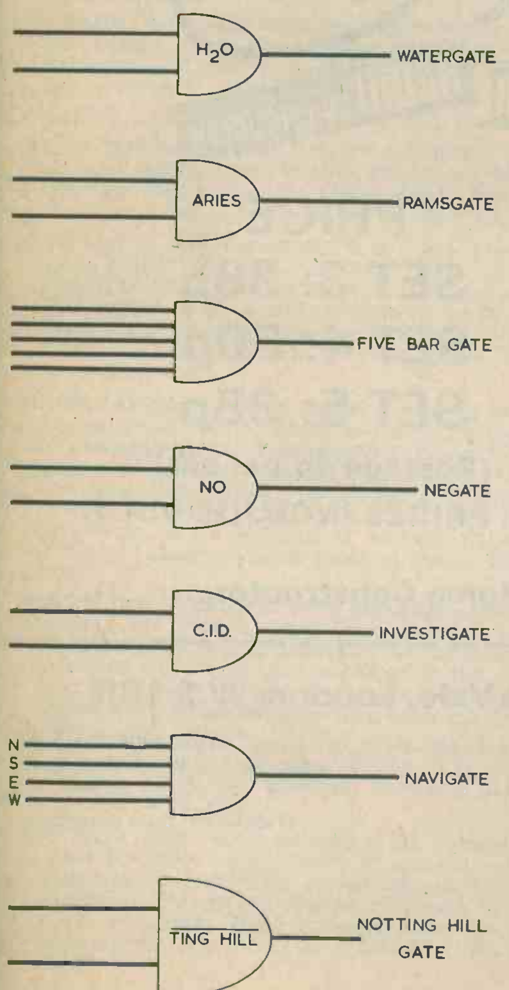
Still, you've got to have a chuckle now and again. ■

ELECTRONIC ODDITIES

By R. River

Not all electronics is to be found in the text-books.

LOGIC



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A. Yes, you can tell because it's got two taps.

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Q. What do you get if you split integrated circuits in two?
A. Fission chips.

A. This is a genius coil.
B. Genius coil?
C. Yes, it's got a high Q of 300.

Q. What can you catch with a mag-net?
A. A tuner fish?

A. Why are you laughing? What's so funny about an inductance capacitance smoothing circuit?
B. Of course it's funny, don't you see the choke?

Q. What will write but won't make a torch light?
A. A lead pen-cell.

A. Our cat's swallowed a frame-frig valve!
B. Did it do him any harm?
A. No, now he's got a bigger μ.

Q. Where does a volt have its ohm?
A. 'Ampshire.

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Q. What do you get if a resistor overheats?
A. Ohm cooking.

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Q. Why are you chewing resistors?
A. I'm an ohmmeter.

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(Continued on page 252)

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6BQ7A	.55	30C17	.80	ECC82	.33	GY501	.70	PY88	.40	BC109	.11
6BR7	1.00	30F5	.80	ECC83	.33	GZ32	.50	PY500	.95	BC113	.28
6BR8	1.50	30FL1	.67	ECC84	.30	GZ34	.60	PY500A		BC118	.25
6BW6	.80	30FL2	.67	ECC85	.40	HVR2A			.95	BCZ11	.42
6BW7	.70	30FL14	.78	ECC88	.44		1.00	PY800	.40	BF159	.28
6BZ6	.49	30L15	.75	ECF80	.34	KTW61		PY801	.40	BF163	.22
6C4	.35	30L17	.70	ECF82	.38		1.50	QQVO3/		BF180	.33
6C6	.40	30P12	.80	ECF86	.75	KTW62		10	1.75	BY100	.20
6C9	1.00	30P19	.75	ECH35	1.25		1.50	R19	.60	BY126	.17
6CL6	.65	30PL1	.85	ECH42	.70	KTW63		U25	.85	BY127	.20
6CU5	.75	30PL13	.95	ECH81	.33		1.00	U26	.66	OA91	.10
6E5	1.00	30PL14		ECH83	.44	KT66	2.50	U191	.75	OA95	.10
6F1	.75		1.10	ECH84	.44	PABC80		U801	.85	OC23	.42
6F6G	.50	35L6GT	.75	ECL80	.55		.38	UABC80		OC24	.42
6F18	.55	35W4	.50	ECL82	.34	PC86	.60		.40	OC25	.42
6F23	.80	35Z4GT	.70	ECL83	.70	PC88	.60	UAF42	.60	OC44	.11
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6K8G	.45	AZ31	.60	EF83	1.00	PCC89	.50	UCC84	.75	OC74	.25
6L6GC	.58	DAF91	.30	EF85	.34	PCC189	.57	UCC85	.45	OC75	.12
6Q7G	.50	DAF96	.50	EF86	.30	PCF80	.40	UCF80	.70	OC78	.17
6Q7GT	.50	DF91	.30	EF89	.27	PCF82	.35	UCH42	.75	OC78D	.17
6SG7	.44	DF96	.50	EF91	.37	PCF84	.59	UCH81	.40	OC81	.12
6SJ7	.55	DK91	.45	EF92	.50	PCF86	.60	UCL82	.38	OC81D	.12
6V6G	.17	DK92	.70	EF98	.80	PCF801	.50	UCL83	.55	OC82	.12
6V6GT	.45	DK96	.60	EF183	.30	PCF802	.50	UF41	.70	OC82D	.12
6X4	.40	DL92	.40	EF184	.35	PCF805	.80	UF80	.35	OC83	.22
6X5GT	.45	DL96	.55	EH90	.55	PCF806	.50	UF85	.44	OC84	.26
7B6	.75	DY87/6	.35	EL32	.50	PCL82	.38	UF86	1.00	OC202	.47
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SMALL ADVERTISEMENTS

(Continued from page 251)

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WANTED: Stroboscope tuning forks. Teletype No's. 103628 for 60 w.p.m. and 104984 for 66 w.p.m. Box No. G247.

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WANTED: Service manual for Hallicrafter's Skyrider communications receiver. Box No. G248.

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FOR SALE: Germanium point contact diodes, equivalent OA91. Branded. 5 for 25p inclusive. T.A.C., 59 Luckwell Road, Bristol, BS3 3ES.

(Continued on page 253)

SMALL ADVERTISEMENTS

(Continued from page 252)

FOR SALE: Handbook of satellites and space vehicles £7.00. Self-sealing plastic bags 2¼" x 2¼", 100–30p, s.a.e. for sample. 5lbs mixed components £2.50. Avo 8 £20.00. Battery operated door chimes (need repair) 75p. Servisol switch cleaner 70p, 2 tins £1.00. 10 mixed LED'S £1.50. Valve tester £20.00. 2-speed drill with 'hammer' action, ⅜" chuck, £12.50. 75 yds x 2" Sellotape roll £1.00. Freezing spray aerosol £1.30. Bush CTU25 colour TV, serviced with new tuners, £125.00. 10" 8Ω speaker £2.75. 100mW walkie-talkies £27.00. 147kHz-220MHz signal generator £38.00. Reconditioned adjustable arm bench lamp £5.00. 24V input 500W 240V inverter £30.00. 50W hi-fi amplifier kit £12.50. Manufacturer's reject (repairable) walkie-talkies (retail £59.95) £30.00. Minifon pocket wire recorder, new condition, £8.00. S.A.E. for lists. Box No. G249.

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(Continued on page 255)

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(Continued from page 253)

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