Official Radio Service Manual

Complete Directory of Commercial Wiring Diagrams
Official

Radio Service Manual

and

Complete Directory of

all Commercial Wiring

Diagrams of Receivers

PREPARED ESPECIALLY
FOR THE

RADIO SERVICE MAN

HUGO GERNSBACK
Editor

CLYDE FITCH
Managing Editor

Gernsback Publications, Inc.
Publishers
96-98 Park Place
New York

© 1930 By Gernsback Publications, Inc., Printed in U. S. A.
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Index to Commercial Diagrams</td>
<td>3, 4, 5, 6, 7</td>
</tr>
<tr>
<td>Introduction</td>
<td>8, 9</td>
</tr>
<tr>
<td><strong>Chapter I</strong></td>
<td></td>
</tr>
<tr>
<td>Service Equipment</td>
<td>10</td>
</tr>
<tr>
<td><strong>Chapter II</strong></td>
<td></td>
</tr>
<tr>
<td>General Service Procedure</td>
<td>15</td>
</tr>
<tr>
<td><strong>Chapter III</strong></td>
<td></td>
</tr>
<tr>
<td>Power Supply Systems</td>
<td>21</td>
</tr>
<tr>
<td><strong>Chapter IV</strong></td>
<td></td>
</tr>
<tr>
<td>Vacuum Tubes</td>
<td>31</td>
</tr>
<tr>
<td><strong>Chapter V</strong></td>
<td></td>
</tr>
<tr>
<td>The Loud Speaker</td>
<td>38</td>
</tr>
<tr>
<td><strong>Chapter VI</strong></td>
<td></td>
</tr>
<tr>
<td>The Antenna System</td>
<td>45</td>
</tr>
<tr>
<td><strong>Chapter VII</strong></td>
<td></td>
</tr>
<tr>
<td>Radio Frequency Amplifiers</td>
<td>50</td>
</tr>
<tr>
<td><strong>Chapter VIII</strong></td>
<td></td>
</tr>
<tr>
<td>Detectors</td>
<td>56</td>
</tr>
<tr>
<td><strong>Chapter IX</strong></td>
<td></td>
</tr>
<tr>
<td>Audio Frequency Amplifiers</td>
<td>60</td>
</tr>
<tr>
<td><strong>Chapter X</strong></td>
<td></td>
</tr>
<tr>
<td>Extraneous Noises and Their Origin</td>
<td>65</td>
</tr>
<tr>
<td><strong>Chapter XI</strong></td>
<td></td>
</tr>
<tr>
<td>Radio Phonograph Combinations</td>
<td>71</td>
</tr>
<tr>
<td>Short Wave Receivers</td>
<td>73</td>
</tr>
<tr>
<td>Servicing Automotive Radio</td>
<td>74</td>
</tr>
<tr>
<td>Standard Radio Symbols</td>
<td>76</td>
</tr>
<tr>
<td>Formulas for Determining Resistance Values</td>
<td>76</td>
</tr>
<tr>
<td>Commercial Wiring Diagrams</td>
<td>77 - 352</td>
</tr>
</tbody>
</table>
INDEX TO COMMERCIAL WIRING DIAGRAMS

A

A.C.DAYTON CO.
XL-20; XL-25, XL-30 77
XL-61; AC-66 78
AC-65; AC-65 79
XL-5; navigator, navigator Power P. 80

ACME ELECTRIC CO.
model S.G. 88; A.C.7 81

ALL AMERICAN MOHAWK CORP.
6 and 8 tube A.C."W" Power Pack 82
Lyric models 60, 61, 62, 65 and 66 82
Lyric models 80, 83, 85, 86, 88 82
70, 73, and 75 83
No. 90 chassis, 50 cycle 83
No. 90 chassis, 25 cycle 84
No. 96 chassis, 60 cycle 84
Mohawk one dial battery and A.C. 226-227 85

AMERICAN BOSCH MAGNETO CORP.
15 Amborola; 27 Amborola; 46 The Little Six; 57 and 87 86
Cruiser, Royal Cruiser, and Imperial Cruiser model 35 battery sets 87
Models 46, 76, and 76L the Cruiser; models 66AC, 95, 118, 136 for A.C.; Model 107 for A.C.; Models 126, 146, 166, 176, 46A.C. 88
Model 96 D.C. 110 V. Cruiser; Model 156 Cruiser; Model 28; Model 825 Super Dynamic Power Pack 89
Models 48 and 49; Typeван edition 2 No battery; Typeван edition 3 and 4 Nobattery; Typesван edition 5 and 6 Nobattery 90
model 54 receiver; moch motor Car receiver 91

AMERICAN TRANSFORMER CO.
PF 250 Power Amplifier 334
ABC HI Power Box 28
2-AP amplifier and 21-D HI power box 342

AMRAD CORPORATION
Neutrodyn e A.C.-5; Model D.C.-6; 92
Model A.C.-6 Concerto Nocturne 92
Model D.C.-7; Model A.C.-7 93
Model 80, 82, and 83; No. 7100; 94
No. S-522; 94
3500-2; 3500-1; S-753; 7191 power unit; No. 3590 95
Amrad model 81 (Bel Canto Series) 96

APEX RADIO CO.
See U.S.Radio and Television Co.

ARGUS RADIO CORP.
D 195; B 126 326

ATTWATER KENT MANUFACTURING CO
Model 10; Model 10B; Model 20 compact; Model 12; Model 19; Model 20 -97
Model 21 dry cell; Model 32; Model 36 with condenser volume control; Model 36 with resistance volume control 98
Models 30, 33, 35, 48 and 49 99
Model 37; Model 38; and power unit 100
Models 40, 42 and 52; Model 44; and power unit 101
Model 41; Model 43 102
Model 50; 2nd. type power unit for model 41; 3rd. type power unit for model 41; 2nd. type power unit for model 44 103
Model 55 and 55C 104
3rd. type Model 60-C 328

AUTOMATIC RADIO AND MFG. CO.
"Tom Thumb" Portable 340

B

BALKITE PRODUCTS COMPANY
Model C; Model F 105
Models A-3, A-5 and A-7 352

BREMER-TULLY MFG. CO.
B.T.Counterphase 6; Counterphase 8; 6-40 power converter 106
6-40 circuit diagram; 8-20A 107
7-70 and 7-71 108

BROWNING DRAKE CORP.
Model 34, 36 and 38 350

BRUNSWICK BALKE COLLINDER CO.
Models 14, 21 and 31 S.P.U. 109
Model 31 combination radio and Panatrope 110
RPA-1; RPA-4 265
Models 3 and 10 267

BUCKINGHAM RADIO CORP
Model 80 348

BUSH AND LANE PIANO CO.
No. 10 DeLuxe; No. 12 S.G. 111

C

CAFEHART CORP.
See Webster Elec. Co. Page 350

CLEARTONE RADIO CORP.
Goldcrest Model 60; Model 80 112
Clearedyne Model 70; Cleartone Series 100 113
Model 110 compact; Model 112 114
OFFICIAL RADIO SERVICE MANUAL

COLONIAL RADIO CORP.
Model 31 A.C. ----------------- 115
31 and 32 D.C. ----------------- 116
32 A.C. ----------------- 117
33 & 34 A.C. remote control ----- 330

COLUMBIA PHONOGRAPH CO. (see Kolster)
6 tube A.C. set; 7 tube A.C. set ----- 118
Columbia C-5 and Kolster K-24;
C-5 substitute ----------------- 119
Models 930 - 300; Model 931 -------- 120
Model 902; Type 950 radio and phonograph combination ------- 121
Models 900 - 901; Model 961 ---------- 122
Power rack for model 980; 6 tube D.U.
set 06 - 07 ----------------- 123
Type 980 radio and phonograph comb. - 124
Screen Grid - 8 ----------------- 125

CONTINENTAL RADIO CORP.
Models 29-A and B with 171-L
Power Unit; Model 9 -------------- 126
Slagel 29-C; Slagel 29-A and B ---- 127
Ten 29-D and C with 250-L power unit 128
All Models ------------------- 129

CROSLEY RADIO CORP.
AG-7 and AC-7C ----------------- 130
Model 55 and 56; Trirdyn 35S; 5-38;
Type V; Model 51; 2-stage A.F. ampli-
Model 4-29; Models 30S, 31S, 33S, 34S; Models 40S, 41S, 42S, 82S .... 132
Models 40S, 41S, 42S, 82S, arranged
for M type speaker; Model 401;
Model 408 ------------------ 133
Models 60S, 61S, 62S, 63S;
Jewelbox 704-A --------------- 134
Model 601 ------------------ 135
Jewelbox 704-B; Showbox 706 ------- 136
Jewelbox 704; Gembox, Gemchest
610 - 609 A.C.; 804 A.C. ........ 137
Jewelbox 706; Models 20, 21, 22;
Model RFL-90 ----------------- 138
Models 41-A and 42-AC; 6-50 and 8-85- 139
Bandbox Jr. 401-A; 602 Bandbox;
Buddy and Chum --------------- 140

DAY-FAN ELECTRIC CO.
See General Motors Radio Corp.

EARL RADIO CORP.
See Chas. Freshman, Inc.

THOMAS A. EDISON, INC.
R-5; R-5 and C-4 ------------- 141
R-1, R-2 and C-2 chassis Jr and Je;
Model C-1 chassis SC ---------- 142
Rt-l, R-2 and C-2 chassis Jr and
Cr (25 cycle) -------------- 143
(Also see Splitdorf)

F

F.A.D. ANDREAS, INC.
Fada 10, 11, 30 and 31 - 60 cycle;
102, 112, 302 and 312 - 25 cycle;
16, 17 and 32 - 60 cycle;
132, and 322 - 25 cycle ---------- 144
Fada 18 D.C.; Fada 22 battery ------- 145
Fada 20 A.C. - 60 cycle; 202 A.C.
25 cycle; 25 A.C. - 50 cycle;
252 A.C. - 25 cycle -------------- 146
25 and 252 with M-250 and M-250Z
Electric Units; 35 A.C. - 60 cycle;
352 A.C. - 25 cycle -------------- 147
Fada 40 A.C. 60 cycle using P-250
Elec. Unit and 7-A speaker; Fada
50, 70, 71 and 72 -------------- 148
E-420 Electric Unit; E-180 Electric
Unit; 192-A receiver, 192-S and
192-BS units ----------------- 149
"7" A.C.; 75 and 77 A.C. 60 cycle -- 150
Special model 285-A and fada "7" model 475-A -------------------- 151
460-A receiver and R-60 unit;
R-80-A unit, 480-A and SF 50/80-A --- 152
"Special" A.C. receiver 285UA or CA
and RF-65-UA or CA; 282-UA or CA and
RF-62-UA or CA; 480-A and SF 50/80-B-153
"ABC" 6 volt supply types 66-Q and
62-R; "ABC" 6 volt supply types 86-V
and 82-W; j type unit; type "G" unit
used with "Special" and 7 AC ------ 154

FEDERAL RADIO CORP.
Ortho-Sonic type D; Series Filament
type D; ---------------------- 155
Model K --------------------- 156
Series Filament type F; Ortho-
Sonic type H ------------------ 157
Series Filament type E; Type M ---- 158

FRED-WIEDEMANN RADIO CORP.
Model NR-6; Model NR-7; Model
NR-9 - 9A ------------------- 159
Model 10; Model NR11; Model NR12 ---- 160
Model FE-15; FE-18; NR-20; NR-60 ---- 161
Models 50 and 40; Models 30N, 40N and
48N; Model 50 ------------------ 162
Model 130; Model NR-215, NR-400;
English long and short wave set ------ 163
Model 457 Power Unit; Model NR-80DC ---- 164
Model 90S AC; Model NR-85 AC; 470 --- 165
Model NR-85; Model 55; Model 800 ---- 166

CHAS. FRESHMAN CO., INC.
Earl models 21 and 22; Earl models
31 and 32 ---------------------- 167
OD-16S; Model N ---------------- 168
Model G; Model G, power pack; Model G with 660-S power supply 169
Earl model 41; freshman model M with M-60-S Power Supply 170
New and Improved Masterpiece; Equaphase; Model H-9 171
Combination K and K-60-S; QD-13S; 172
Q-15 and Q-16; 2N-60-S 173
21AC and 22AC; 2Q-15 and 3Q-16 174
Model 121; Model 21 D.C.; Earl models 175
31, 32, and 24 DC 175
31 and 32 SAC; 31-SAC and 32-SAC and Earl 33-SAC; 41AC 176

G

GENERAL MOTORS RADIO CORP.

Day Fan OEM-11; OEM-7; OEM-7 super selective; 5-tube 1925 model 177
Day Fan Five "5044" 178
Day Fan Five twenty Seven 5-tube; Six - 6-tube; Seven - 7-tube 179
Day Fan 6-51 - 6-tube; 6H - 6-tube; 6 Junier 6-tube; SAC - 6-tube 180
5AC - 5-tube; Model 35 5-tube; SAC 181
Power Set; 6 Junior AC Power Set; 110 volt D.C. 6-tube; Motor Generator 182
set 32 volt D.C. 6-tube; Motor Generator and Filter; Power Supply for 5-tube AC set; Power Supply for 6-tube AC set; B and C Power Supply; 183
B Power Supply for #5624 and #5525 184
8-tube Model 5077; 8-AC Power Set; 185
8-tube Model 5080; 8-AC Power Set 186
General Motors Model "A" chassis; Delco Automotive Radio 187

GILFILLAN BROS., INC.

A.C. Model 60; A.C. Model 100 188

GRAYBAR ELECTRIC CO.

Model 311 338

A.H. GREEBE & CO.

R.F. Amplifier type RORN; 13 Regenerative Receiver; Short Wave type CR-18; Short Wave type CR-6 189
Synchrophase type MU-1; Broadcast Receiver 180
Super Synchrophase type 5K-4; Synchrophase 7-AC 181
Synchrophase 7 182

GRIGSBY-GRUNOW CO.

Majestic Models 60-70-80; 7BPS Power Unit; 7BP6 Power Unit 190
Model 90; 9P6 Power Unit; 9P6 Power Unit; Model 708 chassis in 72 Set 191
Model 100; 90-B 192
Model 100-B; 180 and 181 193

7PS and 7PS Power Unit (old wiring); 7PS and 7PS Power Unit 194
8P6 and 8P3 Power Unit; P.U. System in 130-A Super Screen Grid chassis 195
Super Screen Grid chassis in model 130-A; in Model 230-A 196

GULFARSON COMPANY.

9 in Line, old and new models 197

I

INSULINE CORP. OR AMERICA

C. Short Wave Set 340

K

KELLOGG SWITCHBOARD AND SUPPLY CO.

6 tube Set; A.C. 7-tube set induc-tance tuned 198
Power Unit K-50 for sets #524, 525, 527, 528; Chassis "B" 199
623 and 526 with power unit #245 200
Wave Master; RFL 7-tube Cascade 201

COLIN B. KENNEDY CORP.

Model 281; 110; 220 202
Model 6 type 420; 430 and 431 203
7 Cornet D.C.; Type 435; Model 20 type 440; Model 521 and 525 204
Model 10; Model 11 205

KING MANUFACTURING CORP.

Model E; Model 80; Model 81 207
Model F; Model 82 and power pack 208
Model J; Model H 209
Model 97; Model 98; King Monarch 210
Model G; Power pack wiring King Royal, Imperial, and Monarch 211

KOLSTER RADIO CORP.

Columbia type 950; Kolster 6X 212
Kolster 6-tube receiver; 7-tube A.C. set (Brandeis) 213
Kolster 8A-BC; 6H; 7A and 7B 214
K-44; K-43 215
K-45 216
Brandeis B10; B15; B16 217

L

C.R. LEUTZ, INC.

Trans-Oceanic; "Seven Seas" console 350
M
McMILLAN RADIO CO.
Series 900; 8-AC Power Set --------------- 219

N
NATIONAL CARBON CO., INC.
Eveready models 1, 2 and 3; Series 30, 30-C and 40 ------------ 221

P
PHILADELPHIA STORAGE BATTERY CO.
Philco Model 40; Model 41 ------------------ 222
Model 65; Model 76 ---------------------- 223
Models 77 & 77A; 86 & 82 --------------- 224
Model 87 --------------------------- 225
95 & 95-A; 296 & 296-A ------------------ 226
Models 511, 512, 513, 514, 515, 531, 551, 571; Model 95 ------------ 227

PIERCE AIRO, INC.
AC-24-45 ----------------------------- 352

PILOT RADIO AND TUBE CORP.
PET; K-113 power amplifier; Pilotone
Electric 6-tube; Super Wasp ---------------- 228
Pilot Automatic Radio; Grimes
110-Volt D.C. New Yorker; Twin S.G. -- 229
K-106; K-108; S.G.-108 ---------------- 230

R
RCA-VICTOR CO. (Victor Division)
Alhambra I (7-1); Electrola Cromwell;
Borgia II ----------------------------- 231
Electrola 9-25; Electrola 9-40 ------- 232
Electrola Hyperion; Alhambra II and
Florencia; Radiola 25 Catacomb for
Alhambra II 9(7-2) and Florenza (9-1) 233
Models 7-3, 7-30 and R-20; Electrola
Radiola 7-26; Victor Radiola 16 ------- 234
10-70; AP-777C; Catacomb, Radiola 28;
12-15; 12-25 ------------------------- 235
AP-952 and AP-997; Victor Radiola 18;
AP-974-A; 951-A and 997-A; 12-15 ------ 236
Victor Radiola 17 (in model 7-25);
9-15 ------------------------------- 237
AP-736; AP-997C; Model 9-55 ----------- 238
Electrola Radiola 9-54; Automatic
Electrola 10-69; and power wiring ---- 239
R-32, R-42, RE-45, RE-75; 10-69;
10-51 ------------------------------- 240
AP-947(RPA-1A); AP-952 and AP-997
(RPA-5 and RPA-5 special);
Electrola Radiola 9-18 ------------------ 241
9-26; Radiola 9-54; Electrola 10-70 --- 242

RADIOLA DIVISION
Radiola Senior; Radiola RS; Radiola
III; Radiola AC; Radiola AR; Balanced
Amplifier, Radiola VII ------------------ 243
Radiola V; VII; IV ---------------------- 244
Radiola IIIA; IX; Superheterodyne;
Radiola Grand ------------------------- 245
Radiola 16; AP-937; VIIIB -------------- 246
Radiola 20; Radiola 30 ------------------ 247
67 ------------------------------- 248
Super VIII (AR-810), "semi-portable"
(AR-812), 24 and 25 ------------ 249
Radiola 25 ---------------------------- 250
46 D.C.; 53 -------------------------- 251
Radiola 17; Radiola 60; Radiola 18 --- 252
33 D.C. ------------------------------- 253
28 (battery operated); Loudspeaker
104 RPA unit ------------------------- 254
47 ------------------------------- 255
Radiola 64; AP-951; AP-935 ------------ 256
Radiola 41; Sterling SPU; Receptor
SPU; Loudspeaker 106 ----------------- 257
Radiola 67 ---------------------------- 258
Radiola 47 ---------------------------- 259
Radiola 50; 51 ------------------------ 260
41 D.C.; 51 D.C. ---------------------- 261
18 D.C.; 62 -------------------------- 262
Radiola 66 ---------------------------- 263
30-A 25 cycle; 21 & 22; 30A RPA Unit -- 264
Brunswick RPA-4 with Panatrope and
panel connections (8-tube panel);
RPA-1 with Panatrope and panel conn. -- 265
Radiola 44 chassis; 32 RPA Unit ------ 266
Radiola 44; Models 3 & 10 (Brunswick) - 267

REMLER RADIO CORP.
45 KC Superheterodyne ------------------- 340

S
SILVER-MARSHALL, INC.
Models 30 (chassis), 60 Lowboy, 95
Highboy and 75 Concert Grand ----------- 268
720 A.C. ------------------------------- 59
S.M.690 Public Address System ---------- 340

SONORA PHONOGRAPH CO., INC.
Model 2RP-25 -------------------------- 269
3R and 4R ----------------------------- 270
3RP ----------------------------- 271
5R ----------------------------- 272
7P ----------------------------- 273
B-51 (25 cycle); Phonograph automatic
stop ----------------------------- 274

SPARKS-WITHINGTON CO.
Sparton Model 39; 69A ------------------ 275
49; 9-30 ----------------------------- 276
931 and 301 D.C. ---------------------- 277
6-26, 6-16; A.C.62-63 & A.C.7 ------- 278

SILVER-MARSHALL, INC.
Models 30 (chassis), 60 Lowboy, 95
Highboy and 75 Concert Grand ----------- 268
720 A.C. ------------------------------- 59
S.M.690 Public Address System ---------- 340

SONORA PHONOGRAPH CO., INC.
Model 2RP-25 -------------------------- 269
3R and 4R ----------------------------- 270
3RP ----------------------------- 271
5R ----------------------------- 272
7P ----------------------------- 273
B-51 (25 cycle); Phonograph automatic
stop ----------------------------- 274

SPARKS-WITHINGTON CO.
Sparton Model 39; 69A ------------------ 275
49; 9-30 ----------------------------- 276
931 and 301 D.C. ---------------------- 277
6-26, 6-16; A.C.62-63 & A.C.7 ------- 278
| A.C. 89; DeLuxe 109 | 279 |
| A.C. 5-26, 5-15; Model 110 | 281 |
| OFICIAL RADIO SERVICE MANUAL |
| SPITZEL, MAY, STERN CO. |
| "Melrose" - same as Apex 41 | 306 |
| SPLITZDORF ELECTRIC MFG. CO. |
| R-200; PAD-4; ABBEY (with volume control) | 322 |
| ABBEY Model 171 | 324 |
| STANDARD RADIO CORP. |
| A.C. Model 29 | 342 |
| STEINER RADIO COMPANY |
| 50-A & 102-A | 282 |
| 991, 992, 993; 261 & 262 | 283 |
| STERLING MANUFACTURING CO. |
| No. 4; No. 4 chassis, power unit, and speaker | 284 |
| No. 4 speaker; No. 4 power unit; No. 3A chassis | 285 |
| STEWART-WARNER CORP. |
| 305 - 315; 320; 300; 310 - 325; 330; 335 - 340; 345 - 350; 355 - 360; 385 - 390 | 286 |
| 500 - 520; 525; 700 - 705 - 710; 530 - 535; 715 - 720 | 287 |
| Power unit models 530 - 555 - 715 - 720; Power units models 801 - 801A | 288 |
| 811 - 811A - series B; Model 806 | 289 |
| series B | 290 |
| Model 750; 950 series battery S.G. | 291 |
| 950 D.C.; 950 25 & 60 cycle A.C. | 292 |
| Series 900 | 293 |
| STRUMMENBERG-CARLSON MFG. CO. |
| Circuit D-968; 523 & 524; 635 & 636 | 294 |
| 641 & 642 | 295 |
| 638 D.C.; 652 & 654 | 296 |
| 645 | 297 |
| 403 AA audio power unit; 404RA and 404RA audio power unit | 298 |
| 403B audio power unit | 299 |
| 635 D.C.; 601 & 602 battery | 300 |
| No. 1-B; 465 & 403A power pack; No. 10 and 11 receivers | 301 |
| No. 704-B; 501 & 502 | 302 |
| No. 734-B; 633 & 534 | 303 |
| T | 304 |
| TEMPLE CORPORATION |
| 8-60, 8-80, 8-90 | 305 |
| 8-61, 8-81, 8-91 | 306 |
| TRANSFORMER CORP. OF AMERICA |
| Clarion AC-55, AC-55, 25, 51 - 25, 53 | 307 |
| 25, 55 | 308 |
| TRAV-LER MFG. CO. |
| Model 6 & 7; DC & AC Power Packs | 328 |
| UNITED AIR CLEANER CO. |
| Sentinel 660 9-tube | 346 |
| Sentinel 666-C 9-tube chassis for phonograph combination | 346 |
| model 444 7-tube S.G. | 348 |
| UNITED STATES RADIO AND TELEVISION CO. |
| Model 80; Apex 48 - 60 cycle, 48A - 25 cycle | 305 |
| Apex 41 - 60 cycle, 45 - 25 cycle; Apex 46 & 47 - 60 cycle, 46A & 47A | 306 |
| 25 cycle; Model 30 Automotive | 307 |
| UNITED REPRODUCERS CORP. |
| (Peerless) Courier "65" chassis; Series K-70 | 308 |
| Series 20 Electrostatic (Kylatron) | 309 |
| ZENITH RADIO CORP. |
| 11E & 14E; 11 - 12 - 14 | 310 |
| 17-series filament: 4R; ZE10 power supply; ZE5 power supply for model 17 | 311 |
| 33X & 35X 6-tube electric; 34P & 342P 6-tube electric | 312 |
| Model 27; 31 & 32 | 313 |
| ZE4 "H" Power supply; ZE3 "A" power supply; Models 53-54-55-53A-542-552-552A-562 | 314 |
| 35P-35AP-352P-352AP; 37A | 315 |
| ZE14 power supply; ZE11 power supply; ZE13 power supply; ZE15 power supply | 316 |
| 39-39A-392-392A; 40A | 317 |
| 35FX-35AFX-352FX-352APX-37A; 333-353A 6-tube D.C. set | 318 |
| ZE17 power supply; ZE18 power supply; Models 60, 61, 62, 602, 612, & 622 | 319 |
| without loop; 64, 67, 642, & 672 | 320 |
| with loop | 321 |
| ZE16 power supply; ZE12 power supply; Models 41 & 412 | 322 |
| Models 52 & 53; 54 | 323 |
| Model 70 (71, 72, 73 & 77 60 cycle, 712, 722, 732, & 772 25 cycle) | 324 |
| MISCELLANEOUS CIRCUITS |
| Aerodyne Six | 325 |
| Ambassador Four | 326 |
| Continental Wireless and Supply Co. "Voice of the Road" Automotive | 327 |
| Magnavox TRF-5 and TRF-50 | 328 |
| "Magnaformer 9-8 Superheterodyne" | 329 |
| Blair TRF 6-tube receiver | 330 |
| St. James Superheterodyne | 331 |
| Madison Moore Superheterodyne | 332 |
| Victoreen Superheterodyne | 333 |
| Wells Gardner Co. Nine in Line - same as Gulbransen - see page | 197 |
INTRODUCTION

This book has been compiled in an attempt to give the radio Service Man as complete and concise a compendium of practical data and instruction concerning radio installation, maintenance and repair as could be selected from the hosts of material already written on the subject. It is evident that a book of this type, to be entirely complete, would cover virtually all phases of radio and include complete diagrams and specifications of every radio set that has ever been built -- an enormous undertaking which would give the book a stupendous size. While such a volume would be of value for reference, it would be too clumsy to be handled by the busy radio Service Man who wants practical information, suggestions, and data in few words at his finger tips, with diagrams and specifications of the more popular types of sets in active service that daily require his attention. Therefore, only the salient features of radio servicing are given, and information on the servicing of battery sets, which are daily becoming obsolete, is covered more in general than in detail. In all instances where possible, specifications are given in connection with the diagrams, which were obtained through the kind assistance of the various manufacturers. More up-to-date information on later sets can be supplied from time to time as the material becomes available, for which purpose the loose-leaf form of this book has been adopted. In connection with RADIO-CRAFT Magazine (which supplies the latest important news on the subject in proper page size to fit in this book) the book can be kept alive and up-to-date and be of inestimable value to the active Service Man.

No attempt is made to delve into the theory of radio, since this is not within the scope of a book of this type. There are many technical books covering the theory and practice of radio, from which the would-be Service Man can get a good elementary grounding on the subject. Therefore, it is here assumed that the reader has an adequate technical knowledge of the subject, although technicalities are avoided as much as possible and simple language is used throughout, covering mainly the practical rather than the theoretical aspect of the subject. For, after all, the Service Man is practical. He must go out in the field, diagnose the troubles in radio sets from the symptoms, and in a few minutes' time correct the defects. A man of theoretical knowledge only is at sea when up against a set, apparently in perfect order, but which does not work; and all his theory is of no avail without some background of practice. All the books in the world cannot give as much knowledge in this line of work as can be obtained by installing, servicing, and repairing a hundred sets of different types. Highly-trained engineers have been known to labor for hours on a set that would not work, only to find out later that the antenna was disconnected; a condition which would be instantly noticed by a less-technical but practically-trained Service Man. He who bluffs his way through and makes only temporary repairs in hopes of obtaining future work on the same sets, will soon find that his best customers have left him. A thorough knowledge of the work, backed by a few months' practice, together with a data book of this type containing information one cannot reliably carry in his head, should be the foundation of a successful servicing business, provided it is conducted in an honest manner. We hope that the readers will find this book as valuable as we are trying to make it.

Aside from his theoretical and practical knowledge of radio, the Service Man, like a practicing doctor, should be somewhat of a psychologist. Not that his psychology will have any effect upon the subject on which he is working, as in the case of the doctor, but he will come in contact with all kinds of people, the vast army of radio set owners, some of whom will look upon him with suspicion and presume that they are being swindled, no matter how fairly he treats them. He will be called upon to explain in detail everything connected with the work, and must not only repair the set, but give the highly-
opinionated set owner a still higher opinion of his knowledge of radio. Of course, such cases should be handled tactfully, but just how is beyond the scope of this book, which makes no attempt to teach psychology. This can be learned better out in the field than from books. "Trouble-Shooting" in radio has many interesting and peculiar aspects.

The first section of this book is devoted to pointing out the weak spots in all kinds of radio sets and showing where trouble is likely to occur, now it can be located, isolated and repaired. Of course, the first and greatest symptom of a faulty radio set manifests itself in the loud speaker, which does not speak very pleasantly, or refuses to talk at all. This symptom is noticed by the set owner, who immediately telephones for the Service Man. From the owner's report of the set's behavior, the experienced Service Man can usually point his finger to the cause, since there is a cause for every effect. From this, he can select the necessary tools for making repairs, if any are required, and also any tubes, batteries, etc., which may be needed, and the job is shortly completed. The inexperienced Service Man, however, not being so keen at diagnosing from the meagre symptoms, must necessarily carry all his tools, testing apparatus, and spare parts, and make a longer job of it at greater expense to the owner. By making the tests systematically, the beginner can effect repairs quicker and soon acquire that apparently psychic insight into radio sets that the expert enjoys. The more proficient he becomes, the fewer tools he requires and the fewer tests he has to make. Therefore, we have endeavored to present, in a concise manner, a description of the various testing devices and tools that are indispensable to the beginner, as well as of great aid to the expert, and show how they are used in diagnosing set troubles. While many writings on trouble shooting trace cause to effect, we have attempted to trace effect to cause, which is the necessary procedure of the Service Man out on the job. As a concrete example, it is a simple matter to tell someone through the medium of a book that an open audio-transformer winding will stop the set from functioning, but it is an entirely different matter to trace the cause of a defective set back to the open transformer winding, when there are many other reasons why a set might stop functioning.

We believe that the vast collection of diagrams, forming the main bulk of the book, will be of help to all radio Service Men, and consequently we have made it as complete as possible without including diagrams known to be of little value. In modern manufactured radio receivers of somewhat inaccessible nature, an authentic diagram is almost indispensable in making tests, such as voltage and current readings and resistance measurements, for the difference in internal connections of various receivers is not apparent from the outside, and without the diagram mistakes are likely to be made.

We shall be pleased to receive suggestions and criticisms from those who are out in the field, and at the same time we wish to extend our thanks for the many suggestions submitted to RADIO-CRAFT by so many practical Service Men, which have been of great aid in preparing this book, and also to the manufacturers who have generously submitted data and diagrams concerning their products.

THE EDITORS
CHAPTER I

SERVICE EQUIPMENT

Speed and accuracy in set installation and servicing depend upon the skill of the Service Man and the tools and testing equipment at his command; the greater the skill, the less equipment required, and vice versa. Practice will strike for each his own balance between skill and equipment, and he can be judged accordingly. Good testing equipment will instil confidence into the customer and help largely to alleviate dissatisfaction. The nature of the work and type of set also dictates to some extent the equipment required. If a car is used, one can naturally carry a well-nigh complete set of tools and testing apparatus, but without the car, only the most necessary paraphernalia should be carried, the rest remaining at the shop for work too complex to be done at the customer's home. The list below gives the tools, supplies and instruments that every Service Man should have available:

(2) Tools:

- One pair diagonal pliers
- One pair long-nose pliers
- One pair side-cutting wire nippers or pliers
- Jackknife
- Socket-wrench set
- One pair test prods
- Combination neutralizing and aligning tool
- Automatic blow torch
- Soldering iron
- Can flux
- Short, heavy screwdriver
- Long thin screwdriver
- Roll friction tape
- Hand drill with assorted drills
- Reamer
- Coarse file
- Sheet emery cloth
- Fine file
- Flashlight
- Large piece of cloth

This illustration shows the radio Service Man's ideal tool and testing equipment. Note the convenience of the carrying case. Photo courtesy The Grenpark Co.
Fig. 1. - The Supreme Diagnometer is one of the most completely equipped testing apparatus available to the Service Man.

(3) Miscellaneous Parts: Assorted grid suppressors; center-tapped filament resistors; by-pass and filter condensers; variable high resistors; grid leaks; replacement A.F. transformer; phonograph pick-up adapter; rheostats; hook-up wire; a roll of bell wire; milenite tacks; insulated staples; replacement sockets; tube shield; trimming condensers; neutralizing condensers; tube adapters; R.F. choke; R.F. transformer; open and closed circuit jacks; filament switches; S.P.D.T. switches; phone plug; binding posts; soldering lugs; lock washers; assorted screws; aerial insulators; lead-in screweyes, hooks and insulators; lead anchors; filament ballasts; pilot lights; ground clamps; lead-in strips; lightning arrester; phone cord; 6 or 7-wire battery cable; battery clips, large and small; small knobs; cone apexes; complete set of various tubes; dummy neutralizing tubes; 45-volt "B" batteries; "C" battery.

(4) Instruments: One radio set analyzer, one hydrometer, one speaker unit, one headset or single receiver, one audio-modulated R.F. oscillator, one resonance indicator.

(5) The Radio Set Analyzer. This is one instrument that every Service Man should have, as it will permit the complete analysis of any type of radio set. There are several set analyzers or testers on the market, among which we find the Jewell, Hickok and Weston, and the Supreme Radio Diagnometer. Complete instructions on the operation and use of these instruments are furnished by the manufacturers and therefore we will describe their use here briefly.

(6) Each of these analyzers is in the form of a portable carrying case, as illustrated in Fig. 1, with a small compartment for carrying tools and miscellaneous parts for making minor repairs. They are more or less complete, having measuring instruments with multiple scales whereby, through switching arrangements, a rapid diagnosis of a radio set can be made. The analyzer can be used for measuring plate current of each individual tube, plate voltage, grid voltage, filament voltage, screen-grid voltage, power supply voltage, approximate resistance values, approximate capacity values, continuity tests.

(7) These measurements can be made with the tube in or out of the circuit. For example, by removing a particular tube from the set and placing it in the socket of the analyzer, and placing the plug connection of the analyzer in the empty socket of the set, measurements of actual operation conditions can be made while the set is in operation. Such a test on each tube of the set will soon reveal any defect.
(8) The Supreme Diagnometer. In addition to the above, this instrument contains a modulated radio-frequency oscillator for use in balancing R.F. amplifier circuits and also a resonance indicator. In effect, it is virtually a complete portable radio laboratory. This instrument was fully described in the February, 1930, issue of RADIO-CRAFT.

(9) Charts. Charts are furnished by the makers of the various instruments on which complete readings can be recorded and analyzed as a whole, after which corrective measures can be made if necessary. A copy of the chart should be left with the customer and the original filed for future reference. Fig. 2 shows a typical chart, giving readings taken on an Amrad Model 81 Receiver with a Jewell No. 199 analyzer.

Fig. 2 - Typical Service Man's Chart.

(10) Continuity Tests. One of the most common tests is the continuity test, for determining the condition of circuits or instruments. This test is usually made with a 4½-volt "C" battery connected in series with one of the voltmeters of the analyzer, with long flexible leads for connecting to the instrument or circuit under test. If the circuit is open, the meter reading will be zero; if closed, the reading will be full scale, or partially full, depending upon the resistance of the circuit - the scale reading giving a measure of the resistance of the circuit. Thus open circuits or short circuits can be easily located and values of resistances measured. This test will instantly show you if a by-pass condenser is shorted, or a resistance or coil is open. With the aid of the wiring diagram of the set being analyzed, trouble can quickly be located and the defective part repaired or replaced. We will have occasion to refer to continuity tests quite often in subsequent chapters. Fig. 3 shows a simple circuit for a continuity test.

(11) Capacity Tests. Large condensers having capacities from 0.1 mf. up are measured by connecting them in series with the 110-volt 60-cycle line and measuring the current. The current flow through the condenser is proportional to its capacity. Charts giving the capacity values for different current readings are usually furnished with the analyzers. This test is very useful for testing "B" eliminator, filter and by-pass condensers.

(12) Modulated Oscillator. A modulated oscillator (which is simply a miniature radio transmitting station) is useful in balancing or neutralizing sets. While a strong local broadcast station may serve the purpose of balancing, when no oscillator is available, the oscillator is more reliable and should be part of every Service Man's equipment. A simple modulated oscillator can be constructed by following the diagram, Fig. 4. This is a Hartley oscillator, which is self-modulated by the grid condenser and grid leak; the condenser building up a charge and discharging through the leak at audio frequency. The parts can be mounted in a suitable case with the coil so placed that it can be closely coupled to the first grid circuit coil of the set being adjusted.

Fig. 3 - Circuit for Continuity Test.
(13) Resonance Indicator. While the fineness of tuning and balancing can be fairly well determined by ear, a more accurate method is to employ a resonance indicator. Such a device is indicated diagrammatically in Fig. 5. It consists of a low-range D.C. milliammeter for measuring the rectified output of the radio set. The output of the set is rectified by means of a type '99 tube with the grid and plate tied together, as shown. A variable resistor is shunted across the input to protect the meter from excessive currents, likely to be encountered when testing receivers that do not employ a dynamic speaker. The input should be equipped with a two-conductor telephone cord with clips for connecting to the set output.

(14) Dummy Tubes. Balancing a set requires the use of a dummy tube or balancing tube, which should be of the same type as those used in the set, in good condition and perfectly normal, except that one of the filament prongs is cut off and the internal filament wire resoldered to the shortened prong. This allows the tube to be inserted into the set without lighting its filament. An assortment of dummies for all types of tubes should be part of the Service Man's equipment, the most common being types '01A, '26, and '27. It is important that the elements inside are not jarred out of their normal position, or the internal capacity of the tube will change and its usefulness in balancing will be impaired. The tubes should be distinctly marked, to avoid mistakes.

(15) Balancing a Set. The receiver to be balanced should be connected up in normal operating condition, and either headphones or a resonance indicator used; either of which can be connected to the set output at the speaker or set chassis. The receiver should then be tuned to about 300 meters, or in between interfering stations if they are on the air. The oscillator is now put in operation, and its tuning condenser varied until it is in resonance with the set, as indicated by a reading of the resonance indicator or by sound in the headphones. The oscillator should be placed a distance from the receiver, so that the intensity is about equal to that of normal reception, and the set tunes sharply. The filament rheostat of the resonance indicator should be adjusted, together with changes in the distance between the receiver and the oscillator, so that the meter reads about two-thirds scale deflection. Maximum deflection, while tuning the oscillator, indicates maximum resonance between oscillator and receiver.

Fig. 4 - Socket-Powered Audio-Modulated Oscillator.
(16) The dummy tube is now placed in the last R.F. stage of the set, near the detector, in place of the tube formerly in that socket, and the neutralizing condensers are adjusted until there is no deflection on the resonance indicator, or no sound in the phones. This operation is then repeated with each R.F. stage, and when it is completed, the set is balanced. Note that the trimming condensers should be adjusted for maximum response and the neutralizing condensers for minimum response.

(17) It is well to balance the set at three or more points on the tuning dial, to insure a fine degree of balancing. To test the degree of balancing, replace the regular tube in the set and tune to a very low wavelength, then try forcing the set to oscillate by rocking the antenna trimming condenser or the volume control. If the set is well balanced, it will not oscillate.

(18) Condition of Set. The condition of the radio set should always be taken into account when looking for trouble, as many commercial sets have been tampered with by the set owner or by Service Men who have worked on it previously. We cannot always assume that the set is exactly in accordance with the specifications and circuit diagram given. Defective parts may have been replaced with others of incorrect values. A visual examination will usually reveal any discrepancies and they should be compared with the diagram and corrected before relying on test measurements. This is another important reason why an accurate history of service calls should be kept.
CHAPTER II

GENERAL SERVICE PROCEDURE

 Whether installing or servicing, it is of utmost importance to please the customer, and all complaints should be attended to immediately. At the first complaint of trouble, inquiry should be made of the customer as to the type of set, the nature of the trouble, the behavior of the set before and after the trouble started, the age of the tubes, batteries and set, the condition and type of aerial used, and any further questions that the answers to these questions might involve. This information, together with the shop records of other service calls if any have been made on the same set, may reveal the cause of the trouble and enable a quick and immediate repair. The importance of this phase of the work cannot be too strongly stressed, since it may save much time and many unnecessary trips.

(2) Type of Set. Tracing trouble is always performed, consciously or unconsciously, by a classifying process, and the most general classification is in the type of set, there being four general types, namely:

- Battery sets,
- Battery sets with eliminators,
- D.C. Electric sets,
- A.C. Electric sets.

(3) Contrary to general opinion, electric sets are usually much simpler to service than battery sets, because they are inherently more compact and consequently of sturdier construction, and less vulnerable to mechanical injury. Battery sets, on the other hand, because of corrosion of battery connections, discharged "A" batteries, old "B" batteries, and frequent alterations and replacing of batteries by the inexperienced owner, are a source of many service calls. However, the battery type of set will first be described, in a general way, and we will take for our example a standard 5-tube tuned R.F. set. Let us assume that the owner of this set claims that it will not work, and that is all the information that we have; we will proceed systematically to trace the source of the trouble.

(4) General Survey. The experienced man can often tell, by the nature of the sounds emanating from the speaker, the cause of the trouble and make repairs immediately; but we will assume that there is no sound in the speaker. The first thing to do is make a general survey of the layout, and look for simple things first. Things so simple that they are overlooked have caused much trouble and unnecessary labor on the
more complex parts of the set. For example, in one case a man worked nearly an hour on a set that failed to receive any stations, only to find later that an "S.O.S." call was on the air. Sometimes a tube loose in a socket, or in a dirty corroded socket, will cause trouble. The most common simple fault encountered is a disconnected or loose wire in some part of the battery, aerial, or speaker circuits, which may produce a dead, noisy, or weak set.

(5) Main Sources of Trouble. Further classification reveals that there are seven main sources where trouble may exist in the battery set. These are represented graphically in the chart of Fig. 7. Listing them in order of their importance, they are:

(a) "A" battery or circuit,
(b) "B" battery or circuit,
(c) Tubes,
(d) Speaker or circuit,
(e) Electrical system,
(f) Mechanical system,
(g) Aerial system.

Further classification of each of these seven sources are indicated in the illustration, but the first procedure is to localize the trouble in one, or possibly more, of these main branches, after which it may be traced down to one or more of the sub-branches. This is usually done by a process of elimination.

(6) "A" Battery or Circuit. A glance at the tubes will show whether they light up brightly, or not, after the set is turned on. If they light brightly, the "A" battery connections should be examined to see that they are not reversed, for a reversed "A" battery will produce a very weak set. If the connections are correct, and the tubes light, we can eliminate branch (a) of our chart. If the tubes fail to light or are very
dim, we must examine this branch and test the "A" battery with a hydrometer or quickly short the "A" battery and note if a powerful spark is produced. If the battery tests fully charged, examine the battery clips, which may be corroded; also the filament switch, rheostats, and ballast resistors (if any are in the circuit.) If the battery is discharged, examine the battery charger. See that it is not reversed and that it is charging properly and well connected to the lighting line. Note the amount of electrolyte and add distilled water if necessary. If the charger is in good condition, examine the "A" battery circuit for shorts, or failure to turn completely "off" by the filament switch or rheostats. The age and care of the battery will also give some indication of its condition. If beyond salvation, replace it. If branch (a) is found in good condition, examine branch (b).

(7) The "B" Battery or Circuit. A quick check of the "B" battery is to disconnect the high-voltage lead and listen for a loud click in the speaker when it is re-connected with the set turned on. A strong click indicates a good "B" battery, and vice versa - assuming the speaker is in good condition. The age of the "B" battery will indicate if it needs replacing or not, but if it is fairly new, measure the voltage with the set turned on. If the voltage is low, examine the set before installing a new set of batteries, for a shorted by-pass condenser in the set has ruined many a new set of "B" batteries.

Usually the battery nearest the negative or filament side of the circuit runs down first, because of the greater drain placed on it by the detector tube. Temporary operation can sometimes be obtained by exchanging it with the last one. A large by-pass condenser, about 2 mf, connected across the "B" battery, also helps.

With the "B" batteries in good condition and all the connections examined and tested to make sure that the voltage is applied to the tubes, we can pass on to branch (c).

(8) Tubes. Tubes often cause trouble, but the trouble is easy to rectify. If they are burned out from old age or damaged by mechanical jar, they must be replaced with new ones. Otherwise, the circuit should be examined before inserting new tubes, as the fault may be in the connections. The sockets should be cleaned by forcing the tubes in and out. Sometimes the tubes light normally but the filaments have lost their ability to emit sufficient electrons, or are "deactivated." A couple of good spare tubes should be used for comparing them by trying them in one socket after another, as it is seldom that all tubes in a set become weak at the same time, and the one or more weak tubes can be found. Of course, a set analyzer will instantly indicate the condition of a tube; if the plate current is low with the proper plate, grid, and filament voltages applied, the tube should be discarded, or reactivated, if possible, in a tube reactivator. Study Chapter IV for further information on tube analysis and tests.

(9) Speaker or Circuit. Disconnecting and connecting the "B" battery lead (as described in connection with the "B" battery or circuit) should give a click in the speaker if the speaker is in good condition. Otherwise, disconnect the speaker and test it for continuity, or quickly touch its terminals across a portion of the "B" battery and listen for a click. If the speaker is found impaired in any way, test it in accordance with the directions given in Chapter V. Otherwise, eliminate this branch of the system and examine the next one. Tapping the detector tube with the finger should give a clear ringing sound in the speaker, if the audio amplifier and speaker are in good condition. Comparing the speaker with one known to be good will also reveal its condition.

(10) The Electrical System. The electrical system of the set comprises the radio-frequency amplifier, the detector, and the audio-frequency amplifier; the most common source of trouble being an open winding in one of the audio-frequency transformers (usually caused by soldering flux employed in their manufacture, which eats away the
(11) The Mechanical System. This part of the set receives all the mechanical wear and sometimes gets out of order. The trouble being of a mechanical nature, rather than an electrical one, is easily corrected. Under this heading we have the tuning condensers, dials, volume control, rheostats, filament switch, loud-speaker cord, and any other part that undergoes mechanical wear. A visual examination will usually reveal trouble from these sources. Electrical continuity tests of the manually-operated instruments will also reveal defects. It is better practice to replace defective instruments of this nature than to try to repair them.

(12) The Aerial System. While we analyze this branch of the system last, a hasty examination of the aerial and its associated components should be made before thoroughly going over the entire set. At least one can tell whether the aerial is down or not, without making elaborate tests. Having eliminated the other branches of the system, and traced the trouble to the input or aerial and ground connections, we can make a detailed analysis of this branch by following the instructions given in Chapter VI under aerials.

(13) Battery Sets with Eliminators. The same general procedure for testing battery sets employing "A" or "B" battery eliminators, or both, should be followed as just described in connection with battery sets. In fact, the same chart of Fig. 7 may be used. If trouble is located in branch (a) comprising the "A" battery or circuit, testing methods described in Chapter III should be followed. Likewise, if trouble is located in branch (b), covering the "B" battery system, instructions on "B" battery eliminators should be studied. Since this information is fully covered in separate chapters, we will not go into it in detail here.

(14) D.C. Electric Receivers. These receivers differ from the battery type mainly in the manner by which the plate and filament supply voltages are obtained, and consequently the same testing procedure can be followed as with the battery type. In these receivers, the filaments are connected in series and supplied directly from the D.C. lighting line through a suitable resistor. Since the maximum voltage obtained from the
line is from 115 to 125 volts, a number of output tubes connected in push-pull or parallel are usually employed in the amplifier to get sufficient undistorted output.

(14) Filament Wiring. As an illustrative example, Fig. 8 shows the filament wiring of the Stromberg-Carlson "No. CS" Art Console receiver for D.C. operation. In this receiver, the first, second, and third R.F. amplifier tubes, the detector, and first audio amplifier tubes, are of the 'GIA type and connected in series with the pilot light and resistance; the whole being connected to the line through a filter system. The output stage consists of four type '71, tubes with filaments connected in parallel and connected across the line through a 90-ohm resistor, as shown.

(15) Testing Filament Wiring. In testing the filament circuit of the D.C. receiver, it is obvious that if one of the series filament tubes of the 'GIA type in the diagram, Fig. 8, burns out, the circuit will be open and the others will go out; replacing the burnt-out tube will cause all the others to light. It is well to test the line voltage at the filament terminals to make sure that the series resistors, choke and pilot lamp are in good condition. Voltages at the set sockets can be measured with a set analyzer, but only while the set is in operating condition with all tubes lit. If the tube is burnt-out, from excessive line voltage, the "Hi-Lo" switch, shown in the diagram, should be opened, thus placing an additional 10-ohms in series with the set with consequent voltage reduction.

(16) Power Tube Filaments. The four '71A power tube filaments in this set are connected in parallel and, since they are all fed through one series resistor, if one of these tubes burns out or is removed from the socket, the voltage across the others will rise to a dangerous value and burn out all the others unless the set is immediately turned off. Therefore, it is very important to turn the set off before removing any of these tubes; furthermore, do not turn the set on again until good tubes have been placed back in the empty sockets. Chapter III gives further information of value in this connection.

(17) Plate Supply. Fig. 9 shows a schematic diagram of the plate circuits of this set. Note that all tubes are fed by the maximum line voltage (neglecting the slight voltage reduction caused by the filter choke.) A simple voltage test at the socket will indicate whether there is failure in the plate supply. If so, continuity tests across the choke, series resistor and switch, with the line-plug out, will probably locate the cause. A shorted filter condenser may cause a fuse to blow. The condensers should be tested and replaced if necessary before replacing the fuse. Further information may be found in Chapter III under D.C. "B" eliminators.

(18) A.C. Electric Sets. These sets differ from those previously described mainly in the type of tubes employed and the method of heating their filaments. The filaments in these sets are heated by means of a step-down transformer connected to the A.C. line, and it is consequently a simple matter to trace failure of any part of the filament circuits. Two methods are employed; in one, the filaments are heated by the alternating current and the grid returns find their way back to the electrical center of the filament, by means of a center-tapped resistor placed across the filament, or
by a center tap on the filament transformer winding. If the tap is not at the exact electrical center, hum will be introduced. The type '26 A.C. tube is used in this manner for both radio- and audio-frequency amplifiers. The various power tubes for the output stages in the radio amplifier are also connected in this way.

In the other method, a heating element is used to heat a cathode which is not in electrical contact with the heater, but is brought by the heater to a sufficient temperature to cause electrons to be emitted from it; the cathode serves as a filament and is considered as such in the various circuit diagrams. This type of tube, the '27, is used for the detector in virtually all A.C. sets, and in many cases also used for the radio- and audio-frequency amplifiers. The reader is referred to the special Chapter IV on tubes for more detailed information.

(19) Plate Supply. The plate supply of A.C. sets is obtained by the same basic method as in battery sets employing "B" eliminators; the main difference being that, in the A.C. set, the "eliminator" is usually an integral part of the set and cannot as easily be isolated, removed and repaired.

(20) A.C. Power Supply. A typical example of the power supply system for an A.C. set is illustrated in the schematic diagram of Fig. 10, which shows the power supply of the Stromberg-Carlson "Nos. 635 and 636" receivers. If the initial tests reveal a failure in the power supply, as indicated by absence of plate voltage, the trouble may be caused by a defective rectifier tube, burnt-out filter choke, punctured filter condensers, or open voltage divider. This latter device, indicated as a group of resistances at the extreme lower right of the diagram (Fig. 10) may cause excessive plate voltage on some of the tubes, should the lower or negative end of it be open. This is a frequent occurrence and, if the resistance values and current carrying capacities of the voltage divider are known (as indicated on the diagram of the specific set) a new resistor of the same value should be inserted. Further reference to power supply equipment will be found in Chapter III.

(21) 25- and 60-Cycle Sets. It is well to check the frequency of the power supply, especially when making installations, and make sure that the set is designed to operate on the frequency available. While 60-cycle supply is the most common, in some localities (especially near Buffalo, N.Y., and in many parts of Canada) 25-cycle and sometimes 40-cycle current is in general use. It is ruinous to attempt to operate a 60-cycle set on a 25- or 40-cycle line, but a 25- or 40-cycle set may be safely operated on a 60-cycle line. The 25-cycle set may be operated on a 40-cycle line, but not vice versa.
CHAPTER III
POWER-SUPPLY SYSTEMS

In the course of time the service man will encounter a wide variety of socket-power-supply systems — both filament "A" supply, plate "B" supply and "C" supply units — as indicated by the various diagrams in this book. While the circuits differ widely, and the apparatus employed and combinations also differ, troubleshooting in each system is essentially the same, and can be boiled down to a few simple tests of the various parts. Sets employing batteries for the "A", "B" and "C" supply were sufficiently covered in the second chapter of this book, and will not be included in this chapter; only power-supply systems in connection with the house-lighting line, both A.C. and D.C., will be included. These may be divided into:

(a) Eliminators for battery sets,
(b) Power-Supply Systems for A.C. Electric Sets.

Fig. 12 - (left) Charging a 6-volt battery from a 110V D.C. line using a variable resistance.
Fig. 13 - (center) Charging a 6-volt battery using a lamp bank resistance.
Fig. 14 - (right) Testing the polarity of the D.C. line with salt water.

The first group will include battery chargers as well as eliminators, both A.C. and D.C. types, for use with battery sets. The second group will include power packs and power supply systems for A.C. electric sets. Both groups will be subdivided as we proceed with the discussion. A voltage measurement on any of these devices will reveal an abnormal condition. Current output measurement will show whether the fault is in the set or in the power-supply device. In this chapter we will assume the defect, if any, to be in the power-supply device.

Fig. 15 - (left) Tungar charger.
Fig. 16 - (center) Vibrating reed charger.
Fig. 18 - (right) Dry disc charger.
(2) 110V. D.C. Battery Chargers. This type of charger consists merely of a resistance in series with the battery under charge; the wale being connected to the 110-volt D.C. line. See Figs. 12 and 15. Tracing trouble, therefore, consists merely of checking the continuity of the circuit and its polarity. Trickle chargers usually have an ammeter which indicates the polarity and amount of charge. Trouble is usually found in the connections to the battery, which become corroded in time, and introduce resistance into the circuit. In some sets, automatic relays are employed to disconnect the charger from the line when the set is turned on. Through wear and sparking, the contacts in the relays fail to close and the charger circuit remains open. In lieu of a polarized meter, the line polarity can be determined by dipping the two terminals in water containing a few grains of salt; violent bubbling will take place around the negative wire. See Fig. 14.

(3) 110V. A.C. Battery Chargers. These chargers may be of the tungar-tube type, the vibrating-reed type, the electrolytic rectifier type or the dry-disc rectifier type; the latter two being used mainly for trickle chargers. The illustrations of Figs. 15, 16, 17 and 18 show these types of chargers. Figs. 19, 20 and 21 show the connections, respectively. In addition to the causes of troubles mentioned in connection with D.C. battery chargers, we have a likely source of trouble in the rectifying device. In the tungar type, the filament may burn out, or a defective tube may be encountered. The life of this type of tube is uncertain, even though its filament may be intact. This is true also of dry-disc rectifiers and vibrating rectifiers, which in time require new contact points. Failure in charging may also be due to an open transformer winding, or a dirty or loose tube socket. Some chargers have connections for charging storage "B" batteries, with consequent troubles from corroded connections to the battery.

(4) 110V. D.C. "A" Eliminators. These consist merely of a network of resistors designed to give the required voltage drop, together with a choke coil and condensers for filtering purposes, as indicated in Fig. 22. In some cases the tubes are wired in series, as was illustrated in Fig. 8. In this case, the current drain from the line is much less than when lighting the tubes in parallel. In the latter case Fig. 22 an output voltage of 6-volts is usually desired; but the voltage remains at this value only when the set is turned on and all tubes lit; because the least change

![Fig. 17 - (left) Electrolytic charger.](image1)
![Fig. 21 - (center) Diagram of electrolytic and dry-disc charger.](image2)
![Fig. 20 - (right) Diagram of half-wave vibrating reed charger.](image3)
in current drain charges the resultant voltage drop, causing the output terminal voltage to fluctuate widely, and endanger the tubes. For this reason, no tubes should be removed from the set without first turning off the switch, and the switch should not be turned on again until all good tubes are in the set. However, the variable resistors give a wide range of voltage control, and should be carefully adjusted. Simple continuity tests will indicate the condition of this device. If a fuse blows, because of a short in the eliminator, test the filter condensers for continuity before connecting the outfit in service again.

(5) 110 V. A.C. "A" Eliminators. Such a device is naturally more complex than the D.C. type, since it comprises a power transformer, a rectifier, a filter system and, in some cases, a storage battery. The last arrangement cannot be considered a real battery eliminator, but is merely a combined storage battery and trickle charger. Fig. 23 shows the diagram of the Philo Socket Power "A", which is representative of this type in which no filter system is employed, the storage battery serving for this purpose. In the other types, no battery is used. Fig. 24 shows the diagram of the Balkite "A" Socket Power Unit, which is typical of this. Both of these employ electrolytic rectifiers. We shall describe each in detail.

(6) "A" Power Units With Battery. Troubles in this unit are similar to those occurring in regular batteries and chargers. In these, a comparatively smaller battery is used (about 40-ampere-hour), and it is continually being charged while the set is in operation. Hum may be produced if the battery is operated near or in a discharged condition; in which case the condition of the battery and rectifier should be examined. If the rectifier electrolytic has evaporated, more should be added. Loose binding posts and connecting cables are also a source of trouble. The control resistor also may become loose, dirty, or worn, and require clearing or replacing. Electrolytic or dry-disc rectifiers are usually employed in these units. These need replacing in time, depending upon the length of time they have been in service.

(7) "A" Power Units Without Battery. As shown in Fig. 24, these units comprise a step-down transformer, control resistance, rectifier, choke coil and filter condenser. Since the output voltage is low (about 6 volts) and the current high, the condenser may be designed for low voltage, but it should have an enormous capacity to produce any appreciable filtering effect. The output voltage in these units may vary because of a defective rectifier or leaky filter condenser. The resistance-control allows for adjustment over wide limits, however, and a slight readjustment is usually sufficient.

(8) Series-Filament "A" Supply. If type '99 tubes are used and connected in series, a current of 60 milliamperes is sufficient to light them, and this may be obtained from the "B" supply. If '01A tubes are used in series, a current of 2 ampere is
required, which is too great to be taken from the usual "B" supply, so a separate rectifier is necessary. These systems are not in general use (except for 110V D.C. systems) and need not be described in detail. Trouble shooting resolves itself merely into testing the rectifier and continuity of the circuits, remembering that "C" voltages are obtained by returning the grid-circuit leads to different points of the filament circuit; each point, of course, being at a different potential.

Fig. 25 - "B" Power Supply using half-wave filament type rectifier.

(9) "B" Battery Eliminators. We shall limit this discussion to "B" battery eliminators operating from the A.C. line, as the D.C. type were covered sufficiently in Chapter II. So far we have talked about rectifiers, but made no distinction between half-wave and full-wave ones. In the former, every other half-cycle of the alternating current wave is used, resulting in a D.C. output with a 60-cycle pulsation, which is smoothed out by the filter. In the latter (which is in effect two half-wave rectifiers operating alternately or "out of phase") each half-cycle is used; every other one being in effect reversed, giving a 120-cycle pulsation in the D.C. output. The 120-cycle pulsation is easier to filter than the 60-cycle pulsation and a smaller filter system may be used; however, the sound reproducer is more sensitive to the 120-cycle tone than to the 60-cycle one, and the amount of hum produced is about the same in each case. Filament-type, gas-type, and dry-disc type rectifiers are most generally used.

(10) Filament-Type Rectifiers. Figs. 25 and 26 show typical circuits of half-wave and full-wave filament rectifiers, the latter consisting of two half-wave rectifiers so connected as to obtain full-wave rectification. The type '81 tube is a typical half-wave rectifier. Fig. 27 shows a full-wave rectifier circuit employing a full-wave rectifier, such as the type-'80 tube. A comparison of these three circuits will give a fundamental idea of the basic principles involved, as they are all fundamentally the same and subject to the same defects. Like defects or troubles produce like symptoms in all.

(11) Gas Rectifiers. These are more generally used for commercial "B" eliminators. The Raytheon "B" and "BH" tubes are typical examples. Fig. 28 shows circuits of the

Fig. 26 - "B" Power Supply using two Half-Wave Filament Type Rectifiers for Full-Wave Rectification.
Fig. 27 - (right) Full-Wave Rectifier Circuit for "B" Supply using Filament Type of Tube.

Majestic "B" eliminators employing a full-wave gas-type rectifier. Analysing these, we find them composed of input transformer, buffer condensers, rectifier, filter condensers and chokes, and voltage-control resistors. A condenser, connected between one side of the 110-volt line and ground, is also indicated. The two buffer condensers, connected across each half of the transformer secondary, have a capacity of
o.1-mf each. They are used to absorb or prevent any high-frequency parasitic oscillations across the rectifier tube and are used only with gas-type rectifiers.

(12) Dry-Disc Rectifiers. These can be obtained to plug into the regular socket of the commercial "B" eliminator, without any changes in the internal wiring. Therefore, special circuits will not be given showing their use.

(13) "B" Eliminator Troubles. The most common cause of trouble in a "B" eliminator that fails to work is a shorted filter condenser. Therefore the first thing to do is to turn off the current, open the case, and test each condenser for shorts. The shorted condenser can be clipped out of the circuit and the eliminator put back in service again for temporary use, with only a possible slight increase in hum. It is important, however, to replace the condenser with a new one as soon as possible. The next source of trouble is usually found in the control resistors. If the detector voltage is high, the resistor connecting the detector tap to the negative side of the circuit is open. By measuring the output voltages with a high-resistance voltmeter, a defective resistor can easily be located. Continuity tests will indicate the condition of the choke coils and transformer windings. Slow starting, irregular operation, or low voltage output, indicates a defective rectifier tube. The Raytheon should give about 4000 hours service, after which the voltage output will gradually drop off. By readjustment of the resistors, the voltage can be brought back and the tube used a considerable length of time before discarding it. "Hum" indicates a shorted filter coil or buffer condenser.

(14) Motorboating. Motorboating is a common occurrence when using "B" eliminators,
and is important enough to be considered separately. It produces a "put-put-put" sound in the speaker, similar to that of a small gas engine, from which it gets its title. It is in reality a low-frequency oscillation caused by the combined circuits of the eliminator and set. A different type of eliminator may prevent it, or the use of a separate 45-volt battery for the detector, connected between the negative side of the eliminator and the detector terminal of the set, in which case the "Detector" terminal of the eliminator is not used. Sometimes it may be stopped by reversing one of the transformer windings in the audio-frequency amplifier. In resistance-coupled amplifiers, it is best to remove the first stage and insert in its stead an audio transformer. Sometimes a large by-pass condenser added to the eliminator output (especially the detector output) will prevent it.

(15) Combined "A" and "B" Eliminators. A combined "A" and "B" eliminator is merely the combination of the subjects we have just discussed, and a detailed analysis need not be given. Circuit diagrams, Figs. 29 and 30, showing the Philco and Balkite "AB" socket-power units, are given, however; the illustrations being self-explanatory.

(16) Power Packs. Power packs are made in many forms to suit different set conditions, but they are all fundamentally the same and have the same inherent characteristics. The power pack is a combination of parts designed to furnish the set with plate, grid, and filament voltages for A.C. tubes and is built in a unit separate from the set. It is thus distinguished from electric sets in which the power-supply system is an integral part of the set. We might appropriately call them heavy-duty "B" eliminators. In addition to furnishing plate, grid and filament voltages for A.C. tubes, some power packs also contain a stage of audio-frequency amplification - the output stage - of...
type '71, '10, '45 or '50, singly or in push-pull. A power pack of this type may be connected to the output from the first audio stage of any broadcast receiver and deliver a high-quality output of sufficient power to operate a dynamic speaker. Since servicing of power packs is identical with servicing power-supply systems in A.C. sets, we will describe this phase of the subject collectively at the end of this chapter.

Fig. 31 shows the connections of the Amertran "ABC Hi-Power Box." Note that two audio stages are included, allowing the pack to be connected to the detector output of the receiver. A half-wave, type '81 rectifier tube is used. Note the connection between the two filter chokes to obtain the high-voltage plate supply for the two type '10 push-pull tubes.

(17) "Glow" Tube. It seems fitting to briefly describe the type '74 glow tube employed in many power packs to maintain a constant voltage output of 90 volts for the tubes of the set requiring this voltage. This tube will remedy much trouble from unstable A.C. supply. It is connected between the "B" negative and intermediate (90-volt) terminals, usually in series with a ballast resistor to maintain a constant current flow of 60 milliamperes through it. Characteristics of this tube are given in the tube chart, elsewhere in this book.

(18) Power Supply Systems. There are slight differences in the methods of obtaining plate and grid-bias voltages in the sets whose diagrams are included in this book. These differences, or rather methods, should be understood when making measurements, especially voltmeter readings, in order to be sure that the desired voltage supply leads will be found. Fundamentally, these power-supply systems are the same as those employed in "B" eliminators and power packs described previously. However, we shall point out a few of the variations in them, as designed by different set manufacturers.

(19) Plate-Supply Power. The main differences in plate supply appear in the voltage divider, or resistance network system. For example, Fig. 32 shows the diagram of the Atwater Kent "Model 43" set and power unit. Note that separate resistors (R1, R2 and R3) are used to obtain plate voltages for the first audio, detector, and R.F.amplifier tubes respectively. The resistances are by-passed by the condensers C1, C2 and C3.
With this arrangement, the only drain on the plate supply system is that due to the current consumption of the tubes. This method has certain advantages; if one resistor burns out it will not greatly affect the others. In this set, the field coil of the dynamic speaker serves as a filter choke; this is clearly indicated in the diagram. Series-resistance voltage dividers are more generally used, as indicated in the various diagrams of "B" eliminators and power packs; Fig. 33 shows the Steinite "Model 40" power pack which is representative of this method. In this case the voltage divider may be considered as one resistance, with taps taken off at the required voltage points. In this case the dynamic speaker's field winding is also used as a filter choke. The arrangement of chokes and condensers in the filter also varies in different sets - another reason why the diagram of the set should be studied before making measurements.

(20) Grid-Bias Voltage. The method of obtaining grid-bias voltage for the various tubes is fundamentally the same in all electric sets. Use is made of the voltage drop caused by the plate current of the tube flowing through a resistance. Knowing the plate current of the particular tube, the resistance can be calculated to give the desired drop. The "C" bias resistor is connected between the tube filament (or the center-tapped resistance connected across the filament, in the case of the '26 tube or power tubes; or the cathode in heater-type tubes) and the extreme negative end of the power-supply system. This is shown in the simplified diagram of Fig. 34. In the diagram of Fig. 32 the bias voltage for the power tubes is obtained by the drop across the grid resistance G1; that for the first audio and the R.F. stages is obtained by means of the resistance G2. In the diagram of Fig. 33 the 1190-ohm resistance furnishes the grid bias for the '71A power stage. These bias resistors are sometimes in the power pack and sometimes in the set (or in both) and they should be located before taking grid voltage measurements; although the bias voltage may be obtained by connecting the voltmeter between the grid terminal of the set and the center-tap in the filament circuit of the same tube, or the cathode in heater-type tubes. An
An interesting departure is illustrated in Fig. 35; this simplified circuit shows how the second A.F. bias voltage in the Atwater Kent "Model 66" is obtained from the drop across the speaker's field coil, in the negative side of the filter circuit. It is imperative that the grid-bias resistance is by-passed by a suitable condenser to prevent feed-back, howling and hum.

Fig. 34 - Circuit showing how Grid Bias Voltages are obtained in the Atwater Kent Model 60.

The correct voltage and current outputs are taken from secondary windings on the main power transformer or, in some cases, from a separate filament transformer. Connections are made to the electrical centers of the filament windings by means of center taps on the windings or center-tapped resistors connected across the windings. In many cases, hum is caused by not having the correct center tap; this center-tapped resistor or potentiometer should be carefully adjusted until minimum hum is heard in the loud speaker.

(21) Filament Voltage. Regardless of the type of tubes used, the filament supply system is very simple; raw alternating current being used on all filaments.

(22) Power-Supply Troubles. Troubles in power-supply systems are not very difficult to locate if we proceed in a systematic manner. Knowing the main sources of troubles and their corresponding symptoms, we can trace back and find the detailed faults probably in less time than it takes to read this paragraph. Therefore a complete detailed analysis is deemed unnecessary and we limit ourselves to generalizations only.

Faults in power-supply systems manifest themselves in producing either:

(a) A.C. Hum,
(b) Wrong Supply Voltage,
or both; one usually accompanying the other. Many things can happen to the system that will produce the above effects. By testing each part of the apparatus in turn, the fault is soon located.

(23) A.C. Hum. It is taken for granted that previous tests on the set show that the trouble exists somewhere in the eliminator. If the hum is slight, it may be caused by poor shielding, or proximity of the power transformer to the set, or induction from some part of the A.C. line into the set. Sometimes reversing the A.C. line plug will reduce hum slightly. A general cause of hum is found in wrong "C" bias voltages, poor adjustment of the center-tapped filament potentiometers, or open or shorted by-pass condensers across these resistors. In the Atwater Kent 66 the drop across the speaker field coil gives the grid bias voltage of the 2nd A.F. tube.

Fig. 35 - In the Atwater Kent 66 the drop across the speaker field coil gives the grid bias voltage of the 2nd A.F. tube.
type '26 tube used for radio and audio amplifiers, an accurate center tap on the filament circuit is important. An open filter condenser or a shorted choke coil will also cause poor filtering with a resultant hum. A poor rectifier tube will produce hum. Mechanical hum may be produced by vibration of the transformer core. Continuity tests on the coils and condensers, and voltmeter readings of the different output voltages, will locate the trouble.

(24) Wrong Supply Voltage. In this case, the line-voltage should be checked, adjusted if necessary by the line ballast resistance or taps on the transformer primary. After this is ascertained, the trouble may be found in an open resistor in the voltage divider. This is a common occurrence. The next most likely place is in the filter condensers; the one connected directly across the rectifier output usually punctures first, as it is under the influence of the highest voltage. Of course a wrong load on the system will upset the various voltages; since we are assuming that the set is all right, this may be caused by a short circuit. In making voltage readings, it is important to use a high-resistance meter, otherwise the load placed on the system by the current consumed by the meter will upset the system and give erroneous values. A shorted filter coil, or an open coil, will cause too much voltage or give no output at all. Continuity tests will indicate the condition of the various parts. It is always well to compare the rectifier tube with a new one; as these tubes have a limited life. The resistance, condenser, and choke values should be compared with those specified by the manufacturer, to make certain that someone hasn't inserted wrong parts.

(25) Motor Generators. A.C. electric sets are sometimes operated on D.C. lines by means of motor generators or rotary converters, which change the 110-volt direct current to 110-volt, 60-cycle A.C. form. Aside from the additional cost and noise incurred by the use of the machine, the results obtained are superior to those obtained from D.C. sets. The rotary converter type, although very quiet in operation, should be installed in a closet or some distant place where it cannot be heard. These machines are furnished with a filter for eliminating commutator or line noises, the final result being quieter operation than is usually obtained on the normal 110-volt A.C. line. Both input and output sides of the motor generator or converter should be filtered, as shown in the illustration, Fig. 36. Troubles in these machines are those inherent to any motor or generator. Barring abuse, they should last a long time with only an occasional oiling of the bearings.

The brushes also need repair and replacing occasionally. In one instance, a Service Man reported trouble from brushes which were completely worn down to the brush holders - and these caused excessive grooves in the commutator. The commutator had to be removed and turned down on a lathe before the machine could be placed in service again.

Fig. 36 - At the left is shown the "ESCO" motor generator. The illustration at the right is that of the "JANETTE" rotary converter. Note the size of the filters used in connection with these machines. These instruments supply 110 volts A.C. from the 110 volt D.C. line.
CHAPTER IV
VACUUM TUBES

The vacuum tube is the heart of the radio set, and one must understand vacuum tubes to understand radio. Since the beginning of radio broadcasting, improvements in sets have followed improvements in tubes. The theoretical analysis of vacuum tubes is beyond the scope of this book, which aims mainly to give the practical side only; one can measure tube voltages and characteristics without a profound understanding of the theory. A deeper insight into vacuum-tube action should be sought, however; but this should be obtained from a book devoted to the subject. Not only is the vacuum tube a source of many set failures, as well as successes, but it offers a means of diagnosing virtually all set troubles. The first procedure of the experienced Service Man is to measure quickly the currents and voltages of the different tubes in the set with a set analyzer and record the values. Any great discrepancy from normal values, as given by the manufacturer of the set, is instantly detected and in almost all cases as easily cured: whether it is caused by the tube or some other part of the set.

(2) Types of Vacuum Tubes. We are giving herewith a chart, Fig. 38, showing the average characteristics of the various types of vacuum tubes used in receiving sets, the ratings given being those recommended by the tube manufacturer. Tubes of different makes may vary slightly from these, but this list is representative of the majority. This chart is very helpful as a guide, but it should not be adhered to too closely, for many set manufacturers operate tubes at voltages differing widely from those specified in this list. For example, the Majestic "Model 90" receiver, employing power detection, operates the type '27 detector on a plate voltage of 270 volts, with a grid bias of 30 volts - values much higher than those given for this type of tube in the chart. In the following paragraphs, only the more popular types of tubes of widely different characteristics will be described in detail, which should sufficiently cover the entire field for all practical purposes.

Fig. 39 - Static Characteristic curves of 3-element vacuum tube.
Fig. 40 (right) The type '01A vacuum tube.

(3) Basic Principles. The basic principles of vacuum-tube action should be understood, at least in an elementary way, in order to facilitate set diagnosis. For example, in the three-element tube comprising filament, grid and plate, an understanding of the interdependence of one on the other should be known while taking measurements. Although the plate current will give much information regarding the set's condition, we must not forget that the plate current in a normal tube depends upon the plate voltage, the grid voltage and the filament current - the latter in turn depending upon the filament voltage. The graph of Fig. 39 shows the dependence of plate current on grid voltage, using a fixed plate voltages of 222, 45 and 90 volts. With different
### Average Characteristics of Receiving Radiotrons

**General**

<table>
<thead>
<tr>
<th>Model</th>
<th>DC Output Current</th>
<th>AC Output Voltage</th>
<th>AC Output Power</th>
<th>AC Output Current</th>
<th>AC Output Voltage</th>
<th>AC Output Power</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>1.00 Euro</td>
<td>50 Volts</td>
<td>0.50 Volts</td>
<td>0.50 Volts</td>
<td>50 Volts</td>
<td>0.50 Volts</td>
</tr>
<tr>
<td>Type B</td>
<td>1.00 Euro</td>
<td>50 Volts</td>
<td>0.50 Volts</td>
<td>0.50 Volts</td>
<td>50 Volts</td>
<td>0.50 Volts</td>
</tr>
</tbody>
</table>

**Detectors**

<table>
<thead>
<tr>
<th>Model</th>
<th>Input Resistance</th>
<th>Output Resistance</th>
<th>Bias Voltage</th>
<th>Plate Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>100 Megohms</td>
<td>10 Megohms</td>
<td>12.5 Volts</td>
<td>12.5 Volts</td>
</tr>
<tr>
<td>Type B</td>
<td>100 Megohms</td>
<td>10 Megohms</td>
<td>12.5 Volts</td>
<td>12.5 Volts</td>
</tr>
</tbody>
</table>

**Amplifiers**

<table>
<thead>
<tr>
<th>Model</th>
<th>Input Sensitivity</th>
<th>Output Sensitivity</th>
<th>Bias Voltage</th>
<th>Plate Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>100 Microamps</td>
<td>500 Microamps</td>
<td>12.5 Volts</td>
<td>12.5 Volts</td>
</tr>
<tr>
<td>Type B</td>
<td>100 Microamps</td>
<td>500 Microamps</td>
<td>12.5 Volts</td>
<td>12.5 Volts</td>
</tr>
</tbody>
</table>

**Miscellaneous**

- **Regulators**
  - Voltage Regulator: Series Resistance
  - Current Regulator: Standard Model
  - Input Regulator: Standard Model

- **Transformers**
  - Full-Wave Transformer
  - Half-Wave Transformer

- **Rectifiers**
  - Full-Wave Rectifier
  - Half-Wave Rectifier

- **Voltage Regulators**
  - Series Resistance

- **Current Regulators**
  - Standard Model

- **Input Regulators**
  - Standard Model

**Note:** All grid voltages are given with respect to cathode or negative filament terminal or non-otherwise noted.

---

### Power Amplifiers

<table>
<thead>
<tr>
<th>Model</th>
<th>Input Power</th>
<th>Output Power</th>
<th>Input Sensitivity</th>
<th>Output Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type A</td>
<td>100 Watts</td>
<td>500 Watts</td>
<td>100 Microamps</td>
<td>500 Microamps</td>
</tr>
<tr>
<td>Type B</td>
<td>100 Watts</td>
<td>500 Watts</td>
<td>100 Microamps</td>
<td>500 Microamps</td>
</tr>
</tbody>
</table>

---

**Rectifiers**

- Full-Wave Rectifier
- Half-Wave Rectifier

**Miscellaneous**

- **Voltage Regulator**
  - Series Resistance

- **Current Regulator**
  - Standard Model

- **Input Regulator**
  - Standard Model

**Note:** All grid voltages are given with respect to cathode or negative filament terminal or non-otherwise noted.

---

**Amplifiers**

- **Input Sensitivity**
- **Output Sensitivity**

---

**Miscellaneous**

- **Voltage Regulator**
  - Series Resistance

- **Current Regulator**
  - Standard Model

- **Input Regulator**
  - Standard Model

**Note:** All grid voltages are given with respect to cathode or negative filament terminal or non-otherwise noted.
fixed plate voltages, different curves result, as shown. For undistorted reception in audio amplifiers the tube can be operated only on the straight portion of the curve, which portion is longer with higher plate voltages, thereby affording greater undistorted output. The grid voltage should be held normally at a definite average value indicated by the center of the straight portion of the curve. This allows the plate current to swing equally above and below this point, and cover the entire straight portion. Since the curve is different with different plate voltages, the normal grid voltage or bias will likewise be different; the higher the plate voltage, the greater the negative grid bias voltage required. In other words, within practical limits, a tube may be operated at any plate voltage, provided the corresponding proper grid voltage is employed. For example, the correct grid bias voltages for use with the plate voltages shown in Fig. 39 are indicated at the bottom of the graph; they are, approximately, plus 1, minus \( \frac{1}{2} \), and minus \( 2\frac{1}{2} \), for the 22\( \frac{1}{2} \), 45 and 90 volt curves, respectively.

(4) Battery-Operated Tubes. The type '01A tube is widely used in battery and D.C. electric sets and may be considered in this elementary discussion as typical of all three-element battery operated tubes, the difference being mainly in the ratings. This tube is used for detector, radio, and audio-frequency amplifiers. From our chart we find that this particular tube operates from a 6-volt storage battery and has a terminal voltage of 5; one volt being lost in the filament-control rheostat and connecting leads. At this voltage the filament current is 0.25-ampere. Plate voltages of 45, 90 or 135 may be employed depending upon the circuit in which it is used; corresponding grid-bias voltages are given in the chart. Fig. 40 shows the internal construction of this type of tube. Defects are usually traced to the filament which, through age or abuse becomes impotent and loses its power to emit electrons. Such a defect is accompanied by general weakness of the set and lack of sensitivity. It has almost human qualities. Very low plate current, with proper applied voltages, is another symptom of low electronic emission. It is best to replace such tubes with new ones. In any event, it is advisable to check the filament voltage, especially in D.C. electric sets, as this is one value which should remain normal and constant. Excessive filament voltage will shorten the life of the tube; less than normal filament voltage will give the tube longer life, as a general rule; but for over-all efficiency the rated filament voltages should be adhered to.

(5) Battery-Operated Power Tubes. The types '12A and '71A tubes are commonly used in battery sets, and differ mainly from the '01A type in that they allow a much greater undistorted output; the same general information given in regard to the '01A tube may be applied to them.

(6) A.C. Tubes. The type '26 tube is extensively employed in A.C. sets for both radio- and audio-frequency amplifiers; it is not suited for detection purposes, on account of the excessive A.C. hum produced. This tube is similar to the '01A type, except that its filament is designed for a much lower voltage and higher current; namely, 1.5 volts and 1.05 amperes. The reason for this is to give the filament sufficient mass to hold the heat longer and not rise and fall in temperature with the rise and fall in each half-cycle of alternating current; thereby reducing hum. It has a four-prong base and connections similar to those of the '01A type. In an amplifier stage employing this tube, the grid return leads connect to a center-tapped resistor connected across the filament. If excessive hum is produced in the set, these resistors should be examined and adjusted for minimum hum. This tube is not suited for the output stage on account of its limited output; for this purpose, the type '71, '10, '45, or '50 power tubes are employed, connected singly, in parallel or push-pull, with filaments lit by A.C. and having center-tapped resistors for the grid returns. Sometimes center-tapped resistances are eliminated by connecting the grid returns to a center tap on the secondary winding of the filament transformer.

(7) The A.C. Heater Tube. The type '27 A.C. heater tube is used as a detector in
OFFICIAL RADIO SERVICE MANUAL

Fig. 41 - Vacuum tubes most generally used in modern receivers.

all A.C. electric sets; and also as radio-frequency and first-stage audio-frequency amplifiers in many sets. The filament of this tube draws 1.75 amperes at 2.5 volts; it consists of a fine tungsten wire threaded through two holes in a porcelain-like tube. Around this tube is an oxide-coated metal cylinder, the cathode, which emits electrons when heated to redness. Its heat is obtained by its proximity to the white-hot tungsten filament. Since the cathode is electrically insulated from the A.C. filament, no A.C. hum is introduced into the radio circuits. It takes an appreciable time for the heater filament to heat the cathode to redness, from 15 to 45 seconds elapse before the set gets into action. Some of the early makes of these tubes are known as “blinkers”; a poor weld at the heater causes the circuit to open after the heater becomes hot, and close again after it cools down, making the reception rise and fall in volume. In the circuits in which heater type tubes are used, the tungsten filament is maintained at a positive potential with respect to the cathode, thereby preventing any emission of electrons from the A.C. filament into the cathode with a consequent introduction of hum. These tubes employ a five-prong or “UY” base; having two prongs for the filament or heater, one for the cathode, one for the grid and one for the plate.

(8) Screen-Grid Tubes. In addition to the regular filament, grid, and plate elements of the ordinary tube, the screen-grid tube employs a fourth element, which is a metallic network interposed between the grid and plate, and used mainly as an electrostatic shield for shielding the plate from the grid and preventing electrostatic feedback. This allows much greater amplification in radio-frequency amplifiers without oscillation. Neutralization is therefore unnecessary. A positive potential of from 70 to 90 volts is applied to the screen. Although this type of tube is used mainly in radio-frequency amplifiers, it may be employed as a detector or a resistance- or impedance-coupled audio amplifier; or as a “space-charge” tube in an audio amplifier. In this case the inner grid is connected to a positive potential of about 22½ volts, to neutralize the space charge within the tube. The screen is employed as the control-grid. In radio-frequency amplifiers, the value of the positive voltage applied to the screen, determines the amplification, and this effect is made use of as a volume control. The screen-grid tube is made in the heater type, the type 22, in which a standard 5-prong base is used and the control grid is connected to a terminal at the top of the tube, as illustrated in Fig. 41. The type 22 is also a screen-grid tube, but is not the heater type.

(9) Gas Rectifier Tubes. The gas-rectifier tube is largely employed in “B” eliminators, of which the Raytheon type “BH”, illustrated in Fig. 42, is a typical example. These rectifiers depend upon ionization of gas for their action and take advantage of the difference in size of their electrodes for “unilateral” (one-way) conductivity. In the one illustrated, the two small electrodes connect to the 350-volt output termin-
als of a transformer secondary having a center tap. A direct-current output of 125 milliamperes may be drawn from the hat-shaped electrode and the center tap. Failure in these rectifiers is usually due to age or internal breakdown, in which case sparking can be observed. Chapter III gives further information in connection with this tube, as used in a "B" eliminator.

(10) The Pentode. A new tube to make its appearance on the market is known as the five-element pentode. While not in general use, it is fast becoming popular, and a brief description may not be amiss. It is somewhat similar to the four-element screen-grid tube described above, but with the addition of a "space-charge" grid surrounding the cathode; the connection to this extra grid being brought out to a terminal on the side of the tube base. The remaining terminals are similar to those of the '24 type screen-grid tube. A very high amplification factor is claimed, one stage being sufficient in the audio amplifier. An amplification factor as high as 750 may be obtained with a plate voltage of 250, screen-grid voltage of 135 (positive) and space-charger-grid voltage of 20 (positive). The heater filament is similar to that of the '24 type. An illustration of this tube is also shown in Fig. 42.

(11) Filament Rectifier Tubes. The half-wave '81 and full-wave '80 rectifiers are largely employed in A.C. receivers, and in some cases to supplying field current for dynamic speaker. Characteristics of these tubes are given in the chart. Failure is usually due to internal breakdown, manifesting itself in the form of a blue glow within the tube. When this takes place, the tube may be operated successfully at a lower voltage, but it is usually best to replace it. Circuit connections are shown in Chapter III as well as in many of the diagrams of this book.

(12) Vacuum-Tube Tests. Vacuum-tube tests on any radio set should be conducted systematically. Suppose we arrange our tests in the following order:

(a) Plate-current tests,
(b) Plate-voltage tests,
(c) Grid-voltage tests,
(d) Filament-voltage tests.

A knowledge of these four functions will give a fairly complete indication of the condition of the tubes and associated circuits.

(13) Plate-Current Tests. The milliampere reading of the plate current of each tube in the set tells us a very complete story, but we cannot rely on it...
too much, since the plate current of different tubes in the different sets varies widely and the figures given in the tube chart cannot be rigidly adhered to. Only where the readings deviate very far from those given should we look for real trouble. It is best to follow the ratings given by the set manufacturer, wherever possible. Causes of excessive plate current and of insufficient plate current are given below, which causes should be further checked to find the guilty ones, after which they can be corrected.

(14) Excessive Plate Current may be due to:

(a) Excessive plate voltage,
(b) Insufficient or incorrect grid voltage,
(c) Excessive filament voltage,
(d) Defective tubes,
(e) Leaky condenser, or poor insulation of circuit.

(15) Insufficient Plate Current may be due to:

(a) Insufficient plate voltage,
(b) Excessive negative grid bias,
(c) Low filament voltage,
(d) Defective tube.

(16) Plate Voltage Tests. If the foregoing measurements indicate that the trouble lies in excessive or insufficient plate voltage, the causes of an erratic plate voltage may be traced to the following:

(17) Excessive plate voltage may be due to:

(a) Open in the negative end of voltage divider in the power-supply system,
(b) Excessive negative grid bias,
(c) Low filament voltage,
(d) Defective tube.

(18) Insufficient plate voltage may be due to:

(a) Failure in power-supply system,
(b) Low negative or even a positive grid bias,
(c) Excessive filament voltage,
(d) Defective tube.

(19) Grid-Voltage tests. Should the erratic plate voltage or plate current readings be traced to high, low or reversed grid bias, we may look for the following defects:

(a) Shorted by-pass condenser across "c" battery or grid-bias resistor,
(b) Open "c" battery or grid-bias resistor,
(c) Leakage in insulation or blocking condenser between grid and plate-supply circuit,
(d) Open transformer winding in grid circuit,
(e) Defective tube socket.

(20) Filament-Voltage Tests. If our erratic plate current and voltage readings are traced to wrong filament-supply voltage, we have but to trace the filament-supply circuit and find the cause. In battery sets the filament voltage may be too low, because of poor connections or a weak battery. If an "A" eliminator is used, its adjustment should be checked. In A.C. electric sets, the filament transformer may be
overloaded by a partial short across the filament circuit. The line-voltage should be checked also.

(21) Defective Tube. A defective tube may cause erratic readings due to a deactivated filament, loss of vacuum (causing the tube to emit a blue glow); or a short circuit between the elements within the tube. In this latter case, the grid may touch the plate or filament, thereby upsetting its bias potential and killing the normal tube action. Some tubes have a very detrimental microphonic effect producing a loud howl in the speaker; the detector tube is the worst offender. It should be replaced or exchanged with one of the other tubes.

RCA Radiotron 230

... may be used either as detector or amplifier. Its characteristics are:
- Filament Voltage: 2.0 Volts
- Filament Current: 0.06 Amperes
- Plate Voltage, Max.: 135 Volts
- Grid Voltage (C-Bias): 72.5 Volts
- Plate Current: 1.5 Ma.
- Plate Resistance: 400,000 Ohms
- Amplification Factor: 2.5
- Mutual Conductance: 675 Micromhos
- Effective Grid-Plate Capacitance: 170 Milli capacitance

RCA Radiotron 231

... has been designed for volume output from battery operated receivers where economy of plate current is important. It is for use in last audio stage. Its characteristics are:
- Filament Voltage: 2.0 Volts
- Filament Current: 0.150 Amperes
- Plate Voltage, Max.: 135 Volts
- Grid Voltage (C-Bias): 72.5 Volts
- Plate Current: 1.5 Ma.
- Screen Voltage, Max.: 400 Volts
- Screen Current: Not over 1/3 of plate current
- Plate Resistance: 800,000 Ohms
- Amplification Factor: 440
- Mutual Conductance: 550 Micromhos
- Effective Grid-Plate Capacitance: 0.08 Milli capacitance

Fig. 43 - Average characteristics of three types of 2-volt tubes are given in this illustration.

(22) Tube Reactivation. When a tube has lost its electron-emitting ability and passes a very small plate current, it can often be restored by reactivation. This is true of thoriated filaments such as are in nearly all tubes now in use. The coating of thorium on the surface gradually gives out and the tube loses its sensitivity. By reactivating the thorium inside of the filament is brought to the surface, thus permitting the tube to function normally again. One simple method to restore tubes that are only slightly weak is to burn them for 2 to 12 hours with the plate supply disconnected. This "boils" out the thorium from the inside of the filament and provides a new layer on the surface. Tubes that are very weak can often be restored by "flashing" the filaments from 10 to 20 seconds at a filament voltage of approximately three times the normal filament voltage. After this process, the filament must be burned for about 30 minutes at a filament voltage about 25% above normal. The plate supply should be disconnected while this is being done. While reactivation is not always possible, and there is also danger of burning out the tube filament, the process may come in handy to the Service Man in cases of emergency or for temporary set operation to please a dissatisfied customer. Of course, reactivation of heater type A.C. tubes is impractical, especially "flash" method. Holding a tube over a gas flame will sometimes reactivate it.
CHAPTER V

THE LOUD SPEAKER

The loud speaker or sound reproducer forms a very important part of every radio set; for, with a poor reproducer, good results cannot be expected, no matter how good the set may be. Since the reproducer is partly mechanical and it is in continuous use during reception, it is subject to wear and disintegration due to the excessive continuous vibration. Furthermore, it receives the greatest electrical strains of any part of the set, being connected to the extreme output and subjected to the total amplified output of the set. The importance of good speaker operation, as regards satisfied customers, cannot be too strongly urged.

(2) Speaker Tests. The nature of the sound coming from the speaker usually tells exactly the condition of the speaker; but we are not endowed with ears subtle enough to completely diagnose the trouble by sound alone. Only by much experience can we approach this skill. A dead, weak, noisy, or distorted set may be the effect of trouble either in the set or in the speaker system; and it can easily be localized in either by connecting a speaker known to be in good condition to the set output terminals in place of the questionable speaker, and comparing the two. We will assume, in the following paragraphs of this section, that the set output is of excellent quality and that trouble lurks in the speaker or its associated circuits. There are a variety of speakers in operation, each with its own group of inherent weaknesses, if we may use this term, where trouble may brew. We will describe them in the order of the following classification:

(a) Electrodynamic cone speakers,
(b) Magnetic cone speakers,
(c) Horn-type speakers,
(d) Electrostatic speakers.

Fig. 44 - Front and rear views of the Stromberg Carlson P-1887C dynamic speaker.

(3) Electrodynamic cone speakers. Nearly all the more recent sets employ this form of reproducer. A typical example is shown in Fig. 44. The diagrammatic illustration, Fig. 45, shows that it is composed of a powerful electromagnet and a moving coil or "voice coil," which is attached to the apex of a cone and arranged for free movement within the magnetic gap of the electromagnet. In addition to these, the speaker system comprises the source of direct-current supply for energizing the electromagnetic field coil, and the output choke, filter or transformer adapting the voice
coil to the set output. Trouble may arise in any of these places, but we will first consider the main elements of the speaker shown in the illustration of Fig. 45.

(4) The Field Coil. Very weak, raspy, reproduction with almost complete absence of bass notes indicates failure of the field supply. It is best to remove the speaker from the cabinet before making tests; after which a clean knife blade or other iron tool, held near the center magnetic pole of the voice coil, should be strongly attracted when the field current is turned on. If no magnetism exists there is an open somewhere in the line, and a continuity test across the field winding should be made, after disconnecting it from the set. In many sets, the field coil serves as a filter choke in the power supply, in which case it is merely plugged into a jack in the rear of the set chassis. In such installations, the field coil has a resistance of several thousand ohms, which should be indicated by the continuity tester. The voltage supply to the coil should be measured at the field-coil jack, with the speaker in circuit and the set turned on, to make sure that there is no failure from that source. In some speakers, supplied with low-voltage direct-current obtained from the A.C. line by the use of dry rectifiers, a low-resistance field winding is employed, and this should be noted when making continuity tests in the field.

(5) The Voice Coil. The voice coils of different makes of dynamic speakers vary widely in number of turns and, consequently, in resistance. The resistances are too low to be accurately indicated on a continuity tester, making it difficult to detect a shorted turn. Often a loss of bass in the reproduction is caused by a shorted portion of the voice coil, due to rubbing on the iron field. This is best determined by removing the cone and coil and examining it. While an open circuit will kill reception, sometimes a high-resistance connection to the voice-coil terminals will cause much trouble. In one particular instance, a customer was well pleased with the radio reception, but the results from the phonograph pickup were not much to brag about, and the customer threatened to return the set after several attempts to rectify the trouble failed. It was later found, however, that this particular speaker employed a single-turn voice-coil of heavy copper ribbon connected to a similar copper strip forming the secondary of the output transformer. The coil was obviously of very low ohmic resistance, and it was found that the resistance of one of the connections to the coil, although low, was appreciable when compared with the coil's resistance. This connection was thoroughly cleaned with steel wool and soldered. This not only brought the quality of the phonograph reproduction up to normal, but also improved the radio reception, and the customer was well pleased. The radio reception previously had been sufficiently powerful to give fairly good quality.

(6) The Magnetic Gap. This part of the speaker is more important than it appears, as it has a very bad habit of picking up bits of iron filings and holding them in the path of the moving coil, causing a raspy sound. In bad cases it will be necessary to disconnect the field, dismantle the speaker and wipe the gap with a piece of clean cloth. Sometimes bits of iron may be removed with a sharp-pointed iron tool; the magnetized iron particles will cling to the iron tool and are easily removed.

(7) Cone. The paper or composition cone sometimes becomes damaged by ill treatment, and sometimes it is shattered or broken near the apex by excessive volume. In either...
case, it is best to replace it with a new one. It is important to center the cone accurately so that the coil does not touch the iron field and cause chattering. Loose parts on any part of the speaker or cabinet in which it is mounted are likely to cause rattling or extraneous vibration, and should be corrected.

(8) Field Supply. Field current for dynamics, in addition to the method previously described, in which the field coil forms part of the filter system of the set, is sometimes contained separately by rectified alternating-current or from the 110-volt D.C. line in D.C. installations, or from a storage battery. It is obvious that the rectifier-A.C. method is likely to cause the most trouble. In some cases the current is rectified by means of a vacuum tube such as the '80, giving a comparatively high voltage, and sometimes by means of dry-disc rectifiers, giving a low voltage. These two methods are shown in Figs. 46 and 47. Of the two methods, the vacuum-tube type of rectifier usually causes the least trouble. Sometimes the field is connected across the voltage divider of the set's power supply, as in the Atwater Kent "Model 55" set, as shown in Fig. 48. A filter is required in either case to reduce A.C. hum. Fig. 49 shows a typical speaker installation.

(9) Vacuum-Tube Rectifier. Failure in field supply on speakers using this type of rectifier may be due to a poor rectifier tube, a punctured filter condenser, an open transformer winding or line connection. Continuity tests will soon locate the trouble. As shown in the illustration, Fig. 46, a 2-mfd. condenser is sufficient for filtering purposes.

(10) Dry Rectifiers. A dynamic speaker with a 6-volt field connected to the rectified output of a trickle charger forms the basis of this type of A.C. dynamic speaker, except that the whole is assembled as one unit. The schematic diagram, Fig. 47, shows the usual connections. Fig. 50 shows the Radiola 41 A.C. speaker. Failure of field current is usually caused by the dry-disc rectifiers reaching the end of their useful life, especially if A.C. voltage is found across the secondary of the step-down transformer. Should this be the case, the rectifiers must be replaced. Excessive hum, caused by the pulsating direct current delivered to the field, may be reduced by connecting a low-voltage high-capacity condenser across the field. A condenser of 1000 to 2500 mfd. rating is usually employed for this purpose. Short circuits often occur in this type of condenser, making it another source of trouble for the service man.

(11) Hum. Hum in dynamic speakers is sometimes reduced by means of a short-circuited ring around the center pole, which produces a bucking effect on any magnetic changes in the field and holds the flux steady. (see Fig. 44). In some speakers, part of the pulsating field current is fed into the voice-coil circuit through a variable resistance in order to balance out any hum. In these speakers the hum is under control and

Figs. 46 and 47, showing filament rectifier field current supply and dry-disc rectifier field supply. Illustrations courtesy of Stromberg Carlson.
the control resistor should be carefully adjusted. A stationary bucking coil on the center field pole, connected in series with the voice coil and shunted by a variable resistance, is also employed in some speakers, as in Fig. 47.

(12) Speech-Input Transformer. This transformer may be part of the set or part of the speaker, but in any case its purpose is to match the output impedance of the power tube or tubes to the impedance of the voice coil of the speaker. The secondary of this transformer connects directly to the voice coil, as shown in Fig. 47 and its primary to the set output; sometimes through an output choke and by-pass condenser. In push-pull amplifiers, the primary may have a center connection to the high-voltage plate supply, the two ends connecting to the tube plates. An open speech-transformer winding will cause failure in the speaker. The connections to the transformer should be removed and continuity tests made on all the windings. Also, test between the windings and core to see that they are not grounded.

(13) Audio Filters. Some sets employ a combination of chokes and condensers to filter the audio output by making a definite predetermined frequency cut-off and an improved quality of reproduction. Fig. 51 shows the type of filter used in the Federal "Model K" receiver. It is obvious that an open choke or shorted condenser will interrupt reception, and the components of the filter should be tested separately.
(14) Magnetic Cone Speakers. The testing of magnetic cone speakers is similar to that of dynamic speakers, the main difference being that the magnetic instruments employ permanent magnets and have no field supply, making the localizing of trouble easier. Since these speakers employ a high-impedance coil wound in a small space with many turns of fine wire, open coils are a frequent occurrence. A continuity test at the coil terminals will reveal the condition of the coil. It is best to disconnect the flexible connecting cord, as this may be shorted from dampness or open circuited. The cord should then be tested separately. Speech-input transformers are sometimes employed with these speakers, but usually there are an output choke and condenser, arranged to prevent the D.C. component of the plate current from flowing through the speaker unit winding and destroying it or unbalancing the unit or weakening the permanent magnet. Tests on this apparatus are described in connection with dynamic speakers. Fig. 52 shows the coils, armature and driving mechanism of the R.C.A. Model 100 A speaker.

(15) Troubles in Magnetic Speakers. Weak, tinny sounds may be caused by a damaged or crushed cone near the apex. The cone paper can be strengthened with collodion, which should be allowed to soak in and dry, but it is better to replace the cone. Loud chattering sounds are the result of the armature striking the pole tips, and the unit then requires adjustment. See Figs. 53, 54 and 55. Raspy sounds may be due to iron filings or dirt in the narrow magnetic gaps; these may be removed with pieces of stiff paper forced between the armature and pole tips. Rattling sounds denote looseness in some part of the driving system; either a loose drive pin or a loose cone attachment. Lack of volume may be due to a weak magnet, or poor insulation in the connecting cord, or open coil winding.

(16) Types of Magnetic Speakers. The illustrations, Figs. 56 and 57, show two magnetic units of different
types; the latter called the Inductor Dynamic, in action and sound resembles the dynamic speaker. The armature and cone are free to move a comparatively great distance without hitting the pole tips.

(17) Horn-Type Speakers. These speakers exist with both dynamic and magnetic units, the former being used largely in talking-picture houses in which a large exponential horn is employed. The latter type was used extensively in radio reception a few years ago but is fast becoming obsolete. Diagnosing trouble in these speakers is similar to that just described and need not be repeated here.

(18) Electrostatic Speakers. These speakers are not in general use as yet, although the Peerless Klectron employs one. They consist essentially of a condenser, one plate of which is free to vibrate under the influence of electrostatic attraction and repulsion. A high positive biasing potential is employed across them, being taken from the power supply of the set or from a separate rectifier tube. Since only the current leakage need be supplied by the biasing potential, little current is used; thereby eliminating any trouble from hum. The main trouble may arise due to excessive vibration, together with the high voltage accompanying it, causing a short circuit, or intermittent sparking across plate. This either kills reception or produces annoying rattling sounds.

(19) Microphonic Hum. When a microphonic detector tube is in the set, a hum or ringing sound will be produced in the speaker whenever the tube is jarred. It is evident, therefore, that if the sound from the speaker causes the set and microphonic tube to vibrate, a continuous hum will be produced, which will reinforce itself as soon as it sets up its own vibrations in the speaker. The result will be a continuous howl. It is entirely an acoustical effect. Holding the detector
tube tightly in most cases will prevent it. A "howl arrester" placed over the detector tube also may be used. In bad cases, it may be necessary to change the location of the speaker, or insulate it from the cabinet with felt. Resonance within the cabinet may set up an excessive vibration, which will reinforce this effect and mar the tonal quality. Moving the cabinet away from the wall, or cutting openings in the cabinet, or padding it with felt, may remedy the trouble.

Fig. 56, at the left, shows the Wright-DeCoster Hy-Flux magnetic cone speaker. Note the audio filter mounted near the unit for improved tone quality.

Fig.57, at the right, shows a cross-sectional view of the Farrand Inductor Dynamic speaker. In this unit the armature is attracted in between the pole tips, thus allowing a large movement without chattering.
CHAPTER VI
THE ANTENNA SYSTEM

The antenna system comprises the aerial and lead-in, with its lightning arrester, and the ground connection. While a good sensitive modern receiver will operate after a fashion on any kind of a haphazard aerial system if the location is fair, remember that a well-constructed antenna system is imperative for permanent set operation and satisfied customers.

(2) Types of Aerials. The busy Service Man will encounter various types of aerials, but the general form comprises a single stranded wire, bare or enameled, about 100 feet long, suspended between insulators from 20 to 50 feet above ground or higher when installed on the roof of a tall building. Attached to this is the lead-in connecting it to the set, with an attachment to a lightning arrester which is connected to ground. There are special types of aerials, such as lamp-socket aerials, indoor aerials, underground aerials, multiple aerials and loop aerials, but these will be discussed subsequently under their proper headings. Trouble shooting in the various types is basically the same procedure. We will concern ourselves mainly with the general type of single-wire aerial first mentioned.

(3) Aerial Installation. The subject of aerials comes more under set installation than servicing; but, in either case, care should be taken to see that the aerial is well constructed to insure permanent operation. See the illustrations of Fig. 60. It should be erected as far from other aerials or wires as possible, strung as nearly at right angles as possible to other wires, and placed neither under or over high-voltage lines, which is not only dangerous in case of breakage of a wire but is likely to produce a 60-cycle hum in the set. With a good soldered connection between the lead-in and the aerial (scraping each strand of the aerial wire separately if it is enameled) little trouble should be experienced with it from thereafter. Many installers don't take the trouble to solder the lead-in connection to the aerial, and in time corrosion takes place, causing an imperfect connection which is swayed by the wind and produces "static" in the set. In cases when it is temporarily impossible to form a good soldered connection, the joint should be tightly bound with tape to protect it from the weather.

(4) Aerial Location. The location of the aerial depends largely upon environment, and one phase of environment usually overlooked and likely to cause trouble is that of the so-called "dead spots," more noticeable in the vicinity of large steel buildings than elsewhere. In such installations, when the set fails to function properly and stations are very weak, changing the direction of the aerial (say 90 degrees or at right angles to its former position) will rectify the trouble. Sometimes it will be
necessary to shift the aerial considerably, and if possible support its free end on some near-by building. Sometimes better results are obtained by eliminating the aerial entirely and making connection to the steel window framework of the building instead. Troubles of this nature are encountered mainly in large cities.

The inverted "L" type of aerial, as this type is called, is slightly directional, and will receive better from a direction nearest the lead-in. This effect may be taken advantage of, especially when long aerials are used, either to improve reception from a certain direction, or to reduce reception from certain near-by powerful interfering stations.

(5) **Aerial Tests.** A reliable aerial test can be made by disconnecting the aerial from the set and connecting, in place of it, a wire 30 or 40 feet long strung along the room or outside of the window. A comparison of the two will usually indicate if the regular aerial is defective. This test is not always possible, but the efficiency of an aerial can usually be detected by simply disconnecting it from the set. If the set is noisy when it is known that there is no excessive natural static, and the noise ceases with the aerial disconnected, the trouble will probably be found in a loose connection in the aerial or in a near-by aerial in inductive relation with it. Possibly some wire has fallen in contact with the aerial and is rubbing against it; the aerial system should be thoroughly examined. A continuity test between aerial and ground terminals will indicate whether the aerial is grounded or not. A grounded aerial will sometimes work, especially if the ground is at the further end of the wire; in which case it may act as a large closed-loop antenna. If no defects can be observed in the aerial, yet it appears to be noisy, examine the lightning arrester.

(6) **Lightning Arrester.** The lightning arrester, Fig. 61, may be grounded or partially grounded, by internal defects, and cause a noisy set or kill reception entirely. Try disconnecting the arrester. If the trouble ceases, replace the arrester with a new one.

(7) **Length of Aerial.** The selectivity of many sets depends largely upon the aerial length, and in many cases where complaints of poor selectivity are received it will be found necessary to shorten the aerial and thereby reduce its fundamental period of electrical vibration to a point below the broadcast band. This shortening also reduces the input to the set and gives the effect of greater selectivity. Usually the same results can be obtained by connecting a condenser of about .00025 mf. in series with the aerial.

Some unstable sets may oscillate furiously with a short aerial and cease to oscillate on a long one, by reason of the greater radiation resistance of the long one, which absorbs more energy from the set. Aerial resistance likewise causes broadness of tuning and poor selectivity. Bare copper wire, which has been exposed to the weather and is corroded, has a greater high-frequency resistance than enameled wire.
Broadness of tuning on a near-by local station may be reduced by the use of a wavetrap, tuned to the interfering station, and connected as shown in the illustrations Figs. 62 and 63.

(8) Lead-in Strip. The lead-in from the aerial is usually connected outside the window to a lead-in strip. This is a flexible-copper, insulated strip with spring-clip connections on each end. The window is jammed down against this strip, forming a convenient entry to the inside where connection is made to the set. The connections to the strip should be soldered or thoroughly taped to prevent corrosion. See Figs. 54 and 65. If the set loses sensitivity during rainy weather, this strip should be examined, as well as other outside aerial or lead-in supports, such as the lightning arrester and aerial insulators. Leakage through wet insulation may cause a grounded aerial, especially if the wet lead-in-strip enters through a steel window casement. This is a frequent trouble in many set installations.

(9) Aerial Length. The length of the aerial to be installed depends largely upon the location. As a general rule, the shorter the aerial employed, if it gets the desired stations, the better the results obtained from the set. Many sets have two or more aerial connections, for short aerial, medium aerial, or long aerial. A 30-foot wire may be considered a short aerial; a 60-foot one a medium aerial, and a 100- to 200-foot one a long aerial. In congested districts, a short aerial is recommended.

(10) Counterpoise. Where it is impossible to obtain a good ground connection, a counterpoise may be used. This consists of a wire similar to the aerial and suspended beneath the aerial or in its vicinity, and insulated from the ground. It proves very effective in many installations. In some cases it reduces hum.

(11) The Ground Connection. In many installations the ground connection is made to the radiator pipe. This is usually the most convenient, and often serves very well. But an additional connection to a cold-water pipe is recommended, especially when the installation is made in one of the upper floors of an apartment house or hotel containing noisy elevators and ice machines. This will not only improve signal strength but reduce interference from noisy motors as well; for these motors are also grounded and the long path to earth from both radio and motor ground connections causes induction between the two. It is important that the pipe be thoroughly cleaned with a file before attaching the ground clamp.

(12) Testing The Ground Connection. A continuity test between the ground wire and a metal pipe in the building will indicate the condition of the ground connection. In some D.C. installations, an insulating condenser is placed in the ground lead, and care should be taken to make the test from the ground side of the condenser to the pipe, otherwise a short circuit is likely to occur, as in Fig. 66. If set noises cease after
disconnecting the ground wire, examine the ground connection thoroughly, or run an extra temporary ground wire to some other pipe in the building.

(13) Lamp-Socket Aerial. In some congested districts permission for the erection of an outdoor aerial cannot be obtained and some alternative method must be employed. The electric-light lines are sometimes used, by means of a lamp-socket aerial plug. This contains isolating condensers to prevent the lighting current from entering the set. Good results are sometimes obtained, but sometimes noises are introduced, which are difficult to filter out without reducing the signal intensity. It is dangerous to employ this aerial on some electric sets, as a dangerous short circuit is likely to occur.

(14) Indoor Aerials. A wire strung around the room behind the picture molding, or in some other concealed place, serves as an efficient aerial in many locations, but in steel buildings poor results may be expected. It may be used in combination with a lamp-socket aerial.

(15) Underground Aerials. In outlying districts, where space permits, underground aerials may be employed for the reduction of various kinds of interference. While no exact data as to the efficiency of this type of aerial can be given at this time, we have received many satisfactory reports from various experimenters.

(16) Multiple Aerials. The tangled maze of unsightly copper wires, strung in all directions on the roofs of some apartment houses, should inspire all Service Men to recommend some form of multiple aerial to the owner of the building. The illustration, Fig. 67, shows how neat this arrangement can be made (Amy, Aceves and King, Inc.) One well-erected aerial feeds all sets in the building through special coupling devices, thereby simplifying set installation and insuring satisfactory set operation with virtually no trouble from this source. A defective coupling unit will seldom occur, and in this case, it can easily be replaced.

(17) Centralized Radio System. This apparatus, made by R.C.A., will be found in many hotels and apartment buildings. Fig. 68 shows the circuit diagram. It couples a single aerial to as many as 80 receiving sets, without mutual interference, and comprises an RFC unit shown at the left in Figs. 68 and 69, which is mounted on the roof or near the aerial. This unit feeds as many as 8 RFX units (shown at the right of the above illustrations) by means of a twisted three-wire radio-frequency transmission line. Each RFX unit will feed up to 10 radio sets. The amplification gained in these units compensates for any transmission losses.

In other systems one aerial feeds one master radio set usually located in the basement of the building. This set feeds audio power to the various room outlets. Each room, therefore, has only a loud speaker and volume control, with a switch that will select any one of about four stations.

(18) Loop Aerials. The superheterodyne receiver is the most common type that employs a loop aerial. Lack of sensitivity in the set may be traced to poor location in the room; in
a steel building, moving the set a few feet sometimes makes considerable difference. If it is located near a steel column, the directional effect of the loop is usually impaired, the loop receiving its energy directly from the column by induction effect.

In home-made receivers employing an external loop one sometimes finds a neat-looking flexible telephone cord connecting the loop to the set. The electrostatic capacity of this cord is so great that it is virtually impossible to tune the loop and tuning appears broad. To remedy, connect the loop to the set with two short separate wires.

Often the simplest things cause the most trouble, and one should first make sure that the aerial and ground are connected to the set before making elaborate tests on the latter.

Fig. 68 - Diagram of the R.C.A. centralized radio system.

Fig. 69 - at the left is shown the "RFC," or first unit of the system which supplies plate current also for the coupling units.
- at the right is shown the "RFX" or outlet unit which feeds the individual receivers. The "RFT" unit shown in the diagram of Fig. 68, appears only in the last "RFX" on the line.
CHAPTER VII
RADIO-FREQUENCY AMPLIFIERS

From the viewpoint of the set owner, the radio-frequency amplifier may be considered as consisting of the tuning dial and the volume control and he will detect the least fault in either. The Service Man, however, must know the insides of the particular set in order to localize the trouble and make repairs. The various commercial set diagrams in this book display the almost unlimited forms in which the above two constituents may exist. Each manufacturer, testing the methods of the others, changes or adds to them in attempted improvements, and a new breed of sets finds its way into the homes of the lay public. Otherwise all sets would be alike. Basically they are alike, but vary in details. These details are important, however, and to point out some of the more salient ones, we shall classify the different types of sets and, in turn, the different elements of which the radio-frequency amplifiers in them are composed. We can first classify sets into those -

(a) without screen-grid tubes,
(b) with screen-grid tubes,

and make a further classification of those using -

(c) conventional tuned circuits,
(d) band selector circuits.

In addition we have superheterodyne circuits. The different methods of volume control, both manually-operated and automatic, will also be included in this chapter.

(2) Conventional Tuned Circuits. In the ordinary tuned-R.F. amplifier illustrated in Fig. 6 of Chapter II, three tuned circuits are employed; the first couples the aerial circuit to the first tube, the second couples the first and second tubes, and the third couples the second tube to the detector. When all three circuits are in resonance, amplification takes place; this means that the three tuning condensers must be accurately adjusted. In modern sets the three condensers are all mounted on one shaft and tuned collectively. For maximum efficiency, the circuits and condensers must be identical; otherwise one circuit will be out of resonance and the over-all amplification will be reduced. Slight mechanical variations in manufactured condensers do exist, however, so "trimmer" condensers (or aligning condensers, as they are sometimes called) are connected in parallel with the main tuning condensers, as illustrated in the diagram mentioned above. These condensers are of small size and small capacity. They are adjusted for resonance at two or three points on the dial and left in the best average position. This adjustment can be done by ear through tuning in stations and adjusting the trimmer condensers for maximum volume; but the method described in Chapter I, Paragraph 15, for balancing, in which a resonance indicator is employed, is more accurate.

(3) Neutralizing. It is evident that, in a radio-frequency amplifier, the output circuits contain radio-frequency currents identical with those in the input circuits, but of a much greater value; therefore, if the slightest degree of coupling exists between the output and input circuits, the amplifier will be thrown into violent oscillation, resulting in decreased amplification and whistling, squealing, and howling every time a station is tuned in. To reduce this disastrous coupling, the coils and condensers are enclosed in metal shield-cans. But even then coupling exists within the tube itself in the form of electrostatic coupling between the grid, which is part of the input circuit, and the plate, which is part of the output circuit. Various circuit arrangements have been devised to "neutralize" this capacity coupling within the tube. All these circuits depend upon some form of "Wheatstone bridge" arrangement, whereby an equal amount of capacitative coupling of opposite sign is
introduced between the input and output circuits, thus nullifying the effect of the tube-capacitance coupling. These various arrangements will not be described in detail here, as the diagrams of the various sets show them. The Service Man is interested only in the neutralizing condenser employed to obtain this balancing effect and how it should be adjusted. These condensers are clearly indicated in the diagram of Fig. 6, and the method of adjusting them is described in Chapter I, Paragraph 15. Without instruments, a fair degree of adjustment can be obtained by tuning in a station, inserting a dummy tube in one socket after the other, and adjusting the neutralizing condenser in each case for minimum or zero sound; at the same time adjusting the trimmer condensers for maximum sound. When correctly adjusted, it should be impossible to make the set oscillate at any point on the dial, with any volume-control adjustment.

(4) The Screen-Grid Tube. Having just described the cause and cure of oscillation in the ordinary tuned R.F. circuits employing three-electrode tubes, it seems fitting at this place to point out the effect which the advent of the four-electrode or screen-grid tube has had on circuit design. The use of metal shields to prevent coupling between the output and input circuits has been described; in screen-grid circuits, the shielding is extended until it exists within the tube itself, in the form of a metal network, entirely encompassing the plate, which is called the screen-grid. This fourth electrode is grounded but maintained at a proper positive-bias voltage, so that it does not interfere with normal tube action. It is evident, therefore, that the input and output circuits are entirely shielded, and feed-back coupling cannot exist. The circuit will not oscillate, and neutralizing is not necessary. In practice, the entire tube or the most vulnerable part of it, is enclosed in a metal shield. A very high degree of amplification is obtained, but the characteristics of the tube are different. It has a much higher impedance, requiring special design of the R.F. transformers. These tubes are made in the ordinary battery type (122) and A.C. heater type (124.) See Fig. 41 in Chapter IV.

(5) Band-Selector Circuits. Band-selector circuits are becoming more and more popular, especially since the advent of the screen-grid tube with which they are mainly used.
The band selector, or band-pass filter as it is also called, consists essentially of two or more tuned circuits loosely coupled together. This gives a flat-topped resonance curve which, by proper design, can be made to have a flat top 10-kilocycles wide, thereby accepting the entire program, sidebands and all, giving a high degree of selectivity without distortion. The band-selector circuits may be found ahead of the R.F. amplifier, at the input side; they may be part of the amplifier circuit, or may be placed between the amplifier and the detector. Various combinations are possible. In many sets, as in the Sparton "Model 49," (a diagram of which will be found in the back of this book) the band selector will be found between the aerial and the R.F. amplifier, and an untuned or aperiodic R.F. amplifier is employed. That is, the R.F. transformers are of special design to cover the entire broadcast band without tuning. Incidentally, three-electrode tubes are employed in this set. In the Hammarlund "Hi-Q 30 A.C." receiver, a diagram of which is reproduced in Fig. 70, band-selector tuning is employed between the aerial and the amplifier, as well as tuned stages in the amplifier, giving six tuned circuits in all. The six tuning condensers, illustrated in the upper left side of the diagram, are controlled simultaneously by one dial. The six trimmer condensers are also shown. Note the R.F. chokes in the plate-supply leads of the screen-grid tubes; these leads, as well as the grid return leads and screen-grids, are by-passed to the filament through large condensers.

(6) Grid-Bias Volume Control. Various methods of controlling the volume in different circuits are employed. In the old tuned-R.F. sets, it was customary to control the volume by changing the bias voltage on the grids of the tubes. This was effected by the use of a potentiometer connected across the filament circuit; the variable tap connecting to the grid return leads. Thus a bias voltage from zero (at the negative side of the filament) to plus 6 volts (at the positive side) could be obtained. This positive bias on the grids caused excessive plate current, resulting in short-lived tubes and batteries. Also, tuning was broadened because of the R.F. circuit drain from the tuned circuits.

(7) Filament-Current Volume Control. Another simple method of controlling volume was by means of the filament rheostats of the R.F. amplifier tubes. While this is effective, it is not very satisfactory.

(8) Plate-Current Volume Control. A high variable resistor in the R.F. plate leads is commonly employed to control the volume, by controlling the plate current. These resistors are, of course, by-passed by large condensers. This method lengthens the tube and battery life and is quite satisfactory; it is used in the Sparton No. 49 above mentioned.

(9) Absorption Methods of Volume Control. Variable resistors are sometimes inserted in the R.F. circuits to control volume. Grid-suppressor resistors, connected in series with the grids, are also used to prevent oscillation in unstable sets; about 800 ohms...
is sufficient. A variable resistor in the input circuit is also common. An example is illustrated in the diagram of Fig. 71, showing the method employed in the Majestic "70" or "70B" sets. Sometimes two variable resistors are employed; Fig. 72 shows how this is done in the Stromberg Carlson No. 638 D.C. receiver. Here two 10,000-ohm resistors, mounted on one shaft, are used; one to control the input to the R.F. amplifier, and the other to control the input to the detector.

(10) Screen-Grid Control. Controlling the positive bias voltage on screen-grid tubes makes a very efficient volume control in sets employing these tubes. This is the method employed in the Hammarlund receiver shown in Fig. 70. It is indicated at V.

(11) Automatic Volume Control. Modern sets are so sensitive, and capable of giving such great volume, that it is annoying to tune for a weak station and suddenly have a powerful local roar in. To avoid this, some sets employ automatic volume controls, which limit the volume automatically. Fig. 73 shows the circuit used in the Stromberg Carlson "No. 846" receiver, which employs a type '27 tube, the grid circuit of which is coupled through a .00025-mf. condenser to the output of the R.F. amplifier. A 2-megohm grid leak is used to prevent blocking of the tube and to hold the grid bias at the proper value. The plate is connected to ground through two 100,000-ohm resistors; but, since the cathode is at a lower potential than ground, plate current will pass through these resistors. The drop across both of them serves to bias the grid of the first R.F. stage, and the drop across one to bias the second R.F. stage. Thus, when the received R.F. signal reaches a certain intensity, current through the resistors decreases; resulting in less negative bias on the amplifier tubes and reducing the amplification. An equilibrium is soon established, in which the volume is maintained at a constant limited value. It seems needless to add that all resistors are thoroughly by-passed to prevent any radio-frequency feedback; only the voltage drop across the two 100,000-ohm resistors, resulting from the average signal-intensity value, is instantaneously and automatically fed back to the R.F. amplifier grids. Many other sets use similar controls, such as the Kellogg 523 and 526 shown in the diagram section of this book.

(12) Radio-Frequency Amplifier Trouble. Trouble in R.F. amplifiers resolves itself into:

(a) lack of sensitivity,
(b) broad tuning,
(c) oscillation,
(d) noise,
(e) lack of control.

All of these symptoms may be due to poor tubes or wrong supply voltages; but, since we've described voltage tests and tube tests in chapters III and IV, we will limit this chapter to searching for trouble within the remaining parts of the system.

(13) Lack of Sensitivity. This may be attributed to: poor alignment of the tuning condensers, an open circuit in the input or some part of the system, shorted coils, an open or shorted by-pass condenser. In fact, any default in the circuit may contribute to decrease sensitivity or kill reception entirely. It is probably simpler to test the coils and condensers than to read about all the things that might happen. Even damp weather
is detrimental, as shown in Fig. 74. This shows the results of an actual test. A usual fault in R.F. amplifiers is an open coil winding. The windings should be tested for continuity; a full reading indicates either good coil or a shorted coil. The latter is difficult to detect but, fortunately, is not a common occurrence. A visual examination will usually reveal any damaged condition. Lack of plate voltage at the tube sockets may indicate an open primary winding, or an open choke-coil winding in some sets in which the plate current does not pass through the R.F.T. primary (such as the Stewart Warner "Series 900" receivers.) It may be difficult to solder an open-circuited winding together; the best method is to rewind the coil, making note of the number of turns, size of wire, directions of winding, and external connections. So far as the tuning condensers are concerned, a visual examination is usually sufficient; they should be thoroughly cleaned and the pig-tail connections examined. The method of aligning them for maximum resonance has already been explained in Chapter I.

(14) Broad Tuning. Lack of sensitivity and broad tuning usually go hand in hand. The troubles just described in the preceding paragraph apply here also. Unless some previous Service Man has left a soldering iron or screwdriver inside of one of the shield cans, we may find the cause of broad tuning in the aerial system, to which a separate chapter has been devoted; or in an incorrect "C" voltage on the tubes, or in some defect in the circuit or volume control. The usual complaint from this trouble is found to be due to the closeness to some broadcast station; the fault is not in the set then, and the Service Man is not expected to improve the set far beyond its original abilities. Extreme sensitivity, like a powerful telescope, has the effect of bringing the stations nearer, and also results in complaints of broad tuning. In these cases a shorter aerial is recommended or a wavetrap may be required, as described in Chapter VI. Damp weather causes broad tuning in many sets, due to moisture impregnating the insulation of the coils. If complaints spring up during the damp season, it is well to bear this in mind. See Fig. 74.

(15) Oscillation. Either the shielding is poor, the connecting leads are lying in the wrong positions, or the set is not neutralized. In some sets a defective volume control may cause oscillation. This trouble manifests itself by penetrating squealing, howling and whistling sounds while tuning in a station. There is feed-back coupling somewhere in the set to cause oscillation. Perhaps the antenna lead is too near the detector output region. Check the tubes, tube shields and supply voltages.

(16) Noise. Noise is invariably caused by loose connections, either within the circuit or near to it; as in the case of loose shield-can joints that reflect noises into the circuit, due to their absorbing of energy from it. Loose socket contacts are a common occurrence; also, loose soldered connections to the coils and loose pigtail connections to the condensers. Rubbing contacts on the condensers are also noisy. Condenser plates which touch cause noise, as well as fine metal burrs on the plates, or dirt between them. The volume control is a frequent source of noise; it should be cleaned with alcohol and oiled with Nujol. (This applies to filament rheostats also.) Sometimes a soft lead pencil rubbed on the resistance wire will give sufficient lubrication, due to the graphite, without interfering with the contact.
(17) Lack of Control. Lack of control of the set indicates a defective volume control. In virtually all cases the volume control is a variable resistor of some sort, and it is apt to be worn out from mechanical usage rather than electrically destroyed. Knowing its approximate resistance from the circuit diagram, it may be intelligently tested with a continuity tester, and preferably replaced rather than repaired, if defective. If the set has an automatic volume control, the tube may be at fault and should be tested. By-pass condensers may be shorted, or resistors open; with a continuity tester, almost all faults can be found. Hum may be introduced into the R.F. amplifier, due to electrostatic induction from some nearby high-voltage A.C. line.

(18) Superheterodyne Receivers. A whole volume could be written on the servicing of superheterodynes; but we only have space for the high spots, and let the reader's imagination dip into the valleys wherever it is indicated that he should do this. Owing to the comparative complexity of the superheterodyne, many things can happen to interrupt its service; but, if we segregate it into its main components and test each separately, we may find that the servicing of one superheterodyne is like servicing two ordinary sets. In the superheterodyne we have:

(a) oscillator,
(b) radio-frequency amplifier (in some sets),
(c) first detector,
(d) intermediate-frequency amplifier,
(e) second detector,
(f) audio-frequency amplifier.

Parts e and f are considered in Chapters VIII and IX. Various superheterodyne circuits appear in the diagram section of this book. No matter how complicated the set, if we test one thing at a time we can't help but find the fault if it exists. With all parts of the proper values and properly connected, the set will work, because it did work before the trouble started. Knowing the circuit diagram and the values of the parts, it won't take long to make the tests and make repairs or substitute new parts.

(19) Servicing Supers. Since there are a variety of superheterodyne circuits in use - the greatest variety being the home-built ones assembled from "kits" - it is virtually impossible to list all the causes and cures of troubles that may occur in them. Of the commercial supers, the Radiola is probably the most numerous, and a detailed analysis of the "Radiola 25" Superheterodyne appears in the Radio Data Service Sheet in the diagram section of this book.
CHAPTER VIII
DETECTORS

The detector plays a very important part in every radio receiver - it is the pivot on which the radio-frequency amplifier and the audio-frequency amplifier hinge. Linking the two amplifiers, it could well be described in connection with either, but, since it plays such an important part in radio reception, we will devote a separate chapter to it.

(2) Function of Detector. The function of the detector in the ordinary broadcast receiver is to convert the form of the energy delivered to it by the radio-frequency amplifier to a form suitable for amplification by the audio-frequency amplifier and for sound reproduction by the loud speaker. In other words, in the input or grid-circuit side of the detector we have modulated radio-frequency currents and in the output or plate side, audio-frequency currents. Both forms of current may exist in both input and output circuits, in which case trouble results in some sets, while in others, employing regeneration, this phenomenon is utilized to advantage. In the superheterodyne receiver, two detectors are used, but their basic action is the same. One links the radio with the intermediate-frequency amplifier and the other links the intermediate with the audio-frequency amplifier. In the first case, the highest frequency is wiped out, leaving the intermediate frequency; in the second case the intermediate frequency is wiped out, leaving the audio frequency. Since the detector converts the radio energy into audio energy, it should do this work without distorting the audio-frequency wave shape or discriminating between high and low audio frequencies; it should effect this conversion without great loss of energy, and should introduce no extraneous noises in the set.

GRID CONDENSER

Fig. 77 - (left) Grid Leak and Condenser Method of Detection.
Fig. 78 - Power Detection using a "C" Battery.

(3) Simple Detector Circuit. A simple detector circuit employing a three-element tube (such as the 701A) is shown in Fig. 77. In this circuit, the modulated R.F. current is impressed on the grid of the tube through a grid condenser. The rectifying action of the grid and filament portions of the tube will allow the positive half cycles to pass through to the filament or return side of the input circuit; but the negative halves will be trapped and will accumulate on the grid. The intensity of this accumulation varies in accordance with the intensity of the input, which we know, varies at audio frequencies; resulting in a similar audio plate-current variation. The grid leak resistance of several megohms allows the accumulating negative charge to leak off slowly. This holds the mean grid potential at a constant value and prevents an excessive accumulation which would block the tube action. It is evident, therefore, that the values of the grid condenser, grid leak and the plate voltage are important factors in determining detector efficiency.

(4) Grid-Bias Detector. This method is called "plate detection" and makes use of the "bend" in the lower portion of the "characteristic curve" of the tube for its effect.
Fig. 79 - The '27 type tube detector using a condenser and leak.

as grid-leak detection, but the audio quality output is considered better. It is important that a very accurate adjustment of the grid-bias voltage and plate voltage be maintained. The grid-bias resistance or "C" battery must be by-passed by a condenser of at least 0.5-mf. capacity.

(5) The A.C.Detector. Both the detector methods just described were used in battery sets, but the same methods are used with the heater-type tubes in A.C. sets. Fig. 79 shows the grid condenser-and-leak method used with the type '27 tube, and Fig. 80 the grid-bias method, or plate detection. A "C" battery is seldom used in an A.C. set, as grid voltages are easily obtained from drops across resistors through which the plate current flows. Note the by-pass condenser across the bias resistor in Fig. 80.

(6) Power Detection. The sensitivity of a detector to weak signals depends upon the values of the plate voltage, the grid condenser and the leak, or grid-bias, voltage. Usually 22½ to 45 volts is sufficient for the plate. A detector designed for weak signals would be unsatisfactory for operation where comparatively large amounts of radio-frequency energy is encountered - as in some of the modern high-powered sets. In these, power detection is used. The basic action is the same, as shown in the schematic circuit of the power detector used in the Stromberg-Carlson "No. 846" receiver illustrated in Fig. 81. The main difference is that a plate voltage of 250 volts is employed with a grid-bias voltage of about 28 volts. Where these detectors are used it is seldom that more than one stage of audio-frequency amplification is required; the detector feeds directly into the push-pull power stage, resulting in very quiet operation with excellent quality. The values of the parts are given in the illustration.

(7) Regenerative Detectors. Regenerative detectors are seldom used in modern multi-tube radio sets, and we will not describe them in detail. It is sufficient to state that the circuits are similar to those given, except that

See Fig. 39 on page 31. To operate the tube on this bend, a negative grid-bias voltage is necessary. This may be obtained from a "C" battery or from the voltage drop across a resistance. No grid condenser or leak is used, as shown in Fig. 78. Such a detector works by virtue of the fact that one side of the R.F. alternations is suppressed, allowing the A.F. modulations of the other side only to produce A.F. current variations in the plate circuit. As a rule, this method is not as sensitive
part of the audio-frequency energy existing in the plate circuit is transferred back to the grid circuit by means of a "tickler" coil connected directly in the plate lead. This reinforces the grid current and builds up the signal strength.

(8) **Microphonic Howl.** Microphonic howl is one common source of trouble in detectors, especially those employing battery-type tubes. The heater-type A.C. tubes give practically no trouble from this source. In extreme cases, it is necessary to exchange the tube in order to eliminate the howl, or use a cushioned socket or "howl arrester." See Fig. 82. Since the detector is connected to the input side of the audio-frequency amplifier, it is extremely susceptible to audio vibrations or current variations, which explains the excessive tendency to microphonic howl in this particular tube. The grid-bias or plate-detection type is less susceptible; as far as audio-frequency currents are concerned, the grid may be considered as connected directly to the filament or cathode, thereby preventing the detector from acting as an audio-frequency amplifier, which it is when a grid condenser and leak are used.

(9) **Audio-Frequency Oscillation.** This is partially due to the audio-frequency amplifier, but may be eliminated in many cases by correcting the detector. Audio oscillation manifests itself usually in a high-pitched squal, caused by feed-back coupling in the "B" battery or supply circuit, from the output of the audio amplifier to the detector input. A 2-mf. by-pass condenser connected between the detector "B plus" lead and the filament will usually prevent it. An audio choke or high variable resistor connected between the power-supply lead and the condenser also helps and proves very beneficial in many cases. See Fig. 83. Changing from grid condenser - leak detection to grid-bias detection also helps in extreme cases.

(10) **Sensitivity.** Lack of sensitivity in the detector is usually due to a poor tube, or to wrong plate or filament voltages. An open grid leak or condenser is a contributing cause.

(11) **Noise.** In addition to microphonic howl, noise is caused by a poor or loose grid-leak resistor or dirty socket connections.

(12) **Hum.** Hum is usually caused by induction from near-by A.C. circuits, due to poor shielding or lack of proper by-pass condensers in the grid and plate circuits.
(13) Overloading. In modern powerful sets using power detection, the detector is sometimes overloaded, causing distortion or "dead spots" on the tuning dial. The latter produces the effect of double resonance. The station may be slowly tuned in, approaching a maximum of volume as the set approaches resonance, until the detector is overloaded, causing a decrease in volume with the set tuned to resonance. Tuning beyond resonance removes the overload from the detector and the volume increases again. One may be deceived by this and think that the tuning system is out of order, when in fact the detector is at fault. In this case, the plate voltage should be adjusted to suit the particular location of the set, depending upon its proximity to broadcast stations and the particular stations that the customer desires. The grid leak or "C" bias voltage should be correspondingly changed.

(14) Filter Circuits. The radio-frequency energy that passes through the detector would cause havoc in the audio-frequency amplifier if it were not filtered; noisy, choked, distorting sounds would result. Usually a single .0005-mf. by-pass condenser, connected between the plate and filament of the detector, or across the primary of the first stage audio transformer (or the plate resistor in a resistance coupled amplifier) will suffice. A better filter is illustrated in the circuit of Fig. 81. Here two condensers of .0005-mf. each and a 10-mh. choke, connected as shown, are used. A filter of this kind could with advantage be easily added to a set having the above trouble. It will not interfere with the normal audio quality.

Fig. 84 - Diagram of the Silver-Marshall 720 A.C. screen grid receiver is shown above. This set employs a screen grid power detector, S4, with a 60,000 ohm grid bias resistor, a "B" voltage of 170 volts, and a plate resistor of 300,000 ohms; the first audio stage being resistance coupled. The curves at the left show the comparison of the screen grid power detector with the type 127 tube detector circuit. Excellent audio quality at high volume is reported by users of this set.
SINCE the audio-frequency amplifier determines the tone quality of the set, other things being normal, it is important that this part of the set be kept in the utmost of condition and that the tubes, transformers or other coupling devices and parts, as well as the supply voltages, be maintained in accordance with the specifications supplied by the manufacturer of the set. Good tone quality pleases the set owner. Poor tone quality pains him and breeds trouble for the Service Man - or may we call it pleasure, if he enjoys his work?

(2) Types of Audio Amplifiers. Audio amplifiers vary in the forms of interstage coupling and the types of tubes employed. There are many varieties in the thousands of sets in everyday use. The most common employs transformer coupling between stages. Others employ impedance coupling. Then there are the troublesome resistance-coupled ones, quite popular a few years ago and now not so common, yet again coming to the forefront in the form of direct-coupled amplifiers; to wit, the Loftin-White amplifier. With these three main groups, and from one to three stages in each amplifier, together with a wide variety of tubes, it is evident that many combinations can be produced, and such is the case. Yet trouble shooting is comparatively easy if we centralize our efforts on the coupling devices, tubes, connections and the supply voltages; the latter are assumed to be correct since we have already attended to them in Chapter III; and tubes we have tested and corrected in Chapter IV, leaving our present work limited to the coupling device and connections. Therefore, with the connections and coupling device correct, the amplifier will work. Of course, improvements may be made in the general tone quality and volume of many sets by changing the form of the audio amplifier, but the Service Man is not usually called upon to do this work.

(3) Transformer-Coupled Amplifier. A two-stage transformer coupled amplifier is most generally used and, in many cases, the second stage is of the push-pull type (illustrated in Fig. 86, as compared with the ordinary type of Fig. 85.) Push-pull arrangement gives greater output - which is demanded by electrodynamic speakers. Parallel tubes connected in the last stage give greater output than a single tube, but two tubes in parallel are not equal to two in push-pull. In almost all cases, an output transformer or output choke coil-and-condenser is employed as shown, to couple the amplifier to the speaker; matching their electrical characteristics and eliminating the D.C. plate current from

---

Fig. 85 - above. Standard 2-stage audio amplifier.
Fig. 86 - below. A push-pull audio amplifier circuit. Both circuits are for use on A.C. electric sets.
Fig. 88 - Thordarson '50 push-pull amplifier. A single and two push-pull stages are employed. The power supply is at the top. Note the output transformer in the lower left.

The speaker windings. In sets not employing power tubes, the speaker may be connected directly in the plate circuit without the use of an output coupling device, but in all push-pull amplifiers the coupling device is necessary, because of the circuit arrangement, unless the speaker winding has a center tap (which few have) or two speakers are used. Further reference to speaker coupling devices will be found in Chapter V. Some modern sets employ only one stage of audio amplification; the output from the power detector feeding directly into the push-pull audio power stage. See Chapter VIII. Tone quality with a minimum of hum is thereby obtained, at the expense of sensitivity, which must be compensated for in the radio-frequency amplifier.

(4) Transformer Tests. Lack of plate voltage at the tube socket indicates an open transformer primary winding, or a plate circuit open somewhere in the connections. Lack of grid-bias voltage indicates an open transformer secondary winding, or a grid circuit open somewhere in the connections. A continuity test on the transformer windings will reveal their condition. If the meter of the continuity tester reads full, the winding is short circuited; if the reading is zero, the winding is open or burnt out. The latter is a common occurrence in transformer primaries, which carry the plate current. If only a partial reading is obtained, the winding is intact. These windings have a rather high resistance which is indicated by the partial reading of the continuity meter. When a damaged transformer is located in a set, it should be replaced with one of the same type. Tests should also be made between the primary and secondary windings and between the windings and the core; in these tests the readings should be zero. A full reading indicates a short, and the transformer should be replaced. After the transformer has been disconnected from the set, the wiring in the set should be tested as the short may be in the external wiring to the transformer. Noise in transformers is common, and is due to a poor or loose connection within the instrument. To test, connect a 4½-volt "C" battery, in series with a headset, to the winding under test and listen for noise. No sound except the initial click will be heard if the
transformer is in good condition.

(5) Special Circuits. Some transformers employ a core of special alloy which is more susceptible to magnetic influences than iron. When continually subjected to the magnetizing effect of the plate current of the tube, the core loses its qualities and the resultant tone quality of the set is impaired; bass notes are lacking. When other faults cannot be found in the amplifier, it is well to replace the transformers. Special circuits have been developed to prevent this trouble. In the circuit of Fig. 31 (shown on page 26), methods known as "series plate feed" and "parallel plate feed" are employed. The former is shown in the connections of the first-stage transformer. A series resistor, \( R_1 \), by-passed by the 1-mf. condenser, limits the plate current to a safe value. The parallel plate feed method is represented in the second or push-pull stage connections; here the D.C. plate current passes through a choke coil, the audio-frequency component of the current passing through the 1-mf. coupling condenser to the primary of the input transformer. Note the 50,000-ohm resistors \( R_2 \) in the grid return circuit of the input push-pull transformer. These are to suppress any cross-current "parasitic" oscillations that might develop in the push-pull tube circuit and introduce distortion and noise.

(6) Resistance-Coupled Amplifiers. Ordinary resistance coupling does not give as much amplification per stage as can be obtained from transformer-coupled amplifiers, consequently when it was first introduced, three stages were used. With present receivers, having more efficient radio-frequency amplifiers, more than two stages are seldom employed, with a consequent reduction in sources of troubles. Usually a combination of transformer and resistance coupling is encountered, as in the Atwater Kent "Model 55" and "55C" receivers; here the first stage is resistance coupled and the second stage push-pull transformer coupled. Fig. 48, page 41, shows the first (resistance) stage in this set. The detector and first audio tubes are indicated, together with the "C"-bias resistors and detector-plate filter system. The coupling unit comprises a plate resistor, a blocking condenser and a grid-leak resistor. The audio-frequency current passing through the plate resistor causes voltage variations across it, which are applied to the grid of the following tube by means of the condenser. The purpose of the blocking condenser is to prevent the positive potential of the plate circuit from direct contact with the following grid, which would place a positive bias on it and kill the tube action. Resistor and condenser values vary, in accordance with the requirements of the tubes used.

(7) Troubles in Resistance-Coupled Amplifiers. Many things can happen to a resistance-coupled amplifier to throw it out of kilter; the most common faults are wrong plate voltages and wrong resistance values. Some resistors change with age. Power supply leads to the plate circuits should be thoroughly by-passed, to prevent motorboating, as indicated by the "detector filter condenser" of Fig. 48. A leaky blocking condenser is disastrous, resulting in excessive plate current in the following tube. On the other hand, an open or disconnected blocking condenser will prevent the transfer of voltage variations (signals) from one tube to the next, but will not affect voltage and current readings at the tube sockets. Since the condensers are seldom over 0.1-mf. in capacity, a continuity test or crude capacity measurement will not reveal the open. A quick check is to connect another condenser in parallel with the questionable one and note the results. Aside from checking the resistors and all condensers in the circuit, as well as the supply voltages, there is little to do in the resistance-coupled amplifier. It is well to remember that special "High-Mu" tubes (such as the type 40) have been developed especially for resistance- and impedance-coupled amplifiers and should not be used in transformer-coupled stages. Therefore, check all tubes.

(8) Impedance-Coupled Amplifiers. The circuit arrangements of these are identical to those of resistance-coupled amplifiers, choke coils being used instead of resistors. This makes possible the use of lower plate voltages, as we do not have the excessive voltage drop inevitable with resistors. Combinations of chokes and resistors are also
(9) Direct-Coupled Amplifiers. The elimination of the coupling or blocking condenser in a resistance-coupled amplifier gives us what is called a direct-coupled amplifier, but certain precautions must be taken before this can be effected. Some means must be employed to maintain the grid-bias voltages at the proper values. This has been well accomplished in a practical manner in the Loftin-White amplifier, the circuit of which is given in Fig. 91.

This circuit was designed specifically for use as a phone amplifier, the phonograph pick-up being connected directly to the input terminals. However, with the addition of a suitable coupling device many interesting combinations of this system with various R.F. tuners can be obtained. A simple receiver can be constructed by coupling the input terminals to an antenna and ground through a conventional tuning coil and condenser. In the diagram of Fig. 91, P is a 200 ohm potentiometer; R1 a tapped divider resistance; R5, 25000 ohm metallic resistor; R3, 50,000 ohm metallic resistor; R6, 100,000 ohm metallic resistor; R0, 500,000 ohm resistor; the tubes used are a type '60 rectifier, a '45 amplifier, and a '24 screen grid tube for the first stage. The resistances and connections are such that the correct bias voltages are obtained only when using the correct tubes.

(10) General Audio Troubles. Oscillation, resulting in a high-pitched squeal, is
prevalent in many poor audio amplifiers, especially transformer-coupled ones. Sometimes placing the fingers across the secondary terminals of the first- or second-stage transformer will eliminate this, showing that a high resistor of from 10,000 to 50,000 ohms will do the same thing. This reduces volume, however, and should not be resorted to unless absolutely necessary. A condenser of about .0005-mf. capacity will also be a relief; but this method is likely to absorb high notes and produce distortion and a muffled tone. By-passing the plate-supply power leads or "B" batteries will also help.

A condenser across the first primary, or an equivalent filter system in the detector plate circuit, is essential. For resistance-coupled amplifiers, a supply of resistors should be on hand, so that these can be interchanged.

(11) Audio Amplifier Comparisons. Transformer-coupled amplifiers have limited frequency characteristics; that is, they do not respond equally to all musical frequencies, especially at the extreme high and low ends of the scale, where they are less efficient than in the middle. Also, the magnetic qualities of the core distort the wave shape, introducing foreign frequencies into the tone. But modern transformers are good enough for all ordinary requirements, and are very reliable and practical. Resistance-coupled amplifiers have possibilities of giving extremely wide undistorted frequency-characteristics, resulting in better quality; but, generally speaking, they are less reliable and practical than transformer-coupled amplifiers. Impedance coupling may be placed somewhere between the two in merit. Therefore, in sets employing two or more resistance stages, it is sometimes advisable to substitute a transformer of modern make for one of the resistance stages. This will give more constant, reliable, dependable, practical, operation; with ultimate satisfaction on the part of the set owner. In making the change, it is usually necessary to change to the proper tube, and plate voltage, for transformer operation.

Fig. 92. - A typical resistance-capacity coupled amplifier is shown above. In amplifiers of this type absolute constant operating conditions are necessary. Changes in voltages or resistance values impair the quality and destroy the amplification factor. At the right are shown resistors of small size and high capacity suitable for circuits of this type. The illustrations are full size. The upper one has a rating of two watts and the lower one ½ watt. They are furnished in various resistance values. Illustrations courtesy International Resistance Co. As regards constancy in voltage control, Amperites, (automatic voltage controls) are indicated in the filament circuits of the various tubes. The illustration at the lower left shows a full size amperite. As the current which passes through it increases, the resistance wire in it becomes heated and its resistance increases -- thus tending to reduce the current or hold it at a constant value. Devices of this kind are also furnished to maintain a constant input voltage for electric sets.
EXTRANEOUS NOISES AND THEIR ORIGIN

COMMONLY known as "interference," we may classify everything that comes under the above heading as sounds coming from the speaker that interfere with the program we desire to hear. This covers a broad field. However, we can group these pests into those originating outside the receiver, and those originating within the receiver. When the customer says, "My set is noisy; come and fix it," only the experienced Service Man knows the full significance of that simple sentence. His first procedure is to turn on the set and listen to the noise; if his ears have been trained by long experience, he knows exactly where to find the origin of the noise. Knowing the source, however, does not solve the problem. The difficulty lies in eliminating the noise; and this difficulty has prevented the sale of many electric sets.

(2) External sounds. Suppose we let this cover all sounds originating from electrical disturbances external to the set. We can tell whether the set or lighting line is noisy by disconnecting the aerial; if everything is quiet, we know that the interference comes through the aerial. If the aerial is examined and tested and found to be in good shape, we know that the interference is received in the form of radio waves originating at some external place. We can classify this form of interference into:

(a) Interference caused by broadcast stations,
(b) Interference from some oscillating receiving set,
(c) "Man made" static,
(d) Natural static.

Of the four types, "d" is probably the most annoying from the Service Man's viewpoint.

(3) Interference from Broadcast Stations. This form of interference in one case manifests itself in actual reception of the program of the interfering station, in which case the trouble is in the receiving set. It tunes too broadly and should be corrected, as described in Chapters VI and VII. In the other case, this interference manifests itself in a continuous squeal, due to the heterodyne effect of the interfering waves. Sometimes the squeal, is "scrambled" by the audio program, giving rise to a very peculiar mess of squealing sounds; in this case the trouble is caused by the transmitting station, which is not using its allocated wave. This is more noticeable among the low wave length stations. Since the Service Man's field of action is limited to the receiving set, he can't correct troubles in the broadcast stations and the set owner will have to be content with what he gets until other corrective measures are taken.

(4) Interference from Oscillating Receiving Sets. A regenerative set in the state of oscillation will radiate waves, just like a broadcast station, though not so powerful. These waves heterodyne with those of the broadcast station being tuned in, setting up whistling and squealing sounds which run up beyond and down below the audible musical scale, creating disturbance in all other sets within a half-mile radius. One has a desire to

Fig. 96 - The Flechtheim condensers are ideal for filtering line noises.
in mind that every electrical device, from the simple electric light up to electric railways and down to door bells - in fact, the whole gamut of electrical appliances - gives birth to disturbances that affect the sensitive receiving set. These disturbances travel over three routes, and we can explain all of them by describing the origin of the simple click heard in a radio set when a light is turned off.

(a) We have the low-frequency surge, or impulse, due to interrupting the current when the light is turned off. This upsets the equilibrium of the line voltage, giving rise to an impulse that finds its way into all sets connected to the line.

(b) There is the radio-frequency wave, generated by virtue of the electrostatic capacity and inductance of the line in the immediate vicinity of the circuit interruption where sparking occurs. This exists, though the sparking is ever so slight. This wave travels over the line in the form of "wired wireless"; finding its way into the input or radio-frequency amplifier side of all sets connected to the line.

(c) The radio-frequency wave, generated as described above, radiates from the light-circuit wires, as waves radiate from a broadcast aerial. These waves find their way into all sets in the vicinity, whether connected or disconnected from the line.

It is evident that any electrical device that interrupts the current causes interference. In addition, we have devices, such as arc lights and mercury-arc battery chargers, that give what we may call "continuous interruption" and produce very annoying noises. The nature of the noise may indicate the source. Low sputtering sounds like...
Fig. 95 - Various forms of filter arrangements. Both audio- and radio-frequency coils should be tried.

A rush order of bacon and eggs, indicate 60-cycle sparking, which may be due to a loose street lamp, or leakage in wet power lines, or loose transformer cutouts. See Fig. 93. Continuous clicking or buzzing may be due to ringing door bells or electric vibrators, or a radio station sending out code signals. Continuous semi-musical noises, that rise and fall in pitch, are caused by commutator-type motors that speed up and slow down, as in a trolley car. Short-wave sets seem to enjoy picking up the spark-plug noises from motor cars. "Super-Hets" have this habit also, as those who have operated them in motor boats know.

(6) Eliminating Man-Made Static. Various methods have been devised to eliminate man-made static; all use some form of filter system. For example, we can connect radio-frequency chokes in the line circuit supplying our set. As the name implies, these will choke out the radio-frequency currents existing in the line in the form of "wired-wireless." Then we can connect condensers across the line or between each side of the line and ground, to absorb radio-frequency currents. In addition, we must connect large iron-core chokes and large condensers in a similar fashion to the line to filter out all audio- or low-frequency impulses or surges. A complete filter of this type is illustrated in Fig. 94. Fig. 95 shows various types of filters. If the origin of the noise is definitely located, a filter should be connected there also, as indicated by the various illustrations of Fig. 97. This will block all three routes over which interference travels. Just a single 1-mf. condenser will help a lot.

A good grade of condenser should be used - one that will stand the terminal voltages of the machines being filtered. Fig. 96 shows two types, mainly employed in "B" supply systems, but suitable for filter systems also. Note that the larger one shown has a 2-mf. 5000 V. D.C. rating. The smaller one, measuring 1 1/8" square by 2" high, has a capacity of 1-mf. and will stand a working voltage of 1000 D.C. The unusually small size of this instrument explains why it is favored by many Service Men.

Various filter devices now on the market are available to the Service Man and will facilitate his work in this line. The "Filtervolt" line noise eliminators, two forms of which are shown in Fig. 98, can quickly be applied to any set.

(7) Locating Disturbances. A noisy street light, or other outside interference, may be located by the use of a simple portable regenerative set and a loop aerial. A good way is to ride around in a car with the set until the disturbance is found. The loop is directional, and will point to the direction of the disturbance. This is clearly illustrated in Fig. 99. The neighbors may think that you are looking for a lost radio program, but you will find that the search will be well worth the trouble.
Natural Static. Natural static cannot as yet be eliminated or effectively reduced in any way, but the Service Man should recognize it, not to waste time trying to find trouble elsewhere when static exists. The most common source of static is the lightning discharge, and since there are some two hundred lightning discharges per minute taking place within the receiving area of a sensitive radio set, and more in the tropical regions, we hear a continuous grinding roar when we adjust our set to extreme sensitivity while tuning in a distant station. This is called "the noise level." If we could eliminate it, our receiving range would encircle the globe. Static, or "atmospherics," as it is also called, is more prevalent in the summer months, especially during local thunderstorms.

Noises Originating Within the Set. The most likely sources of noise within the set are loose or poor connections in the circuit; such noise sounds for all the world like static. In addition, there are noises from microphonic tubes, weak batteries, oscillating circuits and mechanical vibration caused by the speaker or loose parts adjoining it or within its acoustical range. In the latter case there are instances when a picture on the opposite side of the room was set into vibration and chattered against the wall. Perhaps the best way to diagnose troubles from the resultant sound would be to list all the various sounds and give all the possible sources of trouble that could produce such sounds. The futility of doing this completely makes one hesitate to start. In the first place, we cannot spell all the various discordant sounds with the 26 letters available, and even if we could we couldn't pronounce them. In the second place, after investigating all the reasons given, the practical Service Man may find that the real trouble is due to a drop of solder spilled into the set by some previous Service Man - a condition that we could not possibly predict in advance. If one understands the function of each part in the set, as well as the electrical coordination of the whole ensemble, he can make a complete test of the set in the time it takes to read a printed diagnosis. Therefore, we will limit the following to the most outstanding symptoms.

![Fig. 99 - above. Showing how a loop aerial is employed to locate the source of man made static. The greatest response is heard when the loop points in the direction of the interference, as shown in the upper illustration. The illustrations at the right show common sources of trouble, and how they were subdued by means of condenser type of filter circuits. Sign flashers, as shown above, always produce noises. Worn out or old commutator type motors, are also noisy.](image)

![Fig. 100 - above. This illustration shows an electrolytic condenser. Its small size and large capacity make it ideal for all kinds of filters.](image)
(10) Dead set, no sound at all. No tube noise when jarring set, or background static hiss.

Probably due to a broken circuit or poor tubes. Examine the aerial circuit, battery or power connections and load speaker.

(11) Low volume.

If the volume gradually decreases when the set is turned on, examine the batteries and tubes. If the volume is unsteady, test the line-voltage. Examine the aerial for swaying and "leaks" in wet weather.

(12) Poor selectivity.

Note the set's location with respect to local stations. Try shorter aerial, wavetrap or rebalance set in the shop.

(13) Poor tone quality.

Check supply voltages. Look for trouble in the speaker, or wrong "C" bias voltages on the tubes. Examine grid leak on detector.

(14) Sharp cracking sounds.

Probably static, or outside line interference. If followed by set going dead, look for loose connection. Examine all soldered joints.

(15) Squeals and howls.

If not very loud, probably due to neighboring set. If very loud and varying in pitch while tuning, due to oscillations in set. Test by-pass condensers and adjust trimming and neutralizing condensers. Examine by-pass condensers on audio transformers.

(16) Gradually increasing ringing sounds.

Due to microphonic tube - probably in detector socket. Try new tube or howl arrester.

(17) Intermittent squeaks, sound of wagon wheel or cold, squeaky snow.

In battery set, look for run-down storage battery or corroded connections.

(18) A.C. Hum.

On A.C. sets, try reversing line plug. Try connecting one side of line to set chassis through a 2- to 4-mf. condenser. Examine rectifier supplying dynamic field current. Examine filter system and A.C. wiring or leads near set. Test "c" bias resistors and voltage divider. On D.C. sets, look for open grid circuit.

(19) Fading.

This may be due to a natural atmospheric condition or poor aerial installation, or nearness to some other receiving set. Check line voltage for variations.

(20) Rattling sounds.

Probably mechanical vibrations. Tighten all parts near speaker and cabinet. Examine speaker and re-center voice coil if necessary.
(21) Fuses "blow" when turning on set. Examine filter condensers on A.C. input and in power supply. Test rectifiers supplying dynamic field current.

(22) In describing sounds indicating radio interference, we cannot improve on those given in "Filterette," a booklet published by the Tobe Deutschmann Corporation.

(23) Whirring, cracking, buzzing, humming, droning, whining. Indicate interference caused by electric motor; sometimes, when the motor starts and stops, the sound will start low and rise in pitch until the motor reaches full speed; when the whine will remain at a steady pitch, usually rather high. Especially true of commutator motors.

(24) Rattles, Buzzes, Machine-gun Fire. Sounds of this sort generally indicate interference caused by telephone dialing, buzzers, or door bells. It is not generally steady, but stops and starts.

(25) Violent heavy buzzing or rushing sound. Sounds of this sort generally indicate interference caused by high-frequency apparatus. Such noises will usually be heard over a large area, a whole town, even; and often are so loud that they drown out the radio program completely.

(26) Crackling, sputtering, snapping, short buzzes or scraping. Sounds of this sort generally indicate interference which is being caused by one or more loose connections in the set, or electrical wiring in the vicinity. Sometimes the sounds are especially noticeable when the room is jarred or shaken by footsteps, street cars or traffic.

(27) Clicking. Sounds of this sort generally indicate interference which is being caused by some sort of make-and-break connection, such as a thermostat; especially if it comes at fairly steady intervals.

(28) Heavy violent, buzzing, usually short. Sounds of this sort generally indicate radio interference which is being caused by arcing of a spark across a gap. This may occur as a short noise or a steady one.

(29) Steady humming. Sounds of this sort generally indicate interference which is being caused by improperly filtered alternating current. Such humming is often a fault of your set or eliminator. Look for dynamic speakers improperly filtered; faulty construction of set or eliminator; filter condensers blown or shorted; ground on set poor; improper wiring; poor tubes; wiring parallel with power line.
CHAPTER XI
RADIO-PHONOGRAPHS COMBINATIONS,
SHORT-WAVE SETS,
AUTOMOTIVE INSTALLATIONS.

RADIO-Phonograph Combinations. Many radio sets have phonograph combinations, and
the Service Man is often called to make repairs on them. These phonograph combina-
tions employ some kind of electromagnetic pickup device, consisting of parts
similar to those in a magnetic speaker unit, except that the armature has an attach-
ment for a phonograph needle. This rides in the groove of the record, causing the arma-
ture to vibrate, thereby inducing corresponding electrical vibrations in a coil surr-
rounding the armature. The armature, of course, is mounted between the poles of a small
permanent magnet. All that remains to do is to amplify these currents induced in the
armature coil; various methods are employed. Part or all of the audio-frequency ampli-
 fier of the radio set is used to amplify these currents, the sound being reproduced by
the regular loud speaker. The phonograph attachment is usually connected to the set
by a plug connection; a switch on the set connects either radio or phonograph to the
amplifier.

(2) Phono-Pickup Circuits. Connections of the phono-pickup circuits are included in
the regular diagrams in the back of this book on the sets employing phonograph combina-
tions. But a few words describing some of the circuits may not be amiss here. Fig. 102
shows a typical method as employed in the Stromberg Carlson "No. 654" A.C. receiver.
In this set the phonograph motor is operated by the A.C. line and drives the turntable
at a rate of 78 revolutions per minute; the output of the magnetic pickup is connected
to a potentiometer volume control which, in turn, connects to the input transformer
as shown. The secondary of the input transformer is led by means of a plug connection
to the set, to the grid and filament of the detector tube, thus employing the detector
as a stage of audio-frequency amplification. Arrangement for obtaining the proper "C"
bias on the detector is included. In many other sets, the pickup connects to the
primary winding of the first audio-frequency transformer, as shown in the diagrams of
the Brunswick-Balke-Collender sets.

(3) Phono-Graph Motors. Special electric motors are employed for driving the turn-
table. In the Sonora sets a slow-speed series-wound commutator type is used; the motor
armature revolves at the same speed as the turntable. A centrifugal-ball governor and
brake disc maintain constant speed. It is operated by the 110V. 60-cycle line. Noises
which the motor might produce in the radio set are filtered out as shown in the diagram
of Fig. 103. Other types of motors run at high speed and have gear-reducing devices.

Fig. 102 - Typical cir-

TO PLATE OF
3RD. R.F.
AMP.

TO B1

TO B2

3.3

3.3

15000

1 MFD.

TO B1

TO B2

TO A1

TO B1

11-9-114

°"11-)-1-

TO B2

TO A2

1 MFD.

Fig. 102 -
Typical cir-

TO LOUD SPEAKER

Fig. 102 - Typical cir-

TO B2

TO LOUD SPEAKER
OFFICIAL RADIO SERVICE MANUAL

Fig. 103 - This shows the connections of a slow speed phonograph motor. Note the filter circuit connected to the motor line to filter out commutator noises which otherwise would be heard in the radio set.

TYPE 2M MOTOR

(4) Automatic Stops. Arrangements are provided to automatically stop the phonograph motors at the end of the record, by an arm projecting underneath the motor board carried by the pickup arm. This arm opens the motor circuit, at the same time applying a brake, so that the motor stops within 8 to 10 revolutions.

(5) Troubles in Radio Phonograph Combinations. One of the simplest tests of a "dead" radio is to try the phonograph combination. If this works, it shows that the audio-frequency amplifier and speaker are in good condition, and that the trouble is in the radio-frequency amplifier or aerial system. So far as electrical trouble is concerned, in the pickup device, this can easily be tested by a continuity test, as well as all the associated parts. Mechanically, the pickup should be examined and the armature adjusted and cleaned if necessary. Loose parts and dirt will cause rattles. If it is "dead," examine the plug connections to the set. Test the volume control for opens and noise, and clean if necessary. Use new steel needles only for each rendition, or Tungstone needles.

(6) Motor Troubles. The speed should be measured and adjusted by timing with a watch. The turntable should turn 39 times in 30 seconds. In case of a stalled motor, test all the electrical circuits for continuity, and also remove the turntable and try turning the shaft with the fingers to see if it binds; this test is applicable to slow speed motors that run at the same speed as the turntable. Low torque may be due to a shorted portion of some of the motor windings, or binding in the mechanical system. Examine the governor. Shorted windings also cause a loud A.C. hum and commutator sparking. Open windings also cause excessive commutator sparking. Clean the commutator with fine carborundum paper. Fluctuations in speed are probably due to the governor, or to an open or loose connection, which should be corrected. Oil all parts indicated, with a good grade of sewing-machine oil. In cases of real difficulty, it is best to take the complete phonograph equipment to the shop for a thorough overhauling, taking care to follow the explicit instructions given by the manufacturer of the apparatus.

Fig. 101 - At the left is shown the magnetic and electric circuits of the Audak "tuned" phonograph pick-up. The right illustration shows the pick-up being tested for magnetic balance by tapping the needle with the finger. It can be balanced centrally by means of the thumb screw adjustment. An unbalanced condition means distorted reproduction.
SHORT-WAVE RECEIVERS.

The same general methods of testing broadcast receivers apply to short-wave receivers. There are outstanding differences in design, however, which we will briefly point out. In the first place, the short-wave receiver employs plug-in coils, so that the entire range may be covered; secondly, regeneration is used, the station usually being tuned in by the heterodyne whistle, after which the set is left on the verge of oscillating, for phone reception. Regeneration is controlled by a rotating tickler coil, a variable condenser, or a variable high resistor. A typical short-wave circuit of wide popularity is that of the Pilot "Super Wasp," illustrated in Fig. 101. This is an A.C. receiver, which required special design, as will be pointed out later. The battery-type short-wave set is more common and of simpler design. The Service Man cannot account for or explain all the vagaries of short-wave reception, but he can test the set and see that it is in working order, and trust to the elements whether Holland, Australia, or the next-door neighbor is tuned in.

(2) Troubles in Short-Wave Sets. In addition to many of the troubles encountered in broadcast sets, the short-wave set has troubles all its own. Perhaps the most common complaint is due to fading of the signals; this, however, is due to external agencies beyond the control of the Service Man. The reflection and refraction of waves by the Heaviside layer some 60 to 200 miles above the earth (depending upon the time of day) influences short waves of different frequencies differently. The waves "skip" around the earth and are apt to be heard at any place on the globe. Foreign stations roar in at certain times and locals fade away. All we can suggest is the use of three or four aerials of different lengths and locations, and switching arrangements whereby any one, or any combination, can quickly be connected for operation.

Fig. 104 - The Pilot A.C. Super Wasp.

(3) A.C.Hum. In the short-wave A.C. set shown in Fig. 104, hum was successfully eliminated by special methods. Two classes of hum were encountered; one existed with the tuning dials at any position; the other seemed to be "tuned in," like a radio station. The former was found to be due to the tube construction; the A.C. magnetic field about the filament reacted on the electron flow and hence the plate current, causing it to vibrate in unison. A special Pilot type '27 tube was subsequently developed, in which the heater filament doubled back on itself, like a hairpin, thus neutralizing its own magnetic field and eliminating this source of hum. The second type of hum was very prominent in regions between 14 and 50 meters and was found to be caused by parasitic oscillations existing in the heater-cathode combination and center-tapped resistor across the filament of the detector. These were modulated by the 60-cycle filament current, producing the hum. A .005-mf. condenser, connected across one side of this resistor, as shown, wiped them out and eliminated the hum. Other forms of troubles are similar to those in broadcast sets and need not be repeated again.
The popularity of this type of radio set makes a few words describing it necessary. While the set proper is similar to that of hundreds of other broadcast sets, certain precautions had to be taken in the design of it, to make it adaptable to the car. For example, the size of aerial and "counterpoise" (ground) is limited. The aerial must be small enough to be contained within the car; the ground is a counterpoise consisting of the metal framework of the car. With this small pick-up system, an extremely sensitive set is required. And a sensitive set of this nature is difficult to operate properly within a few feet of a noisy, sparky, high-tension, ignition system. Add to this the excessive mechanical vibrations acting on the tubes and connections and loosening them, and we have a vague idea of the troubles that had to be overcome to make automotive radio successful.

(2) Auto Installations.

The various illustrations show typical examples of car installations. Fig. 105 shows the general layout of the "Transitone" system; the set is installed under the instrument panel, the tubes being inverted. Flexible control shafts extend from the set to the control dials on the instrument board. The aerial consists of wire netting in the top of the car. The regular 6-volt car storage battery supplies the filaments, and the "B" batteries installed under the front seat supply the plate current. In limousines the magnetic reproducer is mounted above the windshield, and in open cars, below the instrument panel. The layout of the "Bosch" equipment is illustrated in Fig. 106. But the Service Man is more interested in the electrical problems than the mechanical layout.

(3) Interference Problems.

A 25,000-ohm resistor is placed in series with each spark-plug lead to suppress high-frequency oscillations. See Fig. 107. A similar resistor is placed in the high-tension lead between the coil and the distributor. These have negligible effect on the action of the ignition system. In all types of ignition coils a certain amount of "kickback" voltage is impressed on the primary winding by the high-tension side. This finds...
its way back to the storage battery and thence to the receiver, and is therefore filtered out by means of a 1-mf. condenser connected between the battery terminal of the coil and ground. If the ignition coil is mounted on the instrument board, it is necessary to shield the high-tension, and the leads going to the breaker points, at the point where they pass through the engine partition. Remember, in some cars the positive terminal of the storage battery is grounded, and in others, the negative side is grounded.

(4) Type of Circuit.
In the Transitone "Model TR106 set," a schematic diagram of which is shown in Fig. 108, three stages of tuned R.F. amplification are employed, using type '01A tubes, with grid-suppressor resistances to stabilize the circuit. Two tuning-control dials are used. A "soft" (type '00) detector tube is employed, and a two-stage audio-frequency amplifier; the last or output tube being a type '12A. Trouble shooting in the set, therefore, can be in accordance with the instructions outlined elsewhere in this book.

(5) Fig. 109 shows the schematic circuit of the "NR109" set developed by the Automobile Radio Corp. The receiver and detector is in one unit (NR107) and the audio amplifier in another unit (NR108). A single-control dial is used, and the volume-control knob is mounted on the center of the dial. The output tube is a type '71A. This set is used on all Chrysler cars which are radio equipped at the factory.
**STANDARD RADIO SYMBOLS**

In the various diagrams the parts of the sets which they represent are shown by means of symbols. While there is no standardized set of symbols in rigid use, they are somewhat similar. Therefore, in this list are given only the ones more in general use. Since the diagrams in nearly all cases are reproduced exactly as they appear in the service manuals furnished by the manufacturers, the publishers cannot be held responsible for any damage resulting from the use of the information contained in them.

*FORMULAS FOR DETERMINING RESISTANCE VALUES AND TYPES*

<table>
<thead>
<tr>
<th>Voltage in Volts</th>
<th>Current in MA</th>
<th>Resistance in Ohms</th>
<th>Power in Watts</th>
</tr>
</thead>
<tbody>
<tr>
<td>KNOWN</td>
<td>KNOWN</td>
<td>1000 x Volts/MA</td>
<td>Volts x MA/1000</td>
</tr>
<tr>
<td>KNOWN</td>
<td>1000 x Volts/Ohms</td>
<td>KNOWN</td>
<td>Volts x Volts/Ohms</td>
</tr>
<tr>
<td>KNOWN</td>
<td>1000 x Watts/Vols</td>
<td>KNOWN</td>
<td>KNOWN</td>
</tr>
<tr>
<td>MA x Ohms</td>
<td>KNOWN</td>
<td>1000,000 x Watts/MA x MA</td>
<td>KNOWN</td>
</tr>
<tr>
<td>1000 x Watts/MA</td>
<td>KNOWN</td>
<td>1000 x Watts/MA</td>
<td>KNOWN</td>
</tr>
<tr>
<td>√ Ohms x Watts</td>
<td>1000 x Watts/Ohms</td>
<td>KNOWN</td>
<td>KNOWN</td>
</tr>
</tbody>
</table>

These formulas are furnished by the INTERNATIONAL RESISTANCE CO. To use, find the horizontal line in which the two known values appear and the formula for either of the two remaining values will be found in the proper column. These equations include correction factors where necessary so that the current values may be substituted in milliamperes.
XL-61 BATTERY SET

MODEL AC-66
ALL AMERICAN MOHAWK CORP.

The diagrams on this page are taken from the Wurlitzer Service Manual in which the circuit diagrams are identically the same with the exception that the power pack is split into two parts instead of one complete unit as used in the Lyric Models.

NOTE: Above indicated part numbers are the electrical part and assembly numbers of items listed in circuit. When ordering parts or assemblies specify this number as well as name of item.
There are two principal variations in the battery-model Mohawk receiver. The first circuit, shown above does not provide for a power tube at V6; six type 6AK5 tubes are required. A 5-wire cable is used. An odd arrangement of the A.F. output circuit, to select two or three stages of A.F., by means of tip-jacks and a plug, necessitates placing the additional battery required for power-tube operation on the plate side of the A.F. output, at the point marked X2 (otherwise, this supplementary potential would be added to the plate supply of V5). The corresponding "C" potential is added at X1.

In later models, provisions were made for a power tube; and the usual connections are shown at the right of the main diagram. The color code of the (7-wire) cable is as follows: Green, "A-" white (connected to red); slate, "B-" 2215 ± 45 volts; light blue, 0% or 90 volts; pink, "B+" 90, 135 or 180 volts; blue, "C-" 45 volts; brown, "C-" 45%, 9, 2215 or 45 volts; yellow (connected to green), "C+".

The available constants for this receiver are as follows: L1, L2, L3, 25,000 ohms variable resistor which turns off the set by operating switch SW when R1 is turned to extreme left; R2, 2 mega; R3, 10,000-ohm filament ballast; R4, 1-ohm resistor; C4, 0,00025 mf; C5, 0.00025 mf; C6, 0.00025 mf; C7, 0.00025 mf; C8, 0.00025 mf; C9, 0.00025 mf; C10, 1.0 mf; C11, 1.0 mf; C12, 3.0 mf; C13, 3.0 mf; C14, 3.0 mf; R1, 650 ohms; R2, 850 ohms; R3, 2 to 3 mega; R4, 30; R5, 50; R6, 0.5 ohm; R10, 2,000 ohms.

The heater of V3 is held at 45 volts positive. Resistor R6 varies the heater current to V1. The color-code of the Jones cable used in this receiver and battery models.

The A.C. model requires four 26s (or V1, V2, V4, V5; a 27 for V3, and a 71A for V6). The constants of the A.C. model are as follows: C4, 0.00025 mf; C5, 0.00025 mf; C6, 0.00025 mf; C7, 0.00025 mf; C8, 0.00025 mf; C9, 0.00025 mf; C10, 1.0 mf; C11, 1.0 mf; C12, 3.0 mf; C13, 3.0 mf; C14, 3.0 mf; R1, 650 ohms; R2, 850 ohms; R3, 2 to 3 mega; R4, R7, R8, 20 ohms; R5, R9, 1,000 to 2,000 ohms; R6, 0.5 ohm; R10, 2,000 ohms.

The heater of V3 is held at 45 volts positive. If this positive tap open-circuits, there will be a noticeable increase in hum. If R1 or R2 becomes shorted, and may be the result if R1 and R2 are interchanged. If the set cannot be made to oscillate on medium to high wavelengths, try changing the R.F. tubes, though this may be due to C15 being open. A particularly high noise level may be an indication of C9 being open.

Some receivers require a good ground connection; but this is particularly true of the "Mohawks," if hum is to be held at a minimum level.

The tube layout shown is the same for A.C. and battery models.

The tube layout shown is the same for A.C. and battery models.
An unusual method of obtaining neutralization is observed in these popular "Cruisers." Windings (A) in coils L2 and L3 are in the negative filament leads of V1 and V2, for this purpose, and in conjunction with condensers C7 and C8. Resistor R1 is a master control to maintain the filament potential at five volts. Volume is further controlled through R2 (marked "Amplifier") which, at its position of highest resistance, operates switch SW1. Selectivity is governed by SW2 (marked "Clarifier") and C10. A nine-wire cable connects the current supply to the C10.

Four '01A tubes and a '12A or '71A tube are recommended for this set. BOSCH "CRUISER," "ROYAL CRUISER," AND "IMPERIAL CRUISER" MODEL 35 BATTERY SETS

This receiver is balanced like a regular neu-
trodyne receiver, a "dampen" or open-filament tube (or similar expedient) being used in place of the regular tube; first, in place of V2, and then as a substitute for V1. Adjustments of C7 and C8 are made for maximum signal. Condenser C9 resonates the detector circuit for maximum signal.

The location of the main rheostat, R1, is indi-
cated in the top and bottom views of this receiver. The slot in the top of the control will be parallel with the front of the set for the five-volt setting.

Four '01A tubes and a '12A or '71A tube are recommended for this set.

Schematic circuit of "Type BAN (Edition 3) Nobatry" eliminator.

If either of the above adjustments cannot be made, check the R.F. circuit for faults. Remove the shields from C1, C2 and C3, and note whether, at the zero setting of the dial, all the condenser rotors align perfectly straight at the tapered ends of the stators. Adjustment of the stators is accomplished through the bolts which join two end plates (if it is desired to change the spacing between interleaved rotor and stator plates); and the proper spacing here, for minimum setting, is easily obtained by adjust-
ment of the screws on the condenser-shaft couplings.

If the condenser shafts lose their alignment, the condensers may be loosened and reset to the correct positions. Condenser C2 may be shifted for proper alignment after removing the coil assemblies.

With all condensers set at maximum capacity, the dial should indicate 100. If this reading is not obtained, compensation may be secured by adjustment of two stop screws provided for this purpose.

A six ohm rheostat may be used as replace-
ment for R1; R2 has a resistance of about 10 ohms; R3 is the usual 2-meg. leak; C1, C2, C3 are the tuning condensers; C4 is .00025 mf.; C5, C6, 1.0 mf. each; C7, C8, C9, 100 mmf., maximum (approx.); C10 125 mmf. (approx.); C11 .006 mf.

The "Type BAN" (Edition 3) "Nobatry" eliminator is usually used with this model of the "Cruiser" line. (Other models of the "Cruiser" embodying somewhat the same general features but varying in details are the "Model 96DC, 110 watts"; "Model 156," (for direct current); "Models 66, 76, 76L" (battery-oper-
ated); "Models 66AC, 76, 116" (for A.C. operation).

Constants for the above "Nobatry" unit are as follows: C12, C13 0.1-mf.; C14, 3 mf.; C15, 2 mf.; C16, C17, 2 mf.; R4, 4,000 ohms (or a variable, 5,000-ohm unit); R5, 15,000 ohms; R6, 25,000 ohms. V6 is a gaseous rectifier; SW3 the power switch. The principal choke unit in the filter system is a "double" choke.

Although the circuit diagram does not indi-
cate that there is a mechanical connection be-

tween C1, C3, and antenna condenser C1, there is a slip coupling which permits C1 to turn readily when the other two tuning condensers are adjusted or to be operated independently of these two. More complete control of the dial reading designated "Antenna Tuning Scale" will be secured by making C10 one of the compact adjustable units now available. Then, by vary-

ing C10 and SW2, it will be possible to obtain nearly identical readings on both scales for any average antenna conditions.

If it is found that circuit oscillation cannot be stopped, test windings A for reversed con-
nections; checking L3 first and L2 last.

Schematic circuit of "Cruiser," "Royal Cruiser," and "Imperial Cruiser," design of the Bosch "Model 35" battery sets. The arrange-
ment of the neutralizing circuit is such that the respective grids are connected to the grounded "A"-lead if the neutralizing condensers short, without affecting any of the batteries in the set.

Radio Service Data Sheet

BOSCH "CRUISER," "ROYAL CRUISER," AND "IMPERIAL CRUISER" MODEL 35 BATTERY SETS

An unusual method of obtaining neutraliza-
tion is observed in these popular "Cruisers." Windings (A) in coils L2 and L3 are in the negative filament leads of V1 and V2, for this purpose, and in conjunction with condensers C7 and C8. Resistor R1 is a master control to maintain the filament potential at five volts. Volume is further controlled through R2 (marked "Amplifier") which, at its position of highest re-
sistance, operates switch SW1. Selectivity is governed by SW2 (marked "Clarifier") and C10. A nine-wire cable connects the current supply to the C10.

Four '01A tubes and a '12A or '71A tube are recommended for this set.
Models 66AC, 96, 116, 136 Receivers (for AC operation)

Models 126, 146, 166, 176, 46AC (AC operation)

Models 66, 76, and 76L Receivers—The "Cruiser"
Model 96DC 110 Volt "Cruiser"

Model 156 Receiver "Cruiser"

Model 28 Receiver (Model 38 for 25 Cycle Operation)
For Details See Instructions, Form 1302

25—Grid Leak 3 megohms
26—Grid Condenser .00025 mfd.
27—Plate Resistor 50,000 ohms
32—External Cond. .00015 mfd.
36—By-Pass Condensers .5 mfd.
37—By-Pass Condenser 1. mfd.
38—By-Pass Condenser 1. mfd.
43—By-Pass Condenser .002 mfd.
87—Volume Control 500,000 ohms
102—Filter Condenser 2 mfd.
103—Filter Condenser 4 mfd.
107—Bias Resistor 1500 ohms
110—Bias Resistor 300 ohms
111—"B" Resistor 5000 ohms

MODEL 825 POWER PACK
149—Filter Condenser 4 mfd.
150—Filter Condenser 2 mfd.
154—Bias Resistor 500 ohms
155—Bias Resistor 2000 ohms
156—Plate Resistor 10,000 ohms
157—Plate Resistor 10,000 ohms
161—By-Pass Condenser 1. mfd.
162—Buffer Condensers
163—Filter

Model 825 Super Dynamic Power Pack. Used with Model 28 Chassis only to form Model 29 Receiver.
The schematic circuit of the Bosch Motor Car Radio receiver, made by the American Bosch Magneto Corp.; it includes four tuned-input, battery-operated, '24-type screen grid tubes, as R.F. and detector stages, and a single audio output tube, operating the built-in magnetic speaker.
The Schematic Wiring Diagram of The Amrad Neutrodyne Receiver AC-5 Type and Power Unit

**MODEL DC-6**

**MODEL A.C. 6 CONCERTO NOCTURNE**

*NOTE:* The letters and numerals on battery leads refer to markings on eliminator panels.
AMRAD CORPORATION

MODEL-80
82 AND 83

NO 7100

All filament leads to be twisted pairs and are to run from each tube direct to the terminal strip.
Care must be taken that the same number of condensers (C5-C6) are on one side of the 226 filament line as there are on the other.

KEY
A 1st Audio Stage
B 2nd
C 1st Radio
D 2nd
E Detector
F 200 MFD
G 1000 MFD
H .73 Ohms
I .0025 MFD
J .001 MFD
K .001 MFD
L .00022 MFD
M .0001 MFD
N .00022 MFD
O .00047 MFD
P .000001 MFD
Q .0000001 MFD
R .00000001 MFD
S .000000001 MFD
T .0000000001 MFD
U .00000000001 MFD
V .000000000001 MFD
W .0000000000001 MFD
X .00000000000001 MFD
Y .000000000000001 MFD
Z .0000000000000001 MFD

AMRAD RECEIVER
S-522
AMRAD CORPORATION

3500-2

SHOWING INTERNAL WIRING OF DETECTOR 2 STAGE AMPLIFIER 2634 AND
BROADCAST TUNER 3730 AS VIEWED FROM REAR OF INSTRUMENT

3500-1

SHOWING INTERNAL WIRING OF DETECTOR 2 STAGE AMPLIFIER 2634
& BROADCAST TUNER 3470 AS VIEWED FROM FRONT OF INSTRUMENT

Schematic Circuit of the Amrad Type 7191 Power Unit designed for the Model 7100 receiver. The
Model 7100 receiver is designed to operate without an outside aerial, the radio frequency pick-up of
the light line being sufficient in most localities to bring in the signals of distant stations. Units M
and M1 are Mershon electrolytic condensers.
Radio Service Data Sheet

AMRAD MODEL 81 ("BEL CANTO" SERIES) RECEIVER

The tubes required for this receiver are as follows: V1, V2, V3, 24s; V4, V5, 27s; V6, V7, 85s; V8, 80; V9, 2.5-volt bulb.

R1 is the volume control and varies the voltage applied to the screen-grids of V1, V2, V3.

Further constants for this receiver may be obtained from the following list. C1, C2, C3, C4 constitute the four-gang tuning condenser; C5 has a capacity of 0.0025 mf.; C6, C7, C9, C11, C12, are contained in "by-pass block condenser No. 8113" (which may have either lug or wire terminals, connected as shown in the accompanying illustrations), and the values are: C6, C7, C12, 1.0 mf.; C9, C11, 0.5 mf.; C8 has a capacity of 1.0 mf.; C10, 0.002 mf.; C13, 0.25 mf. The four units of the electrolytic condenser have the following ratings: M1, 18 mf., M2, 8 mf., M3, 5,000 ohms; M4, 8 mf.

The resistors have the following values: R1, 50,000 ohms; R2, 21,000 ohms; R3, 1.5 meg.

One type of filter-block terminals:

- R4, 12,500 ohms; R5, 100,000 ohms; R6, 2,250 ohms; R7, 20 ohms; R8, 200,000 ohms; R9, 5,000 ohms; R10, 60 ohms; R11, 31 ohms; R12, 500 ohms; R13, 1,500 ohms. The resistor cartridges are colored as follows: R2, green; R4, black; R5, yellow; R6, orange; R9, brown; R11, purple.

The Model 81 chassis is fused at three amperes. The "antenna chassis" compensating control is the 10-plate variable condenser marked C1A:

- A view looking down on the "81" chassis.

while the remaining trimming condensers are adjustable, through the shield can, with a screwdriver. Binding posts at the rear of the chassis permit selection of the correct tap on the antenna input inductance L1, for the required degree of selectivity and sensitivity. When the tube is renewed at V4, it will probably be necessary to readjust the setting of R8. If circuit oscillation should appear in the receiver, it may usually be traced to a defective '24 tube, which should be replaced.

The cord which operates the tuning dial is kept in tension by an adjustment which compensates for stretching; this is regulated by putting a screwdriver through a hole cut in the edge of the dial square.

Each of the H.F. transformer primaries (L1, as well as P in L2, L3 and L4) consists of a winding of about 200 turns on a bobbin at the grid end of the secondary. It has a direct-current resistance of about 80 ohms. C11 has a resistance of about 100 ohms.

The D.C. resistance values of T1, between ground and the three higher-potential ends, are as follows: to phono tap, 20 ohms; to detector tap, 2,000 ohms; to grid lead, 12,000 ohms. The primary of T2 has a D.C. resistance of 1,650 ohms; the secondary has an over-all resistance value of 10,600 ohms, divided into 4,800 and 5,800 ohms for the grid circuits of T3 and T7. Transformer T3 has a primary D.C. resistance of 110 ohms on one side of the tap, and 220 ohms on the other. The secondary has a D.C. resistance of 0.8 ohm (approx.) to match the voice coil of an RCA "Type 106" dynamic reproducer. The field coil of this instrument has a D.C. resistance of 7000 ohms. As most Service Men know, the voice coil is usually centered by first loosening the center machine screw that clamps the cone-spider to the iron core. (The voice-coil leads of the "106" are marked "B" and the field-coil leads are lettered "C").

Correct operating conditions for the "Model 81" Amrad are as follows: V1, V2 and V3, plate voltage 180; control-grid bias 1.5, plate current 4 ma.; V4, plate voltage 60 (with tube out of socket, 140 volts), grid bias 0.0, plate current 1.5 ma.; V5, plate voltage 160, plate current 4.1 ma., grid bias 10.5; V6, plate voltage 250, plate current 28 ma., grid voltage 50, filament voltage 2.25; V7, same; V8, plate output 110 ma., filament voltage 4.65. (All the other tubes have a filament voltage of 2.25; at the socket with the tube out, 2.32.) These values were obtained with the set adjusted for a 120-volt line supply, and the volume control full "on." The "C" bias figure of 10.5 volts for V5 will not be obtained unless the hum control R7 is turned to the ground side.

Another form of condenser connections.

Electrolytic condenser unit.
The Atwater Kent "Model 10R" is a very early "breadboard" receiver. The circuit is quite simple, and the controls numerous. It is designed for storage-battery tubes, and has a potentiometer R.F. control. It may be readily altered to use a power tube.

Schematic arrangement of the Atwater Kent Model 10 receiver; this set is popularly referred to as the "breadboard" type of construction. The Model 12 set was one of the very first ones to incorporate "grid suppressors" to prevent circuit oscillation. The most usual complaint by owners of this receiver is that the tubes will not light. A check-up would indicate that one of the rheostats had burned out; because someone in the family had connected one side of the storage battery to ground. This put the full storage-battery current across the rheostat controlling the first two tubes.
MODEL 21 DRY CELL SET No. 7780.

WIRING DIAGRAM OF MODEL 32.

WIRING DIAGRAM OF MODEL 36 WITH CONDENSER TYPE VOLUME CONTROL AND CABLE CONNECTION PANEL FOR EARLY Model "Y" Power Unit. (Note that the +B 1st A.F. cable lead is green with a yellow tracer. In some Model 36 sets, and in all other Atwater Kent A.C. receivers, a black-red tracer is used for this connection.)

WIRING DIAGRAM OF MODEL 36 WITH RESISTANCE TYPE VOLUME CONTROL AND CABLE CONNECTION PANEL FOR LATER Model "Y" Power Unit. (Note that the red and the black cable leads feed the R.F. filaments as well as the 1st A.F. filament. In some Model 36 sets, the +B 1st A.F. cable lead is green with a yellow tracer.)
These receivers are six-tube sets of the single-dial, battery-operated type. They are often referred to by their factory catalog numbers, to wit: Model 30, No. 8000; Model 35, No. 8005; Model 48, No. 9840; Model 33, No. 8930; Model 49, No. 9860.

The models 33 and 49 have a tuned input (four tuned circuits); the models 30, 35 and 48 have an untuned input (three tuned circuits). Models 48 and Models 49 are code numbers showing that a gold-finished panel is used. Models 33 and 49 are so wired that R5 limits the current to V3 and V6 only while V4 is controlled by the additional variable resistor Rx. R in the first stage of these two circuits has the same value as equivalent resistors R1 and R2. C is the regular tuning condenser, in shunt to which is the circuit-balancing variable condenser Ca.

The purpose of the untuned antenna input of the 30, 35 and 48, shown in the larger diagram, is to eliminate the detuning effects of aerials of different constants.

If it becomes necessary to change a variable-condenser bank, make certain that the pulleys turn easily on the shafts; if they do not, because of a damaged condenser shaft, replace the entire condenser group.

Each belt must be arranged with the eyelets, which clamp the two ends together, at the bottom of the belt loop. Each belt has two small holes; one is pulled per a pin of the dial-condenser pulley and the other to fit over the pin on the pulley which is controlled by that belt.

Loosen screws in the outer condensers and move them toward the dial-condenser, so that the belts will fit easily over the pulleys. In moving condensers, hold them by the heavy frame of the stator plates, as this avoids strain on the different parts of the condenser assembly.

To arrange the belts on the 30, 35 and 48, first put on the belt which fits over the inner of the two pins on the dial-condenser pulley, and over the other of the two pins on the dial-condenser pulley over the pulley of the first (left) condenser. Then, put on the belt that fits over the inner of the two pins on the dial-condenser pulley, and over the outer of the two pins on the dial-condenser pulley over the pulley of the first (left) condenser.

A bit different procedure must be followed in arranging the belts on the 33 and 49. Put on the belt that fits over the inner of the two pins on the dial-condenser pulley, and over the outside of the two pins on the outer of the two pins on the dial-condenser pulley (this will bring it on top of the first belt) and continue on over the pulley of the fourth condenser. The last step is to put on the belt that fits over the outer of the two pins on the dial condenser pulley and over the pulley of the first or left condenser.

After the belts are in position the next step is to adjust the belt tension. See that the three screws holding the dial-condenser to chassis are tight, and that the three screws in each of the other variable condensers are slightly loosened. Note that the holes through which these latter screws pass are slotted, allowing the condenser to be moved horizontally a fraction of an inch toward or away from the dial condenser. Two steps should be taken: (1) to fit into two horizontal slots and serve to keep the condenser fully from touching the chassis, it is important to see that the limit of this movement is not jammed outside but are in the slots. The frame of the metal-frame variable condensers will be found to partly cover a hole (on the side of the condenser nearest to the dial-condenser) that is provided in the front of the chassis and at the angle of each condenser for the purpose of tightening the belts. By inserting the blade of a screwdriver in this hole and twisting the blade, the condenser may be moved away from the dial-condenser; this motion tightens one belt.

A little dexterity is required when the correct belt tension has been obtained; for the next step is to keep the condenser in the correct position, while, with the right hand, a second screwdriver is used to tighten the three screws that pull the condenser to the chassis. Screws must be pulled up tight as soon as the tension is such that the variable condensers all move at the same instant, forward or backward, when the dial is adjusted, without any slack in the belts.

Following are a few details that relate specifically to the 33 and 49 condenser belt:

- To change the wiring of these, determine the correct right-hand belt first; insert the blade of a screwdriver in the chassis hole at the left-hand edge of the third condenser and twist the blade, opposite. This will force the third condenser toward the right and increase the tension on the belt. When it seems to lie at the right tension as judged by pressing the belt, tighten the three screws with a second screwdriver.

Special notes in connection with the 33 and 49 are as follows: the dial-condenser and third condenser belt should be adjusted first. Following this is the adjustment of the belt passing over the pulleys of the dial-condenser and fourth condenser. (Tension is tested by pressing down the belt between the third and fourth pulleys.) The left-hand belt is the last to adjust.

As it is necessary, in making certain replacements, to know the general classification of the R.F. inductance bank of each model as regards its serial number, these data are included here. The identifying washer is found under the nut on the second R.F. transformer mounting; the colors of the washers are as follows: Model 30, 635,001 to 644,351, black; above 644,351, red. Model 33, below 900,000, no washer; 900,001 to 915,701, red; above 915,701, gray. Model 35, Unit No. 9220: antenna coil has five leads (one red), L1 has one green lead, L2 has one yellow lead, and L3 has one blue lead.

To reduce inter-stage coupling to a minimum, the three R.F. inductances L1, L2 and L3 in the 30, 35 and 48 are so arranged that the axis of each is at right angles to that of the others. The R.F. choke Ch is only about 34-0 6 ohms, and has a negligible field; however, the 33 and 49 incorporate four tuned circuits and, to reduce interstage coupling, the coil design was entirely changed to "binocular" or "astatic" (non-inductive) windings. If, after carefully balancing the variable condensers, it is found that the variable condensers cannot be kept in tuning alignment throughout the tuning range, it is probable that one or more of the R.F. inductances is out of balance; it is then advisable to replace the entire set with a new one.

The A.F. output of any of these sets may be fed to a Weston "Model 242" thermocouple galvanometer, through an additional, or third, stage of A.F. amplification, to determine the alignment of variable condensers when the A.F. modulated output of an R.F. oscillator is picked up by the set. The oscillator should be coupled to the set to a degree which results in an approximate reading of 50 on the galvanometer, at about 30 on the tuning dial (as each stage is brought into resonance the meter reading will rise, while V4 is used to tighten the three screws that pull the condenser to the chassis. Screws must be pulled up tight as soon as the tension is such that the variable condensers all move at the same instant, forward or backward, when the dial is adjusted, without any slack in the belts.

These sets are wired for a power tube in the last A.F. socket except for early types of the 30. To change the wiring of these, determine by continuity test the grid return lead of T2 which connects to the blue lead in the cable. Break this grid return lead, and attach a length of wire to it. Then, connect the positive lead of the speaker to the set to a degree which results in an approximate reading of 50 on the galvanometer, at about 30 on the tuning dial (as each stage is brought into resonance the meter reading will rise, while V4 is used to tighten the three screws that pull the condenser to the chassis. Screws must be pulled up tight as soon as the tension is such that the variable condensers all move at the same instant, forward or backward, when the dial is adjusted, without any slack in the belts.

The A.F. transformers have the following color code for the leads: green to plate; yellow to "B" plus; black to grid; blue to "A-" or "C-". T1 has a ratio of 4:1; T2, 2:1. Approximate values for the parts used in these radio sets are as follows: C4, 0.05 mf.; C5, 0.0625 mf.; C6, 0.05 mf.; R1, R2, R3, R4, 800 ohms; R5, 20 ohms; R6, 4 ohms; L2, 30 ohms, center-tapped; R7, 20 ohms.

The following diagrams are "A-"; in later models, "B-" is connected to "B-"; in older models, "A-" is connected to "B-". This is purely external, however.
**Wiring Diagram of Model 37.** A 2nd A.F. filament shunt resistance is used before Serial No. 1,385,000, in which case speaker post No. 2 connects to the centre-tap of this resistance, and the green-yellow tracer lead is not used. The R.F. plate circuit resistance is used after Serial No. 1,385,000. Note that the red and the black cable leads feed the R.F. filaments as well as the 1st A.F. filament.

**Wiring Diagram of Model 38**

A 2nd A.F. filament shunt resistance is used before Serial No. 1,725,000 and the green-yellow tracer cable lead is not used. Connections for this resistance are shown in dotted lines in the diagram on page 71. Note that the red and the black cable leads feed the R.F. filaments as well as the 1st A.F. filament. A schematic diagram of the volume control is shown in Fig. 60.

**Diagram of Power Unit in Models 37 and 38**

The diagram of the power unit in Models 40, 42, 44 and 52 is similar to that shown above with the following exceptions: A regulating resistance is connected in series with the primary circuit in Models 43, 44 and 52. A filter condenser is connected between F1 and ground. The junction point of the bias resistance is connected to the lower instead of the upper ground eyelet. The color scheme is different and is shown in Fig. 77.
Wiring Diagram of Models 40, 42 and 52

Model 52 does not have the shielded antenna lead, but is provided with two twenty-foot leads which are connected to the volume control, black for antenna and black-green tracer for ground.

Wiring Diagram of Model 44

Schematic Diagram of Power Unit in Models 40, 42, 44, and 52.

Some early units of this type have color scheme similar to unit in Model 38 set. Note that colors as now standardized correspond with the colors of set-cable leads.
Diagram of Model 43 Set and Power Unit. The output transformer is sealed in the power unit.
Black lead (-F) is grounded—not shown in diagram.

Most of Model 50 Sets also have an R.F. choke between plate of second audio tube and speaker post No. 1.
The Model 55 receiver is a 6-tube (and rectifier) A.C. outfit representing a distinct departure in design from previous models.

The screen-grid R.F. tubes furnish a high degree of amplification, and as the various units, including the tubes of the R.F. circuits are shielded; the selectivity and sensitivity are excellent. The resistance coupled audio stage assures that signals never pass into the push-pull audio output stage with minimum distortion where they are further greatly amplified with maximum fidelity. Among the other distinct advantages of this type receiver may be mentioned the following: (1) The various units of the grid plate are mounted in separate metal containers, simplifying replacement in the field. (2) The shielded transformers are used in kilocycles makes for easier operation for the customer.

(3) The volume control operates by regulating the plate voltage on the "screen grid" in the R.F. tube, this voltage being continuously variable from zero to the maximum of about 75 volts. This gives quizzier and smoother operation than previous designs which had the control in the antenna circuit. (4) The Model 4 electro-dynamic speaker which can be used with Model 55 receivers uses for its field supply the same 6-volt storage battery supplied to plate all tubes.

(5) Tube socket contacts, resistors, capacitors, etc., are of new, more rugged and efficient design. (6) The use of heater type tubes in the R.F. stages,detector and first audio stage, and the method of connecting the speaker field coil reduces the A.C. hum to a minimum. There is practically no hum.

As in the other Atwater Kent single-dial receivers, if one R.F. transformer is defective, the entire group must be replaced. Likewise if one variable condenser is defective, all three condensers must be replaced. It is necessary to remove the R.F. stages, detector and first audio stages and transformers. Care must be taken to avoid scratch- ing the shields. Also note that a led from the second audio stage former that signals never pass to the ground shield through the shield-

The Long-Antenna post will give greater selectivity and should be used if the aerial is 30 feet or more in length. The shield may not be grounded.

(3) The fully shielded unit in front left rear corner of each R.F transformer to the bottom stage-the shield and transformers must be replaced. A few experiences in soldering these new nudual resistors will quickly show the correct method required for good results every time.

Whenever a tubular resistor of this type is replaced, the soldered connections should be tested for mechanical strength by endeavoring to push the resistor away from the contact lug. For continuity testing, all of the socket contacts may be ex-

A C. hum being continuously variable from zero to the maximum of about 75 volts. This gives quizzier and smoother operation than previous designs which had the control in the antenna circuit. (4) The Model 4 electro-dynamic speaker which can be used with Model 55 receivers uses for its field supply the same 6-volt storage battery supplied to plate all tubes.

(5) Tube socket contacts, resistors, capacitors, etc., are of new, more rugged and efficient design. (6) The use of heater type tubes in the R.F. stages, detector and first audio stage, and the method of connecting the speaker field coil reduces the A.C. hum to a minimum. There is practically no hum.

As in the other Atwater Kent single-dial receivers, if one R.F. transformer is defective, the entire group must be replaced. Likewise if one variable condenser is defective, all three condensers must be replaced. It is necessary to remove the R.F. stages, detector and first audio stages and transformers. Care must be taken to avoid scratching the shields. Also note that a lead from the second audio stage former that signals never pass to the ground shield through the shield-

The Long-Antenna post will give greater selectivity and should be used if the aerial is 30 feet or more in length. The shield may not be grounded.

(3) The fully shielded unit in front left rear corner of each R.F transformer to the bottom stage-the shield and transformers must be replaced. A few experiences in soldering these new tubular resistors will quickly show the correct method required for good results every time.

Whenever a tubular resistor of this type is replaced, the soldered connections should be tested for mechanical strength by endeavoring to push the resistor away from the contact lug. For continuity testing, all of the socket contacts may be ex-

A C. hum being continuously variable from zero to the maximum of about 75 volts. This gives quizzier and smoother operation than previous designs which had the control in the antenna circuit. (4) The Model 4 electro-dynamic speaker which can be used with Model 55 receivers uses for its field supply the same 6-volt storage battery supplied to plate all tubes.

(5) Tube socket contacts, resistors, capacitors, etc., are of new, more rugged and efficient design. (6) The use of heater type tubes in the R.F. stages, detector and first audio stage, and the method of connecting the speaker field coil reduces the A.C. hum to a minimum. There is practically no hum.

As in the other Atwater Kent single-dial receivers, if one R.F. transformer is defective, the entire group must be replaced. Likewise if one variable condenser is defective, all three condensers must be replaced. It is necessary to remove the R.F. stages, detector and first audio stages and transformers. Care must be taken to avoid scratching the shields. Also note that a lead from the second audio stage former that signals never pass to the ground shield through the shield-

The Long-Antenna post will give greater selectivity and should be used if the aerial is 30 feet or more in length. The shield may not be grounded.

(3) The fully shielded unit in front left rear corner of each R.F transformer to the bottom stage-the shield and transformers must be replaced. A few experiences in soldering these new tubular resistors will quickly show the correct method required for good results every time.

Whenever a tubular resistor of this type is replaced, the soldered connections should be tested for mechanical strength by endeavoring to push the resistor away from the contact lug. For continuity testing, all of the socket contacts may be ex-

A C. hum being continuously variable from zero to the maximum of about 75 volts. This gives quizzier and smoother operation than previous designs which had the control in the antenna circuit. (4) The Model 4 electro-dynamic speaker which can be used with Model 55 receivers uses for its field supply the same 6-volt storage battery supplied to plate all tubes.

(5) Tube socket contacts, resistors, capacitors, etc., are of new, more rugged and efficient design. (6) The use of heater type tubes in the R.F. stages, detector and first audio stage, and the method of connecting the speaker field coil reduces the A.C. hum to a minimum. There is practically no hum.

As in the other Atwater Kent single-dial receivers, if one R.F. transformer is defective, the entire group must be replaced. Likewise if one variable condenser is defective, all three condensers must be replaced. It is necessary to remove the R.F. stages, detector and first audio stages and transformers. Care must be taken to avoid scratching the shields. Also note that a lead from the second audio stage former that signals never pass to the ground shield through the shield-

The Long-Antenna post will give greater selectivity and should be used if the aerial is 30 feet or more in length. The shield may not be grounded.

(3) The fully shielded unit in front left rear corner of each R.F transformer to the bottom stage-the shield and transformers must be replaced. A few experiences in soldering these new tubular resistors will quickly show the correct method required for good results every time.

Whenever a tubular resistor of this type is replaced, the soldered connections should be tested for mechanical strength by endeavoring to push the resistor away from the contact lug. For continuity testing, all of the socket contacts may be ex-

A C. hum being continuously variable from zero to the maximum of about 75 volts. This gives quizzier and smoother operation than previous designs which had the control in the antenna circuit. (4) The Model 4 electro-dynamic speaker which can be used with Model 55 receivers uses for its field supply the same 6-volt storage battery supplied to plate all tubes.

(5) Tube socket contacts, resistors, capacitors, etc., are of new, more rugged and efficient design. (6) The use of heater type tubes in the R.F. stages, detector and first audio stage, and the method of connecting the speaker field coil reduces the A.C. hum to a minimum. There is practically no hum.

As in the other Atwater Kent single-dial receivers, if one R.F. transformer is defective, the entire group must be replaced. Likewise if one variable condenser is defective, all three condensers must be replaced. It is necessary to remove the R.F. stages, detector and first audio stages and transformers. Care must be taken to avoid scratching the shields. Also note that a lead from the second audio stage former that signals never pass to the ground shield through the shield-

The Long-Antenna post will give greater selectivity and should be used if the aerial is 30 feet or more in length. The shield may not be grounded.

(3) The fully shielded unit in front left rear corner of each R.F transformer to the bottom stage-the shield and transformers must be replaced. A few experiences in soldering these new tubular resistors will quickly show the correct method required for good results every time.

Whenever a tubular resistor of this type is replaced, the soldered connections should be tested for mechanical strength by endeavoring to push the resistor away from the contact lug. For continuity testing, all of the socket contacts may be ex-
The B. T. Counterphase circuit using six tubes; three stages of R. F. amplification, detector and two stages of A. F. amplification.

B-T 6-40 Power Converter

Circuit for A. G. Bremer-Tully Counterphase B.
BREMER-TULLY MFG. CO.
B-T 6-40 Circuit Diagram

Terminal Strip on Set

Yellow - B- and Ground - 5 v. A.C.
Blue - B. DET.
Green - B. Amp - 1.5 v. A.C.
Brown - B. R.F. - ANT.
White - B. PWR - SPK.
Black - Grid Leads

Speaker

B-T 8-20-A

Dynamic Power Converter
Radio Service Data Sheet

BREMER-TULLY MODEL 7-70 AND 7-71

This receiver includes three stages of tuned radio-frequency amplification, neutralized in the “Counterphase” manner. To test this part of the circuit, a continuity tester is used to check the connections which include, (in the circuit V1, for example), L2N, C5, and a few turns at the grid end of L13. The “micro-mikes” or neutralizing condensers C5, C6 and C7 are located at the right of the respective tube sockets. The procedure and balancing a receiver using the Counterphase neutralizing method will be described. Usually it is convenient to use a vacuum tube with one of the filament prongs shortened so that the filament circuit is open when the grid, plate and one side of the filament are making contact. Now, tune in a loud signal, adjusting all tuning controls very carefully for exact resonance. Replace V3 with the dummy tube by its panel switch marked “Tone Control” functions by shunting the secondary of AFT1 with C13 and the primary of AFT2 with C16. Normally, there is a shunt capacity of .00025-mf. connected to the secondary of AFT1; it is C14. One side of the secondary of AFT2 is shunted by C17, the single shield can, the connections being brought to soldering lugs. They are represented in these columns by the numerals one to fourteen in small circles.

The panel switch marked “Tone Control” functions by shunting the secondary of AFT1 with C13 and the primary of AFT2 with C16. Normally, there is a shunt capacity of .00025-mf. connected to the secondary of AFT1; it is C14. One side of the secondary of AFT2 is shunted by C17, the

Carbon Composition Resistor

Capacitors

0.0025-mf.

0.01-mf.

0.03-mf.

0.10-mf.

0.33-mf.

1.00-mf.

4.00-mf.

10.00-mf.

6.00-mf.

10.00-mf.

4.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.

10.00-mf.
The Brunswick Models 14, 21 and 31 employ identically the same R.F. chassis and essentially the same socket power unit. In the Model 31 S.P.U. the pickup jack has been replaced with a radio-record switch, cable and input transformer. The input transformer is necessary in order that the low impedance pickup as used on this model may be matched with the relatively high input impedance existing in the primary of the first audio frequency transformer. Commercially available pickups such as can be purchased for use with Models 14 and 21 are of the high impedance type and therefore do not require the use of this extra input transformer.
Radio Service Data Sheet

BRUNSWICK MODEL 31 COMBINATION RADIO AND PANATROPE

In this receiver a radio-record switch, SW2, cable and input transformer, T4, are used, in order that the low-impedance of the pickup may be matched with the relatively high input impedance existing in the primary of T1.

Referencing to the parts layout sketch, units TC1, TC2, TC3 and TC4 are trimmer condensers shunted to the tuning condensers but not shown in the schematic circuit.

This receiver is in three sections: The R.F. chassis, the "SPU" (socket-power-unit) chassis and the dynamic reproducer. Field current for the latter is supplied by the SPU. Note that operation of the receiver should not be attempted unless either the field coil of a dynamic or a 600-ohm resistor is connected across the terminals for the two "field" leads; this resistor must be capable of carrying 100 ma.

To facilitate service, the R.F. chassis and SPU are bolted to a single mounting board which, in turn, may be removed from the cabinet by removing retaining bolts at the rear of the mounting board.

For hum control, two filament shunt resistors, R5, R10, with variable center taps, are provided on the SPU chassis. R9 is adjusted first and then R10. If R10 appears unnecessarily, try other '27s at V4 and V5. Abnormal hum may be due to one or more of the following causes: (1) One or more R.F. stages oscillating; (2) low-emission tube, particularly a '45 or the '80; (3) open filter or by-pass condenser; (4) open grid lead in R.F. or audio amplifier; (5) low area of R9 or R10 not grounded or poorly grounded.

Abnormal hum, which appears usually on a strong local or nearby station and cannot be balanced out with R9 or R10, may be due to condition (1), abnormal bias, and must be remedied before further adjustment of R9 or R10. At the factory, these receivers are neutralized for standard tubes, and the neutralizing screws then need no attention. Before attempting to re-neutralize the receiver, it is advisable to test the tubes or try others; as an abnormal one may be the cause of circuit oscillation.

Additional checks on the possibility of R.F. circuit oscillators are these indications: Distorted reception of any or all stations—usually on the lower wavebands; a whistle or squeal preceding the station being tuned in and not due to a two-station carrier heterodyne; motor-boating on all portions of the broadcast band.

Standard practice in neutralizing this receiver is as follows: Adjust an audio-modulated oscillator for 1400 kc. and couple it to the "low antenna" post of the receiver with a five-foot wire, one end of which should be wound two or three times about the oscillator coil. Tune in the oscillator signal on the radio to maximum volume, using both the tandem-condenser control and C5.

Then allow the receiver and oscillator to operate for about a minute (in order that the tubes may become thoroughly warmed up and "stable") and replace the first R.F. tube with a tube of average characteristics which is known not to cause oscillation in a receiver which has previously been neutralized; this tube must have an open filament circuit. A fault into which some service man falls is to neutralize with one make of tube and then, after neutralizing, insert a different make—the circuit may then oscillate more than before.

Adjust C6 (see parts layout) for minimum hum control, two filament resistors, either '45 or the '80; (3) open filter or by-pass condenser; (4) open grid lead in R.F. or audio amplifier; (5) low area of R9 or R10 not grounded or poorly grounded. There are four points on the turntable unit which require lubrication: (1) Upper turntable bearing; (2) lower turntable bearing; (3) governor bearing, weight end; (4) governor bearing, worm-gear end. To operate noiselessly and at constant speed it is necessary that the motor be kept in good order. To remove the motor for oiling, proceed as follows: (1) Remove the record turntable by pulling it up ward; (2) remove the four motor-securing bolts; (3) detach the motor leads from the cable in the cabinet and lift motor from cabinet. After this, all parts should be cleaned. Then, using a lightgrade oil, proceed to lubricate the motor at the points mentioned above. This lubrication process should be followed every six months. A noisy turntable motor may possibly be traced to: (1) Governor shaft bearings loose; (2) laminations lose in one or more of the four coils; (3) coil shorted on its core; (4) defective spring in governor. If the speed is not constant, it may be due to (1) or (4), above. To tighten governor bearing, loosen set screw, push bearing out past center of motor and tighten screw. Do not force bearing in too far, or it may bind the governor shaft. Be sure set screw of opposite bearing lightly. Laminations may be pressed together by tightening the retaining bolts. If a coil is found loose on its core, force a small wedge of soft wood between coil and core, to prevent the coil from vibrating, and thus stop the noise. A bent or broken governor spring should be replaced.

The average voltages indicated at the terminals of the tubes are given in an accompanying chart.

<table>
<thead>
<tr>
<th>Tube Type</th>
<th>Voltage</th>
<th>Plate Ma.</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>22</td>
<td>150</td>
</tr>
<tr>
<td>V2</td>
<td>22</td>
<td>150</td>
</tr>
<tr>
<td>V3</td>
<td>22</td>
<td>150</td>
</tr>
<tr>
<td>V4</td>
<td>22</td>
<td>150</td>
</tr>
<tr>
<td>V5</td>
<td>22</td>
<td>150</td>
</tr>
<tr>
<td>V6</td>
<td>22</td>
<td>150</td>
</tr>
</tbody>
</table>

The values of the parts in this receiver are as follows: R1, 25,000 ohms; R2, 1000 ohms; R3, 35,000 ohms; R4, 2 megohms; R5, 35,000 ohms; R6, 100,000 ohms; R7, 5,000 ohms; R8, 100,000 ohms; R9; 25 ohms; R10, 25 ohms; R11, 4,000 ohms; R12, 70 ohms. The capacities used are as follows: C9, 0.0015-mf.; C10, 0.2-mf.; C11, 0.002-mf.; C12, 0.002-mf.; C13, 0.0002-mf.; C14, 1.5-mf.; C15, 1-mf.; C16, 0.25-mf.; C17, 0.5-mf.; C18, 0.003-mf.; C19, 1.5-mf.; C20, 1.0-mf. The positions of L1, L2, L3, L4, L5, L6, L7, L8, L9 are obvious.

Trouble with the Panatrope portion of the receiver may usually be classified as: (1) Magnetic pickup XP out of adjustment; (2) SW2 out of adjustment; (3) motor speed irregular.
BUSH AND LANE PIANO CO.

No. 10 De Luxe

301—Four-gang Tuning Condenser.
302—Filter Condenser Block.
303—Double By-pass Condenser, ½ Mfd. and ½ Mfd.
305—0.00025 Mfd. Grid Condenser (included with 4-socket panel also).
306—0.002 Mfd. Detector Plate By-pass Condenser.
307—0.00025 Mfd. Grid Condenser (included with 4-socket panel also).
308—0.002 Mfd. Detector Plate By-pass Condenser.
400—550 ohm Bias Resistor for the three R.F. stages.
401—1,000 ohm Bias Resistor for the first audio stage.
402—5,000 ohm R.F. Bias Resistor
403—1,000 ohm R.F. Bias Resistor
404—Grid Leak, 2 megohms.
405—Hum Control, 29 ohm potentiometer.
406—Volume Control 10,000 ohm potentiometer.
407—Voltage Divider Resistor 5,250 ohm total.
409—Volume Control Insulating Washer, flat.
410—Volume Control Insulating Washer, extruded.
411—Volume Control Mounting Nut.
412—Voltage Divider Resistor 6,250 ohm total.
413—3,000 ohms.
414—1,500 ohms.
415—750 ohms.

No. 12 Screen Grid

4174—Ten Section By-Pass Condenser, C1, C2, C3, C4.
4175—10,000 Ohm Detector Bias Resistor.
4025—5,000 Ohm R.F. Bias Resistor
4172—3,000 Ohm R.F. Bias Resistor R1, R2, or R3
4178—1,500 Ohm R.F. Bias Resistor
4005—20 Ohm Center-Tapped Hum Balance Resistor.
4158—Voltage Divider Resistor 5750 Ohms, Total.
406—10,000 Ohm Volume Control.
317—Electrolytic Filter Condenser Assembly.
The Colonial "31 D.C." which has had very wide distribution, incorporates a number of unusual design features. For instance, volume is controlled by varying condenser C4; with the middle plate centered the signal is balanced out. An absorption loop (L1G) improves the tuning characteristic.

The cable color code is as follows: 7, yellow; 1, maroon; 5, blue; 2, blue; 6, red; 12, gold with black tracer; 9, black with red tracer; 10 red with black tracer; 3, green; 4, 8 and 11 are not used.

V1, V2, V3, V4 and V5 are '26 tubes; V6, V7, 14 ma.; V2, 98 volts; V3, 91 volts; V4, 91 volts; V5, 93 volts; V6, 97 volts; V7, 95 volts. Plate potential, V1, 70 volts; V2, 98 volts; V3, 96 volts; V4, 95 volts; V5, 93 volts. Plate current, V1, 3.5 ma.; V2, 7.5 ma.; V3, 5.5 ma.; V4, 4.3 ma.; V5, 4 ma.; V6, V7, 14 ma.

The following are the values for the chassis parts of the Colonial "32 D.C." screen-grid receiver. Condensers: C1, C2, C3, C4, .0035-mf.; C5, .00035-mf.; C6, C7, C8, 3 mmf.; C10, 0.2-mf.; C11, C12, C14, C15, C16, C18, C19, C21, C22, C23, C32, C33, C35, 0.1-mf.; C13, C17, C20, 0.25-mf.; C24, C25, .0025-mf.; C26, C34, 1.0-mf.; C11, .05-mf. Resistors: R2, 10,000 ohms (volume control); R3, 35,000 ohms (pink); R4, 65,000 ohms (orange); R7, R8, R9, R12, 750,000 ohms (red); R10, 10,000 ohms (black, wire wound); R13, 34.9 ohms ("chimney" type); R14, 1.43 ohms (vitreous); R15, 100,000 ohms (green); R17, 50,000 ohms (black); R18, R22, 100,000 ohms (green); R19, 2,000 ohms (red, wire wound).

For instance, volume is balanced out. The Colonial "31 D.C." which has had very wide distribution, incorporates a number of unusual design features. For instance, volume is controlled by varying condenser C4; with the middle plate centered the signal is balanced out. An absorption loop (L1G) improves the tuning characteristic.
### Part No | Value | Description                              
---|---|---
4473-P | 10,000 ohms | Volume control
4367-P | 35,000 | Pink
4364-P | 65,000 | Orange
4361-P | 750,000 | Red
4366-P | 35,000 | Brown
4366-P | 35,000 | Brown
4402-P | 400 | Yellow wire wound resistor.
4403-P | 200 | Black wire wound resistor.
4473-P | 75,000 | Volume control
4360-P | 10,000 | Blue
4368-P | 250,000 | White
4361-P | 750,000 | Red
4365-P | 50,000 | Black
4362-P | 400,000 | Yellow
4364-P | 65,000 | Orange
4361-P | 750,000 | Red
4401-P | 2,000 | Red wire wound resistor.
4477-P | 80,000 | Green
4363-P | 100,000 | White—mounted on power transformer
4335-P | 1,000 |  

**Model 32AC 10001-Issue J**

| Part No | Value | Description                              
---|---|---
1728-SA | 0.1 | Built into R.F. transformer.
1729-SA | 0.1 | Green lead
1728-SA | 0.25 | Red lead
1728-SA | 0.25 | Brown lead
1728-SA | 0.25 | Brown lead
1748-SA | 0.1 | Yellow lead
1728-SA | 0.1 | Red lead
1728-SA | 0.1 | Red lead
4404-P | 0.1 | Red lead
4405-P | 0.1 | Green lead
4405-P | 0.00025 | Tuning condenser
4404-P | 0.0005 | Green leads
4404-P | 0.1 | Mershon condenser
4407-P | 0.2 |  
4407-P | 0.5 |  
1445-P | 8 |  
4409-P | 0.1 |  

**Notes:**
- 0.00005 mfd.
- Built into R.F. transformer.
POWER PACK FOR MODEL-980

CLASS-153000
4342

6 TUBE D.C. SET C6-C7
CLASS-42000 4002
NOTES:

1. INDICATES CONNECTING MICROPHONE ON DETAIL.

2. INDICATES CONNECTING MICROPHONE ON DETAIL.

3. INDICATES CONNECTING MICROPHONE ON DETAIL.

4. INDICATES CONNECTING MICROPHONE ON DETAIL.

5. INDICATES CONNECTING MICROPHONE ON DETAIL.

6. INDICATES CONNECTING MICROPHONE ON DETAIL.

7. INDICATES CONNECTING MICROPHONE ON DETAIL.

8. INDICATES CONNECTING MICROPHONE ON DETAIL.

9. INDICATES CONNECTING MICROPHONE ON DETAIL.

10. INDICATES CONNECTING MICROPHONE ON DETAIL.

11. INDICATES CONNECTING MICROPHONE ON DETAIL.

12. INDICATES CONNECTING MICROPHONE ON DETAIL.

13. INDICATES CONNECTING MICROPHONE ON DETAIL.

14. INDICATES CONNECTING MICROPHONE ON DETAIL.

15. INDICATES CONNECTING MICROPHONE ON DETAIL.

16. INDICATES CONNECTING MICROPHONE ON DETAIL.

17. INDICATES CONNECTING MICROPHONE ON DETAIL.

18. INDICATES CONNECTING MICROPHONE ON DETAIL.

19. INDICATES CONNECTING MICROPHONE ON DETAIL.

20. INDICATES CONNECTING MICROPHONE ON DETAIL.

21. INDICATES CONNECTING MICROPHONE ON DETAIL.

22. INDICATES CONNECTING MICROPHONE ON DETAIL.

23. INDICATES CONNECTING MICROPHONE ON DETAIL.

24. INDICATES CONNECTING MICROPHONE ON DETAIL.

25. INDICATES CONNECTING MICROPHONE ON DETAIL.

26. INDICATES CONNECTING MICROPHONE ON DETAIL.

27. INDICATES CONNECTING MICROPHONE ON DETAIL.

28. INDICATES CONNECTING MICROPHONE ON DETAIL.

29. INDICATES CONNECTING MICROPHONE ON DETAIL.

30. INDICATES CONNECTING MICROPHONE ON DETAIL.

31. INDICATES CONNECTING MICROPHONE ON DETAIL.

32. INDICATES CONNECTING MICROPHONE ON DETAIL.

33. INDICATES CONNECTING MICROPHONE ON DETAIL.

34. INDICATES CONNECTING MICROPHONE ON DETAIL.

35. INDICATES CONNECTING MICROPHONE ON DETAIL.

36. INDICATES CONNECTING MICROPHONE ON DETAIL.

37. INDICATES CONNECTING MICROPHONE ON DETAIL.

38. INDICATES CONNECTING MICROPHONE ON DETAIL.

39. INDICATES CONNECTING MICROPHONE ON DETAIL.

40. INDICATES CONNECTING MICROPHONE ON DETAIL.

41. INDICATES CONNECTING MICROPHONE ON DETAIL.

42. INDICATES CONNECTING MICROPHONE ON DETAIL.

43. INDICATES CONNECTING MICROPHONE ON DETAIL.

44. INDICATES CONNECTING MICROPHONE ON DETAIL.

45. INDICATES CONNECTING MICROPHONE ON DETAIL.

46. INDICATES CONNECTING MICROPHONE ON DETAIL.

47. INDICATES CONNECTING MICROPHONE ON DETAIL.

48. INDICATES CONNECTING MICROPHONE ON DETAIL.

49. INDICATES CONNECTING MICROPHONE ON DETAIL.

50. INDICATES CONNECTING MICROPHONE ON DETAIL.

51. INDICATES CONNECTING MICROPHONE ON DETAIL.

52. INDICATES CONNECTING MICROPHONE ON DETAIL.

53. INDICATES CONNECTING MICROPHONE ON DETAIL.

54. INDICATES CONNECTING MICROPHONE ON DETAIL.

55. INDICATES CONNECTING MICROPHONE ON DETAIL.

56. INDICATES CONNECTING MICROPHONE ON DETAIL.

57. INDICATES CONNECTING MICROPHONE ON DETAIL.

58. INDICATES CONNECTING MICROPHONE ON DETAIL.

59. INDICATES CONNECTING MICROPHONE ON DETAIL.

60. INDICATES CONNECTING MICROPHONE ON DETAIL.
Models Ten 29-A and B with 171-L Power Unit

Model Nine
CONTINENTAL RADIO CORP.

Ten 29-D and C with 250-L Power Unit

Models 29-A, 29-B, 29-C and 29-D

Circuit Diagram Specifications

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-9</td>
<td>0.5 M.F.D.</td>
</tr>
<tr>
<td>C-10, C-11, C-12,</td>
<td>0.001 M.F.D.</td>
</tr>
<tr>
<td>C-13, C-14, C-15,</td>
<td>0.0028 M.F.D.</td>
</tr>
<tr>
<td>C-16</td>
<td>0.5 M.F.D.</td>
</tr>
<tr>
<td>C-17, C-18, C-19,</td>
<td>0.0025 M.F.D.</td>
</tr>
<tr>
<td>C-20</td>
<td>0.002 M.F.D.</td>
</tr>
<tr>
<td>C-21</td>
<td>0.001 M.F.D.</td>
</tr>
<tr>
<td>C-22, C-23, C-24,</td>
<td>0.001 M.F.D.</td>
</tr>
<tr>
<td>C-25</td>
<td>0.0025 M.F.D.</td>
</tr>
<tr>
<td>C-26</td>
<td>0.002 M.F.D.</td>
</tr>
<tr>
<td>C-27, C-28, C-29,</td>
<td>0.002 M.F.D.</td>
</tr>
<tr>
<td>C-30</td>
<td>0.001 M.F.D.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-2, R-3, R-4, R-5</td>
<td>1500 ohms</td>
</tr>
<tr>
<td>R-6</td>
<td>1200 ohms</td>
</tr>
<tr>
<td>R-7, R-8, R-9, R-10</td>
<td>1500 ohms</td>
</tr>
<tr>
<td>R-11</td>
<td>1250 ohms</td>
</tr>
<tr>
<td>R-12</td>
<td>1500 ohms</td>
</tr>
<tr>
<td>R-13</td>
<td>8330 ohms</td>
</tr>
<tr>
<td>R-14, R-15, R-16</td>
<td>4250 ohms</td>
</tr>
<tr>
<td>R-17, R-18</td>
<td>6-ohm Potentiometer</td>
</tr>
<tr>
<td>R-19</td>
<td>1 Megohm</td>
</tr>
<tr>
<td>R-20</td>
<td>50,000 ohms variable</td>
</tr>
<tr>
<td>R-21</td>
<td>100 ohms</td>
</tr>
<tr>
<td>R-22</td>
<td>16,665 ohms</td>
</tr>
<tr>
<td>R-23</td>
<td>180 ohms</td>
</tr>
</tbody>
</table>
Radio Service Data Sheet

CROSLEY AC-7 AND AC-7C

This receiver employs one (first) stage of tuned push-pull R.F., a second stage of transformer-coupled A.F. amplification (in which circuit oscillation is prevented by a "looser" resistor R12 of 750 ohms and the reversed flicker winding T of L7), a regenerative detector, and the usual two stages of transformer-coupled A.F. amplification. The tubes are as follows: V1, V2, V3, V4 and V5, X'985s; V6, 12V, 7V, BH-type germanium rectifier. (The specified tubes must be used.) The input and output connections of the amplifier and detector tubes are connected in parallel, and the filament current is obtained from the rectifier V7 and high-voltage winding S1 of the power transformer PT. The manner of obtaining grid bias for these tubes is indicated in the detail circuit.

The constants of the components are as follows: R1, 700 ohms (variable); R2, 49 ohms; R3, 1,500 ohms; R4, 63 ohms; R5, 75 ohms; R6, 76 ohms; R7, 500 ohms; R8, 88 ohms; R9, 275 ohms; R10, 1000 ohms; R11, 500 ohms (center-tapped); R12, 750 ohms; R13, 8,750 ohms; R14, 90,000 ohms; R15, 2,400 ohms; R16, 500 ohms (variable). C6-R17 constitute the usual grid-condenser and leak combination; C1 and C2, 0.064 mf. (variable); C3, 0.0016 mf. (variable); C4, 0.15 mf.; C5, C8, and C9, 1.0 mf.; C7, 0.003 mf.; C10 and C12, 15 mf.; C11, 15 mf.; C13 and C14, 0.2 mf. A.F. choke Ch1 is rated at 50 hours; Ch2, 11 h. Ch3 and Ch4 are mounted in a single case and constitute the Mercury electrolytic condenser in one corner of the "ABC Supply Unit".

An insulating film on the plate of the Mercury condenser is built up at the factory; but this gradually breaks down if the receiver is not in use for some time. To build up a film on the plate the receiver is put into operation with all tubes in their respective sockets. At the start of the re-conditioning process, resistor R16 should be turned to extreme left, and with all tubes in their respective sockets. Operate the set for 10 minutes to half an hour, noting the current reading on the milliammeter MA; the value for correct operation of the set is between 55 and 60 milliamps. As the current increases, R16 should be adjusted to maintain this reading. A greater current than 60 milliamps is seldom required before the set begins to play well. If C10-C12 is defective, the Mercury unit should be replaced.

As the filament supply of V6 is alternating, there is no polarity for the (white) supply leads. Meter MA is designed to indicate whether or not its connection posts are connected to the lead wires from the set, directly below it.

The tertiary (third) winding T of L2 is a fixed negative feedback coil used to prevent oscillation in the circuit of V3, while the winding of L3 is a variable positive feedback or regeneration coil; the latter is called the "Crescendo" control. C1 and C2 are shunted by the balancing condensers C1A and C2A, which are controlled from the panel and termed the "Acu-balancing condensers". C1A, in shunt to C3, is adjusted from the bottom of the chassis. R3, R4, R6, R8 and R10 are biasing resistors. If the A.C. line voltage is low, the fuse should be changed over from the pair of clips at the right (in which position it is shipped) to the left pair (as seen from the control-knob side of the power pack).

Approximate position of certain R.F. and A.F. units in the Crosley "AC-7" and "AC-7C" receivers. L31 is a tickler coil arranged for variable coupling to the primary and secondary inductances of L3. In this set, the filament supply for the battery-type tubes is obtained from the high-stage output of the power pack. The filaments of the amplifier and detector tubes are connected in parallel, and the filament current is supplied from a power pack. The buffer condensers are mounted below V7.

The manner of obtaining grid bias for these tubes is indicated in the detail circuit.

The constants of the components are as follows: R1, 700 ohms (variable); R2, 49 ohms; R3, 1,500 ohms; R4, 63 ohms; R5, 75 ohms; R6, 76 ohms; R7, 500 ohms; R8, 88 ohms; R9, 275 ohms; R10, 1000 ohms; R11, 500 ohms (center-tapped); R12, 750 ohms; R13, 8,750 ohms; R14, 90,000 ohms; R15, 2,400 ohms; R16, 500 ohms (variable). C6-R17 constitute the usual grid-condenser and leak combination; C1 and C2, 0.064 mf. (variable); C3, 0.0016 mf. (variable); C4, 0.15 mf.; C5, C8, and C9, 1.0 mf.; C7, 0.003 mf.; C10 and C12, 15 mf.; C11, 15 mf.; C13 and C14, 0.2 mf. A.F. choke Ch1 is rated at 50 hours; Ch2, 11 h. Ch3 and Ch4 are mounted in a single case and constitute the Mercury electrolytic condenser in one corner of the "ABC Supply Unit".

An insulating film on the plate of the Mercury condenser is built up at the factory; but this gradually breaks down if the receiver is not in use for some time. To build up a film on the plate the receiver is put into operation with all tubes in their respective sockets. At the start of the re-conditioning process, resistor R16 should be turned to extreme left, and with all tubes in their respective sockets. Operate the set for 10 minutes to half an hour, noting the current reading on the milliammeter MA; the value for correct operation of the set is between 55 and 60 milliamps. As the current increases, R16 should be adjusted to maintain this reading. A greater current than 60 milliamps is seldom required before the set begins to play well. If C10-C12 is defective, the Mercury unit should be replaced.

As the filament supply of V6 is alternating, there is no polarity for the (white) supply leads. Meter MA is designed to indicate whether or not its connection posts are connected to the lead wires from the set, directly below it.

The tertiary (third) winding T of L2 is a fixed negative feedback coil used to prevent oscillation in the circuit of V3, while the winding of L3 is a variable positive feedback or regeneration coil; the latter is called the "Crescendo" control. C1 and C2 are shunted by the balancing condensers C1A and C2A, which are controlled from the panel and termed the "Acu-balancing condensers". C1A, in shunt to C3, is adjusted from the bottom of the chassis. R3, R4, R6, R8 and R10 are biasing resistors. If the A.C. line voltage is low, the fuse should be changed over from the pair of clips at the right (in which position it is shipped) to the left pair (as seen from the control-knob side of the power pack).

Approximate position of certain R.F. and A.F. units in the Crosley "AC-7" and "AC-7C" receivers. L31 is a tickler coil arranged for variable coupling to the primary and secondary inductances of L3. In this set, the filament supply for the battery-type tubes is obtained from the high-stage output of the power pack. The filaments of the amplifier and detector tubes are connected in parallel, and the filament current is supplied from a power pack. The buffer condensers are mounted below V7.

Since the arrangement of the circuit of this receiver is unusual, it is necessary to give care and attention to details when servicing. A wrong value for a replacement unit will change the voltages across the various resistors. The line-voltage should be determined if MA seems to read too high.

A 71 tube should not be substituted at V6, or the rectifier will be overloaded. However, this or a larger tube may be used if it is included in a separate power unit; an adapter, or a change in circuit wiring, is then required in order to transfer the output of V5 to the external power tube.

The power unit, contained in a metal case, is designed to supply "A" current only for type '99 tubes—except at V6, which is marked "UX-112" and only in the model equipped with a "X" circuit. For this reason it must not be connected to a set in which the tubes are wired different from, or where the filament requirements are different.

If the "A" current drops to 20 to 35 milliamps, despite all adjustments, and consider-
The famous Crosley "Tridyn" (Model 3B3) which incorporates a reflexed and 3C, which, like the "Type V," uses a variocoupler in the stage of R.F. and first A.F. Unlike earlier models, this receiver used a condenser with meshing rotor plates.

The Crosley "5-38" tuned radio-frequency receiver, battery model, at one time a very popular receiver, obtained exceptional sensitivity by the use of controlled regeneration. Feed-back was obtained through RFT2, instead of RFT3, as with most regenerative circuits. Dotted lines indicate the grid returns of early-production models of the set wherein a "C" battery was not used.

The Crosley single-tube "Type V": the red tickler lead runs to the plate of the tube.

The Crosley two-tube "Model 51,: in which there is a "C" lead for the single stage of A.F. amplification. Replacing C1 with a .0001 mf. condenser will increase the tuning range.

This two-stage Crosley A.F. amplifer was designed for use with the single-tube "Type V" tuner diagrammed at the left. The "B-22%" double post of the tuner affords a connection with the battery and across the primary of T1.

In the Crosley "Model XI" (and "XL") a stage of impedance-coupled R.F. amplification precedes the non-regenerative detector. Note that the antenna coupler L1 is without the adjustable coupling of previous models.
Models 40S, 41S, 42S, 82S, arranged for M type speaker.

CIRCUIT, MODEL 401

CIRCUIT, MODEL 608
Radio Service Data Sheets

**CROSLEY MODEL 601**

The circuit used in this receiver incorporates the Hazeltine neutralization system. Tubes V1 and V5 are '01As; V6 may be either a '12A or '71A, the latter being prefabs. To take chassis from 'can,' remove the three knobs; remove the escutcheon by taking out the drive screws; remove two cap screws in front and two in rear, using socket wrench or pliers; raise rear of case until it clears coil shields; then slide the case forward until it clears the shafts of the tuning cones; and lift off. An antenna-lead-in length of 50 to 100 feet is recommended, except where a shorter-length reduces interference. Best results are obtained when the alignment is made to the set. Study of the schematic circuit will show why this is necessary. The volume control regulates the filament current of the four tubes; the ac amplifiers, or trimming condensers, resonate the secondary circuits of V2, and V3; the variable capacity in shunt with the tuning capacitance of the grid circuit of V4 is an "aligning" condenser which is adjusted at the factory and has no panel control. To balance receiver, leave bottom attached, balancing with case on or off. Tune to a strong signal near 210 meters (using head-phones at output) and insulate filament of V3. Insert long-handled wrench (stabilized handle) through balance-condenser hole in chassis (third from left, as seen from front). Tune set for loudest response and balance for minimum signal with wrench removed. Repeat operation with V2, using second balance condenser from left; following to V1 and balance condenser at extreme left. The "aligning" condenser is directly in front of V4. To adjust, tune to strong local with "aculators" at about middle setting; remove two holding screws using wrench and remove the three knobs; remove two holding R.F.T. to chassis. Solder leads to lugs and replace can. If necessary to replace condenser, remove three nuts holding the condenser shield and remove two screws on front panel holding shield in place. Press shield gently back until it clears the rear edge of the front panel, raise vertically, and remove. Unsolder leads and loosen screw which controls belt tension. Remove belt from condenser pulley and remove pulleys. Take out three screws attaching condenser to front panel, and remove condenser. Attach new one to front panel by three screws provided and replace pulley and belt, tightening latter. Solder leads and replace shield. Note that it is necessary to remove indicator dial, pulley and belts if center condenser must be replaced. To remove this indicator dial, or to replace belts, take out three screws attaching indicator dial to center pulley and remove dial. Loosen screws which control tension of belts and take off belts. Put new belts in position with drive pins on pulleys through holes in belts. Tighten tensioning screws. To replace detector by-pass condenser, or grid-leak-and-condenser mounting, unsolder leads, remove supporting screws, place new unit in position and re-solder leads. A 3-megohm grid leak is recommended.

**Continuity Test**

(Two test points and 10 w. lamp in series with the 110 v. circuit.)

**Contact**

<table>
<thead>
<tr>
<th>Gnd-A</th>
<th>light</th>
<th>Open wire or L1B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gnd-V10</td>
<td>Open L1A or wiring</td>
<td></td>
</tr>
<tr>
<td>Gnd-V1G</td>
<td>Open wire or L4</td>
<td></td>
</tr>
<tr>
<td>Gnd-V1G</td>
<td>Shorted C5 or R4</td>
<td></td>
</tr>
<tr>
<td>Gnd-bk.</td>
<td>Open wire, R1 or R2</td>
<td></td>
</tr>
<tr>
<td>Gnd-whi.</td>
<td>Open wire</td>
<td></td>
</tr>
<tr>
<td>Wu-V1P</td>
<td>Open wire or L2</td>
<td></td>
</tr>
<tr>
<td>Wu-V1P</td>
<td>Open wire or L3</td>
<td></td>
</tr>
<tr>
<td>Wu-V1P</td>
<td>Open wire or L8</td>
<td></td>
</tr>
<tr>
<td>Wu-V1P</td>
<td>Open wire or T2 pri.</td>
<td></td>
</tr>
<tr>
<td>Blue-V4P</td>
<td>Open wire or T1 pri.</td>
<td></td>
</tr>
<tr>
<td>Blu-V4F</td>
<td>Open wire or R3</td>
<td></td>
</tr>
</tbody>
</table>

(With Headphone and Battery.)

**Connect:***

| Gnd-V1G; rotate station selector; if click C7 shortened; adjust left acumulator; if click C8 shortened. |
|---|---|
| Gnd-V1G; duplicate above. |
| C6 or C10 |
| Green-V1G; no click shows open wire or T2 sec. |
| Brown-V1G; no click shows open wire or T1 sec. |

**Color Code**

- **Black** "A" - "B" - "C" - "D;" Red "B+40;" White "B+00;" Brown "C-45;" Green "C-Power;" Yellow "A-4."

This set is not critical to antenna length, and will give good results with a short indoor antenna. The total length of from 50 to 100 feet for the antenna and lead-in combined is recommended for average conditions. If locals cause interference, an aerial of 25 to 50 feet, including lead-in, may give better results. The recommended lengths may be exceeded, of course, in many instances with sensitive receivers. Local conditions must govern the choice of antenna length. A good ground should be used.

There are four binding posts on the set, two for the reproducer, one for the aerial, one for the ground. Battery connections are made to the cable attached to the set, in accordance with the color code in the preceding column.

The use of '01As throughout is recommended by the manufacturer, with a '71 'power tube; though a '12 may be used to economize batteries. A separate "C" battery is recommended for the first audio (brown lead) stage.

Lack of sensitivity, critical operation, motorboating, distorted reception, may often be checked to an open R4 leak. (Most of these effects may be experienced if the leak has too high a resistance; replace it with a leak of two to three megohm resistance.) The tube layout of this receiver is as follows: looking at front of set, first R.F. tube socket is in left corner, front; second R.F., left, rear; third B. F. is next, followed by the detector; first A.F. socket is right and second, R.F., right, front; third and right socket. Note that a wavelength of about 210 meters is recommended for neutralizing the receiver; but that one of about 300 meters is recommended for balancing the aligning condenser. If condensers C1, C2 and C4 should short-circuit, there is no danger of shorting "B". ham radio, but they may be adjusted so that one of about 300 meters is recommended for neutralizing the receiver; this fault may be readily localized by following the neutralizing process. Start from the detector tube and work toward the receiver, using the "zero point" upon which a "zero point" or reference point cannot be obtained in the following tests. Low frequency operation during manipulation of R1 indicates poor contact. Instead of the variation of resistance being smooth, it is being effected in relative "steps" or "pumps." The remedy is to clean the resistor and sliding contact of the slipper. This must be done carefully, so as to prevent taking out the spring tension of the slipper, when the arm will no longer make contact with the wire. A short in condenser C6 will cause the set to "go dead," as far as broad-band reception is concerned; in this case, a test from detector plate to filament will show a lower resistance than if the resistance of the primary of T1 were effective, instead of shorted out.
In the Edison Receiver, Models R-4, R-5 and C-4, the R.F. amplifying circuit employed is a form of 'tuned grid' circuit, wherein two primaries are used in each of the frequency transformers, one resonated below and one above the broadcast frequency. The four R.F. transformers employed are identical with each other and their sections are identified by the numbers of the component parts, C1, C6, C7 and C8; L5, L6, L7 and L8 are high frequency transformers, and tuned by means of the variable condensers C20 and C4A. The resonant frequency of the transformer is determined by the effective shunt capacity C20.

Resistance B, first R.F. from the extreme right-hand end position, is shunted by the variable capacity C20. This latter connection places the condensers C19 and C20 in parallel, and with the capacity C21 in series, the necessary amount of the control has been reached and therefore increases in value uniformly with angular movement of the control knob. A further increase in the bias resistance for the second and third R.F.

**IDENTIFICATION OF PARTS**

C1, C2, 2-3 mouse, 0.00015 mf; each, C3, C4, ditto; C5, C6, C7, C8, 0.00025 mf; each; C9, 0.001 mf; C10, 0.0055 mf; C15, 0.1 mf; C19, 0.1 mf; C20, 0.5 mf; C21, 0.6 mf, 300 V.; C10, ditto; C21, 0.6 mf, 300 V.; (C19, C20 and C21 in same can); C22, 0.1 mf, 300 V.; C23, 1.0 mf, 150 v.; (C22 and C23 in same can); C24, 1.0 mf, 150 v.; C25, 4.5 mf, 300 v.; C26, C27, 2.0 mf, 400 v.; C28, ditto; C29, 1.0 mf, 300 v.; C30, C3A, C3A and C4A stagers on side of variable condenser section each shunt.

L1, 1000 ohm, 1 watt; R2, ditto; R3, 400 ohm, 1 w.; R5, 400 ohm, 1 w.; R6, 20 ohm, 1 w.; R7, 1.5 mom; R8, 25, 000 ohm, 1 w.; R9, 25, 000 ohm, 1 w.; R10, 6000 ohm, 1 w.; R11, 100, 000 ohm, 1 w.; R12, 20 ohms; R13, 84, 780 ohms; R14, 10, 000 ohm, 3 w. L1, L2, L3, L4 and L5, 500 myms., each; L5, L6, L7 and L8, 735 turns each; L9, L10, L11 and L12, 240 myms., each (measured at 300 vac.); L13 to 65 millius.; L14 and L15, 4-to-1 A.F.T.; L16, L17 and L18, 4-to-1 A.R.T. with separate position of the variable capacity C20. Isolation of the R.F. component of the plate current of this tube is accomplished by the use of resistor R4 and capacity C19. Self-bias of the second and third R.F. amplifying tubes, in common effect is upon the resistor R3 and the section A of the volume control, by-passed by the capacity C25. Isolation of the R.F. components of current secondary stagers, in common results from the use of the resistor R3 and the capacity C25. The volume control operates to reduce volume in the following manner: As the control is moved to the left, the current from the radio-amplifier pass through the "Long Antenna." When minimum volume is reached, the resistance R4 has been cut off, and is maintained at substantially zero value. A resistance A remains at zero value until approximately mid-position of the control has been reached and thereafter increases in value uniformly with angular movement of the control knob. Resistance A forming part of the bias resistance for the second and third R.F. amplifying tubes, a lefthemotion of the contact of the volume control after approximately mid-position has been reached, this resistance B has been reached, and it is maintained at substantially zero value. A remains at zero value until approximately mid-position of the control has been reached and therefore increases in value uniformly with angular movement of the control knob. Resistance A forming part of the bias resistance for the second and third R.F. amplifying tubes, a lefthemotion of the contact of the volume control after approximately mid-position has been reached, this resistance B has been reached, and it is maintained at substantially zero value. A remains at zero value until approximately mid-position of the control has been reached and therefore increases in value uniformly with angular movement of the control knob. Resistance A forming part of the bias resistance for the second and third R.F. amplifying tubes, a lefthemotion of the contact of the volume control after approximately mid-position has been reached, this resistance B has been reached, and it is maintained at substantially zero value. A remains at zero value until approximately mid-position of the control has been reached and therefore increases in value uniformly with angular movement of the control knob.
FADA ANDREA INC.

Fada 10, 11, 30 and 31 Receivers—60 cycles
Fada 10Z, 11Z, 30Z and 31Z Receivers—25 cycles

16, 17 and 32 - 60 cycles
16-Z and 32-Z - 25 cycles

(Late Production)
FADA ANDREA, INC.

Fada 18 DC Receiver
for use with direct current only

Fada 22 Battery Model Receiver
OFFICIAL RADIO SERVICE MANUAL

F.A.D. ANDREA, Inc.

Fada 25 and 25-Z Receivers
used with
M-250 and M-250-Z Electric Units

35 — AC 60 cycles
35-Z — AC 25 cycles
F.A.D. ANDREA, Inc.

Fada 40
AC 60 Cycles Using P-250 Elec.

Unit and 7-A Speaker

Fada 50, 70, 71 and 72 Receivers

TAPE OF CABLE CONNECTIONS

1: WHT BURNT RED PPA TRACERS
2: BLK BURNT RED PPA TRACERS
3: BURNT RED PPA TRACERS
4: PPA TRACERS
5: PPA TRACERS
6: PPA TRACERS
7: PPA TRACERS
8: PPA TRACERS
9: PPA TRACERS
10: PPA TRACERS

OTHER USES OF LINES DESIGNATED IN DIAGRAM AND IN INSTRUCTIONS WITH CABLE WIRE CONNECTIONS

POWER CABLE "W" 3791-785
F.A. D. ANDREA, INC.

"E-420" Electric Unit
--For Fada 50, 70, 71 and 72 Receivers

"E-180" Electric Unit—For Fada 50 and 70 Receivers

192-A Receiver, 192-S and 192-BS Units
F.A.D. ANDREA, Inc.

"7" AC 475-UA or CA and SF45/75-UA or CA
472-UA or CA and SF45/72-UA or CA

Fada 75 and 77 Receivers
AC 60 cycles
The following is the procedure to be followed for neutralizing the Fada "Model 265-A" battery set: the neutralizing condensers C7, C8, C9 are located from left to right in the set.

Balance V1, V2, V3, and V4, in the same order, using a tube with an open filament. Adjust on a wavelength between 250 and 300 meters. To neutralize this receiver it is recommended that a type '01A tube be used in the detector position, V4, replacing, when balanced, with a type '00A tube.

The compensating condenser C9A is located at the right of the third tuning condenser and is adjusted with a long screwdriver.

In the Fada "Model 475-A" receiver, C7 is accessible through the left hand hole (facing front of set) in terminal board in first can; and the second neutralizing condenser C8 through the right hole. Condenser C9 is reached through the right-hand hole in the second can; and C10, through the right-hand hole in the third can. Each of these condensers is numbered according to the stage it balances. It is recommended that headphones be used to obtain a null point when balancing the receiver. Tune for a strong signal on a wavelength of 250 to 300 meters, when balancing this set, using the loop for signal pick-up. The input circuit compensator C1A is the thumb screw marked "antenna adjuster" on the terminal board in the first can. Condensers C2A, C3A and C4A are accessible through holes in their respective shield cans.

Wavelength compensation in the various tuned stages is obtained by tuning to a strong local station (using the loop) on a wavelength between 250 and 300 meters. After obtaining the loudest signal at a single point, remove the loop plugs and connect an aerial and ground to the set. Without moving left-hand dial, turn antenna adjuster screw to left or right to point of maximum signal.

The following values are used in this set: C1, C2, C3, C4, 0.0035-mf.; C5, 0.01-mf.; C6, C12, C13, C14, C15, C16, 0.5-mf.; C17, 1.0-mf.; R1, R2, R3, R4 are 1.000 ohms; R5, 250,000 ohms; R6, 500,000 ohms; R7, 125,000 ohms; R8, 50,000 ohms; R9, 6 to 20 ohms. Type '01A tubes are used as V1, V2, V3, V4, V5 (or a type '00A may be used here) and V6; and a '71A for V7. Unit L2 is an untuned R.F. transformer.

When servicing the "475-A" check for open resistors R1, R2, R3 or R4; also for an open output condenser C17. If it is difficult to stop circuit oscillation, determine whether a low-resistance ground is being used; and whether any of the by-pass condensers are open.

In both the "265-A" and the "475-A" receivers the filament rheostat and off switch are combined in one unit. Both of these sets are two-dial control.

In the "high gain" Fada "475-A," the R.F. chokes RFC1, RFC3, RFC4, RFC6 are inserted in the positive "A" leads of the first five tubes to prevent circuit oscillation due to this common lead.

The battery cable for the "475-A" connects to terminal strips on the unit comprising T1, T2 and AFC. These strips are shown in an accompanying illustration.

Note the connections and values of R5, R6, R7. An open R1, R2, R3, or R4 resistor may indicate a short in C7, C8, C9, C10.
F.A.D. ANDREA, INC.

460-A Receiver and R-60 Unit

R-80-A Unit, 480-A and SF 50/80-A Receivers
F.A.D. ANDREA, INC.

**TABLE OF CABLE CONNECTIONS**

<table>
<thead>
<tr>
<th>NO.</th>
<th>COLOR</th>
<th>DESIGNATION</th>
<th>LEADS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RED</td>
<td>BLACK LUBED TERMIN</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>GREEN</td>
<td>BLACK LUBED TERMIN</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>BLACK</td>
<td>BLACK LUBED TERMIN</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>RED</td>
<td>BLACK LUBED TERMIN</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>GREEN</td>
<td>BLACK LUBED TERMIN</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>BLACK</td>
<td>BLACK LUBED TERMIN</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>RED</td>
<td>BLACK LUBED TERMIN</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>GREEN</td>
<td>BLACK LUBED TERMIN</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>BLACK</td>
<td>BLACK LUBED TERMIN</td>
<td></td>
</tr>
</tbody>
</table>

- **Special** AC Receiver: 265-UA or CA and RP-65-UA or CA
- 262-UA or CA and RP-62-UA or CA

**480-B and SF 50/80-B Receivers**
The FADA "A-B-C" Power unit shown at the right uses three Elkon, 1500-mf. "dry" condensers in the "A" filter system. If a very bad hum is heard in installations using this power unit, check the "dry" condensers, C₁, C₂, C₃. The trouble is most conveniently checked by disconnecting one condenser after the other, until the hum suddenly drops. As the hum is less with all of the condensers out of the circuit than with a single defective condenser in circuit, the location of the defective unit is simple.

Type "J" unit for 25 cycle current is similar, except that a 1706X power transformer is used instead of the 1696X transformer as indicated on the type "C" unit for 60 cycles.

Type "C" Electric Unit, used with "Special" and "7" AC
FEDERAL ORTHO-SONIC RECEIVER
TYPE - D

Condenser C1, 100 mmf.; C3, 0.005 ml.; C2, 42 mmf.; C4, 1.0 ml.; C6, 200 mmf.; C5, .001 ml.; The grid-plate capacity of about 9 mmf., has been represented in dotted lines; C7, .05 ml.; R1, 1 meg.; L1, 165 mh.

SERIES FIL., TYPE "D" RECEIVER
CODE 79-070

60 Cycle Power Supply Unit, Code 79-001.
(Filament Circuit in Heavy Lines)
In the Model K receiver the volume control is a 700,000-ohm variable resistor R6, in shunt to the secondary of T5. Two place supply rectifiers are mounted in the set chassis, instead of the power unit.

The first consideration is the line voltage. If hum appears at the output of the receiver after the rectifiers and volume control, return the receiver to the manufacturer for service.

Next, replace the fuse in the proper clips and all tubes removed from the chassis, and also the fuse, and plug into the A.C. line. Connect a 0.150 V, A.C. meter between 1 and 16 (note in some units 7, 8 and 9 are the common terminals, and the meter reads the same between 1 and both sides of the fuse, fuse is good. Short posts 1 and 2 with a piece of wire, and put the type '80 tube in the receiver.

...and, if the meter reads the same between 1 and both sides of the fuse, the circuit must be traced through any faulty circuits with the aid of the schematic and the volume control to the frame and one to the chassis.

If changing tubes, and all other efforts, does not stop circuit oscillation, tune in station near 210 meters and, with a non-metallic screwdriver adjust NC1, NC2 and NC3. NC2 (upper left-hand) adjustment not critical. Re-check on 360 meters and under load, rectifier transformer secondary should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamic reproducer) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.

(dynamically reproduced) should read close to 11 volts; rectifier output should be 5.5 to 6 volts.
FREED-EISEMANN RADIO CORP.

**Model - 10**

**Model - NR11**

**Model - NR12**
The Freshman "Model N" and its power pack; the numbering of the terminals shown here may be compared with that in the diagram of the layout at the right. The capacities and ratings of the condensers in the power unit are shown opposite each, respectively, at the left. Note the special 1800-ohm resistor lead shown here.
Schematic diagram of Model "G" Chassis and Model G-60-S Power Supply. Note the one choke coil in Power Supply Circuit.
Radio Service Data Sheets

DAY-FAN FIVE "5044"

The circuit used in this receiver is reflexed. Thus, V2 functions as an amplifier of both radio- and audio-frequency currents. With SW1 in position 1, the audio output of V2 is led to the reproducer; in position 2, V5 is introduced as a third stage of A.F. amplification.

Units R.F. Choke 1, R.F. Choke 2 and R.F.T. 2 are iron-core instruments in radio-frequency circuits.

A Continuity Test of the receiver should be carried out. The reference numbers appear on the "Tube Layout."

The circuit used in this receiver is reflexed.

The receiver should be bypassed with a 4,000 mfd. condenser not being used.

A lock-out on the end of the rotor shaft is available for this purpose; it is loosened, the rotor an insulator plate is centered, and then tightened. If one of the or plates remains out of alignment, they may be centered by careful bending of the plates. If difficulty is experienced in getting distant stations while locals are on, it will be well to check the length of battery leads. Those which are too long will pick up sufficient energy from the locals to cause these signals to "ride in" on top of distant station programs. The solution is to keep battery leads as short as possible.

A peculiarity of this particular receiver is that an antenna length of less than sixty feet will not (contrary to usual practice) result in greater ease of tuning through local stations; a length of more than 100 feet is also inadvisable. The explanation lies in the "selector coil" of this receiver. With an antenna shorter than sixty feet, sufficient energy is not received from the distant station to allow the selector to be turned to a point where the local station is cut out, and at the same time the distance station is brought in. In other words, a strong signal from the distant station as well as from the local allows the user to select either station by proper use of the selector. Selectivity in this receiver depends to a major extent on the setting of the R.F.T. primary coil P in relation to S; reduced coupling increases the selectivity but at the same time the sensitivity, within certain limits. However, the service man may install a small variable condenser of the mica dielectric type inside the cabinet, and connect it in series with the antenna lead to the R.F.T. primary. By adjustment of this unit and of the inductive coupling to the plate, optimum selectivity and sensitivity may be obtained. (This receiver was designed for selectivity conditions not as stringent as those of the present day, and it is not as easy now to obtain interference-free reception in congested districts as formerly.) A suggestion for obtaining additional selectivity is to connect a compact air-dielectric variable condenser from 6 to 11, mounted at a convenient point on the panel. If regeneration on the longer waves is insufficient, it may be necessary to reduce to .002 mf. the capacity of the bypass condenser, connected to the plate of V4 to "A." Still stronger regeneration may be obtained by connecting a radio-frequency choke coil between the plate and AFT1 primary lead of V4. A safety measure recommended for these receivers when operating on "B" batteries is the insertion of a fixed condenser of .01 mf. capacity in series with the variable regeneration condenser mentioned above. A caution regarding this installation is to keep leads as short as possible, and to shield these new leads. The voltage settings of this particular model receiver were obtained with a Weston Student Galvanometer Model 375. With a 4½-volt battery supply, a 7,000-ohm series resistor is used. (An approximation of this value is secured by the use of the secondary of a "replacement" A.F. transformer.) "Sw 1" is the "Speaker Switch."

The Reflex Circuit

An explanation of the paths which the varying R.F. and A.F. currents follow may be an aid to determining the faults which may be encountered in receivers of this type.

The R.F. input is amplified by V1; R.F. Choke 1 filters the R.F. signal to pass through RFT2 to V2; here another plate-circuit impedance (AFT2 pri. or the reproducer) keeps back the R.F., which conveys to the receiver back to V2, being again blocked by R.F. Choke 2. The A.F. output of V4 is "reflexed" through AFT1 back to V2, and the A.F. output of V2 either acts as the reproducer or is passed on through AFT1 to V3 (the option being determined by SW2). Should SW2 be set to V1 is the first R.F. tube; V2 is second R.F. and first A.F.; V3 is third R.F., and V4 is the detector, and V5 is the second A.F.

Other reflex receivers made by Day-Fan are the "OEM-11" 3-tube, "OEM-7" 4-tube, "OEM-2" 4-tube "Super-Selective," and "OEM-12" 4-tube. A word picture distinguishing one from the other for lows. The OEM-21 receiver has a wiring diagram and two of A.F. amplification. The "OEM-7" receiver has on a R.F. stage followed by another T.R.F. section for reflected for first A.F. The second A. F. is a separate tube. The "Super-Selective" varies from this model only in the lower coupling, through the R.F. transformer, as does the "OEM-12" from the "OEM-11."
Day-Fan Five Twenty-Seven—5-Tube

Day-Fan Six—6-Tube

Day-Fan Seven—7-Tube

DAY-FAN 7—7 TUBE
DAY-FAN 600 VOLT A-C. POWER SET
(For Use with 600 Volt A-C. Dynamic Speaker)

DAY-FAN 8-A. C. POWER SET
(For use with 200 Volt D. C. Dynamic Speaker)

Note--Use this circuit diagram for receivers equipped with power blocks, or condenser blocks.

DAY-FAN 8-A. C. POWER SET
(For use with 110 Volt D. C. Dynamic Speaker)

Note—Use this circuit diagram for receiver equipped with power blocks having removable covers.

DAY-FAN 8-A. C. POWER SET
(For use with 110 Volt D. C. Dynamic Speaker)

Note—Use this circuit diagram for receiver equipped with power blocks having removable covers.

Note—Use this circuit diagram for receiver equipped with power blocks having removable covers.

Note—Use this circuit diagram for receiver equipped with power blocks having removable covers.

Note—Use this circuit diagram for receiver equipped with power blocks having removable covers.
The circuit of the Delco automotive receiver. The variometer tuning arrangement and other novelties are obvious.

Appearance of the Delco chassis, with cables connected. The switch and volume control are seen in the foreground, separately.

MODEL - 100
A.H. GREBE & Co.

GREBE SYNCHROPHASE RECEIVER TYPE MU-1
A.H. GREBE & CO., INC. RICHMOND HILL, N.Y.

GREBE BROADCAST RECEIVER ~ 1923.
Radio Service Data Sheets

**GREBE SYNCHROPHASE—7**

Several models of Grebe instruments are available under the name of "Synchrophase": the 7-tube receiver is described and diagrammed this month. In the coupling chain controlling the left-hand dial there is play to permit condenser variation, to compensate for differences in antenna capacities. This should be about two or three degrees. Between center and right-hand dials, only one-half degree is allowed as compensation for variation in parts and tube manufacture.

Condenser C1 has a capacity of .0022-mfd. Units a, b, c, d and e ("Tonecolor") have a capacity of 1750, 1450, 950, 600 and 375 mfd., respectively. Resistors R1, 2, 3, 4, are 400 ohms; X is a "dummy" cartridge having a copper wire in place of a high resistance. Resistors R9, 6, 7, 8 and 9 are 5 to 7 megohms.

**++Continuity Test++**

**Beneath Aluminum Deck**

<table>
<thead>
<tr>
<th>Test Leads</th>
<th>Correct</th>
<th>Fault, if Otherwise</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-39</td>
<td>none</td>
<td>none C4 shorted</td>
</tr>
<tr>
<td>1-7</td>
<td>none</td>
<td>none C4 shorted</td>
</tr>
<tr>
<td>3-59</td>
<td>none</td>
<td>none C4 shorted</td>
</tr>
<tr>
<td>4-59</td>
<td>none</td>
<td>none C4 shorted</td>
</tr>
<tr>
<td>5-6</td>
<td>about 1/3</td>
<td>T1 sec. open</td>
</tr>
<tr>
<td>7-39</td>
<td>about 1/3</td>
<td>T1 sec. open</td>
</tr>
<tr>
<td>8-39</td>
<td>about 1/3</td>
<td>T1 sec. open</td>
</tr>
<tr>
<td>9-10</td>
<td>about 1/3</td>
<td>T2 sec. open</td>
</tr>
<tr>
<td>10-12</td>
<td>about 1/3</td>
<td>T2 sec. open</td>
</tr>
<tr>
<td>11-12</td>
<td>about 1/3</td>
<td>T2 sec. open</td>
</tr>
<tr>
<td>12-9</td>
<td>none</td>
<td>T2 sec. grounded</td>
</tr>
<tr>
<td>9-11</td>
<td>none</td>
<td>T2 sec. grounded</td>
</tr>
<tr>
<td>11-12</td>
<td>none</td>
<td>T2 sec. grounded</td>
</tr>
<tr>
<td>12-39</td>
<td>none</td>
<td>T2 sec. grounded</td>
</tr>
<tr>
<td>21-39</td>
<td>none</td>
<td>Lead open</td>
</tr>
<tr>
<td>21-22</td>
<td>none</td>
<td>Lead grounded</td>
</tr>
<tr>
<td>21-23</td>
<td>none</td>
<td>R.F. pri. grounded</td>
</tr>
<tr>
<td>21-24</td>
<td>none</td>
<td>R.F. pri. grounded</td>
</tr>
</tbody>
</table>

**Test of Cable Leads**

| 14, 15, 16, 17 | none Lead grounded |
| 14, 15, 16, 17 | none Lead grounded |
| 14, 15, 16, 17 | none Lead grounded |
| 14, 15, 16, 17 | none Lead grounded |

**++Continuity Test++**

**Inside Receiver**

| C1, C2, C3, C7, C10, | C11, C12, to 90 |
| Shorted C2, C9, C6, | 30, 31, 32, 33, |
| 34, respectively    | none C5, C6, respectively |

The heavy black bar at the left of the unit marked V5 is the dummy bus referred to in these columns. Each block comprises a coupling condenser, grid leak, and grid suppressor.

In any receiver it may occur that an audio transformer primary open-circuits. The service man may conveniently apply to T1 and T2 the same test used in production. Referring to bottom view of chassis, the north-seeking pole of a compass placed over 5-6-7-8 or 9-10-11-12 should point to the right (with plate current flowing). Both primaries and secondaries may be tested through use of the current in the average continuity test kit; provided the polarity of the prods is known. With "plus" test lead to 7 or 11 and "minus" lead to 6 or 12, the compass should swing to the right; and also to the right when "-" lead of prod is connected to 6 or 10 and "+" to 5 or 9.
NOTE: In some models of the "70," the center-tap of the detector filament connects to the center-tap of the R.F. tube filaments, and the detector plate potential is then only about 30 volts.
MODEL 90

The constants are as follows: V1, V2, V3, V4, V5, type 27 tubes; V6, V7, 45s; V8, J-volt pilot lamp; R1, 75,000 ohms, variable (volume control); R2, adjustable resistor; 500 to 2500 ohms; R3, non-inductive, center-tapped, 1.6 ohms total; R4, 1800 ohms (blue); K5, 35,000 ohms (green); C6, 0.05mf.; C10, 0.01mf.; C11, 0.001mf.; C12, C13, C14, C15, 0.5-mf.; C16, 1.0-mf. C1, C2 and C3 are H.V. choices.

Volume is controlled by varying the grid bias of V1, V2, V3.

The voltage readings for this set should be as follows: filament of V1, V2, V3, V4, V5, 2.35; V6, 2.45; plates of V1, V2, V3, V4, V5, 150; of V5, 250; of V6, V7, 250; grid biases of V1, V2, V3, 8 volts; V4, 9 volts; V5, 30; V6 and V7, 50. The plate current of V1, V2, V3 is 5.5 milliamperes; V4, 5 ma.; V5, 1 ma.; V6, V7, 3 ma. These readings are exact only when the receiver is tuned to 500 kc., the volume control is set at maximum, and the line potential is 115 volts A.C.

R2 is secured to, and rotated by, the gang condenser shaft. It varies the grid bias of V1, V2 and V3 from 9 to 32 volts. This serves automatically to maintain even amplification throughout the tuning range. (This equalizer should have a resistance of 500 ohms at 500 kc., 1,300 ohms at 1,000 kc., and 2,500 ohms at 1,500 kc.)

"9P3" 4 MFD.

MAJESTIC "9P6" CONDENSER PACK FOR MODEL 90 RECEIVER

WHEN testing the power pack of the Majestic "9P6" for shorts in the condenser bank, a reading will be obtained (in the earlier models) between the second and the fifth taps. This is due to a choke coil, which is mounted inside the condenser can, and connected between these two taps.

In the later models, this choke has been replaced by a resistor. In case of an open in this choke or resistor, there will be no plate voltage at the detector tap.

The schematic circuit of the earlier Majestic "9P6" power pack, showing the choke between detector and power-amplifier tap.

MODEL 70-B CHASSIS IN 72 RECEIVER

Schematic circuit of the Majestic 70-B chassis used in the model 72 receiver. In contrast with most neutraline arrangements it is noticed that the neutralizing potential is obtained from the grid circuit; the coil being part of the tuned secondary circuit. The service man must remember this important point, should occasion arise for servicing one of these modern radio sets. Two adjustable 20-ohm "hum balancers" are used in this set.
GRIGSBY-GRUNOW CO.

SCHEMATIC DIAGRAM FOR MODEL 100 MAJESTIC RECEIVER

[Diagram of the schematic diagram for the model 100 Majestic receiver]

RADIO-PHONOGRAPHS SWITCH
FULL LINE INDICATES RADIO POSITION
DOTTED LINE INDICATES PHONOGRAPHS POSITION

SCHEMATIC DIAGRAM FOR MODEL 90-B MAJESTIC CHASSIS
25-40 AND 50-60 CYCLE

[Diagram of the schematic diagram for the model 90-B Majestic Chassis]
GRIGSBY-GRUNOW CO.

SCHEMATIC DIAGRAM OF 8P6 & 8P3 POWER UNITS

SCHEMATIC DIAGRAM OF POWER UNIT AND VOLTAGE DIVIDER SYSTEM
MODEL 130-A MAJESTIC SUPER SCREEN GRID CHASSIS
25-60 AND 50-60 CYCLE

CONDENSER BANK
50-60 CYCLE  25-40 CYCLE
A - 2 MFD  A - 4 MFD
B - 2 MFD  B - 4 MFD
C - 2 MFD  C - 2 MFD
Changes on this chassis have been made on several different occasions and to distinguish how one chassis differs from another, an identification mark is placed on each one changed. This identification mark is a dot of paint found on the end rivet of the tube socket strip.

Yellow Mark The chassis having the first changes may be identified by the yellow indicating mark. This involves four changes.

1. A "dual-volume control" in place of the single type.
2. An interchange of position of the two audio transformers.
3. An addition of a "dual half microfarad condenser" (P. 813) and two carbon resistors in the "B" circuit of the detector and first audio tubes. (Late Models)
4. A change in the location of the grounding of No. 1 lug on the condenser block.

Red Mark
(Serial Number 39,000-42,999)
All chassis having a red mark on the rivet of the tube socket strip have all of the changes mentioned above and in addition, have a one-tenth microfarad condenser (P. 814) connected from ground to one side of the 110 volt line.

Green Mark
(Serial Number 43,000 and up)
All Chassis with a green mark on the rivet of the tube socket strip contain the above changes and in addition have a change in the "combination phonograph switch" circuit. This changed circuit makes use of only the audio system of the set for phonograph reproduction. whereas the original circuit included the detector tube.
POWER UNIT CIRCUIT
K-50 TYPE
FOR SETS 524, 525, 527, 528
Radio Service Data Sheet

KELLOGG 523 AND 526

These two models differ only in the power supply to which they are adapted; their R.F. chassis are identical. The "523" is designed for standard 60-cycle alternating current; the "526" for operation on a lower frequency—25 cycle up—and is recommended for even 50-cycle supply. The receiver proper has three stages of '24-type screen-grid amplification, with '27-type detector and first audio; and employs a '27-type tube in a special circuit as an auto-'27-type detector and first audio. The chassis are identical.

Capacities are as follows: C2, C4, C6, C9, C12, C15, C16, C17, C19, C20, each 0.005-mf.; C8, C10, C13, C14, C18, C23, each 0.001-mf.; C21, C22, C25, C27, (high-voltage), C28, each 2.0-mf.; C26 (high-voltage), 5.0-mf.; C24, .0005-mf.; C7, 10,000 ohms; R9, 3,300 ohms, with a maximum capacity of C7 is not the same as for C1, C3 or C5; hence, the "apparent" selectivity at high frequencies (low wavelengths, and due to the increased number of dial-scale-divisions per station-carrier position) will not be as great as in the other stages.

As to change the drum dial lamp, turn the drum dial so that the opening is on top. The bulb may then be reached with the fingers.

The sensitivity of this set is so great that the antenna hindering post will pick up sufficient energy, in certain localities and under certain conditions, to give loud-speaker reproduction of the station's music. If this is not desired, use a power driven base at the front of the cabinet.

The chassis is held by four screws and covered by a steel protector, held by two wood screws.

This receiver works best with a good ground connection.

Power Unit Type 245 is used with the 523 and 526 receivers.
OFFICIAL RADIO SERVICE MANUAL

KELLOG S'W'BD. & SUPPLY CO.

WAVE MASTER

R.F.L.- 7-TUBE CASCADE RECEIVER

C1 ANTENNA EQUALIZER 00027MF
C2 TUNING ALIGNMENT CONDENSER
C3 BYPASS CONDENSER MFD
C4 BALANCING CONDENSER 000000MF
C5 GRID CONDENSER 00025MF
C6 BYPASS CONDENSER .001MF
C7 GANG CONDENSER 0005MF UNITS [STATION SELECTOR]
L DIAL LIGHT.
R ROTOR PLATES OF VARIABLE CONDENSER
Rf FILAMENT RHEOSTAT 4 OHMS.

Rg GRID LEAK 2½ MEGOHMS.
Rl NON-INDUCTIVE WIRE RESISTANCE 200 OHMS.
Rk RHEOSTAT 20 OHMS.
S STATIONARY PLATES OF VARIABLE CONDENSER.
Sw FILAMENT SWITCH.
Tf RADIO FREQUENCY TRANSFORMERS.
T3 INPUT TRANSFORMER
T5 KELLOGG AUDIO TRANSFORMER
Vm FILAMENT VOLTOMETER
+ GROUND TO SHIELD
MODEL -110
(RANGE - 175 TO 25,000)

MODEL -281
(RANGE - 175 TO 1,000)

MODEL -220
(RANGE - 175 TO 3,300)

CAUTION: WHEN THE DETECTOR AND AMPLIFIER IS USED, IT IS NECESSARY TO USE A BATTERY FOR EACH UNIT.
MODEL 81.
Plate resistors in R.F.
circuit are
1000 ohms each;
in detector cir-
cuit, 100,000
ohms. By-pass
condensers in
R.F. cans and
A.F. circuit
are .1 mf.
capacity.

MODEL 80.
By-pass con-
densers on 1st
and 3rd A.F.
transformers
are .1 mf.
capacity.
Tuning chassis for seven tube sets.


Schematic diagram of the four tube chassis as used with six tube sets.

Power Supply and Power Amplifier Unit.
(Used with K-24)
Use this circuit diagram for all receivers equipped with a sealed power transformer block, or condenser block not having any brown or slate colored leads.

MCMILLAN 8—A. C. POWER SET

Use this circuit diagram for receivers equipped with power transformer block having removable cover, or condenser block having one brown and one slate colored lead in addition to the colors used for circuit diagram shown above.

MCMILLAN 8—A. C. POWER SET
FIXED RESISTORS
SERIES - 50

2290 2 megohm.
2830 4000 ohms.
2834 12,500 ohms.
3440 3000 ohms.
2064 2250 ohms.
2835 200 ohms.
2338 3000 ohms.
2296 2250 ohms.
3004 2500 ohms.

MODELS - 1, 2, & 3

CHASSIS

SERIES - 50
Radio Service Data Sheet

EVEREADY SERIES 30, SERIES 30-C AND SERIES 40 RECEIVERS

Changes in the audio chassis and reproducer are the only things that distinguish the "Series 40" circuit from the "Series 30," the former uses type '45 tubes in push-pull, the latter type '71A. To supply the power for the '45's (a load of 2.5 volts and 31, 250 volts) the No. 2708 unit must replace No. 2460 (P2); a higher voltage condenser, bank No. 2707, replaces No. 2295 (C19); correct "C" bias has obtained across a 900-ohm resistor No. 2705, instead of No. 2339 (R8); tube sockets No. 2704 (designating '45 tubes) replace sockets No. 2232 for V6 and V7; the output transformer No. 2463 (T3) is the only thing that remains the same. A 40" circuit from the "Series 30," the former No. 2463 transformer in the "30-C," the latter type '71A, transformer in the "40." The "30-C" uses type '45 tubes, the "40" uses type '71A.

For aligning and neutralizing, an insulated wrench is the usual tool of the trade; at times, the R.F. inductances are matched in one group. The voltage drop across the portion in the secondary is the neutralizing potential. Hum often may be eliminated by changing detector tubes, readjusting R2 for each tube. The voltages normally found in these Eveready receivers are as given below:

<table>
<thead>
<tr>
<th>Tube</th>
<th>V1</th>
<th>V2</th>
<th>V3</th>
<th>V4</th>
<th>V5</th>
<th>V6</th>
<th>V7</th>
<th>V8</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.2</td>
<td>192</td>
<td>5.10</td>
<td>175</td>
<td>37.5</td>
<td>20.0</td>
<td>24.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>192</td>
<td>5.10</td>
<td>175</td>
<td>37.5</td>
<td>20.0</td>
<td>24.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>192</td>
<td>5.10</td>
<td>175</td>
<td>37.5</td>
<td>20.0</td>
<td>24.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>192</td>
<td>5.10</td>
<td>175</td>
<td>37.5</td>
<td>20.0</td>
<td>24.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Under view of the receiver chassis of the Eveready "30," "30-C," and "40" receivers, the capacitors, mounted on the top of the chassis, is on the same shaft with the tuning condenser.

The two methods are combined in the design of this receiver to obtain even amplification throughout the tuning range. Volume control R6 is a wire-wound unit. Directly below the field terminal jacks on the Model is a snap switch (SW3) which is thrown one way for magnetic operation, and the other for neutralizing receiver. The field coil of the reproducer plugs into pin jack located on the rear face of the power plant; and the voice coil into two pin jacks mounted between the power tubes.

The insulated terminal board, for adjustment to compensate line-voltage conditions, is mounted on top of the power plant between the power and the receiver; the reproducer plug is to be inserted in one of the three holes in the top of this board. The "Model 30" chassis is designed for easy servicing by separate removal of either the set chassis or the power plant; the reproducer plug is to be inserted in one of the three holes in the top of this board.
NOTE. Switch 1 Right-Hand Terminals are shorted in local position. Left-Hand Terminals are shorted in distance position. Resistor is mounted at bottom of cabinet.
I.

Philco Model 65

Philco Model 76

Ant. 223 ANT. INDICATES CHASSIS

Electro-Dynamic Speaker

These stages are grounded from each other. The points indicated in this schematic.
This receiver is of the neutralized, tuned-radio-frequency type. For local reception, in certain localities, good results will be obtained when the light is on as the antenna. To do this, connect a jumper from "Loc." to "Ant."; coupling to the line is then obtained through the series condenser C21 in the filter block. The receiver is shipped with this connection already made.

High selectivity in this receiver has been achieved by the use of four tuned stages, ganged, with compensating condensers for balancing the tuning of each stage, in addition to the panel-mounted compensating condenser, VC, which carries a spring contact. This last control resonates the antenna stage of R.F.; when this condenser is rotated clockwise the grid of the first tube VI is disconnected from the input circuit and grounded. This is the short-range position, used for strong signals. For weak signals the knobs should be rotated clockwise, to reconnect the grid of VI to the input circuit. Further adjustment to the right allows finer tuning of the antenna circuit.

When using the light socket as an antenna it is advisable to reverse the light-socket plug to determine the best connection for maximum signal strength and minimum hum.

The tubes used in this receiver are: four '26s, V1, V2, V3, V5; one '27, V4; two '80, V6, V7; one '26s, V1, V2, V3, V5; one '27, V4; two '80s. A caution is issued by the manufacturer with regard to the tuning-condenser gang. If it has been positively determined that the trouble lies in the alignment of the condenser plates, reverse the entire condenser and return it for adjustment. The arrows holding the stator plates of the tuning condenser in place, and those holding the rotor bearings, should never be loosened. The compensating condensers C5, C7 and C10 may be adjusted with a wrench to equalize the tuned circuits. Replacement R.F. transformers of standard values are separately obtainable.

If trouble has been localized to the dynamic reproducer, a check with a voltmeter across the field coil should show approximately 1,250 volts drop. With a line-voltage of 125, the "Model 87" draws 95 watts from the power line, and the correct set voltages are as follows:

Three R.F., and the first A.F. stages, filaments 1.5 (winding A); plate 90; grid bias 6; R2, R4, Rg are low in resistance and do not reduce plate voltage perceptibly.

Deteriorator 2.5 (winding B); plate 30; grid bias 0.

Second A.F. (and pilot lamp) filaments 2.5 (winding C); plate 245; grid bias 45. Rectifier filament, 5 volts; across secondary 700.

The code used in wiring the receiver is:

- Leads from Colors
  - A.C. Supply .................... Green rubber covered
  - A.C. Supply .................... Black rubber covered
  - A.C. Supply .................... Blue, white tracer
  - "Loc." post to C21 ............ Black
  - Winding A (26 filament) .... White, black tracer
  - Winding A (26 filament) .... Black, white tracer
  - Winding B (27 heater) ...... Yellow, green tracer
  - Winding B (27 heater) ...... Yellow, white tracer
  - Winding C (45 filament) ... Yellow, green tracer
  - Winding C (45 filament) ... Green, white tracer
  - Windings center tap .... Green, black tracer
  - Rectifier center tap ....... Green, black tracer
  - Rectifier center tap ....... Black, yellow tracer
  - Rectifier center tap ....... Black, yellow tracer
  - Rectifier center tap ....... Blue, yellow tracer
  - Rectifier center tap ....... Blue, yellow tracer
  - Rectifier center tap ....... Yellow, green tracer
  - "B4" on A.F. transformer (detector plate) .... Yellow, green tracer

Values of parts are given as follows: R1, 10,000 ohms; R6, 6 ohms. C4, C6, C8 (units included); R2, R3, R4), each 0.01 mfd.; C11, 0.001 mfd.; C19, 0.5 mfd.; C12, 0.01 mfd.; C13, C15, 0.01 mfd.; C14, C16, C18, 2 mfd.; C17, C21, 0.15 mfd.; R7, 20,000 ohms; R8, 4,582 ohms tapped at 127, 640 and 2,786 ohms.
The circuit diagram of the Pilot "P. E. 6" broadcast receiver, at the left; the dotted square at the right encloses the "K.113" power pack, designed for push-pull operation. Circuit values and constants are given in the text and list of parts.
Circuit of the Pilot automotive radio receiver, with three stages of screen-grid K.F. amplification, screen-grid detector, resistance-coupled 27 first audio, and a '45 power tube, in place of the '12 commonly used; its use improves output and simplifies the circuit.
RCA: VICTOR CO. (VICTOR DIV.)

Wiring Diagram Alhambra I (7-1)

Wiring Diagram for Electrola Cromwell

Wiring Diagram for Borgia II
Radiola 25 Catacomb Continuity Diagram for Alhambra II (7-2) and Florenza (9-1)
Wiring Diagram for Models 7-3, 7-30, and R-20

Schematic Wiring Diagram Electroa Radiola 7-26 Above Serial No. 12000

Wiring Diagram for Victor Radiola 16
(Used in Model 7-10)
Wiring Diagram for Electrola 12-25
Wiring Diagram for Victor Radiola 17
(As Used in Model 7–25)

Wiring Diagram for 9-15
These four Radiola superheterodynes use the same 6-300 tube as the catwhisker and have been shaped and placed on the market by the Radio Corporation of America to differ in the mechanical arrangement of the units outside the cabinet, and in the electrical and artistic design.

The "810," to which most of this material specially applies, is an entirely self-contained semi-portable cabinet with a battery compartment at each end. The A.F. output is obtained at a plug-operated switch changes the circuit from one A.F. to two. Another switch controls the "A" circuits. There is a master rheostat ("Battery Setting"), R3 in the diagram on this page, and also a vernier rheostat ("Volume Control") R2, the latter controls I.F. amplifier V2. A fixed loop antena is located in the rear of the cabinet. Paths of R2 may be reversed.

The "AR-810" or "Super VIII" has a high-boy cabinet, with a large rotatable loop and a loud speaker. The filament circuit is controlled by a door-operated switch instead of SW1, which is replaced on the panel by a knob that controls the loop.

Radiola 24, is a black-leather-covered portable with a built-in loud speaker and a rotable loop that fits into the cabinet when not in use. Radiola 26, the well-known portable so often used for locating interference, is extremely compact, includes a loud speaker and batteries, and is the same size as an "810." Radiola AR-810 and AR-812, without rear cabinet, with a large rotatable loop, and in the electrical and artistic design.

Using phones or a meter with a 4½-volt "C" battery, the following table may be used for making continuity tests on the catacomb of Radiola 24, AR-810 and AR-812, without removing batteries; and the battery cable is disconnected; and tubes are removed:

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1 grid</td>
<td>1</td>
<td>Open</td>
</tr>
<tr>
<td>V2 grid</td>
<td>2</td>
<td>Closed</td>
</tr>
<tr>
<td>V1 grid</td>
<td>3</td>
<td>Closed</td>
</tr>
<tr>
<td>V2 grid</td>
<td>4</td>
<td>Closed</td>
</tr>
<tr>
<td>V3 grid</td>
<td>5</td>
<td>Closed</td>
</tr>
<tr>
<td>V4 grid</td>
<td>6</td>
<td>Closed</td>
</tr>
<tr>
<td>V1 plate</td>
<td>7</td>
<td>Closed</td>
</tr>
<tr>
<td>V2 plate</td>
<td>8</td>
<td>Closed</td>
</tr>
<tr>
<td>V3 plate</td>
<td>9</td>
<td>Closed</td>
</tr>
<tr>
<td>V4 plate</td>
<td>10</td>
<td>Closed</td>
</tr>
<tr>
<td>Catacomb can</td>
<td>11</td>
<td>Open</td>
</tr>
<tr>
<td>V4 plate</td>
<td>12</td>
<td>Closed</td>
</tr>
<tr>
<td>Catacomb plate</td>
<td>13</td>
<td>Closed</td>
</tr>
<tr>
<td>V5 plate</td>
<td>14</td>
<td>Closed</td>
</tr>
<tr>
<td>V6 plate</td>
<td>15</td>
<td>Closed</td>
</tr>
</tbody>
</table>

*With headphones, a weak click should be heard.*

The figures in the left column refer to the connection lugs on the terminal strip, to which the whiskers of the catacomb are connected; counting from left to right, and looking at the catacomb from the rear.

Catacomb No. 2 does not appear on the catacomb, and terminal lug No. 2 is not used. Terminal connection No. 9 does not connect to the catacomb, nor No. 16; their connections to parts outside are shown.

To replace C3, a fixed .001mf. unit will usually serve; the value of C31 is 006 mf. C31 (rear of cabinet) may be replaced with a 1.0 or 1.5 voltage rating.

The catacomb of Radiola 26 is mounted differently, and the connections thereto are reversed. As a stage-change switch is not used, the built-in loud speaker is at all times connected to the second audio stage, and the phone-tip pin jacks to the first stage.

**Radio Service Data Sheet**

**RADIOLAS "SUPER VIII" (AR-810), "SEMI-PORTABLE" (AR-812), 24 AND 26**

The loop connects to a terminal board on the back of the cabinet. The normal position for "link" is shown in dotted lines; in the second position shown, an external loop may be led to posts 4 and 2, for increased pick-up or more directional reception. A short antenna may be used on post No. 2 or a longer one on No. 1, with either loop in use. A standard "R.F. transformer" designed for .005 mf. condensers may be used instead of the loop; aerial and ground being connected to the primary, and the secondary leads to posts 4 and 2, with "link" open. This is usually unsatisfactory near strong stations. If the location is particularly shielded, good operation can sometimes be obtained by connecting post No. 1 to ground. Any external antenna or "link" terminal board will change slightly the readings of Selection No. 1.

A convenient method of obtaining just the right degree of signal input to the set is to make a coil of magnet wire, any size, about 30 to 50 turns, with a diameter of about six inches, and connect it between aerial and ground; this coil is brought as close to the back of the cabinet as necessary for good coupling.

The same sequence of signals is reversed, the loop may be caused by wires twisting loose from the collector rings. Dirty or loose rings may cause noise operation. In later sets of the Super VIII, flexible leads supersede the collector ring connections. Without working properly, distant stations can be heard in either of two positions of C2; local stations may come in at three or four places. A wave trap or reclusion of the set may be necessary.

The figures in the left column refer to the connection lugs on the terminal strip, to which the whiskers of the catacomb are connected; counting from left to right, and looking at the catacomb from the rear.

Catacomb No. 2 does not appear on the catacomb, and terminal lug No. 2 is not used. Terminal connection No. 9 does not connect to the catacomb, nor No. 16; their connections to parts outside are shown.

To replace C3, a fixed .001mf. unit will usually serve; the value of C31 is 0.006 mf. C31 (rear of cabinet) may be replaced with a 1.0 or 1.5 voltage rating.

The catacomb of Radiola 26 is mounted differently, and the connections thereto are reversed. As a stage-change switch is not used, the built-in loud speaker is at all times connected to the second audio stage, and the phone-tip pin jacks to the first stage.
Radio Service Data Sheet

RADIOLA 25 SUPERHETERODYNE

This circuit is one of the variations of the "Second Harmonic" Radiola Superheterodyne in which the first tube is reflexed for the first stage of intermediate frequency amplification. The "sequence" of signals in this circuit is as follows: V1 may be considered as both the first stage of R.F. amplification and the intermediate frequency amplification at 45 R.C.; V2 is the oscillator and first detector; V3 is the second intermediate-frequency amplifier; V4 is the second detector; V5 is first A.F. and V6 is second A.F. The desired signals are selected by the loop and Cl. Since LIA has a high impedance to the broadcast frequencies, the signal, having passed through C5, is amplified by V6 and the output fed to the grid of oscillator V2 through the aperiodic R.F. transformer L1-L4. The grid circuit of V2 is tuned by L10-C2, to prevent circuit oscillation in V1, neutralization has been effected through the use of 1.13-L14-L6. C6 is contained inside the cathode and adjustment of this unit is made at the factory. The intermediate-frequency component in the plate circuit of V2 is coupled by L2 to L1A and then amplified by V1. The amplified output of V1 at this frequency is coupled by L1-L6 to the second R.F. amplifier V3: and after amplification, by L1-L8, to the second detector V4. The A.F. output of this tube is amplified by V5 and V6 in the usual manner.

The fixed condensers shown in the schematic circuit as numbers within circles. These springs drop into the receptacle when the first tube is reflexed for the first broadcast stage; and, when the latter is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the diagram as tip-jacks 1 and 2. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to the grid-probe of which is soldered a lead wire, it is possible to connect the probe, through V4 or V5 to an external power amplifier of any type. Some of the variations of the "double-contact" bayonet-base type; either of the filament potentials; while R2 (right, or extreme right) is not connected to anything. Seventeen black wires are seen to leave the cathode of this tube and connect to the lugs shown in the schematic circuit as numbers within circles. By plugging into the socket of V5 or V6 a dummy tube base, to
Schematic circuit diagram of Radiola 17.

(Below) Schematic Circuit Diagram of Radiola 60 and Socket Power Unit.
Schematic diagram of the Radiola 64. A.C. Super-Heterodyne Receiver.
Schematic circuit diagram of the receiver assembly of RCA Radiola 50

Schematic circuit diagram of the Socket Power Unit of RCA Radiola 50

Schematic circuit diagram of the receiver and socket power unit of Radiola 51
Radio Service Data Sheet

SILVER RADIO MODELS 30 (CHASSIS), 60 LOWBOY, 95 HIGHBOY AND 75 CONCERT GRAND

This chassis utilizes '24 type screen-grid tubes in the first four stages: an aperiodic antenna coupling feed V4, which is connected to V2 through the band selector L2-L3-L4. V3 is the third R.F. stage, and V4 a power detector which is followed, however, by a TV type first audio stage V5. In the pull-push power stage, V6 and V7 are '45s.

The volume control in this receiver is the 10,000-ohm potentiometer P1; while the low-resistance instrument P2 is the hum balancer. P1 is a metal-frame component ("PP No. 4477")—Yxaldy "Type 510,000") and must not, under any circumstances, be replaced with one of the earlier bakelite frame type. When inserting a new unit, drop a fiber washer over the shaft bushing; the lock-nut should be removed and a fiber spacing washer used to insulate the potentiometer shaft from the metal chassis. After replacing, the front panel, which is fastened by the lock-nuts of the power switch SW1 and the "overtone switch" SW2, a second fiber spacing washer is dropped over the shaft of P1, and it nut tightened. A test for a ground to the chassis should be made before soldering the connecting leads of P1.

While the low-note amplification of this receiver is high, and the normal operating hum faintly discernible, if this becomes excessive, try other tubes in the detector and audio sockets. The power tubes should be selected for matched characteristics.

In the earlier models of this receiver, the cathode resistor R8 was connected to the white lead of the condenser bank C12, and thus bypassed by 1 mf. capacity; while both red leads of C12 ran to the cathode of V4. In these receivers, produced before July 9, 1929, it will be found desirable, for the reduction of hum, to rearrange the connections as shown in the diagram.

The receivers with a serial number above 12,907 contain the "Type 30 filter"—comprising L12 and C14; in the 25-cycle models, C14 is connected as indicated in dotted lines; in 60-cycle receivers, as shown by full lines.

In any case, the rotor shaft may be desirable to add this unit to reduce hum. Without it, plate potential readings taken from these sets will be found about 10 volts higher than the figures shown below; in later models, the resistance of the choke coil L12 ("No. 339U") causes this drop.

The following figures represent the average readings obtained on a Jewell "Model 1999" set analyzer, with the line-voltage set at 114 and the volume control set at maximum:

<table>
<thead>
<tr>
<th>Tube Screen &quot;A&quot;</th>
<th>&quot;B&quot;</th>
<th>&quot;C&quot;</th>
<th>Plate</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>60</td>
<td>2.25</td>
<td>142</td>
</tr>
<tr>
<td>V2</td>
<td>58</td>
<td>2.25</td>
<td>142</td>
</tr>
<tr>
<td>V3</td>
<td>58</td>
<td>2.25</td>
<td>142</td>
</tr>
<tr>
<td>V4</td>
<td>40</td>
<td>2.25</td>
<td>55</td>
</tr>
<tr>
<td>V5</td>
<td>3.80</td>
<td>200</td>
<td>0.5</td>
</tr>
<tr>
<td>V6</td>
<td>3.80</td>
<td>200</td>
<td>0.5</td>
</tr>
</tbody>
</table>

In normal operation, this receiver may be tested for noise by shorting the antenna and ground posts, and turning P1 to the full "on" position. Practically no background noise should then be heard at 590 kc.; no appreciable hiss becoming evident until the "Selector" drum has been turned to 1500 kc. Excessive noise may be due to tubes, wiring, or parts. Interchange the '24 until a quiet one has been obtained for V4, and another for V1 (the right-hand or first audio socket). V2 is the least critical "24 position.

Inability to receive stations between 200 and 214 meters (1400 and 1500 kc.), or crystal-controlled transmissions below 214 meters (above 1300 kc.), at their designated positions on the "Selector" drum, indicates the need for realignment of the tuning condensers. The correct procedure is: first, remove the chassis from the cabinet, and put it in operation with the third-circuit covering rest of the detector and audio sections in shunt with C4; then, in succession, align C3, C3, C2, C1. To align C2 for lowest signal, it will be necessary to unsolder the red wire from the rear stator soldering lug of C1. Then resolder the red wire to the stator lug of C1 and unsolder both wires (those connected to each other) from the stator lug of C3; and align C3 for lowest signal. Re-solder the wires to the stator lug of C2. When they are properly aligned, the aligning screw of C4 will be practically all the way in; those of C3 and C2 will be nearly all out and with frame and spring separated about 1/4-in. It is absolutely essential that the rotor and dial and volume control settings remain unchanged during the above operations, which must be carried out in the order specified. If the receiver will not tune down to 200 meters (1500 kc.), the aligning process has been carried out with the aligning condensers screwed too-tight.

If the loud-speaker frame becomes ungrounded and "floats," the receiver will usually oscillate; as, also, if the ground lead is unconnected, poor tubes are in use, the R.F. plate leads incorrectly located, or tube shields not firmly in position. It is vitally important that the three R.F. plate leads (leading from lug of a) the socket sets of V1, V2, V3, through and under chassis partition to their respective inductors) be pushed down carefully into the angle between the chassis and the partitions, where they run from the socket lug up to the slot in the partition. If, during previous servicing, these leads have been allowed to struggle through the set, and are not placed exactly as specified, the circuits will invariably oscillate. An inefrant cause of circuit oscillation is a short of L10; or a defective C5 or C8. If the "overtone" switch SW1 fails to change the timbre of programs, carefully check the values of C5, C7 and C8.

A tension screw on the bush of the dial, which is held by a lock-nut, permits the drive cord to be tightened when necessary.

If it becomes necessary to replace an R.F. coil, the replacement coil must have upon its end the same crayon identifying number as the defective coil.

The following values are used in the Silver "Model 30" chassis: C5, C7, .00015-mf.; C6, .006-mf.; C8, .001-mf.; C9, C10, C11, C12, 0.1-mf.; P1, 10,000 ohms; R1, R2, R3, 400 ohms; R4, R5, R6, 2600 ohms; R7, 60,000 ohms (Blue); R8, 2,000 ohms (White); R9, 100,000 ohms (Green); R10, 300,000 ohms (Yellow); R11, 3500 ohms (Brown); R12, R13, R14, R15, 1000,000 ohms tapped resistor; R17, 2 meg. (Red); C14, 2-mf. L1, L7, L8, L9, L10 are "Type 274-D" R.F. chokes.

A screen antenna is contained inside the cabinet top.

To readjust the gang condenser bearings, if they are too tight, loosen the dial set screws sufficiently to free the dial, after removing the chassis. Adjust the condenser so that the rotor turns freely. First release all rotor spring tension screws. If the condenser is still tight, or if end-play exists, the thrust screw must be carefully adjusted. The rotor spring bearings should be adjusted one by one, so they do not press the rotor shaft upward. Otherwise, the screw should be completely removed and the upper spring bent back as to bear down upon the rotor shaft (as the screw is tightened) before the lower rotor spring forces the shaft upward. The proper adjustment of the rotor springs is when they are not loose enough to cause vertical play, but permit side play.
Schematic Drawing of the Sparton Equasonne Circuit
Radio Service Data Sheet

SPARTON "EQUASONNE" MODELS 931 AND 301 D.C.

This will bring back to normal the increased voltage across the filament of the Type 182 (Sparks-Williams Co.'s) power tubes V7-V8 (equivalent to the standard '71A). The dial light, with a 0.75-ohm resistor in series, is shunted across the filaments of the R.F. amplifiers and the power detector V6. Therefore, if the filament of one of the "484" tubes should burn out, V9 will act as a fuse and also burn out; this tube is to the Service Man an indication of the trouble. For this reason, too, tubes should be removed from their sockets only when the set is disconnected from the line, to prevent burning out V9. (If the heater [filament] of one of the 484s should burn out, the remaining tubes in the series will not light until the circuit is completed through a replacement tube or an equivalent resistor.)

As the Sparton tubes carry a 90-day guarantee, the Service Man should acquire himself with the limitations of this guarantee. The specifications set by the manufacturer for tubes subject to replacement and having the proper sticker, dated, are as follows: low amplification; low emission; loose bases; defective webs; unshielded terminals; gray; open heaters; one element shorted to another; loose pins; low mutual conductance; no plate current; loose elements; open filament. Tubes having loose tops; broken glass; broken stems; broken bases, or dented outside the time limit cannot be replaced.

An external "C" battery supplies the bias for the power tubes. V9 may be a 3.8-volt Mazda P3, type G3.

The currents in the filament-heater-resistor circuit is approximately 1.5 amperes under correct conditions. All continuity tests of the apparatus should be made with the set off the line.

Although grounds are shown in the schematic circuit, this is not to infer that no ground should be connected to this set. The reason is that one side of the D.C. line is grounded in one place; consequently, if, for example, with the line-plug connections reversed the set should be connected to an external ground in any manner a short-circuit would result. In some D.C. sets fixed condensers will be found in both ground and antenna leads; in this receiver accidental grounding of the antenna (which usually results, when the lead-in insulation of a poorly installed aerial is rubbed, through permitting the lead to touch metal on the building) is prevented by the antenna condenser shown. An additional safety factor in the D.C. "Equasonne" is a 15-mmp fuse in the negative side of the line.

All tuning is obtained before the input of V1, a band-selector circuit being used to secure the desired selectivity. The signal is amplified successively by V1, V2, V3, V4 and V5. V6 is the "power" detector; the signal transferred being made through "specific" (broadly-resonant) R.F. transformers. In series with a special R.F. coil arrangement in the plate circuit of V1 is a 2,500-ohm resistor, shunted by a fixed condenser of very small capacity.

The bank of three 15-ohm resistors in series with the reproducer's field coil limits the current consumption to approximately the correct amount; some accurate adjustment for high or low line supply is obtained through the 7-ohm resistor which is controlled by the switching switch marked "Hi-Lo." ('Lo.' below 115 volts; 'Hi.' 115-135 volts.) It has been found that the "110-volt" D.C. supply in some instances may rise to a value of 150 volts, and the resistor in this case is too low. The three resistor bank a fourth resistor, also of 15 ohms.

The Service Man is recommended to check first the 15-ohm resistors in the 45-ohm bank. There is no other outstanding point for test, in the event of trouble, in this set; the dynamic reproducer requires usually no attention.

The volume control in this receiver has a resistance of 150,000 ohms. A few cautions must be observed with regard to the filament circuit of this receiver. If the pilot light should burn out, replace it at once.

For reference, the characteristics of Sparton tubes are given in the accompanying table; in which SX is the Sparta tube-type designation; PV, filament volts; FA, filament amps.; GV, grid volts; PF, plate volts; PMa, plate milliamps.; PR, plate resistance; Mn, amplification factor.

The Sparton tube numbers 371, 373, and 301A have been discontinued. The 401 is a "side-heater" tube similar to the Kellogg tube of the same characteristics. The 585 has a wire mesh plate, the 666, also a high-power tube, has a solid plate. The 182 has a slightly higher output than the standard '71A. The 484 is a type tube with a 3-volt filament. The 182B is a special 3-volt tube with slightly higher output than the standard '71B. Type 269 and 281 tubes are similar to the standard '80 and '81.
Schematic Drawing of the Sparton Equasonne Circuit

SPARTON DELUXE MODEL - 109

SWITCH 120 TO 130 V.
FUSE 100 TO 120 V.
POWER SUPPLY 100 TO 110 V.

VOLUME CONTROL
GROUND CONNECTION TO PANEL

POWER CONVERTER

SPARTON MODEL AC - 89
RECEIVER

TWISTED PAIR

DIAL LIGHT

SELECTOR UNIT
AMPLIFIER UNIT

PHONOGRAPH PICK-UP

PHONOGRAPH PICK-UP
TWISTED PAIR

VOLUME CONTROL
GROUND CONNECTION TO PANEL

POWER CONVERTER

DIAL LIGHT

SELECTOR UNIT
AMPLIFIER UNIT

AMPLIFIER UNIT

Schematic Drawing of the Sparton Equasonne Circuit

SPARKS-WITHINGTON CO.
Schematic Drawing Sparton Equasonne Receivers Model 110

SPARTON DELUXE MODEL 110 RECEIVER

Schematic Drawing Sparton Equasonne Receivers Model 110

SPARTON MODEL 5-26
MODEL 5-15 THE SAME EXCEPT FOR DIAL LIGHTS

SPARKS-WITHINGTON CO.
On the terminal strip of this receiver are mounted: the power-cable lugs; the grid leak and condenser; the detector-plate by-pass condenser; the two ammeter-tap resistors; and the 600-ohm and 2500-

A special input circuit is used on the Steinite receivers, for the purpose of obtaining sensitivity. The circuit acts as an autotransformer when the antenna leads are connected at the junction between L1 and C1. The purpose of R1 is to complete the D.C. path for the grid bias.

drawing the four screws which secure it to the cabinet, permitting the entire assembly to be pulled out from the back of the cabinet and making easy access to the six bolts which secure the chassis to its supporting-shelf.

If the volume control does not function, consideration of the schematic circuit indicates that the trouble may be due to a shorted C2 or C3.

If the transformer's filament windings for V4, V5, V8-V9 are making contact or flashing over, resistor R2 (situated under the terminal strip and colored red) will be burst out and consequently show an open circuit, or no "C" voltage on the grid of V5. The remedy for this condition is to remove the transformer from the power pack and substitute another. Only early models should require this repair.

The phonograph turntable should rotate at the standard speed of 78 r.p.m.

Any hum which may develop is ordinarily traceable to the detector; particular care taken in the selection of a detector tube when first setting up the receiver will result in best operation over an extended period.

Variation from the standard circuit to include connections for the phonograph-radio switching arrangement on the 102-A is illustrated; the schematic is laid out to correspond with the view of the switch escutcheon, which is a rear one.

The aligning condensers of the receiver, shown in the parts layout, are not shown in the schematic circuit.

Line voltage tap colors of pack are: red, 90; white, 100; blue, 110; green, 130.

The average voltage readings (as shown by a standard set analyzer) for the 50-A and 102-A are given in the table which follows:

Readings of Tester with Test Plug in Socket of Set

Tube Type "A" "B" "C" "D" "E" "F"

<table>
<thead>
<tr>
<th>Tube</th>
<th>DIAL LAMP</th>
<th>DIAL LAMP</th>
<th>DIAL LAMP</th>
<th>DIAL LAMP</th>
<th>DIAL LAMP</th>
<th>DIAL LAMP</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>22</td>
<td>2.75</td>
<td>134</td>
<td>2.45</td>
<td>125</td>
<td>6.5</td>
</tr>
<tr>
<td>V2</td>
<td>22</td>
<td>2.75</td>
<td>1.34</td>
<td>2.45</td>
<td>125</td>
<td>8.7</td>
</tr>
<tr>
<td>V3</td>
<td>22</td>
<td>2.75</td>
<td>1.34</td>
<td>2.45</td>
<td>125</td>
<td>8.7</td>
</tr>
<tr>
<td>V4</td>
<td>22</td>
<td>2.65</td>
<td>9.2</td>
<td>2.46</td>
<td>32</td>
<td>2.9</td>
</tr>
<tr>
<td>V5</td>
<td>22</td>
<td>2.65</td>
<td>1.44</td>
<td>2.46</td>
<td>118</td>
<td>8.2</td>
</tr>
<tr>
<td>V6</td>
<td>50</td>
<td>2.7</td>
<td>3.55</td>
<td>7.4</td>
<td>3.10</td>
<td>31.0</td>
</tr>
<tr>
<td>V7</td>
<td>50</td>
<td>2.7</td>
<td>3.55</td>
<td>7.4</td>
<td>3.10</td>
<td>31.0</td>
</tr>
<tr>
<td>V8-V9</td>
<td>50</td>
<td>2.7</td>
<td>3.55</td>
<td>7.4</td>
<td>3.10</td>
<td>31.0</td>
</tr>
</tbody>
</table>

These values were determined with a line-voltage of 110 and with the line-voltage tap on the power transformer set at 110 V. (Volume Control position "Max.").
Circuit Diagrams---No. 4 Chassis, Power Unit and Speaker
Circuit Diagrams—No. 3A Chassis, Power Unit and Speaker
Schematic Diagram of Connections for Stewart-Warner One-Dial Control

Model 305-315-320 with 45 volt B on R.F

Model 305 with front panel jacks

Model 305-315-320

Model 300

Model 310-325

Model 330

Model 335-340

One Dial Control

Model 345-350-355-360

Model 385-390

One Dial Control

A Typical Tuned RF Circuit with "C" Batt. Connections
STEWART-WARNER CORP.

- POWER UNIT -

MODELS

530 - 535 - 715 - 720

POWER UNIT
MODEL 801, 801-A, 811, 811-A

ONE DIAL CONTROL

PHONOGRAPH

MODEL 801, 801-A, 811, 811-A SERIES B

ONE DIAL CONTROL

PHONOGRAPH

MODEL 806 SERIES B

SERIES B

+135B
Circuit Diagram of Stewart-Warner 950 Series D. C. Receiver

950 Series 25 and 60 Cycle A. C. Radio Receivers
Radio Service Data Sheet

STEWART-WARNER SERIES 900

This receiver is so designed as to permit the use of tubes of widely differing characteristics. In addition to being adaptable to aerials of the usual type, it makes provision for use of the light-line, if desired, with results which, when the line plug is inserted, are accomplished, with the aid of an adjustable trimmer condenser, C5, controlled from the panel.

The detector output of this receiver may be tapped to any external equipment, by connection to posts provided on the rear of the receiver. Specifically, it is intended to make convenient the operation of television equipment by connecting to binding posts BP1 and BP2. Also, the detector output may be tapped for operation of a phonograph pickup, by connection to posts BP1 and BP2.

There is no switching device for disconnecting the pick-up; for its leads would introduce a capacitance that would impair the “phase” conditions, (resonance of the stages of the set; consequently, the pick-up connections must be removed from the receiver when only radio reception is desired. The amplification of the detector tube is obtained when the “link” is connected to the two binding posts shown at the upper right of the schematic.

This receiver is designed to use either a magnetic or a dynamic reproducer; the field winding of the Stewart-Warner dynamic has a D.C. resistance of approximately 1,800 ohms. There is no transformer in this secondary of the output unit T3 matches the constants of the (12-ohm) speaker voice coil. A connection receptacle is provided for the dynamic reproducer; but magnetic reproducers connect instead to tip-jacks. The “B” voltages, which are disturbed when the dynamic reproducer field coil is removed from the circuit are equalized by load resistor R8, which is placed in shunt with the high voltage D.C. line when the “link” is connected to the two binding posts shown at the upper right of the schematic circuit. Magnetic, and other makes of dynamic, reproducers connect, as shown, from plate to plate of the power tubes.

The line-voltage balast R12 is designed to equalize line voltages between the limits of 100 and 120 volts. The R.F. transformers are checked at three wavelengths from the output of a crystal-controlled oscillator at the factory; little likelihood that they are not in exact balance with each other, should the tuning circuits not “phase” exactly.

In this receiver the plate D.C. supply for the set is fed through R.F. chokes, Ch1, Ch2 and Ch3. Resistors R4 and R3 are wound on one form. Units which might be subject to occasional replacement are easily removable from the set chassis. Filament leads are twisted pairs. The grid bias on the 27s is limited to a minimum value by R1; but R2 makes possible a maximum bias which is sufficient to give full control of the amplification obtainable from the receiver.

[ TABLE 1

(Readings with Jewell "Pattern 199")

<p>| Milliamperes |
|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Tubes</th>
<th>Volts</th>
<th>Volts</th>
<th>Grid</th>
<th>Plate</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>2.2</td>
<td>132</td>
<td>8.5</td>
<td>3.8</td>
</tr>
<tr>
<td>V2</td>
<td>2.2</td>
<td>138</td>
<td>8.5</td>
<td>3.2</td>
</tr>
<tr>
<td>V3</td>
<td>2.15</td>
<td>138</td>
<td>8.5</td>
<td>3.9</td>
</tr>
<tr>
<td>V4</td>
<td>2.10</td>
<td>32</td>
<td>0.0</td>
<td>2.8</td>
</tr>
<tr>
<td>V5</td>
<td>2.2</td>
<td>132</td>
<td>7.5</td>
<td>5.4</td>
</tr>
<tr>
<td>V6</td>
<td>2.25</td>
<td>264</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td>V7</td>
<td>2.25</td>
<td>264</td>
<td>47.5</td>
<td>26.0</td>
</tr>
<tr>
<td>V8</td>
<td>3.7</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

[Diagram and schematic circuit drawing provided]
STROMBERG-CARLSON MFG., CO.

CIRCUIT D-988
(AUDIO POWER UNIT D-947)
FOR 523-524 D.C. RADIO REC.

"523 & 524 D.C. RADIO RECEIVER CIRCUIT"

Schematic Circuit Diagram of Stromberg-Carlson Receivers Nos. 635 & 636.
Radio Service Data Sheets

STROMBERG-CARLSON Nos. 641 & 642

As will be seen in the photograph of the assembled unit, all operating parts are enclosed. All transformers, inductances and capacitors are mounted in metal boxes; and filled with moisture proof compound. The power transformer leads are laced to the main cable. To insure good connection for the grounding leads, the chassis of steel has been copper plated. The 641 is a small model in a cabinet known as the "Treasure Chest." The 642 is the same chassis, nearly, in an art console. A removable panel is provided on the cabinet bottom to allow ready access to the apparatus and wiring on the under side of chassis base without dismounting the cabinet. (In the case of the 641.) The receiver chassis and reproducer are bolted to a removable structure; as is also the front panel. This renders servicing easy. The items shown in the photograph are numbered as follows: 1, Output transformer assembly; 2, audio amplifier socket ("45"); 3, A.F.T.; 4, "gcd." post; 5, "ant." post; 6, cover over tubes (one nearest dial, "27"; next three, "24"); 7, filter condenser bank; 8, cover over high-low switch; 9, power supply cord; 10, rectifier tube ("80") socket; 11, power transformer; 12, choke coil assembly; 13, volume control and switch; 14, dial; 15, selector control; 16, on-off switch; 17, pilot lamp socket and bracket. Pin jacks for loud speaker cord are at rear, left, (and consequently not visible) while the pickup jack, power outlet, and power control cord are grouped at rear right. The volume control is double and operates by varying the voltage applied to the control grids of the first and second radio amplifier tubes as well as the voltage supplied to radio amplifier from the antenna. The two controls are simultaneously operated from one knob. The grid bias control does not begin to operate until the volume is partially reduced by the antenna control; this prevents distortion due to overloading the radio amplifier when the volume is turned down on very strong local signals. This type of volume control does not cause detuning when it is varied. A "27 is used as a "linear" power detector; with automatic bias. This detector operates at high radio frequency voltages provided by the R.F. amplifier and is not subject to the ordinary distortion to which the "square law" detector is heir. The grid bias is automatically adjusted to the proper value for the strength of signal received to obtain this linear characteristic. The value of the R.F. input to the detector is so high that the output may be fed directly to the single stage of amplification shown in the diagram. The output transformer secondary connects to pin jacks, in the model 42 receiver; in the 41, a fixed condenser connects one pin jack capacitively to the primary of the output transformer, while the other pin jack is connected to the center tap on the 10 ohm resistor which shunts the power tube filament. A jack has been placed in the rear of the chassis for plugging in a pickup. By turning the volume control completely "Off" (counter-clockwise) the pickup is connected in the grid circuit of the detector tube. This tube then acts as an amplifier, making a two stage amplifier for the pickup energy. To energize an A.C. type dynamic reproducer an outlet has been supplied in the model 61; it is automatically cut off when the set is disconnected as the panel. In the 42 this outlet is used to supply the A.C. needed for the built-in dynamic reproducer. Hum due to this circuit arrangement of the reproducer is nullified by careful design; including the use of a "shading ring." Rust flakes and filings in the air gap will result in distorted reception. To reduce as much as possible this cause of poor operation, the pole pieces have been heavily zinc plated. Very complete shielding is necessitated by the high amplification obtained and from the antenna to the output of approximately 575,000, it will be observed the Nos. 641 and 642 receivers have approximately 20 times more amplification between the antenna and the detector. This allows the use of a linear power detector, the omission of the first audio stage and still gives an overall amplification of approximately four times that of the other receiver. Instead of the dynamic reproducer field, a floor lamp may be connected to the A.C. output jack mentioned above.

---

Radio Service Data Sheets

STROMBERG-CARLSON Nos. 641 & 642

As will be seen in the photograph of the assembled unit, all operating parts are enclosed. All transformers, inductances and capacitors are mounted in metal boxes; and filled with moisture proof compound. The power transformer leads are laced to the main cable. To insure good connection for the grounding leads, the chassis of steel has been copper plated. The 641 is a small model in a cabinet known as the "Treasure Chest." The 642 is the same chassis, nearly, in an art console. A removable panel is provided on the cabinet bottom to allow ready access to the apparatus and wiring on the under side of chassis base without dismounting the cabinet. (In the case of the 641.) The receiver chassis and reproducer are bolted to a removable structure; as is also the front panel. This renders servicing easy. The items shown in the photograph are numbered as follows: 1, Output transformer assembly; 2, audio amplifier socket ("45"); 3, A.F.T.; 4, "gcd." post; 5, "ant." post; 6, cover over tubes (one nearest dial, "27"; next three, "24"); 7, filter condenser bank; 8, cover over high-low switch; 9, power supply cord; 10, rectifier tube ("80") socket; 11, power transformer; 12, choke coil assembly; 13, volume control and switch; 14, dial; 15, selector control; 16, on-off switch; 17, pilot lamp socket and bracket. Pin jacks for loud speaker cord are at rear, left, (and consequently not visible) while the pickup jack, power outlet, and power control cord are grouped at rear right. The volume control is double and operates by varying the voltage applied to the control grids of the first and second radio amplifier tubes as well as the voltage supplied to radio amplifier from the antenna. The two controls are simultaneously operated from one knob. The grid bias control does not begin to operate until the volume is partially reduced by the antenna control; this prevents distortion due to overloading the radio amplifier when the volume is turned down on very strong local signals. This type of volume control does not cause detuning when it is varied. A "27 is used as a "linear" power detector; with automatic bias. This detector operates at high radio frequency voltages provided by the R.F. amplifier and is not subject to the ordinary distortion to which the "square law" detector is heir. The grid bias is automatically adjusted to the proper value for the strength of signal received to obtain this linear characteristic. The value of the R.F. input to the detector is so high that the output may be fed directly to the single stage of amplification shown in the diagram. The output transformer secondary connects to pin jacks, in the model 42 receiver; in the 41, a fixed condenser connects one pin jack capacitively to the primary of the output transformer, while the other pin jack is connected to the center tap on the 10 ohm resistor which shunts the power tube filament. A jack has been placed in the rear of the chassis for plugging in a pickup. By turning the volume control completely "Off" (counter-clockwise) the pickup is connected in the grid circuit of the detector tube. This tube then acts as an amplifier, making a two stage amplifier for the pickup energy. To energize an A.C. type dynamic reproducer an outlet has been supplied in the model 61; it is automatically cut off when the set is disconnected as the panel. In the 42 this outlet is used to supply the A.C. needed for the built-in dynamic reproducer. Hum due to this circuit arrangement of the reproducer is nullified by careful design; including the use of a "shading ring." Rust flakes and filings in the air gap will result in distorted reception. To reduce as much as possible this cause of poor operation, the pole pieces have been heavily zinc plated. Very complete shielding is necessitated by the high amplification obtained and from the antenna to the output of approximately 575,000, it will be observed the Nos. 641 and 642 receivers have approximately 20 times more amplification between the antenna and the detector. This allows the use of a linear power detector, the omission of the first audio stage and still gives an overall amplification of approximately four times that of the other receiver. Instead of the dynamic reproducer field, a floor lamp may be connected to the A.C. output jack mentioned above.
Nos. 652 and 654 Receivers

STROMBERG CARLSON MFG., CO.

NO. 638 D.C. RADIO RECEIVER
SCHEMATIC DIAGRAM

Dynamic Speaker Field Supply Cord.

Audio Filter

Output Choice

Loud Speaker Pin Jacks

1ST R.F.

2ND R.F.

3RD R.F.

1700'

8000'

A.C. Power Supply

Rectifier

2 MF.

1 MF.

2 MF.

1 MF.

4800'

3000'

4000'

7800'

10000'

GND.
STROMBERG-CARLSON MFG., CO.

No. 1-B radio receiver circuit.

Schematic circuit of chassis for Nos. 10 and 11 receivers.
In this receiver A.F. transformer TR1 has a ratio of 4:1; TR2, 3:1. Cases are occasionally reported where, when a loud signal is run into the set, the receiver will suddenly go dead but immediately start again if it has been returned. This condition is due to fine metallic dust which collects between the condenser plates and causes an electrostatic short at irregular intervals. Every precaution to overcome this difficulty has been taken and it is not found in receivers bearing serial numbers over 8000. (Pipe cleaners make excellent condenser plate cleaners.) The small carbon resistors on the bottom of the chassis have been color coded (to prevent substitution of wrong values), as follows: 750,000 ohm resistor, either all red or natural color with a blue dot. The 2 meg. fixed is natural with a yellow dot and the 45,000-ohm resistor (detector plate lead and also in phonograph pickup lead), all black or black with dark green dot or all black with red end. In case a carbon resistor is substituted in place of the wirewound grid suppressor these will be light green in color. The voltages indicated in the table, "Set Analysis," for 112 volts; any other than this will be satisfactory. In the filament-to-ground circuit of the '45's or a shorted by-pass condenser across the 900-ohm meter, the UX280 or the CX380 is recommended by the manufacturers for the reason that some makers of tubes pass 200 milliamperes instead of the required 125 milliamperes, at 550 volts. This would cause (a) the A.C. input fuse to blow; (b) rectifier tube burnout; or, (c) power transformer to heat to a dangerous point. In instances of excessive hum (a rare condition, as unusual precautions have been taken to prevent this, as a study of the schematic will, in part, show), check the characteristics of the detector and first audio tube. All receivers bearing serial numbers under 7,500 have the pilot light in parallel with the '27 filaments. Beginning with serial numbers approximately 7,600 the pilot light is parallel with the filaments of the '45 tubes. This change was made due to the fact that many of the 25-volt pilot light supplied by the lamp maker would show a deflected flicker when their source of power was from the most, will be satisfactory. In some instances high resistance in the water meter, where sets are grounded to the water pipe will cause oscillation or impaired reception due, often, to excessive regeneration. Cases of this kind are easily remedied. Simply fasten a ground clamp to each side of the water meter and connect a No. 14 wire "jumpers" across the meter, attaching to the two ground clamps. The 14-inch dynamic reproducer is designed particularly for this receiver. Tuning is of the single-control type. With every stage balanced at the factory extreme sensitivity and selectivity result. This excellent operation is obtained through proper use of 1000 ohm grid supressors; and volume is adequately governed by the 6000 ohm unit. Under exceptional conditions it may be desirable to shift the low resistance R.F. transformer in the plate circuit primary of the second stage (second tube), with a 10 ohm resistor. This unit has been provided; and is controlled by the switch indicated in the schematic circuit. As the field coil of the dynamic reproducer constitutes part of the main filter, any defect in this winding will become manifest in the condenser drive. In case of open A.F.T. windings, replace both transformers (the entire can) thus insuring a perfectly matched audio amplifier at all times.

**Diagram of Receiver Chassis**

- **TYPICAL SET ANALYSIS**
  - **Tubes Out**
  - **Tubes In**
  - **Line Voltage 112**
  - **Volume Control Position**
  - **Full On**

- **Reading on meter, one anode only:**
  - **Actual current twice this value.**

Note: Cathode voltages show a reversed reading.

- **Power Pack**
  - **Reproducer Chassis**

- ** repeat readings**

- **Diagram of Receiver Chassis**
  - **Power Pack**
  - **Reproducer Chassis**
  - **Field Coil**
  - **Output transformer**
  - **1200 OHMS**
  - **1400 OHMS**
  - **1600 OHMS**
  - **2000 OHMS**
  - **2500 OHMS**
  - **3000 OHMS**
  - **3500 OHMS**
  - **4000 OHMS**
  - **4500 OHMS**
  - **5000 OHMS**
  - **6000 OHMS**
  - **7000 OHMS**
  - **8000 OHMS**
  - **9000 OHMS**
  - **10000 OHMS**

- **To Line**
  - **DIAGRAM OF RECEIVER CHASSIS**
  - **00225 MF.**
  - **00035 MF.**
  - **00035 MF. EACH**
  - **00035 MF. EACH**

- **43000 OHMS**
  - **75000 OHMS**
  - **12000 OHMS**
  - **20000 OHMS**
  - **30000 OHMS**
  - **50000 OHMS**
  - **70000 OHMS**
  - **90000 OHMS**
  - **110000 OHMS**
  - **130000 OHMS**
  - **150000 OHMS**

- **To Line**
  - **DIAGRAM OF RECEIVER CHASSIS**
  - **00225 MF.**
  - **00035 MF.**
  - **00035 MF. EACH**
  - **00035 MF. EACH**

- **43000 OHMS**
  - **75000 OHMS**
  - **12000 OHMS**
  - **20000 OHMS**
  - **30000 OHMS**
  - **50000 OHMS**
  - **70000 OHMS**
  - **90000 OHMS**
  - **110000 OHMS**
  - **130000 OHMS**
  - **150000 OHMS**
UNITED REPRODUCERS CORP.

COURIER "65" CHASSIS

SCHEMATIC WIRING DIAGRAM, THE SERIES K-70
MODEL 80

ALL MODELS WITH SERIAL NUMBERS ABOVE 5050 WILL HAVE THIS VOLUME CONTROL—NOTE KEYS ONLY ABOVE

TO SET SWITCH

FOR DYNAMIC

GREEN (T)
GREEN
BLACK
BLUE
RED
YELLOW
BLACK
RED
YELLOW
BLACK

100-130K 600 OHM

LOCAL DISTANCE SWITCH

APEX

48-60

48A-25

SECTION SHOWN IN DOTTED LINES IS IN SPEAKER
The schematic circuit and wiring connections of the U. S. Radio "Model 30" screen-grid automotive receiver. When the positive side of the car's storage battery is grounded, the red lead connects to terminal "A" of the junction box, from which one side of all voltage readings is then taken. If the battery's negative is grounded, the red lead connects to "ground" on the screw "B" which mounts the junction box.
OFFICIAL RADIO SERVICE MANUAL

ZENITH RADIO CORP.

MODELS 11-12-14

VOLUME CONTROL

MODEL 11E AND 14E ELECTRIC RECEIVERS

II E FROM 48657 TO 51050
14E FROM 605420 TO 607147.
ZENITH RADIO CORP.

WIRING DIAGRAM
MODEL 31-32
6 TUBE BATTERY SET
ZENITH RADIO CORP.

WIRING DIAGRAM
MODEL 35P-35AP-352P-352AP
& TUBE ELECTRIC SET
SPLITDORF ELEC., MFG., CO.

R-200

PAD - 4

DYNAMIC FIELD PLUG

ABBEY - (WITH VOLUME CONTROL)
Amazingly Easy Way
to get into ELECTRICITY

Don’t spend your life waiting for $5 raises in a dull, hopeless job. Now... and forever... say good-bye to 25 and 35 dollars a week. Let me show you how to qualify for jobs leading to salaries of $50, $60 and up, a week, in Electricity—NOT by correspondence, but by an amazing way to teach, RIGHT HERE IN THE GREAT COYNE SHOPS. You become a practical expert in 90 days!

Getting into Electricity is far easier than you imagine!

Learn Without Lessons in 90 DAYS
By Actual Work—in the Great Shops of Coyne

Lack of experience—age, or advanced education bars no one. I don’t care if you don’t know an armature from an air brake—I don’t expect you to! I don’t care if you’re 16 years old or 48—it makes no difference! I don’t care if you don’t know an armature from an air brake—I don’t expect you to! I don’t care if you’re 16 years old or 48—it makes no difference!

Railroad Fare Allowed
I will allow your railroad fare to Chicago, and if you should need part-time work I’ll assist you to it. Then, in 12 brief weeks, in the great roaring shops of Coyne, I train you as you never dreamed you could be trained on a gigantic outlay of electrical apparatus... costing hundreds of thousands of dollars... real armatures, operating real motors, dynamos and generators, wiring houses, etc., etc.

That’s a glimpse of how we make you a master practical electrician in 90 days. teaching you far more than the average ordinary electrician ever knows and fitting you to step into jobs leading to big pay immediately after graduation.

Jobs—Pay—Future
Don’t worry about a job, Coyne training settles the job question for life. Demand for Coyne men often exceeds the supply. Our free employment bureau gives you a lifetime service. Two weeks after graduation, Clyde F. Hart got a position as electrician for the Great Western Railroad at over $100 a week. That’s not unusual. We can point to Coyne men making up to $350 a month, $250 a week. It’s the beginning of your opportunity. You can go into radio, battery, or automotive electrical business for yourself and make up to $15,000 a year.

GET THE FACTS
Coyne is your one great chance to get into electricity. Every obstacle is removed. This school is 80 years old—Coyne training is tested—proven beyond all doubt—endorsed by many large electrical concerns. You can find out everything absolutely free. Simply mail the coupon and let me send you the big, free Coyne book of 150 photographs... facts... jobs... salaries... opportunities. Help you how many earn expenses while training and how we assist our graduates in the field. This does not obligate you. So act at once. Just mail coupon.

Get This FREE Book

COYNE ELECTRICAL SCHOOL
H. C. LEWIS, Pres. Established 1899
500 S. Paulina Street • Dept. BO-69 • Chicago, Illinois

Mr. H. C. LEWIS, President
COYNE ELECTRICAL SCHOOL, Dept. BO-69
500 S. Paulina St., Chicago, Ill.

Dear Mr. Lewis:
Without obligations and may our big free catalog and all details of Railroad Fare to Chicago, Free Employment Service, Radio, Aviation, Electricity, and Automotive Courses, and how I can “earn while learning.”

Name
Address
City...
State...
ABBREVIATION MODEL-171

SCHEMATIC DIAGRAM OF BALDWIN SCREEN GRID RECEIVING SET

MODEL 80

KEY
1. DC RESISTANCE 2000
2. CARBON RESISTORS
3. VOLUME CONTROL
4. SENSITIVITY ADJUSTMENT
   CONTROLLED BY SCREW IN REAR OF CHASSIS

MODEL 80

NATHANIEL BALDWIN CO.
ADJUSTABLE SLIDING CLIP
--A handy Feature found only on TRUVOLT

“Built with ELECTRAD Resistors”
means
Built to PERFORM!

SINCE the birth of the radio industry, the ELECTRAD organization has built radio resistors of superior engineering refinement, quality manufacture and perfect adaptability to existing radio requirements.

The success of this policy is shown by the universal use and endorsement of ELECTRAD Resistors by radio experts all over the world.

ELECTRAD Resistors in the radio you build, buy or sell will pay you the dividends that come from perfect operation and long efficient service.

ELECTRAD engineers are specialists in resistors and voltage controls. Your problems are their problems and you are invited to ask for their advice and cooperation whenever you desire it.

The radio service man is doing an important work in insuring radio owners satisfaction and the ELECTRAD organization welcomes the opportunity to be service men to service men.

The ELECTRAD line of stock resistors and voltage controls covers practically every radio need. It will pay you to familiarize yourself with all ELECTRAD products.

Mail the Convenient Coupon for general literature, or write us a letter about special problems.
Diagram of Type B-195 Argus Electric Radio Receiver

The numerals followed by letter "R" indicate soldered points in numerical order on the row on left hand of the radio sub-panel (when facing the receiver) and counting from front towards rear.

The numerals followed by letter "F" indicate the leads from the filter box counting from front towards rear (count also the "blank" holes.)
Radio is one of the real marvels of this modern age. Its development has been phenomenal. It is growing, changing, evolving new principles which require constant study. The demand is for technically trained men—men who keep pace with the unfolding revelations of this mighty and promising industry.

The International Correspondence Schools Course in Radio, prepared and constantly supplemented by outstanding authorities in the field, is specifically designed to meet the requirements of the radio industry for technically trained radio men. The manufacturer, the distributor, the dealer, Communication and Steamship Companies, the U. S. Government, all insist upon up-to-date, expert training. Recognized for its completeness and practicability, an I.C.S. Radio Course provides this training.

Authorities responsible for the preparation of the I.C.S. Radio Course include: H. H. Beverage, Radio Corporation of America; George C. Crom, American Transformer Company; Keith Henney, author of “Principles of Radio;” Malcolm E. Gager, instructor at the Massachusetts Institute of Technology; E. V. Amy, consulting radio engineer, formerly with R.C.A.; H. F. Dart, authority on radio tubes; Julius C. Aceves, consulting radio engineer, formerly of Columbia University, and others.

The I.C.S. Radio Course is complete, from the foundational principles of radio to the most advanced stages, thoroughly and scientifically covering every department of this vast industry. It is a modern education in radio, a valuable guide of advancement for men engaged professionally in the radio business. It also outlines the principles and possibilities of television.

Mark and mail the coupon. We will send you all details. This act may be the real beginning of your career in radio!

INTERNATIONAL CORRESPONDENCE SCHOOLS, Box 2326
Scranton, Penna.

Without cost or obligation, please tell me all about the
NEW RADIO COURSE

Name ___________________________________________
Street Address ____________________________________
City ____________________________________________ State __________

If you reside in Canada, send this coupon to the International Correspondence Schools Canadian, Ltd., Montreal, Canada.
In colors of this model, the leads from the filament winding are covered with light gray rubber or black sieving, and the grid return of No. 4 R.F.T. is yellow with black tracer instead of yellow.

In a few of these models, the quality condenser is connected across the primary of the output transformer, the connections being made inside the unit.

In these sets, the output transformer has five leads instead of seven.

Schematic Diagram of Chassis and Power Pack

The replacing of the old battery operated receivers with all-electric Radios has created a tremendous country-wide demand for expert Radio Service Men. Thousands of trained men are needed quick!

30 Days of R.T.A. Home Training

... enables you to cash in on this latest opportunity in Radio

Ever on the alert for new ways of helping our members make more money out of Radio, the Radio Training Association of America now offers ambitious men an intensified training course in Radio Service Work. By taking this training you can qualify for Radio Service Work in 30 days, earn $3.00 an hour and up, spare time; prepare yourself for full-time work paying $40 to $100 a week.

More Positions Open Than There Are Trained Men to Fill Them

If you were qualified for Radio Service Work today, we could place you. We can’t begin to fill the requests that pour in from great Radio organizations and dealers. Members wanting full-time positions are being placed as soon as they qualify. 5,000 more men are needed quick! If you want to get into Radio, earn $3.00 an hour spare time or $40 to $100 a week full time, this R. T. A. training offers you the opportunity of a lifetime.

Radio Service Work a Quick Route to the Big-Pay Radio Positions

Radio Service Work gives you the basic experience you need to qualify for the big $8,000, $10,000 to $25,000 a year Radio positions. Once you get this experience, the whole range of rich opportunities in Radio lies open before you. Training in this association, starting as a Radio Service Man, is one of the quickest, most profitable ways of qualifying for rapid advancement.

If you want to get out of small-pay, monotonous work and cash in on Radio quick, investigate this R.T.A. training and the rich money-making opportunities it opens up. No special education or electrical experience necessary. The will to succeed is all you need.

Mail Coupon for No-Cost Training Offer

Cash in on Radio’s latest opportunity! Enroll in the Association. For a limited time we will give to the ambitious man a No-Cost Membership which need not ... should not . . . cost you a cent. But you must act quickly. Filling out coupon can enable you to cash in on Radio within 30 days, lift you out of the small-pay, no-opportunity rut, into a field where phenomenal earnings await the ambitious. You owe it to yourself to investigate. Fill out coupon NOW for details of No-Cost Membership.

The Radio Training Association of America
4513 Ravenswood Ave. Dept. ORS-7, Chicago, Ill.

The Radio Training Association of America
4513 Ravenswood Ave., Dept. ORS-7 Chicago, Ill.

Gentlemen: Please send me details of your No-Cost training offer by which I can qualify for Radio Service Work within 30 days. This does not obligate me in any way.

Name:__________________________
Address__________________________
City____________________________State____________________
Note—in the 25 cycle models, R3 is shorted out and there is an additional 1 mfd. condenser connected from the R.F. screen-grids to ground.
I will train you at home
to fill a
BIG PAY
Radio Job!
If you are earning a penny less than $5 a week, send for my book of information on the opportunities in Radio. It is free. Clip the coupon now. Why be satisfied with $25, $30 or $40 a week for longer than the short time it takes to get ready for Radio.

Radio's growth opening hundreds of $50, $75, $100 a week jobs every year
In about ten years Radio has grown from a $2,000,000 to a $1,000,000,000 industry. Over 100,000 jobs have been created. Hundreds more are being opened every year by its continued growth. Men and young men with the right training—the kind of training I give you—are needed continually.

You have many jobs to choose from
Broadcasting stations use engineers, operators, station managers and pay $1,000 to $5,000 a year. Manufacturers continually need testers, inspectors, foremen, engineers, service men, buyers, for jobs paying up to $1,000 a year. Shipping companies use hundreds of Radio operators, give them world-wide travel at practically no expense and a salary of $85 to $200 a month. Dealers and jobbers employ service men, salesmen, buyers, managers, and pay $40 to $100 a week. There are many other opportunities too. My book tells you about them.

So many opportunities many N. R. I. men make $5 to $35 a week while learning
The day you enroll with me I'll show you how to do 10 times as much work as you can do now. Throughout your course I send you information on servicing popular makes of sets; ideas that are making $80 to $1,000 for hundreds of N. R. I. students in their spare time while studying.

Talking Movies, Television, Wired Radio included
Radio principles as used in Talking Movies, Television and home Television experiments, Wired Radio. Radio's use in Aviation, are all given. I am so sure that I can train you satisfactorily that I will agree in writing to refund every penny of your tuition if you are not satisfied with my Lessons and Instruction Service upon completing.

64-page book of information FREE
Get your copy today. It tells you where Radio's good jobs are, what they pay, tells you about my course, what others who have taken it are doing and making. Find out what Radio offers you, without the slightest obligation. ACT NOW.

J. E. SMITH, President
National Radio Institute Dept., OG-92
Washington, D.C.

Our Own Home
Pioneer and World's Largest Home-Study Radio training organization devoted entirely to training men and young women for good jobs in the Radio industry. Our growth has paralleled Radio's growth. We occupy three hundred times as much floor space now as we did when organized in 1914.

Lifetime Employment Service to all Graduates

I will give you my new 8 OUTFITS for Radio PARTS for a home Experimental Laboratory
You can build over 100 circuits with these outfits. You build and experiment with the circuits used in Crosley, Atwater - Kent, Eveready, Majestic, Zenith, and other popular sets. You learn how these sets work, why they work, how to make them work. This makes learning at home easy, fascinating, practical.

Back view of 3 tube Screen Grid A. C. tuned Radio frequency set—only one of many circuits you can build with my outfits.

I am doubling and tripling the salaries of many men in one year and less. Find out about this quick way to BIGGER PAY.

OFFICIAL RADIO SERVICE MANUAL 331
TRAV-LER MFG. CO.

AERIAL COUPLER TUBE

AC. POWER PACK

D.C. POWER PACK

Note: Black and white condenser leads are common leads. Numbers correspond to Jones Plug Connections.

Note: Blue Condenser Lead is Common. Numbers Correspond to Jones Plug Connections.
Radio needs you... That's why the entire Radio industry is calling for trained men... That's why thousands of men who answered these advertisements are now earning from $2,000 and up a year. Radio is highly interesting work... with opportunities that are yet unlimited. Manufacturers and broadcasting stations are now eagerly seeking trained RCA Institute men... Aviation and radio in the movies also provide innumerable opportunities... Millions of sets need servicing... thousands of ships require experienced operators... Never before was there an opportunity like this in Radio.

This is the Only Course Sponsored by Radio Corporation of America

RCA sets the standards for practically the entire Radio industry... The RCA Institutes Home Laboratory Training Course enables you to learn more than the mere ABC's of Radio... In your spare time, in only an hour or so a day, you can obtain a thorough, practical education in Radio... You get the inside information, too, because you study right at the source of all the latest, up-to-the-minute developments. RCA, the world's largest Radio organization, sponsors every single detail in this course.

You learn Radio by actual experience with the remarkable outlay of apparatus given to every student. You learn the "How" as well as the "Why" of every Radio problem, such as repairing, installing and servicing fine sets. That's why every graduate of RCA Institutes has the experience, the ability and the confidence to hold a worthwhile Radio job.

Practical Instruction for You to Study in Your Own Home

RCA Institutes offers four different courses... certainly instruction that you need. A complete serviceman's and repairman's technical course... advanced course... complete course without code... and a complete course including code. And practical instruction with each course. Courses that teach construction, repairing, service, broadcasting and ship operating.

Graduates of RCA Institutes Find It Easier to Get Good Jobs

They are closest to the source of Radio's greatest achievements because so much of the progress of Radio is measured by the accomplishments of the great engineers in the huge research laboratories of the Radio Corporation of America.

Students of RCA Institutes get first-hand knowledge, get it quickly and get it complete. Success in radio depends upon training and that's the training you get with RCA Institutes. That's why every graduate who desired a position has been able to get one... That's why graduates are always in big demand.

Study Radio at the Oldest and Largest Commercial Training Organization in the World

Send for our Free Book... it will explain our practical methods of training that has prepared hundreds of men for success in Radio. Remember that you, too, can be successful... can speed up your earning capacity... can earn more money in Radio than you ever earned before. The man who trains today will hold down the worthwhile Radio job of the future. Come in and get our free book or send for it by mail. Everything you want to know about the opportunities in Radio.

See for yourself why graduates of RCA Institutes now occupy thousands of well-paid positions. These positions are usually available in from 3 to 10 days after graduation for men who can qualify. RCA Institutes will back you up to the limit. Our catalogue is yours free... SEND FOR IT TODAY!
Statement by McMurdo Silver  
President, Silver-Marshall, Inc.

It has always been our policy to publish the full technical details of all Silver-Marshall Receivers, for we fully realize that the success of our sets depends not only on careful, painstaking manufacturing, but on the ability of the ultimate consumer to obtain satisfactory service.

We maintain a technical service information department and will be happy to give any legitimate service men or organization complete technical information on any Silver-Marshall Receiver they may be called on to service.

SILVER-MARSHALL, Inc.  
6401 West 65th Street - Chicago, U. S. A.

S -M Data Sheets

A Silver-Marshall Data Sheet, giving complete, detailed information, is published on all S-M parts equipment. They are freely supplied to service men and accredited service organizations for a small part of the handling costs—2 cents each. Recent Data Sheets are listed below:

- No. 16—712 Tuner (Development from the Sargent-Rayment)
- No. 18—722DC Band-Selector Six Receiver
- No. 19—692 Power Amplifier ('50 Push-Pull)
- No. 20—677B Power Amplifier ('45 Push-Pull)
- No. 21—737 Short-Wave Bearcat
- No. 22—770 Screen-Grid Auto-Set
VICTOREEN SUPERHETERODYNE

Victoreen Superheterodyne circuit. The double scale volt meter shown in the diagram is used to ascertain the "A" and "B" voltages at all times.

MADISON-MOORE SUPERHETERODYNE

Madison-Moore Superheterodyne circuit. UX-199 tubes are used throughout this receiver with the exception of the last stage of audio, which is a UX-120 power tube.

ST. JAMES SUPERHETERODYNE

St. James Superheterodyne circuit. A filament control jack is used in the last stage of audio. The filament circuit of the last tube is completed only when a loud speaker is plugged in.
Now!

AMPERITE
Self-Adjusting
LINE VOLTAGE CONTROL

Can Be Installed in ANY
Standard Radio

Insures Perfect
Operation of
A. C. Receivers
Regardless of
Line Variations

The finest designed receiver
and the best tubes can func-
tion properly only within a
voltage range of plus or minus 5
per cent. of rated specifications.

And yet, nationally sold radio sets are subjected to line voltages varying
as much as 30 per cent.

The AMPERITE Self-Adjusting Line Voltage Control automatically
regulates the voltage from the A.C. power main. It assures the right
voltage for most efficient operation, regardless of line variations, over a
30-volt range between 95 and 145 volts.

AMPERITE operates to a degree of accuracy unobtainable by any other
means. It prevents fluctuating line voltage from damaging tubes and
filter equipment. It is trouble free and long-lasting.

Many of the newer makes of receivers are equipped for AMPERITE.
A new development now makes it possible to install AMPERITE in any
A.C. receiver, regardless of standard equipment, in only a few minutes
and at very small cost.

There is an AMPERITE available for any popular electric set. The
Amperite Line Control Guide shows the proper type AMPERITE for
every popular make of electric radio set. Ask your jobber for it or
write direct to us. AMPERITE is an ideal product for the service man
as it assures improvement to any make of radio.

AMPERITE is manufactured and guaranteed by
the world's largest makers of automatic voltage
controls—exclusively.

AMPERITE Corporation
561 Broadway, New York, N. Y.
MODEL 311

Schematic circuit diagram of receiver and socket power unit—all grounds are connected to frame and metal cabinet.

C.R. LEUTZ INC.

Circuit diagram of the Leutz Universal Trans-Oceanic receiver. By means of a voltmeter and nine-point switch all A, B, and C voltages from 0 to 500 are read directly.

"SEVEN SEAS" CONSOLE
Guard your Reputation in service work... use DURHAM Metallized Resistors and insure satisfied customers.

POINTS OF SUPERIORITY

- Metallized Resistors are conservatively rated as to power.
- May be safely loaded to full capacity continuously and will carry a considerable overload.
- Accurately rated... units vary less than 10% plus or minus rated value.
- Metallized Resistors will not exceed their original tolerance even after years of use.
- Ratio of AC to DC resistance is practically 1 to 1, making them ideal for filter systems.
- Offered in all types... all carefully designed to provide maximum compactness, ease of assembly and rugged strength.
- Metallized Resistors are notably quiet, even after years of service.
- Metallized Resistors insure a lower change of resistance due to the homogenous metal coating.

Write for Guide “G. B.” today
Shores how to locate faulty reception and gives proper resistor values for nearly every make of radio... the most complete guide ever offered radio service men.

Durham Metallized Resistors are supplied in any intermediate values from 50 to 10,000,000 ohms. Complete stocks assure prompt deliveries for your service requirements.

SILVER MARSHALL, Inc.

Schematic Diagram of the SM 690 Public Address Amplifier.

AUTOMATIC RADIO AND MFG. CO. ("TOM THUMB" PORTABLE)

INSULINE CORP. OF AMERICA (A.C.-S.W.-KIT)
DON'T worry about condenser problems. If they involve 8 MFD or more—let the Sprague electrolytic condenser take care of them. For this new, perfected condenser is the most adaptable and efficient unit you ever saw. Only 1 3/8" in diameter and only 5" height overall. Yet it rates 8 MFD capacity with peak voltage of 430 DC.

It has an exclusive, one-piece, round-edged anode without a single soldered or welded joint anywhere. The individual screw socket mounting makes it easily adaptable to use in any set.

And because of the Sprague standardized unit construction—you buy just the amount of capacity you require, without paying a premium for useless excess or for "special built" jobs.

Write for illustrated folder on the Sprague electrolytic condenser.

SPRAGUE SPECIALTIES COMPANY
QUINCY, MASS.
Manufacturers also of the well-known SPRAGUE PAPER CONDENSER

Capacity 8 MFD
Peak Voltage 430 DC
Can Negative
Schematic circuit of the Blair receiver. Two stages of T.R.F. R1 are followed by three of resistance-capacity coupled A.F.

The American Type 2-AP Audio Amplifier and Type 21-D "Hi-Power Box."
"Supreme by Comparison"

Simplify your choice of testing instruments... enjoy the profits and prestige of "Supreme" standards... standardize on Supreme Testing Instruments...

"Supreme by Comparison."

SOLUTION RADIO Service MANUAL

343

"SUPREME"

Radio Diagnometer

MODEL 400-B

Makes every test on any Radio Set-

In every competition and comparison Model 400-B Supreme Diagnometer is acknowledged "Supreme by Comparison"—without a rival in its field. Amazingly complete in its testing facilities—providing analysis of Pentode, Screen Grid and Auto Receivers in addition to its countless circuit combinations, Model 400-B is admittedly the marvel of the radio servicing industry. Endorsed and recommended by practically every servicing authority.

Put your service on a par with 1930 proficiency... Modernize with the Supreme Diagnometer. It pays for itself in a few months... Faster and more accurate servicing means greater profits. So far ahead in its field that it will be modern years from now!

A REVOLUTIONARY SET ANALYZER

25 TESTING INSTRUMENTS IN ONE
All Readings on One Meter
Only One Meter to Read

SUPREME SET ANALYZER
MODEL 90

Dealers' Net Price, F.O.B. Greenwood, Miss. $78.50
Shipping weight 6 lbs.
It provides 79 possible analytical readings
It furnishes A.C. and D.C. Voltage and Current readings on ONE METER
Voltage readings up to 900 volts
Current readings to 300 Milliamperes
Resistance 1000 Ohms per volt A.C. or D.C.
External pin jack connections
High and low resistance measurements
Polarity indication
Pentode Testing — Auto Receiver Testing
IT DOES MORE THAN ANY THREE OR FOUR METER Set Analyzer on the Market
QUICKER, SIMPLER and with a higher degree of accuracy...Plus the advantage of ONLY ONE METER TO READ!

"SUPREME BY COMPARISON"

Most good distributors carry the complete line of Supreme Instruments in stock. If yours cannot supply you, write direct to

Supreme Instruments Corp.
373 Supreme Building :: Greenwood, Miss.
Distributors in All Principal Cities
Service Depots in New York, Philadelphia, Pittsburgh, Chicago, Kansas City, Seattle, Toronto, San Francisco
The "Aerodyne Six" was in its day a very good receiver; with certain refinements introduced, it will serve those whose needs are satisfied by a battery-operated set. A few simple changes are shown by the dotted lines and Xs in the original circuit, above; and the recommended "parallel-plate feed" detector circuit is given at the lower left; the plate should be by-passed to ground by C10 in either case.

**AMBASSADOR FOUR**

At the right, the "Ambassador Four" receiver as originally designed. Its first R.F. stage, indicated by a dotted square, may be replaced by the screen-grid stage shown in the dotted panel at the left.

**MAGNAVOX CO.**

Circuit arrangement of the Magnavox Types TRF-5 and TRF-50 receivers; note that this single-dial set is tuned by variable inductances (variemeters) instead of the more usual variable condensers. Servicing one of these receivers requires treatment different from that which would obtain when the more usual type of receiver is being serviced.

**CONTINENTAL WIRELESS & SUPPLY CO.**

Latest circuit of "The Voice of the Road" automobile receiver. The amplification provided is high in both radio and audio channels, giving sensitivity with the small aerial system which can be accommodated in a car. Note the series filament connections and the separate connection for A.F. screen-grid bias.
AN EVER INCREASING NUMBER

of

RADIO SERVICE MEN,
CUSTOM SET BUILDERS,
EXPERIMENTAL LABS.,
BROADCAST STATIONS,
SCHOOLS, COLLEGES,
UNIVERSITIES,
AMATEURS,
HIGH-POWER AMPLIFIER CONSTRUCTORS,
TECHNICIANS,
AIR TRANSPORT LINES,
SHORT-WAVE FANS,
ETC.

ARE USING FLECHTHEIM SUPERIOR CONDENSERS EXCLUSIVELY

3 VERY IMPORTANT REASONS Why:

1—Highest Quality Materials and Workmanship
2—Thoroughly Dependable and Reliable
3—Priced Very Reasonably

IMMEDIATE SHIPMENT OF ALL ORDERS

Write for Catalog No. 22 and name of nearest Dealer

A. M. FLECHTHEIM & CO., Inc.
134 Liberty Street, New York, N. Y.
Complete Training for "SERVICE MEN"

The problem of training men for Radio servicing is solved by R. T. I. Everything that comes up in a service man's daily work is covered from the minute he rings the customer's door bell until he leaves her (or him) with a satisfied smile. It's the training that the radio industry wants men to have.

It is practical, thorough and complete. An R. T. I. service man also receives a pocket-size loose-leaf Radio Service Manual covering the sets of 25 prominent manufacturers—pictures, wiring diagrams, installation, trouble-shooting, repair, etc. It goes along with the course and is very valuable being kept up-to-date.

ALL BRANCHES COVERED
Television and Talking Pictures, Too

R. T. I. training is so complete there is hardly a subject that is not well covered. It includes the latest in Television, Talking Pictures, Public Address Systems, Short-Wave, etc. The R. T. I. booklet gives complete information.

LIFETIME CONSULTATION
Free of Extra Cost to Everyone Who Enrolls

In addition to the regular training Work Sheets which are constantly revised, every R. T. I. student is kept up-to-the-minute with bulletins of latest information right out of the world's laboratories, work shops, factories, etc.

Consultation Service is also supplied on problems of engineering, installation, etc.

Answers promptly given by letter, wire or air mail by the R. T. I. engineering staff out of their own experience, their library or by outside personal investigation.

Inquiries Invited
We shall be glad to send you our booklet and answer any inquiries about the value of R. T. I. training for you.

RADIO & TELEVISION INSTITUTE
Dept. 115B, 4806 St. Anthony Ct., Chicago

LET F. H. SCHNEILL
AND R. T. I. ADVISORY BOARD HELP YOU

Mr. Schnell, Chief of the R. T. I. Staff, is one of the ablest known radio men in America. He has twenty years of Radio experience. First to establish two-way amateur communication with Europe, a pioneer radio engineer and designer of Radio apparatus. Consulting Engineer to large Radio manufacturers. Assisting him is the R. T. I. Advisory Board composed of men prominent in the Radio Industry.

LET F. H. SCHNEILL
AND R. T. I. ADVISORY BOARD HELP YOU


Supervised by Well Known Radio Men

R. T. I. Home Training is practical and up-to-date. It is prepared by experts. Both lessons and training methods are continually supervised by a board of men who are actively engaged in Radio as executives with prominent concerns — manufacturing, jobbing, servicing, broadcasting, engineering, etc.

The Booklet tells how R. T. I. gives practical home training.

R. T. I. BOOKLET
SENT FREE

Send me Free and prepaid your booklet and full details of your three-in-one Home Training (without obligating me in any way).

Name __________________________ Address __________________________
City __________________________ State __________________________

RADIO & TELEVISION INSTITUTE
Dept. 115B, 4806 St. Anthony Court, Chicago

Read me Free and prepare your booklet and full details of your three-in-one Home Training (without obligating me in any way).
ANY RADIO SERVICE MAN WILL MAKE MORE MONEY FOR HIMSELF OR HIS EMPLOYEES

as soon as he realizes that a thoroughly satisfied radio set owner is his best advertisement and endorsement.

Successful service men are always carefully building up an ever-increasing patronage of thoroughly satisfied set owners, thereby securing a continually growing all-the-year 'round income.

Thousands of successful service men have already discovered that a home demonstration with a set of EVEREADY RAYTHEONS helps them make more money because these tubes completely satisfy the most critical set owner.

Everyready Raytheon 4-Pillar Tubes incorporate ALL of the latest developments in the tube art. In addition to their superior electrical design, they have a patented 4-Pillar type of mechanical construction and die spacing which insures that the uniformly excellent characteristics built into the tubes at the factory will be unimpaired by shipping or handling.

EVEREADY RAYTHEON 4-PILLAR TUBES ARE

QUICK ACTING
The listener hears the program in a few seconds because of the perfected space insulated heater and high emission cathode.

HUMLESS
because of the patented non-inductive heater and electrostatic shielding system.

NOISELESS
because all metallic joints in the structure and shielding system are spot welded.

G U A R A N T E E D T O G I V E C O M P L E T E S A T I S F A C T I O N
All Everyready dealers are authorized to replace defective tubes.
A very complete chart showing the electrical characteristics and required operating voltages of all receiving tubes will be sent free of charge to all service men upon request.

NATIONAL CARBON CO., INC.
General Offices: New York, N. Y.
Branches:
Chicago - Kansas City - New York - San Francisco

Unit of Union Carbide and Carbon Corporation
6013 POWER AMPLIFIER USED IN CAPEHART ORCHESTROPE MODEL-28-GB.
Discriminating Service Men Follow the Choice of Well-known Engineers and Specify Polymet Products

These finely built parts are used by practically all leading radio receiver manufacturers, following thorough and successful laboratory tests. ENGINEERS DO NOT GUESS—THEY KNOW!

<table>
<thead>
<tr>
<th>FILTER BLOCKS</th>
<th>FIXED RESISTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Standard of the Industry Built to specification Wire-wound Tubular Flat Strip—Flexible Grid Leaks</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BY-PASS CONDENSERS</th>
<th>VARIABLE RESISTORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>In stock in all usual capacities Carbon Volume Controls Wire-wound Volume Controls Rheostats—Potentiometers</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UNCASED PAPER CONDENSER SECTIONS</th>
<th>TRANSFORMERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>For repair work Audio Transformers Power Transformers Standard Choke Units</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ELECTROLYTIC CONDENSERS</th>
<th>COIL WINDINGS</th>
</tr>
</thead>
<tbody>
<tr>
<td>In single, double and triple units All types of coils, except radio frequency, built to specification</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>MICA CONDENSERS</th>
<th>MAGNET WIRE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Postage Stamp Type Large Molded Small Molded Enameled Wire Sizes, 18 to 42—in case lots</td>
<td></td>
</tr>
</tbody>
</table>

A copy of Special Service Men's Catalog of POLYMET RADIO ESSENTIALS will be sent on request.

POLYMET MANUFACTURING CORP.
World's Largest Manufacturers of Radio Essentials
833-S East 134th Street ::-: ::-: ::-: New York City
BALKITE PRODUCTS CO.

MODELS
A-3, A-5 AND A-7

PIERCE AIRO INC.

A.C. 24-45

MAGNAFORMER
9-8 SUPER-HETERODYNE