THE
RADIO CONSTRUCTOR

Vol. 24 No. 1 AUGUST 1970 3/6

THE 'TREBLE-TWO' H.F. BANDS PRESELECTOR

* Two 6AK5 Pentodes
* 13.5 to 30MHz
* Self-Powered

FEATURED IN THIS ISSUE

1-Valve Record Player Amplifier

Simplified Transistor Superhet

LST

ELECTRONIC COMPONENTS LTD

=BETTER QUALITY, SERVICE, PRICES & LARGEST STOCKS

A1617/3	40/-
AAY30	1/7
AAZ13	3/2
AC107	7/7
AC126	5/-
AC127	4/-
AC127Z	9/6
AC128	4/-
AC176	5/-
AC187	12/-
AC188	12/-
ACY17	5/9
ACY18	4/-
ACY19	4/-
ACY20	3/10
ACY21	3/10
ACY22	3/9
ACY27	3/6
ACY28	3/8
ACY29	7/6
ACY30	7/6
ACY31	4/7
ACY34	3/5
ACY35	3/6
ACY36	3/9
ACY39	12/-
ACY40	3/-
ACY41	3/-
ACY44	8/-
AD140	11/-
AD149	11/6
AD161	6/-
AD162	6/-
ADT140	12/6
ADZ11	32/-
AF102	12/6
AF106	7/6
AF114	5/-
AF115	5/-
AF116	5/-
AF117	5/-
AF118	8/10
AF121	6/-
AF124	4/2
AF125	4/2
AF126	3/6
AF127	3/6
AF178	9/6
AF179	11/6
AF180	12/6
AF181	8/6
AF186W	9/-
AF186G	9/-
AF239	7/6
AFY19	22/6
AFZ11	8/-
AM006	10/-
ASY26	4/5
ASY27	6/-
ASY28	4/5
ASY29	6/-
ASZ21	7/6
AUY10	30/-
B1181	10/-
B2M	12/6
B3M	15/-
B108	2/6
BA111	6/-
BAX13	1/6
BC107	2/9

BC108	2/9
BC109	2/9
BC113	5/-
BC116	8/-
BC118	5/-
BC125	11/-
BC126	11/-
BC134	5/-
BC135	6/-
BC136	8/-
BC137	8/6
BC138	12/-
BC140	13/3
BC147	2/9
BC148	3/3
BC149	3/-
BC154	12/-
BC167	3/6
BC168	3/9
BC169	3/9
BC171	2/-
BC182L	2/3
BC183L	1/10
BC184L	3/-
BC212L	3/4
BCY10	10/-
BCY12	12/-
BCY30	5/-
BCY31	5/6
BCY32	10/-
BCY33	4/-
BCY34	5/-
BCY38	6/-
BCY40	10/-
BCY42	4/-
BCY43	4/-
BCY54	7/6
BCY70	3/10
BCY71	7/8
BCY72	3/2
BCY87	86/9
BCZ11	7/6
BD119	15/-
BD121	18/-
BD123	21/6
BD124	12/-
BDY20	20/8
BF115	5/-
BF152	13/6
BF154	9/-
BF159	15/-
BF163	9/-
BF167	5/-
BF173	6/-
BF178	10/6
BF179	12/6
BF180	6/-
BF181	6/6
BF184	7/-
BF185	8/-
BF194	3/6
BF200	10/6
BF274	
BFX13	5/-
BFX29	6/2
BFX34	
BFX44	8/-
BFX84	5/2
BFX85	6/9
BFX86	4/11

BFX87	5/11
BFX88	5/3
BFY18	15/-
BFY50	4/6
BFY51	3/9
BFY52	4/6
BFY53	3/2
BFY90	24/6
BFW57	6/-
BFW58	5/6
BFW59	5/-
BFW60	4/6
BLY47	31/3
BS05	10/2
BSX19	3/3
BSX20	3/3
BSX21	7/6
BSX60	12/7
BSX61	7/11
BSX76	4/-
BSX77	6/-
BSX78	6/6
BSY27	4/-
BSY29	5/-
BSY32	5/-
BSY36	5/-
BSY37	5/-
BSY38	4/-
BSY95	3/2
BSY95A	2/11
BSW41	8/6
BSW70	5/6
BTX39	
600	120/-
BTX40	
600	120/-
BTY87	
150R	31/-
BTY95	
100	162/8
BY127	4/-
BY234	5/-
BYX38	
300	5/-
BYY16	41/6
BYZ14	33/3
BYZ15	33/3
BZY93	
(C12)	10/3
BZY93	
(C47)	10/3
BZY95	
(C47)	7/7
BZY96	
(C6V2)	7/7
BZY96	
(C6V8)	7/7
C106F	9/-
C111	18/-
C111E	12/-
C400	9/-
C426	8/3
C444	9/8
CG50	2/6
CG61	2/6
CG62	2/6
CG62H	2/6
CG63	2/6
CG64	2/6
CG6E	2/6

CG83	2/6
CG84	2/6
CG85	2/6
CG86	2/6
CG94	2/6
CR1-	
051C	8/-
CR1-	
401C	10/-
CR10151A	25/-
CS16R	10/-
CV2389	7/6
CV4074	7/6
CVS345	10/-
CV7021	10-
CV7022	7/6
CV7023	10/-
CV7042	5/-
CV7065	5/-
CV7075	5/-
CV7076	5/-
CV7081	5/-
CV7086	5/-
CV7117	7/6
CV7316	7/6
CV7317	7/6
CV7318	7/6
CV7372	10/-
CV7477	10/-
CV8790	1/-
D13T1	10/-
D1235	8/-
DT3201	10/-
ER42	7/6
ET116	7/6
F6609	10/-
FCH111	16/-
FCH141	16/-
FCH151	16/-
FCH201	21/7
FCH221	21/4
FST3/8AF	5/-
G828	1/-
GET16	12/6
GET102	6/-
GET103	5/-
GET113	4/-
GET114	6/6
GET120	5/-
GET872	5/-
GET880	9/-
GET887	4/-
GET889	4/-
GET890	6/6
GET896	4/6
GET897	4/6
GET898	6/-
GEX45/1	3/6
GJ6M	18/-
GE W-02	10/-
GP297/1	9/-
GP826	20/-
GT47-B	3/-
HS2180	5/-
KBS2	6/-
MA393	10/-
MA8001	4/-
MAT100	5/-
MAT101	5/6
MAT120	5/-

MAT121	5/6
ME1100	6/-
MJ400	21/6
MJ420	22/6
MJ421	22/6
MJ430	20/6
MJ440	19/6
MJ480	20/6
MJ481	27/-
MJ490	22/6
MJ491	29/6
MPF102	8/6
MPF103	7/6
MPF104	7/6
MPF105	8/-
MPS3638	6/6
MR30	2/-
MR43	2/-
MS50	2/-
NKT11	7/6
NKT12	5/5
NKT32	6/-
NKT42	6/-
NKT43	6/-
NKT72	3/9
NKT73	3/7
NKT101	6/-
NKT102	6/-
NKT103	6/-
NKT104	6/-
NKT105	6/-
NKT106	6/-
NKT107	6/-
NKT108	6/-
NKT109	6/-
NKT121	10/6
NKT122	10/-
NKT123	9/6
NKT124	6/5
NKT125	4/6
NKT126	4/-
NKT127	10/6
NKT128	10/-
NKT129	8/6
NKT135	6/1
NKT137	6/1
NKT141	10/6
NKT142	10/-
NKT143	9/6
NKT144	8/-
NKT151	6/-
NKT153	6/-
NKT154	6/-
NKT161	6/-
NKT162	6/-
NKT163	6/-
NKT164	6/-
NKT165	6/-
NKT201	6/-
NKT202	6/-
NKT204	6/-
NKT205	6/-
NKT206	6/-
NKT208	6/-
NKT210	4/2
NKT211	3/9
NKT212	3/9
NKT213	4/7
NKT214	3/5

NKT215	3/7
NKT216	7/6
NKT217	9/-
NKT218	6/-
NKT219	4/7
NKT221	7/-
NKT222	6/-
NKT223	5/-
NKT224	3/7
NKT225	3/6
NKT226	11/-
NKT227	9/6
NKT228	6/6
NKT229	3/11
NKT231	6/-
NKT232	6/-
NKT237	5/9
NKT238	4/-
NKT239	4/-
NKT240	3/10
NKT241	3/9
NKT242	2/11
NKT243	12/-
NKT244	3/1
NKT245	3/-
NKT261	4/3
NKT262	4/3
NKT263	4/8
NKT264	4/3
NKT265	5/6
NKT270	6/-
NKT271	2/10
NKT272	2/10
NKT273	3/8
NKT274	2/10
NKT275	3/4
NKT276	3/6
NKT279A	2/6
NKT281	5/-
NKT301	18/-
NKT302	12/5
NKT303	17/6
NKT304	9/10
NKT351	10/-
NKT352	17/6
NKT361	20/-
NKT362	20/-
NKT401	14/6
NKT402	15/-
NKT403	14/9
NKT404	11/-
NKT405	11/-
NKT406	9/11
NKT420	28/11
NKT451	9/11
NKT452	9/6
NKT453	6/6
NKT603F	4/8
NKT613F	5/2
NKT654F	4/2
NKT675	6/8
NKT676	5/-
NKT677F	3/10
NKT703	8/-
NKT713	3/10
NKT717	5/10
NKT734	4/11
NKT736	6/2
NKT773	3/7
NKT774	6/-

NKT0013	6/8
NKT10419	3/10
NKT10519	4/5
NKT10339	4/7
NKT10439	5/5
NKT12329	8/5
NKT12429	10/6
NKT13329	3/11
NKT13429	3/11
NKT16229	8/5
NKT20329	6/8
NKT20339	6/4
NKT35219	15/9
OC19	5/-
OC20	19/6
OC22	8/-
OC23	8/-
OC24	8/-
OC25	7/6
OC26	6/6
OC28	12/-
OC29	15/-
OC35	9/-
OC36	12/6
OC41	4/6
OC42	4/6
OC43	4/6
OC44	3/-
OC45	3/-
OC70	2/6
OC71	3/-
OC72	4/6
OC74	8/2
OC75	4/6
OC76	2/6
OC77	5/6
OC81	4/6
OC81D	3/-
OC82	5/-
OC82D	3/-
OC83	4/6
OC84	5/-
OC123	7/-
OC139	5/-
OC140	7/-
OC170	5/-
OC171	6/-
OC200	6/3
OC201	9/6
OC202	18/-
OC203	7/6
OC204	8/-
OC205	9/-
OC206	10/6
OC207	7/6
OC309	12/-
OC470	10/-
OCP71	19/6
OMY122	20/-
ORP12	9/6
ORP60	8/-
ORP61	8/-
ORP63	9/-
P346A	3/9
PBC108	2/6
RAS310AF	6/-
RAS508AF	15/-
RS220F	4/-
RPY58	12/-
S1M	19/-

S4M	33/6
ST140	3/-
ST141	5/-
ST2	9/9
SX631	6/-
SX634	8/6
SX636	8/-
SX638	8/-
SX3826	4/-
SZ20C	6/-
T1407	9/8
TI534	17/6
TI544	1/9
TI545	3/3
TI546	3/3
TI547	3/3
TI548	3/3
TIS49	3/6
TIS50	5/6
TIS51	4/-
TIS52	4/-
TIS53	6/6
TIS60	6/6
TIS61	7/-
TIP31A	12/6
TIP32A	14/10
TSW30C	15/-
U23AAA	5/-
U17236/	
11742	4/-
V205	20/-
V405A	9/3
XA102	6/-
XA702	15/-
XB113	6/-
XK505	6/-
XK508	20/-
XK575	8/-
Z2A13OF	8/-
Z2A56CF	8/-
Z3B16OCF	8/-
ZD4027	15/-
ZE12	4/-
ZE12V7	3/6
ZLE27	6/-
ZT22	10/-
ZT86	27/6
ZT2270	19/6
40250	10/9
40309	6/-
40310	9/-
40311	6/9
40312	9/6
40314	7/3
40315	7/3
40316	9/3
40317	7/3
40319	10/9
40320	7/3
40323	6/6
40324	9/6
40326	7/3
40329	4/9
40344	5/3
40347	7/6
40348	10/3
40360	8/6
40361	9/6
40362	11/6
40370	6/-

40406	11/3
40408	10/3
40462	11/3
40467	16/6
40468A	7/-
40602	8/-
1N4408	15/-
1N4448	15/-
1N547	15/-
1N612	15/-
1N1115	10/-
1N1118	10/-
1N1124	10/-
1N1126	10/-
1N1201	10/-
1N1693	10/-
1N1831A	8/-
1N2940	8/-
1N3713	30/-
1N3717	30/-
1S100	3/2
1S101	4/-
1S105	5/6
1S107	6/6
1S130	1/6
1S410	5/1
1S410R	5/1
1S415	8/-
1S417R	9/4
1S920	1/4
1S5036	12/10
1Z20	10/-
2G301	3/9
2G302	3/9
2G306	8/6
2G339A	5/-
2G371	3/-
2G371B	3/-
2G374	5/-
2G378	7/-
2G381	5/-
2G414	12/-
2N109	11/-
2N174	16/-
2N217	7/6
2N370	15/-
2N384	17/-
2N386	12/-
2N385A/	
2N388A	15/-
2N404	4/6
2N410	8/-
2N458A	25/-
2N511A	49/6
2N513A	122/6
2N599	10/-
2N601	25/-
2N657	20/-
2N696	3/7
2N697	3/10
2N698	6/-
2N706	2/4
2N706A	2/6
2N708	3/1
2N709	8/6
2N711	7/6
2N711A	7/6
2N715	7/6
2N716	7/6
2N743	4/6

2N744	6/-
2N753	5/6
2N911	10/-
2N914	3/11
2N918	8/5
2N929	5/3
2N930	6/-
2N996	14/10
2N1090	6/6
2N1091	6/6
2N1131	6/11
2N1132	7/9
2N1302	3/7
2N1303	3/7
2N1304	4/11
2N1305	4/11
2N1306	6/-
2N1307	6/-
2N1308	6/9
2N1309	6/3
2N1496	34/-
2N1507	4/8
2N1613	4/5
2N1617A	29/6
2N1711	5/1
2N1893	9/2
2N1896	10/-
2N2147	16/3
2N2152	27/6
2N2148	12/6
2N2160	14/9
2N2217	5/5
2N2217A	11/4
2N2218	6/5
2N2218A	8/4
2N2219	7/2
2N2219A	10/-
2N2220	5/10
2N2220A	8/-
2N2221	6/5
2N2221A	8/5
2N2222	7/2
2N2222A	10/8
2N2297	7/7
2N2243	26/-
2N2368	3/4
2N2369	3/4
2N2369A	3/11
2N2432	67/-
2N2483	6/5
2N2484	7/10
2N2613	7/6
2N2614	6/-
2N2646	10/-
2N2711	6/-
2N2712	6/-
2N2713	5/6
2N2894	9/2
2N2904	8/10
2N2904A	9/9
2N2905	12/11
2N2905A	15/1
2N2906	8/10
2N2906A	10/10
2N2923	4/-
2N2924	4/-
2N2925	3/6
2N2926	
Green	2/-

2N2926	
Yellow	2/-
2N2926	
Orange	2/-
2N2926	
Brown	2/-
2N3011	12/6
2N3036	39/-
2N3053	4/5
2N3054	12/6
2N3055	15/-
2N3133	6/-
2N3135	6/-
2N3136	6/-
2N3235	28/6
2N3234	27/6
2N3242	7/9
2N3391A	6/-
2N3392	5/-
2N3393	5/-
2N3394	4/9
2N3402	5/6
2N3403	5/6
2N3404	7/6
2N3414	5/6
2N3415	6/-
2N3416	7/6
2N3436	15/-
2N3525	21/9
2N3528	19/-
2N3606	5/6
2N3607	4/6
2N3607	4/4
2N3702	3/4
2N3703	3/4
2N3704	3/2
2N3705	2/8
2N3706	2/3
2N3707	2/10
2N3708	1/10
2N3709	2/-
2N3710	2/3
2N3711	2/6
2N3789	51/9
2N3819	7/-
2N3820	18/9
2N3826	5/6
2N3854	5/6
2N3854A	5/6
2N3855	5/6
2N3855A	6/-
2N3856	6/-
2N3856A	6/-
2N3858	5/-
2N3858A	6/-
2N3859	5/6
2N3859A	6/3
2N3860	6/-
2N3866	25/-
2N3877	9/6
2N3877A	9/6
2N3900	10/6
2N3900A	11/6
2N3903	7/6
2N3904	7/6
2N3905	7/6
2N3906	7/6
2N4037	15/-
2N4058	3/4
2N4059	5/-

2N4060	5/-
2N4061	4/-
2N4062	4/6
2N4284	3/-
2N4287	3/-
2N4288	3/-
2N4289	3/-
2N4290	3/-
2N4291	3/-
2N4292	3/-
2N4871	6/9
2N5027	10/6
2N5028	11/6
2N5029	9/6
2N5030	8/6
2N5172	3/-
2N5174	10/6
2N5175	10/6
2N5176	9/-
2N5232	5/6
2N5249	13/6
2N5249A	13/6
2N5305	7/6
2N5306	8/-
2N5309	12/6
2N5354	5/6
2N5355	5/6
2N5356	10/6
2S001	10/-
2S002	12/6
2S003	12/6
2S004	15/-
2S005	15/-
2S006	15/-
2S017	15/-
2S018	17/6
2S019	19/6
2S020	20/-
2S104	12/6
2S301	8/6
2S302	7/6
2S303	10/-
2S304	12/6
2S306	15/-
2S320	9/-
2S321	6/-
2S322	8/-
2S323	10/-
2S701	8/6
2S702	11/4
2S703	12/6
2S711	26/6
2S712	34/6
2S720	25/-
2S732	8/6
2S733	5/11
2S1002	10/-
2SA72	10/-
3N128	13/9
3N140	15/3
3N141	14/6
3N142	10/9
3N143	13/3
3N152	17/3
5D6	5/-
AA119	2/-
AAY11	2/-
AAZ12	6/-
AAZ13	2/6
BA110	6/-

BA111	6/-
BA112	10/-
BA115	1/6
BA130	3/-
BAY31	2/6
BAY38	3/-
BY100	5/-
BY125	3/6
BY127	4/-
BY234	2/3
BYX10	3/-
BYX36/150	2/4
BYX36/300	2/10
BYX36/600	3/9
BYY21	25/-
BYY23	26/3
BYY25	31/9
BYY142	3/9
BYZ10	9/-
BYZ12	6/-
BYZ13	5/-
CG6E	2/-
CG63	2/-
EA403	3/6
EC401	5/-
EC402	4/8
EB383	3/6
GEX45/1	4/-
GJ3M	4/-
OA5	3/8
OA10	4/-
OA47	1/8
OA70	1/8
OA73	1/8
OA79	1/8
OA81	1/8
OA85	1/8
OA90	1/8
OA91	1/8
OA95	1/8
OA200	2/-
OA202	2/-
OA211	8/-
OAZ234	10/-
OAZ247	10/-
SD19	7d
TD716	12/-
1N34A	4/-
1N60	4/-
1N64	4/-
1N82A	9/6
1N87A	4/6
1N191	5/-
1N914	1/9
1N4001	1/6
1N4002	2/-
1N4003	2/6
1N4004	2/9
1N4005	3/-
1N4006	3/6
1N4007	3/9
1N4148	1/9
1S44	1/9
1S103	4/3
1S113	4/6
1S130	5/-
1S131	2/5
1S132	3/-
1S420R	8/3

BC107/8/9 2/9
NPN Planar transistors
BC107 & 9 25 + **2/5** 100 + **2/2**
BC108 25 + **2/3** 100 + **2/-**

2N4871 6/9
Motorola unijunction
25 + **5/9** 100 + **4/9**

2N3055 15/-
115 watt silicon power transistor
25 + **13/-** 100 + **11/-**

IRC20 7/-
Int. Rectifier thyristor
200 piv. 1.2 amp.
(similar C106B1)
25 + **6/-** 100 + **5/-**

2N2926 2/-
NPN Planar transistor
25 + **1/8** 100 + **1/6**

BY127 4/-
Mullard Plastic
HV rectifier 800 piv.
1 amp. (similar BY100.
25 + **3/3** 100 + **3/-**

2N3819 7/-
Texas FET
25 **6/-** 100 + **5/3**

ABC171A 2/-
NPN Planar
25 + **1/6** 100 + **1/-**

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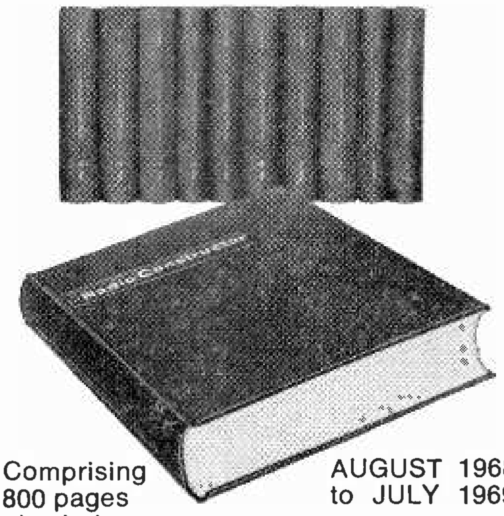

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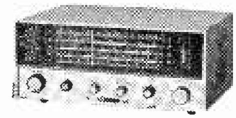

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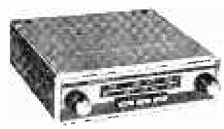

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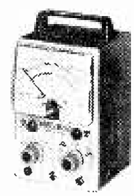

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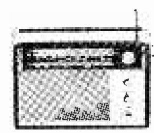

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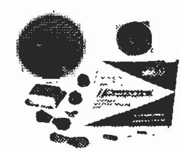

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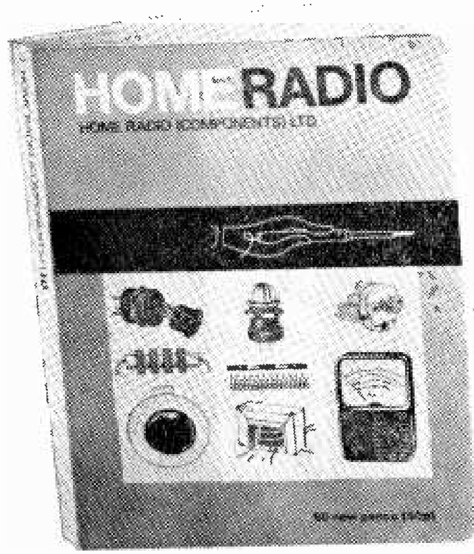

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SECONDARY WAVE CIRCUITS

by

J. BRAUNBECK

The circuits and techniques described in this article form a fascinating subject for experiment. Care must, of course, be taken to ensure that no annoyance to other listeners or viewers results from their use

GENERALLY, ONE DOES NOT PAY MUCH ATTENTION to the fact that every aerial re-radiates part of the r.f. energy it absorbs from the field of the transmitter.

The same principle enables us to see things illuminated by light. Any non-black object re-radiates a part of the light it receives by illumination. We are accustomed to see luminescent objects like lamps, neon signs or stars, as well as illuminated objects, like landscapes by daylight.

If we change from light to radio waves there, too, are "luminescent" objects: the transmitters. But every operating transmitter "illuminates" every aerial and every aerial-like object within its range.

Re-radiation on a certain frequency becomes much stronger if a resonant circuit is connected to the aerial. Though similar effects were heard of in the old days of crystal sets and one-valvers, it is not well known that one can modulate the secondary radiation of an aerial by connecting it to one of the circuits described in this article. Using secondary waves one can build a transmitter which contains no oscillator. Instead of home-made r.f., one uses the ready-made r.f. supplied by existing transmitters.

Depending on wavelength and shape of the aerial, one can send signals up to 60 feet this way. That range is sufficient for experiments or for short range communication like electronic baby-sitting.

SECONDARY WAVE MODULATOR

The principle of any secondary wave modulator is shown in Fig. 1. A resonant LC circuit is connected to the aerial. If we start our experiments in the medium wave range, an aerial wire several yards long is sufficient, but longer aerials of any kind give better results. The resonant circuit consists of any radio receiver medium wave coil and a normal 365 or 500 pF variable capacitor. This circuit is tuned to the station whose carrier one wants to modulate. Signal strength of this station is not very important. While a strong station gives strong secondary waves, it also blankets the re-radiated signal a short distance from the aerial.

As may be seen from Fig. 1, there are two switches connected to the resonant circuit. Short-circuiting the variable capacitor with S1 or breaking the earth connection with S2 reduces the amplitude of the re-radiated carrier. Opening and closing one of these switches causes a crackling noise to be heard in any nearby receiver tuned to the same station. Opening and closing S1, for example, at a rate of 500 times a second would produce a tone of corresponding pitch to be heard in the receiver. In order to achieve this, S1 has to be replaced by an electronic device.

A simple circuit for single-tone modulation of the re-radiated carrier may be seen in Fig. 2. A small neon lamp takes the place of S1. Any low-voltage type without built-in resistor will do. Supply voltage is not critical as long as it is above the neon lamp's ignition voltage. Together with the 470kΩ resistor and the 0.005μF capacitor the neon lamp forms a relaxation oscillator. As the internal a.c. resistance of the neon lamp is quite low, the resonant circuit is short-circuited every time the neon fires. In the moments when the neon is non-illuminated, there is

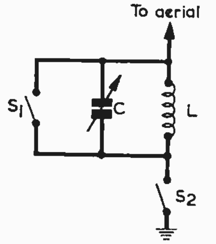


Fig. 1. Basic secondary wave modulator circuit

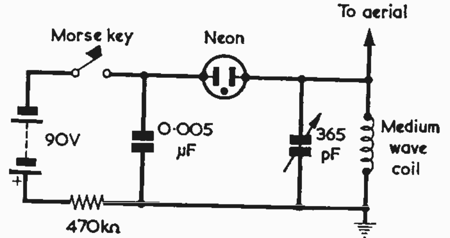


Fig. 2. A circuit providing single-tone modulation of a secondary wave

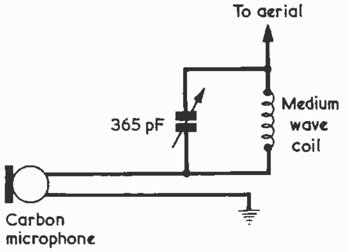


Fig. 3. Voice modulation with a carbon microphone

no shirt-circuit for the r.f. voltage.

This simple circuit is very convenient for studying the distance at which the modulated secondary wave can be heard.

AUDIO MODULATION

If one does not want a single tone only but real audio modulation of the secondary wave, this can also be done. In Fig. 3 the simplest possible audio modulator for secondary waves is shown. A carbon microphone takes the place of S2 in Fig. 1. Every sound of sufficient intensity picked up by the microphone will be heard in any nearby receiver.

While being very simple and cheap, the carbon microphone modulator does not offer a high quality of sound reproduction. If better quality is wanted, the circuit of Fig. 4 may be used. It is essentially a crystal radio with a crystal microphone connected in place of the headphones. In fact, a crystal set still existing may be directly used for this experiment. Modulation is based on the fact that input impedance of a rectifier circuit varies when a voltage source is connected to the output. The audio voltage generated by the crystal microphone affects the input impedance of the germanium diode rectifier circuit and, therefore, the amplitude of the secondary wave. If no crystal microphone is available, a single 2000Ω headset will also do nicely as a microphone. Instead of the microphone it is also possible to connect a record player pick-up to the modulator.

SHORTER WAVELENGTHS

Modulation of secondary waves is not limited to the medium wave band. Devices for shorter wavelengths are even simpler to experiment with because of the smaller aerials required. As is demonstrated in Fig. 5, all one needs is a folded dipole and a carbon microphone. The most convenient way to construct a folded dipole is to use 240Ω ribbon cable*.

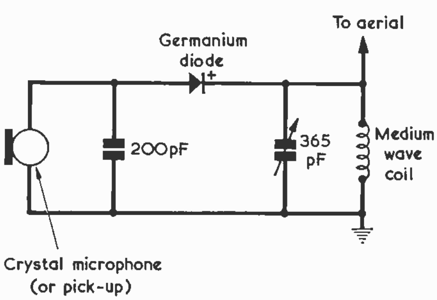


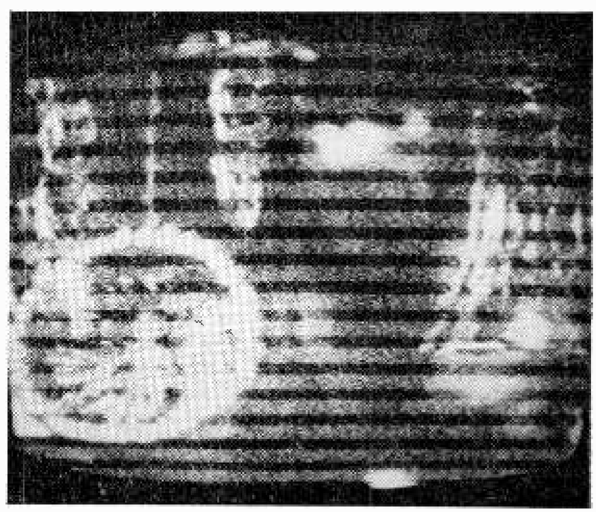
Fig. 4. Modulation circuit for use with a crystal microphone

A typical example of secondary wave modulation as provided by the circuit of Fig. 6

When experimenting with v.h.f. broadcast stations, there is a minor difficulty which does not exist in the medium wave band. Broadcast transmissions in the v.h.f. range are frequency modulated, while the secondary wave circuit produces amplitude modulation. Conventional broadcast receivers for v.h.f. are designed to reject amplitude modulation. Fortunately, a receiver designed this way can sometimes be made to work as a makeshift a.m. receiver simply by tuning it a little off-station.

Propagation of secondary waves in the v.h.f. range is a very interesting subject for experimental study.

* 240Ω ribbon cable, or twin feeder, is not generally available in the U.K., and consists of two wires whose spacing (in air) is approximately 4 times the wire diameter. The dipole of Fig. 5 could, of course, alternatively be made up with ordinary wire suitably spaced. — Editor.



Another example of square wave modulation

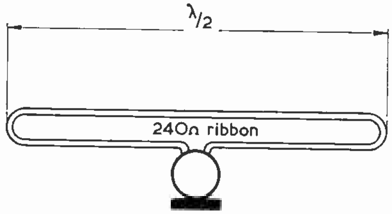


Fig. 5. Secondary wave modulator for the v.h.f. range

When experimenting with the modulator shown in Fig. 5 one will find that reception does not necessarily degrade with distance. Due to reflections and interference phenomena there may be good reception at a point well beyond what at first seems the ultimate range of the secondary wave transmitter. Best results are obtained if the secondary wave modulator picks up more v.h.f. amplitude than the receiver. This can be the case if the receiver is situated in the shadow of a building, etc.

It is interesting to note that similar devices acted a part in the drama of electronic warfare during World War II. Before the invention of the transistor they were the only transmitters which could operate without bulky power supplies. So, for spying purposes a microphone-dipole combination was hidden in the room under surveillance. An unmodulated carrier was supplied by a transmitter situated some distance away.

TELEVISION MODULATION

Seeing is believing, as an old proverb says. There is no reason why one should only hear secondary wave modulation. It is also very easy to extend the principle to television. In Fig. 6 a simple circuit is shown in which two low cost germanium transistors oscillate in multivibrator fashion, powered by a 1.5V cell. The emitter lead of one transistor couples to two general purpose germanium diodes connected in forward direction. When this transistor is in the "off" state both diodes represent a relatively high impedance. In the "on" state the transistor draws emitter current, which causes the impedance of the diodes to drop considerably.

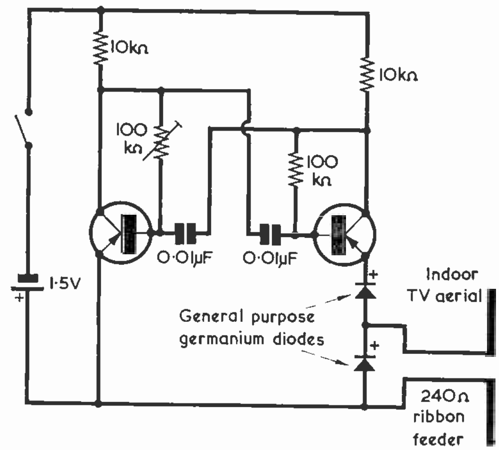
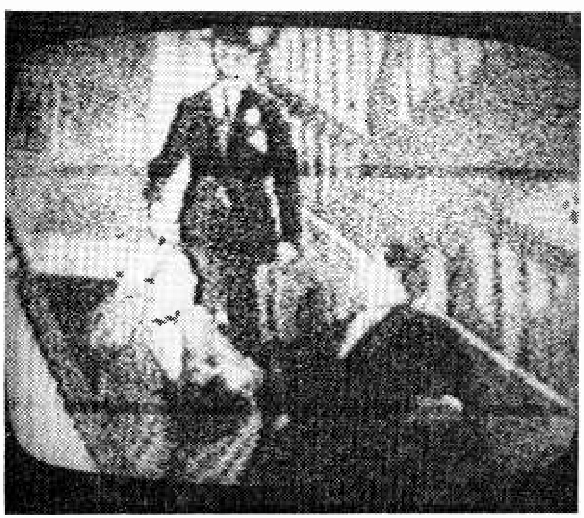
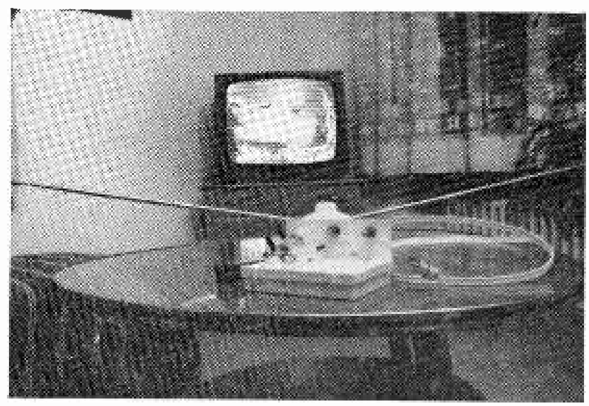


Fig. 6. A modulator for television frequencies. A suitable substitute for the 240Ω ribbon feeder shown here and in Fig. 7 would be a 300Ω flat twin feeder or, quite simply, two wires suitably spaced



Asymmetric square wave, as obtained with the aid of the circuit of Fig. 7



An experimental set-up, illustrating a secondary wave modulator in operation

If an indoor aerial is connected in parallel with one of the diodes the multivibrator works like a periodic short-circuit. This modulates the secondary waves re-radiated by the indoor aerial. *Do not* try the experiment with an outdoor aerial. There are no tuned circuits, therefore even the experimenter

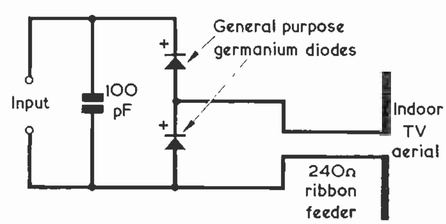


Fig. 7. A circuit which enables a television receiver to function as an "oscilloscope"

with little or no TV experience should have no difficulties. Of course the indoor aerial has to be correct for the channel chosen for experiments. One base bias resistor of the multivibrator is a 100kΩ potentiometer. By means of this potentiometer the frequency of the multivibrator may be aligned in order to obtain a standing pattern.

Typical results obtained with the modulator just described are shown in the accompanying photographs. For the TV set one should not use a large aerial, but one similar to that used for secondary wave modulation. In many areas just a piece of wire will do nicely. A practical application may be for alignment purposes similar to an ordinary bar generator.

Once one has gathered enough experience on how to modulate TV signals, the circuit shown in Fig. 7 may be employed to make use of the TV set as a simple oscilloscope. Of course one should not expect top performance for this simple circuit. Besides poor sensitivity this "oscilloscope" has the disadvantage that the signal is not displayed as a curve, but as a brightness pattern. Nevertheless it sometimes yields technical information of practical value. Another of the photographs shows the TV oscilloscope display of an asymmetrical square wave – superimposed on Stan Laurel and Oliver Hardy. ■

PHASE LOCKED LOOPS

Currently available from L.S.T. Electronic Components Ltd. are two versions of a monolothic integrated circuit capable of selection and demodulation of an r.f. signal, *all without tuned circuits.* Manufactured by Signetics Corporation, California, U.S.A., the devices are known as 'Phase Locked Loops' and have the type numbers NE560B and NE561B. The first of these offers demodulation of f.m. and f.s.k., whilst the second provides demodulation of f.m., f.s.k. and a.m. Both devices may be employed for other functions, these being signal locking, conditioning and shaping, signal tracking, tone decoding and frequency multiplication and division. The frequency range over which a Phase Locked Loop can operate is 1Hz to greater than 15MHz. A typical application is the use of either of the devices as a 10.7MHz demodulator offering a very high level of a.m. rejection in an f.m. receiver. They function with a signal input level between 100μV and 1V, optimum operation being at an input of 5mV. The d.c. supply voltage may range from 15V to 26V.

The input signal to the Phase Locked Loop is applied to a phase comparator in company with the output of a voltage controlled oscillator (v.c.o.), this latter also being incorporated in the i.c. chip. The output of the phase comparator passes through a low pass filter, an amplifier and a range limiter before being returned, as a controlling voltage, to the v.c.o. Thus, an input signal whose frequency is within the capture range of the system can cause the v.c.o. to lock on to it, the v.c.o. control voltage then changing in sympathy with frequency variation and providing, for instance, an f.m. demodulated output. A further point is that, when it has locked on to the input signal, the v.c.o. provides a strong local oscillation at the identical frequency even if the input signal suffers from heavy noise or discontinuities. The low pass filter, range limiter and the two amplifiers just referred to are, like the phase comparator and the v.c.o., all contained within the single integrated chip.

The devices are available, at £12 0s. 10d. for the NE560B and £14 10s. 8d. for the NE561B, from L.S.T. Electronic Components Ltd., 7 Coptfold Road, Brentwood, Essex.

Forty Years On

Recently searching through some old papers, I came across a copy of *The Daily Telegraph* for Friday, August 9th, 1929. Although we are now some 40 years on, scanning through the yellowing pages brought back many memories of life during those days.

In 1929 there were, it seems, three national coverage stations on the medium waves – 2LO London on 842kHz (356.3 metres); 5XX Daventry on 193kHz (1,554.4 metres) and 5GB Experimental Daventry on 626kHz (479.2 metres). The latter station opened at 4 p.m. and closed at 11.15 p.m., whilst the two former mentioned transmitters commenced operations at 10.15 a.m. with the Daily Service and closed at a quarter past midnight.

Perhaps the most intriguing transmission was that listed under 2LO and 5XX from the midnight hour until close-down a quarter of an hour later – Experimental Transmission of Still Pictures by the Fultograph Process. Obviously a milestone in the development of the idiots lantern!

During the day it seems that the populace were to be treated to such entertaining items as:–

1.00 Recital of Gramophone Records by Christopher Stone.
4.15 Orchestra from the Mayfair Hotel.
6.30 Ministry of Agriculture Bulletin.
8.00 Gershom Parkington Quintet.
9.15 "The Promenade Concerts" by Mr. Percy Pitt.
9.30 Shipping Forecast and Fat Stock Prices. (Daventry only)
9.35 Variety Programme with Sandy Rowan (Scottish comedian); Henry Leoni with English and French songs; Renee Rudarni and Billy Carlton in an instrumental act; Jack Payne and the BBC Dance Orchestra, and Jack Hylton and his band from the London Palladium.
10.45 Surprise Item.

It seems we were in for a feast of entertainment that day – I wonder what the Surprise Item turned out to be?

5GB Experimental Daventry offered to 'wireless' owners – not every family owned a set in those days – the following alternatives:–

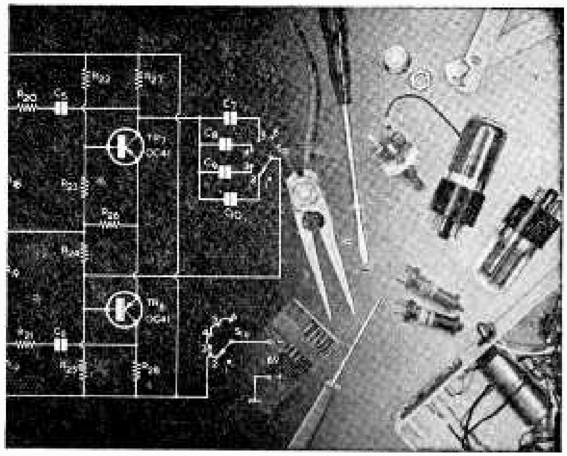
6.30 Lozells Picture House Orchestra.
7.30 The Coldstream Guards Band from the North East Exhibition at Newcastle.
9.00 Berkeley Mason (baritone) and the Wireless Orchestra.
10.15 Band from the Carlton Hotel.
11.00 Dance Music from Blackpool.

I recall that at the time, Dad's latest and proudest possession was a 'Screen-Grid Three' complete in a rosewood cabinet of large proportions atop which gaped an enormous bell-like 'loudspeaker'. We were considered 'with-it'; others were still diligently applying themselves to collective listening gathered around a pair of headphones placed in a metal basin!

Provided "that hog up the road doesn't mess about with his reaction condenser" we could have listened to a heterodyne-free programme. Alas, that was rarely the case. Hog, it seemed, experienced malevolent pleasure in causing a flute-like whistle to be added to orchestral items and gargling-like noises to speech! C.W. ■

Four-way Remote Control System

by G. A. FRENCH



RECENTLY THE WRITER WAS asked by an acquaintance for assistance with a problem concerning his high fidelity reproducing system, which included a radio tuner. The system was installed in the living room of the house in company with the television receiver, and there were frequent occasions when the family settled down to watch television whilst the acquaintance carried out work in his 'shack' in the garden. This 'shack' incidentally, was a well-appointed workshop complete with mains supply. Feeling that it was a pity to let a high fidelity system lie unused during the periods when the family watched television, the writer's acquaintance had run a heavy single pair cable from the living room to the shack, coupling this to a good quality extension loudspeaker. The idea was that he would then be able to turn on the radio tuner and main hi-fi amplifier in the living room, switch the amplifier output to the extension speaker in the shack and then retire thereto whenever he wanted to carry on with some work.

This arrangement worked perfectly well, the only shortcoming being that no control of volume was available in the shack. A simple resistive attenuator had been tried at the extension loudspeaker but the audio quality at low volume levels had been disappointing, this being presumably due to varying impedance in the speaker over its frequency range. In consequence, it had been decided to fit a relay in the living room which would insert a fixed amount of attenuation in the output from the radio tuner, this relay being controlled, over a pair of lines, from the shack. Such a system would, at least, provide a rudimentary control of volume, even if only two volume levels were available. The writer's acquaintance had been more than a little surprised to learn that it would be a very simple matter, with the proposed single pair of control lines, to provide no less than *four* different volume levels. As it transpired, it was not even necessary to use two relay control lines, since one proved to be sufficient!

Whilst the remote control principle involved for this application is not new it does not appear to be widely known, and the writer felt that the appropriate circuitry would make a good subject for this month's article in the "Suggested Circuit" series. In consequence, this article will initially describe the remote control circuit in general, and will then deal with the manner in which it was used in practice in the particular application just discussed.

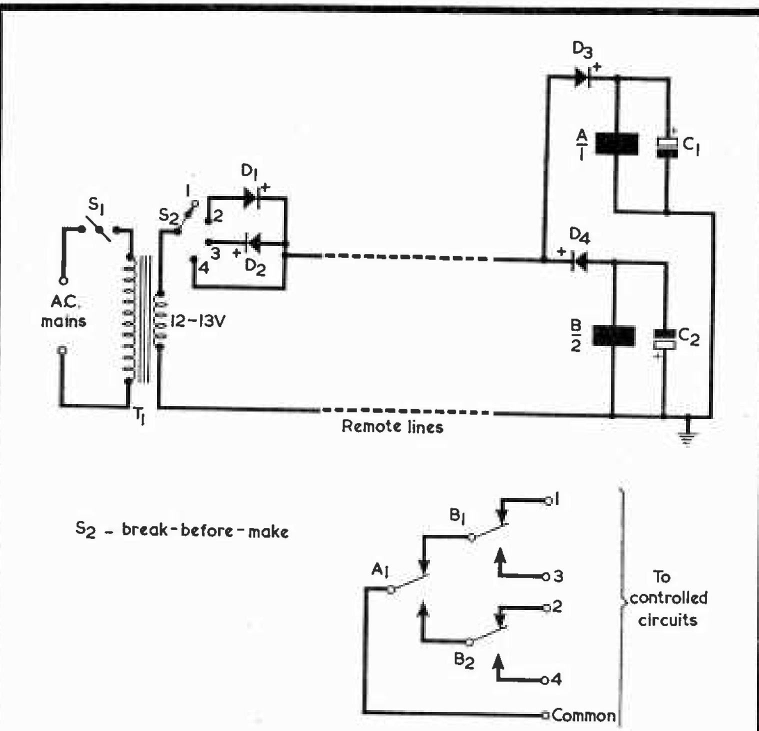


Fig. 1. The basic 4-way remote control circuit. The Common terminal at the right is automatically connected to terminal 1, 2, 3 or 4 according to the position of S2

BASIC CIRCUIT

The basic remote control circuit is given in Fig. 1. It employs two relays, these being shown in the 'detached' manner, in which the coils are drawn as suitably identified rectangles. The contact sets, appearing elsewhere in the circuit, are shown in the position they take up when the appropriate relay is de-energised. Relay A has one set of changeover contacts, whilst relay B has two sets of changeover contacts. The purpose of the circuit is to connect, by remote control, the Common terminal on the right of the diagram to one of the four terminals above it designated 1 to 4.

At the controlling position, to the left in Fig. 1, an alternating supply of 12 to 13 volts is available from the secondary of mains transformer T1 when on-off switch S1 is closed. If switch S2 is then in position 1, no voltage is applied to the remote lines and relays A and B are both de-energised. A circuit is, therefore, completed from the Common terminal via de-energised contact set A1 and de-energised contact set B1 to terminal 1.

When S2 is set to position 2, the secondary of T1 couples to the remote lines via diode D1, whereupon positive half-cycles appear on the upper remote line. Diode D3 at the controlled position conducts, whereas diode D4 does not, and relay A energises. Capacitor C1, connected across the coil of relay A, ensures that the rectified voltage across this coil is sufficiently smooth for the relay to operate reliably without chattering. When relay A energises, a connection is made from the Common terminal via energised contact set A1 and de-energised contact set B2 to terminal 2.

Setting S2 to position 3 causes the secondary voltage from T1 to be applied to diode D2, whereupon negative half-cycles are fed to the upper remote line. This time it is diode D4, and not diode D3, which conducts. Relay B energises whilst relay A de-energises. A circuit is now completed from the Common terminal via de-energised contact set A1 and energised contact set B1 to terminal 3.

The final setting of S2 is at position 4, where it causes the secondary of T1 to be applied direct to the remote lines. In this case both D3 and D4 conduct, whereupon both the relays energise. A circuit is thus made available from the Common terminal via energised contact set A1 and energised contact set B2 to terminal 4.

As may be seen, therefore, the remote control circuit allows the Common terminal to be connected through to any of the terminals 1 to 4 according to the position of the remote switch S2.

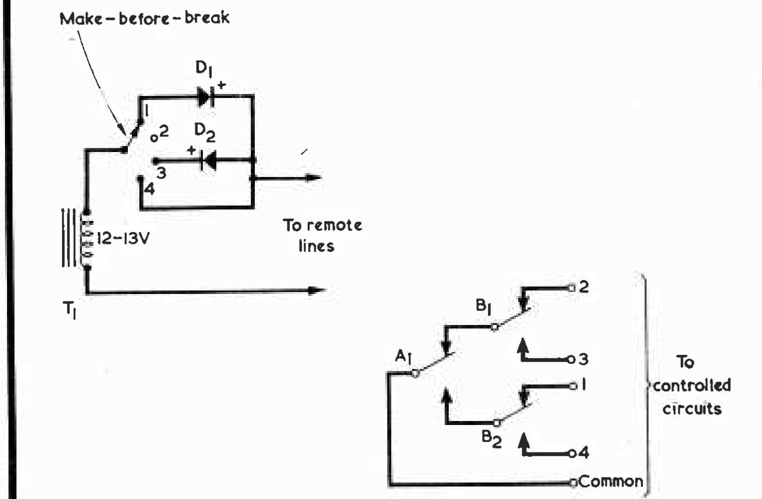


Fig. 2. A small circuit modification allows the use of a 'make-before-break' switch for S2

It is desirable for the lower remote line to be earthed either at the controlling or the controlled end. In Fig. 1 the earth connection is shown at the controlled end.

CIRCUIT VARIATIONS

A number of variations on the circuit shown in Fig. 1 are possible. An attractive modification could consist of ganging S1 and S2 so that S1 is closed when S2 is at positions 2, 3 and 4, and is open when S2 is at position 1. A suitable ganged switch could be made up with Radiospares 'Maka-Switch' parts, which include a mains-on-off switch section. 'Maka-Switch' kits are obtainable from Home Radio and Henry's Radio, both of which suppliers give details in their catalogues of the various switch parts available.

It is necessary for S2 in Fig. 1 to have 'break-before-make' contacts since, otherwise, both the relays will become energised when S2 is moved from position 2 to position 3 or vice versa. If it is desired to use a 'make-before-break' switch which may be already on hand, the alternative circuit of Fig. 2 can be employed. The only difference between this and Fig. 1 is that diode D1 is now brought into circuit when the switch is at position 1 instead of position 2 and that the numbering of terminals 1 and 2 is changed over at the controlled position to correspond. Otherwise, the range of con-

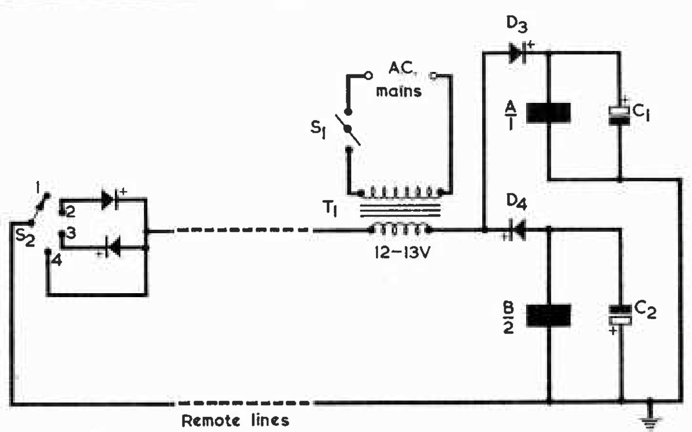


Fig. 3. If desired, the mains transformer may be sited at the controlled position

trol is the same as with Fig. 1. It is not, however, possible to gang S1 with S2 when using the circuit of Fig. 2.

If it is more convenient, the mains transformer may be sited at the controlled end of the remote lines, as in Fig. 3. This circuit has the advantage that there is no necessity to provide a mains supply at the controlling end, but circuit operation is otherwise basically the same as for Fig. 1. If a 'make-before-break' switch is to be used at the controlling end, diode D1 may be shifted from switch contact 2 to switch contact 1, as in Fig. 2.

COMPONENTS

An advantage of the circuit is that none of the components are particularly critical.

Mains transformer T1 is shown as having a secondary voltage of 12 to 13V, and suitable heater transformers are readily available on the home constructor market. Alternatively, low-cost 'charger' transformers with secondary voltages around the same value could also be used. It is assumed, here, that the relays employed at the controlled position will be capable of energising at coil voltages of 10 volts or less. If there is negligible resistance in the remote lines (as compared with relay coil resistance) it is helpful to work to the assumption that the rectified voltage across a relay coil will be, at lowest, about 1 volt less than the nominal secondary voltage of T1.

S2 is a wafer switch whose contacts should be capable of passing the required coil energising current. Unless relays with excessively low coil resistances are employed, a standard wafer switch of the 'wave-change' type will be quite satisfactory. Other points concerning this switch have already been discussed.

Diodes D1 to D4 should be all silicon rectifiers. Suitable types are Lucas DD000 or similar. Higher voltage silicon rectifiers, such as the BY100, will also be quite satisfactory.

The relays can be any type capable of energising at the voltage available, with the proviso that they should have a coil resistance of 300Ω or more. Lower coil resistances may require the use of unnecessarily heavy wire for the remote lines. If the controlled circuits operate at low voltages and currents, P.O. 3000 relays are particularly suitable. These are available on the home constructor market or, made up to specification, from L. Wilkinson (Croydon) Ltd., Longley House, Longley Road, West Croydon, Surrey. Both the relays should be of the same type and have the same coil resistance. This is necessary to ensure that they have equal energising and de-energising times.

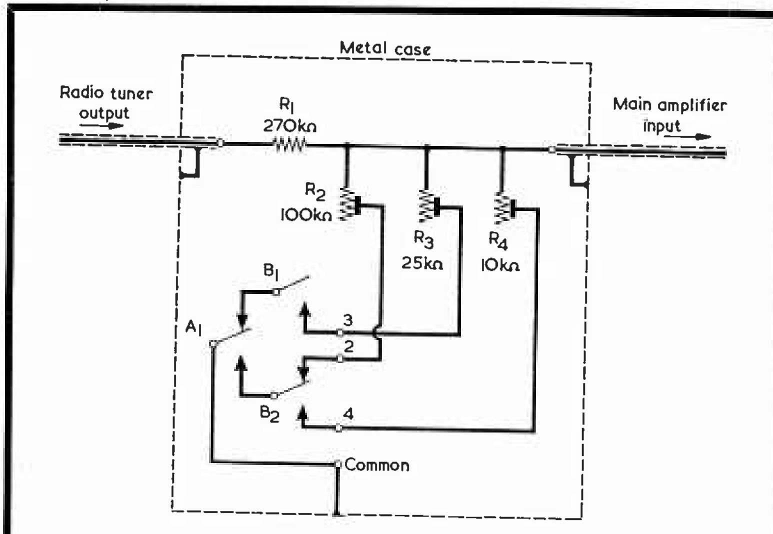


Fig. 4. A practical application of the circuit in which it was employed to vary the signal output voltage from a radio tuner

The values of electrolytic capacitors C1 and C2 are found experimentally, and should be just sufficiently high to provide an adequate rectified voltage across the appropriate relay coil when S2 is in position 2 or position 3. Too high a value in these capacitors will result in slow de-energising. The required values will normally be in the range of 10 to 50μF according to relay coil resistance and other factors. The working voltage of these capacitors must be equal to or greater than the rectified voltage appearing across the relay coils when S2 is in position 4, and care should be taken to ensure that they are connected into circuit with correct polarity.

AMPLIFIER APPLICATION

The high fidelity amplifier application mentioned at the start of this article employed the a.f. potentiometer circuit shown in Fig. 4, in which the terminals numbered 2, 3 and 4 correspond with those illustrated in Fig. 1. The remote control circuit was also the same as that in Fig. 1. The circuit of Fig. 4 was interposed between the output of the radio tuner and

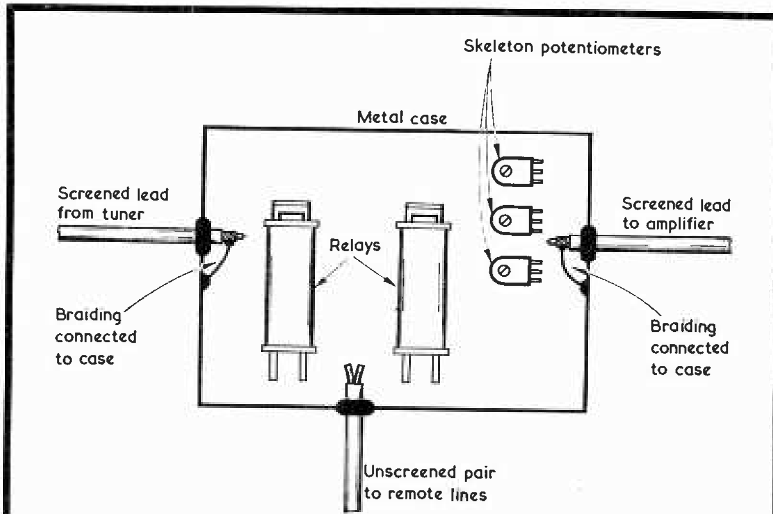


Fig. 5. The components for Fig. 4 were fitted in a metal case for screening, the case being connected to the outside braiding of the screened lead from the radio tuner and the screened lead to the main amplifier

the input of the subsequent high fidelity amplifier previously referred to.

It will be seen that a 270kΩ fixed resistor, R1, is inserted in series between the tuner and the amplifier. There is, in consequence, a small amount of permanent attenuation of tuner unit output. This was of no consequence in the installation in question since (as is to be expected also with other similar installations) the amplifier had more than adequate gain to handle the tuner unit output.

The relay contact circuit in Fig. 3 differs from that in Fig. 1 because there is no terminal 1. In consequence, relay contact set B1 need only be a 'make' type (i.e. its contacts 'make' when the relay energises) instead of a changeover type.

When S2 at the controlling end is at position 1 there is no connection via the relay contact circuit to R1, and the signal from the tuner undergoes minimum attenuation. When S2 selects position 2, a circuit is completed, via the relay contacts, from chassis (i.e. the earthy side of the two screened leads) to terminal 2 and thence to preset variable resistor R2. R1 and R2 form a potentiometer, R2 being adjusted to provide a volume level from the amplifier that is significantly lower than that given when S2 is at position 1. Setting S2 to positions 3 and 4 causes R3 and R4 to be brought into circuit respectively, these being adjusted to produce successively lower volume levels.

In the practical radio tuner and a.f. amplifier application, the relays were P.O. 3,000 types with 500Ω coils. C1 and C2 each had a value of 25μF at 25V wkg. The relays, capacitors and resistors were enclosed in a small metal case which provided complete screening and which was earthed to the braiding of the screened lead between the tuner and the amplifier, as shown in Fig. 5. Remote control wiring to the relay coils was kept clear of a.f. wiring to avoid the possibility of hum being picked up by the latter. The remote lines entered the box in the form of unscreened twin flex.

In the particular installation in which the circuit was employed the mains wiring in the shack had the same basic earth connection as was used in the house. In consequence, the lower remote line of Fig. 1 was dispensed with, it being replaced by connections, at either end, to the mains earth. It is important to note that the earth connection at the amplifier end should be made at the general mains earth point for the hi-fi equipment. It should *not* be made at the screened metal box of Fig. 5, or there will be a risk of introducing hum into the amplifier input. The upper remote line of Fig. 1 consisted of a single length of p.v.c. covered wire of the type employed in twisted lighting flex. ■

U.S.A. UNIVERSITY BUILDS MULTI-DISH RADIO TELESCOPE

Hidden from a busy Californian highway by a screen of trees, one of the world's most advanced radio telescopes is nearing completion in a quiet meadow behind the Stanford University campus.

Five big dish-shaped antennas, each 60 feet in diameter, have been mounted on pedestals in a 675ft. row. In about four months, when their coaxial cable connections and precise mechanical controls become operative, the dishes will begin receiving X-band (3 cm.) radio waves from some of the mysterious radio sources in space.

Strategic spacing of the five elements of this antenna array and its 15,000 square feet of aluminium surface will provide higher resolution and greater sensitivity than any comparable radio telescope in existence, according to Professor Ronald N. Bracewell, the designer and builder.

The five big dishes, aligned in a precise east-west direction, can be pointed simultaneously at any object in the sky, Thus working together, they will scan the heavens with a fan-shaped radio observation "beam" just one-third of one minute of arc in width.

Future plans call for one more dish over the hill to the east, which could squeeze the beam down to a mere one-sixth of a minute of arc. In a few years he also hopes to have a mobile antenna to the south which would move at a right angle to the row, thereby forming a pencil-shaped beam.

The "lobes" of the initial fan beam will spread out in a 10-minute-wide arc. By making successive fan-beam passes across a radio source, the astronomers plan to obtain multiple observations which computers will reduce to a single pencil-shaped observation.

This should enable the new telescope to observe about 75 of the known "quasars" and possibly the newly discovered "pulsars" with great precision. These radio sources range up to about one degree in width. With wider beams they appear fuzzy.

Radio telescopes collect electromagnetic radio waves just as optical telescopes collect visible electromagnetic waves, or light, from the stars. Although X-rays and other kinds of electromagnetic radiation are emitted by the stars, only radio and light waves can penetrate the atmosphere.

MULLARD WALL CHART

Readers might care to know that a wall chart (approximately 38 by 26in.) gives at a glance important data for the wide range of Mullard electrolytic, film and variable capacitors.

Copies of the wall chart can be obtained from Mr. A. Stewart, I.E.D., Mullard Limited, Mullard House, Torrington Place, London, WC1E 7HD (Telephone: 01-580 6633 Ext. 423).

"Good work, Saunders – I see you've flushed out another pirate!"

RSGB EXHIBITION 1970

Wednesday 19th to Saturday 22nd August

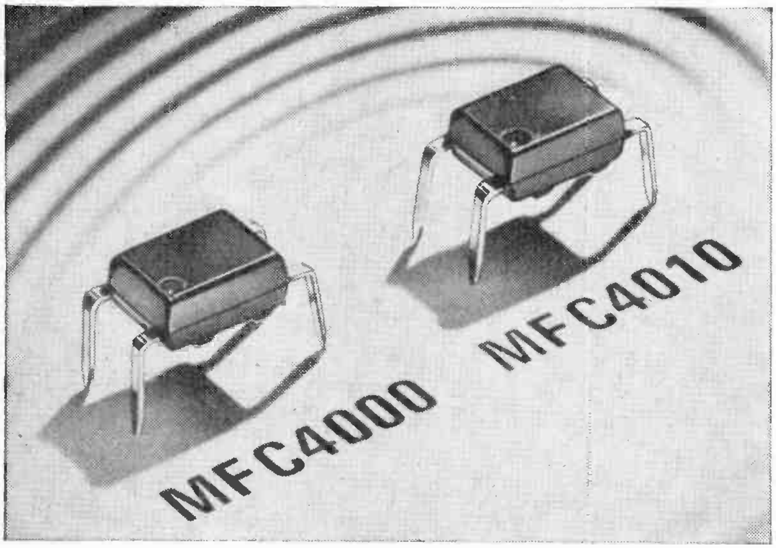
10 a.m. to 9 p.m. daily

The Royal Horticultural Society's New Hall, Greycoat Street, Westminster, London, S.W.1

(Nearest Station – Victoria)

NEWS . . . AND .

LOW-COST I.C. AMPLIFIERS



Motorola Semiconductors have announced a range of low cost integrated circuits for the consumer-equipment field. Known as MFC units, these plastic-encapsulated devices use smaller chips and contain fewer circuit elements than the professional-equipment range of i.c's. These new i.c's. also have wider pin spacing to make them suitable for the printed-circuit boards used in consumer products.

The first two devices in the range to be introduced are a low-power audio amplifier and a wide-band amplifier. The former, Type MFC 4000, is a 250mW a.f. amplifier with a low total harmonic distortion (typically, 0.7% at 50mW output) and is designed for pocket radios. Contained in a four-lead package, it includes six transistors, three diodes and five resistors and requires no output transformer to match to a 16Ω load. The input sensitivity is 15mV r.m.s. for 50 mW output. It requires a 9V d.c. supply and the quiescent current is 3.5mA.

The latter unit, Type MFC 4010, is a high gain (60dB) wide-band (100Hz to 4MHz, −6dB points) amplifier that could be used either as a general-purpose a.f. amplifier or as an i.f. amplifier at 465kHz. Typical output noise is 1mV r.m.s. Maximum power supply potential is 18V and typical current drain is 3mA. This i.c. contains three transistors and five resistors.

VIDEO DISC DISPLAYED

Following upon the information given in this feature in our last issue on Projecting Films on the TV Screen, we can now give news of a European competitor using discs instead of cartridges.

A German invention jointly developed by Telefunken, Decca and Teldec, this new type record was presented before the press in Berlin on Midsummer's Day.

Consisting of a video record player which can be attached to any television set, it is hoped to market the record player within the next two years, together with a wide variety of discs.

The price range is expected to be £50 to £60 for the player, and the discs are likely to cost about two guineas, depending on the size of record. The longest playing time at the moment is twelve minutes, but the use of an automatic record changer allows for longer programmes.

UNUSUAL RADIO AMATEURS

Five monks from Worth Abbey, East Grinstead, are now in Peru running a farm on the eastern slopes of the Andes. They produce protein food to improve the diet of the local Indians. But they felt they could do the job better if they had some personal contact with their brother monks back home at East Grinstead.

However, the farm is the best part of a day's journey from the nearest town, and getting requests through for supplies, or indeed making any kind of communication, is a major operation.

So the monks in East Grinstead have set up their own amateur radio station to link them with their mission 6,500 miles away. The Abbey was given two sets of transmitters and all the equipment needed to maintain a two-way radio link; and two monks, one in Britain and one in Peru, have taken the necessary radio amateurs' exam.

Now if radio amateurs overhear Worth Abbey calling Peru, they will understand what it is all about.
—From a BBC overseas broadcast.

HIGH-SPEED CASSETTE TAPE DUPLICATOR

A new, low-cost, high-speed cassette tape duplicator has been developed that will permit duplication of a master tape on to blank cassettes. The master tape may be either on reel-to-reel or cassette.

The duplicator is available in two versions. The Model DC1542 is a two-track monaural and the Model DC1544 is four-track stereo. Either model will duplicate up to 60 thirty-minute cassettes every hour, and with optional accessory equipment the capability of the duplicator can be increased to 300 cassettes per hour.

For further information and literature contact: Leviant International Inc., 641 Lexington Avenue, New York, New York 10022, U.S.A.

. . . COMMENT

HALF CENTURY OF BROADCASTING

Some fifty years ago, on 15th June, 1920, Dame Nellie Melba sang into a microphone at the Marconi Works in Chelmsford and made broadcasting history. This was the first advertised broadcast in the country, and it provided the first step towards organised broadcast entertainment and the BBC as we know it.

Melba's broadcast, sponsored by the *Daily Mail,* followed more than a year of experimental broadcasting from Marconi transmitters in Chelmsford. These early broadcasts were off-the-cuff affairs, run by the Company's engineers at irregular intervals, to gain experience in the technical problems of broadcast transmission. There were at this time only 300 or 400 amateurs in the country with receiving apparatus, but these few and their fellow enthusiasts all over the world listened eagerly to the early Chelmsford transmissions.

Careful preparations were made for the Melba broadcast. The transmission was made from a specially contrived studio in the New Street Works using a 15kW transmitter on a wavelength of 2,800 metres. The microphone, which till then had been hand-held, was suspended on elastic, and Dame Nellie provided her own 'tuning signal'.

She sang in English, French and Italian, and the broadcast attracted worldwide attention. This great public interest provided the necessary spur for the start of regular transmissions. Two years later the company had inaugurated a regular transmission from station 2MT, one of the Marconi test sites at Writtle just outside Chelmsford, and later, in June 1922, a new Marconi station was opened in London. This was the famous 2LO, a 10kW transmitter located in Marconi House in the Strand. 2LO ran as an experimental station for several months until the Government of the day finally took the decision to form the British Broadcasting Company, later the Corporation we know today. The Company took over the running of 2LO in November 1922, and a number of Marconi men went with the station to help lay the foundations of British broadcasting.

Today, the spot where Dame Nellie Melba sang "Home Sweet Home" is part of the Marconi High Power Test department, where transmitters of 55kW are run at full power on test, before being shipped to all parts of the world.

NEW STYLE SELF BINDERS

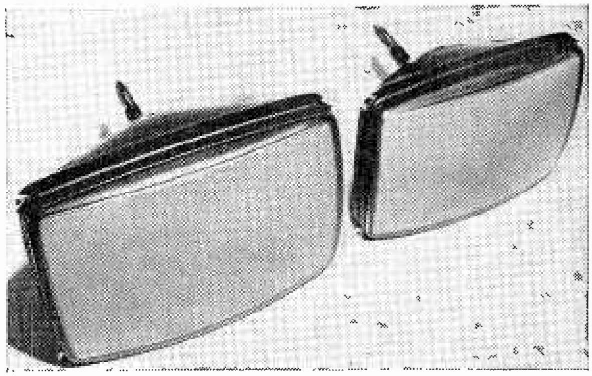
Observant readers of our advertising pages may have wondered why advertisements for our excellent self-binders suddenly ceased.

The reason was that the manufacturers suffered a disastrous fire which meant the abandonment of their factory, the loss of machines, and entailed the search for fresh premises.

Fortunately we kept good stocks in hand and the inconvenience to readers ordering was minimal.

We are glad to say that supplies are now in hand again with the exception of the green plain backed binders which are not expected to be available until mid-September.

MAZDA SQUARED-OFF COLOUR TUBES



Ediswan 26in. A67 - 120X and 22in. A56 - 120X shadow-mask colour tubes with Rimguard III push-through implosion protection and moire – minimised 625-line masks with temperature compensated mountings.

First shown at Paris, April 1970. At London, May 1970, these tubes were shown as Mazda for the British market.

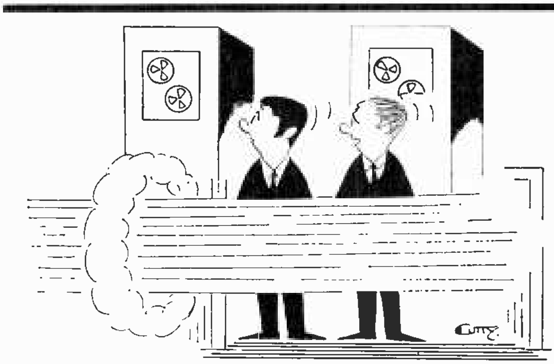
Ediswan and Mazda colour tubes are made in England by Thorn Colour Tubes Limited and marketed through Thorn Radio Valves and Tubes Limited.

FLEX CHANGE DELAYED

Shortly before the General Election it was announced in the House of Commons, by the then Joint Under-Secretary, Home Office, that the date on which the three-core flexible electrical cord in the old British standard colours of red, black and green ceases to be allowed on domestic appliances for sale, is being put back to 1st April, 1971.

SCHOOLBOY HUMOUR

"Sir, if it's a short circuit why can't you lengthen it?"



"Now that's what I call a high speed computer !"

One-valve Record Player Amplifier

by

H. WILLIAMS

Although it only employs a single valve, this little amplifier offers an output of 2.5 watts and incorporates n.f.b. tone control. A useful feature is that a number of the components are not critical in value, whereupon a saving can result by the inclusion of parts that may already be to hand

IT IS THE WRITER'S OPINION THAT, SHILLING FOR shilling, the valve amplifier can still hold its own against comparable transistor types over about 1 watt of power; in addition, salvaged parts stripped from ex-Government equipment or old TV sets can be employed far more readily in valve designs, thereby enabling further savings to be made.

The amplifier described here was specifically designed for a record player and although its quality is not claimed to be high-fidelity it is nevertheless very acceptable and compares favourably with that offered in the cheaper range of commercially available designs. The amplifier uses a single valve, an ECL82. This is really a double valve, since it has a triode and an output pentode in the one envelope. The output is about 2.5 watts and the design incorporates a tone control which gives wide control over the bass and treble response.

IMPEDANCE MATCHING

Apart from the cost saving and the facility for using surplus parts, valve amplifiers have a further advantage over transistor designs so far as simple record player applications are concerned. This is because most record player decks are fitted with a crystal pick-up which matches perfectly and directly into a valve, whereas impedance matching is essential for matching into transistor designs (f.e.t.'s excepted). The impedance of a crystal pick-up is extremely high and good quality can be expected when it is correctly matched. Crystal pick-ups suffer from one major disadvantage, this being that their output can suddenly vary. The output may also change with humidity. Nevertheless, for general usage and economy, crystal pick-ups are excellent.

It is always useful to have a spare amplifier at one's disposal and the amplifier to be described incorporates a jack into which any input can be applied. Inserting the jack plug automatically breaks the connection to the pick-up. This particular feature can be omitted if it is not desired, but the extra versatility it offers is worth the small cost of the jack socket.

THE CIRCUIT

The circuit diagram for the amplifier is given in Fig. 1. The output of the pick-up, which is at high impedance, is connected to the upper end of the track of volume control VR1 via the jack socket contacts. Because of the high impedance at which the input circuit operates, it is essential to employ screened wire for all connections in the pick-up and volume control circuits. If unscreened wire were em-

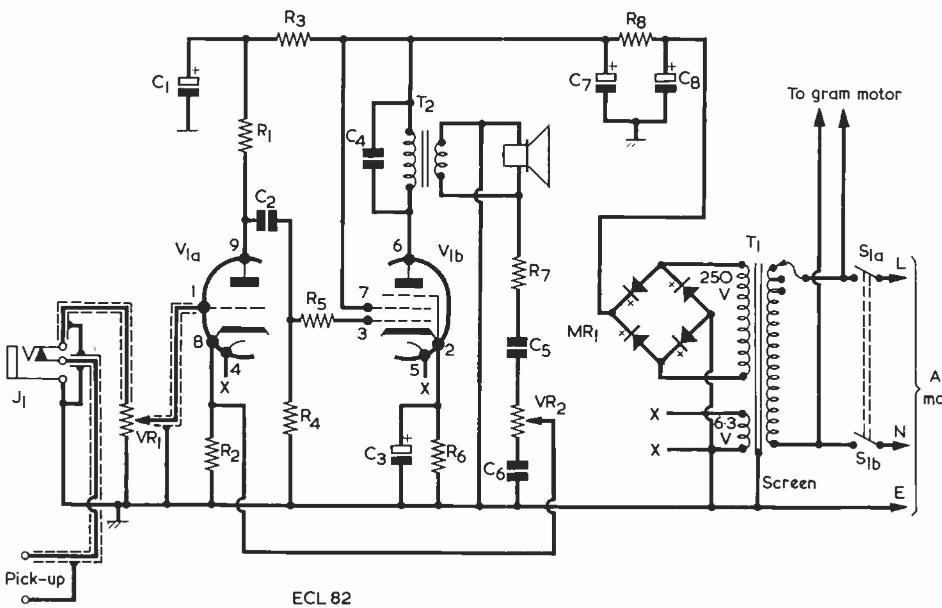


Fig. 1. The circuit of the one-valve record player amplifier

ployed there would be a high level of hum in the amplifier output.

The slider of the volume control connects to the grid of the triode section, V1(a), of the ECL82. So far as bias is concerned, the triode grid is maintained at chassis potential by way of the volume control itself, the cathode being allowed to take up a small positive potential due to the voltage dropped across cathode bias resistor R2. Normally, R2 would have a high-value electrolytic capacitor connected across it to prevent the cathode voltage fluctuating in sympathy with the signal voltage. In the present circuit, however, this capacitor is omitted to enable a negative feedback signal to be applied to the triode from the output transformer.

COMPONENTS

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

R1	220kΩ
R2	2.2kΩ
R3	22kΩ
R4	470kΩ
R5	470Ω
R6	390Ω 2 watt
R7	2.2kΩ
R8	1kΩ 3 watt
VR1	1MΩ potentiometer, log with switch S1(a)(b)
VR2	25kΩ potentiometer, linear

Capacitors

*C1	12μF electrolytic, 350V wkg.
C2	0.1μF paper, 350V wkg.
C3	50μF electroytic, 25V wkg.
C4	0.001μF paper, 350V wkg.
C5	0.1μF paper, 150V wkg.
C6	0.1μF paper, 150V wkg.
*C7	12μF electrolytic, 350V wkg.
*C8	12μF electrolytic, 350V wkg.

* C1, C7, C8 in single can – see text.

Inductors
T1 Mains transformer; secondaries 250V 60mA, 6.3V 1A (see text)
T2 Output transformer; 5,000Ω to 3Ω (see text)

Valve
V1 ECL82

Rectifier
MR1 Contact cooled selenium bridge rectifier; 250V 75mA

Switch
S1(a)(b) d.p.s.t. switch (part of VR1)

Socket
J1 Jack with break contact

Speaker
3Ω moving-coil

Miscellaneous
B9A valveholder
Tagstrip (see text)
2 knobs
Aluminium chassis (see text)
Screened wire
Grommets, solder tags, etc.

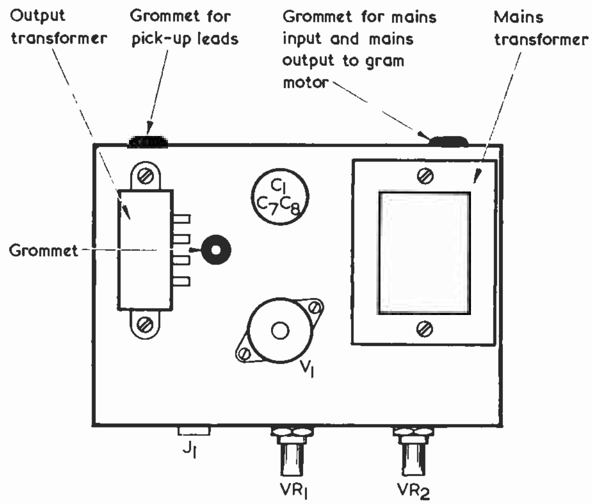


Fig. 2. General layout of components above the chassis

The amplified signal at the anode of the triode is developed across R1 and coupled by way of C2 and R5 to the signal grid of V1(b). The function of R5 is to eliminate parasitic oscillations, which can occasionally give trouble when high gains at high impedance are provided.

R6, bypassed by C3, provides cathode bias for V1(b). The anode load for V1(b) is the primary of the output transformer, T2. C4 provides a tiny amount of top-cut, this being necessary to make the tone control operate over the required range. Usually, tone-correction components do not appear within a feedback loop but, in practice, C4 provides just the right amount of correction required in the present circuit.

Negative feedback is taken from the secondary of the output transformer. One lead from the secondary of T2 connects to chassis while the other passes to a frequency selective filter comprising R7, C5, C6 and VR2. The slider of VR2, which functions as tone control, is then taken to the cathode of V1(a). It is important that the connections to the secondary of the output transformer are made right way round. The incorrect method of connection causes the feedback to be positive instead of negative, whereupon the amplifier will go into violent oscillation. This point is referred to again later.

R8, C7 and C8 comprise the h.t. smoothing components, while R3 and C1 decouple the first stage from the second. The power supply is quite straightforward. One side of the heater winding of T1 is earthed to chassis. In a television set or even a table radio it is perhaps excusable to use a live chassis since this can be completely insulated in a cabinet with suitable knobs, etc. But a live chassis should not be employed with a record player amplifier and a mains isolating transformer (as is used here) is essential).

COMPONENTS

The parts employed in the amplifier are all available through the usual component retail sources. In many cases it may be possible to use components that are already to hand.

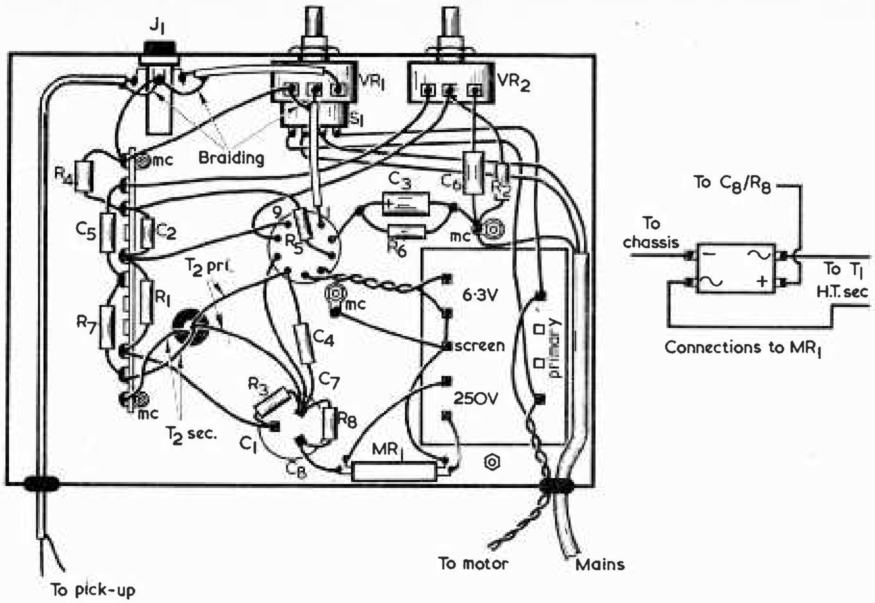


Fig. 3. Underchassis layout and wiring with the prototype amplifier. Some types of jack socket will have different tag positioning to that shown here

The two transformers require special mention. Output transformer T2 should be capable of matching the 5,000Ω load required by the output pentode to a 3Ω speaker, and its ratio should be 40:1. In practice, a certain amount of leeway is permissable and ratios between 35:1 and 45:1 will be quite satisfactory. An excellent choice would be the output transformer available from Home Radio under Cat. No. TO44, which offers 5,000Ω to 3.75Ω and is rated at 5 watts. This transformer may be used with a 3Ω speaker, as specified in the Components List.

The mains transformer should have an h.t. secondary offering 250V at 60mA (or more) and 6.3V at 1A (or more). A good component here is the midget clamped transformer giving 250V, 60mA and 6.3V, 2A which is available from R.S.C. Hi-Fi Centres Ltd., 102-106 Henconner Lane, Leeds 13. Any other mains transformer offering the required secondary voltages and currents could also, of course, be used.

Rectifier MR1 is a contact-cooled selenium bridge rectifier rated at 250V 75mA. This is a standard part available from Henry's Radio and other suppliers.

A triple electrolytic capacitor in a can secured with a clip was used in the author's amplifier for C1, C7 and C8. This offered three separate 12μF capacitors. The actual capacitance required is not very critical and it would be equally in order to use a triple 16μF capacitor. Again, C1 could be 8μF, in combination with either 12μF or 16μF in the C7 and C8 positions. If necessary, C7 and C8 can be a double electrolytic capacitor in a single can, with C1 as a separate wire-ended capacitor. When using double or triple capacitors, check any legend on the can to see if a particular section is recommended for use as 'reservoir'. This section should then be that employed for C8. The normal practice is to code the tag of the reservoir section red.

The input jack J1, should be of a type which breaks a contact when the jack plug is fitted, as is illustrated in Fig 1.

Note that the volume control, VR1, is ganged with the on-off switch, S1(a)(b).

The wiring diagram, Fig. 3 shows an 11-way tag-strip with end tags earthed. The tagstrip actually employed need not necessarily be 11-way provided that its end tags connect to chassis and that six intermediate tags are available for the other connections made to it.

CONSTRUCTION

Layout is not very critical and should follow the general lines shown in the above-chassis view of Fig. 2 and the below-chassis wiring diagram of Fig. 3. No attempt towards making or purchasing a chassis should be made until all parts have been obtained, as the chassis dimensions will naturally depend on the size of the larger components. As a guide, the chassis used by the author measured 6in. by 4in. by 2½in. deep. If a chassis of different size is used it should still have a depth of 2½in.

The mains transformer in the author's amplifier was a drop-through type with tags. Alternative types can be mounted above the chassis with leads passing below through suitably positioned grommets. If the transformer has lead-out wires instead of tags, and is also provided with primary taps for different mains voltages, be careful to tape up the ends of primary tap leads which are not used to ensure that these cannot short-circuit to chassis or any other connection. Some mains transformers do not have a connection for a screen (which appears between the primary and secondary windings inside the transformer) whereupon this connection may be ignored.

The jack socket, VR1 and VR2 are mounted in line on the front chassis apron with symmetrical spacing. Potentiometer tags should face away from the underside of the chassis deck to facilitate wiring later.

Holes for all components and grommets should be drilled before mounting any parts. It is important to ensure that the mounting holes for MR1 are free from burrs so that this component makes good thermal contact to the chassis. This is necessary since the chassis provides the cooling area required by this rectifier.

Should C1 be a wire-ended capacitor, its positive lead-out, together with one end of R3, may be anchored at the same tag on the tagstrip as is used by R1.

When wiring up the connections to S1(a)(b) remember to include the pair which carries mains power for the gram motor. Also, check the switch contacts with a continuity tester or ohmmeter before wiring, to determine which tags correspond to the two poles of the switch.

The braiding of the screened wire is earthed at the points shown. The braiding of the screened wire to the pick-up also connects, at the pick-up end, to the metalwork of the gram deck.

Other points to which attention should be paid are that the heater wiring should be twisted and that the lead between R5 and pin 3 of the valveholder should be kept short. The leads to the speaker travel away above the chassis, either direct from the tags of T2 or, if this component has wire lead-outs, from the appropriate connections under the chassis and through the adjacent grommet.

TESTING

When wiring is complete, carry out a careful visual check for errors; then test for h.t. short-circuits with a continuity tester or, better, an ohmmeter, connected between chassis and the positive tags of both C7 and C8. If an ohmmeter is used, its needle will give an initial 'kick' as the electrolytic capacitors charge after which, if all is well, it will return to a high resistance reading.

Fit the valve, set up VR2 so that its slider is at the end of its track which connects to C5, connect a speaker and apply the mains. Switch S1(a)(b) on, and hold the control knob as the ECL82 warms up. If the speaker should give evidence of oscillation, switch off immediately. The oscillation will be due to the existence of positive instead of negative feedback, and will disappear if the connections from chassis and R7 to the secondary of T2 are transposed.

The amplifier is then ready for use. ■

RADIO AMATEURS' EXAMINATION COURSE

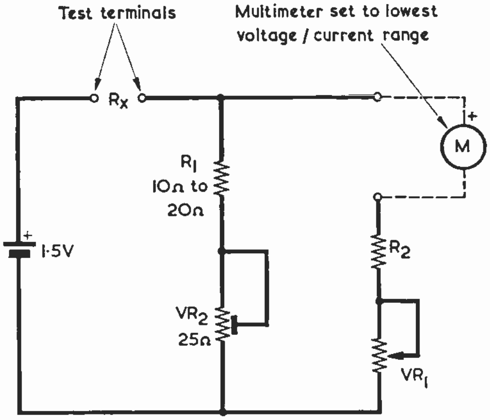
A course for the Radio Amateur Examination will commence at 1900BST on 30th September at Western Road School, Sheffield. Full details may be obtained from J. Bell G3JON, 30 Alms Hill Road, Sheffield S11 9RS. Tel: 367774.

Additional Resistance Ranges for Multimeters

by

J C. EADE, B.A.

Low-cost multimeters may have extra resistance ranges added by the use of an external unit. The existing resistance scale calibration applies for the added resistance ranges



Multimeter	R2*	VR1
1mA (1,000Ω per V)	330Ω	250Ω
100μA (10,000Ω per V)	9kΩ	5kΩ
50μA (20,000Ω per V)	18kΩ	10kΩ

* see text

Fig. 2. A circuit offering a low ohms range with centre scale reading at 30Ω

INTRODUCTORY NOTE

The add-on circuits described in this article rely on the fact that a multimeter switched to a resistance range may be considered as being a battery, an internal resistor R and the unknown resistor Rx in series, the meter movement corresponding to an infinite impedance voltmeter connected across R. (See 'Understanding Radio', page 431, in the February 1970 issue). The meter then reads f.s.d. when Rx is zero and half-scale when Rx is equal to R.

In the circuits to be discussed, an external battery and R are effectively applied to the multimeter, the latter being switched to a low *current* or to a low *voltage* range. Provided that the meter reads f.s.d. when Rx equals zero, and half-scale when R equals the desired mid-scale resistance required, the existing resistance range scales on the multimeter can be used (with appropriate multiplying or dividing factors) for the added ranges. The meter movement is still employed as a voltmeter, but it will not in practice offer infinite impedance; whereupon in some cases the external R is made up of an external resistor in shunt with the effective voltmeter resistance.—Editor.

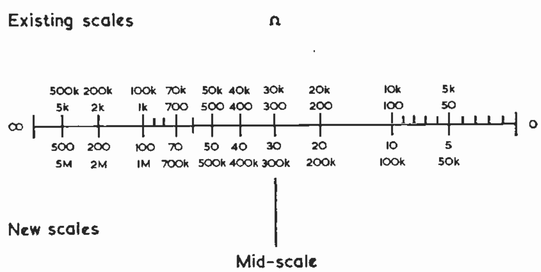


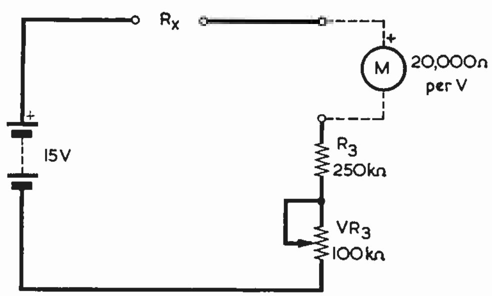
Fig. 1. The resistance scale graduations on the author's multimeter. The original scale has a length of approximately 3½in

MANY CHEAP MULTIMETERS SEEM TO SUFFER FROM deficient ohms ranges. The author has, for example, a meter with two ranges only, these offering 300Ω centre scale and 30,000Ω centre scale. See Fig. 1. Thus, measurements below about 10Ω are almost impossible, whilst the first 50Ω occupies only about half an inch of the scale. It was therefore decided at first to add an extra low ohms range, this having 30Ω at centre scale and enabling the existing low ohms scale to be used with readings divided by 10.

ADD-ON CIRCUIT

The circuit employed is shown in Fig. 2. In this the multimeter is switched to its lowest current or voltage range, according to whichever offers the greater sensitivity. To set up the circuit, VR2 is initially set to insert maximum resistance and the test terminals short-circuited (causing Rx to be equal to zero). VR1 is then adjusted for f.s.d. in the meter. VR2 is next set so that the total series resistance is equal to the required centre scale reading – in this case 30Ω. For meters having a basic movement of 1mA f.s.d. (1,000 ohms per volt) or less, the resistance offered by VR1, R2 and the meter is high relative to that given by R1 and VR2 is in series, whereupon these may be adjusted for 30Ω on their own. Alternatively, and as a final adjustment in any case, a known value of resistance close to, or equal to, 30Ω may be connected across the test terminals and VR2 adjusted for the corresponding multimeter scale reading.

Fig. 2 also shows values for VR1 and R2 suitable for practical multimeters of different sensitivities. (If the meter is switched to a low current range R2 will



(a)

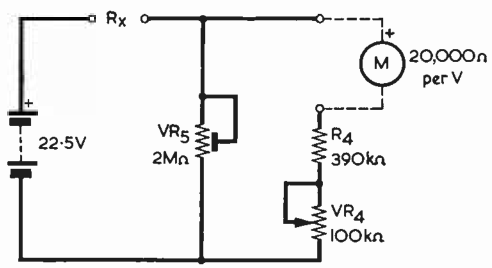
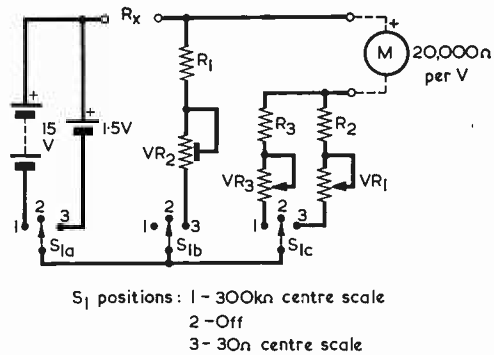
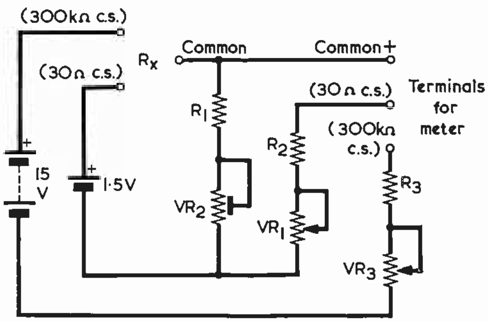


Fig. 3(a). A simple circuit which offers a high resistance range with 300kΩ centre scale (b). A more comprehensive circuit offering the same facility



(a)



(b)

Fig. 4(a). The circuits of Figs. 2 and 3(a) combined in a single unit with switching (b). An alternative method of combining the circuits without switching

probably require a higher value than those shown. It would then be preferable to commence by making R2 plus VR1 equal to about 1.5 times the ohms per volt figure for the meter, then reduce R2 accordingly. —Editor.)

A limitation to the circuit is that when Rx is zero the current flowing in the test terminal circuit is:

$$\frac{V}{R} = \frac{1.5}{30} \times 1{,}000\text{mA} = 50\text{mA}.$$

The current will of course decrease as Rx increases. Thus, when Rx is 30Ω the current is 25mA, and so on. This means, first, that the battery must be able to provide the current and, second, that Rx must be able to stand it!

The component values in the circuit could easily be changed to give other centre scale readings to match existing meter scales. VR1 should be a panel control to allow for dropping battery voltage. Accuracy will suffer when the battery voltage falls below 1.5 unless VR2 is also adjusted, but the effect is unlikely to be noticed in practice.

HIGH RESISTANCE RANGE

It was then decided to add a further range with 300kΩ centre scale. The circuit required here will only be possible for use with meters whose sensitivity is 50μA (20,000 ohms per volt).

Two suitable circuits are shown in Fig. 3. That illustrated in Fig. 3(a) is the simpler and functions because the meter resistance, R3 and VR3 in series add up to 300kΩ when passing 50μA from a 15 volt battery. A value in Rx of 300kΩ will then result in a centre scale reading.

Fig. 3(b) shows an alternative circuit, in which the supply is provided by a 22.5 volt battery. Working to a nominal battery voltage of 22, VR5 requires an estimated value of 943kΩ to provide, in parallel with the meter resistance, R4 and VR4, a total series resistance of 300kΩ. The circuit can be set up in the same manner as was that of Fig. 2.

The circuit of Fig. 3(b) is theoretically better than that of Fig. 3(a) because accuracy can be retained with a dropping battery voltage by adjusting VR4. In practice, however, the circuit of Fig. 3(a) is quite adequate for general requirements.

It is anticipated that the reader will be able to calculate the resistor values and battery voltage required for centre scale readings other than 30Ω by following the two examples shown in Fig. 3.

The circuits of Fig. 2 and Fig. 3(a) have been combined in a box with suitable switching, as shown in Fig. 4(a). An alternative approach, without switching, is shown in Fig. 4(b). These circuits have proved to be a cheap and very useful addition to a multimeter. ■

CURRENT SCHEDULES

Times = GMT *Frequencies = kHz*

IRAQ

European transmissions from Radio Baghdad are as follows–

English at 1930, German at 2020 and French at 2110 on **6030** and the new channel of **9610** (replacing **6095**).

GRENADA

Windward Islands Broadcasting Service signs off the English transmission to the U.K. at 2200 on **21690.**

POLAND

The 1st National Programme can now be heard on short waves on **6135** and **7175** from 0400 to 1600. The 3rd National Programme can be heard on **6020, 6095, 7175, 7205, 9575, 9625** and **11790.**

PORTUGAL

The new station Radio Trans-Europe, Lisbon, has been heard testing from 1350 to 1500 on **11720** and from 1950 to 1960 on the **7150** and **9655** channels. Reports are requested and should be sent to Radio Trans-Europe, Postbox 21040, Lisbon.

BELGIUM

ORU Brussels has been heard on the new frequency of **21555** from 1000 to 1300 and also on **17845** commencing at 1430.

KUWAIT

The Arabic Service of Radio Kuwait can now be heard from 1300 on **21605** and **21685.** Radio Kuwait can also be heard, in English, at 0400 on **17750.**

MALAYSIA

The Voice of Malaysia, Kuala Lumpur, now broadcasts in English from 0630 to 0640 on **15280;** from 0625 to 0855 on **11900** and from 1045 to 1055 on **6175.** The Voice of Malaysia can also be heard from 0900 on **11900.**

CANADA

The International Service of the Canadian Broadcasting Corporation beams programmes in English to Europe as follows – daily from 0715 to 0745 on **9625** and **11765;** from 1217 to 1313 on **9625, 11720** and **15325;** newscast from 1516 to 1522 on **17820** and **21595;** from 2115 to 2152 on **15325, 17820** and **21595.** On Saturdays and Sundays, the latter service to Europe is from 2100 to 2150.

VIETNAM

The Voice of Vietnam broadcasts programmes in English at 0500, 1000, 1300, 1530, 2000 and 2300 on **7360, 7416, 9840, 10224** and **15018.** The station has also been heard on **10040.** The address for reports is Voice of Vietnam, 58 Quan Su Street, Hanoi, North Vietnam.

JAPAN

The Nippon Short Wave Broadcasting Company is the only commercial service in Japan. With 50kW transmitters located in Tokyo, the schedule is as follows – from 2030 to 1600 on **3925, 6055** and **9595;** from 2030 to 2300 on **3945** and from 0800 to 1600 on **3945.**

A second programme via 10kW transmitters located at Sapporo operates as follows – from 2300 to 0720 on **3945** and **7230;** from 0100 to 0500 on **9760.**

Acknowledgements – SCDX and our Listening Post.

Mains-battery Power Supplies

by

D. SNAITH

A mains supply unit which automatically changes over to battery operation on cessation of the mains input is always an attractive proposition. If a small drop in output voltage during battery operation can be tolerated, the circuit resolves to a standard mains power supply plus the stand-by battery and one silicon rectifier!

There's no such thing as the 'ideal rectifier' we read about in the text-books, but the silicon rectifier certainly gets very close to it. Not only does the silicon rectifier exhibit an extremely low forward resistance but it also passes an exceptionally low reverse current. The only major snag with the silicon rectifier is that it does not start to conduct fully, when forward-biased, until the voltage across it is around 0.6 volt.

This last shortcoming of the silicon rectifier is not of great importance in the mains-battery power supply circuits to be described in this short article. On the other hand, the low forward resistance and low reverse current help considerably so far as overall efficiency is concerned. Because of this last point, these circuits should not be used with rectifiers other than silicon types.

POWER SUPPLY

The circuits were evolved following the need to construct a small mains power supply for a transistor radio receiver, the power supply providing automatic changeover to stand-by battery operation if the mains supply should happen to be interrupted. The receiver was capable of giving a satisfactory output with supply potentials ranging from 5.5 to 9 volts, and so it did not matter if the output voltage with battery operation was a little lower than that given by mains operation. A small 6.3 volt heater transformer was already to hand, whereupon it was decided to obtain the mains operation output by rectifying the 6.3 volts available from this component. It was hoped that the usual reservoir capacitor rectifier circuit would cause the resultant direct voltage to be a volt or so higher than the 6.3 volt r.m.s. rating of the transformer secondary.

The first circuit to be tested was that shown in Fig. 1. This was initially assembled in temporary form because the writer wanted to see how well the mains-battery switching section would function in practice. During checks, the output of the supply was connected to a 180Ω resistor instead of to the radio. Such a resistor draws about 40mA with 7.5 volts across it and would be reasonably equivalent to the radio when the latter was working at a high volume level.

If Fig. 1 is examined it will be seen that the mains supply is applied to the primary of T1 via S1(a), which is one section of the On-Off switch for the power supply. The 6.3 volt secondary of T1 couples to the half-wave rectifier circuit given by D2 and C1, and thence to the smoothing components R1 and C2. All this is, of course, perfectly straightforward, until we notice battery B1 and diode D1 lurking near the output terminals. B1 is the stand-by battery which provides current to the load when the mains supply is interrupted, and it is switched in and out of circuit by S1(b), the remaining section of the On-off switch. This battery, incidentally, can consist of five 1.5 volt pen-light cells in series, or of any other cell or battery combination offering a total of 7.5 volts.

The writer was pleased to find that the circuit of Fig. 1 worked extremely well. When switched on with the mains supply applied, the output voltage was 7.7 volts. Removing the mains plug from its socket caused the output to drop to 7 volts, this being provided by the battery. When the mains plug was refitted the output returned to 7.7 volts once more. The changeover from 7.7 to 7 volts was smooth and completely automatic, with no cessation of output current at all.

What happens here is that, when the mains supply is applied, rectifier D2 functions in normal manner, and causes a rectified voltage to appear, across C2, of 7.7 volts. This means that the upper terminal of diode D1 is 0.2 volt positive of its lower terminal, which is held at 7.5 volts positive with respect to the negative rail by battery B1. Thus diode D1 is reverse-biased and cannot conduct current from the battery. All the current to the load is, in consequence, obtained from the mains by way of the D2 rectifier circuit. When the mains supply is interrupted, the rectified current from D2 ceases, whereupon the potential on the upper terminal of D1 drops until it reaches about 7 volts. This time D1 upper terminal is negative of its lower terminal and the rectifier conducts, with the result that all the current passing to the load now flows from the battery. As already mentioned, the fact that the voltage from the battery is a little lower than that from the mains is of no importance when the load is a transistor radio which is capable of functioning at considerably lower supply potentials.

It might be thought that, since

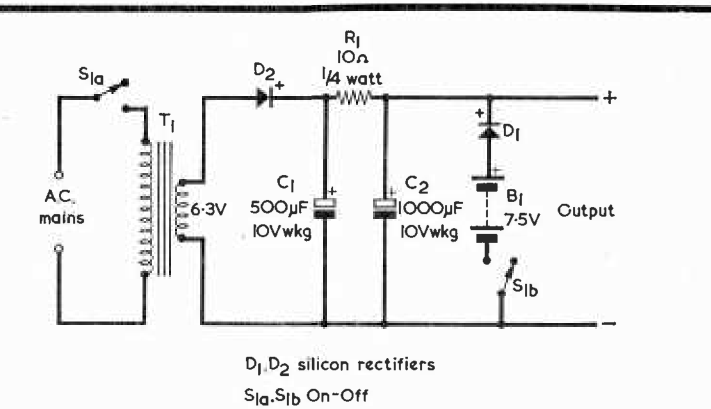


Fig. 1. Mains-battery power supply circuit employing a half-wave rectifier. Load current flows from the battery when the mains input is disconnected

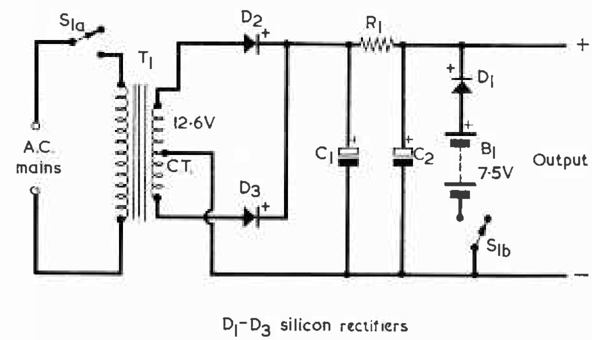


Fig. 2. An alternative circuit incorporating a full-wave rectifier. The values of C1, R1 and C2 are the same as in Fig. 1

there is now no voltage across the 6.3 volt secondary of T1, this winding will act as a short-circuit and draw current from the battery. However, such an eventuality cannot happen because D2 is now reverse-biased and cannot pass current. When the mains is disconnected the only current drawn from the battery in addition to that flowing in the load is leakage current in electrolytic capacitors C1 and C2. If these are good components of reliable manufacture, the total leakage current need only be of the order of 20 to 30μA. Also, C2 could be the high-value electrolytic capacitor which is, in any case, normally connected across the supply rails of a transistor radio, whereupon the existence of a leakage current assumes even less significance.

A testmeter was connected in series with the battery to check the current drawn from it with the supply switched on. When the mains was disconnected, battery current rose immediately to approximately 40mA as required by the load. On the other hand, when the mains supply was connected the current drawn from the battery was so low that it did not cause any noticeable deflection of the testmeter needle when this instrument was switched to read 0-50μA. It can be assumed that, if the mains supply is continually applied, the life of the stand-by battery will be equivalent to its shelf life.

FULL-WAVE AND BRIDGE CIRCUITS

Although not necessary for his immediate requirements, the writer felt that it would be an interesting exercise to check the mains-battery switching circuit with alternative rectifier circuits. That shown in Fig. 2 was next tried out. The only difference between Fig. 2 and Fig. 1 is that the rectifier circuit is full-wave, with D2 and D3 connecting to the outside ends of a centre-tapped 12.6 volt winding. The latter consisted, actually, of two 6.3 volt heater windings connected in series, these being provided by a standard mains transformer pressed into service for the experiment. It will be seen that diodes D2 and D3 are, as is D2 in Fig. 1, reverse-biased when the mains supply is removed, with the result that the only current then drawn from the battery in excess to that passing through the load is leakage current in the electrolytic capacitors.

The results given by the circuit of Fig. 2 were identical to those given by Fig. 1. Output voltage with the mains applied was 7.7 volts, this dropping to 7 volts when the mains supply was disconnected. The current drawn from the battery with the mains applied was not perceptible on the 0-50μA range of the testmeter.

The final circuit checked out employed the original 6.3 volt transformer of Fig. 1, this being now connected to the bridge rectifier given by D2 to D5. The remainder of the circuit is the same as Fig. 1. Here again, the rectifiers D2 to D5 are reverse-biased when the mains supply is disconnected, whereupon current from the battery can then only flow through the load and the electrolytic capacitors.

Results with the circuit of Fig. 3 were a little different from those given by Figs. 1 and 2. With the bridge rectifier circuit there are two forward-biased rectifiers instead of one to conduct on alternating half-cycles, with the result that the output voltage when the mains is applied is lower. Actually, it was 7.4 volts with the writer's set-up, dropping to 7 volts when the mains was disconnected. This means that, in Fig. 3, the upper terminal of D1 is now some 0.1 volt negative of its lower terminal when the mains is connected. D1 still cannot conduct fully, but it can pass a very small forward current. With Fig. 3, a current of 4μA was drawn from the battery when the mains was applied.

Finally, the circuit of Fig. 1 was tried out with the transistor radio instead of the 180Ω test load resistor, and this continued to play uninterruptedly regardless of whether the mains lead was plugged into its socket or not. When the receiver was adjusted for a low volume level, causing the current drain to be less than with the 180Ω resistor, output voltage for mains operation was about 8 volts, dropping to 7 volts when the mains supply was removed. This resulted in a hardly noticeable drop in volume level.

Discerning constructors will be able to adapt the circuits of Figs. 1, 2 and 3 for other supply voltages and currents. Working from the writer's findings the design approach should consist of ensuring that the voltage output provided with mains operation is always at least 0.2 volt greater than nominal stand-by battery voltage. Lower voltages during mains operation may cause the onset of forward current drain via D1, as occurred in the 4μA example observed with Fig. 3. The choice of silicon rectifiers should not be particularly critical – those used by the writer were all BY100's. Although intended for higher voltage

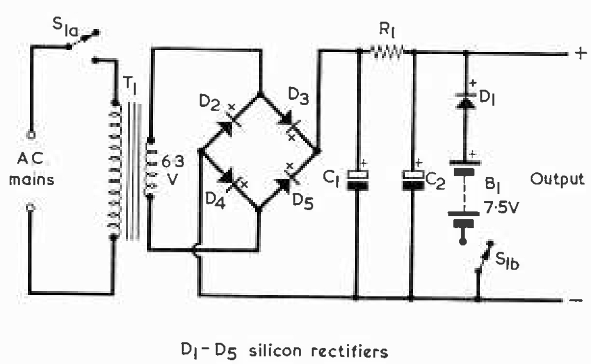


Fig. 3. In this circuit a bridge rectifier is used. The remaining components are unaltered in value

operation, the performance of BY100 rectifiers at lower voltages appears to be identical with that of silicon rectifiers specifically intended for such voltages. There is a slight possibility that some low voltage rectifiers, when reverse-biased, may offer higher leakage resistance than the BY100, whereupon the constructor who wishes to work direct from the writer's experience could, if he so desires, use a BY100 in the D1 position for any of the circuits.

Figs. 1 to 3 assume that the 'chassis side' of the power supply output is common to the negative rail. If it is desired to have the 'chassis side' common to positive, all diodes, electrolytic capacitors and the battery should be reversed in polarity. The values of C1, R1 and C2 are not critical, apart from the fact that C1 and R1 can have some effect on output voltage when the mains supply is applied. Any suitable values applicable to the purpose for which the supply circuit is to be used may be employed for these components. Also, R1 could alternatively be an l.f. choke. ■

CATHODE-RAY TUBE POWER SUPPLY

Brandenburg Ltd., 939 London Road, Thornton Heath, Surrey, are currently developing a range of all solid-state cathode-ray tube power supplies and can now announce the first available units – Models 690 (12kV) and 691 (15kV), available at £49 15s. 0d. single unit cost, ex works.

These compact EHT sources serve as ideal building blocks for computer graphical display units, monitors, oscilloscopes, radar display and any unit using high resolution electrostatically or magnetically focused tubes. They are suitable for continuous operation either on the bench or built into other equipments.

MODEL 691

Outputs—

1. **Up to 15kV d.c. positive at 400 microamps. Variable by pre-set potentiometer. Stability better than 1% against ± 10% input change.**
2. **Fixed positive 400V d.c. first anode voltage.**
3. **0 to 400V d.c. variable positive, focusing voltage.**

Input—

15V d.c.

Size—

2in. (50mm) x 4in. (100mm) x 11in. (280mm).

FOR THE SWL . . .

C. W. OPERATING

Receiving and reading c.w. signals on the amateur bands, like most other accomplishments, requires some degree of operating skill. This is acquired by spending much time, into which many periods of operating must be fitted in, to reach a standard of proficiency necessary to decipher morse signals at speeds—in words per minute—likely to be encountered on these bands, often up to twenty w.p.m.

Operating the c.w. code can be very rewarding to those listeners who are prepared to 'have a go' and master the code. Here one enters the world of RST—readability, signal strength, tone—and the many abbreviations used by amateur transmitters using the code. Such contractions as AGN—again; BK—break; DX—distance or rare prefix; ES—and; FB—fine business; HI—laughter and so on. The list of abbreviations is a long one, that most heard being CQ—general call signifying seek you, a contact being required.

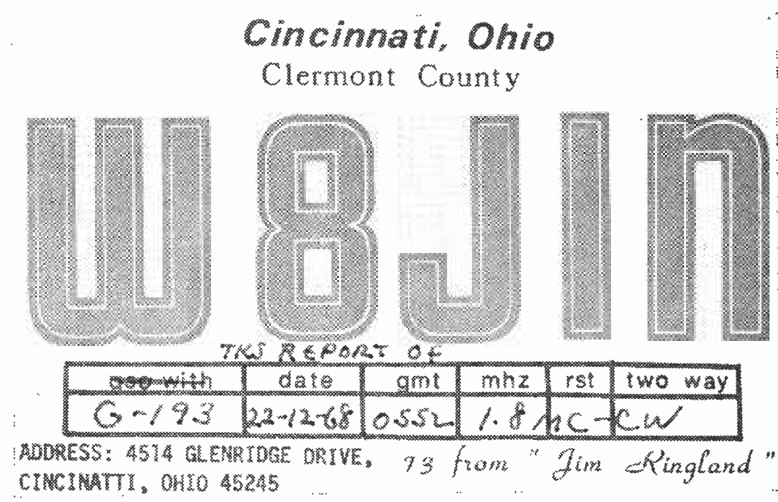
WHICH BAND?

About to operate in the c.w. mode, it is good listening practice to first tune over the c.w. portion of, say, the 3.5MHz band and follow this by taking a quick listen on the 7 and 14MHz bands—this very often paying dividends, especially during early morning sessions, when determining which band is 'wide open' or conversely 'dead'. Sometimes it may be found that when the 14MHz band is producing only semi-local signals, a quick trip down to 7MHz often produces the Dx transmissions. Similarly, it is often found that where the lower frequency bands are not in good shape for Dx. The higher frequency bands are in fine fettle.

During the autumn and winter periods, it is sometimes worthwhile, particularly on Sunday mornings around 0500GMT, to pay a visit to the 1800—1810kHz part of Top Band for Trans-Atlantic c.w. traffic. Recently, several K and W prefixes have been logged and also, as a bonus, the Virgin Islands in the shape of KV4FZ.

14 MHz

When commencing listening operations on 14MHz during an early morning session, listen for those transmissions exhibiting a hollow ringing sound superimposed on the dots and dashes. Past experience has shown that in the first instance these signals often emanate from W6 (California) and, as daylight



QSL card received from W8JIN of Cincinnati, Ohio, for a report on his c.w. signals on Top Band. Almost invariably, reports to American amateurs using 1.8MHz c.w. will bring forth a reply – often accompanied by an appreciative letter or note approaches here, the skip distance lengthens to include some of the exotic Pacific island prefixes such as KC6, KG6, KH6, KJ6, KM6, KP6, KR8, KS6, KW6 and KX6. These signals tend to slowly increase in signal strength up to a maximum and then decrease rapidly as daylight spreads further across the Atlantic. The foregoing is not, however, a hard and fast rule. As with most things in short wave reception, events sometimes turn out differently and W1's and W2's have often been heard with the characteristic ringing tone! The first requirement, as outlined above, is to get the 'feel' of the conditions prevailing on each band as quickly as possible prior to settling down for an operational session. Should, for example, the 14MHz band prove open for Dx signals, it is often of advantage to set the receiver at around 14MHz at the extreme l.f. end of the band. It is here that some of the most exotic c.w. calls have been logged over the years. Right adjacent to the band edge is often a favourite channel of some Dx stations.

THE WAITING GAME

One very interesting and instructive method of logging c.w. signals is to set the receiver at a particular frequency and simply leave it at that point for the remainder of the session. This technique, known to the writer as 'sitting on the fence'—for want of a better term—can be enlightening in that signals from various parts of the globe slowly gain in signal strength and then fade out over a period of time, as the skip distance alters. It is surprising how many stations one can log during one of these sessions and, moreover, the listener is often able to engage in other pursuits such as bringing the log up to date or filling in QSL cards and reports.

RECEIVER CONTROLS

The receiver, when set for c.w. reception, should have the r.f. gain set towards maximum—due consideration being given to the conditions prevailing—and the a.f. gain set as low as required. On the higher frequency bands—from 14 Mc/s and above—the b.f.o. pitch control should be set to the upper sideband (USB) and, for bands below 14MHz it should be set at the lower sideband (LSB) position. If this simple rule is observed, it becomes an easy matter to resolve s.s.b. signals where they are encountered at the high end of the c.w. portions of the various bands. The r.f. and a.f. gain positions should however be reversed for s.s.b. reception.

Where several c.w. signals are being heard at the same time, variation of the b.f.o. pitch control will often result in the required signal standing out from the remainder of the signals. Differing audio tones are preferred by individual listeners and that most suited should be obtained by variation of the pitch control. Furthermore, after much experience has been gained in c.w. reception, it will be found that one is able to concentrate the mind on one particular signal with its individual pitch more than the other signals being heard at the same time. Over a period, one's own aural response to a particular audio pitch, in conjunction with some degree of concentration, combine to act as a highly selective filter.

BEWARE!

On the c.w. bands, one soon learns not to make the mistake of assuming that all weak signals represent Dx—they do not. According to the skip distance and conditions prevailing at the time, it can often be the case that a weak and watery signal represents a Dx transmission whilst, on another occasion, it merely represents a semi-local signal. On some occasions, the weakest signal in the background is that of a G station and much time can be spent listening in the mistaken belief that it is a Dx transmission. Just to catch the unwary, the reverse of the foregoing often occurs—in which the weaker signals are in fact the Dx! On other occasions, it often is the case that conditions will offer strong signals from a particular area—such as the West Indies and surrounding areas, Mexico, Southern United States and the northern parts of the S. American continent, these predominating over all other signals. Under these conditions, such signals are often the strongest on the band. As in many instances, when dealing with short wave reception the unexpected can happen—and frequently does!

QSL's

It is a fact that those listeners who operate over the c.w. parts of the various amateur bands obtain a much higher report to reply ratio with their QSL'ing activities than do their s.s.b. counterparts. Members of the c.w. transmitting fraternity receive far fewer listener reports than a.m. or s.s.b. operators—many of whom are flooded with useless and bad reports.

There was a time, prior to and for some time after the last war, when most of the choice super—Dx was to be heard on c.w. With the advent of s.s.b. usage however some of the Dx stations—but not all—are to be heard using this latter mode of transmission. Reception of c.w. signals however presents the greater challenge to short wave listeners—will *you* pick up the gauntlet? ■

NEW TRIMMER CAPACITOR RANGE

Two ranges of trimmer capacitors manufactured in the United States by the JFD Electronics Corporation are now available in Britain from ITT Components Group Europe. These are the DV-5 and MVM series of capacitors.

The DV-5 series of subminiature ceramic disc variable capacitors offers excellent stability owing to a rotor design utilising special ceramic materials in a monolithic structure. These capacitors occupy less than 0.050in. of printed circuit board space and provide a wide choice of capacitance ranges.

Six models are available covering a minimum of 2.5pF to 9pF capacitance up to a maximum of 5pF to 30pF. Working voltages are 100V d.c. from −55°C to +85°C and 50V d.c. up to +125°C, with an insulation resistance of 10^{10} ohm at 25°C at the rated voltage.

The MVM series of microminiature air variable capacitors is designed for high frequency applications that demand extreme stability, small size and a high Q factor. Metal biasing elements are used in the series which provide a smoother and constant torque, as well as giving reliable electrical contact over a large area thereby reducing noise levels.

Capacitors available from the MVM series are: MVM 003 0.35pF to 3.5pF Q = 5,000, MVM 006 0.4pF to 6.0pF Q = 5,000, MVM 010 0.8pF to 10.0pF Q > 3,000, MVM 020 1.0pF to 20.0pF Q > 1,200.

Working voltages for all models are 250V d.c. with an insulation resistance of 10^{12} ohm at 500V d.c. and 25°C.

Further information can be obtained from ITT Components Group Europe, Capacitor Product Division, Brixham Road, Paignton, Devon – telephone: Paignton (0803) 50762; telex: 42951.

THE "SLIDING CHALLENGER"

200-250mW Economy Amplifier

by

SIR DOUGLAS HALL, K.C.M.G., M.A.(Oxon)

The name chosen for this amplifier – "Sliding Challenger" – is very apt. It employs a sliding bias Class A circuit and offers a performance which, in terms of quality of reproduction and battery economy, effectively challenges that of the generally accepted Class B amplifier design

THE AMPLIFIER WHICH IS DEScribed in this article is offered as an alternative to the very popular small Class B transformerless amplifiers which give about 200–250mW output. It does not employ the Class B principle but is a variant of the much less common sliding bias Class A amplifier, a version of which was described in this journal in November 1968[1].

If one is to challenge a popular design it is as well to first look at that design's assets. The main and obvious advantage of the Class B arrangement is that the passage of current is proportional to the amplitude of the signal, so that battery economy results. A second advantage is that efficiency is higher with Class B than with Class A. Thirdly, a transistor can tolerate a much higher dissipation, without damage, when operated in Class B. Finally, transformerless designs gain just because they are transformerless, and thus save the need to buy comparatively expensive components. On the other hand, a disadvantage with Class B is a tendency to distortion, particularly at low volume levels, and a tendency to instability resulting from the break-through of radio frequencies from the tuner used to drive the amplifier.

EFFICIENCY

With the author's design, passage of current is proportional to the signal accepted, so that the first and greatest advantage offered by Class B is met. As regards efficiency, it is here that confusion is liable to crop up. It is true that the theoretical maximum efficiency with Class B is about 78%. But here one is comparing power delivered to the speech coil, or output transformer primary, with the power *actually available* to the output transistors. For example, with transformerless designs only about half the voltage of the power supply is actually across either of the output transistors at any one time, so that the efficiency is immediately halved and cannot exceed about 39%. In practice, there will be other losses, and it is interesting to examine the Mullard complementary circuit using an OC81 and an AC127, a 9 volt supply, and giving 200mW output[2]. At this output a current of 115mA is quoted, which means that the battery is delivering 9 x 115 = 1,035mW of power. The efficiency, therefore, is

$$\frac{200 \times 100}{1,035} = 19\% \text{ approximately.}$$

With Class A the theoretical maximum efficiency is 50%, but here again, of course, the loss of voltage across the emitter resistor and speaker speech coil or transformer primary must be taken into account. With designs such as the present one, in which a high impedance speaker is directly coupled so that the speech coil carries the current to be passed by the output transistor, only half the theoretical maximum efficiency can be realised as, for maximum power, half the supply voltage must be dropped through the speaker[3]. In the event, the efficiency with a Class A design such as the present one, at maximum output, is not far inferior to that of a typical complementary Class B design, and may even be better.

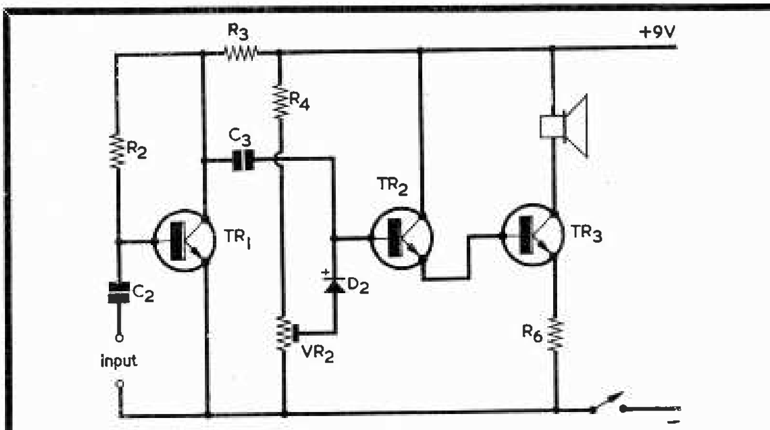


Fig. 1. This basic circuit of the sliding bias amplifier illustrates its principle of operation

The third asset of Class B mentioned, the ability of the transistor to withstand a larger dissipation, is largely theoretical with silicon transistors. The output transistor in this design is perfectly happy without a heat sink.

LOW VOLUME PERFORMANCE

The present design is transformerless, as is the Class B variety which it challenges, and in the author's opinion it offers better quality, particularly at low volume levels. Nor has it shown any sign of instability with various tuners coupled to it.

(Continued on page 38)

1 C. Hargis, "Battery Economy in Class A Output Stages", *The Radio Constructor*, November 1968.

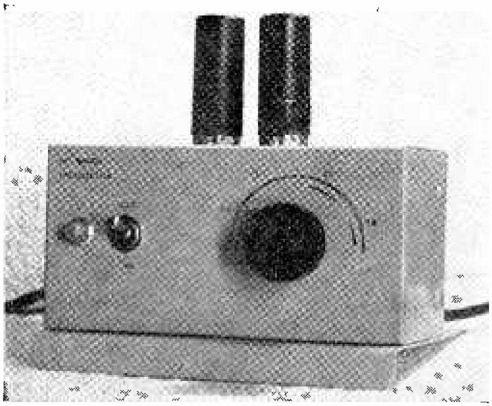
2 See *Mullard Maintenance Manual*, 2nd Edition, Audio Transistor Package type LFK3.

3 See notes in "Radio Topics" by Sir Douglas Hall under heading "Single Transistor Output", page 120 of *The Radio Constructor*, September 1969.

THE TRE
H.F. BANDS

A. S. CARPE

**Employing two pentodes whose perf
tunable preselector offers a very u
the range of**



THE UNIQUE LITTLE UNIT TO BE DESCRIBED CAN BE constructed in two or three evenings. In operation it is continually tunable over the frequency range of 13.5 to 30MHz and thus embraces three amateur bands used mainly for Dx traffic, viz. 14, 21 and 28MHz; these are often alternatively referred to as the '20', '15' and '10' metre bands respectively.

The preselector 'lifts' signals by several 'S' points and although the device cannot 'manufacture' a signal it most certainly can make uncopiable transmissions completely readable. This means that a normally weak Dx signal requiring the use of headphones plus considerable concentration can be taken clearly on the station loudspeaker without difficulty.

To digress briefly it is important to note that a preselector should never be used as an alternative to a suitable aerial. The aerial must always receive first consideration; it should also be equipped with a resonating device or a good aerial matching unit (a.m.u.). It will be found useful, where possible, to erect a long wire of approximately 132ft., since this will resonate roughly on all amateur bands from 3.5 to 30MHz. If such a length cannot be accomodated 67ft. is useful for bands 7.0 to 30MHz. Such 'end-on' aerials are likely to exhibit a high impedance at the station end and a suitable a.m.u. must be provided; details of a matching unit have previously been printed in these pages*

WHAT IS A PRESELECTOR?

A preselector is basically no more than a stage – or stages – of r.f. amplification usually arranged as a separate unit and placed ahead of the associated receiver. Connections are such that signals pass through the preselector before reaching the receiver and in so doing receive a boost; the preselector can be considered as a pre-receiver peaking unit. Not only are the signals amplified considerably; they then also allow the receiver a.g.c. system to be loaded adequately. This results in less noisy reception.

Driving power for a preselector may be taken either from the associated receiver or it may have its own independent supply. Some specialised communications receivers have a preselector built into them and the KW Electronics model KW77 amateur bands receiver is an example of this type.

DESIGN POINTS

Although a preselector can be designed to afford amplification over a large number of bands this is not normally necessary since most receivers are capable of adequate gain on their own on the lower frequency ranges – say 1.8 to 7MHz. Gain normally

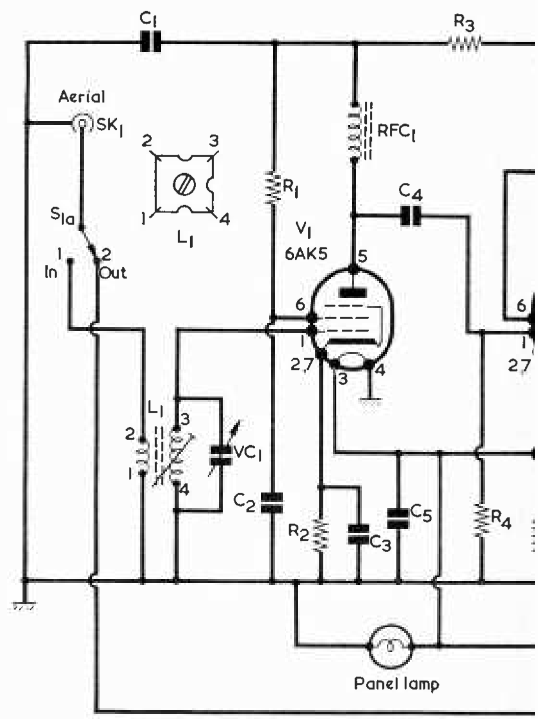


*Fig. 1. The circuit of the h.f. ban
circuit to the right of th*

* A. S. Carpenter, " 'Getting Out' with an End-Fed Wire", *The Radio Constructor*, April 1970.

ꞁLE-TWO RESELECTOR

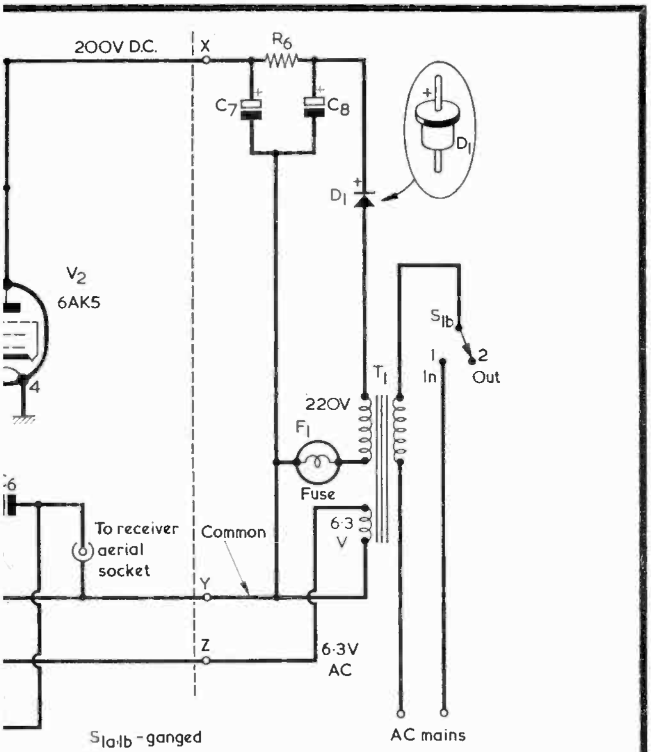
Cover Feature

ꞁER, G3TYJ

ıance can extend above v.h.f., this ul increase in signal strength over .5 to 30MHz

starts to fall off as the higher frequency bands are selected, and at 30MHz circuit losses may be considerable. The better the receiver the less is the loss likely to be noted and, conversely, if it is necessary to use a preselector when operating on 3.5MHz it is time to get another receiver! Receivers most likely to be improved by the addition of a preselector are types fitted with the older international octal valves such as the 6SK7, etc. – the familiar CR100 is an example here.

Clearly the better the receiver the smaller the mar-



preselector. The power supply roken line is optional

COMPONENTS

Resistors
(All ¼ watt 10% unless otherwise stated)
R1 33kΩ
R2 180Ω
R3 6.8kΩ ½ watt
R4 1MΩ
R5 1.5kΩ
R6 2.2kΩ 1 watt (see text)

Capacitors
C1 0.25μF paper
C2 0.01μF ceramic
C3 0.01μF ceramic
C4 100pF ceramic
C5 1,000pF ceramic
C6 100pF ceramic
C7, C8 32 + 32μF electrolytic, wire-ended tubular, 350V wkg.
VC1 100pF variable, type C804 (Jackson Bros.)

Inductors
L1 Coil type QA2 (Osmor)
RFC1 2.5mH r.f. choke type CH1 (Repanco)
T1 Mains transformer. Secondaries: 220V 30mA, 6.3V 1.5A, type P2 (Henry's Radio)

Valves
V1 6AK5 (Brimar)
V2 6AK5 (Brimar)

Rectifier
D1 BY100 (Mullard)

Switch
S1 D.P.D.T. toggle or slide switch, mains voltage rating

Fuse
F1 2.5V torch bulb and holder

Socket
SK1 Coaxial socket

Miscellaneous
2 B7G valveholders, with skirts and screening cans
LES pilot lamp assembly type PL2 (red) (Henry's Radio)
Coaxial cable and plug
Knob and pointer
6-way tagstrip (see Fig. 3)
Aluminium sheet, for box and tray

gin of improvement attainable by preselection. The signal-to-noise ratio also requires careful consideration and no benefits are derived if noise is increased disproportionately. In valve circuitry triodes are not infrequently preferred to pentodes for r.f. amplification and the cascode circuit is a common type employed to ensure a low noise level. The cascode circuit may however require the fitting of a neutralising circuit which, for multi-band work, can prove troublesome. For stability and ease of construction the pentode has many recommendations provided it is operated correctly and is suitable in type.

CIRCUITRY

The circuit of the 'Treble-Two' Preselector, complete with power supply, is shown in Fig. 1 and is seen to be quite straightforward. The r.f. amplifier proper is V1, the essential tuned circuit being coupled to its grid. The aerial is applied to socket SK1. Coil L1 is chosen from the Osmor range, its inductance value approximating to 1.6μH, which, when tuned by variable capacitor VC1, enables the frequency range of 13.5-30MHz to be covered without band-changing. The valve is deliberately operated with low anode and screen-grid potentials to maintain a low noise level compatible with adequate r.f. amplification.

Amplified r.f. output is developed at high impedance across choke RFC1 and is passed on to V2 via capacitor C4; this second valve acts as a cathode-follower. Output at low impedance and suitable for feeding to the aerial socket of the subsequent receiver is then available at C6. The cathode-follower not only completely isolates the tuned circuit from the receiver input but, in addition, acts as a high-to-low impedance matching device.

Valves selected for use in the preselector are the miniature Brimar 6AK5's and these, often seen in 70 and 144MHz designs, are familiar to the v.h.f. fraternity. The 6AK5 is on the B7G base and, according to the Brimar handbook, is useful as an amplifier up to 400MHz. Its mutual conductance is 5.1mA/V. This valve operates well from an h.t. rail voltage of 180 to 200, thus permitting the use of a simple mains transformer.

The h.t. supply for the prototype preselector is obtained from a half-wave rectifier coupled to the h.t. secondary of isolating transformer T1; on no account should the mains supply be connected to the unit without such a transformer in circuit. Adequate smoothing is achieved by the filter comprising R6, C7 and C8. A series limiting resistor for the rectifier is not necessary because of the transformer secondary winding resistance; in any case a safety fuse (which consists of a small 2.5V torch bulb) is provided to protect the circuit.

As was mentioned earlier, power may, in some instances, be taken alternatively from the station receiver or from another power supply, whereupon all items to the right of the broken line in Fig. 1 can be omitted. An h.t. voltage of 200, and 6.3V a.c. for the heaters should then be connected to points 'x' and 'z' respectively, point 'y' being made common to both. H.T. consumption is of the order of 12mA, and consumption at 6.3V is 0.35A plus the current drawn by the pilot lamp.

SWITCHING

Because the preselector is only required for bands higher in frequency than 13.5MHz it will be found both uneconomic and undesirable to keep the unit operative when lower frequency bands are being received. Manual connection and disconnection of aerials and aerial leads is clumsy and a refinement is provided by the inclusion of S1. Due to S1 the

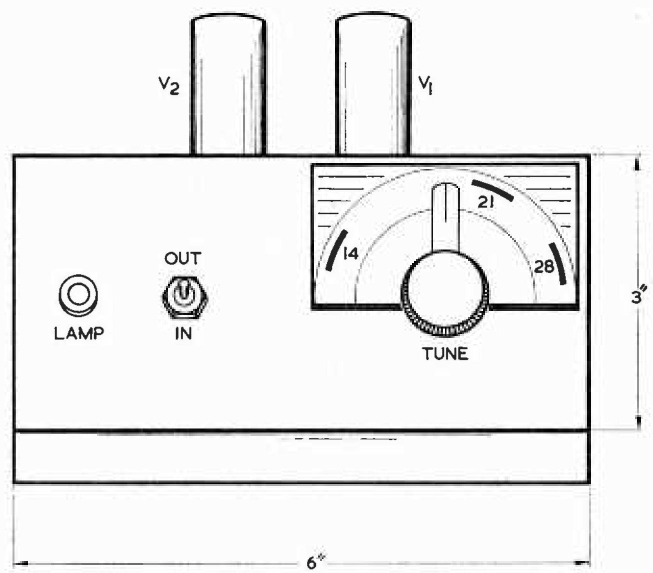
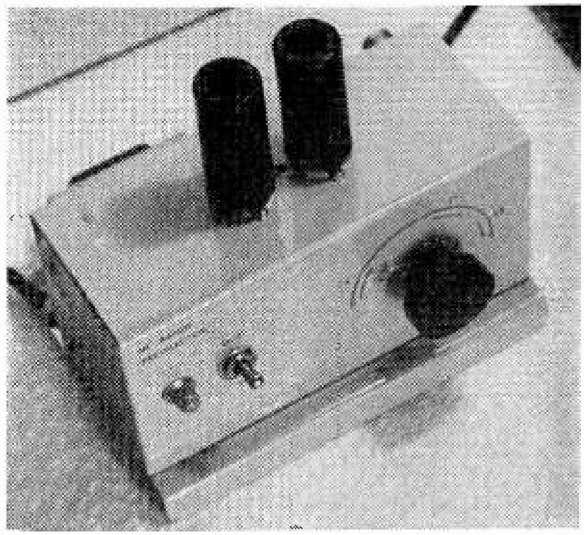


Fig. 2. Front view, illustrating the panel layout. Also given is a side view showing the tray at the base

unit can be left *in situ* at all times since inspection of Fig. 1 shows that when the switch is set as indicated no mains power is applied; additionally the aerial is fed directly through to the receiver. No adverse effects result from leaving R5 and C6 across the aerial input connections to the receiver, and if the latter features an aerial input trimmer this will normally be suitably adjusted.

With S1 set as shown in Fig. 1 all bands up to 30MHz can be tuned normally on the receiver as if the preselector did not exist. Immediately S1 is set to its alternative position, however, several things happen. First, the panel lamp comes to life as T1 is supplied with power from the mains. Also, the aerial is switched to the primary winding of L1 and, if the receiver and preselector are tuned to approximately the same frequency, signals will be heard to increase in strength as the preselector valves warm up. VC1 is then adjusted for maximum received signal strength. The difference in signal strength can be demonstrated with the preselector alternatively 'In' and 'Out' merely by operating S1; a change of several 'S' points is likely to be noted since a gain of some 15dB can be obtained.



A top view, which clearly illustrates valve positioning

CONSTRUCTION

The prototype preselector is built into an aluminium box measuring 6 by 3 by 2½in. but size is not critical; the constructor may in fact adopt his own method of assembly provided long signal-carrying leads are avoided. The construction is such that all items to the left of the broken line in Fig. 1, except the valves themselves, are completely enclosed, and consequently screened, inside the box. The valves, fitted with screening cans, appear at the top. The frontal appearance of the unit is illustrated in Fig. 2 and the simple home-made dial shows the positions taken up by the three bands on the scale. Since the aerial damps the preselector, tuning is not sharp, hence the rather wide 'spreads' for each band.

A simple scale can be made using a bow pen to produce suitable arcs on white card. Alternatively a scale can be selected from Data Publications transfer sets. The pointer knob can be easily arranged, and it should indicate the 9 o'clock scale position with the vanes of VC1 fully enmeshed. Aerial damping also makes it unnecessary to fit a reduction drive to the tuning shaft; direct drive is quite satisfactory.

The 'Out' 'In' switch is shown as a toggle type in Fig. 2 but it can equally well be a small slide type. To make the general appearance more elegant and to bring the controls to a convenient operating position a section of 18 s.w.g. aluminium sheet size 6 by 4½in. is bolted to the bottom of the box as a tray, its front edge being bent down to form a ½in. deep flange. The panel is thus tipped backwards slightly as indicated in the side view shown inset in Fig. 2. When the power supply components to the right of the broken line in Fig. 1 are fitted, they may be mounted to the spare section of the tray at the rear. It will be necessary to fit a protective cover at the rear to ensure that mains and h.t. positive points are covered and cannot be accidentally touched, and the design of this cover is left to the individual constructor. The mains wiring to S1 and the h.t. and heater supply leads pass through a grommet in the rear of the box at the same end as the panel lamp. Two small angle brackets (not shown in the diagrams) are used to secure the tray to the box, these taking self-tapping screws passed through the tray.

In Fig. 3 the box top and front sides are shown laid flat in order to reveal in slightly expanded form component layout and wiring. Except for a single 6-way tagstrip, wiring 'anchors' are provided by valveholder tags. If supplies are to be taken from the associated receiver or other power supply unit, the 200V h.t. positive connection should be made to tag 'A', 6.3V a.c. to tag 'B', and the common chassis connection to tag 'C'.

H.F. AMATEUR BAND FREQUENCIES

Band (MHz)	Type of emission
14.0-14.1	c.w. only
14.1-14.35	c.w. and phone
21.0-21.15	c.w. only
21.15-21.45	c.w. and phone
28.0-28.2	c.w. only
28.2-29.7	c.w. and phone

Note that a length of coaxial cable carries the output from the preselector to the receiver, it being terminated in a suitable coaxial plug. The cable should be as physically short as possible and must be firmly anchored inside the preselector unit box. It passes out through a grommet at the rear centre.

The use of miniature components is recommended throughout and for the valveholders low-loss types are advised. The coil L1 is located, by means of the clip provided with it, on the side of the box close to VC1. Its core should be set to project from the head of the former by approximately ⅛in. True do-it-yourself enthusiasts can try winding a coil of their

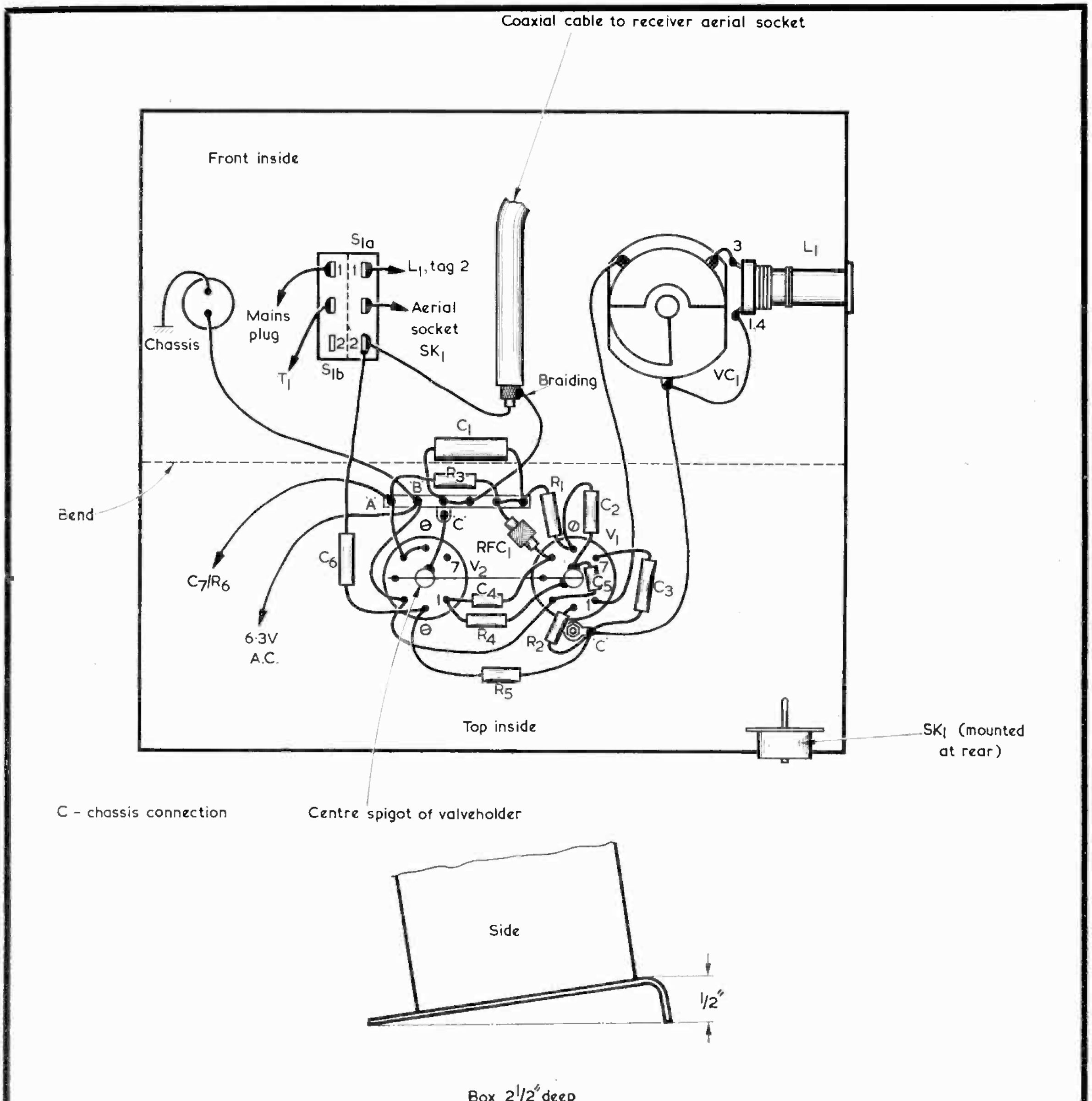


Fig. 3. The preselector r.f. components, whose layout and wiring are shown here, are completely screened inside the aluminium box

own using a former of approximately 0.25in. diameter fitted with an adjustable dust-core. The tuned winding can consist of 9 turns of 28 s.w.g. enamelled copper wire close-wound, with an aerial coupling winding made up of 8 turns of 36 d.s.c. copper wire close-wound, and spaced 0.1in. from main winding.

TESTING

Before applying mains power to the unit a test should be made with an ohmmeter to ensure that no short-circuits exist between the h.t. positive rail and chassis. When the ohmmeter is connected across points 'x' and 'y' of Fig 1 its pointer should initially kick over towards the zero resistance end of the scale then slowly move back towards infinity as capacitors C7 and C8 charge up. The initial kick is quite in order but, should the ohmmeter continue to indicate zero resistance, or a low resistance, a wiring or component fault exists and this must be cleared before proceeding further. There will, of course, be no initial kick if the components to the right of the dashed line in Fig. 1 are not fitted.

If all seems satisfactory the preselector may be hooked up to the receiver with which it is to be used and the aerial and mains supply connected. With S1 set to 'Out' and the receiver switched on, a weak but reasonably steady signal should be sought on the 14MHz band. The preselector pointer knob should then be set to approximately a 10 o'clock position on the dial and S1 set to 'In' whereupon the panel lamp and valve heaters should light up. The positive potential with respect to chassis should be checked at point 'x' after the valves have warmed up, and is satisfactory if found to be in the range 180 to 200V. If necessary the value of R6 can be adjusted slightly at a later time to achieve this requirement. After allowing a few seconds for the unit to warm up the signal which was previously received weakly should be heard to increase in strength; if this does not happen the core of L1 requires adjustment. The direction of core movement required can be found by experimentally swinging the preselector tuning control slightly to and fro. If it is found that 14MHz band signals seem strongest when the control pointer is at say 12 o'clock on the scale, then the coil has too much core inserted; if on the other hand signals appear to be getting stronger as the pointer goes over towards the 9 o'clock position the core should be inserted further into the coil. The aim is to peak 14MHz signals at the 10 o'clock position of the dial pointer. When this has been done, signals on the 21 and 28MHz bands should fall into the positions indicated in Fig. 2.

To check the effectiveness of the preselector compare signal strengths audibly (or, when an S-meter is fitted to the receiver, both audibly and visually) with the unit alternatively switched 'In' and 'Out'. Some weak transmissions will virtually disappear completely when the preselector is inoperative!

AMATEUR H.F. BANDS

As mentioned earlier, the amateur h.f. bands are 14, 21 and 28MHz, these often being referred to as '20', '15' and '10' metres respectively. A great deal of interesting Dx traffic of amateur origin can be heard on these bands at the appropriate times – for they are not always 'open'. On each band three modes of transmission take place, viz. c.w. (continuous-wave, Morse code), a.m. (amplitude modulation) and s.s.b. (single-sideband). For reasons of mutual benefit each band is, under the H.F. Band Plan, given a c.w. – only segment and the majority of radio amateurs adhere to this. The three bands and their sub-divisions are detailed in the accompanying Table. 'Phone' includes both a.m. and s.s.b. transmissions. Nowadays, the majority of amateur transmissions are either c.w. or s.s.b.

FINISHING

When the preselector is functioning correctly it may be finished attractively by applying a coat of Japanese lacquer – grey is very effective – on to which, when dry, legends are applied using Data Publications Panel-Sign transfers from Set No. 4. The legends should be 'fixed' by means of clear nail varnish. The dial can either be drawn directly on to the lacquer using Indian ink and a bow pen or, again, transfers (from Panel-Sign Set No. 5 for clear background or Set No. 6 for black background) can be used. If care is taken, a professional-looking and highly effective item of equipment will result. ■

NOW HEAR THESE

Times = GMT *Frequencies = kHz*

● **ANGOLA**

CR6RD Radio Clube de Huambo, Nova Lisboa, operating on **5060** and **7280,** has increased power from one to 10kW. Schedule is from 0500 to 2300.

CR6RZ Emisora Official de Angola, Luanda, now has a five minute newscast in English daily at 1800 on **4820** (10kW). Schedule is from 0500 to 0800 and from 1700 to 2300.

● **PHILIPPINES**

The South East Asia Radio Voice has a test transmission for Chinese listeners over DZU5 on **9740** at 1300 with English announcements at commencement. Reports are required to P.O. Box 566, Kowloon, Hong Kong.

● **UGANDA**

Radio Uganda, Kampala, which can be heard on **4976** with Red Network programme (3/8kW), has a schedule from 0325 to 0545 and from 1400 to 2102. Reports requested to Chief Engineer, Radio Uganda, Ministry of Information, Broadcasting & Tourism, P.O. Box 2038, Kampala. Distant listeners only.

● **CEYLON**

Radio Ceylon has been heard around 1800 on **17745** with tests to Europe and identification in English every ten minutes.

● **EQUATORIAL GUINEA**

Radio Santa Isabel, Fernando Po, has been heard with an English programme from 1915 on **6250** (10kW) and newscast at 1930.

● **PORTUGAL**

Radio Trans-Europe (see Current Schedules) has also been heard on the **9655** and **11720** channels from 0900 to 1000 with a programme for Scandinavia and the U.K.

● **LIBERIA**

The Voice of America transmitter at Monrovia can be heard with news in English at 1800 on **21660** (250kW).

● **U.S.A.**

The Voice of America station at Bethany radiates a newscast in English at 1815 on **21485** (250kW).

● **SOUTH AFRICA**

RSA Johannesburg can be logged with the English programme at 1815 on **21480** (250kW).

● **CHINA**

Peking is currently to be heard with a programme in English at 2100 on **9030.**

● **PAKISTAN**

Karachi can be logged with the English programme and station identification at 2000 on **9460** (10/50kW) – listed on **9465.**

● **MEXICO**

XERMX Radio Mexico can be heard on **6055, 9535** and **11720** on which channels they have recently been carrying out tests. Reports are requested to – Radio Mexico, Apartado Postal 20100, Mexico 20, D.F., Mexico.

● **CYPRUS**

Nicosia has been heard on **9715** (30kW) from 1900 to 2100.

Acknowledgements – SCDX and our Listening Post.

THE "SLIDING CHALLENGER" AMPLIFIER

(Continued from page 31)

But its biggest advantage over its Class B counterpart is its considerably greater sensitivity. No additional pre-amplifier is required for most purposes, whereas a 3 transistor transformerless Class B amplifier is very insensitive. In fact, the author's amplifier will take a 1MΩ series resistor at its input, to raise the input impedance to this value, and still be fully loaded by a medium or high output crystal pick-up.

A difficulty with sliding bias amplifiers which is often mentioned is that the bypass capacitor used in conjunction with the bias diode (to which the controlling signal is applied) must be large enough to prevent unwanted a.f. feedback over the stages within the sliding bias loop, but not so large as to cause a delay in the application of bias with a consequent degree of distortion which could not be tolerated. It is extremely difficult to achieve a suitable compromise value, and this fact accounts for the unpopularity of the design in general. The author has overcome this difficulty by placing the diode at an early stage of the amplifier rather than after the output. In other words the bias is fed forward with the signal, and not backwards. No bypass capacitor is therefore required, and no delay problems arise. Transient response is, in consequence, good.

The basic circuit is shown in Fig. 1. TR1 is a high gain common emitter amplifier with R3, a 10kΩ resistor, as its collector load. Bias is fed back to the base through R2, a 3.3MΩ component. The signal then passes to TR2, which is a common collector, or emitter follower, amplifier. As such, its input impedance is high and TR1 consequently gives high amplification. Base bias for TR2 is obtained from the potentiometer given by R4 and VR2, and it will be noted that there is a diode, D2, in the circuit.

VR2 is adjusted so that D2 just begins to pass current under no-signal conditions. TR2 is directly coupled to TR3, a common emitter output amplifier having a 35Ω speaker as its collector load. When no signal is applied TR2 passes a few microamps only and, since this is the base current for TR3, the latter transistor only passes 1 or 2mA. Any signal arriving at the base of TR2 causes D2 to pass more current, which means that base current for TR2 increases. In consequence, the base current and collector current in TR3 increase also. This process continues until TR3 is passing about 120mA, whereupon battery voltage (allowing for the small drop in R6) is shared equally by the speaker and TR3, and maximum output is achieved. Any increase in current through the speaker and TR3 will merely cause an excessive voltage drop through the speaker, thus starving TR3 and reducing output. In addition, of course, there will be mismatching to the speaker under these conditions.

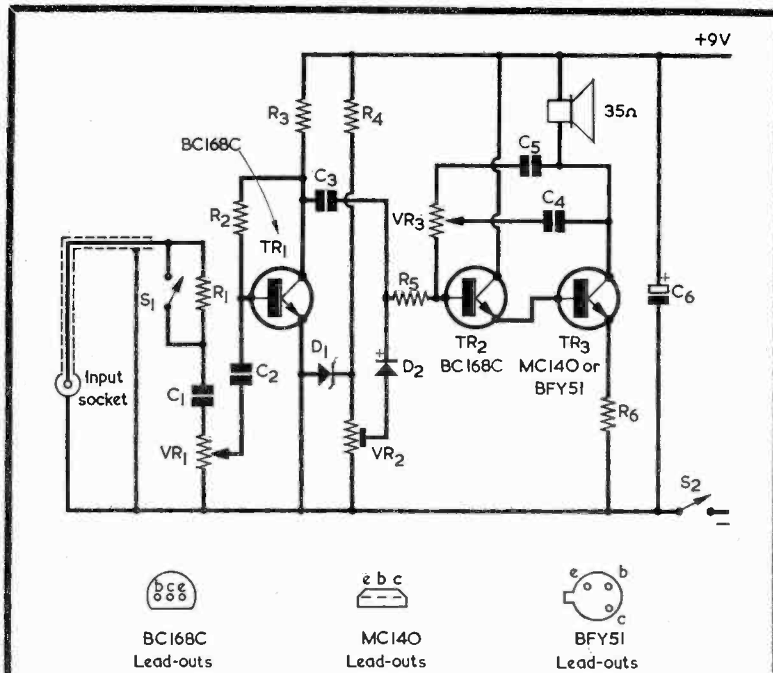


Fig. 2. The full practical circuit of the amplifier

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)

R1	1MΩ
R2	3.3MΩ
R3	10kΩ
R4	2.7kΩ
R5	100kΩ
R6	4.7Ω
VR1	10kΩ potentiometer, log track, with S2
VR2	5kΩ potentiometer, preset, slider type
VR3	1MΩ potentiometer, log track

Capacitors

C1	0.22 or 0.25μF, paper or plastic foil
C2	0.1μF, paper or plastic foil
C3	0.1μF, paper or plastic foil
C4	500pF, silver-mica
C5	0.01μF, paper or plastic foil
C6	640μF, electrolytic, 10V wkg.

Semiconductors

TR1	BC168C
TR2	BC168C
TR3	MC140 or BFY51
D1	2.7 volt 250mW zener diode, Radiospares (see text)
D2	Silicon diode (see text)

Switches

S1	s.p.s.t., toggle
S2	s.p.s.t., part of VR1

Speaker
35Ω speaker, 7 by 4in.

Battery
9-volt battery (see text)

Groupboard
18-way groupboard, Radiospares "Standard" (Home Radio Cat. No. BTS10)

Socket
Coaxial input socket

Miscellaneous
2 knobs
Screened wire (as required)

FINAL CIRCUIT

Necessary refinements are shown in Fig. 2, which gives the complete circuit of the amplifier. R1, with a switch across it, is included to provide a high impedance input, when required, for crystal pick-ups. A 2.7 volt zener diode, D1, is connected across VR2 to hold the stand-by bias constant as the battery voltage drops. R5 maintains the input to TR2 at a high impedance and also enables the feedback and tone control circuit incorporating VR3, C4 and C5 to function. This circuit is important as it provides negative feedback which affects the a.c. component only, but which has no effect on d.c. bias. When the slider of VR3 is at the end of its track which connects to C5, the feedback is virtually the same for all audio frequencies. As VR3 slider approaches the R5 end of its track there is a greater attenuation of the higher audio frequencies.

If a tone control is not required, VR3 may be replaced by a 1MΩ fixed resistor and C4 omitted. C5 must still, however, be retained. It is important that the direct voltage fed forward as bias due to the action of D2 should be slightly greater than the signal voltage, or there will be overloading and distortion. The tone control components (or the alternative given by C5 with the 1MΩ fixed resistor) will look after this requirement. Finally, C6 is the usual large value electrolytic capacitor whose function is to maintain stability as the battery begins to age.

To set up the amplifier it is only necessary to adjust the slider of VR2 to a position which ensures that quality is maintained at low volume levels. The slider should be no nearer the R4 end of its track than is needed to give this result, or stand-by current will be unnecessarily high. If a meter is put in circuit between the speaker and the positive battery terminal it will read between 1 and 4mA when VR2 is correctly set. Under no-signal conditions, TR1 passes about

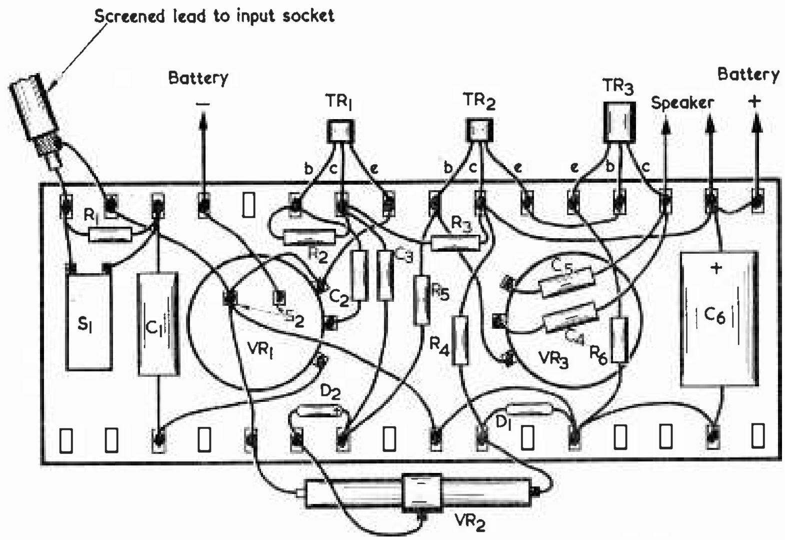


Fig. 3. Details of wiring and layout, with all components mounted on a 16-way groupboard

500µA and TR2 only a few microamps. The potentiometer network draws a little over 2mA. Total stand-by current lies, therefore, between 4 and 7mA.

The components used for the amplifier are standard types. D1 is a Radiospares 2.7 volt 250mW zener diode. An obliging retailer will order this (Radiospares components may only be obtained through retailers) but if difficulty is experienced a suitable alternative is the type ZF3 from Henry's Radio, Ltd. The ZF3 is a 3 volt, 5%, 400mW diode. D2 can be any silicon diode. The type used by the author was a silicon "bias diode" obtained from Amatronix, Ltd. The transistors specified are also available from Amatronix, Ltd.

The author employs a 0–250mA meter to monitor battery current with his amplifier, but this meter is not essential and is not shown in the Components List.

In the prototype all the components, apart from the input socket, speaker and battery, were fitted on a 16-way groupboard, using the wiring layout shown in Fig. 3. The groupboard is a Radiospares "Standard" 18-way type cut down. S1, VR1 and VR3 are mounted direct to the board, and it is necessary to drill bush-mounting holes for these components. Ensure that D1 is connected with the same polarity as shown in Fig. 2.

The author's version employs a plywood baffle 12in. square, with a 7 by 4in. speaker mounted in the centre and the amplifier below it. The 0–250mA meter just mentioned is permanently installed at the top. The author believes that the cost of the meter is soon covered by battery savings, as it can often happen that a perfectly acceptable reduction in volume is accompanied by a halving of average current passed. A PP9 battery is adequate, but for maximum economy with heavy use three No. 800 3-volt "cycle lamp" batteries, connected in series, are recommended. ■

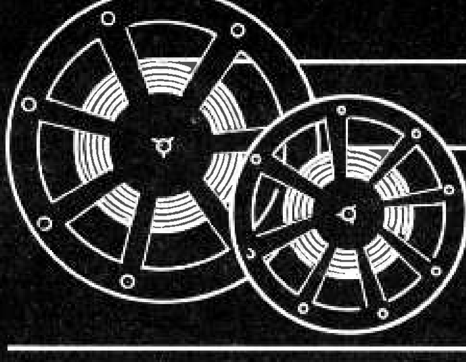
COOLING CONTRACT FOR RADIO RESEARCH STATION

The York Division of Borg-Warner Ltd. is working on an order, worth over £20,000, for two Turbopak centrifugal packaged water chilling systems for air conditioning in the Orford Ness, Suffolk, Research Station being constructed for the Ministry of Public Building and Works by Balfour Beatty & Co. Ltd. The air conditioning installation and other mechanical services are being carried out by G. N. Haden & Sons Ltd.

When fully operational, this new station will conduct joint research for the Ministry of Defence and the U.S. Department of Defense into problems of long-range propagation of radio signals.

Both York Turbopaks, when operating simultaneously, will have a combined full load duty of 422 TR, when operating with evaporators in series, condensers in parallel, equivalent to cooling 900 gal/min recirculated water from 52.4°F to 43°F.

Due to the possibility of high concentration of salt in the atmosphere being picked up by the water passing over the cooling towers, the condenser tubes and tube plates are of cupro nickel. A single master chilled water temperature controller varies the capacity of both Turbopak systems in accordance with signals received from a detector located in the outlet of the downstream machine.



UNDERSTANDING TAPE RECORDING

by W. G. Morley

This fourth article in our short series on tape recording first discusses the application of a.c. bias to the record head, after which it deals with the process of tape erasure

In last month's issue we devoted our attention to the basic magnetic theory involved in recording a signal on a length of tape. We started by introducing the hysteresis loop, which can be drawn for any magnetic material passing through one or more cycles of magnetisation. The hysteresis loop is drawn on a horizontal axis corresponding to magnetising force (designated H) and a vertical axis corresponding to the consequent flux density in the material (designated B). We saw that the recording process causes the flux density in each section of the tape to be taken up to a value corresponding to the magnetising force pertaining as it passes the head gap, after which the flux density in the tape drops to the remanence value (also referred to as 'remanent induction') when it leaves the gap. We next drew up a transfer characteristic defining the relationship between record head magnetising force and remanent induction in the tape, and we finally examined two simple methods of applying d.c. bias during the recording process. Both these methods of bias are intended to shift the recording operating point away from the non-linear section at the centre of the transfer characteristic. However, their practical performance is by no means as good as is that of the system of applying bias which we shall next consider.

A.C. BIAS

One of the two d.c. bias methods we dealt with last month employed the very simple technique of feeding a direct current through the record head coil in company with the alternating signal current. The magnetising force due to signal current was then moved to one of the more linear sections in the upper or lower half of the recording transfer characteristic. In the process which we shall now discuss a sine wave alternating current is used instead of a direct current. This alternating current, known as the *a.c. bias* current, flows in the head coil together with the record signal current, and has an amplitude which is greater than the signal current. Its frequency is well above the audio spectrum being, typically, of the order of 50 to 60kHz.

It is a surprising fact that, although a.c. bias has been employed in tape recorders for a large number of years, the exact manner in which it enables low-distortion recordings to be obtained has still not been satisfactorily explained in a form that is generally accepted. Quite a few theories have been advanced, and virtually all the practical development work carried out on a.c. systems has stemmed from experimental observation. We shall be looking at several of the theories put forward to explain a.c. bias operation, but first we will examine the process itself.

Fig. 1 gives a graphical illustration of recording with a.c. bias. The alternating magnetising force at the record head gap due to the signal and a.c. bias currents appears at the bottom of the diagram. This recording waveform is applied to the transfer characteristic, which is the same as that we developed from basic magnetic theory last month. It will be seen that the effect of the record signal current is to cause the peaks of the bias cycles to be displaced to left or right in sympathy with signal current amplitude and polarity. At the same time, the signal amplitude is such that the bias current peaks do not pass outside the range corresponding to the more linear sections of the transfer characteristic.

The corresponding induction in the tape is then plotted graphically, by way of the transfer characteristic, so that it appears on the right. For simplicity of drawing it will be assumed that the a.c. bias cycles shown on the right still have a sine wave form, even though in actual fact each cycle will have suffered distortion due to the central non-linearity of the transfer characteristic. However, such distortion is not, in any case, an important matter, because the bias cycles disappear in the tape after it leaves the head gap because of self-demagnetisation. What *is* of importance is the fact that, since the bias cycle peaks on the right of the diagram were produced by way of the more linear sections of the transfer charactistic, they exhibit the same relative degree of displacement as do the bias cycle peaks at the bottom of the diagram. The peaks on the right correspond to remanent induction in the tape, with the consequence that the average remanent induction, shown in their centre, is an undistorted copy of the signal current which was originally applied to the record head.

This description covers the effect due to a.c. bias and it also gives an idea as to why the resultant average remanent induction on the tape is an undistorted copy of the original record signal. Some readers may be content with this simplified concept but others will prefer to look at it in a little greater depth. We shall, in consequence, deal briefly with several of the explanations normally given.

One approach towards explaining the action of a.c. bias takes the following line. Since the bias frequency is very high, each iron oxide particle in the tape will be subjected to a number of cycles of magnetisation during the period it is actually at the record head gap. At the same time, due to the slight spread of magnetic field on either side of the gap, magnetisation of any particle in the tape at bias frequency will increase, as the tape is drawn past the gap, from zero to a maximum amplitude at the gap and will then decrease to zero again afterwards. Further, magnetisation at bias frequency disappears due to self-demagnetisation in the tape. If there had been no signal current in the record head, the remanent induction in the tape when it had left the decreasing field after the gap would be zero. However, the presence of signal current causes the remanent induction to be equal to the displacement of the bias magnetisation cycles, with the result that the average remanent induction has the same waveform as the record signal current.

This last explanation does not take into account the formation of hysteresis loops in the iron oxide particles in the tape during each cycle of magnetisation at bias frequency, and the explanation may be taken a stage further (without, however, otherwise altering it) by introducing these loops. As the tape enters the gradually increasing field around the gap, each iron oxide particle is taken through a series of hysteresis loops which increase in size until they reach a maximum at the gap itself. On leaving the head gap the hysteresis loops then decrease in size until they are eventually negligibly small and disappear. As with the previous explanation the remanent induction is then equal to the displacement of the bias magnetisation cycles at the moment when the tape was at the record head gap.

A more detailed approach, due to A. A. McWilliams[1], assumes initially that the individual particles of iron oxide in the tape all require the same critical value of magnetising force (on either side of the zero point on the H axis of the transfer characteristic) to cause them to exhibit a remanence value after leaving the record head. Below this critical value no remanent induction is left. Also, under the assumed conditions, the magnitude of the bias current is made such that the peaks of the bias alterations in the +H and —H directions just meet, without passing, the critical value, whereupon in the absence of signal current there is no remanent induction left in the tape. When, however, a signal current is applied, the resultant displacement of the bias peaks cause 'pulses' of magnetising force above critical value to appear on the +H side of the zero point when the bias waveform is displaced in the +H direction, or on the —H side of the zero point when the bias waveform is displaced in the opposite direction. The remanent induction due to these 'pulses' is then the recorded signal. In practice the particles of iron oxide in the tape do not all require exactly the same critical value of magnetising force to achieve a residual induction because they are not all identical in properties and size. Nevertheless, the critical values for the individual particles are all close together, being bunched near the central zero point of the transfer characteristic. This accounts for the markedly slow rate at which the slope of the curve increases before it blends into the linear sections. Thus, the set of circumstances which exists in practice sufficiently resembles the assumed situation to enable the explanation to apply.

There are further theories which account for the action of the a.c. bias recording process, but those which have just been given should give an adequate idea of design engineers' thoughts on the subject.

WAVEFORM, FREQUENCY AND AMPLITUDE

A first essential for the signal used for a.c. bias at the record head is that it must be as pure a sine wave as is reasonably possible. Distortion in the bias signal will cause its waveform to be asymmetric about its zero axis, giving the same result, during recording, as would be given by d.c. bias. The consequence can be the introduction of noise on the tape together with distortion of the record signal. Asymmetry in the bias waveform will normally be caused by the presence of even harmonics[2], and it is common, in higher-grade tape recorders, to use push-pull oscillators to produce the bias current. Readers may recall, here, that one of the advantages of push-pull operation (as exemplified in Class A audio output stages) is the fact that it causes automatic cancellation of even harmonics.

The frequency of the bias current is also of importance and, to prevent heterodyne effects, this should be at least four times the highest audio frequency to be passed to the record head. Lower bias frequencies can cause the appearance on the tape of heterodyne beat notes formed with harmonics of the record signal. If, for instance, the bias frequency were 30kHz, this could beat with the third harmonic of an 8kHz record signal (i.e.

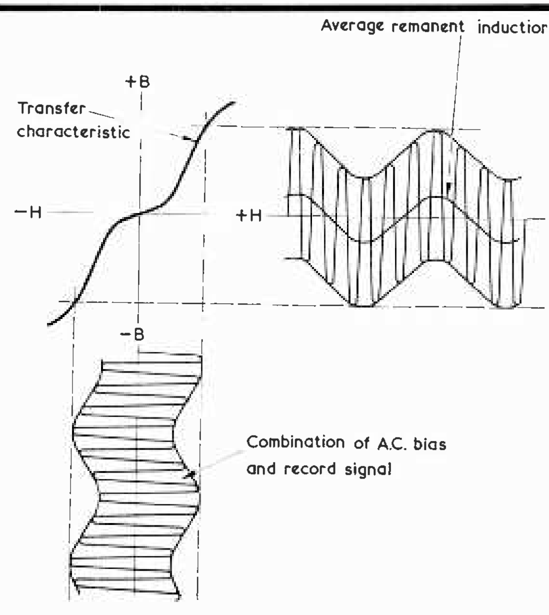


Fig. 1. Illustrating the remanent induction, at the right, resulting from the application of a.c bias and signal waveforms to the transfer characteristic

1 A. A. McWilliams, "Tape Recording and Reproduction," Focal Press.

2 See, for instance, D. J. Griffiths, "Getting The Best From Your Oscilloscope," Part 2, *The Radio Constructor*, June 1968.

24kHz) to produce a spurious 6kHz tone on the tape. It is virtually impossible to completely eradicate harmonic distortion in the record signal, but it is fairly safe to assume that in a well designed record amplifier the only distortion at significant amplitude will be second and third harmonic, the fourth and subsequent harmonics being too weak to give rise to trouble due to heterodyning with the bias signal. In a recorder of reasonable quality, where the range of frequencies, to be handled extends beyond 10kHz, the bias frequency is, in consequence, normally 60kHz or higher. At frequencies as high as this, 'losses' in the record head due to eddy currents in the core material and similar effects can become large, and it will be necessary to apply more bias current to obtain a given magnetising force than would be required at lower frequencies. This point can introduce a limiting factor to the bias frequency, particularly with lower cost recorders, whereupon a bias frequency may be chosen which is only just sufficiently high to avoid heterodyne effects.[3]

The amplitude of the bias current in the record head is another important factor because it dictates the points along the transfer characteristic at which the tape is to be magnetised. It is found that the level of magnetisation in the tape (as checked by measuring the output from a subsequent playback head) follows a curve having the general shape shown in Fig. 2. It will be seen that this has a peak value, at which maximum recording efficiency occurs. It might be thought desirable to adjust the bias current so that it lies exactly at this value. However, this is not the best approach in practice as the peak value tends to shift slightly with different tapes, giving the risk of operating at a point on the left hand side of the curve where it drops steeply. It is better to aim at operating at a value slightly beyond the peak, as illustrated in Fig. 2, whereupon any small variations due to different tapes will cause relatively small changes in recording efficiency. Incidentally, operating slightly above the peak value is also of advantage in valve recorders, since it ensures reliable operation if bias current drops slightly due to ageing of the oscillator valve or valves.

Under normal conditions, operating at a bias current slightly greater than peak value also results in a low noise and distortion level. A further point which should be mentioned is that too high a bias current causes a loss in recording efficiency at the higher frequencies. This is because the bias current is then partly erasing the signal being recorded on the tape, the erasure being most evident at the higher frequencies where self-demagnetisation in the tape is most likely to occur. (We shall be discussing the subject of tape-erasure in the next section). This erasure effect should not be troublesome if the bias current is at the level slightly higher than peak value which is indicated in Fig. 2.

3 Difficulty in obtaining adequate magnetising force amplitude at the erase head can also be a limiting factor to the frequency.

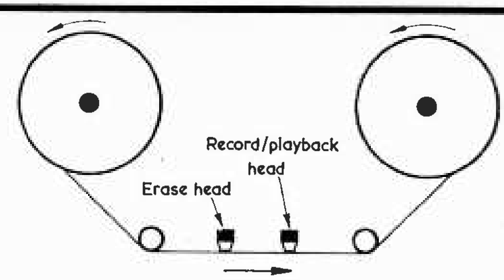


Fig. 3. The recording tape passes over the erase head before it reaches the record/playback head

THE ERASE HEAD

In a conventional tape recorder the tape passes over an erase head before it reaches the record, or record/playback head. See Fig. 3. The erase head carries out no function during playback. During recording, on the other hand, it serves to remove any signal, or noise due to random magnetisation, that was previously on the tape.

The erase head has a front gap which is much wider than that in a record, or record/playback head, a typical width being 0.02in. A high frequency alternating current is applied to the erase head coil, this current being obtained from the same oscillator in the recorder which produces the bias current. The amplitude of the erase current is considerably greater than that of the bias current, whereupon the usual practice consists of feeding the erase head directly from the oscillator, the record head receiving its bias current by way of an attenuating circuit.

The processes involved in erasure are quite simple. Fig. 4(a) illustrates the tape as it passes over the head and it will be noted that due to the wide gap, the tape is subjected to a magnetising force extending for a relatively large distance on either side. As the tape is drawn past the head the magnetising force exerted on it increases from zero to a maximum value at the gap itself, after which the force drops down again to zero.

The magnetising force applied to any section of the tape as it passes the head has, in consequence, a form similar to that shown in Fig. 4(b). The central part of this waveform has maximum amplitude, and the very high magnetising force applied to the tape here completely removes any previous magnetisation

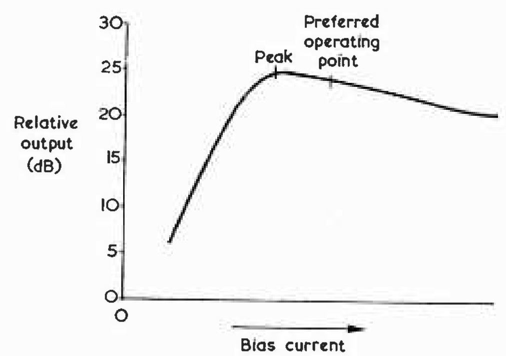


Fig. 2. Representative curve showing the relationship between bias current and recorded signal amplitude (the latter being expressed as output from a subsequent playback head)

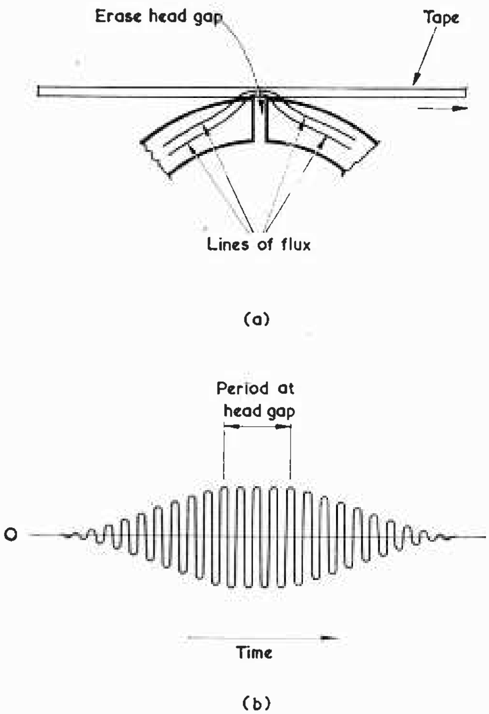


Fig. 4(a). The magnetising force at the erase head extends on either side of the gap (b). The erase magnetising force applied by the head increases gradually from zero to maximum amplitude at the gap, then decreases gradually to zero again

it may have had. If this high magnetising force suddenly ceased, the tape particles would revert to a value of remanent induction corresponding to the last peak applied to them; such a state of affairs is obviously undesirable and it is necessary to reduce the magnitude of the magnetising force gradually to zero. This process causes each iron oxide particle in the tape to be taken through a number of hysteresis loops, each smaller than the last, until it eventually reaches a hysteresis loop of negligible proportions and the magnetisation becomes zero. The gradual reduction in magnetisation is given automatically by the decreasing field after the tape passes the erase head gap. This process, incidentally, is reminiscent of the second explanation, given earlier, for recording with a.c. bias.

It is necessary for the erase current to be, as near as possible, a pure sine wave. A signal having an asymmetric waveform will result in a d.c. bias being left on the tape, and this can introduce distortion in the subsequent recording process. Asymmetry is caused by the presence of even harmonics and these, in particular, have to be eradicated. As may be seen, requirements here are the same as for the bias signal, and apply for the same reasons.

Before concluding this month, a final point concerns the oscillator which provides the erase and bias currents. This oscillator may be referred to as either the *erase oscillator* or the *bias oscillator* of the recorder, both terms being generally employed.

NEXT MONTH

Apart from the subject of the recording tape itself (which will be dealt with in a later article) we have now completed our examination of the basic magnetic theory encountered in the tape recorder. In next month's issue we shall commence to discuss circuit design. ■

NEW CONCEPT IN INTERFERENCE CONTROL

Birch-Stolec Ltd., Hastings, Sussex, announce the introduction of the Ammonite (Regd. Trade Mark) range of interference suppressors, claimed to represent a completely new concept in the suppression of electrical noise.

The suppressors have been designed specifically to meet the needs of the latest technological developments, covering Thyristor and Triac suppression and the increasingly sensitive and sophisticated equipment used in computors, data logging instruments and communications equipment.

Ammonite suppressors offer three design philosophies in one package – the virtual elimination of discrete inductors and capacitors, the absorption of unwanted interference power and the use of suppressor rather than filter techniques.

These features have been incorporated into a low-cost product capable of satisfying the military, aircraft and consumer markets. It is based on a new patented principle which can be applied to most of the usual physical configurations.

The unique construction of the Ammonite lends itself to a discoidal (grommet) shape which is admirably suited to suppression work and offers the further advantage of low profile mounting.

Ammonite designs are possible for cut-off frequencies as low as 2kHz, but it is expected that the most frequent applications will be in the 20-100kHz region. Initially, these designs will be available in the 2, 3 and 5 section styles, depending on the rate of cut-off required.

In order to simplify selection, a standard range of suppressors is being made available. These have a rated voltage of up to 250V a.c., 50Hz; a rated current of 0.5 to 15 amps and a cut-off frequency from 5kHz to 50 kHz.

It is pointed out that the suppressors are broadband units, having a low cut-off frequency and are not to be confused with purely R.F. rejection suppressors.

SIMPLIFIED TRANSISTOR SUPERHET

by

PAUL DEWHURST

Fresh thinking on an established subject has resulted in the simplified medium wave superhet design which is described in this article. One aspect of the receiver – the tuning capacitances employed – falls into the experimental category, but there is no reason why the constructor need not use conventional tuning values in the same basic line-up if he so wishes. The receiver may be readily adapted to cover 'Top Band' in addition to medium waves

IT HAS BEEN NOTICED BY THE AUTHOR THAT THE majority of small transistor radios are used only for listening to the transmissions radiated by the B.B.C., and that under these conditions the volume control is turned well down, since the sensitivity given by two intermediate frequency stages is not really needed for such reception. It occurred to him that, for many people, a much less sensitive receiver could be designed, for there must be many who are in the position of wanting only B.B.C. programmes.

Since it is easy enough to lose gain (!) it was decided to attempt making a medium wave set – using transistors – which would have none of the disadvantages of the usual reflex circuit (for example critical reaction, poor selectivity, lack of gain on receiving weak stations and overloading on strong ones) and most of the advantages of the superhet. Examples of the latter are good selectivity, reasonable gain, an absence of critical controls and efficient a.g.c. with a consequent lack of overloading.

THE CIRCUIT

Accordingly, and after much experiment, the circuit shown in Fig. 1 was evolved. In practice (which is what counts!) this fulfilled all the requirements of a listener who wants to tune in to medium wave B.B.C. programmes only, and with the minimum of fuss and expense.

It will be seen from Fig. 1 that the circuit consists of an AF117 used as an oscillator-mixer, a second AF117 used as an i.f. amplifier with a.g.c., an OC71 or OC81D as audio amplifier, and an OC81 as audio output amplifier. It will also be noticed that the circuit is, in effect, a transistorised version of the once-popular four-valve all-dry battery superhet, and it is found that the results given with this extremely simple circuit do not fall far short of those given by the valve version. The main difference is that the simple transistor class A output stage cannot approach in power output the usual 250 to 300 milliwatts of a DL96 valve output stage. However, the output from the OC1 is more than sufficient for most purposes, although it would not be found suitable, for instance, in a car.

MIXER STAGE

Since there are several points of interest and peculiarity in the circuit, it is perhaps best to go through it stage by stage. The signal is picked up by L1 which is wound on a ferrite rod 7in. long by $\frac{3}{8}$in. diameter. (This rod is available from G. W. Smith & Co. (Radio) Ltd., 3 Lisle Street, London, W.C.2. The turns required for L1 are discussed later). It was found that the number of turns on L1 was fairly critical since the pick-up of a ferrite rod aerial is considerably increased when the coil is at or near the centre of the rod. It is thus necessary to ensure that L1 resonates at the correct frequency with the coil almost at the centre of the rod – not exactly at the centre, otherwise one could not be sure that it was resonating correctly. In other words L1, when slid along the rod with the receiver tuned to the low frequency end of the band, should cause a signal to peak twice, both positions being near the centre. These points are mentioned at some length since it was found in the original experiments that the difference between the coil resonating near the centre of the rod and resonating near the end of the rod meant the differenec between a receiver which would pick up Radio Eireann and Hilversum in broad daylight and one which would only receive at usable volume the most powerful local stations.

L1 is tuned by one section of a twin gang 500pF tuning capacitor, since components of this value are readily available from most peoples' junk boxes, rather than by one of the smaller-value tuning capacitors normally found in transistor equipment. C2 is employed for trimming at the high frequency end of the band, and in the original version was a concentric trimmer. TR1 deserves little mention, since it functions as a normal mixer-oscillator, and the only thing which may need adjustment for maximum performance is the value of R1; 47kΩ was found to be suitable with several AF117's, but if a different oscillator coil than the one specified is used then it may well be worth experimenting with alternative values for this resistor. Values from 33kΩ to 100kΩ are typical, and the one finally selected should be that which gives maximum sensitivity

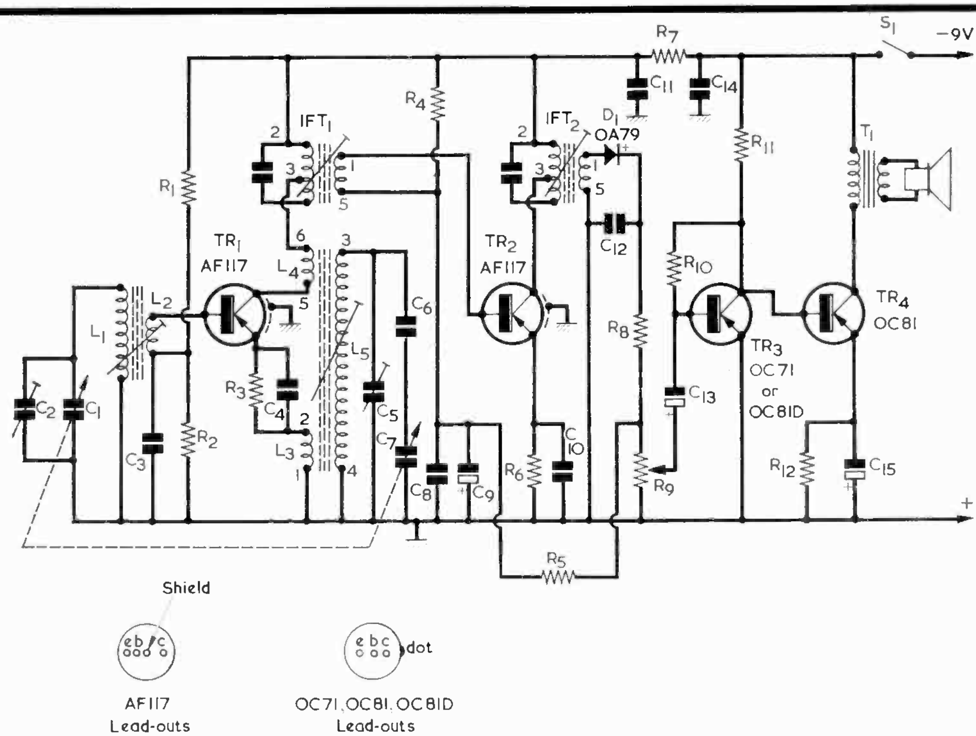


Fig. 1. The circuit of the simplified superhet receiver. The functioning of each stage is dealt with, in turn, in the text

COMPONENTS

Resistors
(All fixed values ⅛ watt 10%)

R1 47kΩ
R2 10kΩ
R3 1.2kΩ
R4 33kΩ
R5 10kΩ
R6 470Ω
R7 330Ω
R8 330Ω
R9 5Ω potentiometer, log track, with switch S1
R10 100kΩ
R11 4.7kΩ
R12 330Ω

Capacitors

C1 500pF variable, ganged with C7
C2 3–30pF trimmer
C3 0.01μF
C4 0.01μF
C5 3–30pF trimmer
C6 800pF silver mica 5%
C7 500pF variable, ganged with C1
C8 0.01μF
C9 10μF electrolytic, 3V wkg.
C10 0.1μF
C11 0.1μF
C12 0.05μF
C13 10μF electrolytic, 3V wkg.
C14 50μF electrolytic, 10V wkg.
C15 50μF electrolytic, 6V wkg.

Inductors

L1, L2 Home-wound (see text)
L3, L4, L5 Weyrad P50/1, or other medium wave transistor oscillator coil
IFT1 Weyrad P50/2, or other transistor interstage i.f. transformer
IFT2 Weyrad P50/3, or other transistor last i.f. transformer
T1 9.2:1 transformer type T/T4 (Radiospares)

(N.B. – L3 L4 L5, IFT1 and IFT2 are normally available under type numbers P50/1AC, P50/2CC and P50/3CC respectively)

Semiconductors

TR1 AF117
TR2 AF117
TR3 OC71 or OC81D
TR4 OC81
D1 OA79, or other germanium diode

Switch

S1 s.p.s.t., part of R9 (see text)

Battery

9-volt battery (see text)

Speaker

3Ω moving-coil

without any tendency to squegging at the high frequency end of the band. Lower values of R1 than the optimum will tend to produce squegging whereas higher values of R1 than the optimum will tend to reduce sensitivity and may possibly result in lack of oscillation towards the low frequency end of the band.

The oscillator coil was a P50/1 (Weyrad), which was originally intended for use with an OC44 mixer-oscillator. It has, however been found entirely satisfactory with the AF117. L5 is tuned by the second section of the 500pF twin gang capacitor. The value of the padding capacitor C6, at 800pF, may cause surprise since this is by no means the usual value found in this position with a 500pF tuning capacitor in a valve oscillator circuit. However, this value was found to offer excellent tracking in the present slightly unconventional tuning circuit. Of course, if a more usual value of tuning capacitor and/or a different type of oscillator coil is employed, then the maker's recommended value of padding capacitor should be adhered to. C5 is another concentric trimmer.

I.F. AMPLIFIER

I.F. transformer IFT1 is a P50/2 (Weyrad), but this component is not critical, and almost any transistor i.f. transformer could be used.

The i.f. signal is amplified by TR2, another AF117. The value of R4 may seem rather small, but it was found to give the best results in this circuit. Like R1, this resistor may be worth some experiment to determine the value required for optimum amplification. However, several different AF117's were tried as the i.f. amplifier with R4 at the value given, and all gave good results. IFT2 should be of the variety intended to feed a diode detector (in the Weyrad range this is a P50/3). D1, besides giving detection, also provides a positive rectified d.c. component, the amplitude of which is dependent on the strength of the received signal. This positive voltage is applied back to the base of TR2, thus controlling the gain of that transistor. The simple a.g.c. circuit which results was found adequate under all conditions encountered. R9 is a 5kΩ volume control which can, if desired, be ganged with an on-off switch, the latter being inserted in the negative battery lead (or in both leads if the switch is a double-pole component).

It will be noticed that there is no resistor between the slider of R9 and C13, as is the customary practice. It was found that a resistor inserted here reduced gain considerably and did not in any case appear to serve any useful function.

AUDIO SECTION

The audio section, consisting of TR3 and TR4, is extremely simple but very effective, giving high gain and good quality. The power output is of course necessarily limited since the collector current of TR4 is in the 10mA region. T1, the output transformer, is a T/T4 (Radiospares), and its ratio is 9.2:1. This matches the collector of TR4 to a 3Ω speaker, which means that a reasonably large speaker can be used – a great advantage when the power output is limited. It will be found that the quality given by a medium or large sized speaker in the present circuit is vastly superior to that in the usual transistor portable set having a small speaker in a plastic cabinet.

CONSTRUCTION

It has already been mentioned that this circuit is to some extent a transistorised version of the old four-valve battery portable, and a good idea would be to use one of these old sets as a basis for the present receiver. The original tuning capacitor with its slow motion drive and station indicator could be employed, and a suitable speaker will be already installed. The loudspeakers in these old sets were usually of reasonable size and in many instances were fitted to a wooden baffle and sometimes into a wooden cabinet, giving quite good quality reproduction. There would, of course, be more than enough room in the cabinet for the set described here, and for its 9-volt battery. If the set is made up in this fashion, then it will be found that an economical choice of supply is given by two 4.5-volt batteries (Ever Ready type 1289) connected in series. The total current consumption of the set is only about 12mA, and these batteries are capable of supplying this for many months.

ALIGNMENT

After construction is completed, the next thing to do is to get the i.f. transformers aligned to about 470kHz. If a signal generator is available then of course there is no problem. The author's usual method of aligning i.f. transformers without a signal generator is to take advantage of another receiver. This may be any transistor or valve set provided that, if mains-driven, its chassis is isolated and is *not* common to one side of the mains supply. The second receiver is used in the following manner. First of all tune it to a fairly strong signal. A piece of insulated connecting wire is then taken to some part of the receiver handling amplified i.f. (say, at the primary of the last i.f. transformer or at the secondary connection to the diode or, with valve receivers, at the diode anode). The other end of the lead is

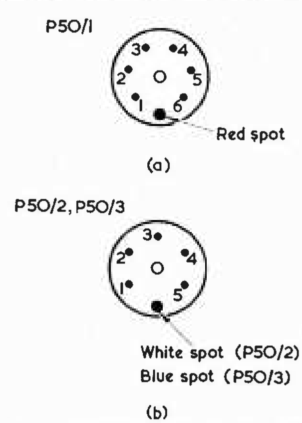


Fig. 2. Pin connections to (a) the P50/1 oscillator coil and (b) the P50/2 and P50/3 i.f. transformers

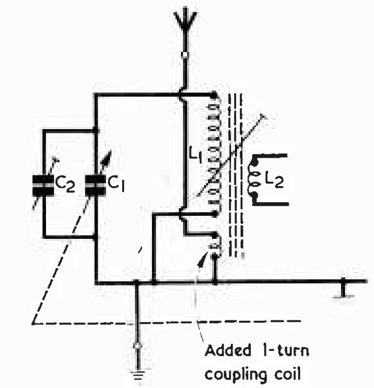


Fig. 3. Adding a 1-turn coupling coil enables an aerial and earth to be connected for 'Top Band' reception

wrapped round the wire connecting L4 to IFT1 to give a capacitive coupling without a direct connection. If this does not give sufficient input, then the chassis of the two receivers can be connected together.

The receiver providing the i.f. signal should then have its volume control turned right down, after which the cores of IFT1 and IFT2 are adjusted for maximum output. The i.f. cores can be given a final touching-up on a weak signal after the r.f. and oscillator circuits in their own receiver have been aligned. In the case of the Weyrad i.f. transformers listed it is worth checking that two peaks can be obtained by adjusting the cores, because if the signal peaks with a core right in the centre position then one cannot be sure that the transformer is tuned to the correct frequency.

For aligning the r.f. and oscillator sections without a signal generator it is easiest to connect a few feet of wire as a temporary aerial to the non-earthy end of L1. The core of the oscillator coil should then be adjusted until signals at the low frequency end of the band are received with the tuning capacitor vanes correctly enmeshed; in other words, when the vanes are fully enmeshed the receiver should be tuned to about 550 metres. The trimmer, C5, should then be adjusted until signals at the high frequency end of the band are received at their correct settings, so that with the capacitor vanes fully open the receiver tunes to about 190 metres. This adjustment of C5 may be found to have affected the core adjustment of the oscillator coil, and the whole sequence should be repeated three or four times until the correct band coverage is obtained. The temporary aerial should now be disconnected and, with a signal received towards the low frequency end of the band (for instance, B.B.C. Radio 3 on 464 metres), L1,2 should be slid along the ferrite rod until maximum signal strength is achieved. The tuning capacitor should then be opened and a signal at the high frequency end of the band tuned in (say, B.B.C. Radio 4 on 206 metres, or B.B.C. Radio 1 on 247 metres) and C2 adjusted for maximum output. Again, this sequence should be repeated, and the position of L1,2 can be finally adjusted on a weak station at the low frequency end of the medium wave band, such as Radio Eireann on 531 metres. C2 can then be given a last adjustment on some weak station round about 200 metres. These final adjustments will probably be found much easier to carry out after dark, when there are many more stations to be heard.

If L1 resonates towards the end of the rod, turns should be removed from it until there are two points of resonance just either side of the centre of the rod. If L1 peaks at the centre of the rod, then turns should be added until two peaks either side of the centre position are obtained. These adjustments to L1 should always be made at the low frequency end of the band, and after each adjustment C2 should be readjusted. In the original receiver, the correct number of turns for L1 was 40 of 26 s.w.g. enamelled wire wound with the turns side by side on a cardboard sleeve just able to slide along the rod. L.2 consisted of five turns of the same wire wound over the earthy end of L1. It did not appear to make any difference to the results which way round L2 was connected into circuit. When the receiver is properly aligned, the tracking all over the band should be found to be very accurate. The sensitivity of the prototype was found to be more than adequate for the original purpose, and it was found possible to receive Radio Eireann (531 metres,) Hilversum (402 metres), Hilversum (298 metres), and a few other Continentals, together with most of the regional stations of the B.B.C. in broad daylight. For most of the B.B.C. stations the volume control had to be turned down to avoid overloading the audio stages, and the volume from these was more than adequate. Although the set uses only two tuned circuits at i.f. the selectivity was found to be quite reasonable, and after dark several Continental stations, including Radio Luxembourg, were received at good strength and, as far as this is possible nowadays on the medium wave band, free of interference.

MODIFICATION FOR 'TOP BAND'

It was found that the receiver was quite sensitive enough for the reception of the local 'net' on the 1.8 to 2.0MHz amateur band using only a six-foot length of wire connected to the non-earthy end of L1, and it is thought that constructors may be interested in details of how to use the set for this extremely interesting and fascinating band.

There are two ways of making the receiver tune over 'Top Band'. The first and easiest is to reduce the values of the two trimmers, C2 and C5, until the tuning extends up to 2.0MHz. It is then possible, by judicious adjustment of these trimmers at the high frequency end of the band and L1,2 at the low frequency end of the band, to make the receiver track fairly well over the whole range of 150 to 550 metres. The six-foot aerial will be found necessary for amateur reception in most cases, as the field strength of amateur transmissions is naturally somewhat lower than that of broadcast stations, and the extra capacitance of the short aerial is easily allowed for by adjustment of C2. This method has the advantage that the circuit needs no tampering with apart from minor adjustments, although it may be found that the value of R1 may have to be increased slightly if the mixer-oscillator squegs or oscillates too fiercely at the high frequency end of the band.

A much better method, however, is to remove the twin gang capacitor, C1, C7, and fit in its place a twin gang 50pF component. This will be found to give a tuning range of about 150 to 200 metres with the coils and padding capacitor specified. With such a tuning capacitor the local 'net' was easily received, and some amateurs much further afield were also quite readable. The use of an earth may give a significant increase in signal strength. One can connect a longer aerial to the set by winding one turn of wire over the earthy end of L1 to act as a coupling coil, the other end connecting to the receiver chassis and to earth, as in Fig. 3.

If the set is used only for amateur band reception, then it will be found worth while adjusting the value of R1 until optimum reception is obtained, a higher value than the one used for medium wave reception being generally found to lower the noise level. If it is found that signals are received which appear to be of higher frequency than that of the band being tuned, this indicates that TR1 is oscillating too fiercely and that the value of R1 should be increased until these spurious signals disappear. Reception of these signals is due to harmonics of the local oscillator, and they can always be recognised by the fact that they tune much more sharply than a signal on the correct band, and that adjustment of the aerial trimmer will not cause them to peak. This point is mentioned as it is a fairly commonly encountered phenomenon with transistor mixers, which are very likely to generate harmonics, and the signals could prove extremely confusing to a beginner attempting to align the set. ■

RECENT PUBLICATIONS

RADIO AND LINE TRANSMISSION. VOL 3. By G. L. Danielson, M.Sc.Tech., B.Sc., C.Eng., M.I.E.E., and R. S. Walker, C.Eng., M.I.E.R.E. 308 pages, 5½ x 8½in. Published by The Butterworth Group. Price 45s.

This book is the third volume in a series which has been specially written for students taking the telecommunications technicians' certificate examination of the City and Guilds of London Institute. The first two volumes cover the full syllabuses of Radio and Line Transmission A and B, whilst the present volume deals with the syllabus of the Technicians' Certificate Examination for Radio Communication C. The authors are Head of Telecommunication and Electronics Department, Norwood Technical College, and Senior Lecturer, Norwood Technical College, respectively.

Though primarily intended for students taking the examination just mentioned, the book should also be of use to those taking H.N.C. and professional examinations. The subjects dealt with include: superhet receivers, ganging and tracking, r.f. amplification, amplitude and frequency modulation, transmitter output stages, aerial systems, and receiver and transmitter tests and measurements. There are 183 clear diagrams, and test questions (some taken from previous City and Guilds papers) are provided at the end of each chapter. Also, many worked examples are given in the text. Symbols and nomenclature are in accordance with British Standard recommendations, and the S.I. system of units is used throughout.

The book may be confidently recommended to the students for whom it has been specifically prepared. Also, it is capable of providing much useful and reliable information for others dealing with electronics at City and Guilds level.

COLOUR TELEVISION, Volume 2. By P. S. Carnt, B.Sc.(Eng.), A.C.G.I., C.Eng., F.I.E.E., and G. B. Townsend, Ph.D., B.Sc., C.Eng., F.Inst.P., A.K.C., A.M.B.I.M., F.I.E.E., F.R.T.S., F.B.R.S.T.S. 284 pages, 5½ x 8½in. Published by Iliffe Books Limited. Price 75s.

Both the PAL and SECAM systems of colour television transmission and reception are developments from the original American N.T.S.C. system which was introduced by R.C.A. In the PAL system the R-Y subcarrier component is reversed in phase on successive lines, whereupon it is possible for the receiver to 'average out' phase errors in the signal path from camera to c.r.t. screen. With SECAM, R-Y and B-Y are transmitted singly on successive lines.

Volume 2 follows Volume 1 (which, originally published some years ago, dealt with the N.T.S.C. system in full) and takes the colour television story up to PAL and SECAM. The present book starts with a chapter giving revision on the N.T.S.C. system by covering, amongst other things, the Chromaticity Diagram, N.T.S.C. subcarrier modulation and colour burst phase synchronisation. The bulk of the book then carries on to two chapters on the PAL system and PAL equipment, these being followed by a chapter on comb filters. Two further chapters deal with the SECAM system and SECAM equipment. The next chapter discusses the German ART system, the Russian NIR system and derivatives, whilst the final chapter in the volume is devoted to dot structure and cross-colour.

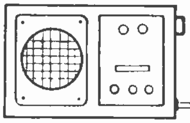
Like Volume 1, this book is written for the receiver engineer rather than for the studio technician. It provides an excellent textbook and reference for the British engineer working with PAL, and the two volumes give authoritative information on all the major colour television systems used throughout the world.

20 SOLID STATE PROJECTS FOR THE HOME. By R. M. Marston. 113 pages, 5½ x 8½in. Published by Iliffe Books, Ltd. Price 18s.

Intended mainly for the home constructor, this book has an international flavour since all the semiconductors are common types available in both Europe and the United States. Where applicable, alternative component specifications are given for 120 and 240 volt supply mains, and wire gauges are specified in both British and American standards.

Regular readers of *The Radio Constructor* will need no introduction to the author, who has written many articles for this journal. The approach towards each project in the book remains the same as for the magazine articles. First, the device to be built is introduced, its circuit function is then discussed, after which full details are given on construction and use. A commendable feature is the wide range of semiconductor types employed, these including unijunction transistors, field-effect transistors, thyristors, triacs and integrated circuits in addition to ordinary silicon transistors. Thus, the constructor automatically gains experience with sophisticated devices whilst making up the relatively simple projects described.

In your work-shop



This month Dick and Smithy follow their usual August custom and take a day off, away from the constraints of the Workshop. On the present occasion their steps lead them to a promenade by the sea, but they still have time to discourse on a number of subjects, most of which are concerned with power and its measurement

"FOR GOODNESS' SAKE," SAID Dick irritably, "put your jacket back on."

"But it's hot," protested Smithy, mopping his brow. "I'm just about working up to vapourising level."

The Serviceman stepped awkwardly to one side as a trio of giggling Bikini-clad girls rushed past him along the promenade. Defensively he held his jacket tightly under his arm.

"I *knew* this would happen," said Dick crossly. "Whenever I get away from the Workshop with you, you always show me up."

MATTER OF SUSPENSION

Dick gazed vindictively at the perspiring Smithy.

"Show you up?" protested Smithy. "How on earth can you say that I'm showing you up?"

"You're doing it with your rig, mate," returned Dick irately. "Just *look* at what's happened. It's a sweltering hot day, and we both decide to take a day off by the sea. Okay? Whereupon here we are with birds all prancing around us like nobody's business, and *you* have to come along dressed like a middle-aged City clerk from the early 1930's."

"And what, may I ask, is wrong with my attire?"

"Everything," returned Dick flatly "But worst of all, now that you've taken your coat off, are those puce and green braces with the bright yellow leather fittings at the ends."

Dick surveyed the Serviceman with disgust.

"Corluvaduk," he exclaimed incredulously. "On a day like this you've got woollen underpants on too. What's even more inconceivable is that they're the type that are held up by the braces. Just look! Great grotty loops hooked over the brace bottoms, together with vast areas of repulsive yellowing frayed underpant showing up alongside over the top of the trousers. Ye gods, I didn't even know you could *buy* underpants like that these days."

Smithy drew himself up.

"I didn't come here," he replied icily, "to listen to insulting comments about my underpants."

"Then put your jacket back on again," returned Dick promptly, "and hide the horrible things from public view."

Reluctantly, Smithy resumed his jacket.

"Satisfied?"

"That's *much* better," approved Dick. "Ah, now that we've got that little matter sorted out, I see that there's one of those little wooden cafes a bit further ahead. Let's get ourselves a spot of tea or something."

Mention of the life-saving fluid brought a purposeful glint to Smithy's eye and it was not long before he and his assistant were seated, in the shade of a gaily coloured umbrella, at a round tin table with a large steaming pot of tea beside them. Their table was right against the sea-wall, and they looked over a broad expanse of beach, comfortably filled by holiday makers of all ages. Beyond, the sea shimmered and shone as it gradually blended, at the horizon, with the cloudless sky above it. Somebody at the Meteorological Office must have put in a stint of really inspired overtime: it was an immaculately beautiful summer's day.

A light breeze, carrying with it the scent of seaweed and the ocean, played fitfully about them.

"This is just the job," pronounced Smithy with complete satisfaction. "Blow me, Dick, if I'd stayed much longer on the promenade out in that sun you'd have had to clamp me to a heat sink!"

"You were certainly dissipating a fair quantity of heat," agreed Dick, "and I've just thought of something. If the dissipation in your case was expressed in watts they'd be equal to I^2R; and I could then say that the R term stood for radiation from the sun whilst the I^2 bit stood for that well-known square intransigence of yours, as demonstrated by your stubborn refusal to change into more suitable clothes!"

"Dear me," said Smithy, impressed. "You're very bright this afternoon. Okay then, seeing that you want to show off your knowledge on power formulae let me give you a little problem. You have an electric fire element whose resistance is 240Ω and you connect it to 240 volt mains. What's the wattage dissipation?"

"Does this element" asked Dick suspiciously, "have the same resistance both when it's hot and when it's cold?"

"It has," confirmed Smithy. "It's 240Ω for both conditions. Anyway, don't waste your time working it

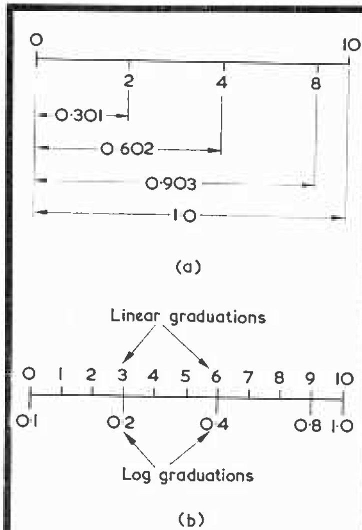


Fig. 1(a). Indicating spacing between zero and figures 2, 4, 8 and 10, as expressed in logarithmic form
(b). Following the procedure introduced in (a), a log scale can be drawn directly from linear scale graduations

out, because the answer is 240 watts."

"Are you sure? It seems queer to me that 240Ω at 240 volts should give you 240 watts."

"It isn't when you think about it," chuckled Smithy, pleased at having regained the ascendancy over his assistant. "The current flow in 240Ω when 240 volts is applied across it is obviously 1 amp. Watts are amps times volts, and so the power is one times 240, or 240 watts."

Dick still did not seem to be entirely convinced.

"I *suppose* you're right," he remarked dubiously. "How about trying those figures in the equation which gives you power directly from voltage and resistance?"

"If I did," said Smithy, "it would show even more clearly how the result is obtained. The equation you're referring to is

$$P = \frac{E^2}{R}$$

where P is in watts, E is in volts and R is in ohms. If you substitute the figures in our example, P becomes equal to 240 times 240 divided by 240."

"Stap me, so it does," said Dick. "Those figures are bound to simplify down to 240. Why, you could make up a general rule for this. If the volts and ohms are the same, so also are the watts!"

"Exactly," grinned Smithy. "Similarly, if the volts and watts are the same so also are the ohms, and if the ohms and watts are the same so also are the volts."

"Yes, of course they must be," remarked Dick. "It's funny how some of these simple mathematical things pan out. Do you know any other little tricks with numbers like that?"

"Well," said Smithy musingly, "there's an oldie which quite a few people still don't seem to have heard about. How do you tell quickly if a large number is divisible by three or nine?"

Dick frowned.

"I don't see that you can tell *quickly*," he remarked thoughtfully. "I should imagine that you just have to divide all the way through by three or by nine and see that there's nothing left over at the end."

"There's a quicker way than that," said Smithy. "What you do is to add up the digits in the number and see if the sum of these digits is divisible by three or nine. If the sum is divisible by three then so is the number, and if the sum is divisible by nine the number may also be divided by nine. Or, of course, by three as well."

"Give me an example"

Smithy reached into his pocket, extracted a diary and opened it at a blank page.

"Here we are then," he said, writing a number in the diary. "I've just dreamed up a four-digit number at random, and it happens to be 7,194. As you can see, the sum of all four digits comes to 21. This is divisible by three and so, if you check it, is 7,194. I could have made the last digit 1, whereupon the whole number becomes 7,191, and the sum of the digits is 18. And both 18 and 7,191 are divisible by nine."

There was silence for some moments whilst Dick mentally divided the numbers in Smithy's diary.

"You're dead right, you know, Smithy. Are there any other mathematical short-cuts you know about?"

LOG GRAPH PAPER

Smithy pondered for a moment.

The tables alongside them were beginning to fill up as people wandered in from the beach in search of afternoon sustenance. The younger of these, attractively attired in their skimpy swimming costumes, presented a pleasant spectacle, but this was unfortunately marred by the sight of their elders, who tended to overflow a little here and there. Perhaps Smithy had been wise to retain his sober garb.

"Here's a useful idea I've just remembered," remarked Smithy suddenly. "This has to do with numbers, too, and it applies to the drawing of curves which require log graph paper."

There was no response from Dick.

"I said," repeated Smithy in a louder voice, "that this idea I've just remembered has to do with curves which require log graph paper."

His assistant remained silent.

"Look, Dick," said Smithy, raising his voice even higher. "If that gorilla with the big hairy chest over there sees you drooling at his fiancée much longer, he's going to flatten you, mate."

Dick redirected his gaze then turned hastily back to the Serviceman.

"Gosh, Smithy," he gasped, "I hadn't noticed him."

He shivered at the thought of the averted catastrophe, then looked closely at the Serviceman.

"Just a minute," he asked suspiciously. "How did *you* know that she's his fiancée?"

"Because she's wearing an engagement ring, you great naive twit," snorted Smithy. "Rule Number One with strange females is to check what's carried by the significant digit. Anyway, assuming I *have* got your full attention, let's get on with what I was talking about, which concerns log graph paper. Now, it sometimes happens that you have to make up curves, for things like loudspeaker responses and so on, which need to be drawn on log graph paper. However, when you start to look for the stuff, you find that the only graph paper available has a graticule with linear spacing."

"I can certainly visualise that happening," replied Dick. "How do you get over the problem?"

"I'll show you," said Smithy, applying his pen to the diary once more, "Let's assume that this is the start of a log scale drawn out on plain paper. (Fig. 1 (a)). All I'll draw in for the moment are 0 and 10 graduations at the ends, as you'd get on a linear scale, with a straight line between them. What we'll do next is to put in some intermediate log graduations, and what we have to remember here is that their spacing on a linear scale is equal to the logarithm of the number that will be written in."

Dick grinned the grin of one who is totally without comprehension.

"I'll take your word for it!"

"Good," returned Smithy, concentrating on his sketch. "Well, we'll start off by saying that the log of 10 is one. Two is the next number to deal with and it so happens that the log of two is 0.3010."

"Are you sure?"

"Of course I'm sure," replied Smithy testily.

He turned the pages of his diary and indicated the figures in a table near the end.

"I should have known better than to ask," commented Dick. "Trust you to have a diary with log tables in it."

"I believe," pronounced Smithy, "in being prepared for all eventuali-

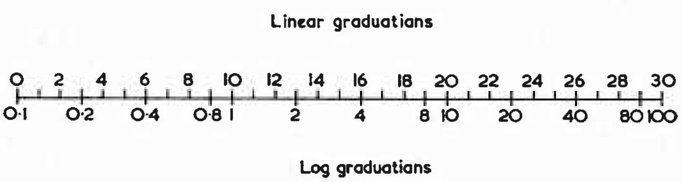


Fig. 2. The idea introduced in Fig. 1 may be extended over any number of decades

ties. Anyway, as I've just said, the log of two is 0.3010. We needn't bother about the fourth significant figure, and so we'll just say that the log of two is 0.301. The log of four, which is two multiplied by two, then becomes 0.602, whilst the log of eight, which is four multiplied by two, becomes 0.903. Okay?"

"I *think*," remarked Dick, "that the first glimmerings of what your driving at are beginning to break through."

"Hooray," said Smithy dryly. "Well now, we know that 0.301, 0.602 and 0.903 are all log values along the scale and so we can draw them in on our plain piece of paper. As you can see, the figures give us the linear dimensions between the points. We now proceed to the final bit where, instead of using plain paper, we're going to use graph paper having an ordinary linear graticule. (Fig. 1(b)). What we do then is to mark in the log figure 0.2 at linear three, the log figure 0.4 at linear six, the log figure 0.8 at linear nine, and the log figure one at linear 10. Also, 0.1 appears at the linear zero point."

Dick looked supremely unimpressed.

"What on earth," he asked, "is the use of that? What log scales do you get having values like 0.2 and 0.4?"

"You get plenty," returned Smithy irritably. "Loudspeaker response curves can, for instance, have a scale which takes in 0.1 to 1kHz. But you've missed the main point, which is that this idea can be extended to other decades."

Smithy turned a page of his diary.

"I'll just be able to squeeze this next sketch in across the two pages," he remarked. "Now, assume that I've got some linear graph paper with thirty squares available. The first ten squares can take 0.1 to 1 in log, the next ten squares can take one to 10 in log, and the third ten squares can take 10 to 100 in log. Got it?" (Fig. 2).

"Gosh, yes," exclaimed Dick, as light suddenly dawned. "Why, it's a darned neat approach, this. To get a log scale then, all you have to do is simply pick up the two, four and eight graduations direct from the three, six and nine graduations on the linear scale."

"Exactly," confirmed Smithy. "The result is that you then have enough log scale points to draw nearly all

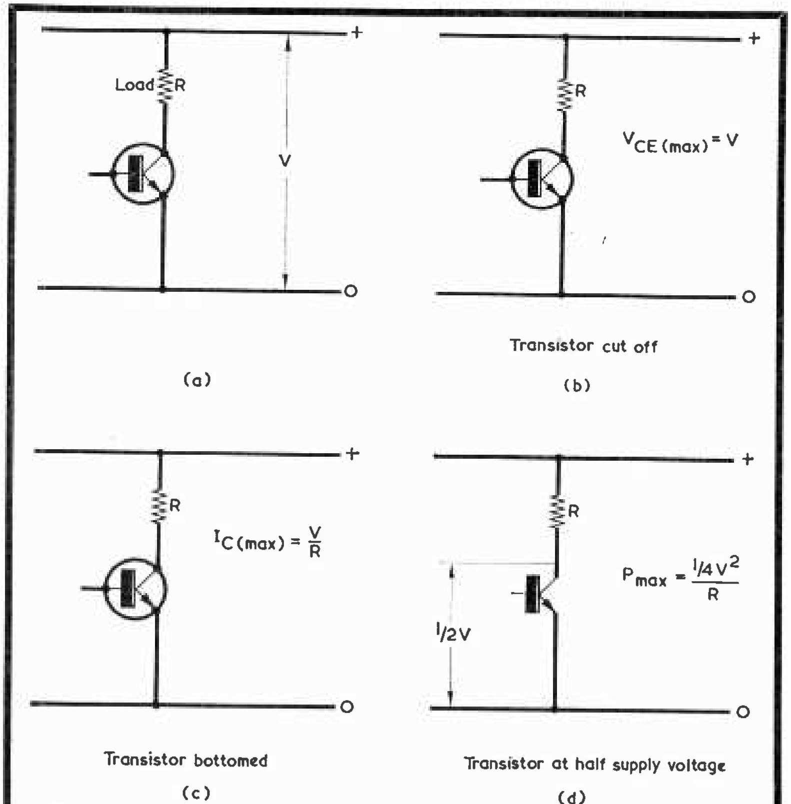


Fig. 3. Illustrating the maximum voltage, current and power dissipation conditions for a transistor in grounded emitter. (A protective diode across the load, if this should be a relay coil or similar, is assumed)

the log curves that are likely to be required in a hurry, and the error in the positioning of the log graduations is only one part in 300."

Smithy drained his cup and hastily refilled it.

"Phew!" he said. "I thought I'd never be able to get that one over to you. Let's talk about something else that doesn't involve logs."

POWER DISSIPATION

"Okey-doke," replied Dick equably. "We'll go back to the subject of power then. Let's say you've got a transistor in grounded emitter which has a resistive load in its collector circuit such as a relay coil or something similar. How do you work out the maximum power the transistor will be called upon to dissipate?"

"You've put up rather a good question there," commented Smithy, sketching out the circuit described by his assistant (Fig. 3(a)). "The reason I say that is because this basic circuit sets up three important maximum operating quantities for the transistor."

"Three?"

"Three," repeated Smithy. "The first maximum quantity is the voltage which the circuit can cause to be applied across the collector and emitter. This is given when the transistor is cut off. (Fig. 3(b)). Ignoring leakage current in the transistor, which causes a corresponding very small voltage drop in the load, the voltage across the collector and emitter is then the voltage of the supply. The second maximum quantity demonstrated by the circuit is the maximum collector current it can cause the transistor to pass. This current flows when the transistor is hard on and bottomed (Fig. 3 (c)). Assuming that the small voltage which will still exist across the collector and emitter of the transistor is negligibly low and may safely be ignored, the collector current then becomes equal to the current which would flow in the load if the supply voltage were applied directly across it. Thus, the maximum collector current the transistor will have to pass in the circuit is given, from Ohm's Law, by $I = V/R$."

"What's the third maximum operating quantity? Is it the maximum power dissipation figure I queried you about at the beginning?"

"It is," said Smithy. "In this circuit the transistor dissipates maximum power when it is biased such that the voltage across it is equal to half the supply voltage. (Fig. 3 (d)). The power is then given by

$$P = \tfrac{1}{4}V^2/R$$

where P is the power dissipated by the transistor in watts, V is the supply voltage and R is the resistance of the load."

"Hang on a bit," interrupted Dick. "You're getting ahead of me here. Where do you get this $\frac{1}{4}V^2$ business from? And how does R come into it? It's the dissipation across the transistor and not across the load we're interested in."

"Let's deal with your questions one by one," replied Smithy. "To begin with, the basic equation for power is the one we referred to earlier on, where we had E^2 in the top half of the fraction. The E in the present case is $\frac{1}{2}V$ which, when squared, becomes $\frac{1}{4}V^2$. And we get R into the equation because, when half the supply voltage appears across the transistor, the resistance it offers must be equal to the load resistance. Since we know the latter we have a nice known figure all ready to put into the equation."

"Oh I see now," said Dick. "There's something else I've just noticed. When you have half the supply voltage across the transistor, both the transistor and the load dissipate the same power."

"True enough," confirmed Smithy. "That's because the circuit has become symmetrical about the junction of the transistor and the load."

"It's peculiar," said Dick musingly, "that you should get maximum power dissipation in the transistor when exactly *half* the supply voltage is dropped across it."

"I suppose it is really," replied Smithy. "I must confess, also, that it's one of those obvious little things that tend to be rather difficult to explain without maths. You may find it helpful to look at the circuit in the light of a generator matching into a load. (Fig. 4 (a)). If the generator has an internal resistance equal to R1 and the load resistance is R2, maximum transference of energy and, hence, power dissipation in the load is given when R1 and R2 are equal. If the generator circuit is rearranged (Fig. 4 (b)) it then becomes similar to the one with the transistor, the load R2 replacing the transistor."

"Ah, yes," said Dick brightly. "I'm with it now. Anyway, let me do a spot of summing up on these three basic things that need to be checked when considering a transistor circuit of this type. First, the maximum voltage which can appear across the transistor is the supply voltage. Second, the maximum current which can flow in the transistor is V/R. And, third, the maximum power which can be dissipated in the transistor is $\frac{1}{4}V^2/R$."

"You've got the idea," said Smithy approvingly.

INPUT POWER

Smithy picked up his cup and spluttered into it as he was unceremoniously jostled by someone passing behind him. The café terrace was now quite full. Also, there had become less a preponderance of youngsters in swimming costumes than there was of youngsters who were more fully apparelled in faded cotton, corduroy and suede. Frills and beards appeared to be *de rigueur* and someone must have made a packet selling beads to the natives.

"Dear me," remarked Smithy a little apprehensively. "Some of these people look a bit hippy-like don't they?"

"They won't hurt you," said Dick, glancing unconcernedly about him. "So long as you leave them alone, that is."

"I can assure you," returned Smithy decisively, "that I shall do just that."

Two tall slender figures entered the café, each dressed in what appeared to be the regulation loose jacket and jeans. Both wore dark glasses with large round lenses. One sported a head of very blond hair whilst the other's hair was auburn. In either case, the coiffure extended down to the shoulders, ending in a mass of curls.

"Here, come off it," called out Dick. "It's *you* who'll get filled in if you don't stop staring at people."

Smithy dragged his attention

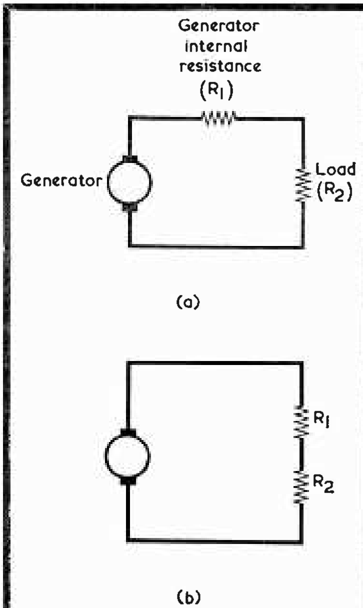


Fig. 4(a). There is a maximum transfer of energy from a generator to a load when the resistance of the latter equals the generator internal resistance
(b). When re-drawn, the generator circuit becomes similar to Fig. 3(d)

away from the last two arrivals, who had now joined the queue at the counter, and turned back to his assistant.

"For a moment," he remarked, "I was quite carried away then. What were we talking about?"

"Nothing much in particular," said Dick carelessly. "Mainly about matters concerned with power. Which reminds me about something else. What exactly is meant by d.c. input power?"

"In amateur transmitters?"

"That's right."

"Well," said Smithy, "it's the d.c. input power to the anode circuit of the final amplifier in the transmitter. A maximum d.c. input power is quoted by the authorities for each of the amateur bands in use, and licensed amateurs operating in these bands are required to ensure that the input power they use does not exceed the figure specified."

"How do you measure this input power?"

"That's quite simple," said Smithy. "All that has to be done is to insert a current-reading meter in series with the h.t. supply to the anode of the power amplifier feeding the aerial, whereupon d.c. input power is the current indicated by this meter multiplied by the h.t. voltage applied to the anode." (Fig. 5).

"I wonder," queried Dick, "why the authorities work in terms of d.c. input power? This doesn't define exactly the amount of r.f. power which is fed to the aerial, does it?"

"The d.c. input power figure is employed," explained Smithy, "because it's an easy quantity to measure. Also, the figure provides a *limiting* factor to the r.f. power which can be fed to the aerial. The latter type of power is not quite as easy to measure with the aid of simple instruments, and the readings given might be subject to argument. But it's impossible to have arguments in the interpretation of a d.c. input power figure because the method of measurement is so straightforward and unambiguous."

"Fair enough," remarked Dick. "I see your point."

He looked up.

"Hallo," he continued, "I think we're going to have a couple of guests at this table of ours."

"Are we?" remarked Smithy, filling the last cup from the tea-pot. "Well, I'm nearly ready to go, so they can have the table all to themselves in a minute or two."

As Smithy drank his tea, there was a scraping of chairs. He glanced up, to find that the newcomers, each carrying a bottle of Coca-Cola complete with twin straws, were the pair who had entered the café a few minutes earlier. Politely, Smithy moved his cup and saucer further towards his end of the table to give them more room. The two newcomers sat down.

BRIEF ENCOUNTER

There was a long silence.

Smithy decided to launch a conversation.

"Er," he remarked hesitantly, to the auburn-haired figure opposite him. "It's a really lovely day, madam, isn't it?"

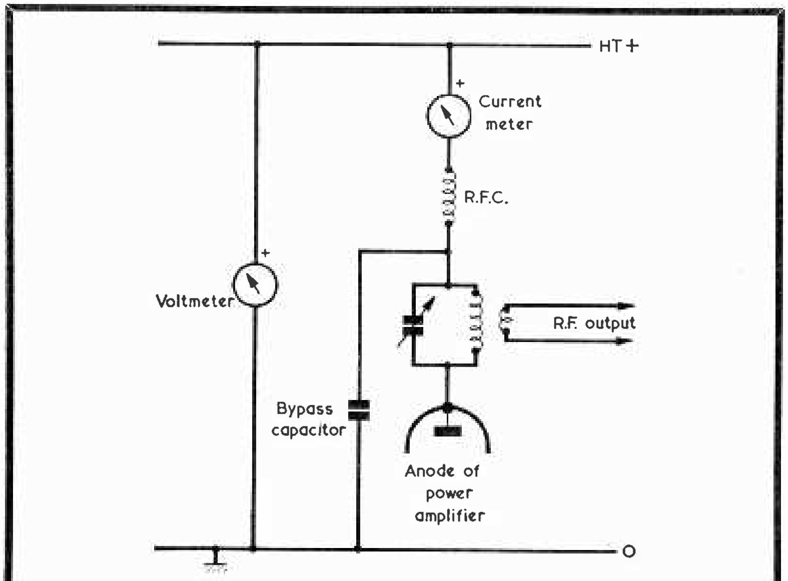


Fig. 5. D.C. input power in a transmitter is the product of power amplifier anode current and h.t. supply voltage

A pair of dark glasses rose from their sombre contemplation of the Coca-Cola bottle and became directed at the Serviceman.

"I'm a bloke, man," said the figure, in a deep voice.

"Good gracious, are you?" replied Smithy, amazed. "Then I suppose you're having a day out with your young lady?"

"Young lady?" replied he of the auburn curls. "What's this young lady scene?"

Smithy pointed an embarrassed finger at the young man's companion.

"I mean her. Well yes, I suppose I do."

Smithy's voice died away into uncertainty.

The second pair of dark glasses rose to confront the now almost completely demoralised Smithy.

"Hey," remarked an even deeper voice, "I'm a bloke too, man."

"Of course," stuttered Smith, "of course you are. How stupid of me not to have noticed."

The two twin lenses glared balefully at Smithy, who turned a terrified glance at Dick for assistance. But that worthy had unaccountably acquired a deep scarlet complexion and seemed incapable of speech. Unwillinging, Smithy turned back to the two young men.

"Hey, daddio," said the first of these, "you kinky or something?"

"Just a minute," said the second. "Get the gear, man."

In his confusion Smithy had allowed his jacket to fall wide open, leaving his puce and green braces fully uncovered.

"How," continued the second, "do those suspenders *grab* you?"

The auburn headed figure inspected the article of clothing in question. Leaning forward, he inserted a finger under one of the braces and experimentally checked its elasticity.

"Like, groovy man,"

"Well, really," spluttered Smithy, his sense of outrage overcoming his original apprehension. "This is too much."

At last Dick spoke.

"Come on, Smithy" he grinned. "I think we'd better get going."

Smithy rose with alacrity.

"Is," asked the blond gentleman, looking at Dick, "the old fellow with you, like?"

"Sure is," returned Dick. "I suppose you could say he's my responsibility, sort of."

This explanation was apparently accepted at its face value. The two newcomers turned their dark lenses towards each other as Dick and Smithy (the latter very hurriedly) left the table.

"Burdens," remarked the first young man mournfully. "All of us got burdens."

"That's so right," replied his companion sadly. "It's lousy that a kid so young should be lumbered with one so old."

But, fortunately for Smithy's complacency, he had passed out of earshot by the time these last few words were uttered. Nevertheless, his sense of self-esteem was probably shattered to an equal extent as his assistant, on leaving the café burst into a fit of uncontrolled laughter for at least three minutes, after which he submitted the fuming Smithy to a lengthy explanation on the differences between male and female gender in the younger generation.

We use the word 'gender' intentionally. Permissive Society or no Permissive Society, we're not going to let *that* three-letter word get in here. ■

LOW PHASE-DISTORTION AUDIO TRANSFORMERS

Gardners Transformers Limited, of Christchurch, Hampshire, England, announce a new standard range of low phase-shift audio transformers capable of handling steep-sided transient signals.

These transformers, the result of years of research, employ toroidal winding and nickel-iron ribbon of extremely high permeability.

They offer four salient features. Firstly, the very low phase-shift over the audio frequency band is less than five degrees from 20Hz to 20kHz, covering a span of ten octaves as opposed to the usual seven or eight.

Secondly, the frequency response is within 0.5dB from 10Hz to 80kHz (13 octaves).

The third advantage of these new transformers is their ability to handle steep-sided transient signals without generation of overshoot.

And, fourthly, they are designed to cope with high-level transient signals up to +12dBm at 20Hz and +20dBm at 50Hz. One type in particular, the MU7590, which is designed for 600 ohm line-bridging applications, will handle voltage levels up to +24dBm at 20Hz.

Gardners' new transformers are electrostatically and magnetically shielded. They are assembled in a cylindrical mumetal case 6.05cms in diameter and 7.1cms high and mounted on an International Octal plug-in base.

Three types in the range are available for common matching impedances: MU7582, MU7584 and MU7590.

Full details of the new transformers are given in Manual GT.22 which is available from Gardners Transformers Ltd., of Christchurch, Hampshire, England.

Radio Topics

By Recorder

MY RIGHT ARM IS NOW SIX inches longer than my left arm.

Or, at any rate, that's how it feels to me after having taken the family Cavalier spaniel (who, *Daily Mirror* readers may be interested to learn, rejoices in the name of Boot) out for a brisk walk on the lead. Boot's method of taking a walk consists of exerting a continual tension on the lead, maintaining this tension just slightly below the level at which asphyxia sets in. The resultant panting progress on his part sets the old ladies tut-tutting, but the dog seems to enjoy it.

WASTED ENERGY

Now, I hate to see useful energy wasted and I have spent quite a little time working out ways in which the efforts of our spaniel could be put to good use.

First, however, the lead-pulling effect has to be analysed. The tension imposed on the lead is constant, and it rises smoothly from zero to its maximum level as soon as walking commences. When I cease walking the tension drops almost immediately to zero, since Boot then stops and looks round to see what's happening at the other end of the lead. In consequence, therefore, we have a smooth and steadily applied tension which exists only during the actual process of walking.

One obvious application here is, of course, the removal of over-tight control knobs from television receivers. As most service engineers will agree, such knobs are one of the bugbears of the business: they are held to their spindles by means of internal springs of fantasic strength and tenacity, and can only be removed by a long, continual and steady pull. Any jerks or attempts at levering merely break the plastic. What I propose to do, therefore, when I encounter the next over-tight control knob, is to couple the non-dog end of Boot's lead to it, couple Boot to the other end of the lead, and then take him for a walk whilst I carry the TV set with the knob pointing forwards. I should imagine that a quick walk several times around the block would be sufficient to cause the most recalcitrant of knobs to become shifted from its spindle, and the process would offer the added bonus of fresh air, exercise and change of scene.

Another application which also springs to mind could be employed prior to my next coil-winding session. When I next plan the winding of any single-layer coils, I'll initially make up a special dog lead consisting of twelve strands of the coil wire. After a brief and vigorous walk with the dog I'll then have a dozen strands of coil winding wire all beautifully straight, and with all the kinks eased out of them.

A possible third application should be mentioned as a matter of interest, but it is doubtful whether it will be successful in practice. I'm always hunting around for short lengths of resistance wire and it occurred to me that the Boot-tension process could be applied to the straightening out of several coiled electric fire elements. After calculation, unfortunately, I find that whilst the process is feasible its inevitable end would consist of my being legally in charge of a dog who was several streets away.

50 AMP TRANSISTORS

The two transistors doing a balancing act in the photograph are a pair of complementary silicon power transistors recently introduced by Motorola Semiconductors Ltd. These are p.n.p. type 2N5684 and n.p.n. type 2N5686. Also introduced by Motorola are the 2N5683 (p.n.p.) and 2N5685 (n.p.n.) which have the same basic characteristics as the two illustrated.

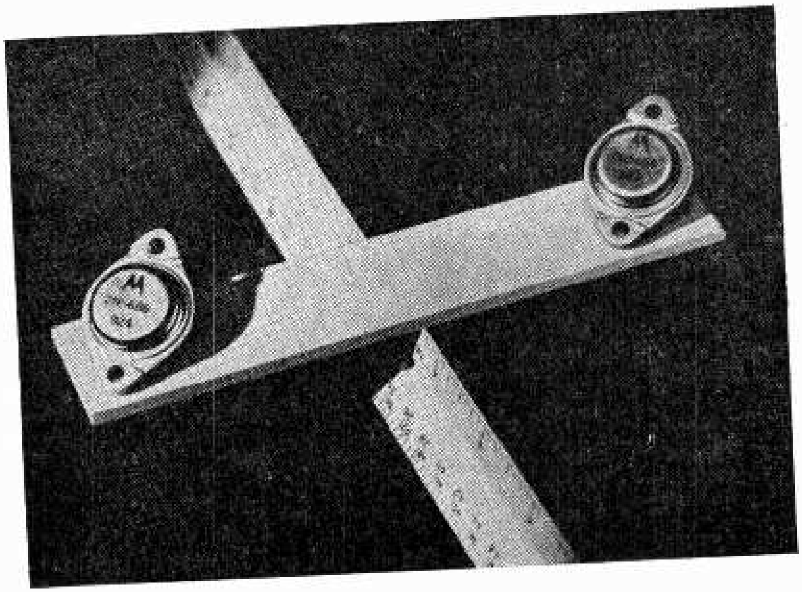
All these transistors are rated at a maximum collector current of 50 amps. Together with a collector breakdown voltage of 60 to 80 volts, this high current rating makes the transistors suitable for high power amplifying equipment such as 200 to 300 watt audio and servo amplification, motor speed control and power supply regulation. Minimum current gains of 15 at 25 amps and 5 at 50 amps are exhibited.

The transistors can also be used in switching circuits such as 1,000 watt inverters and converters, motor controllers and lamp drivers. A maximum collector-to-emitter saturation voltage of only 1 volt at 25 amps ensures low-loss operation in saturated switching circuits. A maximum transition frequency of 2MHz at 5 amps provides for a good performance in high power switching applications.

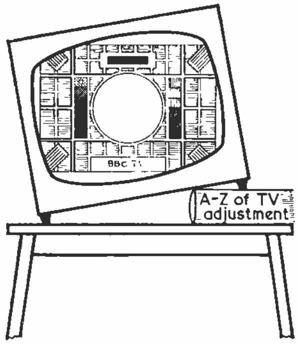
Hosed in a TO-3 case, each of these hefty devices dissipates a total of 300 watts at a case temperature of 25°C.

TILT

The accompanying little cartoon, redrawn by our draughting depart-



Complementary transistors type 2N5684 and 2N5686, recently released by Motorola Semiconductors Limited. They are rated at a maximum collector current of 50 amps, with a collector breakdown voltage of 60 to 80 volts ment from a sketch received from a South Wales reader, Mr. B. G. Ball, provides an amusing development from a true story.



Mr. Ball carries out a few TV repairs in his spare time every now and again and, in the instance which inspired his sketch, was called in to look at a receiver which suffered from the fault illustrated. What had happened was that the deflection coils had, for some reason, become rotated out of their correct position on the neck of the tube, with the result that the picture, although perfect in every other respect, had become tilted. To bring the picture horizontal again, the set-owner had, quite simply, tilted the whole receiver in the opposite direction with the aid of a book.

WIRE INDUCTANCE

A straight wire possesses inductance.

This fact is not normally of importance until you start working at v.h.f. above about 60MHz, whereupon the fact that a straight wire has inductance can have a considerable effect on tuned circuits at these frequencies. If you ever change a component in a v.h.f. tuned circuit you should always ensure that the new part is fitted in with exactly the same lead length as the previous one had. The components most likely to be replaced are fixed coupling and bypass capacitors and, to retain the same inductance, it is always wise to use a capacitor of the same type for the replacement. Thus, if the faulty capacitor was silvered mica so also should be the new component. Similarly, a tubular ceramic capacitor should, preferably, be replaced by a tubular capacitor, and a disc ceramic capacitor by another disc capacitor. These points only apply to components which actually enter the tuned circuit.

What is less generally realised is that the inductance of a straight piece of wire increases as it gets thinner. Sometimes, part of the inductance in a v.h.f. tuned circuit is given by a straight piece of wire connecting to what is obviously a coil. If you replace that wire with another which is considerably thinner or considerably thicker you may be surprised to find that you have shifted the resonant frequency by a couple of MHz! This change of inductance with wire thickness is taken advantage of in the Band III coils of some TV turret tuners, where the design necessitates that the tuned coils be wound with an exact number of turns. The coil designer then makes the shift from the inductance required for one channel to that required for the next by ringing the changes in wire gauge.

To take an example, let's assume that, in a particular turret tuner design, one of the band-pass coils for Channel 12 requires three turns comfortably spaced out. The corresponding coil for Channel 11, which is 5MHz lower in frequency, could probably be catered for by three turns of the same wire, with close spacing to give the requisite increase in inductance. For Channel 10 it may be impossible to get a further increase in inductance by closer spacing again, whilst four turns would give too great an inductance. So the designer uses three turns of a thinner wire to obtain the necessary 5MHz drop in frequency. Channel 9 may be three turns of an even thinner wire again, then at Channel 8 the designer can, at last, increase the number of turns to four, these using a relatively thick wire with the turns well spaced out. So, the small changes in inductance required for each 5MHz drop in frequency are catered for by changing wire thickness before making the relatively large inductance change given by adding a turn.

Next time you have a Band I – Band III turret tuner in front of you, take a look at the Band III coils. If the design is of the type where the tuned coils must have an exact number of turns you'll soon be able to spot the changes in wire gauge. ■

BETHESDA 625-LINE TV RELAY STATION

The BBC has placed an order with Watkin Jones & Son Limited, of Bangor, for the construction of the building for the UHF television relay station to serve Bethesda, Caernarvonshire.

The Bethesda relay station, which is one of several being built in Wales, is sited near Cil-geraint, three-quarters of a mile west of Bethesda. It is expected to start service towards the end of the year, on its BBC-2 channel, 63, with vertical polarisation. Later it will also transmit BBC Wales on channel 57 and ITV on channel 60. Group C receiving aerials will be required.

LATE NEWS

Times = GMT *Frequencies = kHz*

★ AMATEUR BANDS

● LIBERIA
EL7NB has been heard using the c.w. mode on **21080**, giving the QTH as Tchien and name as Laura.

● PAKISTAN
AP2MR logged on **14260** s.s.b. at 1900 and also on **21350** s.s.b. at 1445.

● OGASAWARA
Formerly Bonin Is., JD1AAZ heard using s.s.b. at 1520 on **21235.**

● MINAMI TORISHIMA
Formerly Marcus Is., JD1AAH using c.w. on **14050** at 0700 and on **14063** at 1030.

● SAUDI ARABIA
7Z3AB heard using s.s.b. mode at 1717 on **14236** and on **21291** at 1638.

● CROZET Is.
FB8WW heard **14077** c.w. around 1400 and also on s.s.b. on **21250** at 1412.

● TOP BAND
Braving the Summer static on this band recently have been GD3TNS, GM3PFQ, OK1AQA/P, OK1HBT, OK1KRS, OK1KWS and OL7ANL – using the c.w. mode.

★ BROADCAST BANDS

● COLOMBIA
HJIQ La Voz del Llano, Villavicencio, has moved from the listed **6115** channel to **6070** (1kW).
HJDV Radio Vision, Medellin, has moved from **6105** to **6180** (1kW).

● ANGOLA
A new station, Emissora Regional de Saurimo, operates on **4860** (5kW) from 1900 to 2200. Address – Caixa Postal 166, Henrique de Carvalho.
CR6RE Radio Clube de Malanje, has moved to **4965** (1kW) from the listed **4935.**

● BRAZIL
ZYR232 Sao Paulo, which was on the air from 1959 to 1965, has been reactivated on **17725** (1kW) from 2300 to 0300.

● DOMINICAN REPUBLIC
Whilst no private station can now operate above the 60 metre band, **6090** and **9505** channels are used by the government owned station Radio Television Dominicana under a special law. The former channel is at present inoperative.

● MALAWI
The newly installed 100kW transmitter will operate on **3380** (old 20kW transmitter used **3375)** and on **5995.**

● VENEZUALA
YVLK Radio Rhumbos, Caracas, is using the new channel of **9660** in parallel with the usual **4970** (10kW).

Acknowledgements – SCDX, ISWL and our Listening Post. ■

NEW CRT BROCHURE

The new Brimar Industrial Cathode Ray Tubes brochure is an international publication which has been called "the best in the business". It contains 30 pages devoted solely to cathode ray tubes, and now covers more than 200 available types, not counting "specials". A new feature of this year's catalogue is the listing of "Standard Phosphors" in normal production against each individual tube type. "Special Phosphors" available to order at extra cost are listed at the bottom of the data pages.

For convenience of selection by design engineers, tubes are grouped by application, then arranged in ascending order of screen size, with separate columns to indicate the other major selection criteria of screen shape and mounting facilities, implosion protection, deflection angle, neck diameter, overall length and screen glass light transmission.

For maintenance technicians, the catalogue gives typical operating conditions and base connection diagrams on the same pages. There is also a useful table of tube "Comparables' at the back.

Copies of the brochure may be obtained from Brimar Publicity Dept., Thorn Radio Valves & Tubes Ltd., 7 Soho Square, London W1V 6DN.

LAST LOOK ROUND

CHEAP SKATE!

"Keep the pot a-boiling sir" called out S. Weller, Esq., as he and others of the immortal Pickwickians whizzed along the slide during a long agone Yuletide at Dingley Dell.

Unlike Sam you won't be having a cheap skate on thin ice if you build the inexpensive transistor *Sliding Challenger Economy Amplifier* **featured on page 31 of this issue.**

Just slip up to your supplier and haul in the component catch!

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If you are fishing around for a little sprat of a single valve record player amplifier then catch the design on page 20 in your net.

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For a whale of a time make sure you get a line on our next issue – like the proverbial sardine tin it's packed full! It will cost you but 3/6d. so spare no expense – and give the cat a goldfish! ■

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(Continued on page 61)

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SMALL ADVERTISEMENTS

(Continued from page 59)

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(Continued on page 63)

SMALL ADVERTISEMENTS

(Continued from page 61)

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RADIO CONSTRUCTORS DATA SHEET 41

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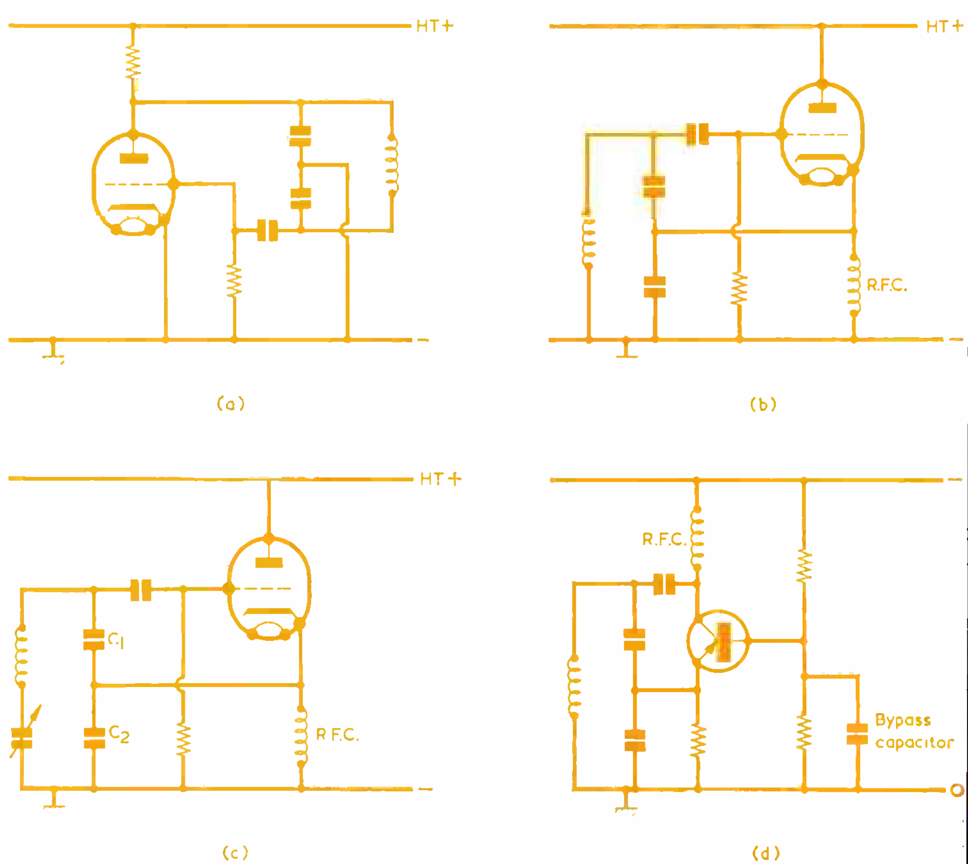

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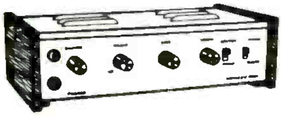

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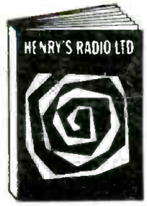

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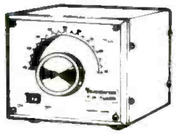

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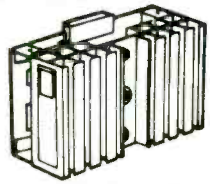

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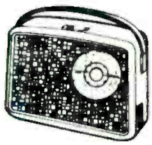

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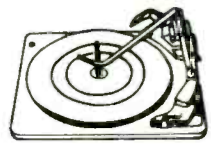

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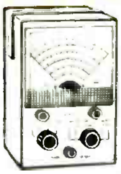

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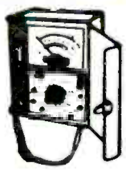

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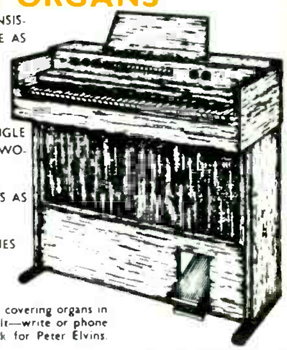

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