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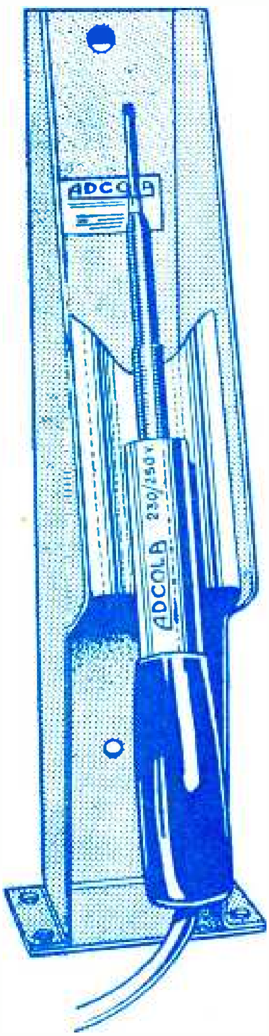

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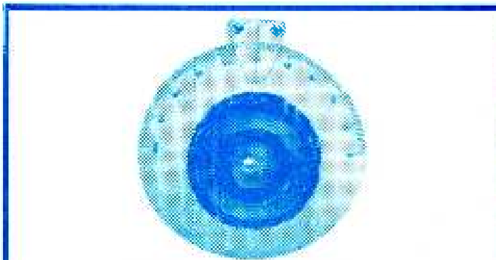

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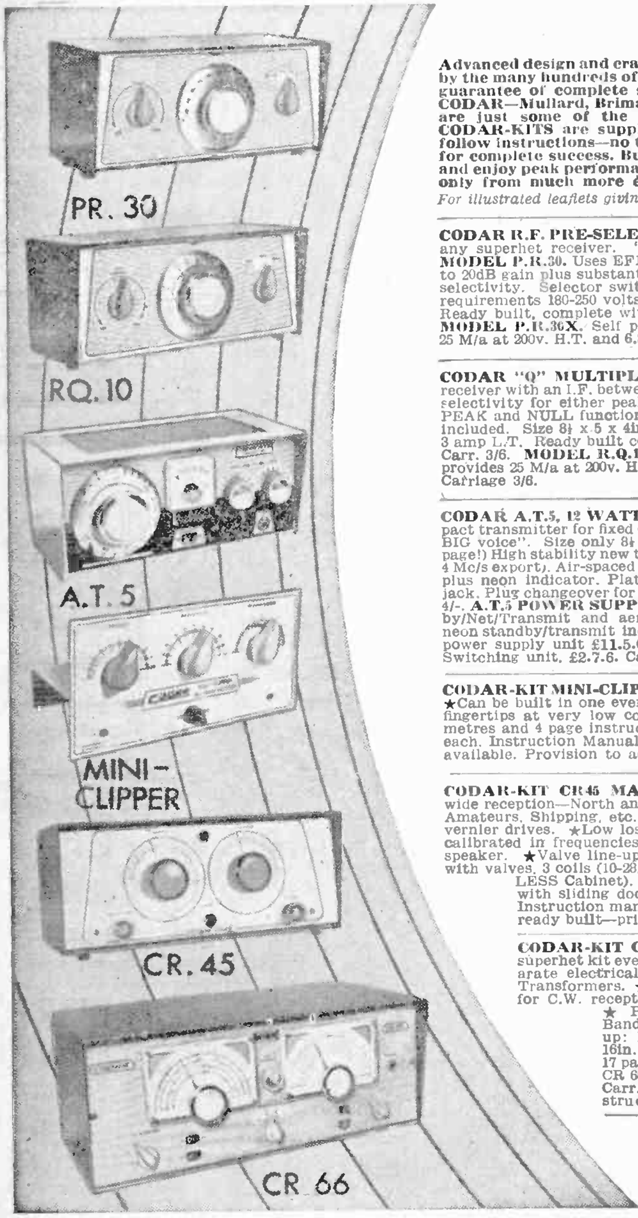

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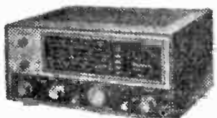

RA-1

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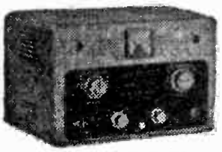

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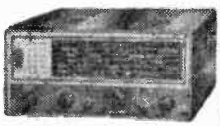

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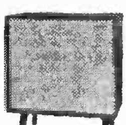

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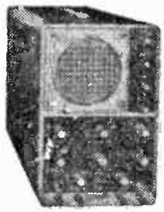

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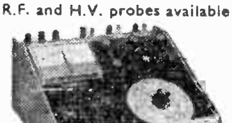

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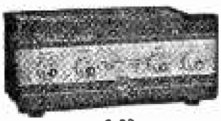

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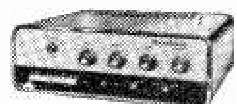

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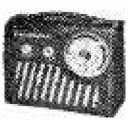

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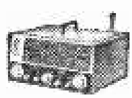

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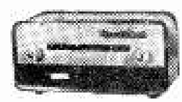

FM-4U

AM/FM TUNER. Covers FM 88-108 Mc/s. A.M. 16-50, 200-550, 900-2,000 m. Tuning heart (£4.13.6 incl. P.T.), and I.F. Amp (£22.11.6). Total **£27.5.0** Kit
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6BQ7A	7/6
6BR7	8/3
6BR8	8/-
CB87	25/-
6BW6	7/6

6BW7	5/-
6BX6	4/-
6C4	2/3
6C5	4/-
6C6	3/-
6C8	3/-
6C9	10/9
6C10	8/-
6C12	5/9
6CD6G	18/-
6CH6	5/-
6CW4	24/-
6D1	1/6
6D3	9/6
6D6	3/-
6E5	9/6
6F1	9/6
6F6G	3/9
6F6GT	7/6
6F7G	5/-
6F8	5/-
6F11	17/9
6F12	3/-
6F13	3/9
6F14	23/3
6F15	6/9
6F17	12/6
6F18	13/5
6F23	9/3
6F24	10/6
6F32	3/-
6F33	3/6
6G6	2/6
6H6	1/6
6J5G	3/-
6J5GT	4/3
6J6	3/-
6J7G	4/6
6J7GT	7/-
6K6GT	5/6
6K7G	1/3
6K7GT	4/-
6K8G	3/3
6K8GTM	8/6
6K25	24/-
6L1	10/-
6L5G	12/6
6L6GT	7/3
6L7GTM	5/6
6L18	10/-
6L19	19/-
6LD3	7/-
6LD13	7/-
6LD20	5/6
6N7GT	7/-
6P1	9/3
6P25	6/6
6P26	9/-
6P28	11/6
6Q7G	4/-
6Q7GT	7/9
6R7G	5/3
6R7GT	11/-
6SA7GT	7/-
6SC7	4/9
6SG7	4/9
6SH7	3/-
6SJ7	4/6
6SK7	4/6
6SL7	5/3
6SN7	4/-
6SQ7	5/-
6SR7	12/6
6SS7	2/-
6U4GT	8/6
6U5G	5/-
6U7G	7/-
6V6G	3/6
6V6GT	5/6
6X4	3/9
6X5	5/3
6Y7G	12/6
6Z4/84	5/-
6Z5G	15/-
7A7	12/6
7B6	12/6
7B7	9/6

7C5	8/-
7C6	6/9
7C7	5/-
7D3	15/-
7D5	14/6
7D6	14/6
7H7	5/9
7R7	12/6
7V7	5/-
7Y4	5/-
8D2	2/6
9BW6	9/6
9D2	3/-
9D7	7/6
10C1	9/9
10C2	12/-
10D1	7/-
10D2	11/8
10F1	10/-
10F9	9/9
10F18	9/9
10LD3	6/3
10LD11	9/6
10P13	8/3
10P14	11/6
11D3	17/6
11D5	17/6
11E1	15/-
11E3	17/-
12A6	2/3
12A8	16/6
12AC6	8/6
12AD6	9/6
12AE6	8/-
12AH7	5/-
12AH8	10/9
12AT6	4/6
12AT7	3/6
12AU6	5/9
12AU7	4/6
12AV6	5/9
12AX7	4/6
12AY7	9/9
12BA6	5/3
12BE6	4/5
12BH7	6/-
12E1	16/9
12H6GT	1/6
12J5GT	2/6
12J7GT	7/3
12K5	10/-
12K7GT	3/6
12K8GT	8/6
12Q7GT	3/6
12SA7GT	6/9
12SC7	4/-
12SG7	3/-
12SH7	3/-
12SJ7	5/-
12SK7	3/-
12SQ7	8/-
12SR7	5/-
12U5G	7/-
13D1	5/-
13D3	5/6
14B6	20/9
14H7	9/6
15D2	6/-
18	12/6
19	10/6
19AQ5	7/3
19BG6G	20/5
19H1	6/-
20D1	10/-
20D2	21/-
20F2	11/6
20L1	12/6
20P1	12/6
20P3	12/-
20P4	13/3
20P5	12/3
25A6G	7/6
25L6	4/9
25U4GT	14/7
25Y5	7/9
25Y5G	7/9
25Z4G	6/6

25Z5	7/3
25Z6GT	8/-
27SU	23/3
28D7	6/9
30C1	6/6
30C15	9/3
30C17	11/9
30C18	8/9
30F5	7/3
30FL1	9/3
30L1	5/6
30L15	9/6
30L17	12/9
30P4	12/-
30P12	7/6
30P16	5/3
30P19	12/-
30PL1	9/3
30PL13	10/6
30PL14	11/3
35/51	12/6
35A5	20/9
35L6GT	6/-
35W4	4/6
35Z3	16/2
35Z4GT	4/6
35Z5GT	5/9
40SUA	6/6
41MTL	8/-
41STH	10/-
42	5/-
43	10/-
45	17/6
45Z6GT	15/-
50A5	21/10
50B5	6/6
50C5	6/6
50CD6G	40/9
50L6GT	6/3
52KU	14/6
53KU	14/6
72	6/6
77	5/-
78	4/9
80	5/3
83V	8/-
85A2	6/6
90AG	67/6
90AV	67/6
90CG	42/-
90CV	42/-
90C1	16/-
150B2	16/6
150C2	4/6
161	13/-
185BT	34/11
215SG	6/6
220B	10/6
301	20/-
302	15/-
303	15/-
304	15/-
305	16/6
306	13/-
866A	12/6
956	2/-
1203A	7/-
1622	12/6
2101	12/6
4033	15/-
4687	71/-
5763	7/6
6067	10/-
7193	1/6
7475	2/9
9002	4/6
9006	2/6
A1834	20/-
ACO44	9/-
AC2HL	10/6
AC2pen	11/6
AC2PEN/DD	12/6
AC5PEN/DD	23/3
AC6PEN	4/9

AC/PEN (5)	17/6
AC/PEN (7)	17/-
AC/SG	22/6
AC/SG VM	12/-
AC/TH1	15/-
AC/TP	18/-
AC/VP1	12/-
AC/VP2	12/-
ATP4	2/3
AZ1	8/6
AZ31	6/6
AZ41	6/6
B36	4/9
B339	4/6
B719	5/9
BL63	10/6
C1	12/6
CK506	6/6
CL4	19/6
CL33	11/6
CV6	2/6
CV63	10/6
CV85	14/6
CV271	12/6
CV428	19/-
CY1	16/4
CY1C	6/6
CY31	5/9
D1	1/3
D15	13/6
D42	10/6
D63	5/-
D77	2/3
DAC32	7/6
DAF91	3/3
DAF96	6/-
DCC90	6/9
DD4	12/6
DD41	10/6
DDT4	7/6
DET25	7/6
DF33	8/6
DF66	15/-
DF72	30/-
DF91	2/3
DF96	6/-
DF97	10/-
DH30	15/6
DH63	4/-
DH76	3/6
DH77	3/9
DH81	23/3
DH101	25/-
DH107	16/11
DK32	7/6
DK40	15/6
DK91	4/-
DK92	8/-
DK96	6/6
DL33	6/9
DL35	5/-
DL63	5/3
DL68	15/-
DL72	15/-
DL75	30/-
DL92	4/9
DL94	5/-
DL96	6/-
DL810	10/6
DM70	5/-
DM71	9/9
DW4/350	8/6
DW4/500	8/6
DY86	6/6
DY87	7/6
E80F	24/-
E83F	24/-
E88CC	10/-
E180F	19/6
E1148	1/9
EA50	1/6
EA76	6/9
EABC80	5/9
EAC91	3/3

EAF42	7/9
EB34	1/-
EB41	4/9
EB91	2/3
EBC3	20/6
EBC33	6/-
EBC41	7/-
EBC81	5/9
EBC90	3/9
EBC91	5/6
EBF80	5/9
EBF83	7/3
EBF89	6/-
EBL21	10/3
EC52	4/3
EC53	12/6
EC54	6/-
EC70	4/9
EC90	2/5
EC91	4/-
EC92	6/6
ECC31	7/3
ECC32	4/-
ECC33	29/1
ECC34	21/7
ECC35	5/3
ECC40	7/-
ECC81	3/6
ECC82	4/6
ECC83	4/6
ECC84	5/6
ECC85	5/9
ECC88	8/9
ECC189	11/6
ECC804	9/-
ECC807	15/-
ECF80	7/3
ECF82	6/3
ECF86	11/6
ECF804	24/-
ECH3	23/3
ECH21	9/-
ECH33	22/8
ECH35	6/-
ECH42	8/-
ECH81	5/9
ECH83	6/6
ECH84	9/6
ECL80	5/9
ECL82	6/6
ECL83	8/9
ECL86	8/-
EF6	20/6
EF9	20/6
EF22	6/6
EF36	3/8
EF37A	7/-
EF40	8/9
EF41	6/6
EF42	3/9
EF50	2/6
EF54	3/-
EF72	5/-
EF80	4/-
EF83	9/9
EF85	4/6
EF86	6/6
EF89	4/-
EF91	3/-
EF92	2/6
EF97	10/-
EF98	9/9
EF183	7/3
EF184	6/6
EH90	9/6
EK32	5/9
EL2	19/6
EL32	3/6
EL33	6/6
EL34	9/9
EL35	10/-
EL36	8/9
EL37	12/3
EL41	7/-
EL42	7/9
EL81	8/3
EL83	6/9

EL84	4/6
EL85	7/6
EL86	7/3
EL91	2/6
EL95	5/6
EL360	27/-
EL820	16/4
EL822	20/3
ELL80	13/6
EM4	17/9
EM34	11/6
EM35	12/-
EM71	15/6
EM80	6/3
EM81	7/-
EM84	6/9
EM85	8/9
EM87	7/6
EN31	10/-
EN91	5/6
EY51	5/6
EY81	7/3
EY83	9/3
EY84	9/6
EY86	5/6
EY88	8/9
EY91	3/-
EZ35	5/3
EZ40	5/3
EZ41	6/3
EZ80	3/9
EZ81	4/3
EZ90	3/9
FC2	14/6
FC4	8/9
FC13	14/6
FC13C	17/-
FW4/500	6/6
FW4/800	8/6
GT1C	9/9
GU50	55/-
GZ30	7/6
GZ32	8/-
GZ33	17/6
GZ34	10/-
GZ37	14/6
H30	5/-
HABC80	9/3
HL2	7/6
HL13C	4/-
HL23	12/6
HL23DD	5/-
HL41	8/9
HL41DD	12/6
HL42DD	12/6
HL133DD	9/6
HN309	25/-
HVR2	8/3
HVR2A	8/9
IW3	5/6
IW4/350	5/6
IW4/500	6/-
KBC32	20/-
KF35	12/6
KL35	11/6
KLL32	21/7
KT2	5/-
KT8	15/-
KT32	4/9
KT33C	6/-
KT36	29/1
KT41	6/6
KT44	5/-
KT61	6/9
KT63	3/9
KT66	12/3
KT74	12/6
KT88	28/-
KTW61	4/9
KTW62	5/6
KTW63	5/6
KTZ41	5/6
L63	3/-
LN152	5/9
LN309	9/6
LN319	9/3
LP2	9/6

LZ319	6/6
LZ329	6/6
MHD4	7/6
MHLD6	12/6
ML6	5/9
MS4B	20/5
MSP4	12/-
MU12/14	4/6
MX40	8/9
N37	10/6
N78	26/-
N108	26/2
N339	25/-
P41	3/6
P61	2/6
PABC80	6/9
PC86	7/9
PC88	9/-
PC95	6/9
PC97	6/9
PCC84	5/6
PCC85	6/9
PCC88	10/6
PCC89	8/6
PCC189	10/-
PCF80	6/6
PCF82	6/-
PCF84	8/6
PCF86	8/6
PCF801	10/-
PCF802	10/-
PCF805	8/9
PCL82	6/6
PCL83	9/6
PCL84	7/6
PCL85	8/6
PCL86	8/9
PCL88	12/6
PEN40DD	34/-
PEN45	7/-
PEN45DD	12/-
PEN46	4/-
PEN383	10/3
PEN453DD	10/6
PENA4	7/-
PEN/DD 4020	17/6
PFL200	20/5
PL33	9/-
PL36	9/-
PL38	16/-
PL81	6/9
PL82	5/-
PL83	6/-
PL84	6/3
PL500	15/6
PM84	9/3
PT15	10/-
PX4	9/-
PX25	8/6
PY31	6/9
PY32	8/9
PY33	8/9
PY80	4/9
PY81	5/-
PY82	4/9
PY83	5/6
PY88	7/3
PY800	5/9
PY801	7/6
PZ30	9/6
QP21	5/-
QP22B	12/6
QP25	5/-
QQVO3/10	35/-
QS75/20	10/6
QS150/15	9/6
R10	15/-
R12	5/6
R16	29/-
R17	17/6
R18	9/6
R19	6/9

R52	7/6
RG1/240A	54/-
RK34	7/6
S130	22/6
SP4B	19/6
SP13C	12/6
SP41	2/-
SP42	12/6
SP61	2/-
SU25	27/2
T41	9/-
TDD2	12/6
TDD4	7/9
TH4B	10/-
TH21C	10/6
TH30C	14/6
TH41	10/-
TH233	6/9
TP22	5/-
TP25	5/-
TP2620	7/6
TY86F	11/6
UABC80	5/-
UAF42	6/9
UB41	10/6
UBC41	6/3
UBC81	6/3
UBF80	5/6
UBF89	6/6
UBL21	10/9
UC92	6/3
UCC84	8/-
UCC85	6/6
UCF80	8/3
UCH21	8/-
UCH42	8/-
UCH81	6/6
UCL82	7/3
UCL83	9/3
UF41	6/9
UF42	4/9
UF80	6/3
UF85	6/9
UF86	9/-
UF89	5/6
UL41	7/-
UL44	23/3
UL46	[illegible]/6
UL84	5/6
UM4	17/6
UM34	16/10
UM80	8/3
UR1C	6/6
UU5	7/-
UU6	11/-
UU7	7/6
UU8	11/6
UU9	5/3
UU12	4/3
UY1N	10/3
UY21	7/9
UY41	5/-
UY85	4/9
U10	9/-
U12/14	7/6
U16	15/-
U17	5/-
U18/20	6/6
U19	48/6
U22	5/9
U25	8/6
U26	7/6
U31	6/6
U33	13/6
U35	16/6
U37	29/-
U45	15/6
U47	8/6
U50	4/9
U52	4/6
U76	4/6
U78	3/9
U101	19/6
U107	17/6
U191	9/6
U251	9/-

U281	8/9
U282	12/3
U301	11/-
U329	9/-
U339	9/6
U403	9/9
U404	6/-
U801	15/-
U4020	6/6
VMP4G	11/9
VMS4B	12/-
VP2	3/6
VP2B	9/6
VP4	14/6
VP4A	14/6
VP4B	12/-
VP13C	7/-
VP23	2/6
VP41	5/-
VP133	9/9
VR75	21/-
VR105	5/6
VR150	4/9
VT61A	7/-
VT501	3/-
VU111	5/-
VU120	10/-
VU120A	10/-
VU133	7/-
W21	5/-
W42	12/-
W61M	24/6
W63	10/6
W76	3/6
W77	2/6
W81M	5/9
W101	26/2
W107	10/6
W729	17/6
X14	7/9
X18	8/-
X24	16/6
X41	10/-
X61	6/-
X63	5/9
X64	4/6
X65	5/6
X66	7/3
X76M	8/6
X78	20/6
X79	27/-
X81M	29/1
X101	23/6
X109	26/-
X118	9/9
X119	6/6
X142	8/-
Y63	5/-
Y65	5/-
Z63	4/6
Z66	7/3
Z77	3/-
Z152	4/-
Z729	6/6
Z749	9/3
Z759	36/-
Transistors and diodes	
AA120	4/6
AA129	4/6
AC107	14/6
AC113	8/-
AC114	8/-
AC127	9/6
AD140	25/-
AF102	27/6
AF114	11/-
AF115	10/6
AF116	10/-
AF117	5/6
AF118	20/-
AF124	11/-
AF125	10/6
AF126	10/-
AF127	9/6
BY105	7/-
BYZ13	11/6

GD3	5/6
GD6	5/6
GD14	10/-
GET103	7/-
GET104	10/-
GET106	17/6
GET111	12/-
GET113	6/9
GET114	6/6
GET116	17/-
GET873	9/3
GET874	9/6
GEX13	3/6
GEX35	3/-
GEX36	10/-
GEX45	6/6
GEX64	11/6
GEX66	15/-
MAT100	7/9
MAT101	8/6
MAT120	7/9
MAT121	8/6
OA5	6/-
OA10	6/6
OA70	3/-
OA73	3/-
OA79	3/-
OA81	3/-
OA85	3/-
OA86	4/-
OA90	3/-
OA91	3/-
OA95	3/6
OA210	9/6
OA211	13/6
OAZ204	9/6
OAZ210	7/6
OC16W	35/-
OC19	25/-
OC22	28/-
OC23	57/-
OC25	12/-
OC26	8/-
OC28	23/-
OC29	16/6
OC35	9/6
OC36	21/6
OC41	8/-
OC42	5/-
OC43	12/6
OC44	4/9
OC44PM	8/9
OC45	4/9
OC45M	8/-
OC65	22/6
OC66	25/-
OC70	6/6
OC71	6/6
OC72	8/-
OC73	16/-
OC74	5/-
OC75	8/-
OC76	8/6
OC77	12/-
OC78	8/-
OC81	4/-
OC81D	4/-
OC81M	8/-
OC82	10/-
OC83	6/-
OC84	8/-
OC139	12/-
OC140	19/-
OC170	8/6
OC171	9/-
OC200	10/6
OC201	29/-
OC203	14/-
OC204	10/6
OC206	10/6
OCP71	17/6
ORP12	12/6
SX641	10/-
TS2	12/6
TS3	15/-
V10/15A	12/-
XA103	15/-

WE REQUIRE FOR PROMPT CASH SETTLEMENT ALL TYPES OF VALVES, LOOSE OR BOXED, BUT MUST BE NEW

METAL RECTIFIERS. DRM1B 13/-. DRM2B and DRM3B 15/6. LW7 21/-. LW15 26/-. RMO 7/11. RM1 5/3. RM2 6/3. RM3 7/9. RM4 12/9. RM5 17/6. 14A86 17/6. 14A97 19/6. 14A100 23/-. 14A124 26/6. 14A163 35/6. 14B130 31/-. 14B261 11/6. FC101 16/9. 16RC.1.16.1 8/-. FC31 21/-. 16RD.2.2.8.1 11/-. 16RE.2.1.8.1 8/6. 18RA.1.1.8.1 4/-. 18RA.1.2.8.1 11/-. FC116 6/-. FC124 12/6. 8B3 10/6. C2D 9/-. C2H 5/9. C2V 9/-. C3D 11/-. C3B 14/8. C3V 11/-. R3/2D 4/3. Q3/4 3/7.

ELECTROLYTICS. Can types: 32 x 32/450v. 6/-. 50 x 50/350v. 6/-. 64 x 120/350v. 9/-. 60 x 250/275v. 9/6. 100 x 400/275v. 12/6. 100/275v. 3/-. 200/275v. 4/-. 100 x 200/275v. 8/6. Tubular types: 8/450v. 1/9. 16/450v. 2/9. 32/450v. 3/9. 8 x 8/450v. 3/-. 16 x 16/450v. 4/-. 32 x 32/350v. 4/-. 8 x 16/450v. 3/9. 32/350v. 3/-.

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MARTIN AUDIOKITS & RECORDAKITS

F.M. TUNER UNITS Nos. 15, 16 and 17 .... Cash £12.17.6
Or Dep. 51/6 and 12 m. pymts. of 18/10 .... (H.P. Price £13.17.6)
TRANSISTORISED AMPLIFIER with 5 position input selector, pre-amp and controls, 10 watt amplifier and Power Pack.
For 3 Ohm Speaker. Cash £14.5.0
Or Dep. 57/- and 12 m. pymts. 20/10 .... (H.P. Price £15/7/0)
For 15 Ohm Speaker. Cash £15.8.0
Or Dep. 62/- and 12 m. pymts. 22/6 .... (H.P. Price £16.12.0)
All above include Front Panels, Knobs and Instructions.
TWO TRACK RECORDAKIT AMP. (Valve) FOR STUDIO DECK, 6 valves, controls, self powered .... Cash £11.11.0
Or Dep. 47/- and 8 m. pymts. 25/6 .... (H.P. Price £12.11.0)
COLLARO STUDIO DECK 3 speed latest Two Track Cash £10.19.6
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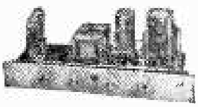

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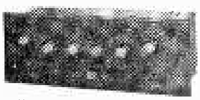

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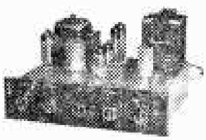

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A High-Fidelity design providing up to 10 watts (per channel).
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A four-valve design for both Stereophonic and Monophonic operation.
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(12) Stereo Tape Pre-Amplifier Model STP-1

For use with current Truvox, Brenell or Collaro "Studio" ½- and ¼-track Stereo Decks.
KIT OF PARTS £22.0.0
Built and tested £28.0.0 (C. & I. 8/6)

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Suitable for most ¼-track Mono Tape Decks.
KIT OF PARTS £14.0.0
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(14) Mullard Tape Amplifier Model HF/TR3

Based on Mullard's type "A" design and suitable for most ½-track Mono Tape Decks.
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(17) Double Feature Pre-Amplifier

Inputs for microphone, crystal or magnetic pick-ups, tuner unit, and in addition offers full facilities for tape recording and high fidelity replay. This unique feature means that should you wish to include tape in your hi-fi system at a later date all that is required is a suitable tape deck. Push-button switching for 3 tape speeds equalised.
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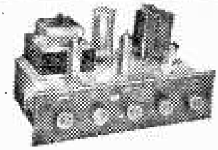

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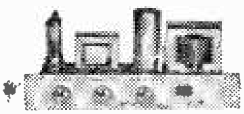

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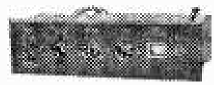

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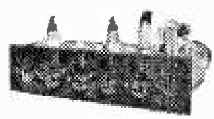

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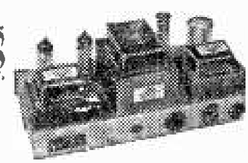

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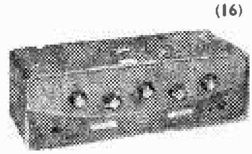

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Fully descriptive leaflets available on any of the above items.

Instruction Books and Detailed Price Lists are supplied Free with Kits of Parts but may be purchased separately if required.

Items 1, 2 and 14, 3/- each; 6 and 13, 3/6 each; 7, 8, 9, 10, 2/- each; 11, 2/6 each; 12, 5/-. All Post Free.

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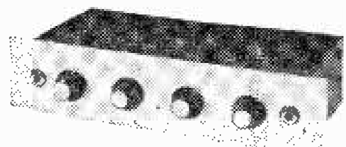

★ Input (a) Direct from High imp. Tape Head. (b) From a Tape Amplifier or Pre-Amplifier. ★ Sensitive Microphone Channel. ★ Wide range BASS and TREBLE Controls. Now with brushed aluminium front panel with contrasting lettering and control knobs.

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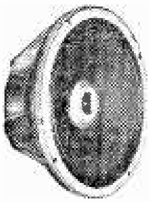

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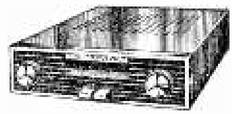

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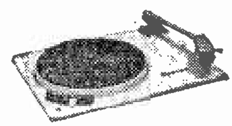

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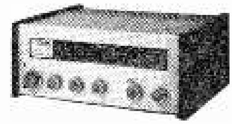

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Mono/Tuner Amp. Model 127M	£26.10.0
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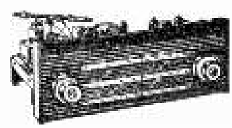

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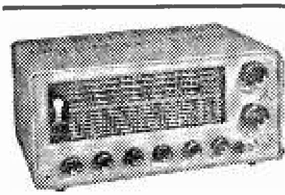

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DA30	12/6
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E1148	2/6
E1266	50/-
E1415	30/-
E1524	12/6
EA50	1/-
E173	7/-
EABC80	5/-
EA91	3/6
EAF42	8/-
EB34	1/6
EB91	3/-
EBC23	6/-
EBC41	7/-
EBC81	5/-
EBF80	5/-
EBF83	7/6
EBF89	6/9
EC52	4/-
EC53	12/6
EC70	4/-
EC90	2/-
EC91	3/-
ECC81	4/-
ECC82	5/-
ECC83	6/-
ECC84	5/6
ECC85	6/6
ECC88	9/-
ECC91	4/-
ECF82	7/-
ECH42	8/-
ECH81	5/-
ECH83	7/6
ECL80	6/-
ECL82	7/6
ECL83	10/-
ECL86	10/-
EF36	3/4
EF37	7/-
EF39	5/-
EF40	8/-
EF50	2/6
EF52	6/-
EF53	4/6
EF55	8/-
EF71	7/6
EF72	5/-
EF74	4/-
EF80	5/-
EF81	6/-
EF85	4/6
EF86	6/6
EF89	3/9

EF91	2/9
EF92	2/-
EF95	5/-
EF183	8/-
EF184	8/-
EHT1	300/-
EL32	3/9
EL34	10/-
EL36	5/-
EL38	17/6
EL41	7/-
EL42	8/-
EL50	8/-
EL81	8/-
EL83	6/3
EL84	5/-
EL85	8/-
EL91	4/6
EL95	5/-
EL360	20/-
EM80	6/-
EM81	7/6
EM84	6/3
EM85	9/-
EN31	10/-
ESU74	80/-
ESU208	6/-
EY51	5/6
EY86	6/6
EY91	3/-
EZ40	5/-
EZ41	6/6
EZ80	5/6
EZ81	3/6
F/6057	5/-
F/6061	5/-
F/6063	4/-
FW4/500	6/6
FW4/800	8/6
G1/236G	9/-
G1/371K	19/-
G50/2G	5/-
GM4	45/-
GZ32	10/-
GZ34	10/-
H63	7/-
HK54	22/6
HL2K	2/6
HL23	6/-
HL23DD	5/-
HL41	4/-
HVR2	9/-
K3A	30/-
KT8C	22/-
KT32	8/-

KT33C	6/-
KT44	5/9
KT63	4/-
KT66	12/9
KT67	15/-
KT76	8/6
KT88	20/-
KTW61	4/6
KTW63	2/-
KTZ41	6/-
KTZ63	5/-
LP2	10/-
MS100	9/-
M8142	12/-
MH4	5/-
MHLD6	10/-
ML6	6/-
N108	8/-
NE17	7/-
OB3	7/-
OC3	5/-
OD3	5/-
OZ4A	5/-
PCC84	5/-
PCC85	7/-
PCC89	10/-
PCF80	6/6
PCF82	6/6
PCF84	6/-
PCL81	9/-
PCL82	6/-
PCL83	8/3
PCL84	7/-
PCL85	8/6
PCL86	9/-
PEN25	4/6
PEN46	3/-
PEN200A	3/-
PL36	7/6
PL38	16/-
PL81	7/-
PL82	5/-
PL83	5/-
PL84	6/6
PM24A	5/-
PT15	10/-
PT25H	7/6
PT25M	7/6
PX4	14/-
PX25	9/-
PY33	8/6
PY80	5/6
PY81	5/6
PY82	5/-
PY83	6/-
PY800	6/6
PZ1-35	9/-
PZ1-75	12/-
QP21	6/-
QP25	5/-
QP230	5/-
QS150/15	10/-
QS95/10	5/6

QS1202	8/-
QV04/7	8/2
R3	8/-
RG4 1250	60/-
RK72	6/-
SL30P	15/-
SL30	12/6
SP2	8/6
SP41	1/6
SP61	1/6
SP210	3/6
STV280/40	12/6
STV70/80	8/-
SU2150A	10/-
T41	6/6
TP22	5/-
TP25	15/-
TT11	5/-
TT15	35/-
TTR31	45/-
TZ0520	4/-
TZ20	16/-
U81	30/-
U12/4	8/-
U17	5/-
U18	6/-
U25	11/-
U27	8/-
U52	4/6
UABC80	4/6
UBC41	6/-
UBF80	5/6
UBF89	6/6
UBL21	11/-
UCC85	6/6
UCH42	6/6
UCH81	6/-
UCL82	8/-
UCL83	10/-
UF41	7/-
UF89	6/-
UL41	6/-
UL84	5/6
UU5	7/-
UU9	8/6
UY21	7/6
UY85	5/-
V1120	4/-
V1507	5/-
V1924	20/-
VMP45	12/-
VP23	3/-
VP133	9/-
VR99	8/-
VR105/30	5/-
VR150/30	5/-
VU33A	4/-
VU39	6/-
VX3256	4/-
VX8122	5/-
W21	5/-

W118	8/-
W119	8/-
X66	7/6
X118	8/-
X145	8/-
Y63	5/-
Y65	4/-
Y66	8/-
YF	1/-
Z21	6/-
Z800U	20/-
Z801U	10/-
1A3	8/-
1A5GT	5/-
1B22	30/-
1C5GT	6/-
1D8GT	6/-
1E7G	7/6
1F2	3/-
1G6GT	6/-
1L4	2/6
1LA6	6/-
1LC6	7/-
1LH4	4/-
1N21B	4/-
1N43	4/-
1N70	4/-
1R4	5/-
1R5	3/6
1S4	5/-
1S5	4/6
1T4	2/-
2A3	5/-
2A5	6/-
2B26	8/-
2C26	7/-
2C26A	3/-
2C34	2/6
2C43	12/6
2C45	22/6
2C46	30/-
2C51	12/-
2D21	5/-
3X2	3/-
3A4	4/-
3A/108A	20/-
3A/46J	35/-
3A/167/M	25/-
3B7	5/-
3B24	5/-
3B28	15/-
3D6	4/-
3E29	50/-
3Q4	6/-
3Q5GT	7/-
3S4	4/-
3V4	5/9
4C27	35/-
4D1	4/-
5A173G	5/-
5A174G	5/-
5R4GY	9/-
5T4	7/-

5U4G	4/6
5V4G	8/-
5X4G	8/6
5Y3G	4/-
5Y3GT	5/-
5Y3WGTB	9/-
5Z4G	6/6
5Z4GT	8/-
6AB7	4/-
6AC7	2/-
6AG5	2/6
6AG7	6/-
6AH6	10/-
6AJ7	3/-
6AK5	5/-
6AK7	6/-
6AL5	3/-
6AL5W	7/-
6AM5	2/6
6AM6	4/-
6AQ5	7/-
6AQ5W	9/-
6AS6	4/-
6AS6W	9/-
6AS7G	20/-
6AT6	3/6
6AU6	7/-
6AX4	8/-
6B7	6/-
6B8G	2/6
6BA6	4/-
6BA7	5/-
6BE6	4/3
6BJ7	7/-
6BQ7A	9/-
6BR7	9/-
6BW6	9/-
6C4	2/-
6C5G	2/6
6C5GT	6/-
6C6	4/-
6C6G	3/-
6C8G	3/-
6CH6	1/6
6C21	80/-
6CL6	9/-
6D6	3/-
6E5	6/-
6F5G	5/3
6F5GT	5/9
6F6G	4/-
6F7	6/-
6F8G	6/6
6F12	4/6
6F13	5/-
6F14	5/-
6F32	4/-
6F33	3/-
6G6G	2/6
6H1	6/-
6H6M	1/6
6J4WA	10/-
6F5G	2/-

6J6	3/6
6J6W	6/-
6J7G	5/-
6J7M	8/-
6K6GT	5/6
6K7G	2/-
6K7GT	4/9
6K8G	3/-
6K8GT	8/8
6K8M	8/6
6L5G	6/-
6L6G	6/-
6L6GA	7/6
6L6M	11/-
6L7G	4/-
6L34	4/6
6LD20	5/9
6N7	6/-
6N7G	5/9
6Q7G	6/-
6R7	5/6
6SA7	7/-
6SA7GT	6/6
6SK7GT	4/-
6SC7	7/-
6SC7GT	5/-
6SFGT	5/6
6SH7	3/-
6SJ7	5/-
6SJ7GT	5/6
6SJ7G	6/6
6SK7	4/6
6SL7GT	5/6
6SN7	3/6
6SQ7GT	6/-
6SS7	2/-
6U4GT	9/6
6V6G	5/-
6V6GT	5/6
6V6M	8/-
6X4	3/6
6X5G	5/-
6Z5GT	5/3
6Y6G	6/-
6-30L2	10/-
6Z4	5/-
7B7	7/6
7C5	10/-
7C6	7/-
7C7	6/-
7H7	7/3
7Q7	7/-
7V7	5/-
7Z4	4/6
8D2	2/6
9D2	3/-
9D6	3/6
11E3	37/6
12A6	2/6
12AH7	5/-
12AH8	11/-
12AT7	4/-
12AU7	5/-
12AX7	6/-

12AY7	10/-
12BA6	5/6
12BE6	7/-
12BH7	7/-
12C8	3/-
12H6	2/-
12J5GT	2/6
12J7GT	6/6
12K7GT	2/-
12K8M	10/-
12Q7GT	3/3
12SA7	7/-
12SC7	4/-
12SG7	3/-
12SH7	3/-
12SJ7	5/-
12SK7GT	3/-
12SNTGT	5/9
12SR7	5/-
12Y4	2/-
12L7	7/-
15D2	6/-
19E2	15/-
19G3	10/-
19G6	9/-
19G7	5/-
19H1	6/-
19M1	5/-
20P4	1/-
21B6	9/-
25L6GT	5/6
25Y5	6/-
25Z4G	6/6
25Z5	7/6
25Z6GT	8/6
25D7	6/-
30	5/-
30C15	9/6
30F5	8/6
30FL1	10/6
30P19	12/-
30PL1	8/-
3516GT	7/-
35T	17/6
35W4	5/-
35Z3	8/-
35Z4GT	6/-
35Z5GT	6/-
37	4/-
38	4/-
41MP	4/-
44A/160N	30/-
215SG	6/-
50L6GT	8/-
53A	7/6
57	6/-
58	6/-
59	6/-
75	5/6
76	5/-
77	6/6
78	5/-

80	5/6
81	9/-
82	8/-
84	8/-
85A2	8/-
210VPT 7-pin	2/6
220PA	7/-
220TH	4/-
225DU	9/-
307A	5/6
310C	25/-
350B	8/-
357A	7/-
368A	5/-
393A	15/-
446A	8/-
703A	30/-
705A	10/-
715B	60/-
717A	3/-
724A	15/-
801	6/-
803	22/6
807	8/-
808	8/-
811	17/6
813	70/-
815	35/-
829A	80/-
829B	50/-
830B	4/-
832A	45/-
832	15/-
833A	£12
837	9/-
843	5/-
866A	14/-
884	10/-
954	4/6
955	2/6
956	2/-
957	5/-
958A	4/-
1612	6/-
1616	3/-
1619	5/-
1625	6/-
1626	3/-
1629	4/6
2051	5/-
4043C	13/6
4063	8/-
4313C	30/-
5704	9/-
5726	6/-
6060	5/-
6064	7/-
6065	6/-
6080	22/-
7193	1/9
7475	2/-
8013A	25/-
8020	8/-

9001	3/-
9002	4/6
9003	6/-
9004	2/6
9006	2/6
C.R. Tubes	
CV1596 (09J)	55/-
E4504/B/16	28/-
VCR97	28/-
VCR138	30/-
VCR138A	40/-
VCR139A	35/-
VCR517B	40/-
VCR517C	40/-
3FP7	45/-
3EG1	40/-
5PC1	30/-
5FP7A	12/-
Photo Tubes	
CMG8	5/-
G816	12/6
931A	55/-
6097C	350/-
Special Valves	
ACT6	£8
K301	£4
KRN2A	£3.10.0
1B24	25/-
2J22	£2.10.0
2J54	£8
417A	30/-
3J/92/E	£37.10.0
714AY	£4
725A	30/-
726A	19/-
Transistors	
OC44	6/-
OC45	7/-
OC71	5/-
OC72	6/-
OC81	7/-
OC82	10/-

***MANY OTHERS IN STOCK** include Cathode Ray Tubes and Special Valves.* All U.K. orders below £1, P. & P. 1/-; over £1, 2/-; over £3, P. & P. free. C.O.D. 2/6 extra. Overseas Postage extra at cost.

MARCONI COMMUNICATION RECEIVERS CR. 150. Frequency coverage 2-60 Mc/s in 5 bands. Two Ifs 1st 1,600 kc/s, 2nd 463 kc/s. Image signal protecting over 40 dB up to 30 Mc/s and 20-40 dB from 30-60 Mc/s. Self-checking calibration (built-in calibrator). Stabilisation of supply and temperature compensation. Electrical and mechanical indicator Bandpass from 100 c/s to 10 kc/s bandspread. Metering and visual tuning in 5 stages. Acoustic filter associated with 100 c/s. Bandpass position for CW reception. Facilities for diversity reception. Excellent checked condition, **£39.** Mains P.S.U. by P.C. Radio **£4.10.0.** Carriage 30/-.

CR.150/2. Frequency coverage 1.5-22 Mc/s in 4 bands, all other features as in CR.150. Price **£31.** Carriage 30/-.

P.C. RADIO'S mains P.S.U. for above, **90/-.**

DHR HIGH RESISTANCE HEADPHONES. New, 14/-. P. & P. 1/6.

WIDE RANGE MULLARD VALVE VOLTMETER TYPE E 7555/2. 100mV-500v. D.C. or A.C. peak from 35c to 5mc, additional range 500v. to 15kc D.C. or peak A.C. Frequency response with probe is level from 35c to 100mc. Power supply 110/245v. A.C. Price **£19.** Carriage £1.

VERY HIGH CLASS COMMUNICATION RECEIVER TYPE BRT 402E. 150 kc/s-385 kc/s., 510 kc/s-30 mc/s. Fully tested **£60.** Carriage 30/-.

EVERSHED MEGGER CIRCUIT TESTER. 2 ranges 0 to 1,000Ω, 100Ω to 200,000Ω. With test leads, leather carrying case. Tested **£4.19.6.** P. & P. 3/6.

PANEL METERS (round)

0-50 microamps	$2\frac{1}{2}$"	D.C.**	40/-
0-100 microamps	2"	D.C.**	35/-
0-100 microamps	$2\frac{1}{2}$"	A.C.	30/-
0-200 microamps	2"	D.C.	32/6
0-500 microamps	$2\frac{1}{2}$"	D.C.	30/-
0-500 microamps	$3\frac{1}{2}$"	D.C.	37/6
0-1 mA*	2"	D.C.	19/6
0-1 mA	3"	D.C.**	35/-
25-0-25 mA	$2\frac{1}{2}$"	D.C.	45/-
500 mA	$3\frac{1}{2}$"	A.C.	25/-
0-100 mA	$3\frac{1}{2}$"	A.C.	22/6
150-0-1500 mA	3"	D.C.	29/-
0-500 mV	$3\frac{1}{2}$"	D.C.	32/6
0-5 V	$3\frac{1}{2}$"	A.C.	22/6
0-15 V	2"	A.C.	17/6
0-50 V	$2\frac{1}{2}$"	D.C.	28/-
0-150 V	$2\frac{1}{2}$"	A.C.	24/-
0-10 kV	$2\frac{1}{2}$"	D.C.	63/-

** "Weston", as usually used in H.R.O. as "S" meter. *Projection type

2 KW ULTRASONIC GENERATOR together with power supply unit for 200-250v. A.C. Complete two chassis with interconnecting cables. Frequency 37 to 43 kc/s adjusted by fine control. Peak output 2kw, average output 500w. Completely new with valves and manual **£65.** Carriage paid U.K.

R.F. CHOKES. Ideal for vibrators and anti-interference filters. Very low resistance (0.02 Ω).30μh inductance. 4/3 incl.post.

P.C. RADIO LTD
170 GOLDHAWK ROAD, W.12
Shepherd's Bush 4946
Open 9-5.30 p.m. *Thursday* 9-1 p.m.

STABILISED POWER SUPPLY UNIT TYPE R.1095 (EDISWAN) with 2 independent outputs.
1. D.C. 120-250v. 50mA metered and regulated.
2. A.C. 6.3v. C.T. 3 amps.
Stability 0.02%. Price **£18.**

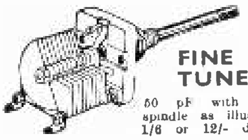
STABILISED POWER SUPPLY UNIT TYPE R.2001 (EDISWAN) with 2 independent outputs.
1. 0-100v. 50mA metered and regulated by coarse and fine adjustments.
2. 250v. Bias as 5mA.
Stability 0.02%. Price **£18.**

WIDE RANGE MULLARD VALVE VOLT METER TYPE E 7555/2. 100 mV-500 v. D.C. or A.C. peak from 35c. to 5 mc. additional range 500 v. to 15 kc. D.C. or peak A.C. Frequency response with probe is level from 35 c. to 100 mc. Power supply 110/245 v. A.C. Price **£25.** Carriage £1.

WIRELESS SET No.52 (CANADIAN) Complete station consisting of Transmitter, Receiver, supply unit for 12 v. All contained in special carrier. 1.75-16 mc/s in 3 bands. 813 as output valve. 45-75 w. phone and MCW, 70-100 watt CW. M.O. or crystal. Receiver includes crystal callibrator. Tx can be exactly tuned to Rx frequency. Noise limiter. Sidetone. Loudspeaker on receiver with on/off switch. All brand new with accessories. Export. Price on application.

OUTPUT TRANSFORMERS for push-pull small battery valves (1T4) with output winding for 15 and 600 ohm impedance. 15/- carriage paid.

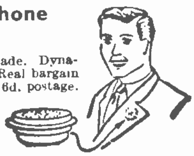
www.americanradiohistory.com



FINE TUNERS

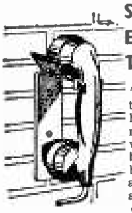
50 pF with long spindle as illus. 1/6 or 12/- dozen.

Microphone Inserts



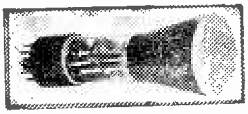
American made. Dynamic type. Real bargain at 2/6, plus 6d. postage.

SELF ENERGISED TELEPHONES



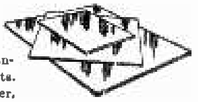
These require no batteries: in fact they have only to be connected by a pair of wires. They can thus be fitted into existing bell circuits. Results are extremely good and maintenance costs are nothing. Handsets only 15/- each, post etc. 2/6. Two, post free.

Building a 'Scope



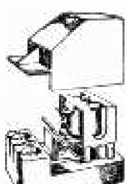
3in. oscilloscope tube. American made type No. 3PF7, 6.3v. 0.6 amp. heater electrostatic deflection. brand new and guaranteed with circuit diagram of 'scope 15/- each. Plus 2/6 post and insurance.

Sheet Paxolin



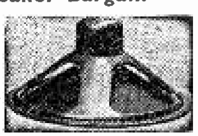
Ideal for transistor projects. Special offer, 12 panels 5 x 8in., 5/-.

RELAYS



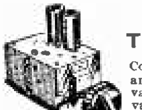
Totally enclosed in bakelite, this relay has a 24v. coil but can of course be rewound for mains operation. Its contacts are suitable for breaking 20 amps. Price 2/6 each, 24/- doz.

Speaker Bargain



12in. High-fidelity loudspeaker. High flux permanent magnet type with either 3 ohm or 15 ohm speech coil. Will handle up to 10 watts. Brand new by famous maker. Price 27/6 + 3/6 post and insurance.

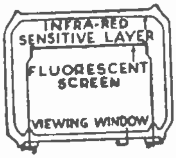
Brayhead Turret Tuner



Complete with Band 1 and Band 3 coils. Less valves 10/- each or with valves 17/6 each. Post 2/6. Knobs 3/6 extra.

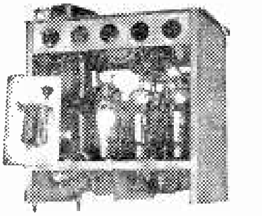
Where postage is not definitely stated add 2/- all orders under £3.

SNIPERSCOPE



Famous wartime "cat's eye" used for seeing in the dark. This is an infra-red image converter cell with a silve caesium screen which lights up (like a cathode ray tube) when the electrons released by the infra-red strike it. It follows that as light from an ordinary lamp is rich in infra-red these cells will work burglar alarms, counting circuits, smoke detectors and the hundred and one other devices as will the simpler type of photo cell. Here then is a golden opportunity for some interesting experiments, price 5/- each. Post 2/-. Data will be supplied with cells if requested.

BUILDING AN AMPLIFIER



Here is a buy for you. Modulator Unit type 20. Contains parts ideal for building a large output amplifier and all ready set out in metal case. To name a few: Four high output valves Type KT44. Driver valve Type MH41. Iron cored choke for up to 200 milli-amps. Dozens of wire wound and carbon resistors, paper and mica condensers. Terminals and tag panels etc., etc. Three other items of interest to everybody and well worth the price asked for the unit are: 1. Transformer Reference 10K/143. This can act as auto-transformer to convert 230 to 110 or 230 to 460, and also as a filament transformer 230 to 6.3 or 230 to 12.6 volts. 2. Miniature Circuit Breaker. For breaking 10 amps A.C. reset by pushing knob. 3. Steel Coase. With heavy gauge chassis, all ready cut out and fitted valve holders, etc. Price for complete unit is 12/6. Carriage 7/6.

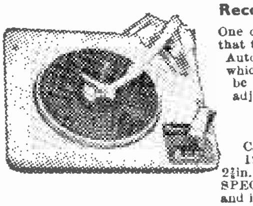
THIS MONTH'S SNIP

TAPE PLAYBACK MACHINE

Made by a very famous British Company to a very exacting specification. This is a really superior machine—the capstan being driven by a synchronous motor and wow and flutter completely eliminated by a very heavy flywheel.

Playback is through a full ft tape head which works into a "high fi" amplifier using five modern type valves, EL84 etc., fitted with output transformer needing only a speaker to complete. The machine operates from standard A.C. mains and uses a heavy duty transformer for safety and reliability. Brand new—unused and guaranteed perfect—limited quantity only £5.19.6, plus 7/6 post and ins.

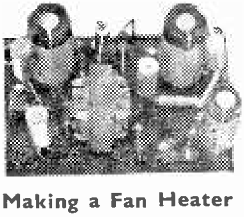
AUTOCHANGER BARGAIN



Garrard Auto-Slim Record Changer

One of the nicest record changers that this famous company make—Automatic selection of records which may be mixed—may also be played manually. Finger tip adjustment of stylus pressure. Fitted with monohead—but pick-up wired for stereo—suitable 200/250 A.C. mains. Cabinet space required 14¼ x 12¼in. with 4¾in. above and 2¼in. below. DON'T MISS THIS SPECIAL SNIP only £5.15.0 (post and insurance, 6/6).

750 mW TRANSISTOR AMPLIFIER



4 transistors including two in push-pull input for crystal or magnetic microphone or pick-up—feed back loops—sensitivity 5 m/v.

Price 19/6

Post and insurance 2/6. 35 ohm Speaker, 12/6 extra.

Making a Fan Heater

Miniature motor laminated poles. Operates off 20-30v. D.C.
Original cost at least £3 each, 8/6 plus 1/6 postage and insurance. Mains model 9/6 plus 2/9 postage and insurance.

Cabinet Snip

This fine cabinet as illustrated but less control knobs is available this month at a special snip price of 12/6 plus 3/6 post and insurance. Size is 13½in. x 9in. x 4in. and it is nicely covered in two tone I.C.I. fabric.

Five Core Cable

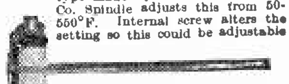
Ideal for switching circuits, intercoms. P.A. runs etc. each core flex copper with rubber insulation, cores covered overall in tough rubber or P.V.C. 9d. per yd. or 30 yds. length 15/- plus 5/- post.

Waterproof Heater Wire

16 yds. length 70 watts, self regulating temperature control. 10/-, post free.

THERMOSTATS

Type 'A' 15 amp. for controlling room heaters, greenhouse, airing cupboard. Has spindle for pointer knob quickly adjustable from 30/-80°F. 9/6 plus 1/- post. Suitable box for wall mounting, 5/-. P. & P. 1/-.
Type 'B' 15 amp. This is a 17 in. long rod type made by the famous Sunvic Co. Spindle adjusts this from 50-550°F. Internal screw alters the setting so this could be adjustable



over 30° to 1,000°F. Suitable for controlling furnace, over kiln, immersion heater or to make flamestat or fire alarm. 8/6 plus 2/9 post and insurance.

COMPONENT BARGAINS

465 Kc/s IF Transformers. Standard type in aluminium can with trimmers, size 1½in. square, 1/6 each, 12/- doz.
46 Receiver/Transmitter. Complete except for crystals packed with valves and components, easily buildable into other gear. 19/6, plus 6/6 carriage and insurance.
Output Transformer. Standard pentode type 2/6, 24/- doz.
Mullard 510. Amplifier chassis complete with inner screening section, stove enamelled, 7/6, plus 2/9 postage.
Precision Wheatstone Bridge. Opportunity to build 100K wire wound pot, 15 watt rating, 5/- only. Also 100K 100 watt, American made, 15/-, post 2/9.
Toggle Panel Switch, 25/30 amp. single pole, 2/6, 24/- dozen.
Toggle Switch, 10 amp. double pole, 2/-, 18/- dozen.
Electric Lock. 24v. coil but rewindable to alter voltages, 4/6; 48/- dozen.
Head Phones ideal for short wave listening etc. Low resistance, best makers. 6/-, post 2/6.
Sound Powered Inserts (D.L.R.5) as P.E. intercomm. as speakers or microphones, 5/6; 54/- dozen.
½ Meg. Potentiometers. Sealed type by Morganite, among the best ever made. Standard ¼ spindle. 1in. long, 6/- dozen. 2 meg. ditto, 6/- doz. ½ meg. ditto, 6/- doz. 100K. ditto 5/6 dozen. 50K, 5/- dozen.
MU Metal Screen for American 5 CP1 etc. 6/6 pair for VCR97 and other 6in. tubes, 7/- complete. Ditto for 2-3in. tube, 5/- complete.
Trimmer Bank. 5 x 50 pF compression trimmers mounted on metal strip 3½in. long, ideal if making pre-set station receiver—ceramic/mica insulation, 2/- each; 18/- doz.

MAINS POWER PACK

Designed to operate transistor sets and amplifiers. Adjustable output 6v—9 to 12 volts for up to 500mA (class B working). Takes the place of any of the following batteries: PP1-PP3-PP4-PP6-PP7-PP9 and others. Kit comprises: mains transformer-rectifier, smoothing and load resistor 5000 and 500 mfd condensers, zener diode and instructions. Real snip at only 14/6 plus 2/6 post.

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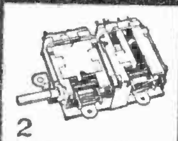
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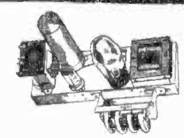
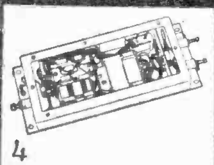

Comprising chassis 8¾ x 2½ x 1in. Double wound mains transformer, output transformer, volume and tone controls, resistors, condensers etc. Valves 6V6, ECC81 and metal rectifier. Circuit 1/6 free with kit 29/6 plus 4/- P. & P.
3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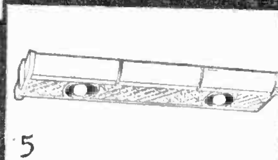
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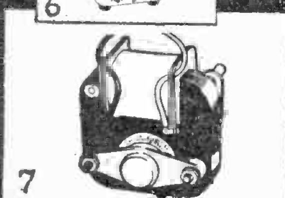
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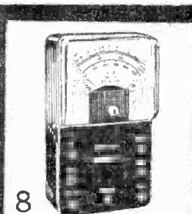
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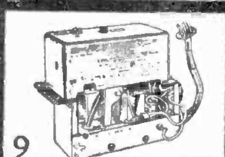
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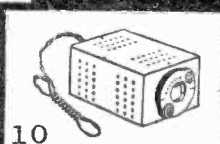
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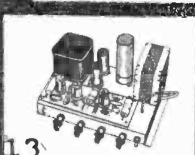
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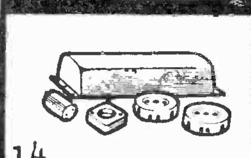
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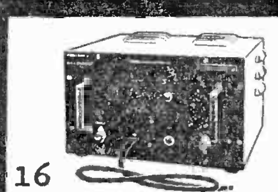
16

1. **6 VALVE 15 WATT PUSH-PULL AMPLIFIER.** 15 x 7 x 1½in. A.C. Mains 200-250 volts. 4 inputs with controls for same and bass and treble lift controls. Tapped for 3 and 15 ohm speakers. Extra H.T. and L.T. for F.M. Tuner supplies etc. Built and tested. **7 gns.** P. & P. 13/6.

2. **CYLDON A.M. F.M. PERMEABILITY TUNERS FOR ALL TRANSISTOR OPERATION.** Size 2½ x 2¾in. approx. By famous manufacturer. A.M. I.F. 470 Kc/s. F.M.-I.F. 10.7 Mc/s. A.M. coverage from 1620 Kc/s-525 Kc/s. F.M. coverage 108 Mc/s-88Mc/s. Circuit diagrams 2/6. FREE with Tuner, 1st. 2nd and 3rd A.M. I.F.'s, 1st. 2nd. 3rd and 4th F.M. I.F.'s V.H.F. Osc. choke. A.M. I.F. trap. All the above are the R.F. end of an A.M./F.M. receiver car radio etc. The above items, **£2.10.0.**

3. **AMPLIFIER KIT.** 3 to 4 watt Amplifier Kit.

4. **TRANSISTOR INVERTOR.** 50 v. D.C. Input. Output 240 v. A.C. 40 watts incorporating transformers, choke, condensers and 2 GET573. In solid 16 gauge aluminium case, size 15 x 6 x 2½in. by famous manufacturer, **19/6**, plus 7/- P. & P.

5. **FLUORESCENT LIGHT FITTING.** Twin 40 watt 200/250 v. less tubes. 39/6. P. & P. 7/-.

6. **OSCILLOSCOPE for D.C. and A.C. APPLICATIONS.** Push-pull X amplifier: Fly-back suppression: Internal Time-base Scan Wave form available for external use: pulse output available for checking TV line O/P Transformers, etc. Provision for external—I/P and C.R.T. Brightness Modulation. A.C. mains 200/250 v., **£18 18.0.** P. & P. 10/-
FULL 12 MONTHS' GUARANTEE INCLUDING VALVES and TUBE.

7. **A.C. MAINS MOTOR.** Can be used for a variety of purposes, silent running, satisfactory in every way. 230/250v. A.C., **9/6.** P. & P. 3/-.

8. **POCKET MULTI-METER.** Size 3¾ x 2½ x 1⅜in. Meter size 2¼ x 1¼in. Sensitivity 1,000 O.P.V. on both A.C. and D.C. A.C. and D.C. volts. 0-15, 0-150, 0-1,000. D.C. current 0-150 mA. Resistance 0-100K Ω. Complete with test prods, battery and full instructions, **39/6.** P. & P. 2/6.
FREE GIFT for limited period only. 30 watt Electric Soldering Iron value 15/- to every purchaser of the Pocket Multi-Meter.

9. **CHANNEL TUNER I.F.** 16-19 Mc/s. Continuously tunable from 174-216 Mc/s. Valves required—PCF80 and PCC84 (in series). Cover BBC and ITA ranges. Also Police, Fire and Taxis, etc. Brand new by famous maker, 10/-. P. & P. 3/-.

10. **POWER SUPPLY KIT** in metal case, size 3¾ x 2½ x 2in. incorporating mains transformer, rectifier and condensers. 230/250 A.C. mains Output: 9v., 100mA. 10/6 plus 3/- P. & P.

11. **B.S.R. MONARCH UA14 WITH FULL FI HEAD.** 4-speed, plays 10 records, 12in., 10in. or 7in. at 16, 33, 45 or 78 r.p.m. Intermixes 7in., 10in. and 12in. records of the same speed. Has manual play position: colour brown. Dimensions: 12½ x 10½in. Space required above baseboard 4⅝in., below baseboard 2⅝in. Fitted with Full Fi turnover crystal head. £5.19.6. P. & P. 7/6.

12. **50 MICRO-AMP METER** movement by world famous manufacturer. Size 3 x 2⅜in., 25/-, plus 2/- P. & P.

13. **8-WATT 5-VALVE PUSH-PULL AMPLIFIER & METAL RECTIFIER.** Size: 9 x 6 x 1½in. A.C. Mains, 200-250v. 5 valves. For use with Std. or L.P. records, musical instruments, all makes of pick-ups and mikes. Output 8 watts at 5 per cent total distortion. Separate bass and treble lift controls. Two inputs, with controls for gram. and mike. Output transformer tapped for 3 and 15 ohm speech coils. Built and tested. £8.19.6. P. & P. 8/-

14. **40W. FLUORESCENT LIGHT KIT** incorporating GEC Choke size 8½ x 1¾ x 1¼in. 2 bi-pin holders, starter and starter holder, 11/6. P. & P. 4/6.
Similar to above: 80W Fluorescent Light Kit incorporating GEC choke size 11¾ x 1½ x 1¼in. 2 bi-pin holders, starter and starter holder 17/6. P. & P. 5/6.

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7in. Std. 1200ft.	11/6	3in. T.P. 600ft.	8/-
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7in. L.P. 1800ft.	18/6	7in. T.P. 3600 ft.	37/6

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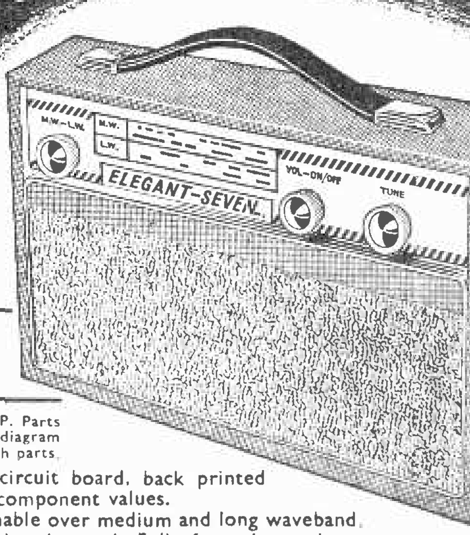

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Ex. GOVT. SMOOTHING CHOKES. 200mA. 3-5 H, 50 ohms, Parmeko **8/9**; 150mA. 10H. 50 ohms **9/9**; 120mA. 12H. 100 ohms **8/9**; 100mA. 10H. 100 ohms **6/9**; 60mA. 5-10H. 250 ohms **2/11.**

TANNOY RE-ENTRANT LOUD-SPEAKERS. For outdoor or Factory use. 8 ohms. 8 watts. Only **25/9**

EX. GOV., 2V ACCUMULATORS, 16 A.H. Size 7 x 4 x 2in. Brand new, 4/9 each. Three for 12/6, carr. 5/-.

HI-FI 10 WATT AMPLIFIERS

BRAND NEW EX-GUITAR AMPLIFIERS **8 Gns.** Carr. 6/6

Manufacturers' discontinued Model. Push-pull output. Latest high efficiency valves. Dual separately controlled Inputs for 'Mike' and gram. Separate Bass and Treble Controls. High Sensitivity. Output for 3 or 15 ohms speaker. Guaranteed tested and in perfect working order.

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350-0-350v. 80mA. 6.3v. 2a. 0-5-6.3v. 2a	21/9
250-0-250v. 100mA. 6.3v. 2a, 6.3v. 1a ..	21/9
250-0-250v. 100mA. 6.3v. 3.5a. C.T. ..	19/9
250-0-250v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a	28/9
300-0-300v. 130mA. 6.3v. 4a, 6.3v. 1a. for Mullard 510 Amplifier	35/9
300-0-300v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a	28/9
350-0-350v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a	28/9
350-0-350v. 150mA. 6.3v. 4a. 0-5-6.3v. 3a	37/9

FULLY SHROUDED UPRIGHT

250-0-250v. 60mA. 6.3v. 2a, 0-5-6.3v. 2a Midget type 2½ x 3 x 3in.	18/9
250-0-250v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a	29/9
300-0-300v. 100mA. 6.3v. 4a. 5v. 3a ..	29/9
300-0-300v. 130mA. 6.3v. 4a, C.T. 6.3v. 1a, for Mullard Amplifier	36/9
350-0-350v. 100mA. 6.3v. 4a, 0-5-6.3v. 3a	29/9
350-0-350v. 150mA. 6.3v. 4a, 0-5-6.3v. 3a	33/9
425-0-425v. 200mA. 6.3v. 4a, C.T. 5v. 3a	57/9
425-0-425v. 200mA. (6.3v.4a Twice). 5v. 3a	59/9
450-0-450v. 250mA. 6.3v. 4a, C.T. 5v. 3a	69/9

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200-250v. 50 c/s primaries 6.3v. 1.5a. **5/9**; 6.3v. 2a, **7/6**; 12v. 1a, **7/11**; 6.3v. 3a, **8/11**; 6.3v. 6a, **17/6**; 12v. 1.5a, twice, **17/6.**

OUTPUT TRANSFORMERS

Standard Pentode 5,000Ω to 3Ω ..	5/9
Standard Pentode 7,000Ω to 3Ω ..	5/9
Push-Pull 8 watts, EL84, or 6V6 to 3Ω or matched to 15Ω	9/9
Push-Pull 10-12 watts to match 6V6 or EL84 to 3-5-8 to 15Ω	19/9
Following types for 3 and 15Ω speakers	
Push-Pull 10-12 watts, 6V6 or EL84 ..	18/9
Push-Pull 15-18 watts, 6L6, KT66 ..	22/9
Push-Pull Mullard 510 Ultra Linear ..	29/9
Push-Pull 20 watts, sectionally wound 6L, KT66, EL34, etc.	49/9

SMOOTHING CHOKES

150mA. 7-10 H. 250 ohms	11/9
100mA. 10 H. 200 ohms	8/9
80mA. 10 H. 350 ohms	5/9
60mA. 10 H. 400 ohms	4/11

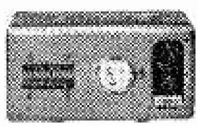
CHARGER TRANSFORMERS
All with 200-230-250v. 50 c/s Primaries; 0-9-15v. 1½a, **12/9**; 0-9-15v. 2a, **14/9**; 0-9-15v. 3a, **16/9**; 0-9-15v. 5a, **19/9**; 0-9-15v. 6a, **23/9**; 0-9-15v. 8a, **28/9.**

AUTO (Step up/Step down) TRANS.
0-110/120-230/250v. 50-80 watts, **13/9**; 150 watts, **27/9**; 250 watts, **49/9**; 500 watts **99/9.**

MICROPHONE TRANSFORMERS
120:1 high grade, clamped **8/9.**

R.S.C. BATTERY CHARGER and KITS

for A.C. Mains 200/250v., 50c/s.



ASSEMBLED 4 amps 6/12v. Fitted Ammeter and variable charge rate selector. Also selector plug for 6v. or 12v. charging. Louvred steel case with stoved grey hammer finish. Fused and ready for use with mains and output leads and battery clips. **59/9** Carr. 4/6. Terms: Deposit **12/-** and 5 monthly payments of **12/-** (**Total £3.12.0**).

HEAVY DUTY CHARGER KIT 6/12 v. 6 amps., variable output. Mains transformer 0-200-230-250v. F.W. (Bridge) Selenium Rectifier. Ammeter, Variable Charge Rate Selector panels. Plugs, Fuses, Fuse-holder and circuit, **59/9.** Carriage 4/6.

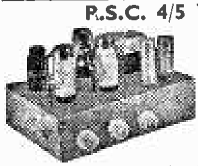
SELENIUM RECTIFIERS
F.W. (BRIDGED) TYPES
6/12v. 1a. **3/11** 6/12v. 6a. **15/3**
6/12v. 2a. **6/11** 6/12v. 10a. **26/9**
6/12v. 3a. **9/9** 6/12v. 15a. **35/9**
6/12v. 4a. **12/3**

COMPLETE POWER PACK KIT
Consisting of Mains Trans., Metal Rectifier, Double electrolytic smoothing choke chassis and circuit. For 200/250 v. A.C. mains. Output 250v., 60mA, 6.3v., 2a. **19/11**

ARMSTRONG, TRUVOX, LEAK, QUAD, ROGERS, LINEAR, W.B., FANE, WHARFEDALE, GOODMANS GARRARD, GOLDRING, GRAMPIAN, LUSTRAPHONE, SHURE, RESLO, TANDBERG, FERROGRAPH Products stocked. Our usual credit terms available.

SCOOP PURCHASE OF HIGH QUALITY RECORD CHANGERS
Brand new Garrard 3000 LM. Very latest model. Normal Retail price approx. £12.15.0. Heavy Turntable and light-weight pick-up arm. High fidelity Stereo/Mono cartridge. Fully guaranteed. **10 GNS.** Carr. 5/6

R.S.C. 4/5 WATT A5 HIGH-GAIN AMPLIFIER



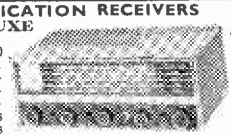
A highly-sensitive 4-valve quality amplifier for the home, small club, etc. Only 50 millivolts input is required for full output so that it is suitable for use with the latest High-fidelity Pick-up heads in addition to all other types of pick-ups and practically all "mikes". Separate Bass and Treble Controls are provided. These give full long-playing record equalisation. Hum level is negligible being 71 dB down 15 dB of Negative feedback is used. H.T. of 300v. 25mA and L.T. of 6.3v. 1.5a. is available for the supply of a Radio Feeder Unit or Tape-Deck pre-amplifier. For A.C. mains 200-230-250v. 50 c/s. Output for 2-3 ohms speaker. Chassis is not alive Kit is complete in every detail with fully punched Gold Hammer finished chassis, point-to-point wiring diagrams and instructions. Exceptional value £4.15.0, or assembled ready for use 25/- extra, plus 3/6 carr., deposit 22/6 and 5 monthly payments of 22/6 (Total £6.15.0) for assembled unit.

R.S.C. GRAM AMPLIFIER KIT. 3 watts output. Negative feedback. Controls Vol., Tone and Switch. Mains operation 200-250v. A.C. Fully isolated chassis. Circuit, etc., supplied. Only **39/9.** Carr. 3/9.

G.E.A. MINIATURE 2-3 WATT GRAM AMPLIFIER. For use with any single or auto-change unit. Output for 2/3 ohm speaker. For 200-250v. A.C. mains. Size 11¾ x 2½ x 2½in. Controls: Vol. and Tone with Switch. Only **59/6**

COMMUNICATION RECEIVERS

RX 60 DE LUXE 4 BAND

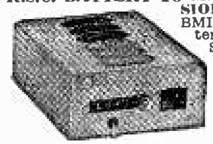


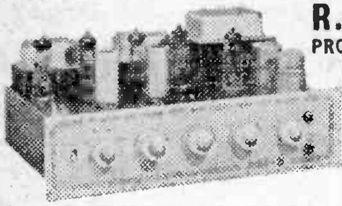
220/240v. 50/60 c.p.s. A.C. mains operation. Frequencies covered 1600 Kc/s to 30 Mc/s continuous. Incorporates 5in. speaker. Slide rule tuning dial 'S' meter. Internal ferrite aerial for medium wave. Telescopic whip aerial 58in. 10 section for short waves. Fitted sockets for optional outdoor aerial. Headphones. external speaker socket. Other features are electrical bandspread tuning. Noise limiter, A.V.C., B.F.O., stand by switch. Size approx. 12½ x 5¾ x 8¾in. Handsome crackle finished metal cabinet. Brand new with full instructions manual. Usual guarantee **19 Gns.** Carr. & pkg. 10/-.

R.S.C. 4 WATT GRAM. AMPLIFIER KIT. Complete set of parts to build a good quality compact unit suitable for use with any record playing unit. Mains isolated chassis. Separate Bass and Treble controls. Output for 2-3 ohm speaker. For 200-250v. A.C. **59/9**

R.S.C. BABY ALARM or INTER-COMM KIT. Complete set of parts with diagrams, etc. Housed in two polished walnut finished cabinets of pleasing design. High sensitivity. For 200-250v. A.C. mains. Fully isolated. Controllable at both units. An intercomm. of this class would normally cost £20-£30. Only **89/6**, carr. 5/-. Ready for use, **6 gns.**

R.S.C. BATTERY TO MAINS CONVERSION UNITS. Type BMI. An all-dry battery eliminator. Size 5½ x 4½ x 2in. approx. Completely replaces batteries supply 1.4v and 90v where A.C. mains 200-250v, 50 c/s is available. Suitable for all battery portable receivers requiring 1.4v. and 90v. Complete kit with diagram **39/9** or ready for use **46/9**





R.S.C. STEREO 20/HIGH FIDELITY AMPLIFIER

PROVIDING 10/14 WATTS ULTRA LINEAR PUSH-PULL OUTPUT ON EACH CHANNEL

SUITABLE for "MIKE", GRAM., RADIO OR TAPE. INTENDED FOR THE HOME OR STUDIO BUT SUITABLE FOR LARGE HALLS OR CLUBS

FREQUENCY RESPONSE ±2dB. 30-20,000 c.p.s.
HUM LEVEL 65dB down.
SENSITIVITY: 5 millivolts maximum.
HARMONIC DISTORTION (each channel) 0.2%.

- ★ Four-position tone compensation and input Selector switch.
- ★ Will amplify direct from Tape Heads.
- ★ Stereo/Mono switch so that peak monaural output of 28 watts can be obtained.
- ★ Separate Bass "Lift" and "Cut" and treble "Lift" and "Cut" controls.
- ★ Neon panel indicator.
- ★ Handsome Perspex Frontplate.

Send S.A.E. for illustrated leaflet.

Based on a current Mullard design and employing valves ECC83, ECC83, ECL86, ECL86, ECL86, ECL86, EZ81. Output transformers are high quality sectionally wound to required specification. Output matchings for 3 and 15 ohm speakers on each channel. Complete set of parts with point-to-point wiring diagrams and instructions **13 Gns.** Carr. 10/-. or Factory assembled, tested and supplied with our usual 12 months' guarantee for 18 gns. or DEPOSIT 2 gns. and 9 monthly payments of 41/6 (total £20.15.6).

AUDIOTRINE HI-FI TAPE RECORDER KIT 25½ GNS. Carr. 17/6.

REALISM AT INCREDIBLY LOW COST, CAN BE ASSEMBLED IN AN HOUR

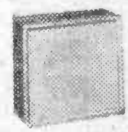
Incorporating the latest Collaro Studio Tape Transcriptor. The Audiotrine High Quality Tape Amplifier with negative feedback equalisation for each of 3 speeds. High Flux P.M. Speaker, empty Tape Spool, a Reel of Best Quality Tape and a Handsome Portable Carrying Cabinet tastefully covered in two contrasting shades of Rexine and Vynair. Size 14¼ x 15 x 8½in. high and circuit. Total cost if purchased individually approximately £40. Performance equal to units in the £60-£80 class. S.A.E. for leaflets. **TERMS.** Deposit £3 and 12 monthly payments of 44/- (Total 28 Gns).

ONLY 3 PAIRS OF SOLDERED JOINTS PLUS MAINS

R.S.C. A10 30 WATT ULTRA LINEAR HIGH FIDELITY AMPLIFIER

A highly sensitive Push-Pull high output unit with self-contained Pre-amp. Tone Control Stages. Certified performance figures compare equally with most expensive amplifiers available. Hum level 70 dB down. Frequency response ±3 dB, 30-20,000 c/s. A specially designed sectionally wound ultra linear output transformer is used with 807 output valves. All components are chosen for reliability. Six valves are used EF86, EF86, ECC83, 807, 807, GZ34. Separate Bass and Treble Controls are provided. Minimum input required for full output is only 12 millivolts so that **ANY KIND OF MICROPHONE OR PICK-UP IS SUITABLE.** The unit is designed for **CLUBS, SCHOOLS, THEATRES, DANCE HALLS or OUTDOOR FUNCTIONS,** etc. For use with Electronic **ORGAN, BASS, LEAD OR RHYTHM GUITAR, STRING BASS,** etc. For standard or long-playing records. **OUTPUT SOCKET PROVIDES L.T.** and **H.T.** for **RADIO FEEDER UNIT.** An extra input with associated vol. control is provided so that two separate inputs such as Gram and "Mike" can be mixed. 200-250 v. 50 c/s. A.C. Mains output for 3 and 15 ohm speakers. Complete Kit of parts with fully punched chassis and point-to-point wiring diagrams and instructions. Supplied factory built with EL34 output valves and 12 months' guarantee, for 14 Gns. If required perforated cover with carrying handles can be supplied for 19/9. **11 Gns.** Carr. 10/-. Send S.A.E. for leaflet, also speaker. **TERMS: DEPOSIT 34/6** and 9 mthly. payments of 33/6 (Total 16 gns.)

12in. 10 WATT HIGH QUALITY LOUDSPEAKER



In walnut veneered cabinet. Gauss 12,000 lines. Speech coil 3 ohms or 15 ohms. Only **£4.19.6** Carr. 5/6. Terms: Deposit 11/3 and 9 monthly payments of 11/3 (Total £5.12.6). **12in. 20 WATT HI-FI LOUDSPEAKERS IN CABINETS.** Size 18 x 18 x 10in. Finish as above. Only £7.19.6. Terms: Deposit 17/9 and 9 monthly payments of 17/9 (Total £8.17.6). Carr. 8/6.

INTEREST CHARGES REFUNDED

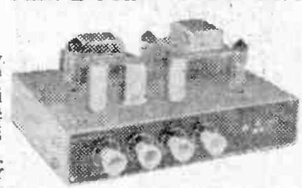
on H.P. and CREDIT SALE Accounts settled in 6 months.

LINEAR TAPE PRE-AMPLIFIER. Type LP/1. Switched Equalisation, Positions for Recording at 1⅞in., 3¾in., 7½in. per sec., and Playback. EM84 Recording Level Indicator. Designed primarily as the link between a Collaro Tape Deck and Hi-Fi amplifier, suitable almost any Tape Deck. Only 9½ gns. S.A.E. for leaflet.

W.B. "STENTORIAN" HIGH FIDELITY P.M. SPEAKERS HF1012. 10 watts rating. Where a really good quality speaker at a low price is required, we highly recommend this unit with an amazing performance. £4.12.0. Please state whether 3 ohm or 15 ohm required.

HIGH FIDELITY 12-14 WATT AMPLIFIER TYPE A11

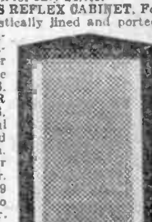
PUSH-PULL ULTRA LINEAR OUTPUT "BUILT-IN" TONE CONTROL PRE-AMP STAGES



Two input sockets with associated controls allow mixing of "mike" and gram., as in A10. High sensitivity. Includes 5 valves, ECC83, ECC83, EL84, EL84, EZ81. High Quality sectionally wound output transformer specially designed for Ultra Linear operation and reliable small condensers of current manufacture. INDIVIDUAL CONTROLS FOR BASS AND TREBLE "Lift" and "Cut". Frequency response ±3 dB 30-20,000 c/s. Six negative feedback loops. Hum level 60 dB down. ONLY 23 millivolts input required for FULL OUTPUT. Suitable for use with all makes and types of pick-ups and microphones. Comparable with the very best designs for **STANDARD or LONG PLAYING RECORDS.** For **MUSICAL INSTRUMENTS** such as **STRING BASS, LEAD or RHYTHM GUITARS, etc. OUTPUT SOCKET** with plug provides 300v. 30mA, and 6.3v. 1.5a. for supply of a **RADIO FEEDER UNIT.** Size approx. 12 x 9 x 7in. For A.C. mains 200-250v. 50 c.p.s. Output for 3 and 15 ohms speaker. Kit is complete to last nut. Chassis is fully punched. Full instructions and point-to-point wiring diagrams supplied. Only **8 Gns.** Carr. 10/-. (Or factory built 51/- extra).
If required louvred metal cover with 2 carrying handles can be supplied for 18/9. **TERMS ON ASSEMBLED UNITS. DEPOSIT** 25/- and 9 monthly payments of 25/- (Total £12.10.0). Send S.A.E. for illustrated leaflet detailing Cabinets, Speakers, Mikes, etc.

R.S.C. JUNIOR BASS REFLEX CABINET. Designed for above speaker, but suitable for any good quality 8in. or 10in. speaker. Acoustically lined and ported. Polished walnut veneer finish. Size 18x12x10in. Strongly made. Handsome appearance. Ensures superb reproduction for only £4.7.6.

R.S.C. STANDARD BASS REFLEX CABINET. For 12in. loudspeaker, acoustically lined and ported. Size 20 x 14 x 13in. Beautiful walnut veneer finish. Recommended for use with Audiotrine Speaker System. £5.19.6.



AUDIOTRINE CORNER CONSOLE CABINETS. Strongly made. Beautiful polished walnut veneered finish. Pleasing design. **JUNIOR MODEL.** For up to 8in. speaker. Approx. 20x11x8in. 49/9. **STANDARD MODEL.** To take up to 10in. speaker. Size 27 x 18 x 18in. 5 Gns. Carr. 7/6.

SENIOR MODEL. To take up to 12in. speaker and with Tweeter cut-out. Size approx. 30 x 30 x 15in. (Recommended for use with Audiotrine speaker system). 8 gns. Carr. 8/6. Terms available.

R.S.C. STEREO/TEN HIGH QUALITY AMPLIFIER

A complete set of parts for the construction of a stereophonic amplifier giving 5 watts high quality output on each channel (total 10 watts). Sensitivity is 50 millivolts. Suitable for all crystal stereo heads. Ganged Bass and Treble Control give equal variation for "lift" and "cut". Provision is made for use as straight (monaural) 10-watt amplifier. Valve line-up ECC83, ECC83, EL84, EL84, EZ81. Outputs for 2-3 ohm speakers. Point-to-Point wiring diagrams and instructions supplied. Send S.A.E. for leaflet. **8 Gns.** Full constructional details and price list 2/6. Carr. 10/-
Or supplied factory assembled with 12 months' guarantee for £11.7.6.
Terms: Deposit 2 gns. and 9 monthly payments of 24/2 (Total £12.19.6).

AUDIOTRINE HI-FI SPEAKER SYSTEMS. Consisting of matched 12in. 12,000 line, 15 ohm high quality speaker; cross-over unit (consisting of choke, condenser, etc.) and Tweeter. The smooth response and extended frequency range ensure surprisingly realistic reproduction. Standard 10 watt rating. £4.19.9. Carr. 5/-. Or Senior 20 watt, £6.19.6. Carr. 7/6.

S4/4 STEREO AMPLIFIER

A complete set of parts to construct a good quality Stereo amplifier with an undistorted output total 8 watts. For A.C. mains input of 200-250 v. Sensitivity 150 m.v. Ganged Volume and Tone Controls. Preset balance control. Full instructions and wiring diagrams supplied **5 Gns.**

Always in Stock at keen prices SINGLE and AUTO RECORD PLAYING UNITS, PICK-UPS, CARTRIDGES, MICROPHONES, VALVES, CABINETS and COMPONENTS too numerous to list.

www.americanradiohistory.com

R.S.C. (MANCHESTER) LTD.

Addresses on page 292

R.S.C. G100 100 Watt AMPLIFIER

TERRIFIC POWER OUTPUT FOR ALL PURPOSES

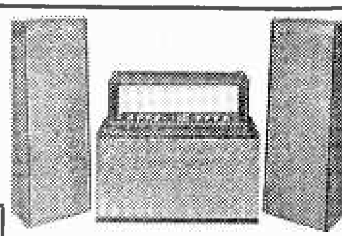
For ELECTRONIC ORGAN, LEAD, RHYTHM and BASS GUITAR and any other musical instrument. FOR VOCALIST, Gram, RADIO and Tape etc.

★ Incorporating SIX 12in. PLUS TWO 15in. HEAVY DUTY LOUDSPEAKERS. Total Rating, 140 watts.
★ Housing in 4 substantial Wood Cabinets of pleasing design and covered in contrasting shades of Rexine and Vynair with gold trimmings.
★ 4 Jack Inputs in TWO CHANNELS with 4 Independent Volume Controls.
★ Separate Bass and Treble Controls on each channel.
★ For standard 200-250v. A.C. mains operation.

Fantastic Value at only 89½ Gns. Carr. 50/-

Or **Deposit £11.7.6** and 52 weekly payments of 35/- (Total 97½ Gns.)

Send S.A.E. for full descriptive leaflet, or visit one of our many branches and hear this fabulous amplifier.



FULL RANGE of MICROPHONES in stock. Most makes. Prices from 12/9 to £50. Credit Terms available over £6 or with other equipment.

R.S.C. BASS-REGENT 50 WATT AMPLIFIER

AN EXCEPTIONALLY POWERFUL HIGH QUALITY ALL-PURPOSE UNIT

For lead, rhythm, bass guitar and all other musical instruments
For vocalists, gram, radio, tape and general public address

★ UNUSUALLY POWERFUL LOUDSPEAKER COMBINATION consisting of a FANE HIGH FLUX 15in. 30 watt unit PLUS A FANE 12in. 20 watt unit with extended frequency response.
★ 4 Jack Socket Inputs and two independent Vol. Controls for simultaneous use of up to 4 pick-ups or 'mikes'.
★ Separate cabinets fully covered in contrasting tones of Rexine/Vynair with gold trimming, for speakers and amplifiers.
★ Separate Bass and Treble Controls giving 'Boost' and 'Cut'.

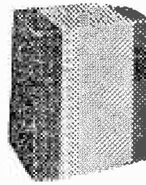
Send S.A.E. for leaflet. Or call at one of our many branches and compare the Bass-Regent with units at more than three times the cost.

47 GNS. Carr. 25/-

Or deposit £5.11.0 and 12 monthly payments of £4. (Total 51 Gns).

HEAVY DUTY SPEAKERS IN CABINETS

TYPE BG1. Two Tone Rexine/Vynair covered Suitable for Bass Guitar. Speaker Unit 15in. High Flux, 15 ohms, 30 watts. Robust cabinet size approx. 24x21x13in.

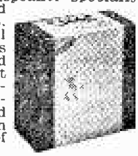


Only **19½ Gns.**

Or Deposit 51/9 and 9 monthly payments of 44/5 (Total 21½ Gns.)

R.S.C. B20 MULTI-PURPOSE AMPLIFIER especially suitable for Bass Guitar

A highly efficient unit incorporating massive 15in. high flux loudspeaker specially constructed to withstand heaviest load conditions. Rating 25 watts. Individual bass and treble controls give ample "Boost" and "Cut". Two jack socket inputs separately controlled. Cabinet is of substantial construction and attractively finished in two contrasting tones of Rexine and Vynair.

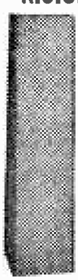


Size approx. 24 x 21 x 13ins. Carr. 17/6.

Sends S.A.E. for leaflet. **29½ Gns.** Or deposit £3.4.6 & 12 monthly payments of 51/6. **(Total 32½ gns.)**

INTEREST CHARGES REFUNDED ON H.P. ACCOUNTS SETTLED IN 6 MONTHS

R.S.C. COLUMN SPEAKERS



Covered in two-tone Rexine/Vynair. Ideal for vocalists and Public Address. Normally supplied for 15 ohm matching but can be supplied for 100v. line for 35/- extra.

Type C58, 15-20 watts. Fitted five 8in. high flux speakers. Overall size approx. 42 x 10 x 5in.

12½ Gns. Carr. 10/-.

Or deposit of 29/- and 9 monthly payments 29/- (Total £14.10.0).

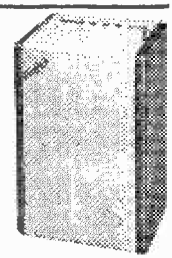
Type C412. 40 watts. Fitted four 12in. 12,000 line 10 watt speakers. Overall size 56 x 14 x 9in. approx. **19½ Gns.**

Carr. 15/-

Or deposit of 51/9 and 9 monthly payments of 44/5 (Total 21½ Gns).

R.S.C. BASS MAJOR 30 WATT MULTI-PURPOSE HIGH FIDELITY HIGH OUTPUT AMPLIFIER for VOCAL & INSTRUMENTAL GROUPS

Eminently suitable for lead, rhythm, bass guitar and all other musical instruments



★ Incorporating two 12in. 25 watt Heavy Duty High Flux Fane Loudspeakers, one with dual cone for high frequencies.
★ Robust wood cabinet with exceptionally attractive covering of Rexine/Vynair with gold trimmings.
★ Four Jack Socket Inputs and two independent Volume Controls for simultaneous connection of up to four Pick-ups or "Mikes".
★ Separate Bass and Treble Controls.

SUPERIOR TO UNITS AT TWICE THE COST. **Send S.A.E. for leaflet or call for demonstration at any branch.**

39½ Carr. 17/9

Terms: Deposit £4.3.0 and 12 monthly payments of £3.8.4 (Total 43 Gns).

30 WATT HIGH QUALITY AMPLIFIER FOR LEAD RHYTHM AND BASS GUITAR

and for Vocal or Instrumental Groups

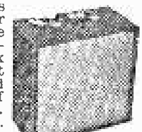
A Four Input, two volume control Hi-Fi unit with separate Bass and Treble "Cut and "Boost" controls. Designed for vocal or instrumental groups. For Bass, Lead or Rhythm Guitar. Mullard or Brimar latest type valves. Housed in strong Rexine covered cabinet with twin carrying handles. Attractive black and gold perspex fascia plate. For 200-250v. A.C. mains. Output for 3 or 15 ohm speakers. Send S.A.E. for leaflet.

16½ GNS. Carr. 12/6

or Deposit 2 Gns. and 9 monthly payments of 38/6 (Total 18½ Gns).

R.S.C. G15 15 WATT AMPLIFIER for Lead or Rhythm Guitar, 'Mike', Gram or Radio

High-fidelity push-pull output. Separate bass and treble "Cut" and "Boost" controls. Twin separately controlled inputs so that two instruments or "mike" and pickups can be used at the same time. Loudspeaker is a heavy duty flux 12in. 20 watt model with cast chassis. Cabinet is covered in constrasting shades of Rexine/Vynair. Size approx. 18 x 18 x 8in.



Only **19 Gns.** Carr. 10/-

Or DEPOSIT 2 Gns. and 12 monthly payments of 33/3 **(Total 21 gns.)**

Send S.A.E. for leaflet.

LINEAR TREMOLO/PREAMP UNIT

Designed for introducing the Tremolo effect to any amplifier which is fitted with a reserve power supply point for smoothed H.T. and 6.3v. A.C. L.T. The unit plugs into power supply point and any input socket or amplifier. Controls are Speed (frequency of interruptions). Depth (for heavy or light effect). Volume and Switch. Three sockets are for two inputs and Foot Switch. ONLY **4 Gns.**

FANE 12" 20 W HEAVY DUTY LOUDSPEAKERS 15 ohm voice coil. Suitable Lead or Rhythm Guitar, Vocal and general P.A. purposes. ONLY **5 Gns.**

R.S.C. G5 AMPLIFIER

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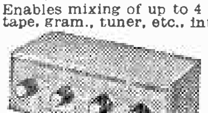
Enables mixing of up to 4 inputs. i.e. mic., tape, gram., tuner, etc., into single output. Compact and completely self-contained, uses standard 9 volt battery. Four standard jack inputs.



PRICE **49/6** Post 3/6.

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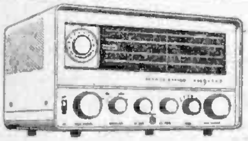
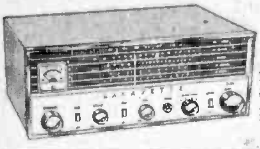


LAFAYETTE HA 63 COMMUNICATION RECEIVER

7 valves + Rectifier. 4 Bands 550 Kc/s—31 Mc/s. 'S' Meter-BFO-ANL-Bandspread Tuning. 200/250v. A.C. Brand New. **24 Gns.** carr. paid.

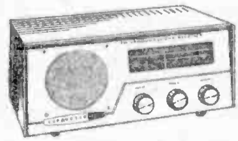
NEW MODEL! LAFAYETTE HA-230 AMATEUR COMMUNICATIONS RECEIVER

Supercedes model HE-30. 8 valves + rectifier. Continuous coverage on 4 bands. 550 Kc/s—30 Mc/s. Incorporates 1 RF and 2 IF stages. Q Multiplier, BFO ANL, 'S' meter, electrical bandspread, Aerial trimmer etc. Supplied brand new and guaranteed. **33 Gns.** SAE for full details.



STAR SR 40 COMMUNICATION RECEIVER

4 Bands 550 Kc/s—30 Mc/s. 'S' Meter-BFO - ANL - Bandspread Tuning. Built in speaker. 200/250v. A.C. Brand New. **18½ Gns.** Carriage 10/-.



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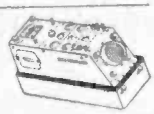
108—136 Mc/s. High selectivity and sensitivity. Incorporates 2 RF stages including 6CW4 Nuvistor. 8 tubes for 11 tube performance, solid state power supply, adjustable squelch control, slide rule dial, built in 4in. speaker and front panel phone jack. 220/240v. A.C. Supplied brand new and guaranteed. **19 Gns.** Carr. 10/-.

OS/8B/U OSCILLOSCOPES



High quality Portable American Oscilloscope. 3in. c.r.t. T/B 3c/s-50 kc/s X Amp: 0-500 kc/s Y Amp: 0-2 Mc/s. Power requirements 105-125v. A.C. Supplied in "as new" condition, fully tested.
£25. Carr. 10/-. Suitable 230/115v. Transformer, 15/6.

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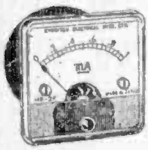
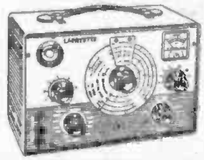


First grade quality. Moving Coil panel meters, available ex-stock. S.A.E. for illustrated leaflet. Discounts for quantity. Available as follows. Type MR 38P 1 21/32in. square fronts.

		2mA	22/6	3V. DC	22/6
		5mA	22/6	10V. DC	22/6
		10mA	22/6	20V. DC	22/6
		20mA	22/6	50V. DC	22/6
		50mA	22/6	100V. DC	22/6
		100mA	22/6	150V. DC	22/6
		150mA	22/6	300V. DC	22/6
50μA	32/6	200mA	22/6	500V. DC	22/6
100μA	29/6	300mA	22/6	750V. DC	22/6
200μA	27/6	500mA	22/6	15V. AC	22/6
500μA	25/-	750mA	22/6	50V. AC	22/6
50-0-05μA	29/6	1-0-1mA	22/6	150V. AC	22/6
100-0-100μA	27/6	1A. DC	22/6	300V. AC	22/6
500-0-500μA	22/6	2A. DC	22/6	500V. AC	22/6
1mA	22/6	5A. DC	22/6	"S" Meter 1mA	29/6

POST EXTRA. Larger sizes available—send for lists.
ILLUMINATED "S" METER. 1 21/32in. square front. Cal. in S units, 6V. lamp. 29/6. P.P. 1/-. Ditto 2 5/16in. square 39/6. P.P. 1/-.

TE-22 SINE SQUARE WAVE AUDIO GENERATORS



Sine: 20 c.p.s. to 200 Kc/s on 4 bands. Square: 20 c.p.s. to 25 Kc/s. Output imp. 5000 ohms. 200/240 v. A.C. Brand new Guaranteed. £15. Carr. 7/6.

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2pF, 2,000 mFd. 2 ohms, 200 megohms. Also checks impedance. Turns ratio. Insulation 200/250v. A.C. Brand New. £15. carr. 7/6.

LAFAYETTE TE-20A R.F. SIGNAL GENERATOR

120 Kc/s—390 Mc/s on 6 ranges. Variable R.F. and A.F. outputs. Large clear scale. Size 7½ x 10¾ x 4¾in. 200/250v. A.C. operation. Brand New. £12.19.6. Carr. 7/6.

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Supplied reconditioned, guaranteed perfect. Model D, £8.19.6. Model 7, £12.10.0. Post & Ins 5/-.

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Generator Bell Ringing, 2 Line Connection. With Wood Carrying Case. Fitted Batteries Supplied Fully Tested, £4.19.6. Pair Carr. 7/6.

TWO-WAY RADIOS

3 Transistor Transceiver. Range up to 1 mile. £9.19.6 per pair complete.
9 Transistor Transceiver. Range up to 5 miles. £25 per pair complete. Post extra. S.A.E. for full details.

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20,000 O.P.V. 0/.06/6/30/120/600/1,200/3,000/6,000 v. D.C. 0/6/30/120/600/1,200 v. A.C. 0/60μA/6/60/600 mA. 0/6K/600K/6. Meg./60 Meg. Ω. P.F.-.2 MFD. £5.19.6. P. & P. 3/6.

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Timebase 2 c/s.-750 kc/s. Separate Y1 and Y2 amplifiers. Up to 5.5 Mc/s. calib. at 100 kc/s. and 1 Mc/s. 110/230 v. A.C. Guaranteed perfect, £27.10.0. Carr. 20/-.

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200 P.I.V.	200mA	2/6
200 P.I.V.	6 amp	5/6
1,000 P.I.V.	650mA	7/6
800 P.I.V.	500mA	5/6
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400 P.I.V.	500mA	3/6
150 P.I.V.	165mA	1/-
70 P.I.V.	1 amp	3/6
95 P.I.V.	3 amp	5/6

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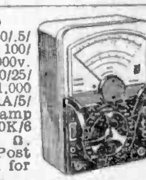
VOLTAGE STABILIZER TRANSFORMERS

Will stabilize your mains voltage. Ideal for TV Receivers and Industrial equipment. Input 80-120 v. and 160-240 v. Constant output 110 v. or 240 v. 250 watts. Brand new guaranteed. £10.10.0 Carr. 7/6.

MODEL 500



30,000 o.p.v. 0/.5/1/2.5/10/25/100/250/500/1,000v. DC 0/2.5/10/25/100/250/500/1,000 v. AC 0/50μA/5/50/500mA/12 amp DC. 0/60K/6 Meg/60 Meg Ω. £8.17.6 Post Paid. S.A.E. for full details.

AMERICAN TAPE

First grade quality American tapes. Brand new and guaranteed. Discounts for quantities.

3in.	225ft.	L.P. acetate	4/-
3¼in.	600ft.	T.P. mylar	10/-
5in.	600ft.	std. plastic	8/6
5in.	900ft.	L.P. acetate	10/-
5in.	1200 ft.	D.P. mylar	15/-
5in.	1800ft.	T.P. mylar	35/-
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7in.	1200ft.	std. mylar	12/6
7in.	1800ft.	L.P. acetate	15/-
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7in.	2400ft.	D.P. mylar	25/-
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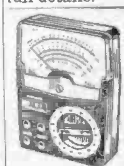
MINE DETECTOR No. 4A

Will detect all types of metals. Fully portable. Complete with instructions, 39/6 each. Carr. 10/-. Battery 8/6 extra.

VARIABLE VOLTAGE TRANSFORMERS

Brand New Guaranteed. Fully Shrouded. Input 230v. 50/60 c/s, output 0-23v.

1 Amp £4.10.0.
2.5 Amp £5.17.6.
5 Amp £9.0.0.
8 Amp £13.10.0.
10 Amp £17.0.0.
12 Amp £19.10.0.
20 Amp £32.10.0.
2.5 Amp Portable Metal Case with Meter Fuses etc. £9.17.6.



TE-51 NEW 20,000 Ω/ VOLT MULTI-METER

0/6/60/120/1,200 v.A.C. 0/3/30/60/300/600/3,000 v. DC. 0/60μA/12/300 mA. DC. 0/60K/6 Meg. ohm. £4.5.0. post & pack. 2/6.

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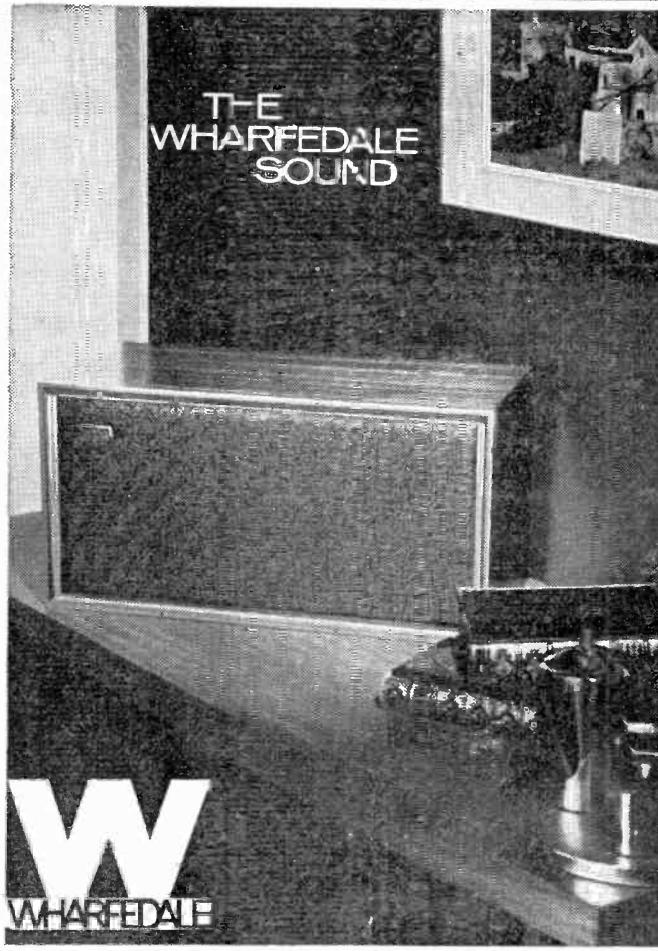
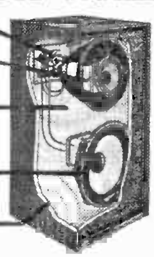
THE WHARFEDALE SOUND

stereo/mono

The LINTON



The LINTON is another of the 'new look' loudspeakers developed by Wharfedale and styled by Robert Gutmann, F.S.I.A. The cabinet—made in high density man made timber for reduced panel resonance is superbly veneered. Back radiation is completely eliminated by special internal treatment. A new 8″ cast chassis bass unit has been developed by Wharfedale for the Linton. It has a 12,000 oersteds magnet and is fitted with a flexiprene roll surround giving a fundamental open baffle resonance of only 43 c/s. The linear performance is such that the bass distortion is extremely low. A special version of the world famous Super 3 tweeter is combined with a treble control to compliment the 8″ bass unit giving an extremely smooth treble response up to very high frequencies. The result is a well balanced twin speaker system of high performance capable of being driven by relatively small amplifiers to provide adequate volume and fatigue free listening.



Free technical folder on the Linton from Dept. P.

Frequency range 40 *c/s*—15,000 *c/s.*
Impedance 8-10 *ohms.*
Power handling capacity 10 *watts*
(20 watts peak)
Size 19″ x 10″ x 10″ *Weight* 18 *lb.*

Finish zebrano veneers or walnut and oiled teak to special order.

£18.7.4

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PRACTICAL WIRELESS

AUGUST 1965

VOL 41 NO 702

REQUIEM FOR A SHOW

IF we had a flag, it would now be at half mast. For the radio and television industry has stood by and doomed to oblivion the 1965 Radio Show, a venture that was hardly allowed to get off the ground.

Since the 1920's the Radio Show has flourished until in recent years it began to flounder, and both public attendance and stand bookings began to decline. No single factor can be pinpointed for the reasons are several, complex and partly intangible.

However, the snowball effect of company mergers progressively reduced the number of potential exhibitors. The increasing cost of buying stand space and of fitting and manning exhibits, also took its toll, and then the broadcasting authorities made less spectacular provision for entertaining the public.

But the death knell for the old-type Radio Show clearly rang out when major exhibitors began staging their own independent trade-only splinter shows. Now this year with most of the big boys opting out, the 1965 Show had little chance.

Whatever the success of these private ventures, however, we do not think they are in the industry's long-term interest. The public may often prove tiresome and exhausting at exhibitions but these are the people who buy the products and keep the manufacturers in business.

Other major industries manufacturing highly competitive consumer goods continue to run successful exhibitions catering for trade and public. The radio industry is the odd man out—and surely it cannot afford to be so insular. Let it have the foresight to organise something worthwhile for 1966.

The Radio Show is dead! Long live the Radio Show!

CONTENTS

All correspondence intended for the Editor should be addressed to: The Editor, "Practical Wireless", George Newnes Ltd., Tower House, Southampton Street, London, W.C.2. Phone: TEMple Bar 4363. Telegrams: Newnes Rand London. Subscription rates, including postage: 29s. per year to any part of the world. © George Newnes Ltd., 1965. Copyright in all drawings, photographs and articles published in "Practical Wireless" is specifically reserved throughout the countries signatory to the Berne Convention and the U.S.A. Reproductions or imitations of any of these are therefore expressly forbidden. **THE SEPTEMBER ISSUE WILL BE PUBLISHED ON AUGUST 5TH.**

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Can Anyone Help

PLEASE can anyone help me? I need a small internal switch for a wireless set issued by R.A.P. Ltd., London, 7634. Apart from this component the set appears to be in good condition. R.A.P. appear to have discontinued this model.

W. M. Stanley.

17 Denton Road,
Wokingham,
Berkshire.

C.W. Standards

As an ex-W.T. operator of 20 years' standing I find after months of listening on the amateur bands that the standard of British operators (c.w.) is fast deteriorating compared with other countries. Many of them seem barely able to work at 10 w.p.m.

At a recent R.A.E. examination centre I met a few of the old ex-Service operators who are all eager to do a spot of operating. These men are excellent operators and quite good mechanics, capable of building their own transmitting and receiving equipment. But these men failed the R.A.E. simply because they were unable to memorise a few formulae. Several lads of about 16, however, passed the test, yet they had not a clue how to operate. Consequently they turn to phone working—too scared to work c.w.

If this state of affairs continues there will be very few British operators working on c.w. in a few years' time.

F. Taylor.

Plymouth,
Devon.

Octal Valves Again!

I DISAGREE with R. A. Packer's comments on I.O. valves (May issue). Manufacturers are all for miniaturisation, as we all know, but need constructors follow blindly along the same path?

While I.O. valves are obtainable I consider that the saving in odd shillings far outweighs the sacrifice of that inch or so of not so valuable space.

J. Huet.

Canvey Island,
Essex.

NEWS AND...

404 LOUDSPEAKERS IN WEMBLEY P.A. SYSTEM

The largest public address system in Britain is that of the Wembley Stadium where no less than 404 loudspeakers are installed. Sixty of these are mounted on baffle boards and the remainder in 86 column enclosures.

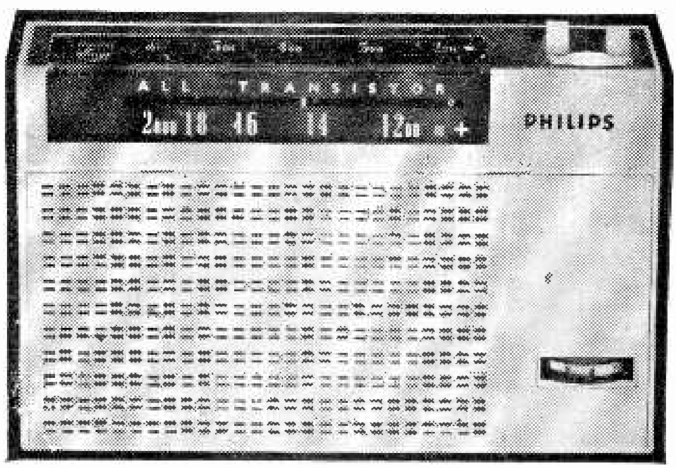
The p.a. system was recently installed by Rediffusion technicians in time for the F.A. Cup Final in May, but only after they had solved the formidable problem of the Stadium's acoustics which, when it is empty are very different from when it is packed to capacity.

NEW COMPUTER FOR THE MIDLANDS

Businessmen in and around Birmingham requiring computer services can now make use of a new Honeywell 200 machine recently installed by Midlands Computing Centre Ltd.

The new British-made computer is expected to find ready acceptance by Midland-based firms too small to buy their own computer, yet large enough to warrant the analysis of production, sales and costs which modern equipment can provide.

LOW-COST PORTABLE MADE IN BRITAIN



This portable receiver is British made and inexpensive. In fact according to the makers, Philips Electrical Limited, it is the lowest-priced British-made portable radio ever.

Known as the "Popmaster", it has been introduced to combat the ever-growing imports of Hong Kong-manufactured portables into the UK and will sell at £7 19s. 6d.

Each set carries a six months guarantee covering spares and labour and also a world-wide service guarantee valid for any service department of Philips companies throughout the world.

The "Popmaster" covers long and medium wavebands and measures just over $5\frac{1}{2}$in. x $3\frac{1}{2}$in. x $1\frac{1}{2}$in. The 6-transistor circuit is powered by four U7 batteries housed in a sealed compartment in the base of the cabinet. Also contained in the base is a fitted earpiece attachment.

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..COMMENT

OXFORD MOBILE RALLY

On July 11th the Oxford and District Radio Society will hold its tenth anniversary mobile rally. The organisation of this event has been in conjunction with the RSGB.

Talk-in stations on 160m, 80m, 4m and 2m will be operating at the venue in the grounds of the College of Technology, Headington, Oxford. Attractions planned for the day include morris dancing, films, demonstrations, competitions, etc.

TRANSCEIVERS FOR NEW POLICE SQUAD

Radio communications is playing a big part in London's new 100-strong police patrol group, which began operations recently. The group has been formed to counteract sudden outbreaks of crime by saturating trouble spots with uniformed police.

Contact between the group's vehicles and Scotland Yard and the P.C.s on foot, is by v.h.f. radio' each constable in the group carrying a light-weight transceiver.

There are just two women P.C.s in the group; one of them is seen here using one of the fully-portable transceivers.

THE '65 SHOW CANCELLED

The '65 Show—this year's planned successor to the National Televison and Radio Show—is off due to lack of support.

The organisers of the Show—Industrial and Trade Fairs Ltd.—announced the complete cancellation of the venture after many of the largest companies in the British radio industry had decided not to take part. The commercial TV companies also dropped out.

The exhibition was to have taken on a new appearance this year, with all parts of the radio, television and home entertainment industry represented. This year too, overseas participation was expected for the first time.

GPO TO HAVE SEVEN COMPUTERS

The first of seven English-Electric LEO 326 computers ordered by the GPO has been installed at Charles House, Kensington, London, where it succeeds a LEO 3 machine which has been operating for nearly a year. The work of producing six million telephone bills a year, calculating repayments of National Savings Certificates, preparing experimental route schedules for mail vans and analysing stores and equipment, which the old machine handled, will be carried on by the LEO 326 at much faster speeds and still provide extra computer time for further developments.

A second LEO 326 computer will be installed at Charles House later this year and another two will go to the POs Savings Department at Lytham St. Annes, Lancashire.

When all seven are installed and operating, the GPO will be the largest commercial computer use in Europe.

Bottling Acid

SURELY Mr. Ian Gregory (News and Comment, June, 1965) is a little antiquated in his choice of containers for hydrofluoric acid. In this day and age a polythene bottle would probably be cheaper and more easily obtainable than one of wax or gutta-percha and equally effective.

I. M. Hutchings.

Rugby,
Warwickshire.

Correspondents

I AM 27 years of age and studying radio and television servicing with a correspondence school.

I would like to correspond with radio and television servicemen anywhere in the world.

Ernest Tchakanga.

P.O. Box 357,
Mufulira,
Zambia,
Cent. Africa.

I WOULD like to correspond with anyone in South Africa who is interested in radio and motor-yachts. I am 14 years old.

Ian Thornton.

13 Adshead Close,
Poundswick,
Manchester 23,
Lancs.

I AM a regular subscriber to *Practical Wireless*. In addition to being interested in electronics I am a philatelist and would like to correspond with people in England willing to exchange Indian stamps and first-day-covers for miniature electronic components not available here.

G. H. D'Cruz.

Sugar Factory,
Shimoga,
South India.

The Solo Organ

I HAVE located a small error in the transistor solo organ article (April issue, page 1163). The wire from top right-hand tuning resistance tag should go to the lower arm of VR2 and not to the middle arm as shown.

G. W. Hardy.

Poole,
Dorset.

more News and Comment on page 330

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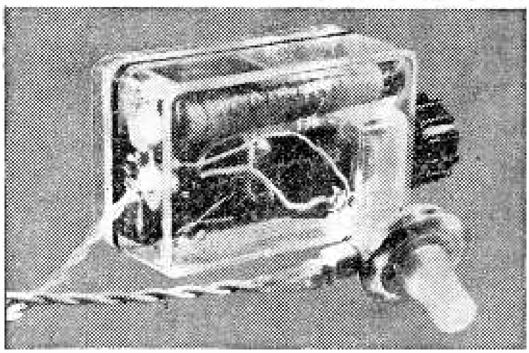
COVER SUBJECT



SOLAR-POWERED POCKET RECEIVER

by C. J. Walton

THIS is a receiver circuit using the minimum of components, driving a hearing aid type earpiece, and having as its power supply a solar cell. It requires no external aerial or earth. The final circuit was developed from the somewhat standard receiver circuit of Fig. 1, and it is advisable to build this one up first to test reception conditions in your area. If you have already experimented with one and two transistor circuits of the regenerative and reflex types and you know that you are in a good reception area then the final version may be constructed immediately. Otherwise build up the circuit of Fig. 1 e.g. in a "bread-board" arrangement. This circuit should easily, without external aerial or earth, drive the earpiece on most m.w. stations—the local Home (and possibly Light) should be loud and continentals should be fair. If these conditions are fulfilled then the final Mark 3 version is assured of some success. However, some areas of the country, especially those in deep valleys or below high cliffs, provide very low signal levels (and even a standard six transistor superhet has difficulty in these areas) in which case the circuit of Fig. 1 will receive little if anything and the light powered circuit even less. Thus the disappointment of building something doomed from the start to failure is avoided (and the expense of the solar cell is saved).

Tr1 can be any standard r.f. type for this circuit (in fact a number of accepted "low frequency" transistors will function here, e.g. odd specimens of OC71, XB103, and even an occasional "red spot"—however the recommended r.f. types are necessary for the final circuit) and examples tested were: OC44, XA112, OC171, AF114. Slight variation of R1 may be necessary but the results of this reflexed-regenerative should be good. The coil may need a few turns adding or removing to cover the entire m.w. depending on the characteristics of the components used. It was considered initially that this type of circuit, providing maximum gain at both r.f. and a.f. with separate detection by diodes, would be the most efficient for a light powered receiver.

Then came the choice of a solar cell. Data was obtained from Ferranti Ltd. (Gem Mill, Chadderton, Oldham, Lancs.) and it became obvious that no single cell had been designed solely as a power supply for an application like this, however it appeared that most could provide sufficient current in average light conditions, all of them appearing to produce a voltage which remained constant at about 0·5V. The type finally chosen was of large (comparatively speaking) surface area: 0·75in. x 0·45in. (1·9cm. x 1·2cm.), designed for both high and low light levels—type MS2A and appears as in Fig. 2.

The current provided by the cell depends on the light intensity, from zero in darkness to about 20mA in bright sunlight on open circuit. Thus the receiver had to be capable of operating from these power conditions. The voltage supply for the design of Fig. 1 was thus reduced to a single dry cell, i.e. 1·5V, and R1 was likewise reduced to approx. 150kΩ in order to keep the same current—of the order of 1mA—flowing in the transistor. Suitable adjustment of TC1 and VR1 then resulted in a fairly similar performance, at slightly reduced volume, to that of the 9V circuit. At this stage the solar cell was substituted for the dry cell, giving

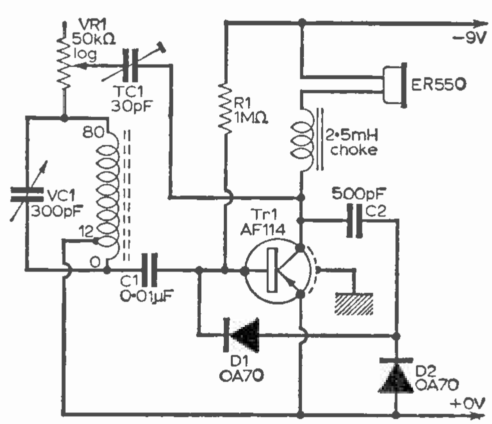


Fig. 1: The circuit of a simple one-transistor reflex receiver which formed the basis of the final design. The coil is wound on a 2in. length of $\frac{5}{16}$in. diameter ferrite rod using 34s.w.g. d.c.c. wire.

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the Mark 1 version of Fig. 3. At this stage it was found that the alloy junction type transistors were not as effective as the alloy diffused types at these low power levels. However the alloy diffused types—OC171, AF114, and a micro alloy type: MAT 121, were all operating quite well. Volume was down from the 1·5V circuit but in my area (Sowerby Bridge near Halifax, in the West Riding of Yorkshire) the Home and Light came through quite well.

With the receiver not tuned to a station as the cell was turned towards a window or other light source, a hissing could be heard in the earpiece signifying that current was flowing in the circuit (and in strong sunlight the hiss was louder than with the 1·5V cell in circuit). Stations became audible just before the hiss commenced, became louder as more light was allowed to fall on the cell, and finally regeneration in the form of whistling was heard. Keeping the light intensity constant and varying R1 the graph of Fig. 4 was obtained. No quantitative measurements were possible, but it can be seen that for regeneration to occur under fairly bright conditions, the optimum value for R1 should be between 10kΩ and 150kΩ approx. A value of 47kΩ was therefore chosen.

Regeneration was, however, difficult to control, occurring either at one end of the band or the other and was very critical, no matter what adjustment was made to TC1 and VR1 the circuit tended to "plop" in and out of oscillation. To try and alter this unsatisfactory situation and as a further experiment, it was decided to operate the circuit as a regenerative detector, i.e. C2, D1, D2 were removed. The results of this were interesting. Output volume was reduced slightly but regeneration was more easily controllable, far less feedback being required to achieve the same effect. In fact the 30pF trimmer used for TC1 had a too high value even at minimum capacitance (approx. 3pF). VR1 and TC1 were thus removed and a length of insulated (plastic coated) wire was connected to point X and another to point Y (see Fig. 3) and these were twisted together to act as a fine trimmer. This is a very sensitive type of control, the value changing at each twist by only a very small amount.

Finally the effect of removing the r.f. choke (i.e. allowing the earpiece to act as its own choke) was tried. Again there was a reduction in volume but this time regeneration was much easier to control and extended more evenly over the entire band with medium light intensity, tailing off at the low frequency end as the light was reduced. This was the final Mark 3 version shown in Fig. 5. Note that it only uses 8 components altogether. Omitting R1 resulted in very weak reception of the Home Service and nothing else.

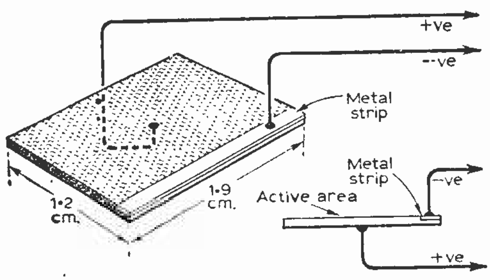

Fig. 2: Physical details of the MS2A solar cell.

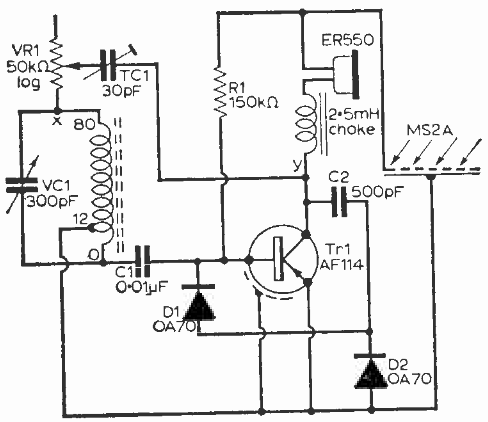

Fig. 3: The basic circuit of Fig. 1 with the solar cell introduced to replace the power supply.

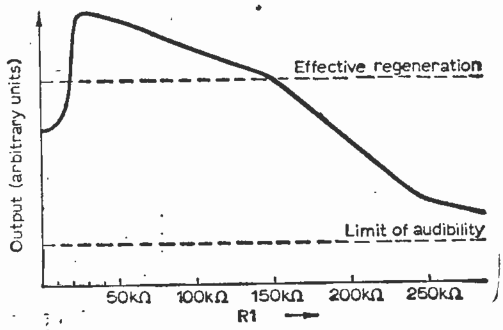

Fig. 4: This graph illustrates the level of sound output with various values of R1, the light intensity kept constant.

Details of Components Used in Final Receiver

Transistors tested included OC171, AF114 (this was the actual transistor used when built into a case) and MAT121. VC1, miniature solid dialectric 300pF tuner.

A small, clear plastic case available from dealers (or from T.S.L., Hudson House, 63 Goldhawk Road, W.12) at 1s., size 2·2in. x 1·4in. x 0·9in. The 2in. length of ferrite rod used as aerial would just fit into the case.

The earpiece used in all the versions is an Ardente ER550. Any good quality *magnetic* (not crystal) earpiece would be suitable provided its impedance is > 1kΩ. The chassis is a small piece of perforated eyelet board (cut from a 4½in. x 2½in. piece) which is available, including eyelets, from

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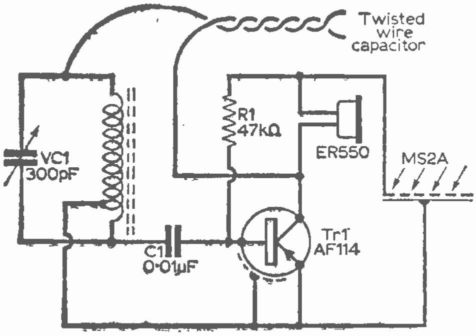
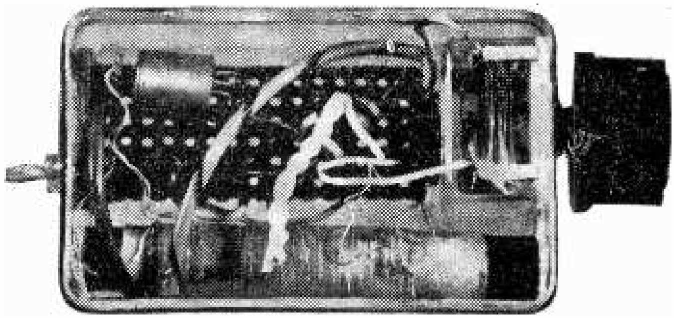


Fig. 5: The final circuit of the receiver.



Right: The finished receiver mounted in its plastic case.

Home Radio (Mitcham), Ltd., 187 London Road, Mitcham, Surrey. The ferrite rod is wound with 32s.w.g. enamelled or silk covered wire. Other details are given in Fig. 6.

The layout of the finished receiver is given in Fig. 6. The cell was stuck with Sellotape to the inside of the case (loss of light through absorption in the plastic is negligible) and its leads sleeved. If an opaque or coloured case is used the cell obviously will have to be stuck on the outside. Feedback was set for dull daylight and if the light intensity should become too high, i.e. a lot of whistling occurring, then the set must be turned away from the light to reduce current rather than changing the feedback.

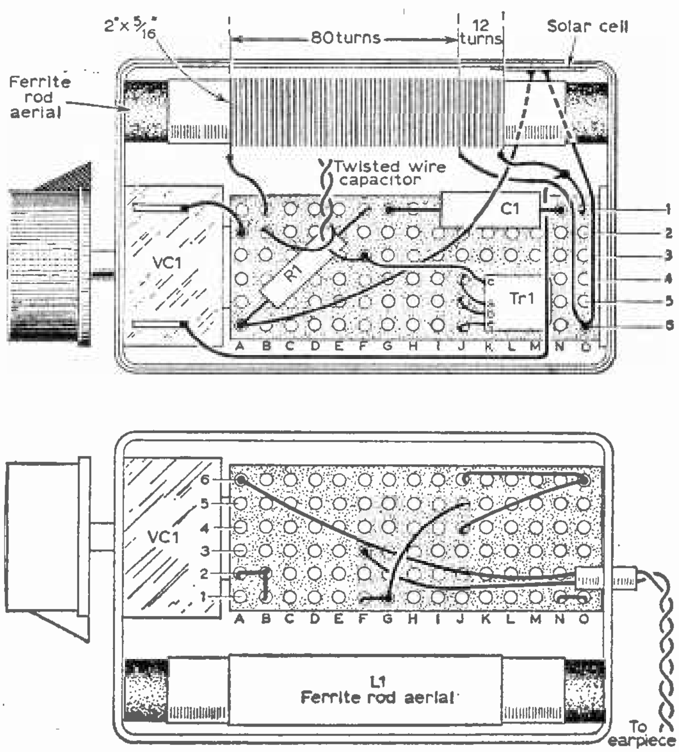


Fig. 6: These two views of the completed receiver show clearly the construction and wiring.

Further Details of Operation

The circuit does cover the entire m.w. band but obviously local conditions will determine exactly what the performance will be. In Leeds the Home, Light and Third are all at reasonable volume and in the evening the heterodyning whistles of most of the Continentals are heard. Careful tuning in quiet surroundings has brought in Luxembourg, A.F.N. and Berlin as well as Athlone (Eire) and the northern Caroline. At night some form of artificial light must be used. Any operated from the mains are found to produce an annoying buzz of "mains hum" either at one end of the band or at various points along it as the cell is moved to and from the light source. An ordinary torch is much better, whilst a fluorescent light is useless, producing a continuous buzz. It was found that the set will operate, if held close enough, from a cigarette lighter or even a match. Note that as with all ferrite rod aerials the set is very directional and sometimes a

—continued on page 338

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TAPE TAPE TAPE TERMINOLOGY TAPE

PART ONE

by H. W. Hellyer

NOWADAYS every branch of art and science carries around with it an enveloping cloak of jargon. Although this may be understood by the coterie of enthusiasts many of the terms are quite incomprehensible to the outsider.

Not least among the "specialist fields" is the art (or science, if you insist) of tape recording. Most readers of this magazine are quite aware of the general idea of tape recording and can interpret most of the terms in everyday use. But now and again the need arises for a more precise definition.

We want to know what a "drop-out" is and how it is caused, not merely be told it exists. More important, when weighing up a possible bargain we want to know just what those impressive specifications mean.

The following notes are compiled, more or less alphabetically, to clear up a few of these vague definitions. This is not a complete glossary of tape terms—which would insult the average readers' intelligence—but an illustrated description of some of the special aspects of tape recording.

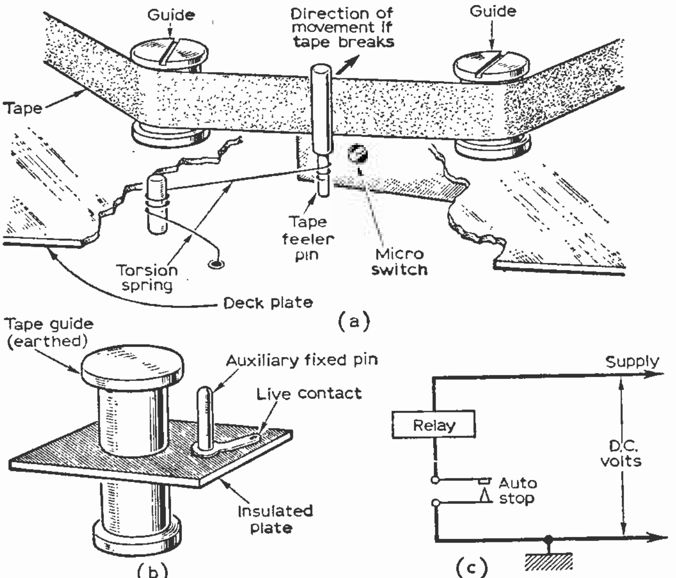

Fig. 1(a): Micro-switch actuated (open-circuits motor supply) by feeler pin if tape breaks; (b): auto-stop tape guide with separate electrode (alternative may be split-insulated guide); (c): metal foil of tape leader short-circuits contacts to activate relay.

AUTOMATIC RECORDING LEVEL

The principle of automatic gain control for radio and television is well known. In tape recording there are special difficulties and special circuits. A portion of the amplified signal is sampled, amplified and fed back as bias to a controlled stage whose gain varies with the applied voltage.

The difficulty lies in the long time constant needed with audio frequency signals. The sampling circuit must react quickly to a loud sound, apply the bias and then retain a comparative level of sounds for a reasonable period.

It is hoped to devote more space to a detailed description of how this is done in a future number of PRACTICAL WIRELESS.

AUTOMATIC STOP

A method of halting the tape transport system when (a) the tape breaks or (b) metal foil leader tape, usually at the end of the reel, completes a relay circuit.

The actual method of stopping the spools varies from the simple interrupter switch in the motor supply to relay-operated solenoid which disengages the head and capstan pressure system, applies the brakes and neutralises the mechanism. Fig. 1 shows typical systems.

AZIMUTH ADJUSTMENT

Setting of record, playback and erase heads to bring the gap into the right position at 90° to the tape length.

Correct positioning is important to allow tapes to be played on different machines and to ensure maximum gain and frequency response. Incorrect azimuth setting of the record/playback head causes loss of high frequencies (see Fig. 2).

Normal method of azimuth adjustment is to replay a pre-recorded signal of constant level (see Test Tape) and adjust the playback head for maximum response.

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BALANCED INPUT AND OUTPUT

Method of connecting items of equipment by transformer coupling with centre-tapped windings which may be earthed.

Hum and noise are cancelled out to a greater extent by this method and longer leads can thus be used. Normally two-cored screened cable is employed and matching is at low impedance.

BANDWIDTH

In hi-fi work this normally refers to the frequency range covered by the amplifying equipment which is between two extremes that occur where the output is 3dB below that of a standard reference frequency. (Usual reference for this purpose is 1kc/s.)

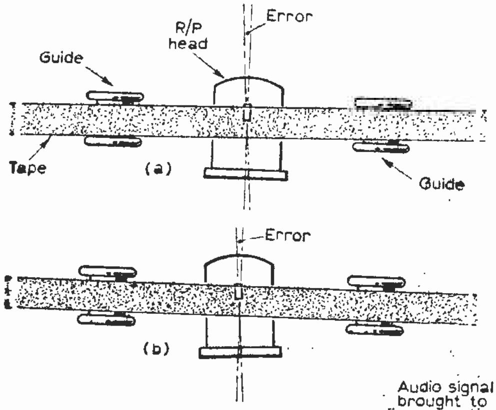

Fig. 2: Off-set guides (a) or head (b) cause h.f. loss.

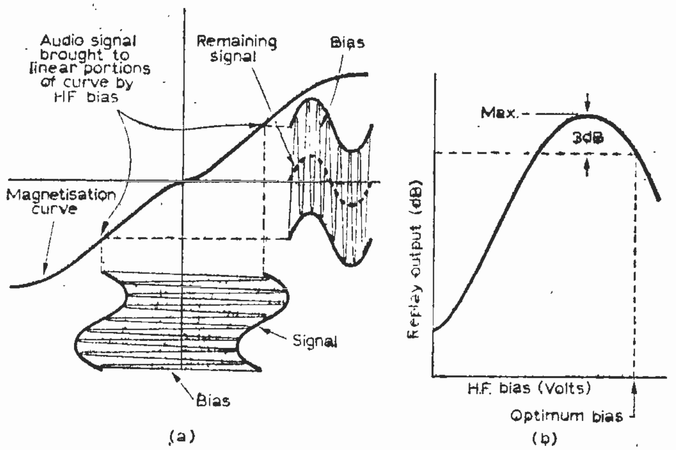

Fig. 3(a): Signal imposed on bias waveform prevents distortion due to "kink" in magnetisation curve. Optimum bias setting (b) is at value which produces a 3dB drop in output beyond peak.

Where the two limit frequencies only are quoted the above standard is understood. (See also Frequency Response.)

BIAS

The non-linear characteristics of the recording medium are overcome by imposing the audio signal on a high-frequency bias before applying the combined waveform to the recording head (see Fig. 3a).

The frequency of the bias should be as high as possible, allowing for heating losses in the head windings. Normally the bias frequency is about four or five times that of the highest frequency to be recorded; 45 to 70kc/s is the range used in domestic tape recorders.

A bias frequency that is too low will cause shrillness of reproduction of heavily modulated signals.

Bias voltage depends upon the head and tape characteristics and is usually adjustable by a preset control for optimum conditions. Normal adjustment is a little beyond that which produces the maximum output, i.e. over the peak of the curve (see Fig. 3b).

CAPSTAN

Normal method of driving the tape to attain constant speed is by pressing it against a revolving spindle called the capstan. The capstan may be mounted on a flywheel and driven by coupling belts or intermediate wheels from the motor.

The flywheel tends to "iron out" minor speed variations due to its inertia. On some single-motor machines the capstan and flywheel are integral with the motor.

Method of keeping the tape in constant contact with the capstan is by applying a spring-loaded *pressure roller* or *pinch wheel*.

CASSETTE

An enclosed spool of tape, usually adapted for automatic loading, either in a complete *magazine* or as a replacement for a single spool with a free end of tape fed to the take-up spool.

An *endless cassette* contains a long loop of tape which is wound off the outside and back on the inside of the spool for continuous playing.

C.C.I.R.

See Standards.

CHANNEL

In stereo reproduction, one amplifier chain.

CHANNEL SEPARATION

The degree of interference between channels must be reduced below 30dB for stereo systems. Parallel track systems require more stringent separation, greater than 50dB.

CROSSTALK

The above interference is known as crosstalk and may be specified at certain frequencies. It is more noticeable at higher frequencies. Overall separation at all frequencies for tape recording systems should be better than 40dB.

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CROSSTRACK

A method of mixing the output from one track with the input to another by which a composite signal can be built up without the need for "super-imposition". Modern tape recorders may incorporate this under the specified terms *multiplay* or *sound-on-sound*.

CUEING

Marking of particular places on the tape, visually or aurally. Special controls for "inching" may be fitted to aid cueing.

Dictation machines may use a method of slow wind when required to assist the finding of particular places on the tape. (See also Tape Position Indicator.)

DEFLUXING OR DEGAUSSING

Heads and ferrous metal parts such as supports and guides tend to build up a residual magnetism during use. This causes noisy reproduction when it affects the modulated tape. Method of removing this residual magnetism is to apply a strong and varying field with a *defluxer* and gradually remove this source so that the normal "random" disposition of magnetic "domains" in the metallic parts is resumed.

The construction of a defluxer is generally based on a solenoid with a projecting pole, shaped to be inserted in the tape path mechanism. Regular defluxing should be carried out to reduce background noise. A pronounced hiss is the usual indication of head magnetisation.

Degaussing of the record/play head can be effected by gradually removing the bias voltage. One method is to switch to "Record" and interrupt the mains supply, allowing oscillations to die away. Repeated several times this can keep a recording head degaussed but will not demagnetise other ferrous parts.

DISTORTION

The difference in waveform between input and output of the amplifier as a whole. This is mainly harmonic distortion and may be expressed as a percentage at a specified frequency at full modulation. (e.g. less than 5% at 1kc/s, third harmonic distortion at full modulation, may be stated as $\leqq 5\%$.)

The signal-to-noise figure may also be stated as that obtained for a certain distortion factor (see Signal-to-Noise).

DOUBLE GAP

Method of achieving more complete erasure by applying the erase field at two successive places along the tape path. Dimensions are such that the delay from first to second gap is a few milliseconds.

DROP-OUT

Short-term loss of signal which may be caused by discrepancies in tape coating or uneven tracking of tape.

DUOPLAY

Name given to the system of feeding two outputs from a tape recorder into a single channel amplifying system.

DYNAMIC RANGE

The separation, expressed in decibels, between the smallest and the greatest signals the system can handle with specified minimum distortion. The limits are imposed by the loudest sounds received at the input having to be recorded without over-modulating, while the quietest sounds are still above the noise level and the balance between is in proportion.

For a domestic machine the dynamic range may be between 40 and 60dB. In practical terms this means that a 1kc/s signal has a ratio of 10,000 or 1,000,000 to 1. Although the actual dynamic range of a full orchestra may be as much as 70dB the above range is adequate owing to the non-linear relationship between loudness and sound power.

DYNAMIC MICROPHONE

See Moving Coil Microphone.

DUBBING

A term used, mainly in editing, to denote the combining of two or more sound sources into a single recording. Also, in ciné work, the adding of a soundtrack to the film.

ECHO

A signal delay produced by feeding back a replayed signal into the recording channel. The time of delay is determined by the physical separation of the heads and tape speed and may be doubled on two-channel machines by using the second channel as an intermediate stage.

An echo chamber can be either a device similar to the above, to produce the echo effect, or an acoustic method of achieving the same end. Note that echo alone is not effective without *reverberation* for realistic simulation of original sounds.

EDITING

Altering of the signal by cutting and interposing programme material. This can be done physically (see *Splicing*) or by a form of dubbing, using two machines with the first playing back the original programme, the second recording such parts as are required to be used, and halted meanwhile, or with interposed material recorded during the same operation.

ELECTROSTATIC MICROPHONE OR LOUDSPEAKER

A device which depends on capacitor action for its operation. Fig. 4a shows examples.

Basically a diaphragm is held between perforated plates and charged by an external voltage. Sound signals cause vibration and a change in capacity in the former case and in the latter case set up vibrations of the diaphragm to produce the aural output.

The electrostatic loudspeaker is particularly suited to high-frequency reproduction and is often used as a "tweeter".

EQUALISATION

Compensation for the rising frequency response of the tape system and for high-frequency loss which occurs in the playback head. Circuits in the playback amplifier "shape" the response to a

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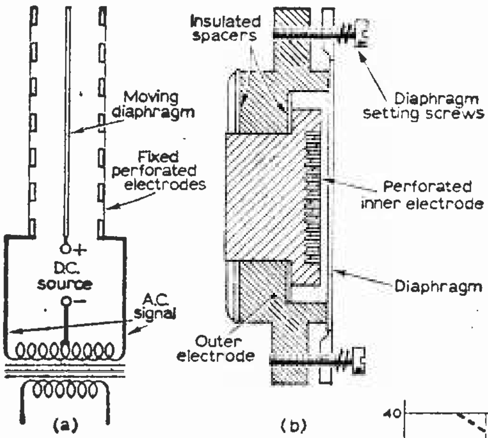

Fig. 4(a): Capacitor loudspeaker and microphone principle; (b): section of capacitor microphone capsule.

		Table 1. Equalisation Standards			
		Speeds (in./sec.)			
		15	7½	3¾	1⅞
Time Constant (micro-secs.)	CCIR	35	70	200 (old)	
	NAB	50	50		
	DIN	35	70	140	280
Turnover Frequency (kc/s)	CCIR	4·5	2·6	0·8 (old)	
	NAB	3·2	3·2		
	DIN	4·5	2·6	1·3	0·68

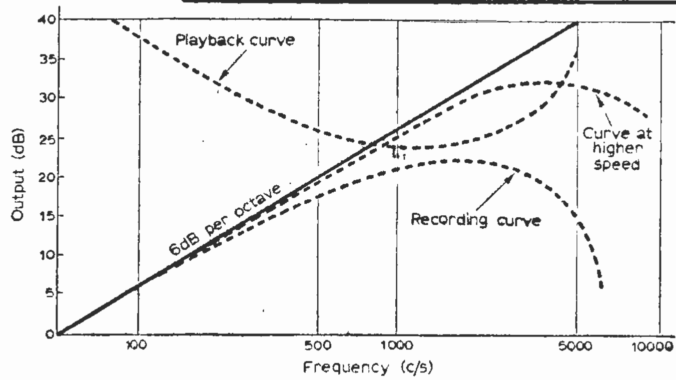

Fig. 5: Recording and playback curves, showing effect of h.f. loss in recording which must be compensated by a boost during playback. At higher speed the loss is less. 6dB octave curve is ideal response.

recognised standard. For a fuller explanation see *Standards* and *Pre-emphasis.*

Equalisation is necessary to enable interchange of tapes and tape recorders. It is defined by the time constant of the attenuating section of the circuit. Examples, depending on the speed of the replayed tape are given in Table 1, which also shows the "turnover frequency".

Equalisation standards were revised a year ago and it will be noted that there are three distinct sets of standards, the CCIR, DIN and NARTB. The previous standard, generally accepted, for 3¾in./sec. tape speed was 200 microseconds, now revised to the DIN standard of 140 microseconds, with a turnover frequency at the point where the reactance of the capacitative arm of the attenuator equals the resistance of 1·3kc/s and a low-frequency roll-off of 3.180 microseconds (at 30c/s).

Fig. 5 shows typical equalisation curves. Low-frequency roll-off is generally recognised nowadays as machines in the domestic class rarely reproduce frequencies below this point.

Replaying tapes recorded to one standard on a machine equalised to another will require some modification to the amplifier response to achieve a "level" output. Thus American tapes, recorded to NARTB standards, replayed on European machines, equalised to CCIR standards, will tend to sound over-brilliant and with some bass accentuation.

Conversely CCIR recorded tapes replayed on machines with NARTB standards, having bass and treble cut to compensate for the recording pre-emphasis, will tend to sound weak in both treble and bass.

ERASE

One virtue of the tape recording medium is the possibility of "cleaning off" a tape for re-use. This is termed "erasure" and consists of destroying the pattern of magnetism on the tape and reverting to the normal random disposition of magnetic domains.

Erasure is effected by the application of a strong and varying field as the tape passes a point prior to the recording head.

The method of applying erasure may be by passing the tape across a permanent magnet, or magnets, or by applying the field from the gap of a d.c. or a.c. energised head. The last-mentioned is preferable, as d.c. or permanent magnet erasure tends to build up a unidirectional magnetism, resulting in a hiss.

The waveform should be symmetrical, and is often derived from the common oscillator used to provide the bias waveform.

Bulk erasure is a method of removing the modulation from a tape in one action by inserting the complete spool in a strong field. Special apparatus for this purpose has been developed and is widely used. The applied a.c. field is made to diminish regularly, to prevent residual magnetism leaving a high background level.

PART TWO NEXT MONTH

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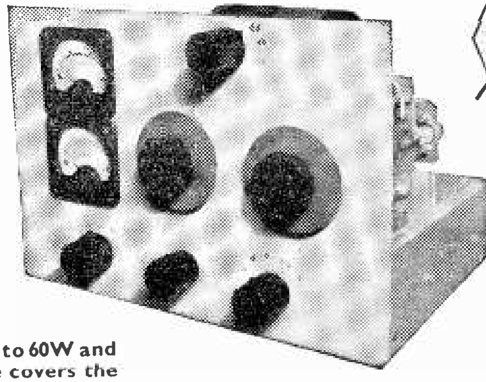
HAM FEATURE

3 BAND TRANSMITTER



by G3OGR

THE 6146 will take an input of up to 60W and the transmitter described here covers the 80, 40 and 20m bands. The building cost is not very great and can be further reduced by simplifications described later if required. The transmitter itself is crystal controlled but it can readily be used with a v.f.o.

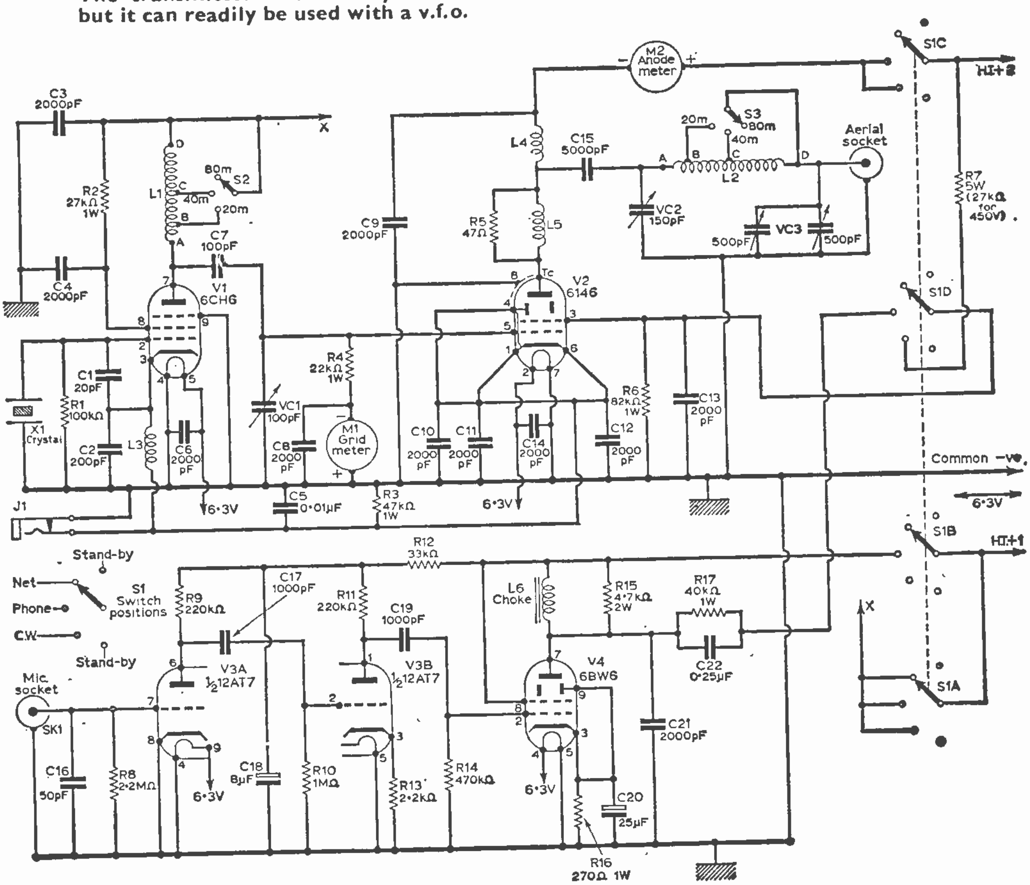


Fig. 1. The transmitter circuit complete except for the power supply.

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Fig. 1 shows the transmitter circuit. A 6CH6 is used as an oscillator (V1) which gives high harmonic output when wanted, so that 3·5Mc/s crystals may be used for the 80, 40 and 20m bands. Some 160m band crystals are also satisfactory, especially for 80m.

L1 is the oscillator anode coil switched to cover the 80, 40 and 20m bands and tuned by the 100pF variable capacitor VC1, which also allows grid drive to be adjusted to obtain suitable grid current. It was found that more than sufficient grid current was available on all bands, so this capacitor is normally tuned somewhat off the resonant point. This has no effect on oscillator frequency.

The 6146 (V2) runs with about 2mA to 2·5mA grid current, providing about 40-50V bias developed across the 22kΩ grid resistor R4. This valve has three cathode and beam plate pins each grounded for r.f. by a 2000pF capacitor to chassis (C10-12). For c.w. operation the key plug is inserted in closed-circuit jack J1, the cathodes of both stages being keyed. For 'phone transmission the plug is withdrawn or the key shorted.

L2 is the pi tank coil for three-band coverage and this can work directly into many aerials. L5 is an anti-parasitic choke. Anode current is checked with the anode meter M2. For a 600V h.t. supply the anode current of the 6146 is listed as 112mA, providing an input of 67W. It is, however, probably as well to restrict the anode current to 100mA. This would give an input of 60W at 600V or 50W at 500V and so on. Good results have been obtained with a 275V h.t. supply or input of 27·5W.

In order to avoid the necessity of providing a large modulator, screen grid modulation is used. A single 6BW6 (V4 in the circuit diagram) will easily supply enough audio power for this type of modulation, excess being dissipated in the 4·7kΩ resistor R15.

When using 'phone it is necessary to reduce the power amplifier (6146) input to about one-half that which can be run on c.w. This is a general rule with screen grid modulated systems. The transmitter thus has an input of up to about 30W on 'phone for average work and 60W on c.w., which is adequate for much DX working.

The modulator section is very straightforward and has enough gain for a crystal microphone of reasonable output. Component values have been chosen to give some treble and bass cut.

Full control switching is furnished by a four-pole, five-way switch S1, the positions of which are shown in Fig. 1. Each "standby" position switches off all circuits but leaves the heaters running. These positions are used while receiving. The second standby position is merely to allow the operator to switch from C.W. to Standby without passing through the 'phone and net positions.

With the switch at "net" h.t. is applied to the oscillator only, allowing tuning up for grid current and netting the receiver on the transmitter frequency. (With a v.f.o. this allows the v.f.o. to be tuned to the receiver frequency also.)

With the switch set for "'phone" the modulator is brought into use and h.t. applied to the p.a. anode. Choke modulation of the screen grid is by the 6BW6, with the d.c. potential derived from the modulator high-tension supply.

When the switch is in the "c.w." position the V2 screen grid is supplied from the high-voltage supply through a dropping resistor chosen to allow full input. This resistor can usually be 27kΩ but is selected as described later.

Metering

As grid and anode currents are very important in setting up, two meters are included. A single meter with grid/anode switching is sometimes employed but the use of separate meters avoids the need for repeated switching from grid to anode circuits and avoids errors such as looking for anode current while the single meter is switched to read grid current.

Two "surplus" meters were used and suitable thermo-couple meters can be purchased at very low cost. When the thermo-couple is removed these instruments usually have a full-scale reading of about 2mA to 5mA. They are thus readily shunted to allow suitable scales to be drawn. The latter can be on thin card cemented to the old dial.

For grid current a 5mA meter is suitable. The one used was 2mA full scale, shunted for 4mA full scale. For anode a 100mA, 150mA or 200mA instrument is suitable or a smaller meter shunted to 150mA or 200mA full scale.

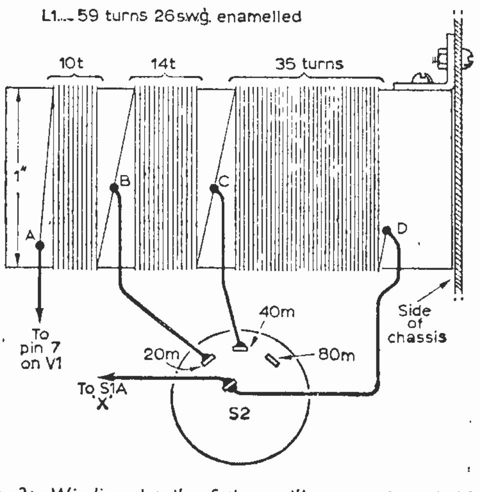

Fig. 2: Winding details of the oscillator anode coil, L1.

Oscillator Stage V1

The oscillator anode coil L1 is shown in Fig. 2 and is wound with 26s.w.g. enamelled wire on a paxolin or similar former 1in. in diameter and 2½in. long. A space of about 3/16in. is left between each section. All turns are in the same direction.

Ends A and D are anchored by passing them through holes. Taps B and C are made by baring and twisting the wire and soldering the loop. Switching is so arranged that ten turns are in circuit for 20m, 24 turns for 40m and the whole 59 turns for 80m.

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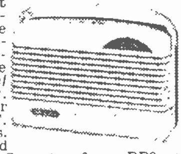

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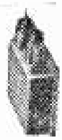

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4in. Triple play, 900ft., Mylar base	17	6	7in. Standard play, 1,200ft., Mylar base	12	6
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5in. Long play, 900ft., Acetate base	10	0	7in. Double play, 2,400ft., Mylar base	25	0
5in. Standard play, 600ft., PVC base	8	6	7in. Long play, 1,800ft., Acetate base	15	0
5in. Triple play, 1,800ft., Mylar base	35	0	7in. Triple play, 3,600ft., Mylar base	58	6
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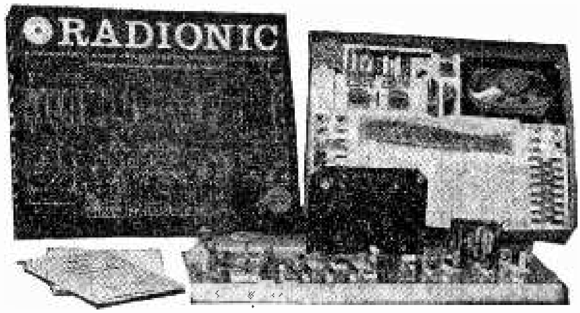

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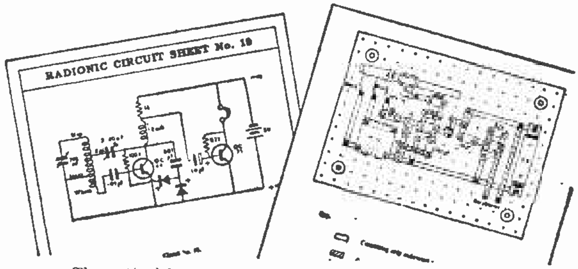

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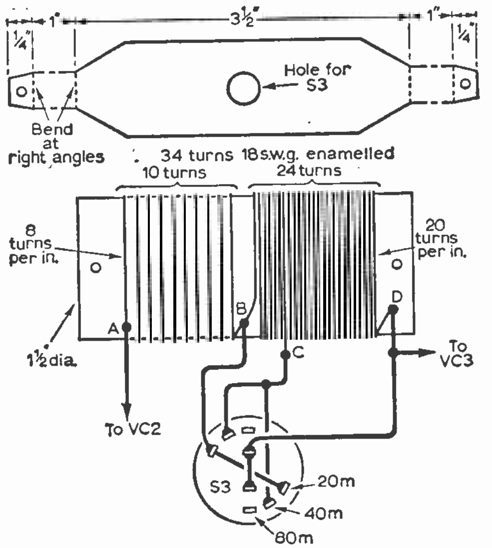

Fig. 3: Winding details of L2, the p.a. tank coil, and dimensions of a bracket to mount it in association with S3.

The maximum effective capacitance across the coil is 50pF and tuning should be correct with the 100pF capacitor nearly open for 20m and 40m and about one-half closed for 80m. If 3·5Mc/s and 7Mc/s crystals are used it is not possible to tune this circuit to unwanted harmonics. L3 is a 2·5mH 60mA r.f. choke.

P.A. Tank Coil L2

This is wound on an insulated tube 3¼in. long and 1½in. diameter as shown in Fig. 3. Beginning about ⅛in. from one end, the 18 s.w.g. wire is anchored in hole A and ten turns are wound at eight turns per inch. The wire is secured at B. A further ten turns are then wound and a small loop made at C. After 14 more turns the wire is fixed at D.

The aluminium bracket shown in Fig. 3 holds the coil to the switch. It is cut and bent as shown and fitted to the coil with 6BA bolts, S3 already being in the central hole. Stout connections are then soldered to S3. They are as short as possible. S3 has two three-way sets of contacts and they are used in parallel.

The completed tank coil assembly can be attached to the panel by the securing nut of S3 and short connections taken from A to VC1 and D to VC3.

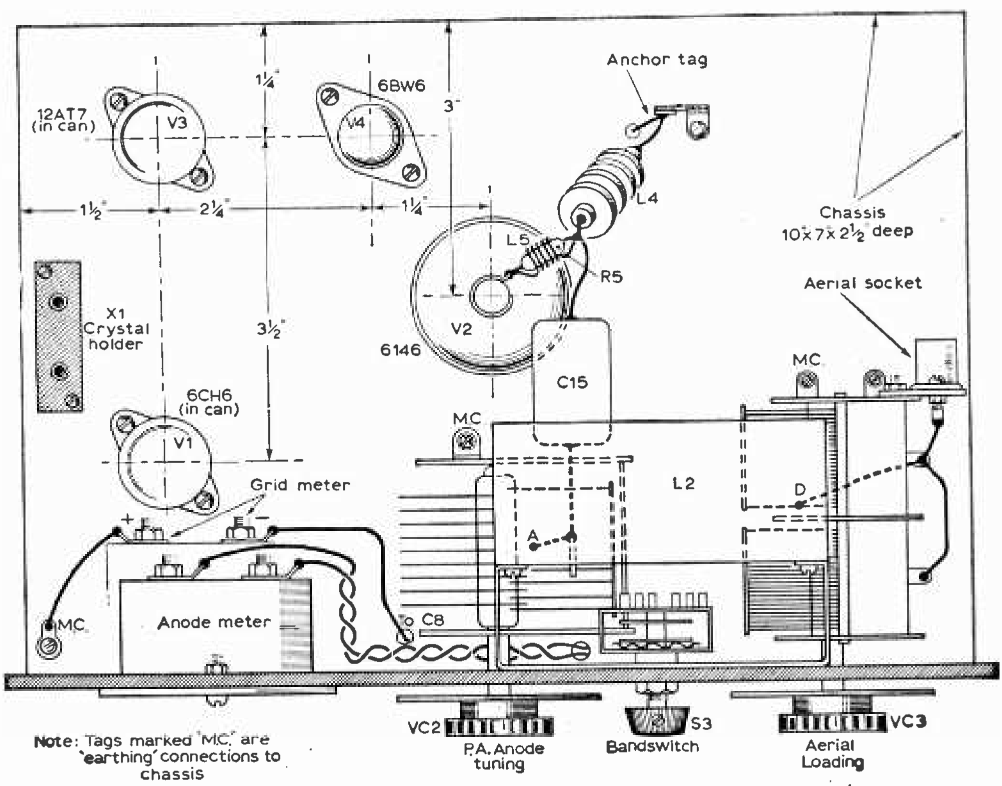

Fig. 4: Above chassis layout where most of the larger components are mounted.

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Above Chassis

The chassis measures about 10 x 7 x 2½in. and the layout is shown in Fig. 4. The crystal holder can be for ½in. or ¾in. spacing crystals or both. Valveholders can be located from the dimensions given.

VC2 must have wide spacing to avoid sparking over; a spacing of 0·05in. between plates is more than adequate for 600V. For 40 and 20m 100pF will suffice but 150pF is required for 80m and 200pF would be better.

VC3 is a receiver type capacitor and should have a total of at least 1,000pF (two-gang 500pF with sections in parallel). For low impedance aerials on 80m 1,500pF is better (three-gang capacitor) but 1,000pF is easily sufficient for the 20 and 40m bands.

Both capacitors are bolted to the chassis and short earth returns provided for their rotor contacts. A small plate carrying a coaxial socket is bolted to the frame of VC3 and allows a coaxial feeder from an aerial to be plugged in. The socket outer sleeve is common to the chassis. This socket is not placed on the rear of the chassis as complete segregation of the p.a. anode and aerial circuit from other wiring would then be difficult.

The front panel measures 10½ x 7½in. It can be of hardboard or aluminium. Holes are required for the meters, capacitors and S3. S1, S2 and VC1 hold the panel to the chassis. L4 and C15 are wired together and to VC2 (Fig. 4). The assembled tank coil unit can then be fixed by S3 and a short lead taken from A on the coil to VC2 fixed plates. D on the coil is connected to the fixed plates of VC3. L4 is a 2·5mH r.f. choke rated at 150mA d.c.

The anti-parasitic choke L5 consists of five turns of 20 s.w.g. wire with an outside diameter of ⅜in. and a total length of ½in. When the choke is made R5 is placed inside it and connected to choke and anode cap with the shortest possible leads.

Twin twisted leads from the anode current meter pass through a hole nearly under S3 to C9 and the switch. The grid meter is connected from chassis to C8 as in Fig. 4. The lead from L4 goes through the chassis to C9, which is immediately below.

S3 control knob should have band positions marked. It is convenient to use 0-100 or similar dials for p.a. anode tuning and aerial loading (VC2 and VC3) but control knobs without dials are also perfectly satisfactory. Screening cans should be provided for the 12AT7 and 6CH6.

Underside of Chassis

Positions of components and leads are shown in Fig. 5 and the transmitter may conveniently be

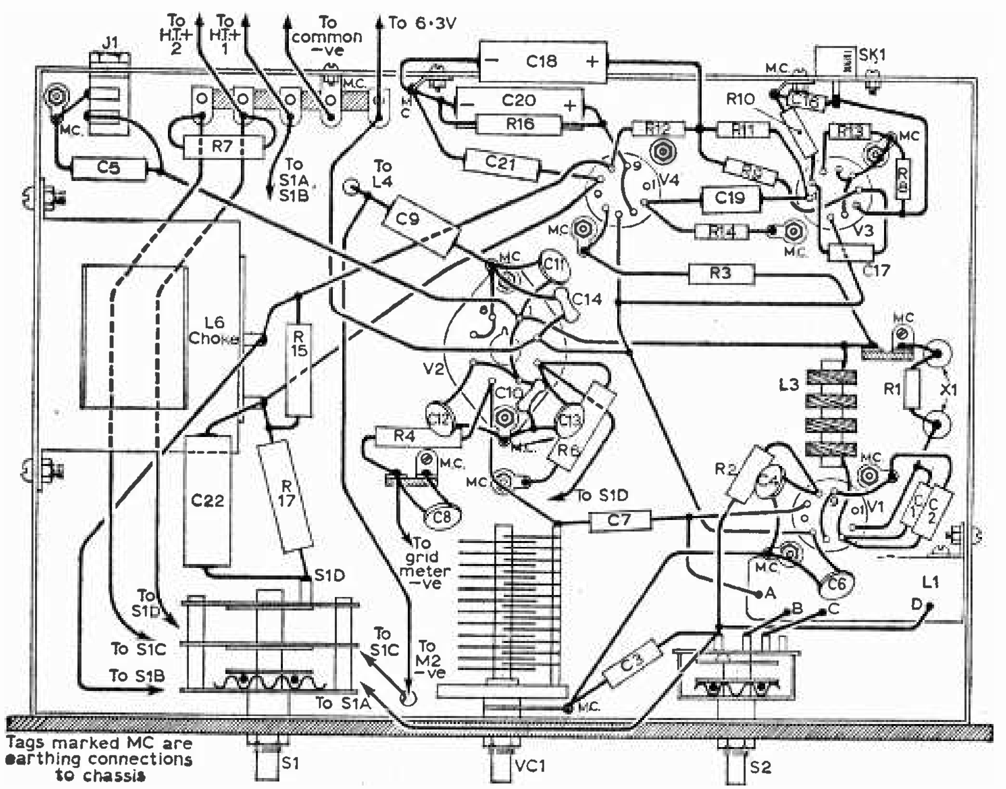

Fig. 5: Complete underchassis wiring, except for the switch, S1.

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wired in stages. For r.f. circuits 18 or 20 s.w.g. wire is used. Heater and h.t. wiring should run against the chassis and be adequately insulated. It will be helpful to use sleeving or insulated wire of several colours, especially to identify meter, h.t. and switch circuits.

6CH6 Oscillator

Coil L1 is left until wiring is otherwise finished here. C4 and C6 are disc ceramic capacitors. L3 and R3 are anchored to an insulated tag near the crystal holder. Points MC are tags bolted to the chassis in the usual way.

Connections to C7 and C3 should be as short as possible. L1 is held with a bracket bolted about 1in. from the lower edge of the chassis and 2½in. from the panel.

The oscillator may be tested, if desired, by applying 6·3V a.c. to the heaters and about 250V d.c. to point X (see Fig. 1). With valve and crystal in, current should drop to about 20mA as

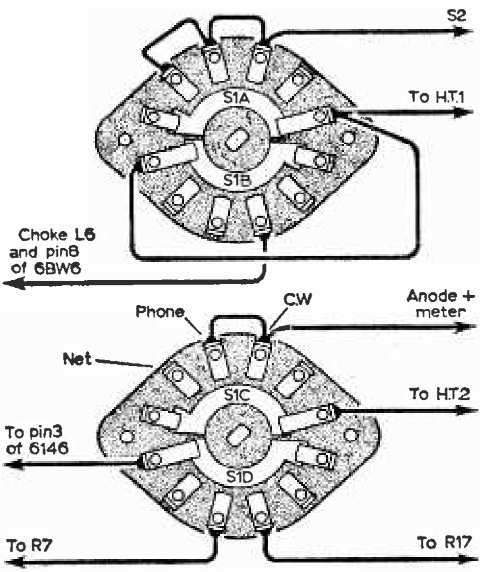

Fig. 6: Connections to the four poles of the function switch, S1.

oscillation commences. The carrier may be detected with a receiver or a tuned wavemeter with bulb indicator will glow if near L1, with S2 and VC1 adjusted for each band.

Power Amplifier

C10, C11, C12 and C13 are disc capacitors connected with very short leads. R4 is clear of the chassis and anchored at a tag providing the grid meter negative connecting point. C8 is a disc capacitor. The meter leads run against the chassis and anode meter leads are clear of the grid meter connections and pass through a separate hole near the function switch S1.

When no plug is inserted in the key jack, L3 and the p.a. cathode circuit are returned to chassis by closing of the jack contacts. Efficient grounding for r.f. by C10, C11 and C12, as shown, is necessary to avoid unwanted oscillation.

Double Triode

C17 and C19 should be mica or of equal quality as any slight leakage will upset bias on the second triode section (V3B) or on the 6BW6 (V4). C18 is displaced in Fig. 5 to show connections but lies over R16.

The microphone has the usual screened lead terminating in a coaxial plug. The inexpensive type of general purpose crystal mike should be satisfactory. It may be necessary to keep the microphone and its lead reasonably clear of the aerial.

6BW6 Output

The 6BW6 audio output stage or modulator V4 is very straightforward. For the anode choke L6 a speaker output transformer is most suitable. The type intended for a mains pentode, rated at 60mA or more and probably with a ratio of about 40:1, is ideal. The secondary is not used.

The optimum load of the 6BW6 is about 5kΩ, but the modulating impedance of the screen grid is much higher and not uniform throughout the audio cycle. As more power is available than required a 4·7kΩ resistor R15 is thus added to supply a stable load. The 6BW6 anode connection runs near the back of chassis and tag strip, clear of r.f. circuits, as in Fig. 5.

The modulator may be tested, if required, by temporarily connecting a loudspeaker to the transformer secondary. R15 may be disconnected. Speech should be clear and distinct. The microphone must be well away from the loudspeaker to avoid feedback howling.

Function Switch S1

This is four-pole, five-way, but no circuits have to be completed at either extreme position. Two two-pole, four-way wafers were actually used, assembled on a cut-down spindle from an old switch, and with a stop removed so that a second "off" position was obtained.

Fig. 6 shows the wiring for a new switch, consisting of two wafers, each having two-poles with five-ways. Lengths of coloured flex or other insulated wire can be soldered on before mounting the switch in the chassis.

Switching can be checked without supplies and valves. High tension should reach the 6CH6 anode (pin 7) in all but "standby" positions. With the switch at "phone" h.t.+1 should be connected to pin 8 of the 6BW6 holder and through R17 to pin 3 of the 6146 holder. H.T.+2 also goes to 6146 anode. When the switch is at "c.w." h.t.+2 remains connected to the 6146 anode but pin 3 is now fed through R7 from h.t.+2. In no circumstances must switching be such that screen grid voltage is present on the 6146 when the anode voltage is absent.

Power Supplies

The heaters require 3·2A at 6·3V, so a 3½A or 4A secondary will do well. For h.t.+1 a 250V receiver type power pack is ideal. A supply of about 220V to 270V at 60mA is sufficient.

The voltage applied at h.t.+2 depends on the

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power supplies which may be available and the input wanted. It is a good plan to make an initial test or tuning up with reduced voltage, such as can be obtained from a 250V supply, or by joining h.t.+2 to h.t.+1.

About 100mA at 450V to 600V falls easily within the rating of a transformer of moderate size and a suitable power supply is shown in Fig. 7. R7 controls the screen grid voltage when working on c.w. and it may be reduced to 10kΩ or less for a 300V supply. The screen voltage of V2 should not exceed 250V or 400V with key open. A screen voltage of about 150V is generally suitable for c.w. current, being about 10mA. Screen dissipation (volts x current) should not exceed 3W.

If there is any doubt the best solution is to begin with a high-value screen grid resistor and reduce this after checking the screen grid voltage and current with a meter. For 'phone the screen voltage is much lower as this is necessary for correct modulation.

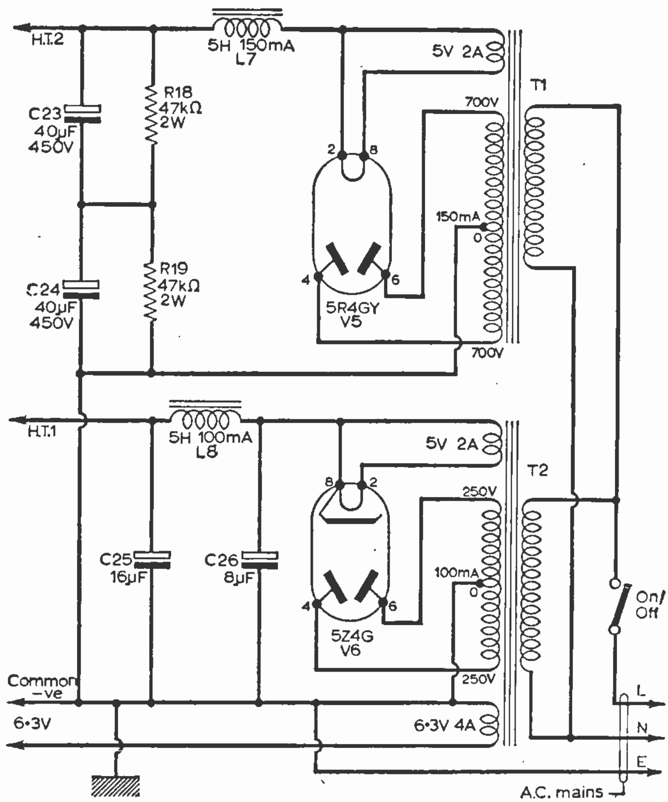

Fig. 7: Circuit of a suitable power supply for the transmitter.

Tuning Up

First tests should be made with the switch at "Net". A 3·5Mc/s band crystal can be inserted and adequate grid current should be found on each band by adjusting VC1. Grid current should not be allowed to exceed 3·5mA and should generally be between 2mA and 2·5mA. S2 is always switched to the band upon which output is wanted, so that the final amplifier is not used as a doubler.

A 7Mc/s band crystal is useful to check 14Mc/s tuning to make sure the third harmonic of 3·5Mc/s (10·5Mc/s) is not selected by VC1 in error. Or a bulb indicator meter or receiver can be used. The 14Mc/s band should peak up with VC1 nearly open.

An initial test can be made with power delivered into a 60W household lamp connected to the aerial socket and chassis by a few feet of twin flex. With S2 and S3 at 80 close VC2 and VC3 and tune for grid current at "Net". The function switch is then turned to "'Phone" and VC2 is immediately adjusted to find the dip in anode current as shown by the anode meter. The current is increased by opening VC3 and retuning with VC2. VC2 is *always* tuned for minimum anode current, corresponding to maximum r.f. output.

Grid current is readjusted if necessary by VC1. When the p.a. has been tuned to resonance the switch can be turned to "c.w." if wanted (key closed). As loading progresses in the way described the lamp will light with increasing brilliance. For c.w. the anode current may run up to 100mA.

Loading the transmitter into an aerial follows the same method. A coaxial-fed dipole can be fed directly from the transmitter. Various end-fed aerials can also be used in this way with a good earth to transmitter chassis. For resonant end-fed aerials some type of aerial tuner placed between aerial and transmitter will be almost essential.

Crystal Frequencies

Crystals with fundamental and harmonics falling within the band limits may be used on all three bands but some crystal frequencies will not supply harmonics within the bands. For 7Mc/s and 14Mc/s, 7Mc/s crystals may be used, while 3·5Mc/s crystals will do for 3·5, 7 and 14Mc/s. Any 1·75 to 1·9Mc/s crystals will do for 3·5-3·8Mc/s also.

'Phone Loading

For best speech quality with screen grid modulation the p.a. must be heavily loaded. To accomplish this the screen voltage of V2 is kept low by R17 and loading with the pi-tank is continued until the dip in anode current on rotating VC2 has become small. An input of about

—continued on page 321

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on the Short Waves

MONTHLY NEWS FOR DX LISTENERS

All times are in G.M.T. All frequencies are in kc/s.

The Broadcast Bands—by John Guttridge

ONE station getting its schedule out well in advance is Radio Moscow. Until the end of August English for Europe is aired at 0700—0730 on 11,830/9,710/9,600/9,480/7,240; 1200—1300 on 15,490/11,930/11,830/11,700/9,780; 1900—1930 on 9,710/9,480/7,340/6,050/1,320; 2000—2030 on 9,710/9,480/7,160/7,340/6,050/1,380; 2100—2200 on 9,710/7,340/7,260/6,050/1,490; 2200—2230 on 9,710/7,340/6,050/1,490/1,380/1,320. In September/October the following changes are made: 0700—0730, 11,830 dropped; 1900—1930, 2000—2030, 7,280/6,170 replace 9,710/9,480; 2100—2230, 7,280 replaces 9,710.

Frequencies used for several English transmissions were changed by *Radio Prague* for its summer schedule. Changes are: 0100—0155, 0330—0425 on 5,930/7,120/7,345/9,795/11,990; 0300—0355 on 15,285/15,448/17,825; 0800—0855 on 6,055/9,503/15,235/15,285/21,450. On its QSL, says D. Hill, date, time and metre band are given.

T. Robinson, Liverpool, reports that *Radio Nederland* (P.O.B. 222, Hilversum) has a DX programme at 1600 on Fridays and a request programme on Saturdays. In London 15,425 gives better reception than 11,730 for the 2100—2150 English transmission but suffers from severe interference from A.F.R.T.S. New York on 15,430.

A. Waddelow, Norwich, has heard the Bonaire relay with Dutch at 2100 on 15,290 giving SINPO 33433. He reports full verification details from *Radio Denmark* (Radio House, Copenhagen V), *Radio Andorra* (Roc des Anelletes, Andorra-la-Vielle, Andorra—return postage required), *Radio Berlin International* (Berlin-Oberschoneweide, Nalepastrasse 18-50, German Democratic Republic), and *Radio Belgrade*.

The 1315—1400 English transmission to South-East Asia from *Emissova Nacional de Rediodiffusao* (Rua Sao Marcal, IA, Lisbon) is now on 21,495/17,895. The BBC now has an English transmission to East Africa from 1800—1830 on 15,420.

D. Hill mentions two English transmissions from *Radio Bucharest* (P.O.B. 111, Bucharest) from 1930—2030 on 9,570/9,510/7,225 and 2230—2300 on 7,195/6,190.

Middle Eastern stations reported this month are *Radio Ankara*, *Kol Israel* (Broadcasting House, Jerusalem, Israel), *Radio Baghdad* (Salihiya, Baghdad), *Radio Iran* (Ministry of Information, Meydan Ark, Teheran), and Saudi Arabian Broadcasting (Ministry of Information, Airport Road, Jeddah). Paul Harris, Elgin, says that English from Kol Israel is now from 2045—2115 on 9,009/9,625/9,725. Ankara now has French at 1930—1945 and German at 1800—1815 on 15,160. A. Waddelow reports English on this frequency at 2200—2230 (SINPO 44441).

E. Conduit, Wolverhampton, has had a QSL with date and frequency only from Saudi Arabia and with frequency only from Baghdad, although W. Smith had a yellow card giving date and frequency from Baghdad. Alex Bushby, Glasgow, reports a letter giving no details from Iran.

Two African stations, *Radiodiffusion de la Republique Democratique du Congo* (B.P. 3171, Leopoldville) and the Nigerian Broadcasting Corporation (Broadcasting House, Lagos) are reported by R. Howard, Stockport. The former he has heard between 2030—2200 on 11,795. Nigeria was logged in English between 2130—2205 on 11,900/15,255.

Cairo Radio (U.A.R. Broadcasting and TV, Maspero) has changed the language segments for its transmissions on 17,920 to East and Central Africa. They are now Nianga 1545, Shona 1615, Somali 1645 and English 1745—2030.

According to Paul Harris, *Radiodiffusion Television, Ivorienne* (B.P. 2261, Abidjan, Ivory Coast), has replaced its International Network frequency of 11,820 by 6,015. He has heard this frequency at 2200—2400 and presumes it carries the 1830—1900 English transmissions on weekdays.

A. Wildsmith, Manchester, advises those who have written to *Radio Ghana* (Broadcasting House, P.O. Box 1633, Accra) and have not received a reply not to despair. He has just received a verification after five months.

Conflicting reports on the QSL of *All India Radio* (P.O. Box 500, New Delhi) from E. Conduit and D. Hill. The former's card had the date only, whilst the latter's had all details.

Finally three reports on *Radio Pyongyang* (Pyongyang, North Korea). Paul Harris has heard English at 1800—1900 on 10,380 and 1900—2000 on 6,540/7,379 with 7,580 being announced as well. According to announcements, he says, other transmissions are 1000—1100, 7,580; 1100—1200, 9,750; 2400—0100, 17,520; 0300—0400, 9,570. M. Clark, Cheltenham, has heard the station on 6,500 at 1900 when it says it is using 7,389/7,595/8,333/10,381. A transmission from 1000—1200 on 6,061/7,353 was also announced.

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The Amateur Bands—by David Gibson G3JDG

ONCE more unto the h.f. bands, dear friends, and verily DX shall be thine. Unbelievers should listen on 20m, where thousands of stations from almost everywhere are battling it out.

It is fair to reckon that all those not on 20 are on 15 and this band seems more consistent these days. It stays open for longer and although there is often some QSB it's on the up and up, certainly as regards reliability.

Poor old 10? Not any more—half Europe gets on at the weekends and the African continent shows itself, too. Those with directional antennas on this band should have very full logs.

TWENTY

Let's start with a bang. Here is the pick of the log from **BRS26813**, of Cheltenham, who uses an S640 and HRO5T with a 90ft longwire. All c.w.: AC4H (Tibet), CN8MH, CR4AE, 4BC; EL2AE, 2AM; ET3GO, 3USA; DU1OR (Philippines), FG7XS (Guadeloupe), FM7WH (Martinique), HI4ARM, HK3RQ, HP1BR, HZ3TYQ (Saudi Arabia), JA1BZR, 1FHK, 1DU, 1ZZ, 7AB, 7ARZ; JT1AG, KH6DSW, FLK, IJ, TD, WU; KM6DJ, KP4ARS, LA4EJ/P (Jan Meyen Island), LU2DAW, 8EE; OA4EM, OY7ML (Faroes), PY1BTX, 2ON; PJ2CZ, SU1IM, UL7PY, UN1BR, VE8CO, VK2EO, 2OO; VO2NA, VP5BH/MM, 9EP; VU2GW, 2LI; W5IUW/VP9, 6JNX; XE1OE, YV1AD, 4MC, 5AAQ, 5ACP, 5BHI; ZD8BC, ZE8TT, ZP5LS, ZS6AJQ, 4U1ITU, 4X4HK, MZ, QA; 5A3TT, 5Z4DW, 6Y5MJ, XG; 7X2ARA, 7X3CT, 9J2GJ.

Which goes to show that if it emits r.f. then it can be found on 14Mc/s and BRS26813 will hear it! Well done, Bob—when do you sleep?

Norman Ponsford (Devon) found these on his t.r.f. CR45 with 60ft longwire, all on a.m.: HB9VW, K3NHL, K2YLM, OE3CL, PY7GV, SVØWBB, WA4IIO, 4X4FA, 5Z4AQ, 5Z4ERR. **W. Langham** (Somerset) got these on a domestic receiver and 75ft longwire: I1BUG, LZ1KBD, PAØPAN, UA9KCF, UO5KBR, YU6BC, 4X4OS, all a.m.

Messrs. **McWhirter** and **Weare** are the ops at Derby School Signals Platoon and pulled in these on an R107 with 200ft longwire: K2ZRK/P, SP4AUQ, UA2KBD, VE4SA, W2RKV, W8HCP (all on a.m.), ET3USA, UA1KIB, UA9MX, UN1BR, UW3FV(?) on c.w.

FIFTEEN

Stephen Beale (London), using the P.W. t.r.f. (May, 1964) and a 66ft. longwire, got these on a.m.: CR6BY, EA8ER, LA4EI, SV1DL, ZC4MO, 4X4QR, 5A1TK, 5A5TE, 5N2KOB, 9G1MR, 9J2DT, 9L1WN, 9Q5DL, 9X5RZ.

D. F. Carrington (Derby) pulled in on his HE30 and 68ft longwire with 14ft vertical whip at far end: CT3AQ (Madeira), EL5CG, EA6GL, PY1NBA, PY1AGP, SVØWO, W9ACU, ZC4KW, 4X4QR, 5A1TK, 9X5WTB and 9Q5's DL, US, AWB, RB, AQ and AD.

Mike Silverstein (London), CR100 and 132ft longwire, hooked CR6BY, CR7FR, HI8BGA, JA1GTN, KZ5BE, OA4OS, PY1BYS, VP4LE, VS9ANR, ZE7JR, 9X5RZ.

TEN

Back in circulation! Why, we have even been getting logs!

George Owen (Bristol), using a five-valve t.r.f. and vertical joystick, leads the field with CE4FB, CR4AO, BC; CT1CN, MZ, ILX, IOF, LIM; EA3PA, EL2L, F2SI, HB9FMA, I1SO, BIW, IYJ, MTO, PAI, WRR; KC4CKC, OK1ABN, ZD8JC, ZE1JJ, 5A4HR, 5Z4AA, 9Q5AA.

THE L.F. BANDS

Only the real stalwarts stick at it. On 7Mc/s **Bob Garvy** (Gloucester) had these on his HRO and 90ft longwire, all on c.w.: DJ3ZXA, EI9TF, OK4ADX, PY7AOD, SM7ACR, UA1KAL, VP2LZ, ZS6DF.

On 3·5Mc/s **A. Rolfe** (Halstead) got DJ8RS, DL2UZ, DL6VU, F2WW, F3ZK, PAØPAL, SM3YF/MM using an R109 and 12ft whip. And an unsigned log from Preston mentions DJ6QT, DL6ME, EI4R, GC2AZ, OZ3IH, SM7WW, VE1IE.

Top band almost abandoned and the only letter we had was from **W. Smith** (Staffs) with a large list of G stations heard.

IN GENERAL

The coat-hanger and cuff-link gang are still at it! **BRS26325** (Dundee) used a fireguard on 21Mc/s for 5A1TK, CT1LJ, 9M4LP, EA8EH. **M. Carter** (North Wales) used a ground-floor window frame into an HRO for 14Mc/s s.s.b.: EP2DS, KH6BK, KR6AAC, MP4BCC, OD5BZ, HV1CN, HBØAFM, HL9PK, KP4CL, VE6TP, W6VPY, W7MKI, ZS6XB, 5N2AAC, 9M2SR. Anybody thought of the little strip of metal foil around cellophane wrapped cigarettes? (Watch it, they resonate at 947Mc/s!)

ZB1 (Malta) is now 9H1 for sure. The Western Carolines and Kure Islands are on and the calls to listen for KC6 and KH6 respectively. 4U1ITU is the headquarters station of the International A.R.C. located in Geneva. Others rumoured to be squirting r.f. about are South Georgia VP8, Christmas Island and Cocos Keeling both VK9, ZD8 on Ascension Island. Crete SVØWGG high end of 20 on s.s.b., Willis Island VK4 and Samoa KS6. For Top-band addicts there is a beacon on 1.801Mc/s in South Africa signing ZE1AZD, reports very much appreciated.

What a lot of field days, British, American and now Korean. The Korean effort will be July 3rd-4th on 80, 40, 20 and 15m. Callsigns to listen for are HM and HL. Other activities on in July are: 4th, 144Mc/s portable contests; 11th, three mobile rallies, tenth anniversary rally, South Shields rally and Torbay mobile rally; 17th-18th, 1,296Mc/s tests (you've just got time to wind a set of coils); 25th, 70Mc/s portable contest and Cornish mobile rally. August 1st, SLADE D/F qualifying event. Good hunting and don't forget to drop me a line on what's coming in at your QTH.

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FOR THE BEGINNER

Practical Substitutes

by M. L. Michaelis, M.A.

THE lists of parts for constructional articles are those found satisfactory in the prototypes and available at the time of publication. Many queries which the editor receives show that many beginners regard a published list of parts as being strictly binding down to the last detail.

Whilst this may be true for special projects a considerable latitude normally exists and the informed constructor can use his discretion regarding substitution of components already in his possession or more readily available.

It is the aim of this article to help readers in making on-the-spot substitute decisions if a dealer does not happen to have the exact item desired in stock. The information given will also serve many other useful practical purposes, such as the selection of modern replacements for defective components in obsolete equipment, or just to make better use of items available in the junkbox instead of making new purchases.

RESISTOR AND CAPACITOR VALUES

A frequent type of enquiry concerns apparently strange component values, such as "a capacitor of 0·056μF". Whilst the familiar sequence of preferred values is quite commonplace for resistors, it is less familiar in Britain for capacitors. However, our example of a 0·056μF capacitor simply bears the same relation to a more familiar 0·05μF capacitor as does a 56kΩ resistor to an older-type 50kΩ resistor. Such values are mutually interchangeable unless very critical conditions are involved and which the author of an article would point out. Unless otherwise stated, the constructor may assume that a $\pm 20\%$ tolerance is implied for resistor and capacitor component values. This obviously permits mutual interchange of a 0·05μF capacitor with a 0·047μF or 0·056μF preferred-value capacitor. (The 0·05μF$\pm$20% could, of course, be anything between 0·04–0·06μF.)

If a preferred-value component is outside the tolerance of a near old-type component, one should select a parallel combination of two standard value capacitors to get closer to the specified value. Thus, given $\pm 20\%$ tolerance, the correct substitute for a 0·68μF capacitor is a parallel combination of a 0·5μF and a 0·2μF.

Similarly a 50kΩ resistor can generally replace a 47kΩ or 56kΩ resistor, but a 68kΩ resistor requires either a 75kΩ resistor as substitute, or various combinations of two resistors, such as a 50kΩ and a 20kΩ component in series, or two 150kΩ resistors in parallel. Note that the individual wattage ratings of series or parallel combinations of two resistors can be halved only if the individual values are equal or very nearly equal.

In cases where resistor or capacitor substitutions of the kind discussed above lead to a residual discrepancy close to the tolerance limit, e.g. when substituting a 10kΩ resistor for a 12kΩ resistor, it is advisable to measure the actual values. Judicious selection can often lead to a closer approach to the specified value and will avoid additive tolerance errors greater than the tolerance limit. However, a large number of experimental circuits remain uncritical even under the latter circumstances.

The important thing to remember is that, generally speaking, any value within the tolerance of the specified value will be acceptable.

CRITICAL CAPACITOR AND RESISTOR VALUES

Resistor values are frequently more critical when they constitute parts of bleeder networks which determine the operating point of a valve or transistor, or when they are parts of calibrated shunts, multipliers, attenuators or other measuring circuits.

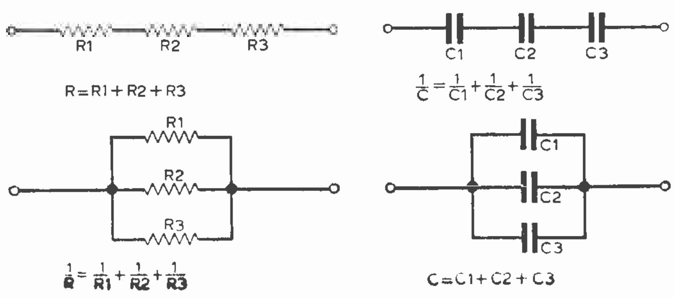

Fig. 1: Series and parallel combinations of resistors and capacitors

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Capacitor values are critical in tuned r.f. and i.f. circuits and in oscillator padding positions. Even then, substitutions of combinations of two or even more components in series or parallel to make up the exact specified value are generally permissible.

Note that capacitors in parallel and resistors in series are added whereas capacitors in series and resistors in parallel are equal to the reciprocal of the sum of the individual reciprocals, see Fig. 1.

ELECTROLYTICS

It is normally permissible to substitute non-electrolytic capacitors of the same value for specified electrolytics, if space permits, but electrolytic capacitors cannot be substituted for paper or foil capacitors when insulation and capacitance stability are important factors.

Thus it is usually unsatisfactory to substitute an electrolytic for a paper or metallised foil component in an anode-grid coupling circuit since leakage of the electrolytic would lead to an intolerable displacement of the operating point of the subsequent stage. Very large metallised foil capacitors in long-period high-impedance timing circuits (minutes or hours) cannot be replaced by electrolytics. However, low-impedance transistorised timing equipment does often use low-voltage electrolytics. The accuracy of such circuits, or at least their long-term stability, nevertheless tends to be inferior.

Electrolytic capacitors are relatively coarse, inaccurate components whose capacitance and insulation may vary greatly during the useful lifetime and according to the length of resting time without applied voltage. Thus even if an electrolytic capacitor is found to function satisfactorily in a critical circuit position at some particular time, that circuit cannot in general be relied upon to function satisfactorily with it at all subsequent times. In valve circuitry, electrolytics should normally be confined to smoothing and decoupling functions.

Electrolytics are more widely usable in transistorised circuitry because impedances are generally lower, so that insulation deficiencies are less important. Therefore any slight leakage of electrolytic coupling capacitors leads to much smaller relative displacements of the transistor operating points than in the case of valve circuits.

RF CAPACITORS

It may be unsatisfactory to substitute paper capacitors for ceramic or mica capacitors in r.f. circuits when the operating frequencies are high, although this may not matter so much in long- and medium-wave circuits. On the other hand, ceramic or mica capacitors of adequate voltage rating may be substituted for specified paper ones.

In most r.f. applications it is immaterial whether ceramic or mica types are used. Modern ceramic materials have a greater capacitance in a smaller space, but their voltage ratings are often more limited. Paper capacitors generally have a lower capacitance stability, so that even if they work in local oscillator circuits they should nevertheless be avoided in these stages, otherwise trouble is likely to be encountered with drift. Mica or ceramic components of good basic stability are most desirable, especially for v.h.f. circuits.

Where an author specifies strange combinations of odd-value capacitors with exact details of manufacturer and type number, and with two or more such capacitors connected in parallel at each position, the intention is to achieve mutual cancellation of the individual temperature coefficients. In such cases it is not possible to make straightforward substitutions of other capacitors without impairing the frequency stability of the circuit.

Forbidden resistor substitutions can arise in circuits where the stray inductance of the resistors plays a significant role. This often means that wirewound resistors cannot be used in place of specified carbon resistors in such circuits as the signal amplifiers of oscilloscopes and wideband a.c. valve voltmeters, or in the video stages of television equipment. However, in these same types of equipment wirewound resistors with a definite inductance used as frequency-correcting peaking inductance may sometimes be found.

If such resistors fail and have to be replaced, simple substitution of a carbon resistor or an arbitrary-inductance wirewound resistor of the same wattage and resistance value may lead to unsatisfactory performance of the equipment (generally reduced bandwidth at the high-frequency end).

POWER SUPPLIES

Due to the lack of standardisation in mains transformers, difficulty in obtaining the exact one specified in an article is a common problem.

Other power supply problems concern rectifier substitutions, in particular the conditions under which valve, metal and silicon rectifiers may or may not be mutually substituted. Finally, readers often query possible interchanges of halfwave, fullwave and bridge rectifier circuits if a specified rectifier arrangement is not available.

There are standard rules of substitution which can be applied to most power supply problems.

MAINS TRANSFORMER SUBSTITUTION

Space permitting, it is always possible to use separate heater transformers, either to cater for all heater requirements independently, or to augment the heater supplies available on the transformer which also carries the h.t. winding. If more than one transformer is used, all primaries should be connected in parallel, but *never* connect secondaries of physically or electrically different transformers in parallel. Series connections of secondaries are always permissible for any combination of transformers, within the insulation ratings, e.g. to obtain higher heater voltages.

If it is possible to obtain a transformer with all the required windings as far as voltages are concerned, but the current ratings are too low, then it is always permissible to wire two such *identical* transformers in parallel.

All primary *and secondary* connections should be respectively connected in parallel. The current

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rating of each composite winding is then twice that of a single transformer. It must be stressed that such connections are possible only for *truly identical* transformers.

If, for example, an h.t. current rating of 150mA is specified, there is no objection to using a transformer with a somewhat higher rating, e.g. a 200mA or even 250mA. However, overloading of h.t. windings in the other direction should be avoided, since it leads to severe overheating. Thus if 150mA h.t. rating is required but only a 100mA transformer type is available, two such identical transformers will have to be connected in parallel.

Fig. 2 shows such a transformer substitution. In the example, a 250-0-250V 200mA transformer with two separate 6·3V 2·5A heater windings has

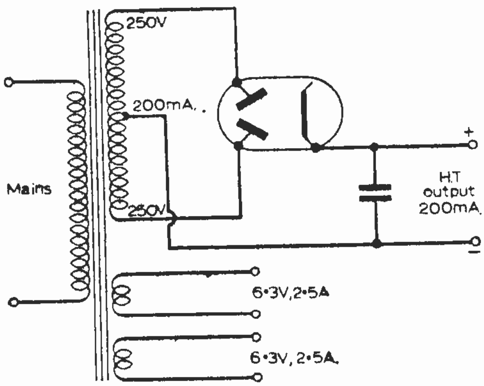

Fig. 2a: Normal full-wave rectifier circuit.

been specified (Fig. 2a). This may be replaced by two smaller transformers, each having a simple 250V 100mA winding *for halfwave rectification* and a single 6·3V 2·5A heater winding.

Provided that the two transformers are fully identical, there is no objection to feeding the two sections of a full-wave rectifier circuit from separate transformers in the manner shown, and the current rating of each transformer need only be one half of the required rectified h.t. current.

But there is one rather important reservation. The two separate transformers must be of a type specifically intended for halfwave rectification at their full rated current output. Halfwave rectification always passes a d.c. current component through the secondary winding of a transformer, which magnetises the core and lowers the primary inductance. The primary inductive current therewith increases and the transformer gets much hotter than it would otherwise do.

There is no net d.c. magnetisation of the core when the type of full-wave rectification shown in Fig. 2a is employed, with both rectifiers fed from the conventional centre-tapped h.t. winding on a *single* transformer.

If the two transformers of Fig. 2b are not designed for halfwave rectification, it is better to change the rectifier arrangement too, using a single transformer with a simple h.t. winding (now rated for the full required h.t. current) feeding a bridge rectifier as shown in Fig. 3.

Provided that the transformer voltages are the same and the rectifier classes of Fig. 2a and Fig. 3 are the same (e.g. in both cases contact-cooled selenium rectifiers, or all silicon diodes), the respective circuits are generally completely interchangeable, whichever one an author should happen to specify.

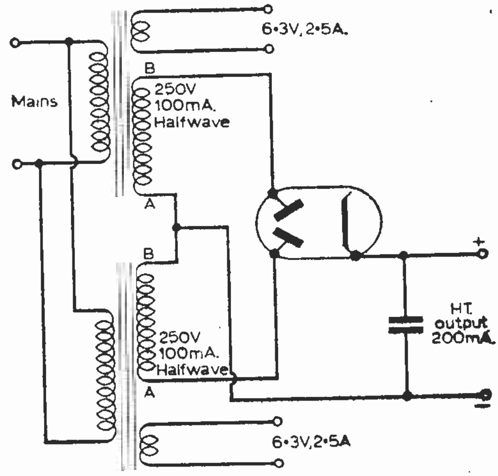

Fig. 2b: Full-wave rectifier circuit with two half-wave transformers.

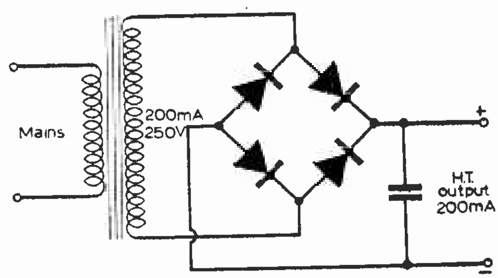

Fig. 3: Bridge h.t. rectifier circuit with simple transformer winding.

PROBLEMS WITH HEATER WINDINGS

Unless two or more transformers are absolutely identical, heater windings should not be connected in parallel, but any form of series connection for obtaining higher voltages is permissible. It is inadvisable to connect two heater windings on the same transformer in parallel, even if the current ratings are identical.

If two or more heater windings are required to meet the demands of all valves in a piece of equipment, it is generally best to "common" one side of each winding to chassis and to connect

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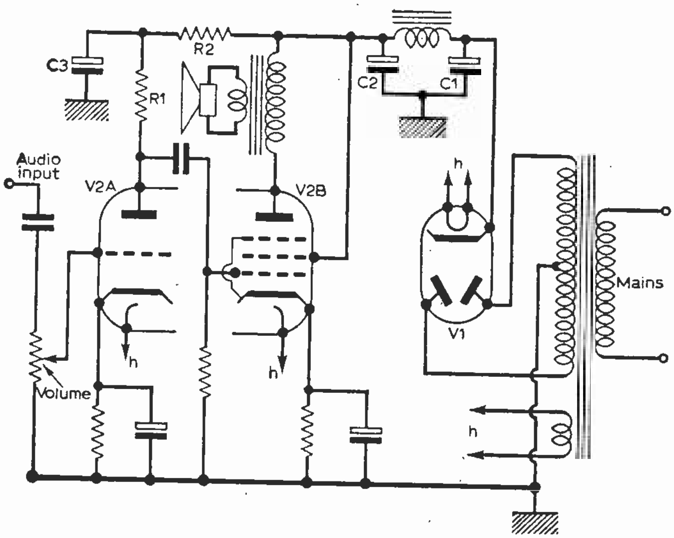

Fig. 4: Surge voltages in electrolytics C1, C2, C3 (see text).

respective groups of valve heaters independently to the other ends. In most cases the specified heater requirements may be redistributed in any manner within reason.

If rectification of the output from a heater winding is required, keep to fullwave or bridge rectification unless the current drain on the d.c. side is only a small fraction of the a.c. current rating. Otherwise d.c. magnetisation of the transformer core can lead to severe overheating and possible burnout.

Whereas h.t. windings may be fairly generously overrated, e.g. there is little objection to loading a 200mA winding with no more than 50mA actual h.t. current drain, such severe underloading is undesirable on heater windings since it can lead to unduly high heater voltages which would endanger valves.

Check with a multimeter and if necessary insert a low-value series resistor (e.g. a coiled length of stout resistance wire determined by experiment or calculation). Adjust for correct voltage reading at heater pins of valves. Alternatively, connect the primary to a higher voltage tap than the prevailing mains voltage. Slight resulting loss of h.t. output voltage is generally tolerable.

RECTIFIER SUBSTITUTIONS

There is little to choose between conventional metal rectifiers, contact-cooled ("flat") selenium rectifiers and silicon rectifiers as far as normal performance in h.t. circuits is concerned, although the efficiency improves in the order given and the heat dissipations and physical sizes decrease accordingly.

The modern silicon h.t. rectifier is undoubtedly the best component in the semiconductor class of h.t. rectifiers and it can serve as a versatile substitute in most cases where specified metal rectifiers or contact cooled rectifiers are unavailable. Contact cooled selenium rectifiers use a coding such as, for example,

E250 C50=Halfwave (E), 250V a.c. input, d.c. current (C) 50mA

B450 C200= Bridge (B), 450V a.c. input, d.c. current (C) 200mA.

Whilst the first example is very common, the second example and similar types often specified for high-power electronic or amplifier designs may be difficult to obtain. Four simple 250V a.c. input silicon h.t. rectifiers connected in a bridge circuit represent a perfect substitute for a B450 C200 and are always easy to obtain.

It is fairly general to use the ubiquitous silicon mains rectifier if any other specified *semiconductor* rectifier is unobtainable. If the a.c. input does not exceed 250V for non-bridge circuits or 450V for bridge circuits, use a single silicon mains rectifier for each diode section of the substituted rectifier. Otherwise use two silicon rectifiers in series for each diode section if the a.c. input voltage lies between 250V and 500V for non-bridge circuits or between 450V and 900V for bridge circuits.

The silicon mains rectifier has the further advantage that it is generally equally suitable for rectifying low voltages, e.g. heater voltages, although cheaper types with lower inverse voltage ratings are available.

VALVE RECTIFIERS

Whilst it is generally possible to substitute a valve rectifier for a semiconductor h.t. rectifier, if one is willing to go to the trouble of introducing a rectifier heater supply, *the converse is not necessarily true*. Equipment for which a valve rectifier is specified may well be damaged if a metal rectifier is substituted without due consideration.

Consider the circuit Fig. 4, in which a full-wave valve rectifier circuit feeds a two-stage audio amplifier. If V1 is indirectly heated as shown (e.g. type EZ80), it will not pass any current into the reservoir capacitor C1 until the audio output valve V2b has also warmed up and is able to draw full h.t. output current from C2. The voltage developed across C1 and C2 thus does not rise much above the r.m.s. (a.c.) input voltage from the transformer if the loading is correct.

If a semiconductor rectifier is now substituted for V1, the h.t. voltage builds up *immediately* across C1 and C2 at switch-on, but there is no output current drain until V2 has warmed up.

The voltage build-up across C1 and C2 will thus initially rise to the *peak* a.c. input voltage, which is about 1·4 times the r.m.s. input voltage. Electrolytics of correspondingly higher voltage

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ratings are then required for C1 and C2.

If the valve rectifier is directly heated (e.g.. type 5Y3G), it will deliver h.t. voltage before many of the other valves in the equipment have fully warmed up and are able to draw full h.t. current. The initial h.t. voltage excess will then be less than in the case of semiconductor rectifier circuits, and certainly of shorter duration. but it will often still be significant. Thus beware even of substituting a directly heated rectifier valve for a specified indirectly heated one.

Note that some indirectly heated rectifier valves, e.g. the EZ80, will tolerate the full h.t. output voltage between cathode and heater, so that the rectifier heater may be connected in parallel with the heaters of the other valves, with one side connected to chassis. Other rectifier valves, and of course all directly heated types, will not tolerate this and require a separate rectifier heater winding floating at h.t. voltage on the mains transformer.

If the transformer h.t. winding delivers 250V a.c. or less to the rectifier, a common figure for small amplifiers and receivers, standard 350/380V electrolytics will always be satisfactory for any type of rectifier, whether valve or semiconductor, since this voltage rating withstands the maximum peak voltage which could arise under such conditions. In such equipment there is generally no objection to straightforward substitution of a metal rectifier for a specified valve rectifier.

The same applies for equipment which derives h.t. voltage by direct rectification of the mains input without a transformer, since the a.c. input voltage is then also below 250V.

Whenever transformer voltages higher than 250V are employed (as in high-power amplifiers and oscilloscopes) care must be exercised if it is desired to replace a specified indirectly heated valve rectifier by a metal rectifier or silicon diode combination.

If any such changes are undertaken, the reservoir (C1) and smoothing (C2) electrolytics, as well as all decoupling electrolytics for individual stages, must be replaced by components of higher voltage rating equal to 1·5 times the a.c. input voltage applied to the rectifier.

The operating voltage across C3 is much lower than that across C1 and C2, because of the large voltage drop across R2 due to anode current of V2a. But until V2 is warm, there is no anode current, so that *even C3 charges to the full peak voltage.* This will also require replacement.

Apart from such replacements of electrolytics where necessary, a careful check of the complete circuit diagram should be made to see if any other components could be damaged by the higher surge voltages which arise when a metal rectifier is substituted.

PART TWO NEXT MONTH

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3 BAND TRANSMITTER

—continued from page 314

50mA should be suitable. If loading is too small speech quality will deteriorate. Excessive loading will reduce r.f. output.

When working with the full anode voltage the p.a. should always be tuned up initially on 'phone, even when c.w. is required, as this helps keep off-tune anode current down. The p.a. stage must not be left operating off tune or without grid current.

V.F.O.

The voltage stabilised v.f.o. originally described for the 160/80m 'phone transmitter is satisfactory*. This v.f.o. operates on 1·75Mc/s. The 160m anode coil is replaced by a slug-tuned coil broadly resonant in the 80m band. Tuning may be done by observing grid current, then leaving the coil alone.

It is necessary to short L3 and C1 may be disconnected. Drive to the 6CH6 is on 3·5Mc/s. for all bands. Any other ordinary v.f.o. is likely to be satisfactory.

Simplifications

If 'phone working only is wanted, R3, C5, C10, C11 and C12 may be omitted, the cathode circuit going directly to chassis. R7 is not wanted, nor the "c.w." switch position. For c.w. only the whole modulator and associated circuits can be omitted. It is also possible to use an 807 as the p.a. with useful results and this type of valve is very inexpensive.

* PRACTICAL WIRELESS, March, 1965.

All this

E.H.T. VOLTMETER FOR OLYMPIC ● RECORD PLAYER CONVERSION ● IMPROVING SYNC ● MUTUAL AND SELF INDUCTANCE BRIDGE ● PULSE VOLTAGE TRIPLER *plus* THE LATEST INSTALMENT OF "THE OLYMPIC" TRANSISTOR TV *plus* REGULAR SERVICING ARTICLES *and* FEATURES

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TWO-BAND DIPOLES

CONFIGURATED COAX-FED AERIALS

by F. G. Rayer

A HALF-WAVE dipole, centre fed with a coaxial or twin line, is one of the simplest aerials which can be used successfully without trouble. Most ready-made, kit and home-built transmitters have a pi-output circuit which allows the transmitter to be loaded directly into a 75Ω or similar coaxial line. This method of working is accordingly very convenient.

An ordinary dipole of this type has two disadvantages which sometimes prevent its use. First it needs to be of particular length and enough space may not be available. Secondly the aerial is generally suitable for one band only, which rather limits operating unless another aerial is also available. Both these difficulties can be overcome to a useful extent.

Dipole Length

Requirements for a single band dipole can best be noted first. An aerial of this kind is shown in Fig. 1. The total length is a half-wave at the operating frequency. This can be found from:

$$\text{Length in feet} = \frac{468}{\text{Mc/s.}}$$

It is usual to cut the aerial for about the middle of the band so that actual coverage includes most of the band. On this basis typical lengths are:

80 metre band	...	128ft.
40 „ „	...	66ft. 4in.
20 „ „	...	33ft.
15 „ „	...	22ft.
10 „ „	...	16ft. 3in.

If particular interest lies at the c.w. end of a band, or any other frequency, length can be adjusted to suit.

A 75Ω coaxial feeder is generally used and can be of any length. It may run against roof, walls or elsewhere and is thus easily brought back to the transmitter.

Practical Construction

A suitable method of making the aerial is shown in Fig. 2. A ceramic dipole "T" piece is most convenient at the middle and the overall length is measured as indicated. Hard-drawn 14s.w.g. wire is most suitable but 7/26 aerial wire is lighter and cheaper. The 14s.w.g. wire can be tightly twisted at insulators but the 7/26 needs knotting, soldering or binding.

The coaxial cable outer braiding is separated with a pointed tool and twisted into a pigtail. This is soldered to one aerial wire. The inner lead is soldered to the other wire. Tape holds the feeder to the "T" piece. If moisture enters the coaxial cable this will upset working. Some spacing material can be melted with the soldering iron to seal the end. Or a sealing compound can be used. Ribbed insulators are generally used. For supporting, polythene line is excellent.

If the aerial is not too long, and supports are rigid, the wire can be drawn taut from the ends. But if the aerial is long (say for 80m) an additional pole or other support at or near the centre is useful to help take the weight of the coaxial cable. The latter should run away at right-angles from the aerial.

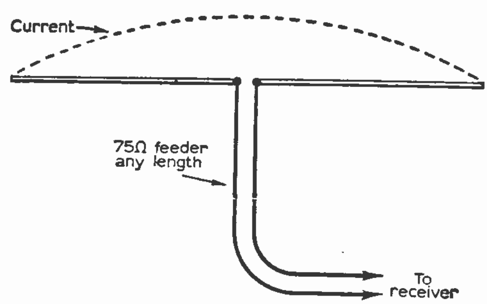

Fig. 1: The usual form for a half-wave dipole.

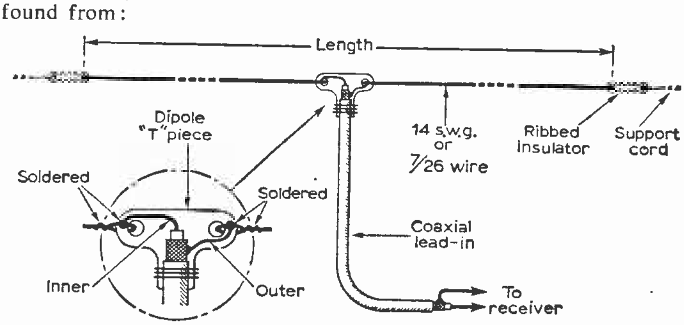

Fig. 2: A practical arrangement for a dipole complete with coaxial feeder.

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Two-band Aerial

Distribution of current in the aerial is as shown in Fig. 1 and current is large and impedance low at the centre. This is why the 75Ω feeder is satisfactory.

On any even multiple a high-impedance point will be found near the centre, so the 75Ω feeder is then unsuitable. But on odd harmonics an uneven number of half-waves exist on the aerial, so that the centre is again low impedance. This is shown for three half-waves in Fig. 3.

As a result a 7Mc/s dipole can be used on 21Mc/s. The actual calculated length for three half-waves is:

$$\text{Length in feet} = \frac{492 \times 2{\cdot}95}{\text{Mc/s.}}$$

It will be found that three half-waves for the 21Mc/s band result in an aerial of about 68ft. Despite this quite good results can be obtained. No other two amateur bands can be covered with a single wire in this way.

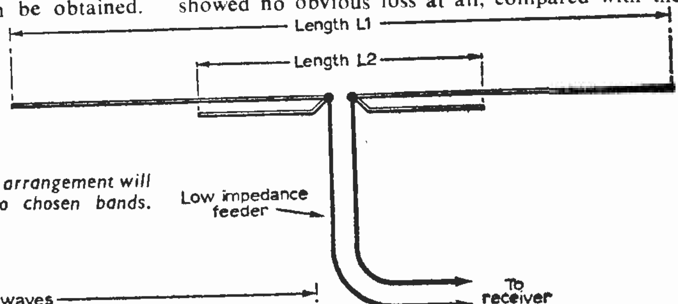

Fig. 4: This dipole arrangement will work for any two chosen bands.

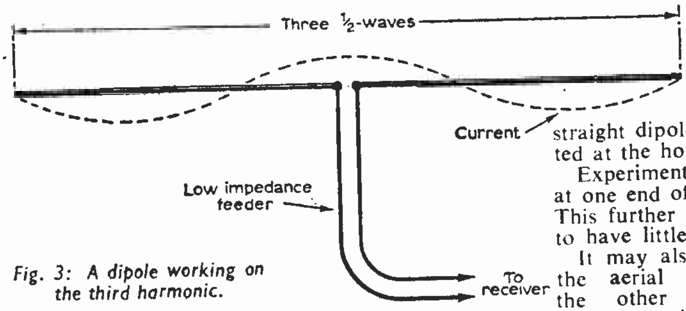

Fig. 3: A dipole working on the third harmonic.

Double Dipole

A dipole for any two chosen bands can be made as in Fig. 4. Length L1 is for the lower frequency band and L2 is for the chosen higher band. One half of L1 is high impedance at even harmonics, so has little effect on the band covered by L2.

In an aerial of this kind made for 3·5Mc/s (80m) and 14Mc/s (20m) bands it was found convenient to suspend the smaller dipole by 6in. ceramic spreaders as used for open-wire lines. L1 was 120ft and L2 33ft. Three spreaders were used each side the centre "T" piece.

On the first day of testing this two-band dipole the best signal report received was strength 8 to 9 from K4QVK, using 120W a.m. Subsequent results in general seemed about the same as those from a single band dipole cut for 20m. On 80m no change in signal strength compared with an 80m dipole could be found.

From these results it appears that the system is completely practical, though it is clear that the aerial is not one offering any gain in signal strength but merely allowing immediate operating on either of two bands.

It is apparent that if L1 or L2 is operated in the way described for Fig. 3 three-band working is possible. That is, coverage is given for 7Mc/s, 21Mc/s and one other band.

Bent Dipoles

Since the aerial has to be a half-wave this may require a clear span greater than available. This can often be overcome by using some other configuration for the dipole.

Tests show that the conventional arrangement of elements in line can be varied considerably, without much loss of efficiency. A dipole with its two wires at about right angles has almost no directivity. Lengthy tests with such an aerial showed no obvious loss at all, compared with the straight dipole. The apex and feeder were supported at the house.

Experiments were made by letting several feet at one end of the horizontal wires drop vertically. This further reduces the space needed, and seems to have little effect on radiation.

It may also be possible to have one half of the aerial in a roof or attic space, with the other half suspended over a short garden. Sloping dipoles were also tried, the angle being from about 30° from vertical to 45° so that 15m and 20m band aerials could run from a single pole down to an anchor point a few feet from the ground. These all gave good results.

Length Adjustment

When making tests with practical dipoles which were in part near earth or walls, etc., it became apparent that the theoretical length as calculated in the way described was not always best. As a result, it was found that some aerials would load the transmitter in a satisfactory manner near the low-frequency end of the band, but not near the HF end.

This is cured, if necessary, by pruning the outer ends of the aerial. With a 80m aerial, there will probably be no harm in cutting off 2ft. at each end to begin. But with the higher frequency bands, pruning should be correspondingly less, say about 2 per cent of the total, at a time. ■

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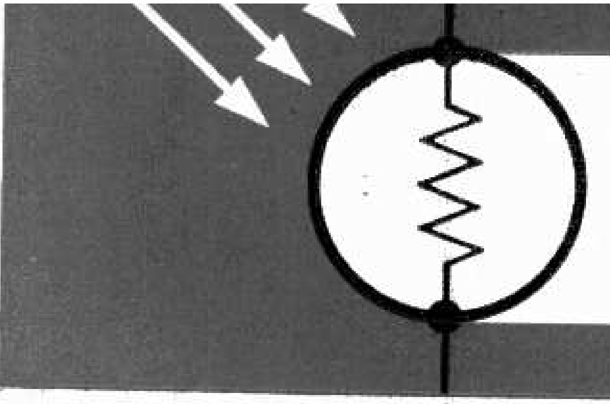

circuits for PHOTOCE

FOUR circuits are described, starting with a simple design using the photocell in series with a relay and supply and concluding with a more advanced device using two cells and a transistor logic circuit.

There are several different types of device which are called collectively "photocells". This article is concerned only with one type: the photoconductive cell, which is compact, fairly cheap and suitable for most switching applications. The photoconductive cell is essentially a resistance which changes its value according to the intensity of the light falling on it. Cells are available which give a very large change of resistance with light intensity; a typical change might be from 10MΩ to 300Ω when the cell is exposed to bright, unfocused daylight after being in complete darkness. From this it can be seen that a simple switching circuit need be no more complicated than that shown in Fig. 1.

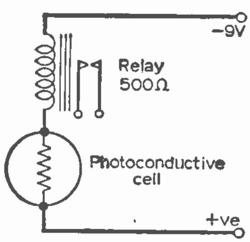

Fig. 1: A simple switching circuit employing a photocell.

With the values given the current in the relay when the cell is illuminated will be a little more than 10mA and this should be sufficient to operate many surplus relays.

The values are given simply as an example and are not critical. For instance, the supply voltage could easily be increased to 12V if required. The range over which the supply voltage and relay resistance can be changed is limited by three considerations:

(1) The current required in the relay for it to operate. This is determined by the mechanical construction of the relay and will fix an upper limit to the relay resistance for any given supply voltage.

(2) The maximum voltage which the cell can sustain across it. If the voltage across the cell exceeds a certain value it will "break down" and become permanently damaged. This maximum permissible voltage is usually about 100V or above.

(3) The power dissipated in the cell. This is measured in the normal way by the product of the voltage dropped across the cell and the current flowing through it. Photoconductive cells are not usually capable of dissipating much power and this places an upper limit to supply voltages and a lower limit to relay resistance. The maximum power which a cell can dissipate varies according to the type. For the Mullard ORP12 (which is the cell for which Fig. 1 was designed) the value is 200mW. The circuit must be designed so that this value is not exceeded for *any intensity* of illumination. The cell is not necessarily dissipating the most power when it is fully illuminated and the current is at a maximum, nor when it is in the dark and the voltage across it is at a maximum. The most power is dissipated when the current flowing is half the value it would have if the cell were short-circuited and the relay placed straight across the supply.

Suppose a circuit is required to operate a 1,000Ω relay which needs 20mA to actuate it. Assuming a maximum cell resistance when illuminated of 200Ω then:

Supply voltage$=20 \times (1{,}000 + 200)=24$V.
Dissipation in cell=80mW at 20mA current and =144mW at 12mA (with relay alone I=24mA). Since these values are within the maximum ratings for the cell (ORP12) the circuit will be satisfactory.

The photoconductive cell is not sensitive to the polarity of any voltage across it. Consequently in the simple circuit of Fig. 1 it is not necessary to use a d.c. supply; a.c. is equally satisfactory. It should, however, be remembered that the values given for a.c. voltages are usually r.m.s.; it is important to consider whether the peak supply voltage (r.m.s. $\times \sqrt{2}$) is going to cause the cell to exceed its maximum voltage rating.

If it is desired to make the sensitivity of the circuit adjustable a variable resistance can be put in series with the other components. As the relay is held on when the cell is illuminated it is best to use a relay with changeover contacts so that the circuit is suitable for such applications as automatic garage door opening by the headlights as well as detecting intruders or counting people passing through doorways.

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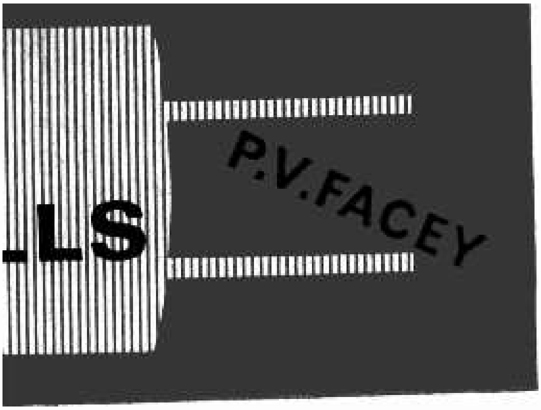

The circuit of Fig. 1, whilst it has the merit of being extremely simple and compact, nevertheless has some disadvantages. If the cell is used so that it is normally illuminated the relay will be held on all the time and battery drain will be high. Also the power limitations of the cell mean that relays requiring currents above 30mA or so cannot be used.

CIRCUIT ONE

Fig. 2 shows a circuit which overcomes these disadvantages and uses an OC83 transistor as a current switch operated by the cell. In this circuit the photocell forms part of a potential divider to which the base of the transistor is tapped. When the cell is illuminated the transistor will be cut off and the total battery drain will be substantially equal to the current flowing in the potential

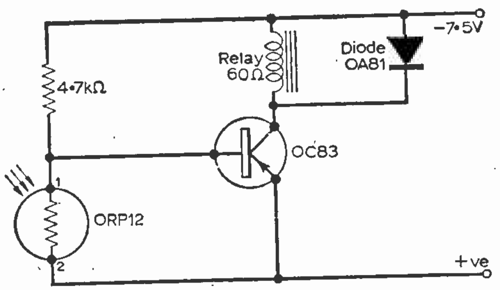

Fig. 2: In this switching circuit the photocell operates the transistor as a current switch.

divider. This is less than 2mA and so photocells with a low power rating can be used provided they give a suitable change in resistance.

The magnitude of the collector current is determined by the supply voltage, the relay resistance, the current gain of the transistor (α) and the base current. With the values given in the figure and assuming $\alpha=90$ we have:

$$Ic=\alpha \times Ib,\ Ib=1{\cdot}5\text{mA approximately.}$$

$$\therefore Ic=90 \times 1{\cdot}5=135\text{mA.}$$

However, since the maximum voltage across the relay is 7·5V and it has a resistance of 60Ω the current is limited to 7·5/60=125mA. Any relay that will operate at this current or below will do and the coil resistance need not be exactly 60Ω. If a relay with a different coil resistance is used the 4·7kΩ resistor should be changed accordingly to give a suitable base current. The OC83 can carry a maximum collector current of 500mA but for power dissipation reasons it is necessary to limit the current to a maximum value of considerably less. Currents up to about 200mA should be O.K. The OA81 diode is placed across the relay to short-circuit any induced e.m.f. set up across the relay windings when the transistor switches off. If the diode were not present any induced e.m.f. due to the relay inductance would give rise to a large voltage across the transistor at a time when it is still conducting quite heavily. In other words, the transistor would be called upon to dissipate too much power.

CIRCUIT TWO

Fig. 3 shows a circuit with variable sensitivity using a 100Ω 20mA relay. The circuit can be adjusted to respond to any desired intensity of light above a certain minimum. It will work equally well with a bright focused beam and with the light from a 60mA pea bulb underrun at 40mA from a supply chopped at 10c/s. The

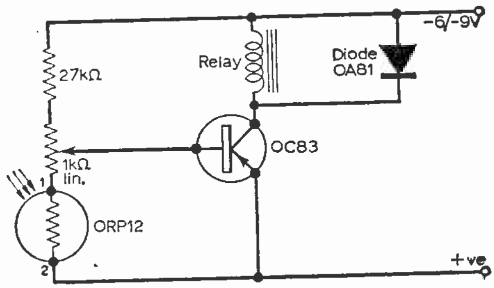

Fig. 3: This circuit, which incorporates a sensitivity control, was found to work well even with an underrun 60mA bulb as the light source.

circuit has been run under these latter conditions for five hours in daylight with the cell unshielded and placed a few centimetres from the flashing bulb. The relay oscillated in sympathy with the light for the whole period in spite of the changing ambient light level. Since the transistor was continually being switched on and off during this time this trial serves as a good test of power stability. The transistor did not heat up at all.

There is much scope for experiment in the circuits of Figs. 2 and 3. Almost any relay to hand may be tried (with due attention to the power handling capacity of the OC83) and the potential divider adjusted to suit any special requirement. Additional sensitivity to dim light may be achieved by connecting point A to a third supply line, positive with respect to the OV line. (+1·5V, OV and −7·5V supplies can readily be obtained from a 9V grid bias battery). Different types of screening, lattice windows and coloured filters can also be tried. Photoconductive cells will respond to most of the visible spectrum and

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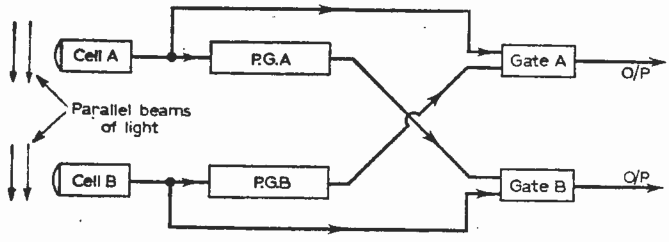

Fig. 4: An arrangement for a device to determine the direction of a body passing two cells.

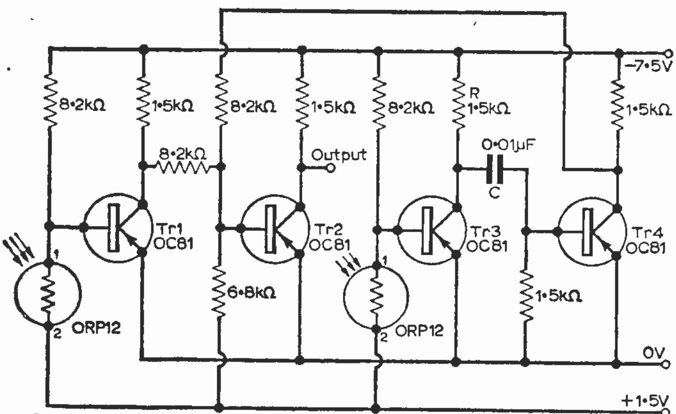

Fig. 5: A practical circuit for the arrangement of Fig. 4.

also to infra-red rays which cannot be seen by the **human eye.** This is useful for burglar alarms.

CIRCUIT THREE

Fig. 4 is a schematic diagram of a device which uses two parallel beams of light across an entrance with two cells and is capable of determining the direction in which any body interrupting the beams is going. Suppose something is travelling through the beams in the direction of the arrow and that we call the output of the cells "0" when they are illuminated and "1" when the beam is interrupted. The pulse generator in this circuit is a device that only emits a short output pulse when its input goes 1/0. The gate has output 0 only when both its inputs are 1. Fig. 5 is the practical circuit and 1 indicates a potential of 0V and 0 a potential of −7·5V when related to this circuit.

Beam A will be blocked first and the o/p of cell A (Tr3) goes 0/1. The o/p of gate A is unchanged. since its other i/p (from P.G.B.) is at 0. The pulse generator A is unaffected since it does not respond to 0/1 voltage steps but only to negative going steps (1/0). Then beam B is broken and cell B (Tr1) goes 0/1. Gate B is not affected since its other i/p (from P.G.A., Tr4) is still 0. P.G.B. is unaffected. A little later the body moves out of beam A and cell A (Tr3) goes 1/0. Gate A does not respond since its other input (from P.G.B.) is at 0. P.G.A. (Tr4) now produces a short pulse 0/1/0. Since beam B is still blocked one i/p to gate B (Tr2) is already at 1 and the gate therefore gives a short output pulse 1/0/1 as P.G.A. goes 0/1/0. When the body moves out of beam B, P.G.B. gives a short pulse, but as cell A (Tr3) is at 0 gate A is unaffected.

As the circuit (Fig. 4) is symmetrical gate A will produce a pulse when something passes through the beams in the opposite direction. If a body only passes through one beam, or is too thin to interrupt both beams simultaneously, the device gives no output. This may be used to discriminate between persons and arms where it is necessary to prevent people from interfering with a counter by moving their arms through the beams or between pedestrians and vehicles. If it is required to detect objects moving in one direction only, half of the circuit can be removed (i.e. to detect objects moving in the direction of the arrow P.G.B. and gate A can be discarded). Fig. 5 gives the circuit of such a unidirectional device; for bidirectional detection Tr3 and Tr4 should be duplicated with associated components.

The width of the output pulse is determined by the time constant CR and will be less than 1mS with the values given. Such a short pulse cannot be detected on a meter and, unless the device is feeding into further electronic equipment, it is necessary to connect the output to some prolonging circuit such as a monostable. In the case of a unidirectional circuit and if the operation initiated

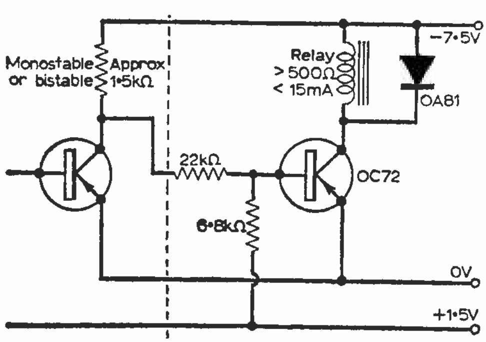

Fig. 6: A relay drive circuit.

—continued on page 338

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LIGHT PROGRAMME EXTENSION

by V. E. Holley

THE design to be described is essentially a simple inexpensive fixed-tuned Light Programme receiver which is fitted into an extension speaker cabinet. By a system of simple switching either the programme on your main receiver, or on this receiver may be selected at the extension position. Construction is simple and there are no problems of alignment or stability; the less experienced constructor may therefore attempt it with confidence.

Circuit Description

Fig. 1 shows the circuit of the prototype. The ferrite rod aerial fitted with a long wave coil L1, is fixed-tuned by C1 to 200kc/s. V1, an EF91 high gain r.f. pentode, is a most versatile and inexpensive valve. The arrangement of V1 is conventional, and the stage gain is high and selectivity ample for reception at 200kc/s.

Further r.f. amplification is provided by a second EF91, V2. It must be explained at this stage, that the prototype unit is in service in a locality where the Light Programme is not very well received. In many areas V2 and its associated components will not be required and the amplified signal from V1 may be passed through capacitor C4, direct to the diode detector D1. With only one r.f. stage, the decoupling components R2 and C2 can also be dispensed with. These modifications simplify the receiver considerably. As a guide, the single stage version worked very well in the North-west London area but V2 had to be added for satisfactory results in South-west England.

A GEX34, crystal diode, is used as a detector, and the rectified signal passes via the filter network C7, R8 and C8, and thence to the volume control VR1.

A.F. amplification and output are provided by an ECL82 triode-pentode. Bias for the triode section is obtained through the 10MΩ grid resistor R9, and the cathode can therefore be returned direct to chassis. R10 is the anode load resistor, and C10 couples the audio signal to the grid of the pentode section. R11 and C11 are audio decoupling components. The usual biasing components are included in the pentode cathode circuit, while in the anode circuit, a filter network, comprising R14 and C13 give tone correction. The optimum load for the ECL82 is 9,000Ω and the output transformer should therefore have ratio of about 55:1 for a 3Ω speaker or 25:1 if the speaker is of 15Ω impedance. There will be a voltage drop across the primary winding of the output transformer and resistor R13 ensures that the voltage at the screen grid shall not exceed that at the anode.

Power Supply

The total h.t. current requirement with two r.f. stages is 60mA at 230V, while the valve heaters need 2A at 6·3V. This is provided by a miniature

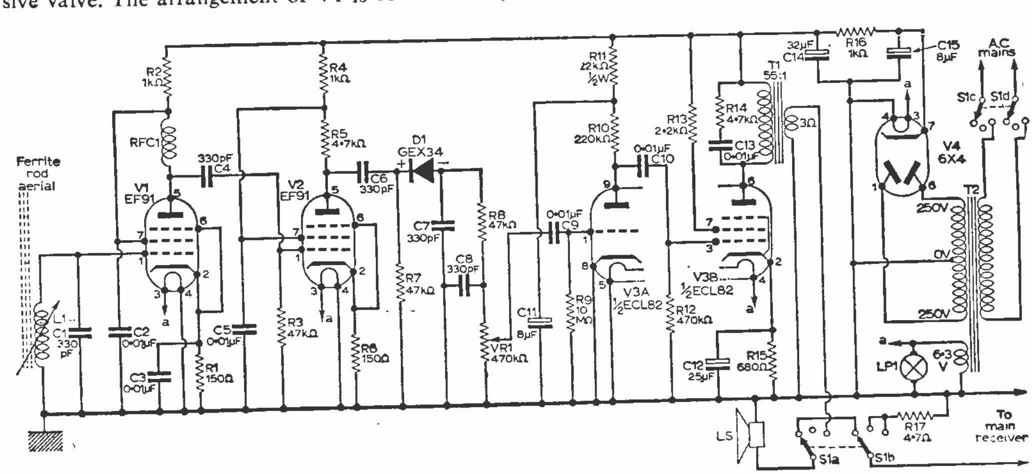

Fig. 1: The Light Programme receiving circuit.

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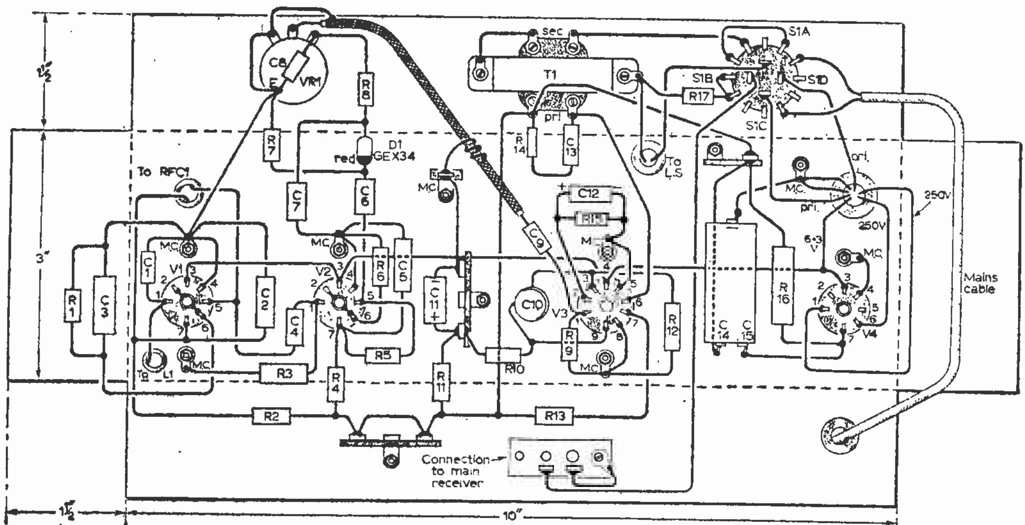

Fig 2: The underchassis wiring of the unit.

mains transformer and a 6X4 valve rectifier. Any other arrangement which provides these currents and voltages will be quite suitable, however, if half-wave rectification is used, it will be necessary to double the value of the reservoir capacitor C15. Smoothing is provided by resistor R16 and capacitor C14. Depending on whether there are one or two r.f. stages and upon the transformer-rectifier combination employed, the value of R16 may need alteration to bring the h.t. line voltage within the range 230—250V. A 6·3V 0·3A pilot light is fitted in any convenient position on the front of the speaker cabinet.

Connection to Main Receiver

Switches S1 a, b, c and d, are the poles of a 4-pole, 3-way switch. This is arranged so that, from a central OFF position, rotation in one direction connects the speaker to the main receiver and in the other, to the internal receiver, at the same time switching the power supply as necessary. Switch S1b introduces a dummy resistive load at the positions where the speaker is not connected to the main receiver, so that the loading of the main output stage will not be upset by operations at the extension. If the extension speaker is of 15Ω impedance, the value of R17 should be increased to

COMPONENTS LIST

Resistors:

R1	150Ω	R10	220kΩ
*R2	1kΩ	R11	22kΩ
*R3	47kΩ	R12	470kΩ
*R4	1kΩ	R13	2·2kΩ
*R5	4·7kΩ	R14	4·7kΩ
*R6	150Ω	R15	680Ω
R7	47kΩ	R16	1kΩ, 5W
R8	47kΩ	R17	4·7Ω
R9	10MΩ		

All 10% ¼W carbon, unless otherwise stated
VR1 470kΩ potentiometer

Valves:

V1	EF91	V3	ECL82
*V2	EF91	V4	6X4

Inductors:

L1 Dual-wave ferrite rod aerial (Denco FRA2)
RFC1 R.F. choke (Denco RFC7A)
T1 Output transformer. 55:1 ratio for 3Ω speaker; 25:1 ratio for 15 Ω speaker
T2 Mains transformer. Secondaries: 250-0-250V, 60mA; 6·3V, 2A

Capacitors:

C1 .. 330pF silver mica 350V
*C2 0·01μF paper 350V
C3 0·01μF paper 350V
C4 330pF silver mica or ceramic 350V
*C5 0·01μF paper 350V
*C6 330pF ceramic 350V
C7 330pF ceramic 350V
C8 330pF ceramic 350V
C9 0·01μF paper 350V
C10 0·01μF ceramic 350V
C11 8μF electrolytic 350V
C12 25μF electrolytic 25V
C13 0·01μF paper 350V
C14 32μF electrolytic 350V
C15 8μF electrolytic 350V

Miscellaneous:

S1 4-pole, 3-way rotary switch
D1 GEX-34 or similar diode
LP1 6·3V, 0·3A pilot lamp
Three B7G and one B9A valveholders. Lampholder. Tinned copper wire, sleeving, grommets, etc.

*These components are not required if there is to be only one r.f. stage.

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about 22Ω. The connection to the extension line is made by way of a non-reversible plug and socket as shown in Fig. 2, the "earthy" side of the line being taken to the larger of the plug pins.

Construction

This is not at all critical and the size and shape of the chassis can be varied to suit the cabinet into which it is to be fitted. For the prototype, an 8in. speaker in a cabinet 12 x 12in. offered a narrow space at the bottom and a chassis 10 x 3 x $1\frac{1}{2}$in. of 18s.w.g. sheet aluminium was used. Because of the proximity of the aerial, V1 and V2 must be screened and RFC1 must also be enclosed in a screening can. A satisfactory mounting for the aerial can be made from sheet aluminium, cut to shape shown in Fig. 3 and bolted to the rear chassis runner. Fit rubber grommets into the two $\frac{3}{8}$in. holes and pass the aerial rod through them as shown in the illustration.

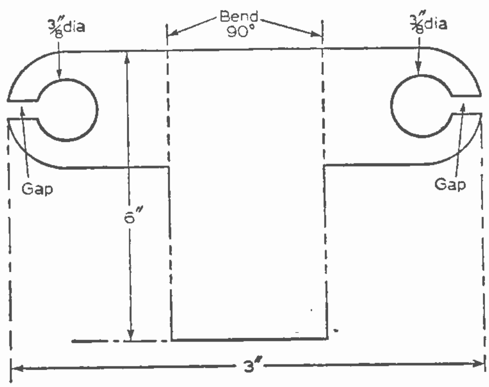

Fig. 2: A suggested addition to the chassis for mounting the ferrite rod aerial.

Fig. 3 shows all the wiring and the approximate positions of the components on the chassis. Tinned copper wire of 22s.w.g. covered with sleeving, is suitable for all the wiring. Work can proceed in any desired order, but it is convenient to deal with the power, output and a.f. stages first and to fit the aerial last, one lead from L1 being earthed at a convenient point above chassis. The ratings for resistors and capacitors are given in the components list. No special components are required but it is convenient to use a disc ceramic for C10.

Testing and Alignment

When all the wiring is complete, check with a meter between C15 and chassis to see that there are no shorts in the h.t. circuits. Now connect the power supply and after allowing a minute or so for warming up, advance the volume control and slide L1 along the ferrite rod until the programme is heard. Accurate tuning is obtained by connecting a high resistance voltmeter, positive to chassis, across VR1 and adjusting the position of L1 carefully for maximum indication. Alternatively, the adjustment can be done by ear at very low volume. When the best position for L1 has been found, fix it in position with a little beeswax. ■

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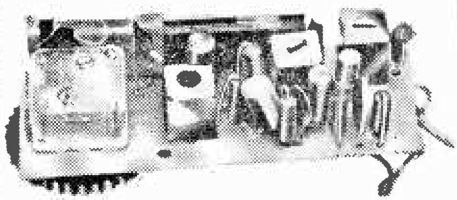

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Wonderful Response

YOU will, I am sure, be pleased to know that my letter, printed in the May issue of *Practical Wireless,* has more than served its purpose.

I have received a complete set of transformers from a student in Bridlington and a set of slugs from a Londoner. I also received a rather bald request for "the h.f. coil" with no mention of slugs at all! Even then I would have replied, of course, if he had had the goodness to include a s.a.e.

Perhaps the most pleasant result of your publication was a brief note asking me if I was a person the writer knew years ago in . . . I am indeed, so you have found an old friend for me!

Again many thanks and my best wishes for the continued success of P.W.

G. H. Scholey, G3CDR.

Dartford,
Kent.

Like Practical Television

I AM a keen reader of *Practical Wireless* and *Practical Television.* I think that they are both excellent magazines but I would like to see a Test Case relating to radio in *Practical Wireless.* I would also like to see a monthly section on Servicing Radio Receivers set on similar lines to Servicing Television Receivers as in *Practical Television.*

Wm. G. Hall.

Billingham,
Co. Durham.

I would be interested to hear what other readers may have to say on the above subject.—Editor.

Competent Constructors

WITH reference to Mr. R. A. Packer's letter (News and Comment, May issue). In my view, a competent constructor is one who makes the best possible use of components he *already has in stock.* Or to put it another way, no sensible person would go and buy a new Mini if there was a perfectly good and reliable large car of somewhat older vintage already in the garage.

H. T. Kitchen.

Nuneaton,
Warwicks.

NEWS AND...

SEMICONDUCTOR SUPERMARKET

For the first time in the UK, semiconductor components will soon be available on a self-service basis in a number of centres throughout the country.

Pre-packaged components complete with technical data and information booklets will be displayed in selected retail shops where constructors will be able to help themselves to a range of solar cells, transistors, rectifier diodes, zener diodes, silicon controlled rectifiers, selenium photocells, etc.

The manufacturers of all the products are International Rectifier of Oxted, Surrey, and the first semi-conductor centre opened at Stern-Clyne Ltd. in Holloway Road, London, during May.

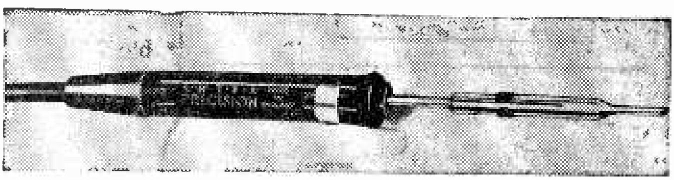
All these components have guaranteed performance figures and in the case of such items as transistors, hundreds of American and European equivalents are listed in accompanying literature.

HONG KONG IMPORTS BRITISH RESISTORS

A British electronics firm—Morganite Resistors—is exporting a quarter of a million resistors to Hong Kong every week. According to a recent announcement this is because Japan—a major component supplier to the Hong Kong radio industry—cannot make resistors of the same accuracy within the price range, with a tolerance of better than 10%.

The resistors are mainly used in low-cost transistor receivers.

MINIATURE 18W SOLDERING IRON



This new 18W miniature soldering iron—model "G"—was announced recently by Antex Limited of Grosvenor House, Croydon.

As in all Antex irons, the heat-source of this model is placed inside the actual bit, which is split to prevent "freezing" to the iron. Extra heat storage capacity is achieved with this particular iron in the heavy shank of all the bits designed to fit it. In fact there is a range of four bits (from $\frac{3}{32}$in. to $\frac{1}{4}$in.) available for the model "G".

Complete with bit the iron weighs between two and three ounces (according to the bit used) and costs 32s. 6d.

RADIOTELEPHONES FOR TANKER FLEET

The installation of a v.h.f. a.m./f.m. radiotelephone in the S.S. *British Holly* this year brings the number of Redifon v.h.f. equipments now in use aboard B.P.'s fleet of tankers up to one hundred. A similar installation was also made in the 100,000 ton *British Admiral*—the largest tanker ever built in Europe.

Redifon supply two types of v.h.f. radiotelephone—the GR.286 Mk.2 and the GR.289 Mk.2—for use in vessels of all classes. The GR.286 Mk.2 provides complete coverage of all allocated f.m. channels in the International Maritime band of 156–162Mc/s.

The GR.289 Mk.2 radiotelephone provides 11 f.m. channels and covers international distress and safety, inter-ship, port control and radar advice services while also providing public correspondence and private band ship-to-shore channels.

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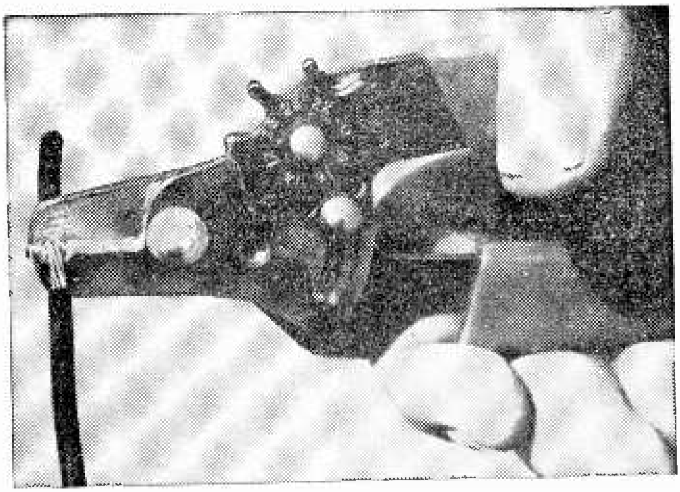
..COMMENT

IMPROVED WIRE STRIPPERS



A wire stripper and cutter, more sophisticated than previous models, has been introduced by Multicore Solders Limited (Maylands Avenue, Hemel Hempstead, Herts.).

The tool is in the form of a pair of pliers and is shown in the photograph above. A rotating gauge on the side selects the depth to which the stripper blades cut for any Standard Wire Gauge between 12 and 26, while the blades will also cut through any wire or flex if required. The price is 7s. 6d.

ELECTRICAL ENGINEERS EXHIBITION 1966

Over 30,000 sq. ft. of extra floor space will be available to exhibitors at next year's Electrical Engineers Exhibition.

Already the dates for the Exhibition, to be held once again at Earls Court, London, have been fixed as 23rd to 30th March. Increased overseas participation is expected at the larger show.

RADIO/TV LICENCES TOP 13¼ MILLION

The total number of combined sound and television receiving licences in the UK now stands at over 13¼ million. The actual figures for April just issued, show an increase during the month of 42,722 to 13,295,767.

The number of sound only licences continues to decrease, the April total being 2,788,405, including 630,191 for sets in cars.

TELEGRAMS VIA EARLY BIRD

During June American telegraph companies and selected customers in Great Britain exchanged pictures and data, telex calls and public telegraph messages via the Early Bird satellite. (Before this Early Bird had been used to relay trans-Atlantic television exchanges).

The telegraph messages transmitted, were ones selected at random from normal "traffic", and were transmitted both by trans-Atlantic cable and by the satellite. Recipients of these received two copies of the telegrams, one clearly marked "Via Early Bird".

BECAUSE OF THE LARGE NUMBER OF OUTSTANDING "SELL OR LOAN" REQUESTS NOW HELD BY US, WE REGRET THAT FOR THE NEXT FEW MONTHS WE WILL NOT BE ABLE TO ACCEPT ANY LETTERS FOR THIS COLUMN.

Sir, I would be grateful if any reader could sell or loan me . . .

. . . circuit diagram and/or any information regarding the Holland-made radio Type KY5841E "Nr 3731". I do not know the brand but there is a symbol showing an orchestra conductor on the cabinet.—Lee Soon Eng, 147 Sungei Korok, Alor Star, Kedah, Malaya.

. . . any details for making a bass guitar. The main points I wish to know are; the space measurements between the fret wires and the distance from the junction of head and stem to bridge.—G. Braddock, 36 Hardy's Road, Cleethorpes, Lincs.

. . . modification details (2m) for 19 "B" set.—J. H. Dresner, Paul's Hill, Leigh, Nr. Tonbridge, Kent.

. . . manual or any information about Geloso G209 Receiver.—C. R. Doherty, 53 Bedford Street North, Liverpool 7.

. . . a circuit diagram and/or information about the valves used in the "Packard" A00914 four valve superhet m.w. receiver.—E. Jones, 13 Curie Way, Meadowbridge, Cape, South Africa.

. . . information on the connections to, or any other data on, the c.r.t. type CV1526.—A. F. Young, 56 Church Road Kearsley, Bolton, Lancashire.

. . . the details for a s.s.b. adaptor and a circuit diagram and data of a 60W v.f.o. type transmitter and modulator.

Also, could the reader who very kindly lent me the manual for SX28 please let me have his address.—S. L. Anand, 207 I.I.T. Quarters, Kalianpour, Kanpur U.P.

. . . any information on the G.P. receiver R1116A, ref. 100/1322, serial No. 2888.—P. Hogarth, 16 Blackett Ave., Norton, Stockton-on-Tees, Co. Durham.

. . . any information on the crystal controlled oscillator section of the Ekco v.h.f. receiver unit AP61357—62H, No. 1597, including the type and frequency of crystal required.—P. Neeson, 34 Bangor Road, Holywood, Co. Down, N. Ireland.

. . . circuit diagram and information re Hallicrafters Communications Receiver model S40; frequency range ·55Mc/s to 44Mc/s.—Nimal Ratnayake, Royal Ceylon Air Force, China Bay, Ceylon.

. . . any information at all on unit R-3/ARR-2X and/or indicator unit type Z6.—D. Bartle, Runnymede, 35 Oakland Avenue, West Hartlepool.

. . . the handbook or circuit diagram for the wireless set (Canadian) 58 Mk.I.—M. Brereton, 38 Burma Road, Stoke Newington, London, N.16.

. . . a circuit of an oscilloscope using the "Etel 4EP7" tube.—James P. F. Windle, 57 Victoria Rise, London, S.W.4.

. . . the handbook for the R220.—J. Freer, 83 West End, Kirbymoorside, York.

. . . the handbook for the Globe Scout model 65, by World Radio. Also information as to where a stockist for this company exists in Britain.—Denis McCann, 23 Ochilview, Cowie, Stirlingshire, Scotland.

. . . a service sheet or circuit diagram for Smith's Radiomobile model 4100 or 4200 car radio.—J. Carpenter, 7 Hawkdene, Chingford, London, E.4.

. . . the circuit and servicing manual of the Walter Metropolitan tape recorder.—13 Grange Avenue, Leicester Forest East, Leicester.

. . . any information on the army set No. 19.—B. Kitcher, 11 Scarborough Road, Blackburn, Lancashire.

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PREPARING FOR THE R.A.E.

BRIAN ROBINSON.

10. CRYSTAL OSCILLATORS; FREQUENCY MULTIPLIERS; POWER AMPLIFIERS; TRANSMITTER KEYING; AMPLITUDE MODULATING A TRANSMITTER

10.1 R.F. Oscillator Stability

VARIOUS oscillator circuits were dealt with in a previous article (R.A.E., May, 1965. P.W.) and in each case the frequency of oscillation was determined by an inductance and capacitance combination forming a tuned circuit. (Types of oscillators mentioned included the Tuned Anode-tuned Grid (T.A.T.G.), Colpitts and Hartley.)

In any of these circuits a change in the value of any component in the tuned circuit will result in a change in frequency of the oscillator. For example, if the oscillator valve generates sufficient heat to slightly alter the size of the inductance a gradual frequency drift will occur. Changes in voltages applied to the valve electrodes may also cause frequency changes as different voltages will cause different amounts of heat to be generated. Mechanical vibrations in an oscillator may also cause frequency changes—and can even modulate the oscillator frequency.

An extremely stable oscillator can, however, be constructed which does not use the familiar inductance/capacitance in the grid circuit but instead uses a quartz crystal.

10.2 Crystal Controlled Oscillators

The frequency of an oscillator can be maintained at a constant level by using a quartz crystal as the tuned circuit. The crystal is resonant at a particular fixed frequency and this is determined almost completely by the dimensions of the crystal. In fact the thickness of the crystal is the main controlling factor. In order to make a quartz crystal oscillate, however, feedback from the anode to the grid must be facilitated in much the same way as in other types of oscillator mentioned.

When a crystal oscillator is operating, a small current passes through the crystal, this being determined primarily by the amount of feedback applied. If this current becomes too large, heating of the crystal will occur and slight frequency changes will result. It is important to use as low a crystal current as possible—consistent with easily maintained oscillation.

It can be seen that the power output of a crystal controlled oscillator should preferably be kept low and in this respect it is inferior to the inductance/capacitance controlled oscillator.

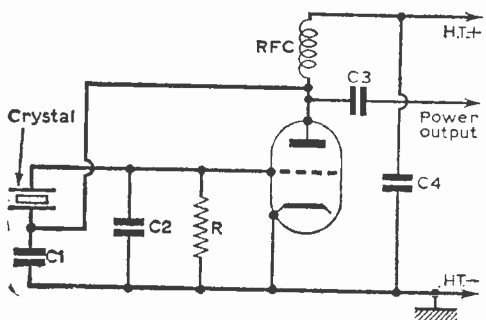

Fig. 88: The Pierce crystal controlled oscillator.

10.3 Typical Crystal Controlled Oscillator Circuits

In Fig. 88 is shown a very simple crystal controlled oscillator circuit—this is, in fact, a Pierce oscillator.

In Fig. 88 the amount of feedback is controlled by the ratio of the values of C1 and C2. If the circuit is studied carefully it can be seen that C1 is in parallel with the anode/cathode interelectrode capacitance of the valve and that C2 is in parallel with the grid/cathode interelectrode capacitance of the valve. In order to obtain feedback the interelectrode capacitances of the valve are effectively increased. R is a grid leak and may have a value of 20-100,000Ω. R.F.C. is a radio frequency choke and this prevents r.f. power from the oscillator being dissipated in the power supply or from being passed to another circuit through the power supply circuits.

Shown in Fig. 89 is an oscillator circuit which is basically the same as the tuned anode-tuned grid oscillator dealt with previously. In this case the inductance/capacitance in the grid circuit has simply been replaced by a quartz crystal.

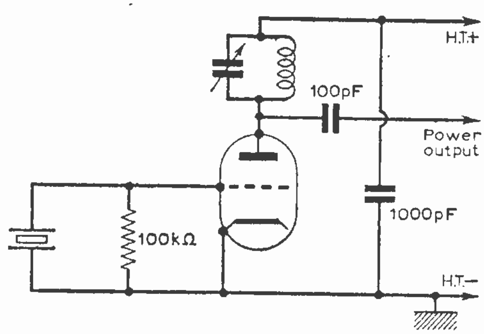

Fig. 89: A grid plate crystal controlled oscillator.

10.4 Frequency Multiplier Circuits

Up to quite recently crystals were only reliable up to a frequency of about 20-30Mc/s, crystals for higher frequencies being very thin and able to operate at very low powers only. Therefore it was found to be comparatively easy to multiply the frequency of operation of a crystal. Frequency

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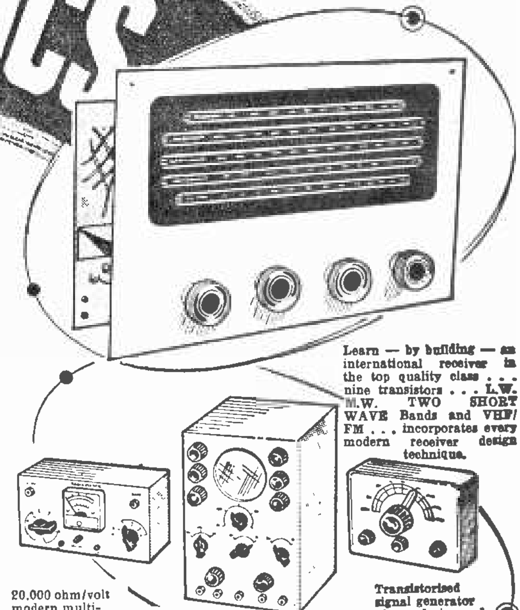

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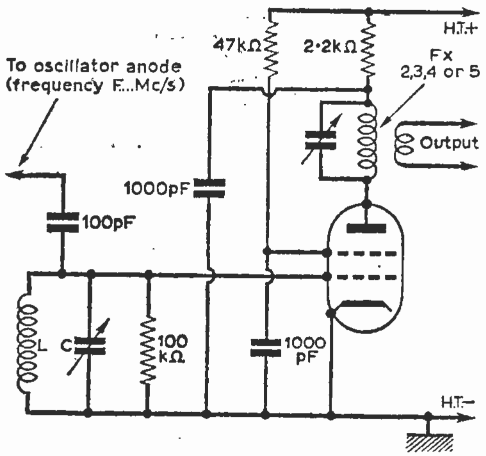

Fig. 90: A frequency multiplier circuit.

multipliers are also of use to enable a single crystal of, say, 3·5Mc/s to be used to obtain output frequencies of 3·5, 7 and 14Mc/s, etc.

In a simple form a frequency multiplier could be as represented in Fig. 90. The tuned circuit in the grid of the valve is resonant at the same frequency as the crystal oscillator and the tuned circuit in the anode may be resonant at two, three, four or five times this frequency. The power output from a frequency multiplier can never be as great as when the stage is used as a straight amplifier. Consequently the greater the number of times the frequency is multiplied the less the power output from the multiplier. Bearing this in mind it is not general to use frequency multipliers which multiply the frequency more than five times.

A simpler frequency multiplier does not use a tuned circuit in the grid but is connetced directly to the oscillator anode. This circuit is shown in Fig. 91.

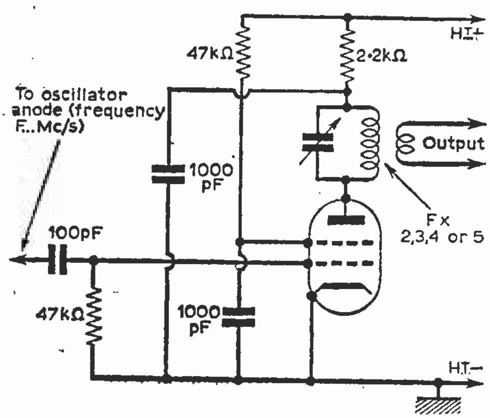

Fig. 91: A simpler frequency multiplier in which the tuned circuit in the grid of Fig. 90 is eliminated.

10.5 R.F. Power Amplifier Circuits

In order to radiate considerable power from a transmitter the signal generated by the oscillator has to be amplified to a very great extent. The function of a power amplifier is, as mentioned, to generate high r.f. powers, but it must also be efficient in respect that harmonic radiation is low. In order to minimise harmonic radiation the Q of the tuned circuits used in a Power Amplifier (p.a.) is made very high.

A simple p.a. is shown in Fig. 92 and L2 may be connected to the aerial or to the next amplifier stage. The load resistance at which the valve operates must be matched to the transmission cable which carries the power to the aerial. For example, the transmission line or feeder may be of, say, 300Ω impedance and, as the p.a. load resistance is usually much higher, L1—L2 constitute a step-down matching transformer.

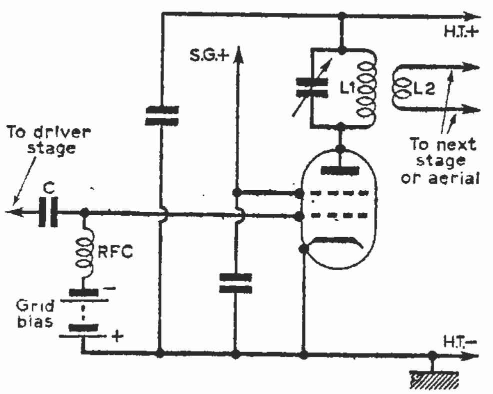

Fig. 92: The circuit of a simple r.f. power amplifier.

In Fig. 92 the r.f.c. is to prevent the power from the driver stage being dissipated in the low impedance bias supply. R.F. power amplifiers are generally operated under Class C or AB conditions. Output circuits will be dealt with further when aerials are discussed.

10.6 Keying a Transmitter

In order to radiate carrier wave (c.w.) signals, using the Morse Code, the output of the transmitter must be reduced to zero after each "dot" and "dash". This is simply a way of saying that in fact the transmitter must be switched on and off in order to radiate the desired signal. This is usually accomplished by using a key. In the interests of safety it is desirable to key the transmitter at a point where high voltages are not present. The key is often placed in the cathode circuit of a crystal controlled oscillator or in the cathode circuit of a buffer amplifier (a buffer amplifier is an amplifier which is used to isolate an oscillator from any higher power amplifier which may follow and it usually operates at the same frequency as the oscillator). In a v.f.o. (variable frequency oscillator) it would be

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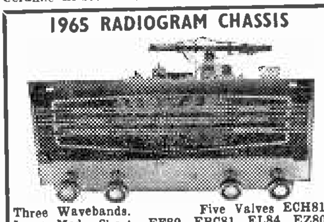

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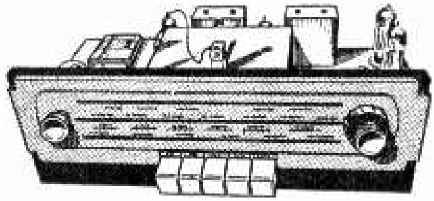

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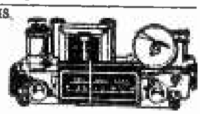

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With 3.5 mm. Jack plug, 12/6 (Post 1/6).
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preferable to key the buffer amplifier rather than the oscillator in order to ensure that the signal does not become "chirpy". A chirpy note results when the keying of the transmitter either directly or indirectly alters the frequency of the oscillator.

When the transmitter key is closed a spark may result; this will generate an r.f. signal but this will only be heard in the immediate vicinity of the transmitter.

When key clicks can be detected on a receiver many miles away they are formed in a different way. When the transmitter is keyed and the carrier wave is interrupted almost instantaneously a key click will result. In order to eliminate the key click the components in the keying circuit must be arranged so that the carrier wave is not interrupted instantaneously but fairly gradually. (The time taken for the signal to reach its peak value is, of course, only measurable in micro-seconds—μS.)

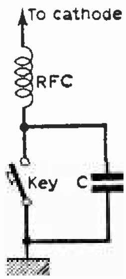

Fig. 93: A typical keying circuit. The r.f. choke and capacitor eliminates key clicks.

A simple keying circuit which could be used in the cathode circuit of a buffer amplifier is shown in Fig. 93. The radio frequency choke and the capacitor act as a filter to eliminate r.f. clicks.

10.6 Amplitude Modulating Transmitter

Modulation is the superimposing of one type of signal on to another, in fact in the cases to be discussed it is the superimposing of an a.f. signal on an r.f. signal.

In Fig. 94a an r.f. signal is represented and in Fig. 94b an a.f. signal is represented. (Scales are not, of course, correct.) If 94a is modulated by 94b the modulated wave will be of the type shown in Fig. 95. The line AB on Fig. 95 represents the mean value of the modulating signal and the ratio of x to y enables the percentage modulation to be calculated, i.e. percentage modulation

$$= \frac{x}{y} \times 100\%.$$

Obviously if x equals y the modulation must be 100%. A carrier modulated to 100% is shown in Fig. 96.

If modulation exceeds 100%, distortion will occur as the signal envelope is no longer the same shape as the modulating signal.

When a carrier is modulated the signal which is transmitted does in fact consist of three components, a carrier, an upper sideband and a lower sideband. If a carrier of 100kc/s is modulated by an a.f. signal of 10kc/s the transmitted signal would consist of three components—100kc/s (the carrier), 100kc/s+10kc/s (the upper sideband) and 100kc/s—10kc/ (the lower sideband). The modulating signal is carried by the sidebands.

10.7 Anode Modulating a Transmitter

A very common method of amplitude modulating a transmitter is anode modulation. The output from an audio amplifier (class A or B and generally push-pull) is passed, via a modulation transformer, to the anode voltage supply of the r.f. power amplifier valve. The modulation of the r.f. amplifier will be 100% when the output of the audio amplifier is such that the voltage appearing at the r.f. amplifier anode varies between 0 and 200% of its d.c. operating voltage.

In order to obtain 100% modulation the sine wave audio power output from the modulator

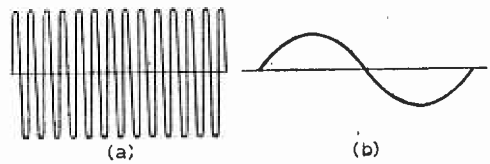

Fig. 94(a): The r.f. signal; (b): the a.f. signal.

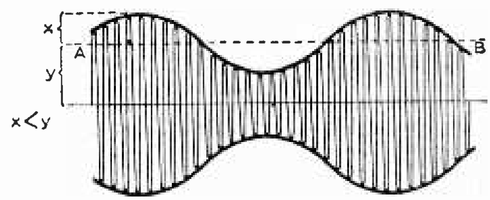

Fig. 95: Here the r.f. signal has been modulated by the a.f.

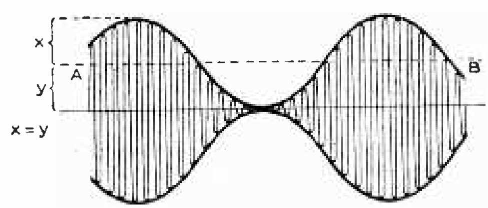

Fig. 96: 100% modulation.

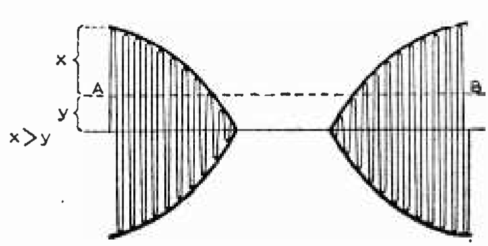

Fig. 97: Modulation in excess of 100%.

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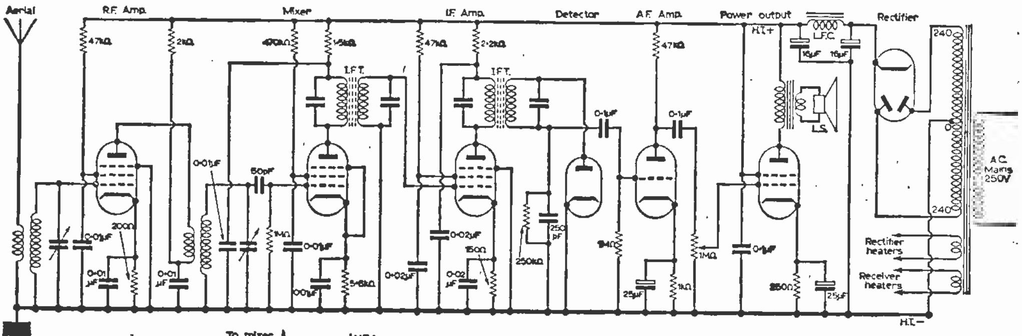

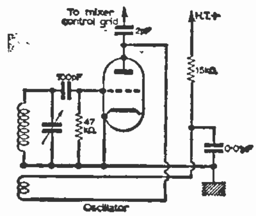

Fig. 98: A typical superhet circuit which would fulfil the requirements of last month's question. It should be remembered however that there could be many variations to this circuit and therefore many correct solutions.

must be at least half of the d.c. power input to the r.f. amplifier.

Readers are advised to study also control grid modulation, screen grid modulation and cathode modulation.

Question.—Draw diagrams of the type shown in Figs. 95, 96 and 97 to show a carrier wave modulated to—

(a) 50%—let x be denoted by 50.
(b) 75%— „ „ „ „ „ 75.
(c) 150%— „ „ „ „ „ 150.

Last Month's Question.—A typical answer to this question is as shown in Fig. 98.

PART II NEXT MONTH

SOLAR-POWERED POCKET RECEIVER

—continued from page 302

compromise between the signal direction and the light direction has to be made.

The total cost of the final receiver was about £3, but this may be reduced considerably by using an International Rectifier B2M solar cell, price 15s.

The effect of adding a second transistor was negligible but further experiments may prove fruitful. The final circuit appears so simple that to many it would appear inconceivable that it works, yet it does. Surely in this circuit the transistor is operating to its capabilities (as they should in all circuits). The field of light operated transistor circuits appears to be almost untouched by experimenters, both amateur and professional (what about Sinclair Radionics Ltd. and others?). The writer would be very interested in receiving details of similar experiments carried out by readers.

PHOTOCELL CIRCUITS

—continued from page 326

by the device has a definite ending (e.g. garage door opening, gate opening, etc.) the output from the gate can be made to set a bistable which controls the opening motor. A limit switch can then be used to reset the bistable when the doors have opened.

No particular transistor is specified for the bulk of the circuit as almost any type will do except surface barrier types.

Fig. 6 shows a suitable relay drive circuit which may be tacked on to any bistable or monostable designed for these supply voltages and with a collector resistance of around 1·5kΩ.

For simple on/off applications the photocell should be mounted in a lightproof box painted matt black inside. A simple lens system using two converging lenses with the cell and lamp filament at the foci will do. The cell lens should be shielded by a tube painted matt black inside so that light can only enter from sources along the axis of the tube.

The constructor who has some old glass encapsulated transistors which are lightproofed with black paint might like to try making his own photocell by scraping off the paint. The paint can easily be scraped off with a penknife and should be removed from the rounded top end and for about 2mm down the side. The capsule will be filled with blue, white, greyish or transparent grease. Obviously the transparent grease types are best and the blue and white types are no good at all; it is best to repaint them for future use. The scraped transistor will function as a photoconductive cell (emitter +ve) with the base open circuit, but for best results try a resistance between base and emitter. The value will be between 5 and 100kΩ and can be found experimentally. Photocells made in this way will not be as sensitive as proper ones but can be made to work perfectly well by the use of a suitable transistor amplifier stage.

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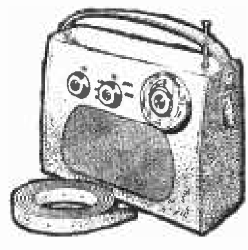

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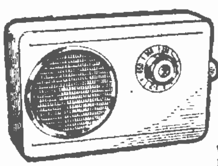

"Transona Five" size 6¼ x 4¼ x 1½in. approx.

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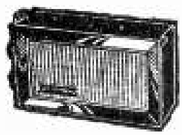

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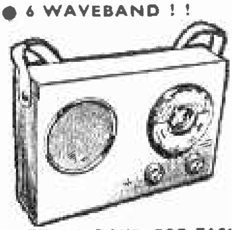

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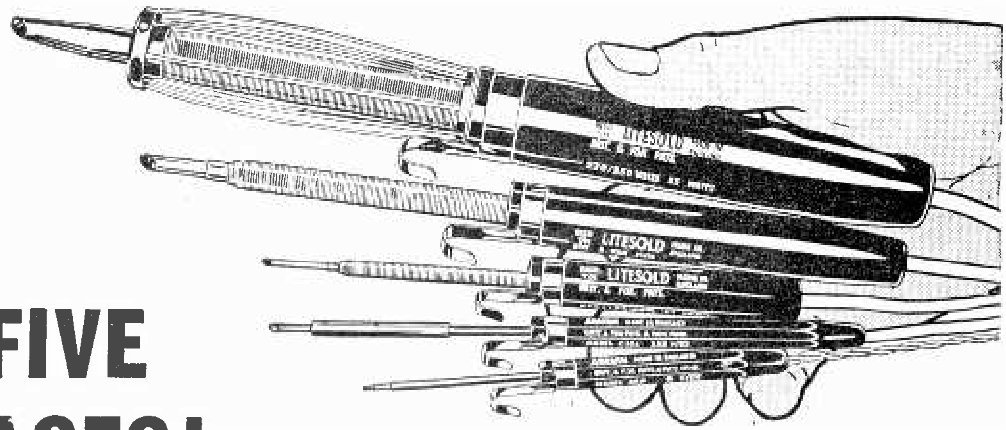

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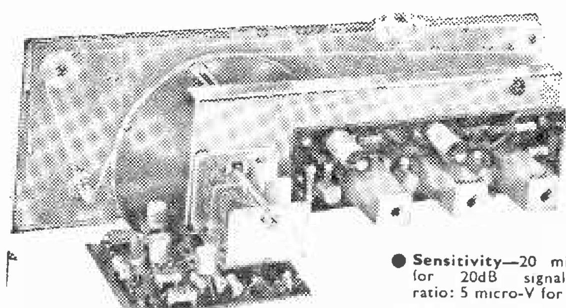

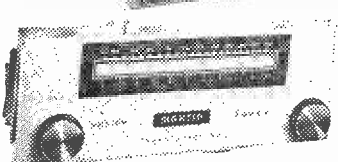

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A COMMENTARY BY HENRY

PRACTICALLY WIRELESS

No. 12 Little Bittery

THE Radio and Electronic Component Show was held at Olympia from May 18th to 21st.

The old joke about disposable sets—you know, throw it away when the battery runs out—is coming uncomfortably close to reality.

Of the 300 firms exhibiting, more than twenty were making a thing of micro-miniaturisation. Despite the off-hand attitude of one demonstrator, *"Needn't bother us, old boy. Thing of the future, what?"* I was impressed by the strides recently made by some of the firms we have always regarded as stick-in-the-mud reactionaries. Tiny switches, banks of printed-foil circuits, combination components, and everywhere that with-it word Integration. If a circuit is not integrated nowadays, nobody wants to know.

The ultimate seems to be achieved when our old friends Mullard come up with a three-stage amplifier about the size of a soldered joint. As one critic said: *"What's the point if the piece of equipment is smaller than the knob which is being used to control it?"*

Whatever the PRO boys may tell you, quoting reliability, efficiency, weight-cost factor, serviceability, etc., it boils down to one essential: is the tiny fellow going to be cheaper to produce, in quantity than the hand-assembled juggernaut it transplaces? And the answer appears to be Yes. Modern methods have found ways of whittling down capacitors and reducing resistors to strips of etching.

Who makes these things?

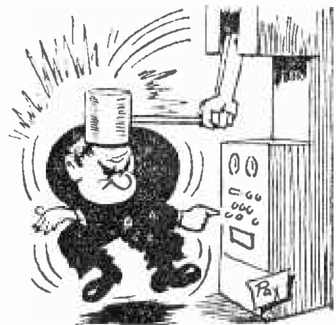
So far, the problem of reducing inductors physically has proved difficult, but the bright lads at Manchester University have been playing about with that one. They have already used computer control on a thin film micro-circuit to prove what can be packed into its 1 square millimetre area and come up with the amazing answer of 100 passive elements. That is equivalent, to save you reaching for the slide rule, to 70,000 per square inch. So, in the space taken up by that coil you can make up practically any R-C combination you wish to supersede it.

Certainly, the modules shown by Erie had quite a few identifiable bits packed into them, and the sub-miniature switches by Elcom and Arrow made one want to hide one's clumsy fingers.

Who makes these things? we wanted to know. How the dickens are they assembled? And the answer, as we might have expected, is that magic word "automation". Cassandra Henry has already commented on the machine that is more reliable than the circuit designer. Here, at Olympia, we saw machines ten times more reliable at fault tracing than any engineer.

Elliott-Automation had an automatic circuit tester that monitors up to 1,000 contact points for continuity and insulation at a rate of ten tests a second. Faster than our apprentice as clocking-off time approaches.

More threatening still, from Solartron we hear of a machine which is programmed to allow



The machine prevents him

the operator to carry out a sequence of tests, or make connections. But if he makes a wrong connection in the sequence, the machine *prevents him* from making the next move. I was afraid to ask how!

Flexible printed circuits—no, not those from certain portable radios which the makers really intended to be rigid — but genuinely flappable boards, copper-clad laminate that could be bent and shaped without cracks in the foil appearing. That's another thing on the way —as Formica and Electroprints Ltd. showed us. This seems to promise much fun in the workshop.

Yet another aspect of the modern trend is the increasing use of "precious metals". There are firms specialising in the plating of switch contacts with not only silver and platinum, but gold, rhodium and palladium.

With memories of the old days, when circuits were laboriously screwed together by hand, when scraping off a resistor was the accepted method of modification, when the nearest approach to integration were those horrible "blocks" of components covered with shiny black pitch, Henry is not at all sure whether he will be able to bring himself to throw away his radio each time the sun goes in and his solar cell runs down.

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A DIRECTION FINDER for Small Craft

by F. C. Judd

PART TWO

FULL constructional details of this receiver were given in Part 1, together with calibration procedure and notes on the Radio Information Charts which are essential when using the long wave marine radiobeacons. This part deals with a suitable mounting for the receiver and gives further notes on calibration and testing, etc.

Receiver Mounting

The receiver is much easier to handle if it can be rotated through 360° by mounting it on a heavy base as shown in Fig. 8. The base could be made of wood, preferably loaded with brass or lead or, better still, made entirely of brass. A cast-iron base could also be used, in fact the one shown in the photograph in Part 1 is cast-iron. In this case, however, careful checks must be carried out to ensure that it does not interfere with the compass. A 360° protractor, obtainable from most large stationers, should be screwed to the top of the base, for this is most useful when working against the heading of a vessel or when there is no alteration in position, i.e. when the vessel is at anchor. A small pointer is attached to the bottom of the receiver case for use with the bearing scale.

The receiver could, of course, be permanently mounted in a vessel providing it (the receiver) can be rotated through 360°. In this case a compass need not be fixed to the receiver but the bearing scale would have to be used in conjunction with the compass on the vessel.

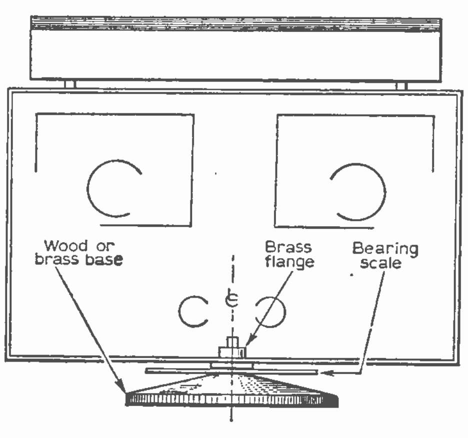

Fig. 8: A suitable mounting arrangement for rotating the receiver on a heavy base.

Calibration of the Tuning Dials

The tuning dials, which are small Data Panel Signs (100° type), require pointers which can be attached to the flanges of the Jackson epicyclic ball drives. These pointers can be cut from thin perspex or stout celluloid and shaped and drilled as in Fig. 9. The tuning control knobs can be left to the discretion of the constructor.

The actual calibration of the tuning dials has already been dealt with but as a further guide the diagram in Fig. 10 may prove useful. It is, however, very important that the exact tuning point of each radiobeacon group frequency is known. As it is difficult to mark the actual spot frequencies on the r.f./oscillator dial it is suggested that a separate calibration chart is compiled, this being mounted on stiff card and protected by a celluloid cover.

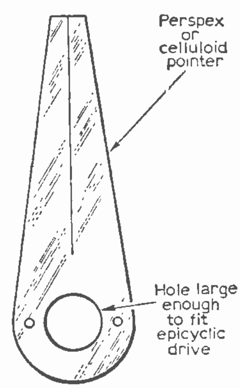

Fig. 9: Two of these perspex tuning dial pointers are required.

Testing the Receiver

Preliminary tests and approximate tuning, etc., can be carried out with a long aerial loosely coupled to the ferrite aerial coil via a small series capacitor. This will allow the radiobeacons to come in quite strongly, but as soon as initial alignment has been completed, close calibration, etc., should be carried out with the band switch in position 3 (d.f.) and any other aerial disconnected. Remember, you may not hear a particular radiobeacon if the ferrite aerial happens to be *end on* (in the null position) to that particular station. When listening for different stations in different

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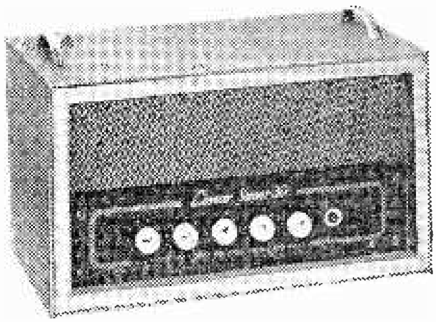

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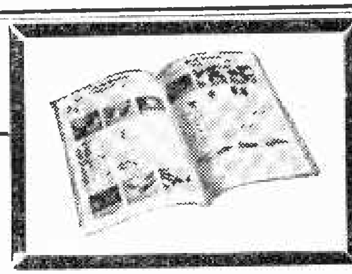

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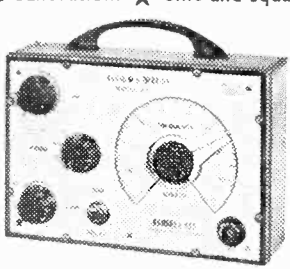

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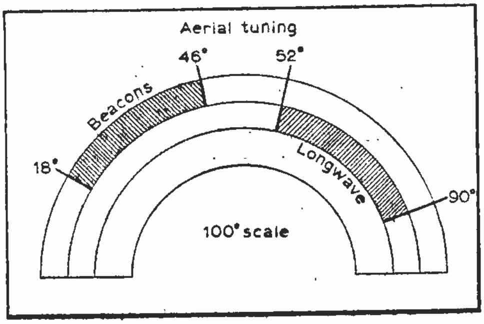

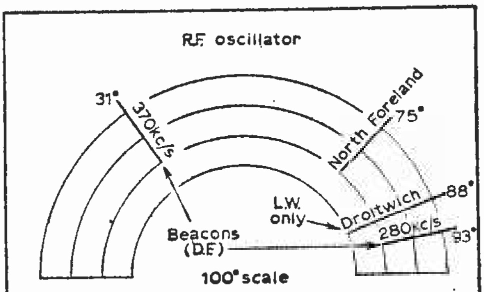

Fig. 10: The aerial and r.f. oscillator tuning dials after calibration.

groups, etc., it is essential to work with the Radio Information Charts, a compass and a protractor, so that whilst calibration is being carried out maximum signals can be maintained with the ferrite aerial *broadside* to the station.

Use of the telescopic aerial will alter the tuning of the ferrite aerial slightly, but remember, *this aerial is only an aid to finding weaker signals and must not be used when direction finding.*

The final calibration of the dials or the making of a calibration chart requires infinite patience, since it may be necessary to wait for each particular group to operate. It is, of course, only necessary to identify one station in a group working on a particular frequency and it does not follow that all the stations in a group will be heard. These stations use quite low power (10 to 20W) and a good deal depends on propagation conditions as to whether they will be received inland.

D.F. and Compass Checks

On no account should d.f. checks be carried out at night as errors may occur through so-called "night conditions" which cause the signals to arrive by different paths. When, and only when, you are satisfied with the calibration, d.f. and compass checks should the receiver be used under working conditions. **On no account should one blindly rely on a radiobeacon d.f. receiver whether made commercially or home constructed. Radio direction finding is a navigation aid, not a method of navigation.** Like other navigation aids a d.f. receiver is used mainly to confirm position as otherwise plotted by compass and charts.

It is interesting to note that whilst we were carrying out d.f. checks with this receiver in the North Sea and in thick fog at that (see last month's cover), two other small cruisers hailed us to enquire as to where they were. They also requested direction to a particular position on the mainland. This information, confirmed also by our own d.f. fixes, depth finder readings and compass and chart navigation, we were able to give. To our great surprise, however, both cruiser skippers then admitted *that neither had even a compass ! !* We pointed into the fog and they went thataway! !

The Radio Information Charts

Details of these charts were given earlier, and it must be emphasised that they are not suitable for navigation of any kind. The charts merely show the positions of the radiobeacons on a large scale. The exact position in latitude and longitude of all the radiobeacons is, however, given in the tables printed on the charts. These should be used in conjunction with standard navigation charts. The Radio Information charts also give precise details of frequencies, groups and sequences as well as radiotelephone, British Coastal radio stations and Aircraft beacons. The latter can be received with the d.f. receiver but should be used with caution as most of them are inland which may result in serious bearing errors.

Finally, when using a d.f. receiver, it is necessary to be aware of the various reasons for bearing errors. These can be due to (a) night effects when signals arrive at the receiving aerial by two different propagation paths, (b) reflection from high land such as cliff faces, (c) reflection from other aerials or stay wires or even from metal structures on the vessel.

Errors in plotting can also occur, especially when converting magnetic to true bearing or vice versa and in taking into account the heading of the vessel which is usually from magnetic compass. Remember the d.f. aerial will indicate a true bearing and the difference between this and a magnetic compass reading is approximately seven degrees. Up to date navigation charts will show the exact deviation.

Radio on Yachts and Cruisers

The ordinary broadcast receiving licence authorises the reception of programmes sent only from authorised broadcasting stations for general reception. It does *not* permit the reception of messages from coast stations, ship stations, special service stations and radio navigation stations. If reception of messages etc., from these stations is desired (this includes marine radiobeacons) a special "ship" receiving licence is required. This does, however, cover broadcast station reception as well and can be obtained from the Radio Services Department, W.T.S. G.P.O., London, E.C.1. The licence costs £1 per year.

Useful References to Radio Navigation etc.

Admiralty list of Radio Signals and R.D.F. Stations and Beacons Vol. 2 27s. 6d.

Motor Boat and Yachting Manual 17th Edition 21s. Temple Press Books

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BOOKS REVIEWED

AMATEUR RADIO CIRCUITS BOOK, compiled by G. R. Jessop, A.M.I.E.R.E., G6JP.
Published by the Radio Society of Great Britain.
96 pages. Size 9¾in. x 7¼in. Price 8s. 6d. post paid.

IF you were asked to find the circuits of a 3·5Mc/s transistor transmitter, a Q-multiplier, a cathode modulator and an electronic T/R switch, it is highly probable that you would have to search through a number of books and sort issues of magazines in order to find them.

Amateur Radio Circuits Book is a collection of some 150 circuits liable to prove useful to the average ham. Transmitters, front ends, oscillators, power supplies, noise limiters, and a host of other items. There are circuit diagrams only, for the person who needs just this and values.

At first sight this appears a most excellent book, but a second more detailed reading brings disappointments. For although the drawings score full marks many details are omitted.

The first page depicts an A.T.U. We are shown how the coils are mounted, informed that the diameter should be 2½ and 3 inches and that 14s.w.g. is suitable. But not told how many turns, or even the inductance.

It is this lack of odd bits of information which spoils the ship. A 15W transistor transmitter has all the information except the transistor types. A d.c. amplifier has no transistor type or voltages specified for the two batteries. And so on.

The idea of having all those useful circuits together in one volume is excellent, but it is to be hoped that when second edition time comes around the editor will have filled in the few remaining details.—*F.H.S.*

THE OSCILLOSCOPE, by George Zwick.
Published by Gernsback Library Inc., New York, N.Y.
224 pp. 8½in. x 5½in., paper back. Price 28s.

MANY books have been written about the uses and applications of the oscilloscope. It is a great pity that these are studied only by the committed reader, the experimenter, would-be constructor, student, etc. The man with his cobwebbed 'scope, past its first intriguing fascination, hidden in a corner of his den, seldom finds the book to suit him. And the technician who brings his workshop instrument into occasional use often has no idea of its potentialities.

This book does much to remedy the defect. It first appeared in February, 1963, and has already in March, 1964, come out with a healthy reprint. Its virtue is the method of presentation, rather like an amplified operating manual. As such it should appeal both to the inquiring experimenter and the man at the service bench.

The first four chapters are descriptive. Chapter 1 discusses waveforms, laying the ground for later works. Chapters 2 and 3 cover the theory of the cathode ray tube and the principle of sweep systems. In Chapter 4 a more practical approach is introduced. Detailed descriptions of both general purpose and laboratory type oscilloscopes are given with 21 diagrams of the vital portions of circuitry.

From this point we enter the field of application. Chapter 5 is a long one, dealing with alignment. Although it is obvious that precise instructions cannot be given because of variations of circuit design a valiant attempt has been made to cover the many possibilities. Chapter 6, on Oscilloscope Techniques, underlines this practice and could profitably have been juxtaposed. There is much useful information in these 24 pages.

More applications are to be found in the next chapter, dealing with tests and measurements. Audio experimenters and students of electronics would find several points of interest; the "hooking-up" details, so often ignored in more technical works, are meticulously outlined. Values of network components, too, are not ignored.

In the final chapter this is carried a step farther by the explicit instruction in 16 useful experiments. We should like to have seen the "hook-up" diagram continued in this chapter but by the time this stage is reached the student should be able to cope.

Both as general reading and as a bench-side reference this book is to be recommended.—*H.W.H.*

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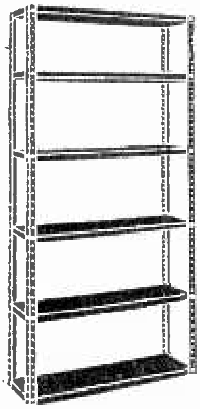

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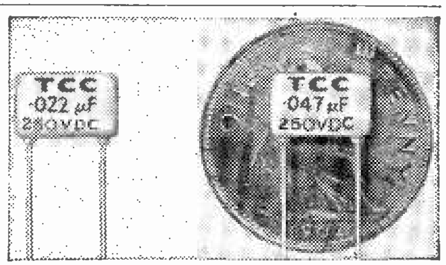

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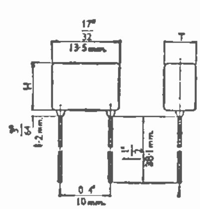
0.047	11/32" 9mm	7/32" 5.5mm	PMX3
0.1	7/16" 11mm	9/32" 7·2mm	PMX4



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by G. H. Meeten

THE instrument to be described was intended for use as an indicator of resonance while making r.f. measurements. Its range is 0·1 to 1V peak, approximately, with a high input impedance. It was felt advantageous to use a circuit giving a known scale law so that no calibration of the movement would be necessary, also making the instrument generally more useful. To fulfil these conditions the Moullin or anode-bend circuit was chosen. In this simple, well-known circuit a triode is biassed almost to cut-off, and if the V_g–I_a characteristic of the valve is non-linear in this region, partial rectification takes place as shown in Fig. 1.

In particular, if the characteristic can be represented by the relation $I_a = aV_g^2 + bV_g + c$, where a, b, c are constant for a particular value of the anode potential, then analysis shows that when the input e.m.f. to the grid is of the form $v = V_{pk} \sin \omega t$, the mean value of the increase in anode current is $\frac{a}{2} V_{pk}^2$, where V_{pk} is the peak e.m.f. Hence a square-law scale can be produced. This means that true r.m.s. values can be read, independent of the input waveform.

CHOOSING A VALVE

The following valves were measured (all pentodes and tetrodes being connected as triodes) to determine the form of the $V_g - I_a$ curve when using 9 volts anode potential. IT4, EF91, 12AT7, 3S4, CK503AX. The 3S4 and CK503AX gave the most promising results when plotting $\frac{d I_a}{d V_g}$ against V_g, which should be a straight line if the $V_g - I_a$ curve is of the required form. The CK503AX is a miniature wire-ended output tetrode. It was decided to use the 3S4 (a battery powered output tetrode) since it is more readily obtainable. The 3S4 filament is tapped and, except where stated, half the filament is unused, the valve taking 50mA at 1·4V.

WORKING POINTS

The basic circuit, shown in Fig. 2, is self-explanatory. The potentiometer across the filament ensures that V_b is the true bias on the grid.

It was stated above that the change of anode current, which will be called ΔI_a, was equal to $\frac{a}{2} V_{pk}^2$, assuming parabolic $V_g - I_a$ characteristics.

In practice there is a best value of V_b for a maximum ΔI_a as the graph of Fig. 3 shows. It was drawn using

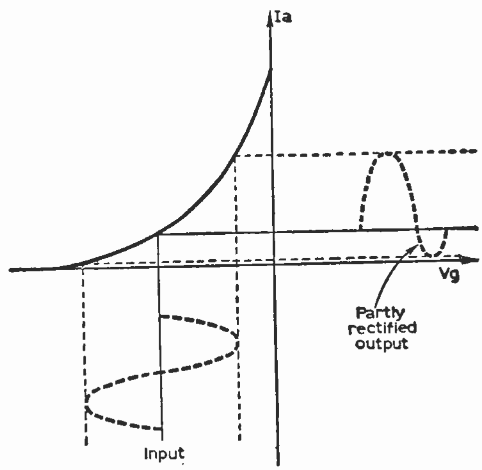

Fig. 1: Partial rectification occuring in the non-linear section of a triode characteristic.

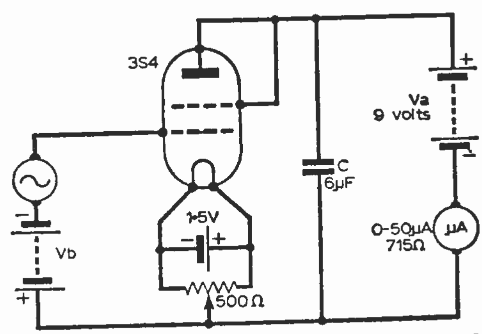

Fig. 2: The basic circuit. A conducting source of e.m.f. is assumed.

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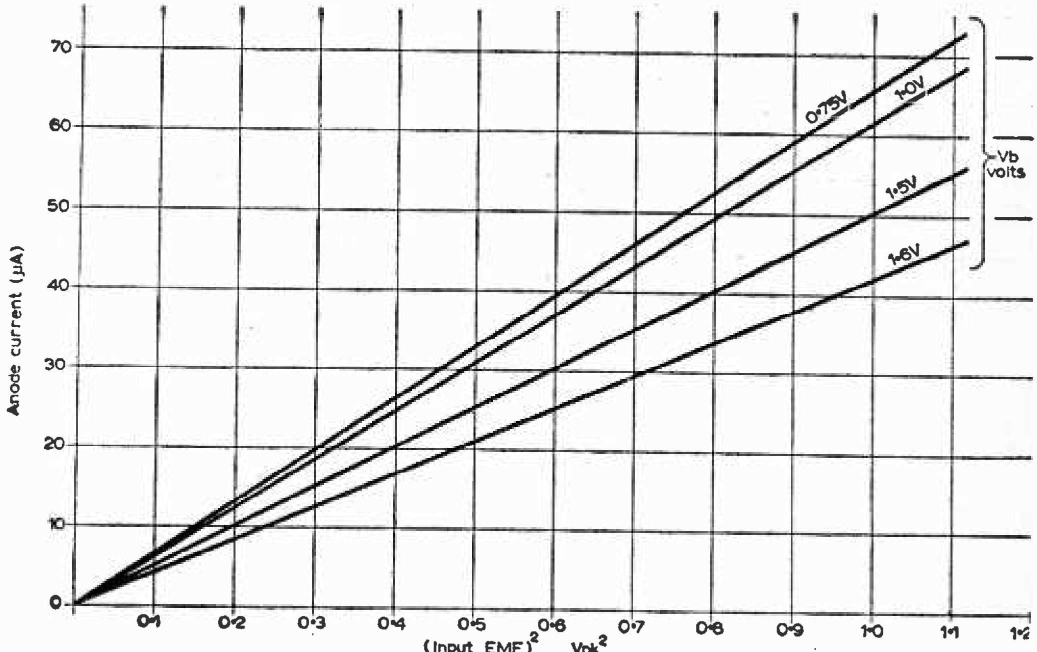
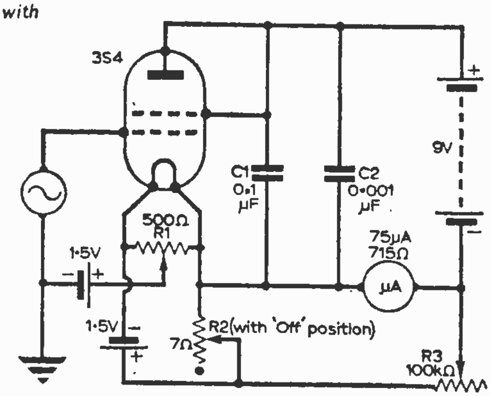


Fig. 3: Illustrating variation of sensitivity and linearity with bias (Vb).

Fig. 4 (right): The complete circuit. Backing-off current is taken from the heater supply cell.



the circuit of Fig. 2 with V_b variable and a source frequency of 50 c/s.

It can be seen from Fig. 3 that although the square-law is true approximately for a range of V_b, it is best when $V_b = 1{\cdot}5$V or greater, but the sensitivity falls as V_b increases. A bias of $-1{\cdot}5$V is a good compromise between sensitivity and linearity and is also the e.m.f. of a single dry cell. A mercury cell could be used with a little loss of linearity and negligible current is drawn.

It was found that if all the filament of the 3S4 was used i.e. 0·1A at 1·4V, then ΔI_a for any given V_b was approximately doubled, but a greater non-square linearity was also incurred. Since the use of dry cells was contemplated the 50mA consumption will be used henceforth.

The complete circuit is shown in Fig. 4. The meter movement is backed off with an equal and opposite current to the standing anode current with no signal which was approximately 80μA.

The values of the resistors and capacitors are not at all critical. The following are the components used in the original:

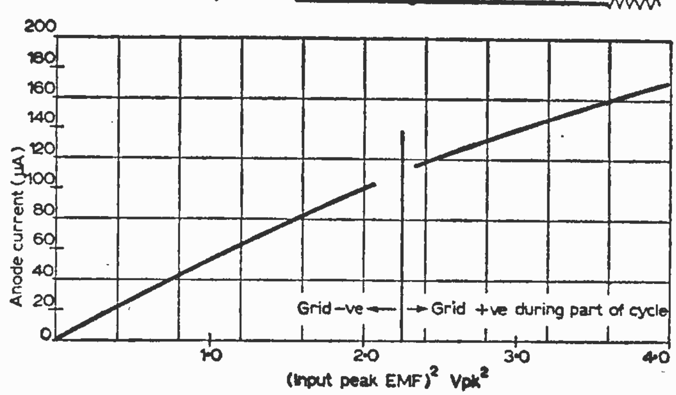


Fig. 5: Large signal characteristics showing the effect of driving the grid positive.

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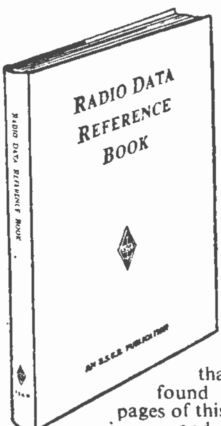

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Compiled by

G. R. JESSOP, A.M.I.E.R.E.

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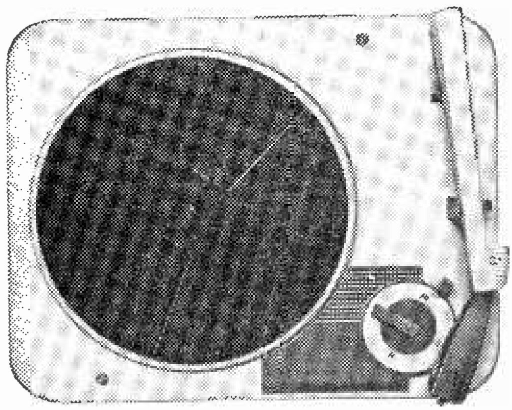

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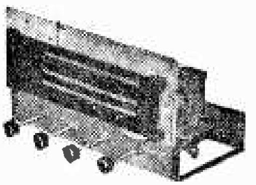

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Med. and VHF 190 M-550 M, 85 Mc/s-103 Mc/s, 6 valves and metal rectifier. Self contained power unit. AC 200-250 v. operation. Magic eye indicator, 3 push-button controls on/off. Med., VHF diode and high output sockets with gain control. Illuminated 2-col. perspex dial 11½ x 4in. Chassis 11½ x 4 x 5½in. A recommended Fidelity Unit for use with Mullard 3/3 5-10 amplifiers. Available only at present as built up units, aligned and tested ready for use. Bargain price £12.10.0, carr. 5/-. We hope to produce this popular unit in kit form very shortly.

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Designer-approved kits available.

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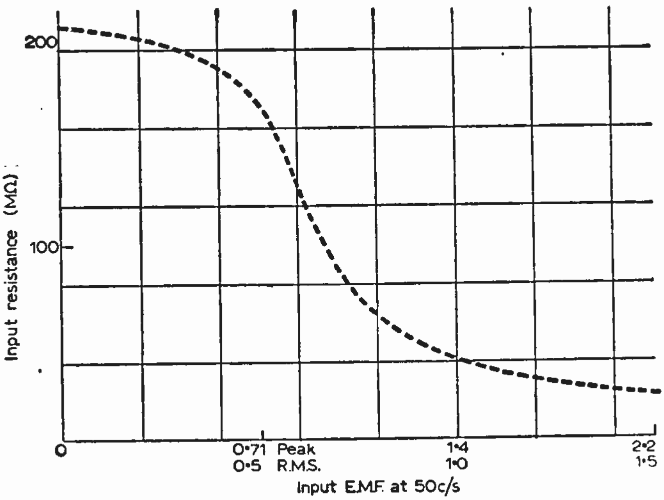

Fig. 6 (left): Illustrating the variation of input resistance with input e.m.f.

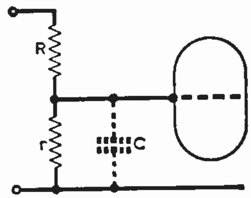

Fig. 7: The input capacitance (dotted) in parallel with the potential divider arm.

R1	500 Ω	wire-wound
R2	7 Ω	wire-wound with filament on/off switch.
R3	100k Ω	carbon
C1	0·1 μF	paper
C2	0·001 μF	ceramic

Meter 0–75μa, 715 Ω movement.

If a multi-range instrument is used for the detector it should be of roughly constant input resistance from one range to the next or the sensitivity, i.e. the slope of the $V_{pk}^2 - \Delta I_a$ graph will vary.

SQUARE-LAW LINEARITY

The degree of square-law linearity and the effect of bias upon it is shown in Fig. 3. The effect of driving the grid positive is shown in Fig. 5. The grid is made positive when the peak input signal exceeds the standing bias. When the grid is positive, grid current flows, which is equivalent to saying that not all the electrons from the cathode reach the anode. Hence a lowering of anode current change and sensitivity as Fig. 5 shows. The over-all increase in anode current can be explained by the positive grid now attracting more electrons from the cathode than were formerly emitted. It can be seen that the square-law is not quite true for large input e.m.f. even when the grid is negative.

INPUT IMPEDANCE

If the input of the voltmeter can be assumed to consist of an input resistance R in parallel with an input capacitance C then simple measurements can be made, to arrive at an estimate of R if C is known (or vice-versa). If ΔI_{a1} is the current change when the voltmeter is fed from a low impedance source, and ΔI_{a2} is the reading when the voltmeter grid is connected to the same source by a high resistance R_1 ohms, then it can be shown that:

$$R = \frac{R_1}{\sqrt{[(n-1)^2 + \omega^2 R_1^2 C^2]}}$$

where R and C are defined above, ω is the angular source frequency and $n^2 = \dfrac{\Delta I_{a1}}{\Delta I_{a2}}$

C includes the capacitance of the wiring in the grid circuit and between the grid and other electrodes. An average value is about 15pF. A graph of input resistance R with input e.m.f. is shown in Fig. 6, in which C=15pF is assumed. The decrease of input resistance is due to the increasing number of electrons reaching the grid as it becomes more positive. The input resistance is however still greater than 30M Ω when the grid is being driven positive during part of the input cycle.

CALIBRATION

It should be stressed that permanent calibration of the instrument is not readily obtainable without voltage stabilisation of the supply power. The square law however is valid over a fairly wide range of battery ageing and for many purposes only the ratio of two e.m.f.'s need be known.

FREQUENCY RANGE

The original instrument was used at all frequencies between 25c/s and 25Mc/s; beyond these limits it was not tested. The Moullin instrument of the 'twenties was stated to be useful up to about 30Mc/s.

—continued on page 354

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CLUB NEWS

BRADFORD RADIO SOCIETY
Hon. Sec.: J. D. Midgley, G3SAO, 77 Brantwood Road, Bradford 9, Yorkshire.

Meetings are now held in the Bradford Technical College, and the callsign G3NN has been issued for the Club station, G30TO.

There was an "inquest" on the N.F.D. on 22nd June.

COVENTRY AMATEUR RADIO SOCIETY
Hon. Sec.: A. J. Wilkes, G3PQQ, 141 Overslade Crescent, Coundon, Coventry.

The Society will be taking part in the N.F.D. event again after an absence of many years.

DERBY AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: F. C. Ward, G2CVV, 5 Uplands Avenue, Littleover, Derby.

Raymond F. Street gave a lecture entitled "Introduction to Colour Television" on 23rd June, and on the 30th G. D. Kelsey, B.Sc., discussed the problems of Effluent and its Treatment.

On 3rd—4th July, the 144 Mc/s (portable event) was held, and on 17th July there will be a Garden Party and Exhibition at Heanor Aldecar Secondary School.

HALIFAX AND DISTRICT AMATEUR RADIO SOCIETY
Hon. Sec.: J. Ingham, G3RMQ, Lambert House, Greetland, Halifax, Yorkshire.

On 27th July, G. Drake, G3SJG, will give a talk on Transmitters, and on 24th August, there will be a lecture by F. Nicholls, G3MAX and a visit from the Huddersfield Radio Society.

HUDDERSFIELD AMATEUR RADIO SOCIETY
Hon. Sec.: R. Higton, 5 Brian Avenue, Dalton, Huddersfield, Yorkshire.

Recently the Society held a lecture and demonstration on Oscilloscopes. The Society operating QTH has proved very good with G DX in mind, using a 250ft. dipole.

MID-WARWICKSHIRE AMATEUR RADIO SOCIETY
Hon. Sec.: H. C. Loxley, 5 Guy Street, Warwick.

There will be an open meeting on 12th July, when members will be able to discuss a range of subjects.

Meetings are now held on the top floor of 7 Regent Grove, Leamington Spa. These premises are well situated in the centre o the town, close to main bus routes and with ample car-parking accommodation.

NORTHERN HEIGHTS AMATEUR RADIO SOCIETY
Hon. Sec.: A. Robinson, G3MDW, Candy Cabin, Ogden, Halifax, Yorkshire.

Recent activities of the Club have been a recorded lecture by the late G2SU who was a founder-member; and the first of this year's demonstrations when the Club callsign was first used.

A novel innovation this year was a mobile car in the Warley Gala procession which was able to report back to the fixed station on the progress of the parade.

Some future events will include, on 21st July a Ragchew and on 4th August, a lecture on D.F. Equipment by G3LGN.

READING AMATEUR RADIO CLUB
Hon. Sec.: N. C. Taylor, G3TOQ, 83 Stoneham Close, Tilehurst, Reading, Berkshire.

The first Mobile Picnic of the season was held on 20th June, and a good time was had by all. Talk-in stations were operated by G3TOQ on 2 metres and G3EJA on 160 metres.

SALTASH AND DISTRICT AMATEUR RADIO CLUB
Hon. Sec.: D.Bowers, BRS 26760, 95 Grenfell Avenue, Saltash, Cornwall.

A "Mobile Rally" was held at Calstock on Whit Monday, 7th June, and on the 18th, there was a tape and slide lecture which was kindly loaned by Northern Heights A.R.S.

An R.S.G.B. Tape Lecture on Receivers was heard on 2nd July. There will be a Treasure Hunt on 16th July.

SOUTH BIRMINGHAM RADIO SOCIETY
Hon. Sec.: J. Rowley, G3TQO, 195 Castle Lane, Solihull.

On 17th June there was a demonstration and display of Heathkit Products and transmitters, receivers and test gear were on show for members to see.

SOUTHGATE, FINCHLEY AND DISTRICT GROUP OF THE R.S.G.B.
Hon. Sec.: R. Wilkinson, G3TXA, 23 Ashridge Gardens, Palmers Green, London, N.13.

The May lecture was given by G3OLE, who spoke about his "hybrid" mobile transmitter. The next meeting will be on 8th July.

SOUTH SHIELDS AND DISTRICT AMATEUR RADIO CLUB
Hon. Sec.: D. Forster, G3KZZ, 41 Marlborough Street, South Shields.

The Club is making preparations for its 6th Mobile Rally which is to be held on Sunday, 11th July at the Bents Park Recreation Ground, Coast Road, South Shields.

Meetings are held weekly on Friday evenings at 7.30 p.m., in Trinity House Social Centre, Laygate Lane, South Shields.

SPEN VALLEY AMATEUR RADIO SOCIETY
Hon. Sec.: N. Pride, 100 Raikes Lane, Birstall, Nr. Leeds.

On 24th June there was an Open and Final Meeting of the season. The A.G.M. of the New Session will be held on 8th July.

Meetings are held at 7.30 p.m. at Heckmondwike Grammar School.

WEST KENT AMATEUR RADIO SOCIETY
Hon. Sec.: H. F. Richards, 17 Reynolds Lane, Tunbridge Wells, Kent.

On 9th July, John Gould will give a talk entitled "Seventy C.M.S.", which is aimed at getting all the Club members on 430 Mc/s.

WIRRAL AMATEUR RADIO SOCIETY
Hon. Sec.: A. Seed, G3FOO, 31 Withert Avenue, Bebington, Wirral, Cheshire.

A Tape Lecture was given on 7th July. Meetings are held at Scout H.Q., Harding House, Park Road West, Claughton, Birkenhead, at 7.45 p.m. on the first and third Wednesdays in each month.

A BASIC MOULLIN VOLTMETER

—continued from previous page

CONSTRUCTION

No special construction is needed and the constructor may adopt any layout. The only wire that is at all critical is the grid lead. It should be short and well spaced from any other wires to minimise the input capacitance, and very well insulated. The input terminals should be well apart on a panel of insulating material and a ceramic valve-holder should be used. A high input resistance will not be obtained if the above is disregarded although of course the instrument will still work.

RANGE EXTENSION

Although a range of 0·1 to 1V peak is ample for radio-frequency measurements, i.e. measuring Q or self-capacitance of coils, an extension of range would make the instrument more versatile. It is however very difficult to do at high frequencies due to input capacitance. At low frequencies, when the reactance of the input capacitance is considerably less than the resistance of the potential divider in parallel with it, (see Fig. 7) it can be done.

The e.m.f. at the grid is then $\frac{r}{R+r}$ of the applied e.m.f. If a non-contributory source of e.m.f. is being used then the grid must be given a d.c. path to earth. This can be done with a high resistance, 5M Ω being a suitable value. The input resistance then drops to slightly below 5M Ω, but which is high enough for most purposes.

HiFi

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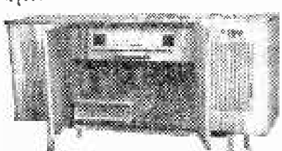

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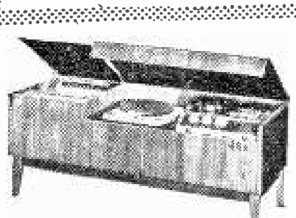

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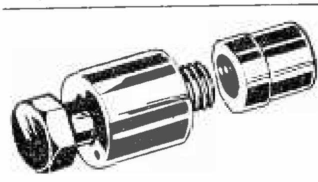

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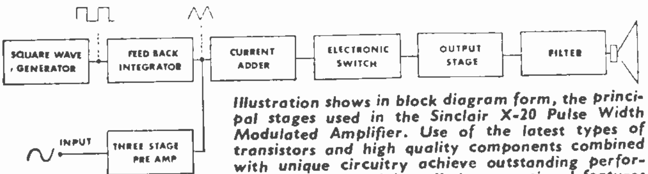

Illustration shows in block diagram form, the principal stages used in the Sinclair X-20 Pulse Width Modulated Amplifier. Use of the latest types of transistors and high quality components combined with unique circuitry achieve outstanding performance whilst retaining all the operational features of conventional quality amplifier design.

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- ★ Signal-to-noise ratio—better than 70 dB
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- ★ Built-in low pass filter cutting off above 20 Kc/s makes the X-20 widely tolerant of the load connected to it
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- ★ Superb quality and reliability
- ★ The opportunity to connect your own choice of tone control system

SINCLAIR X-10 P.W.M. SYSTEM

This superb Sinclair integrated P.W.M amplifier and pre-amp gives you all the advantages of quality and efficiency which makes these Sinclair designs so outstanding in every way, but it has less power than the X-20, and is suited to less spacious listening conditions. Prices are particularly attractive. *For 12–15V operation. Tone control system is added to choice.*

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X-20 integrated 20 watt P.W.M. Amplifier and Pre-amplifier

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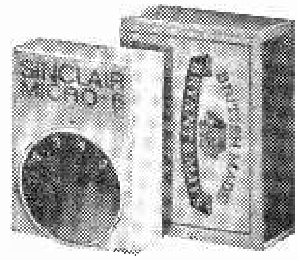

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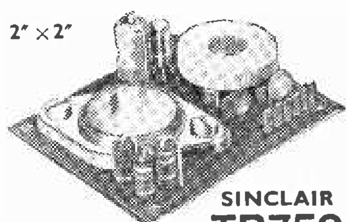

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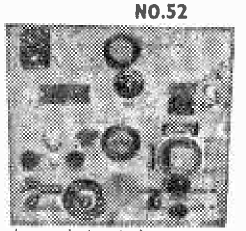

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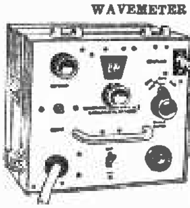

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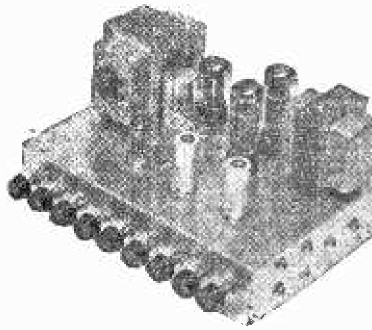

Five jack socket inputs, four with separate mixing volume controls, and one input "straight through". All inputs are of very high sensitivity only 10 millivolts input is required for full output, making them suitable for all types of guitars and microphones. Separate Bass and Treble controls, giving a wide range of lift and cut. Separate master gain control. Tremolo speed and depth controls. Jack socket for remote tremolo switching. Outputs for 3 and 15 ohms speakers. Valves used in the 30 watt and 50 watt amplifier ECC83, ECC83, EL34, EL34, GZ34. In the 15 watt amplifier ECC83, ECC83, EL84, EL84, EZ81. An extra valve ECC83 is used in the tremolo circuit. The chassis is complete with baseplate and is solidly made of 18 gauge steel, finished silver grey hammer. Size 12 x 8 x 6½ inches high.

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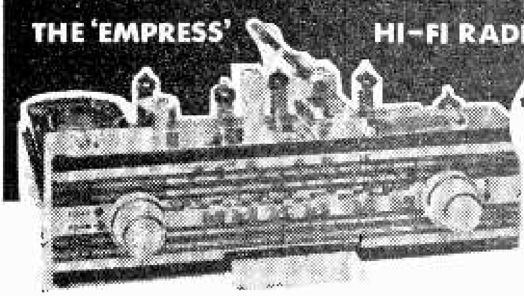

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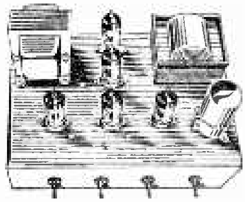

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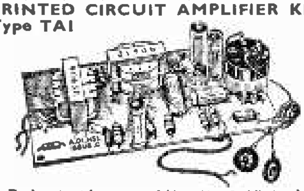

● Peak output in excess of 1½ watts. ● All standard British components. ● Built on printed circuit panel size 6 x 3in. ● Generous size Driver and Output Transformers. ● Output transformer tapped for 3 ohm and 15 ohm speakers. ● Transistors (GET 114) or 81 Mullard OC81D and matched pair of OC81 o/p ● 9 volt operation. ● Everything supplied wire battery clips solder etc. ● Comprehensive easy to follow instruction and circuit diagram 1/6. (Free with Kit). All parts sold separately.

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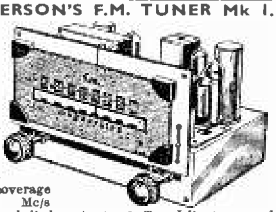

● F.M. tuning head by famous maker. ● Guaranteed non-drift ● Permeability tuning ● Frequency coverage 88-100 Mc/s ● Balanced diode output. ● Two I.F. stages and discriminator. ● Attractive maroon and gold dial (7 x 3in. glass). ● Self-powered using a good quality mains transformer and valve rectifier. ● Valves used ECC85 two EF80's and EZ80 (rectifier). ● Fully drilled chassis. ● Size of completed tuner 8 x 6 x 5½in. ● All parts sold separately Set of parts if purchased at one time £5.19.6. plus 8/6 P. & P. and ins. Circuit diagram and instructions 1/6 post free. **Mark II** Version as above but complete with magic eye front panel and brackets £6.12.6. P. & P. 8/6. **Mark III** Version as Mark I but with output stage. (ECL82) and tone control £7.7.0. P. & P. 8/6. **Handsome Metal Cabinets.** Choice of Black or Green. To fit Mark I, 25/-. P. & P. 3/-. To fit Mark II, 17/6. P. & P. 3/-.

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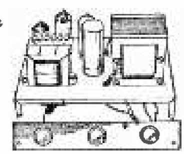

A really excellent all purpose A.C. mains 200/240v. **AMPLIFIER KIT TYPE HSL 'FOUR' 3 VALVE 4 WATT USING ECC83, EL84, EZ80, VALVES**

Special features include:

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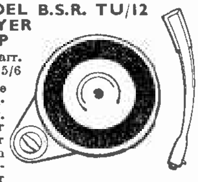

7in. metal turntable Low flutter performance. 200/250 v. shaded pole motor with 90 v. tap for valve heaters. High gain crystal pick-up with turnover LP/78 head complete with sapphire stylii.

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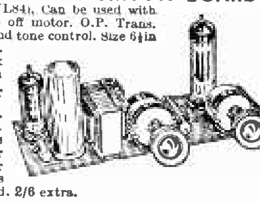

(UY85, UL84). Can be used with 80 v. tap off motor. O.P. Trans. volume and tone control. Size 6¼in wide x 2in. deep x 3¾in. high overall. ONLY 39/6. P. & P. 2/6. Mains dropper res. for filaments if required. 2/6 extra.

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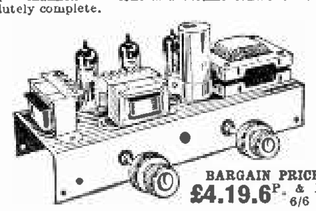

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SUPER DE LUXE version of above incorporating ECL86 valves separate bass and treble controls and full negative feed back. 8 gns. P. & P. 6/6.

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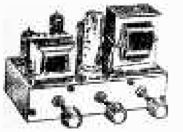

Designed for Hi-Fi reproduction of records A.C. Mains operation. Ready built on plated heavy gauge metal chassis size 7¼in. w. x 4in. d. x 4¾in. h. Incorporates ECC83, EL84, EZ80 valves, heavy duty double-wound mains transformer and output transformer matched for 3 ohm speaker, separate Bass, Treble and volume controls. Negative feedback line, Output 4½ watts. Front panel can be detached and leads extended for remote mounting of controls. The HA34 has been specially designed for us and our quantity order enables us to offer them complete with knobs, valves, etc. wired and tested for only **£4.5.0** P. & P. 6/-

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5in., 12/6; 6½in., 15/-; 8in., 21/-; 10in., 25/-; 12in., 27/6; (12in. 15 ohm, 30/-) 10in. x 6in., 26/-. E M I 13½ x 8in. with high flux ceramic magnet, 42/-; 15 ohm, 45/-.

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6AM6	2/6	ECC83	5/3	PL84	6/3
6K7G	1/3	ECC84	6/3	PY32	8/6
6K8G	3/3	ECC85	5/3	PY33	8/6
6Q7G	4/3	ECF80	7/6	PY80	4/9
6V6G	3/6	ECF82	6/-	PY81	5/3
12K8GT	8/6	FCH35	5/9	PY82	4/11
20P4	13/3	ECH42	7/9	PY83	5/6
20P5	11/6	ECH81	6/3	PY800	5/11
30FL1	9/6	ECL80	5/11	U25	8/-
30L15	10/3	ECL82	7/6	U26	8/6
30PL13	10/6	ECL86	8/-	U191	9/6
35L6GT	6/-	EF39	3/6	U301	11/-
85A2	5/9	EF41	5/9	U801	15/-
CL33	8/6	EF80	4/3	UABC80	5/-
DAC32	6/9	EF85	4/6	UAF42	6/11
DAF91	3/3	EF86	7/3	UBC41	6/-
DAF96	5/11	EF89	4/3	UBF80	5/6
DF33	7/6	EF91	2/6	UBF89	5/9
DF91	1/9	EL41	7/-	UCC84	7/11
DF96	5/11	EL84	4/9	UCC85	6/-
DK32	7/6	EY51	5/6	UCF80	8/3
DK91	4/-	EY86	5/6	UCH42	6/9
DK92	8/-	EZ40	6/6	UCH81	6/9
DK96	6/3	EZ80	3/9	UCL82	7/3
DL33	6/9	EZ81	4/3	UCL83	8/9
DL35	4/9	PCC84	5/6	UF41	6/3
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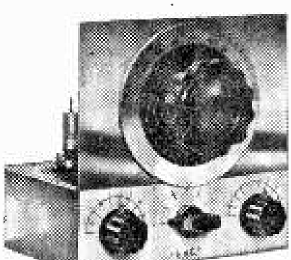

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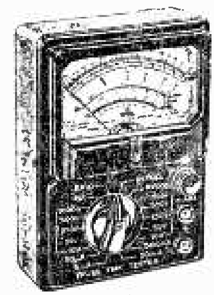

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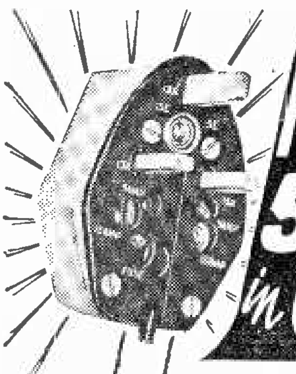

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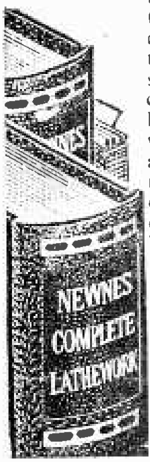

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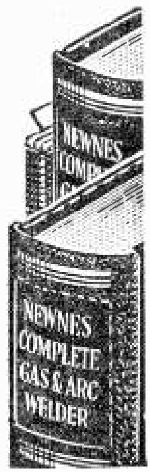

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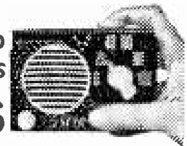

EVEN THE OLDER CHILDREN BUILD THEM! . . . no soldering—only 16 connections! then hear it reach out bringing in station after station, loud and clear. Palm-of-hand size 4½ x 2½ x 1½in. Many Testimonials: M.H. of Bradford, writes: *"... I have just completed one of your sets successfully, it is the first time I have ever tackled anything like a radio, and I must state here and now, I am amazed how easy it is to a layman like me. Your instructions and plan have obviously been very carefully thought out so that even the most dim can follow them . . ."* Direct from Manufacturers to You. Send 19/6 plus 2/6 post, etc.

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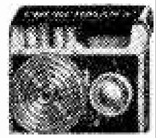
AMAZING CIGARETTE RADIO! ONLY 18/6



Yes, a perfectly ordinary packet of cigarettes! — but watch your friends astonishment on hearing it fetch in station after station, loud and clear! Still holds 10 Cigarettes—yet cleverly conceals highly sensitive, fully transistorised circuit (including tiny battery). Even a young boy can assemble it in under 2 hours. No soldering. No experience necessary. Only 16 connections to make. Ideal for taking to work with you. From our bulging testimonial file. Mr. D.B. of Huddersfield, writes: *"... I have fitted the parts in and it is working wonderfully . . ."* ALL PARTS including Semi-Conductors, A.B.C. Plans, etc. ONLY 18/6 plus 2/6 post etc.

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B.M. of HARROGATE writes *. . . I would like to thank you . . . It is a real bargain.*

L.S. of LONDON W.8 writes *. . . given it a good try out and . am very pleased with the results.*

S.B. of SOMERSET writes *. . . delighted with this radio . . . glad if you could send one more.*

D.R. of GLASGOW writes *. . . it is a lovely little thing and as clear as a bell.*

T.F. of STEVENAGE writes *I would just like to say how pleased my son is with this radio.*

J.W. of BRIGHTON writes *. . . I have recommended your radio to many of my friends.*

W.H. of MIDDLESEX writes *Thank you for my dear little radio. It is a real treasure to me.*

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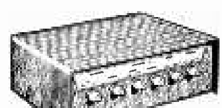
Roitone



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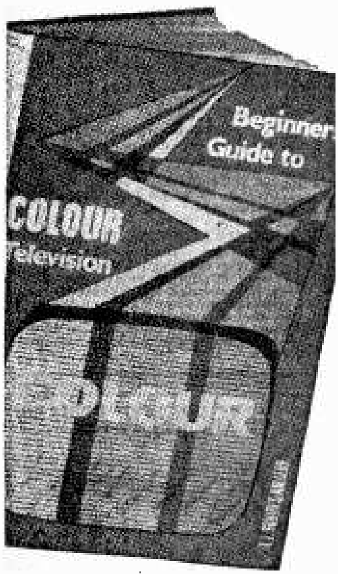

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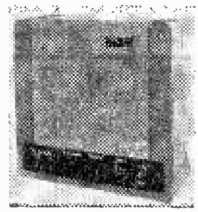

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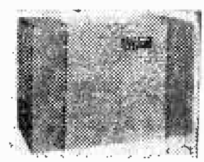

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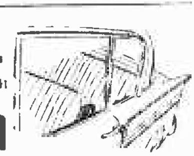

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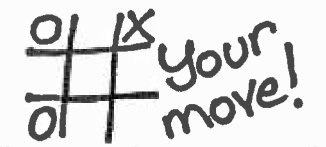

No doubt you will put your X between the two O's. The machine will then play O in the bottom right hand corner. Play what you will, the machine wins at the next move. This is just one of the games played on our Noughts and Crosses machine. As Brian Trueman of Granada TV said, after demonstrating the machine on television on April 12th. "I'm glad I wasn't playing it for money".
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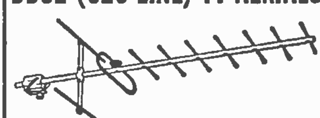

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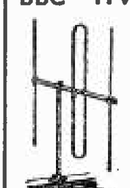

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(*a*) We cannot undertake to design equipment or to supply wiring diagrams or circuits, to individual requirements.

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PRACTICAL WIRELESS, AUGUST, 1965

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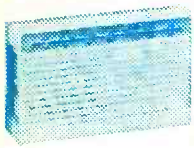

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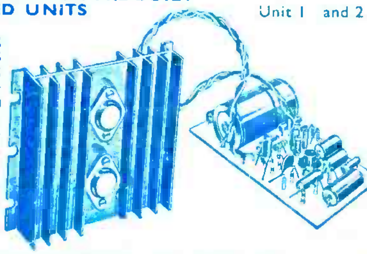

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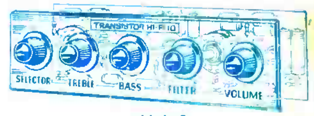

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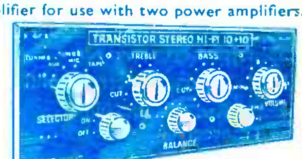

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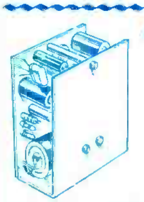

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