# 2nd Edition

# MODERN RADIO SERVICEMAN'S Pocket Book . . .

CONTENTS





**25¢**

# GENERAL PURPOSE TRIODES

(FOR WESTERN ELECTRIC GENERAL PURPOSE TRIODES SEE PAGES 8 AND 9)
(FOR OUTPUT TRIODES SEE PAGE 4)
(FOR OUTPUT TUBES WITH NEW-CODE NUMBERS SEE PAGE 7)

## As Detectors and Amplifiers

| TYPE | W X 12 | 56 | 112 | 199 | 201A | 226 | 227 | 230 | 237 | 240 |
|---|---|---|---|---|---|---|---|---|---|---|
| Bulb | T-10 | S-12 | S-14 | T-8 | S-14 | S-14 | S-14 | S-12 | S-12 | S-14 |
| Base | 4 Pin | 5 Pin | 4 Pin | 4 Pin | 4 Pin | 4 Pin | 5 Pin | 4 Pin | 5 Pin | 4 Pin |
| Pin No. 1 | Grid | Grid | Grid | Grid | Grid | Grid | Grid | Grid | Grid | Grid |
| " No. 2 | Plate | Plate | Plate | Plate | Plate | Plate | Plate | Plate | Plate | Plate |
| " No. 3 | Fil. + | Fil. + or − | Fil. + | Fil. + | Fil. + | Fil. + or − | Fil. + or − | Fil. + | Fil. + or − | Fil. + |
| " No. 4 | Fil. − | " | Fil − | Fil. − | Fil. − | " | " | Fil. − | " | Fil. − |
| " No. 5 | None | Cathode | None | None | None | None | Cathode | None | Cathode | None |
| Filament V | 1.1 | 2.5 | 5.0 | 3 to 3.3 | 5.0 | 1.5 | 2.5 | 2.0 | 6.3 | 5.0 |
| Filament A | 0.25 | 1.0 | 0.25 | .06 to .063 | 0.25 | 1.05 | 1.75 | 0.06 | 0.3 | 0.25 |
| Plate V. (Max. | 135 | 250 | 180 | 90 | 135 | 180 | 180 | 90 | 180 | 180 |
| Plate Mils | 3 | 5 | 7.6 | 2.5 | 3 | 6.2 | 5 | 1.8 | 4.7 | 0.2 |
| Grid Bias | − 10.5 | − 13.5 | − 13.5 | − 4.5 | − 9 | − 14.5 | − 13.5 | − 4.5 | − 13.5 | − 3.0 |
| Mu | 6.6 | 13.5 | 8.5 | 6.6 | 8 | 8.3 | 9 | 9.3 | 9 | 30 |
| Plate Resistance | 15,000 | 9,500 | 5,000 | 15,500 | 10,000 | 7,300 | 9,000 | 13,000 | 10,000 | 150,000 |
| Mutual Cond | 440 | 1,450 | 1,700 | 425 | 800 | 1,150 | 1,000 | 700 | 900 | 200 |
| Plate Load | 18,000 | 37,000 | 10,000 | 15,500 | 20,000 | 10,500 | 18,700 | 15,000 | 20,000 | 250,000 |
| Audio M. Watts | 35 | 300 | 260 | 7 | 55 | 180 | 165 | 16 | 165 | ...... |

## CONDITIONS FOR BIAS DETECTION

| | W X 12 | 56 | 112 | 199 | 201A | 226 | 227 | 230 | 237 | 240 |
|---|---|---|---|---|---|---|---|---|---|---|
| Plate V | 135 | 250 | 135 | 90 | 135 | Not | 250 | 90 | 135 | 180 |
| Plate Mils | 0.2* | 0.2* | 0.2* | 0.2* | 0.2* | So | 0 2* | 0.2* | 0.2* | Small |
| Grid Bias | − 18 | − 20 | − 15 | − 10.5 | − 13.5 | Used | − 30 | − 7.5 | − 15.5 | − 4.5 |

The tubes in this table will operate as transformer-coupled grid-leak detectors, using ¼ to 5 megohm leaks and condensers of .0001 to .00025 microfarad capacity for broadcast reception (500 to 1500 kc., or .00005 for short waves. The plate voltage should not exceed 45 except for the 26 and 27 which may use 135 volts.

* The "no signal" current as read on a D. C. meter. This current increases with signal strength and may rise to 10 or even 20 times the value given.

# R. F. AMPLIFIERS

**THE RCA-75 IS A HIGH-MU 85 (SEE TABLE BELOW) WITH MU 100, BIAS —2.**

**(THE 77 AND 78 ARE IMPROVED FORMS OF 236 AND 239 RESPECTIVELY)**

**(FOR LEAK OR BIAS DETECTION WITH THESE TUBES SEE PAGE 5 OF MODERN RADIO SERVICEMAN'S POCKETBOOK)**

| TYPE | 222 Tetrode | 224 and 24A Tetrode | 232 Tetrode | 234 R. F. Pentode | 235‖ Vari.-Mu R. F. | 236‖ S. G. Tetrode | 230‖ Vari.-Mu. R. F. Pent. | 44‖ Vari.-Mu. Pentode | 551* Vari.-Mu. R. F. | 55¶ Diode Triode | 57‖ Special Pentode | 58‖ Vari.-Mu. Pentode | 85¶ Diode Triode |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bulb | S-14 | S-14 | S-14 | S-14 | S-14 | S-14 | S-12 | ST-12 | S-14 | ST-12 | ST-12 | ST-12 | ST-12 |
| Base | 4 Pin | 5 Pin | 4 Pin | 4 Pin | 5 Pin | 5 Pin | 5 Pin | 6 Pin | 5 Pin | 6 Pin | 6 Pin | 6 Pin | 6 Pin |
| Pin No. 1 | Screen | Screen | Screen | Screen | Screen | Screen | Screen | Screen | Screen | Plate A | Screen | ← | Plate A |
| " No. 2 | Plate | Plate | Plate | Plate | Plate | Plate | Plate | Plate | Plate | Triode Plate | Plate | ← | Triode Plate |
| " No. 3 | F + | F + or − | F + | F + | F + or − | F + or − | F + or − | F + or − | F + or − | F + or − | F + or − | ← | F + or − |
| " No. 4 | F − | " | F − | F − | " | " | " | " | F | " | " | ← | " |
| " No. 5 | None | Cathode | None | None | Cathode | Cathode | Cathode | Cathode | Cathode | Cathode | Cathode | ← | Cathode |
| " No. 6 | None | None | None | None | None | None | None | Suppressor | None | Plate B | Suppressor | ← | Plate B |
| Cap | Grid | Grid | Grid | Grid | Grid | Grid | Grid | Grid | Grid | Grid | Grid | ← | Grid |
| Filament V | 3.3 | 2.5 | 2.0 | 2.0 | 2.5 | 6.3 | 6.3 | 6.3 | 2.5 | 2.5 | 2.5 | ← | 6.3 |
| Filament A | 0.132 | 1.75 | 0.06 | 0.06 | 1.75 | 0.30 | 0.30 | 0.30 | 1.75 | 1.0 | 1.0 | ← | 0.30 |
| Grid Bias | − 1.5 | − 3 | − 3 | − 3 Up | − 3 Up | − 3 | − 3 Up | − 3 Up | − 3 Up | − 20 | − 3 | − 3 Up | − 20 |
| Mu | 290 | 615 | 580 | 620 Down | 370 Down | 370 | 750 Down | 600 Down | 370 Down | 8.3 | 1,500 | 1,500 Down | 8.3 |
| Plate Res | 600,000 | 600,000 | 1,150,000 | 1,000,000 | 350,000 | 350,000 | 750,000 Up | 605,000 Up | 350,000 | 8,000 | 1,500,000 Up | 800,000 | 8,300 |
| Mutual Cond | 480 | 1,025 | 505 | 620* Down | 1050† Down | 1,050 | 1,000 Down | 1,050 Down | 1,050 Down | 900 | 1,225 | 1,600‡ Down | 1,000 |
| Plate V | 135 | 250 | 135 | 180 | 250 | 180 | 180 | 250 | 250 | 250 | 250 | 250 | 250 |
| Plate Mils | 3.3 | 4 | 1.4 | 2.8 | 2.5 | 3.1 | 4.5 | 65 Max. | 2.5 | 8 | 2 | 3 Max. | 7 |
| Screen Volts | 67.5 | 90 | 67.5 | 67.5 | 90 | 90 | 90 | 90 | 90 | ...... | 100 | 100 | ...... |

* Drops to 15 if bias is raised to − 22.5 volts.
† " " 15 " " " " " − 50 "
‡ " " 10 " " " " " − 40 "
¶ See detector table for operation. (page 5)
‖ " " chart. (page 5)

**Western Electric 259A, resembles 224 in appearance, base-style and connections, but fil. 2 volts, 1.6 amps., bias —1.5, mu 500, plate res. 350,000, plate 7.5 ma. at 180 volts with screen at 90 volts.**

# AUDIO OUTPUT TUBES

**(FOR TUBES WITH NEW-CODE NUMBERS ALSO RCA-79, SEE PAGE 9, FOR THE 59 TUBE SEE PAGE 30)**
**THE 48 AND 43 ARE 2-WATT 110-VOLT AUDIO OUTPUT TETRODE AND PENTODE RESPECTIVELY, BOTH HAVING 25-35-VOLT 400-MA. FILAMENTS. THE 49 IS A 46 WITH 2-VOLT 120-MA. FILAMENT, 3.5 WATTS PER PAIR.**

| TYPE | 210 Triode | 220 Triode | 231 Triode | 233 Triode | 238 Pentode | LA Pentode | 241 Pentode | 242 Pentode |
|---|---|---|---|---|---|---|---|---|
| Bulb | S-17 | T-8 | S-12 | S-14 | S-12 | ...... | S-17 | S-17 |
| Base | 4 Pin | 4 Pin | 4 Pin | 5 Pin | 5 Pin | 5 Pin | 6 Pin | 6 Pin |
| Pin No. 1 | Grid | Grid | Grid | Grid | Screen (to + 135) | Grid | Screen (to + 167) | Screen (to+250) |
| " No. 2 | Plate | Plate | Plate | Plate | Plate | Plate | Plate | Plate |
| " No. 3 | F+ or − | F + | F + | F + | F + or − | F + or − | F + or − | F + or − |
| " No. 4 | " | F − | F − | F − | " | " | " | " |
| " No. 5 | None | None | None | Screen (to + 135) | Cath. and Suppressor | Screen (to + 165) | Cathode | Cathode |
| " No. 6 | None | None | None | None | None | None | Grid | Grid |
| Cap | None | None | None | None | Grid | None | Grid | Grid |
| Filament V | 7.5 | 3 to 3.3 | 2.0 | 2.0 | 6.3 | 6.3 | 6.3 | 6.3 |
| Filament A | 1.25 | 0.125 | 0.13 | 0.26 | 0.30 | 0.3 | 0.65 | 0.65 |
| Input Grid Bias | − 39 | − 22.5 | − 22.5 | − 13.5 | − 13.5 | − 11.0 | − 12.5 | − 16.5 |
| Mu | 8 | 3.3 | 3.8 | 70 | 100 | 100 | 215 | 220 |
| Plate Res | 5,000 | 6,300 | 4,950 | 50,000 | 100,000 | 50,000 | 120,000 | 100,000 |
| Mutual Cond | 1,600 | 525 | 760 | 1,450 | 975 | 2,000 | 1,800 | 2,250 |
| Plate V | 425 | 135 | 135 | 135 | 135 | 165 | 167 | 250 |
| Plate Mils | 18 | 6.5 | 6.8 | 14.5 | 9 | 17 | 16.5 | 34 |
| Load | 10,000 | 6,500 | 9,000 | 7,000 | 13,500 | 8,500 | ...... | ...... |
| Audio M. Watts | 1,600 | 110 | 150 | 700 | 525 | 1,200 | ...... | ...... |

| TYPE | 245 Triode | 46* Class A Triode | 46* Class B Triode | 247 Pentode | 250 Triode | 89 Class A Pentode | 89 Class A Triode | 89 Class B Triode |
|---|---|---|---|---|---|---|---|---|
| Bulb | S-17 | S-17 | ← | S-17 | S-21 | Dome | ← | ← |
| Base | 4 Pin | 5 Pin | ← | 5 Pin | 4 Pin | 6 Pin | ← | ← |
| Pin No. 1 | Grid | Inner† Grid | ←‡ | Grid | Grid | No. 2 Grid§ | ←¶ | ←‖ |
| " No. 2 | Plate | Plate | ← | Plate | Plate | Plate | ← | ← |
| " No. 3 | F + or − | F + or − | ← | F + or − | F + or − | F + or − | ← | ← |
| " No. 4 | " | " | ← | " | " | " | ← | ← |
| " No. 5 | None | Outer† Grid | ←‡ | Screen (to + 250) | None | Cathode | ← | ← |
| " No. 6 | None | None | ← | None | None | No. 3 Grid§ | ←¶ | ←‖ |
| Cap | None | None | ← | None | None | No. 1 Grid§ | ←¶ | ←‖ |
| Filament V | 2.5 | 2.5 | ← | 2.5 | 7.5 | 6.3 | ← | ← |
| Filament A | 1.5 | 1.75 | ← | 1.75 | 1.25 | 0.4 | ← | ← |
| Input Grid Bias | − 56 | − 33 | 0 | − 16.5 | − 84 | No. 1 at − 18 | No. 1 at − 20 | No. 1 and 2 at 0 |
| Mu | 3.6 | 5.6 | Varying | 150 | 3.8 | 135 | 4.6 | Varying |
| Plate Res | 1,670 | 2,380 | " | 6,000 | 1,800 | 80,000 | 3,000 | " |
| Mutual Cond | 2,100 | 2,350 | " | 2,500 | 2,100 | 1,600 | 1,570 | " |
| Plate V | 275 | 250 | 400 | 250 | 450 | 160 | 160 | 180 |
| Plate Mils | 36 | 22 | 6 Each | 31 | 55 | 17 | 17 | 3 Each |
| Load | 4,600 | 6,400 | 1,450 × 2 | 7,000 | 4,350 | 9,000 | 6,000 | 3,400 × 2 |
| Audio M. Watts | 2,000 | 1,200 | 20,000 per Pair | 2,500 | 4,600 | 1,500 | 300 | 6,000 per Pair |

* 46 tubes have two grids. If pin 5 is tied to the plate (pin 2) see Class A column, but if it is tied to the input grid (pin 1), see Class B column. Class B tubes are always used in push-pull pairs.
† Pin 1 used for input, pin 5 tied to pin 2 (plate).
‡ Pins 1 and 5 tied together, serving as one grid.
§ No. 1 grid (cap) for input. No. 3 grid (pin 6) tied to pin 5 (cathode). No. 2 grid (pin 1) used as screen, with 3 Mu at 180 volts.
¶ No. 1 grid (cap) for input. No. 2 grid (pin 1) and No. 3 grid (pin 6) tied to plate (pin 2).
‖ No. 1 grid (cap) and No. 2 grid (pin 1) tied together for input. No. 3 grid (pin 6) tied to plate (pin 2)
General Note — Class B tubes are very high mu. Their "resting" plate currents are shown. With signal it may rise to 10 times this value.

**Western Electric output tubes. 252A resembles R.C.A. 250 but has 5-volt filament. 271A indirectly heated by 5-volt, 2-amp. filament and has 5-pin base, otherwise lies between R.C.A. 210 and R.C.A. 250. 275A, lies between R.C.A. 45 and 2A3. Filament 5 volts, 1.2 amps., plate 52 ma. at 250 volts, 1,000-ohm plate res., mu. 2.9.**

# Tetrode and Pentode Bias-Type Detectors, Also Special Detectors

(FOR TRIODE DETECTORS SEE PAGE 2 OF THE POCKETBOOK)

(FOR GRIDLEAK DETECTION SEE NOTE BELOW)

(SEE PAGE 7 FOR THE 2A7, 6A7, 2B7, 6B7)

(THE 77 AND 78 ARE IMPROVED FORMS OF THE 36 AND 39)

(SEE PAGE 3 FOR RCA-77 AND RCA-78)

(THE 75 IS AN 85 WITH THE TRIODE SECTION MADE HIGH-MU (100))

| Type | 224, 224A | 32 | 36 | 57 | 58‡ | 35‡ | 39‡ | 44‡ | 551‡ | 55 and 85 Diode-Triode |
|---|---|---|---|---|---|---|---|---|---|---|
| Bias | —5 | —6 | —6 | —6 | —10 | —7 | —7 | —7 | —7 | See r.f. |
| Plate V. | 250 | 135 | 135 | 250 | 250 | 250 | 180 | 90 | 250 | table |
| Plate Ma. | 0.1 to 4.0* | 0.2 up | 0.1 up | 0.1 up | ...... | ...... | ...... | ...... | ...... | for |
| Screen V. | 20 to 45 | 67.5 | 67.5 | 100 | 100 | 90 | 90 | 90 | 90 | constants |
| Load | ¼ Meg.† | 100,000 | ¼ meg.† | ¼ meg.† | I.F.T. | I.F.T. | I.F.T. | I.F.T. | I.F.T. | also Note 2 |
| Suppressor | ...... | ...... | ...... | to cathode | to cathode | ...... | to cathode | to cathode | ...... | below. |

* First value correct for no signal, second for strong signal.

† Or 500 Hy. with ¼ meg. shunt.

‡ As first "detector" in superheterodyne with oscillator input of 1 volt less than the bias (peak value).

NOTE 1. Gridleak detection possible with any of these tubes except the 55, 85, and variable mu types. Use about ⅓ of the plate and screen voltage given in the R.F. table, no grid bias and a gridleak of ¼ to 5 megs. Grid condenser .0001 to .00025 for broadcast, .000050 to .0001 for short waves.

NOTE 2. The 55 and 85 have one cathode, two small plates, a grid and one large plate, and are used as second detectors in superheterodynes. A push-pull i.f. transformer feeds the two small plates A and B which, with the cathode, give full-wave rectification. The resulting mixture of d.c. and audio is passed through a load resistor and the resulting voltage is applied to the grid. The grid and the large plate then act as an audio amplifier. The resistor-voltage (which depends on the carrier level) can also be filtered and fed back to the r.f. stages for automatic volume control. (Also see page 3.)

# Comparison of Receiver and Transmitter Plate-Supply Rectifiers

(SEE PAGE 7 FOR 5Z3 AND 25Z5 ALSO FOR RCA-1 AND RCA-84)

| Type Number | 80 | 280M | 82 | 83 | 81 | R81 | 66 | 72 and R4 | BA | BH |
|---|---|---|---|---|---|---|---|---|---|---|
| Half or Full Wave | Full | Full | Full | Full | ½ | ½ | ½ | ½ | Full | Full |
| Mercury Vapor | No | Yes | Yes | Yes | No | Yes | Yes | Yes | Gas | Gas |
| Filament Volts | 5.0 | 5.0 | 2.5 | 5.0 | 7.5 | 7.5 | 2.5 | 5 | None | None |
| Filament Amperes | 2.0 | 2.0 | 3 | 3.0 | 1.25 | .... | 5.0 | 10 | None | None |
| Max. R.M.S. Volts Per Plate | 350<br>550** | 600** | 500 | 500 | 700 | 750 | .... | .... | 350 | 350 |
| Max. Peak Inverse Volts | Does Not Matter | 1,680** | 1,400 | 1,400 | Does Not Matter | 1,960 | 7,500 | 7,500 | .... | .... |
| Max. D.C. Load (Ma.) | 135 | 200 | 125 | 250 | 85 | 150 | .... | .... | 350 | 125 |
| Max. Peak Plate Current | .... | .... | 400 | 800 | .... | .... | 600 | 2,500 | .... | .... |
| Tube Voltage Drop | 0 to 70 | 15 | 15 | 15 | 0 to 70* | 15 | 15 | 15 | 0 to 200* | 0 to 200* |
| Over All Length | 5⅜" | 5⅜" | 4 11/16" | 5⅜" | 6¼ | 6¼ | 6⅝" | Same | .... | .... |
| Max. Diameter | 2 1/16" | 2 1/16" | 1 13/16" | 2 1/16" | 2 7/16" | 2 7/16" | 2 7/16" | as for | .... | .... |
| Bulb | S-17 Same as 10 | S-17 Same as 10 | S-14 Like 27 and 201A | ST-16 New Large Domed Type | S-19 Like 66 | .... | S-19 Like 81 | 50 Watt Triodes | S-19 Like 66 and 81 | S-14 Like 27 and 201A |
| Top Cap | No | No | No | No | No | .... | Yes | Yes | No | No |

NOTE—The "B" tubes are known as "Raytheons", the "R" tubes as "Rectobulbs. An R3 Rectobulb is the same as R4 above but has a 10-volt filament.

* Drop depends on load current.

** When using this voltage the filter must begin with a choke, not a condenser.

Precautions—The mercury vapor tubes (280M, 82, 83, R81, 66, 72, R4) and the gaseous tubes (BA and BH) all create radio-frequency disturbances and the tube should be shielded (allow for ventilation) also r.f. chokes and small mica bypass (.005) provided ahead of the ripple-filter.

In no case exceed voltage or current ratings of mercury tubes. First filter condenser for these tubes should be 2 microfarad or less and preferably should be preceded by choke of at least 1½ Henrys.

WESTERN ELECTRIC RECTIFIERS. 249A resembles 66 but has increased filament current (7 amps.) and plate current max. peak may therefore be 1,100 ma. Peak inverse voltage 6,500.

274A resembles the 80 having same filament demand, with max. r.m.s. volts per plate 450 or 660 on same basis as for the 80 in the table above.

280A resembles the 66 but fil. only draws 3 amps., hence max. peak plate current 500 ma. Peak inverse voltage 3,500.

# Tubes With New-Code Numbers

| TYPE | Filament | Replaces | Mu. | Output | Plate Volts | Load | Plate Res. | Bias |
|---|---|---|---|---|---|---|---|---|
| 2A3—A.F. Output Triode .................. | 2.5V.- 2.5A. | 45 | 4.2 | 3.5 Watts | 250 | 2,500 | 765 | 40 |
| 2A5—A.F. Output Pentode ................. | 2.5V.-1.75A. | 47 | 220 | 5 watts | 250 | 7,000 | 100,000 | 16.5 |
| 2A7—Det. Plus Electron-Coupled Oscillator... | 2.5V.- 0.8A. | .. | ... | | 250 | A.F. | | ** |
| 6A7—Det. Plus Electron-Coupled Oscillator... | 6.3V.- 0.3A. | .. | ... | | 250 | A.F. | | ** |
| 2B7—Duo-Diode Detector Plus Pentode....... | 2.5V.- 0.8A. | .. | 730 | | 250 | I.F. | | * |
| 6B7—Duo-Diode Detector Plus Pentode....... | 6.3V.- 0.3A. | .. | 730 | | 250 | I.F. | | * |
| 5Z3—Full-Wave Rectifier .................. | 5V.- 3.0A. | .. | ... | 250 Ma. | 500 | B+ | | † |
| 25Z5—Full-Wave Voltage-Doubling Rectifier.. | 25V.- 0.3A. | 80 or 83 | ... | 100 Ma. | 125 | B+ | | .. |

The 25 Z5

The 2A5

** In the 2B7 and 6B7 the input grid is biased by a 1-megohm resistor or 3-volt source. The screen is at plus 125 volts, the suppressor is permanently connected to the cathode. The pentode section may work into either an a.f. or i.f. amplifier.

* Depends on use for several of the grids present.

† Approximately equivalent to two 80 tubes in parallel, but with improved insulation.

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RCA-1 IS 50 MA., ONE-HALF WAVE MERCURY VAPOR RECTIFIER WITH 6.3-VOLT 300-MA. HEATER-FILAMENT, MAX. INPUT VOLTAGE 350 R.M.S. (100 MA. FOR 2 TUBES) 4-PIN BASE.

RCA-84 IS FULL-WAVE 50-MA. VACUUM RECTIFIER WITH 6.3-VOLT 500-MA. HEATER-FILAMENT, MAX. INPUT 225 VOLTS R.M.S. PER PLATE. 5-PIN BASE.

RCA-79 IS TWO CLASS B AUDIO TRIODES IN ONE BULB. 6.3-VOLT HEATER, NO BIAS, 3 WATTS INTO 7,000 OHMS AT 180 VOLTS.

# Special and Transmitting Tubes

### R.C.A.-Cunningham

200A — Obsolete grid-leak detector containing gas or vapor.

203A — High-mu (25) transmitting tube, 75-watt, general purpose.

204A—High-mu (25) 250-watt transmitting tube (amp.).

211—Medium-mu (12) transmitting tube, 75-watt, general purpose.

841—High-mu (30) equivalent of the '10, used as voltage amplifier.

842—Low-mu (3) equivalent of the '10, used as an audio output or modulator tube; at 425 volts gives 2/3 the output of a '50.

845—Low-mu (6) transmitting tube, 75-watt, general purpose.

849—Medium-mu (19) 350-watt transmitting tube (amp.).

851—Medium-mu (20) 1,000-watt transmitting tube (amp. or modulator).

852—75-watt transmitting tube for short waves.

860—75-watt screen-grid equivalent of 852.

861—500-watt size of the 860 (amp.).

864—A 1.1-volts, ¼ amp., non-microphonic tube midway between the 199 and 230.

865—A screen-grid equivalent of the '10, 7½ watts rating.

874—Gaseous glow-discharge voltage regulator in the S-17 bulb (like a '45) designed to be connected across a 90-volt plate supply. 4-pin base. Pin 1 (Anode) tied to pin 4. Pin 3 (Cathode) tied to pin 4.

876—Iron-filament ballast lamp to operate at 1.7 amps. with 40 to 60-volt drop.

886—Same as 876 but for 2.05 amps.

### Hygrade-Sylvania

830 — 30-watt, 750-volt transmitting triode.

### National Union

Note—In d.c. line sets with tubes in series watch for National Union 6.3-volt tubes as they have .4 amp. filaments instead of .3 amp. std.

### DeForest

(DeForest tubes use the same numbers with a 5 replacing the 2 or 8. DeForest 560=RCA 860.)

### Wunderlich

Wunderlich tubes operate similarly to the 55 shown in the r.f. and detector plate but are simpler, having but one plate and two grids. The two grids are fed push-pull to give grid rectification and both together act on the plate exactly as the grid of a '27, which the tube resembles.

### Majestic

Majestic tubes can usually be replaced by standard tubes. When replacing the "spray shielded" types slight additional shielding is occasionally needed.

216—Replace with 281.

213—Replace with 280.

### Western Electric

(Mostly tubes released to amateurs.)

205D—Spherical bulb triode, mu. 7.3, fil. 1.6 amps. at 4.5 volts. Audio output 1200 m.w. at 370 volts, R.F. output 3 watts at 400 volts.

205E—Non-microphonic 205D.

212D—250-watt sending tube.

231D—Interchangeable with '99.

242A—"50-watt" sending tube resembles R.C.A. UV211 closely.

254A—Resembles R.C.A. 865 "7½-watt" transmitting screen-grid tetrode but has 5-volt fil.

254B—See 254A, except fil. like R.C.A. 865.

256A—"Trigger" triode containing Argon gas —When plate voltage reaches about 30 times grid bias, tubes breaks down and conducts up to 75 ma. with drop of only 10 to 20 volts. Heater fil. 2.3 volts, 1.7 amps., 5-pin base.

264A—Resembles R.C.A. 864 but fil. 1.5 volts, 300 ma.

276A—Resembles R.C.A. 211 and W.E. 242A but has lower capacities and fil. takes but 3 amps.

277A—Big brother to 256A.

282A—Big brother to R.C.A. 865 and to Western Electric 254A and 254B above. Hard glass, can work at 1,000 volts, 30 to 50 watts out.

284A—"50-watt" triode equivalent to R.C.A. 845. For audio work, output 10 to 40 watts, harmonics 1 to 5% depending on load and applied voltages.

Other W. E. tubes are listed as follows: 101D and E, 215A, 244A, 247A, 262A, 264A, 272A on p. Nine. 259A on p. Three. 252A, 271A, 275A on p. Four. 249A, 274A and 280A on p. Six.

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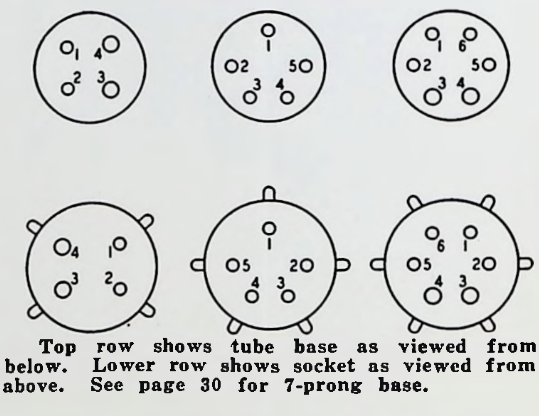
## STANDARD NUMBERING OF 4, 5, AND 6-PIN BASES AND SOCKETS



Top row shows tube base as viewed from below. Lower row shows socket as viewed from above. See page 30 for 7-prong base.

# Western Electric General Purpose Triodes

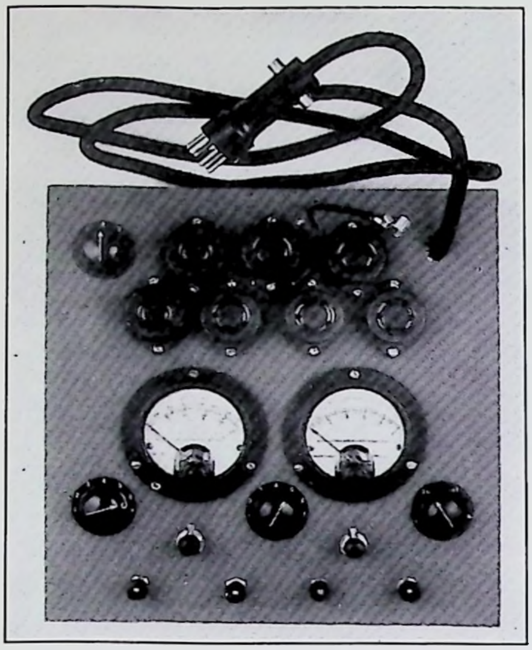
(FOR OTHER WESTERN ELECTRIC TUBES SEE PAGES 3, 4, 6 AND 8)

| TYPE | 101D* | 215A | 244A | 247A | 262A | 264A | 272A |
|---|---|---|---|---|---|---|---|
| Base Pins .................... | 4 | 4 | 5 | 5 | 4 | 4 | 5 |
| Cap. .......................... | — | — | — | — | Grid | — | — |
| Fil. V. ...................... | 4.5 | 1.0 | 2 | 2 | 10 | 1.5 | 10 |
| Fil. A. ...................... | 1.0 | 0.25 | 1.6 | 1.6 | .320 | .300 | .320 |
| Bias .......................... | —18 | —10 | —10 | —7 | —7.5 | —7 | —21 |
| Mu. ........................... | 6 | 5.6 | 9.7 | 14.6 | 15 | 7 | 5.5 |
| Plate Res. .................... | 5,600 | 15,000 | 10,000 | 16,000 | 18,000 | 12,000 | 7,000 |
| Plate Volts .................. | 190 | 100 | 180 | 180 | 180 | 100 | 180 |
| Plate Ma. .................... | 8 | 1.9 | 6 | 3.8 | 2.8 | 2.6 | 6 |

* 101F is a low-microphonic form of 101D.

# THE PERPETUAL ANALYZER Part 2*

## . . . NEVER OUT OF DATE



A "Perpetual" analyzer made up from standard parts. The toggle switches are double-pole. In this case the selector switch markings have the meanings of the table except that the "cap" point is No. 4.

In Part 1 of this paper it was pointed out that an analyzer has no reason for existence unless it SAVES TIME, also that it can best do this if it permits one to read AT THE SAME TIME the plate current and any desired one of the tube's voltages, so that two meters are essential. However, it was also shown that much of the usefulness of analyzers is lost if they attempt to provide for every possible measurement from-the-socket, if many adapters are necessary or IF IT FAILS TO PROVIDE FOR FUTURE TYPES OF TUBE-BASES.

Of course it is necessary to provide for the use of the voltmeter with a pair of leads and prods, both as a voltmeter, and as an ohm-meter. This is admitted in all designs.

### The Circuit

The circuit diagram is mainly self-explanatory and only the following points need be brought out:

A—*No adapters* are needed in the analyzer itself, enough 4, 5, 6 and 7-prong sockets being provided to take care of existing tube types, with space for more if need be. Some types are NOT provided for because it would be senseless. Thus a duo-diode-triode or a duo-diode-pentode has its elements operating at such low voltages, and has such high impedances in series that ordinary meters are useless; the best test is to try a new tube and to check voltages BACK of the impedances with the voltmeter and prods.

B—*No provision is made for rectifier measurements.* Rectifier trouble is apparent to the eye in most cases—no meters are needed. If a new tube does not cure things, voltmeter examination of the B filter and associated circuits is necessary—the voltmeter with prods again serving. This is an excellent example of the sort of thing that should NOT be done from the socket. One might think of hunting for a grounding short at some OTHER socket by means of the analyzer plug—but since one already has the base off the set for filter examination this also is most quickly done with the prods.

C—*The milliammeter* is put once for all into the PLATE circuit and left there. The writer has yet to find any actual use for it elsewhere. For example—why measure screen current? If the screen current is abnormal the plate current will certainly be abnormal and tell the story just as well—the voltmeter will tell what is wrong, provided a new tube makes no improvement.

This meter has a range switch—nothing else.

D—*The voltmeter is cut off from the analyzer plug* when switched to the posts—the plug can be left in the set without the usual fireworks.

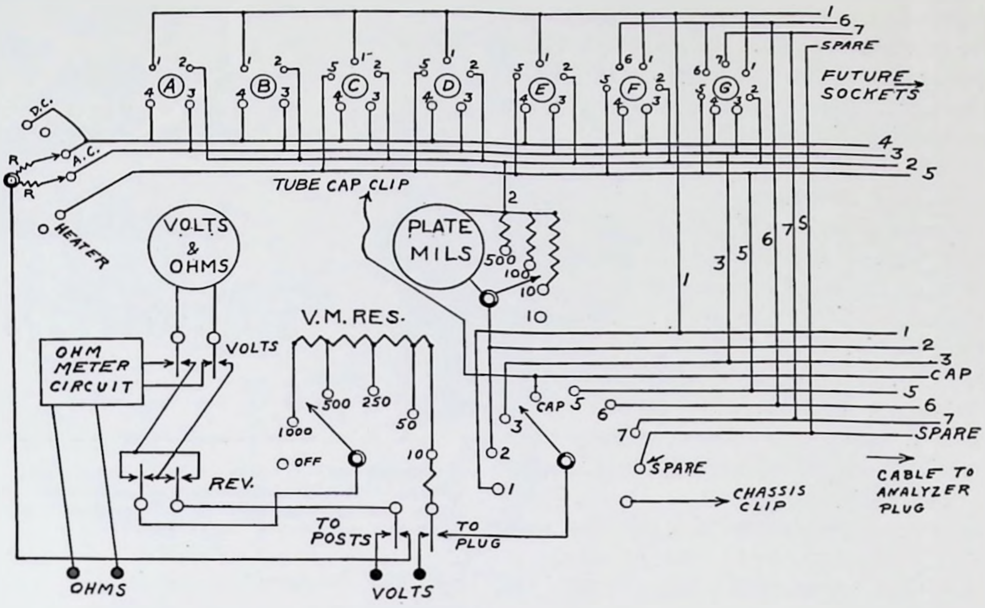
*Part 1, February "Modern Radio." See p. 16 as to back copies.

E—*The ohm-meter circuit* has been intentionally omitted from the diagram. Not only has each serviceman his own pet circuit, but enough such have been printed in MODERN RADIO and elsewhere. A good one was shown in Part 1 of this article.

F—*No adapters are used at the analyzer panel.*

G—*Future tube and socket types are provided for as follows:*

1—The only fixed things about the present tube system are that the socket prongs in every type of socket never change numbering and the filament (whether d.c. or a.c.) always turns up on socket prongs 3 and 4, everything else comes and goes—or moves from one prong to another. However, the numbering of the prongs stays put always—therefore the voltmeter selector switch has its positions marked for the socket terminals—not for the tube elements. The appearance of another sort of tube only calls for the addition of one line of words to the table in the analyzer lid—not




## SETTINGS OF VOLTMETER SELECTORS FOR DIFFERENT TUBE TYPES

**Numbers refer to the standard base-prong designations in which prongs No. 3 and No. 4 are always filament, No. 2 ordinarily plate.**

**Where grids are numbered the one nearest the cathode is No. 1.**

**Caution: Rectifiers must not be tested in the analyzer sockets. Substitute new rectifier in set or apparatus and test its load circuit with voltmeter prods.**

| TUBE | Use Socket | Set 3-Point Selector | Position of Main Selector Switch 1 | 2 | 3 | Cap. | 5 | 6 | 7 | Chassis |
|---|---|---|---|---|---|---|---|---|---|---|
| d.c. fil. triodes | A | d.c. (1) | G | P | F | .... | .... | .... | .... | ...... |
| a.c. fil. triodes | A | a.c. (2) | G | P | .... | .... | .... | .... | .... | ...... |
| Heater triodes | D | h (3) | G | P | Cath. to F | .... | .... | .... | .... | Cath. to chassis |
| d.c. fil. tetrodes | B | d.c. (1) | Sc. | P | F | G | .... | .... | .... | ...... |
| d.c. or a.c. fil. pentodes like 33 and 47 | C | d.c. (1) a.c. (2) | G | P | .... | .... | Sc. | .... | .... | Fil. to chassis if a.c. |
| 5-pin heater tetrodes and pentodes | E | a.c. (3) | Sc. | P | Cath. to F | G | 0 | .... | .... | Cath to chassis |
| 6-pin heater pentodes (r.f.) | F | a.c. (3) | Sc. | P | Cath. to F | G | 0 | Sup. | .... | ...... |
| 59 type triple grid | G | a.c. (3) | G No.2 | P | Cath. to F | .... | 0 | G No.3 | G No.1 | ...... |

**Extend list to other types as desired, adding sockets if necessary.**

a wire need be changed, nor an adapter bought.

2—If new socket types appear (9 prongs?) add a socket in the panel space left for that purpose and run a lead from each terminal to the corresponding point (same number) of the selector switch. When such tubes appear a little thought will show whether a new cable and plug with more wires is needed.

3—The cable plug (unfortunately) still needs adapters.

H—*The voltmeter reference point,* that is to say the point "against" which voltages are measured, must be shifted to accord with tube types. Thus our reference is:

For d.c. filaments—one end of the filament (201A, 230, etc.).

For a.c. filaments—the centertap of a resistor switched across the filament (245, 247, etc.).

For a.c. filaments with cathodes separate (heater type) the reference is to this separate cathode (56, 58, etc.).

For EXISTING tubes this could be provided for by doing the voltmeter-selecting with a multi-blade switch—thereby automatically tying the "socket terminal selecting" feature up with the "reference selector" and spoiling all chance of being able to handle new and peculiar tubes. This is why two voltmeter selector switches are used—with the more common types of tubes one soon automatically flips both to the proper position—and in fact most tubes give no readings of the 3-point "reference" switch is in the wrong position. In any case—the table in the lid tells.

### TUBE AND SOCKET LIST

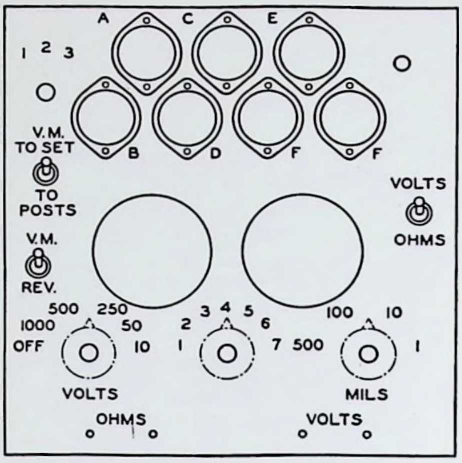
**SOCKET A—200, 01A, '11, 20, 26, 30, 31, 40, 45, 50, 71A, 99, 210, 2A3.**
**SOCKET B—22, 32.**
**SOCKET C—33, 47.**
**SOCKET D—27, 56.**
**SOCKET E—24, 35, 36, 38, 39, 51.**
**SOCKET F—57, 58.**
**SOCKET G—59.**

**Tubes not in enough use to warrant socket as yet: 46, 89, 48, 2A5, 53, 75, 77, 78, 79, 2A5.**

**Tubes not suited for from-the-socket methods, regardless of analyzer used: See text—55, 85, 90, 92, 2A7, 2B7, 6A7, 6B7—all rectifiers.**

### Conclusion

It is not claimed that this is the last word in analyzers—but it is claimed that this type has for many months been found very useful by numerous servicemen who built it with variations to suit their individual needs or opinions. The appearance of several crops of new tubes




**Layout of a 10½" x 11" panel type "Perpetual." The arrangement is somewhat different from the photograph to allow more space for engraved or incised markings.**

has not bothered them in the least and nothing we have heard about additional forthcoming tubes seems to make these "Perpetual analyzers" any less suited to the daily needs of the serviceman.

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## THE NEW TUBE NUMBERING SYSTEM

The Radiotron-Cunningham organization has initiated a new tube numbering system which works as follows:

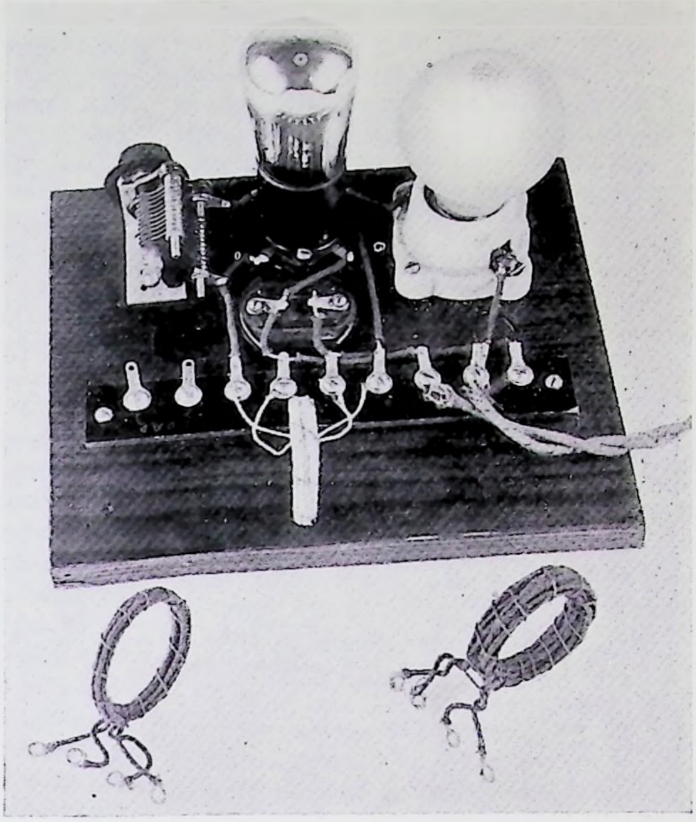
The first number indicates the filament voltage. Thus a 2A5 or 2A3 has a filament voltage between 2 and 2.9, while a 25Z5 has a 25-volt filament.

The letter after this first number is somewhat arbitrary, although in general rectifiers take letters in the last of the alphabet (25Z5) while other tubes take letters in the first part of the alphabet.

The final number shows the number of usable tube elements which have external connections. Thus a 2A3 has external connections to 3 usable elements—in other words, it is a triode. On the other hand a suppressor grid not going to an external connection is not counted in this system.

OLD TUBE NUMBERS ARE NOT CHANGED AT ALL.

# The Simplest Modulated Oscillator



Precision oscillators are too costly for the ordinary shop, station or laboratory. Luckily the grand bulk of all work doesn't require precision, or shielding, but only a reliable signal at about the right frequency. One can save the purchased oscillator for its proper use

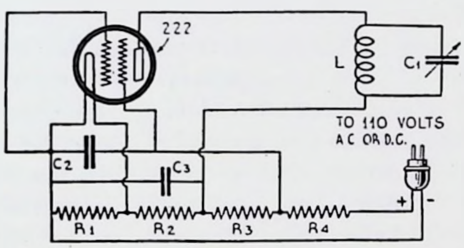
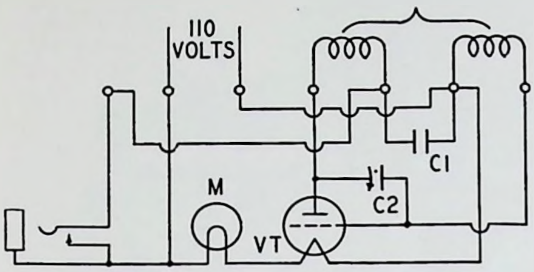



Fig. 1

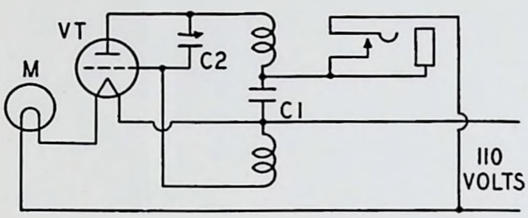
**DYNATRON OSCILLATOR FOR SHOP USE**
**222—Any '22 type tube which works in the circuit.**
**C1 and L—Chosen as in text.**
**C2 and C3—1 mufd. for 125 volts a.c. or more.**
**All resistors to be of 5 to 10 watt type such as Aerovox 992 or the like.**
**R1—1,000 ohms.**
**R2—150 ohms.**
**R3—300 ohms.**
**R4—50 ohms.**

and for ordinary use knock together a whole family of cheap affairs such as shown in the photograph and in Fig. 2. Nothing is claimed for the construction except that it is cheap, simple and dependable. If the lamp goes out one knows the thing is dead—if the lamp burns the tube is oscillating—even if it is an ancient '01 that merely gasped and choked in a receiver. Of course the tube is being over-run, but you got it out of the junk box! It didn't cost anything and usually gives about 250 hours of service before expiring, and then it gives several hours of fair warning in the shape of a rough tone. The jack is added to permit plugging in a plate-current meter so a rough calibration may be made (or a setting for a particular test).

This is done by the traditional method of placing a wavemeter with its tuned coil near the oscillator coil. At resonance the plate meter of the oscillator jumps. A 0-10 Ma. meter is handy but there isn't any law about it; another size will serve. The little condenser shown will cover only a 2 to 1 tuning range for short-wave work, also it hasn't a dial. Both objections can be met by a regular broadcast-band condenser with a dial. The coils shown are scramblewound on a 1½ inch tube and pushed off for tying with thread. They are exchanged with a screwdriver. A socket and plug-in coils make a prettier job, of course, but we were trying to be cheap! If worked on a.c. there is automatically a heavy growl on the signal. If the line




ACTUAL




SCHEMATIC

**Diagram of the Hartley-circuit oscillator of the photograph.**

**V.T.—An old '01 or '12 from the junk box.**

**M—25 watt 110 volt Mazda lamp.**

**C1—Mica, .005 or more.**

**C2—Pilot 23 plate midget for 2/1 tuning range; regular b.c. condenser for 3/1 tuning range.**

**Approximate short-wave tuning ranges with Pilot condenser and coils wound as described:**

| Wire | Turns | Meters | kc. |
|---|---|---|---|
| 18 | 3 & 3 | 15- 30 | 20,000-10,000 |
| 18 | 7 & 7 | 29- 59 | 10,330- 5,080 |
| 22 | 11 & 11 | 55-112 | 5,450- 2,680 |
| 22 | 19 & 19 | 111-196 | 2,700- 1,530 |

**The No. 18 was ordinary annunciator, the 22 was cotenamel.**

happens to convey d.c. into the shop one can provide a tone by an adjustable grid leak and a .00025 grid condenser.

If all this is too low-brow, your attention is called to Fig. 1, taken from the June issue of the "Aerovox Research Worker." This shows a dynatron oscillator, which is more stable as to frequency, and will behave itself on an unsteady line. On the general principle that one gets what one pays for this circuit makes one pay for its advantages. It will not work on junk-box tubes; even the new '22s from the shelf must be picked over. After the proper tube has been found nothing can be nicer in the broadcast band and down to about 100 meters—or up to 3,000 kc. Naturally it will work well at longer waves—or lower frequencies . . , in fact the dynatron is at its best when used as an I.F. or audio oscillator. The tuned circuit is made up for the proper frequency, and the dynatron doesn't change that frequency very much. One may even use a wavemeter for the L C1 circuit and still use the original calibration on the wavemeter! For I.F. work one may use an ordinary tuned I.F. transformer winding and adjust the trimmer until 175 kc. is struck—as determined by a high-grade oscillator or by comparison with several sets believed to be right. Again, if run on a.c. there is a growl on the signal, but if the 110 volt line is d. c. one has to use two tuned circuits like L C1, the second one being a "tone circuit" and consisting of nothing but an audio transformer primary cut into the wire connecting L and C3. Usually the r.f. oscillations stop until a small mica condenser is connected across the audio transformer. The size of this mica condenser, and the inductance of the transformer decide the tone. If the tone is too low use a smaller condenser. If that stops the r.f. oscillation replace the larger condenser and take off part of the transformer winding or throw out a part of the core. Even a little loudspeaker coil may provide enough inductance to give a tone.

The usefulness of either oscillator is vastly improved if worked with an output meter—See page 15, December "Modern Radio", for some very simple home-made kinds.

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Note: December copies at regular price.

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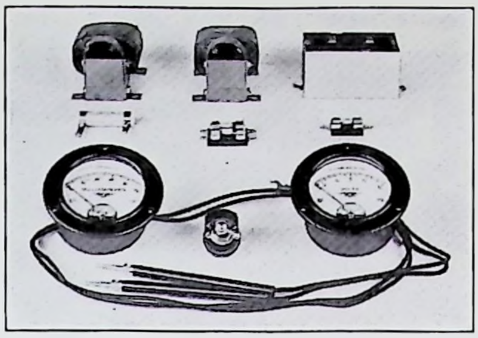
CONCERNING "MODERN RADIO"

"Every issue is read and studied until the printing is hardly readable. So you see it is very much missed around here when it is late."

Cyril Fossey,
Salt Lake City, Utah.



# A Tester for

# • • ELECTROLYTIC

# • • CONDENSERS

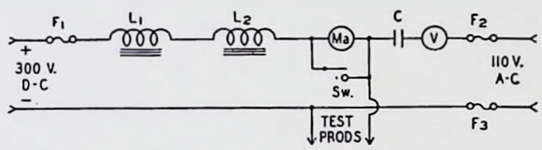
Because electrolytic condensers are relatively short-lived devices the modern service shop certainly cannot get along without a tester for electrolytic condensers. Do not take this to be a condemnation of electrolytics—present low prices justify their use in filter circuits where their relatively high losses are of little importance.

Electrolytics have two sets of troubles; the leakage goes too high, and they lose capacity. Both changes decrease the filtering efficiency of the condenser, consequently the only tester suitable for electrolytics must check leakage and capacity both—preferably at once.

Capacity checks are most easily done with a.c., whereas leakage tests are most easily done with d.c. It is safe enough to put a.c. on a paper condenser but this should not be done to an electrolytic condenser—it takes but a few seconds to damage the condenser and in 5 minutes it may be ruined. The tester accordingly must place on the condenser enough d.c. voltage so that any a.c. which is fed to it during the test will not be able to reverse the voltage. Since 110 a.c. has a peak voltage of 157 we must have at least that much d.c. voltage on the condenser for protection. Furthermore —since most electrolytics are intended for peaks in the region of 500 volts we may as well make the d.c. voltage high enough so that on the "plus" part of the a-c cycle we will run up to about 500 volts (a.c. plus d.c.). This brings us to the actual construction.

Notice the diagram. At the leakage current of the good electrolytic the average old Majestic or other 180 volt B eliminator will deliver 250 to 325 d.c. volts, or an average of 300 volts. 300 volts d.c. put in series with 110 volts a.c. will give a rippling d.c. voltage on the condenser with lows of 143 volts and peaks of 457 volts, which is just right. The two chokes of the B-sub serve for the chokes in the diagram and keep the a.c. out of the d.c. supply. If the old condensers in the B are good, one of them will serve as the 4 mufd. required to keep the d.c. from shorting through all the lamps in the building.

The microfarad meter can be a Jewell 10 or 15 volt meter Pattern 54 or 78 with a resistor in series (not shown). This resistor will be in the region of 1,000 ohms and must be adjusted to allow full-




**L1 and L2—Filter chokes, at least 30 henry at 25 Ma.**
**Ma.—100 Ma. d.c. meter.**
**Sw.—Meter protective switch.**
**C—4 mufd., 600 v. d.c. rating, paper condenser.**
**V—Microfarad meter or voltmeter used as microfarad meter, see text.**
**F1—1/8 amp. Littelfuse.**
**F2 and F3—1 amp. fuses.**

scale deflection of the meter with the resistor in series across 110 volts. This combination will allow readings up to 8 mufd. in the circuit shown. It can be calibrated from good electrolytics as rough standards or from paper condensers. The process is so simple and has been so often described that no further talk is necessary. A standard microfarad meter may be used if allowance is made for the series condenser of 4 mufd. and is preferable. The milliammeter should be about 100 ma. maximum. It is read in the usual way.

The average electrolytic will have a

leakage when new on the order of a ¼ ma. per mufd. (4 ma. for 8 mikes) or less. Some sources of information say that leakage is allowable up to 2 ma. per mufd. but this means 16 to 48 ma. extra current for the receiver rectifier to supply and from 16 to 32 extra ma. to pass through filter chokes probably near core saturation anyhow; the serviceman should not in my opinion tolerate more than 1 ma. per mufd. Aged electrolytics being liable to eventual decrepitude should be suspected in any circumstances.

Finally, the serviceman, after building a tester such as this, will discover that the average electrolytic of the best brands is very ununiform as to capacity. He will also discover that electrolytics tend to show susceptibility to mechanical damage as well as shelf-decay. I suspect he will also come to the final conclusion that since "good" electrolytics are as bad as they are, that the cheaper ones must be avoided.

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## TURNS OF WIRE PER INCH FOR VARIOUS INSULATION

(Use with Chart 103, page 17)

| Wire Size | Enameled | S. S. C. | D. S. C. or S. C. C. | D. C. C. |
|---|---|---|---|---|
| 10 | 9.5 | 9 | 8.75 | 8.5 |
| 14 | 15 | 14.5 | 13.5 | 13 |
| 16 | 18.9 | 18 | 16.5 | 16 |
| 17 | 21 | 20 | 18.5 | 18 |
| 18 | 23.5 | 22.5 | 20.5 | 20 |
| 19 | 26.5 | 25 | 22.5 | 21.5 |
| 20 | 29.5 | 27.5 | 25 | 24 |
| 21 | 33 | 31 | 27 | 26 |
| 22 | 37 | 34 | 30.5 | 28 |
| 23 | 41 | 38 | 34 | 31 |
| 24 | 46 | 42 | 37 | 34 |
| 25 | 52 | 47 | 41 | 37 |
| 26 | 58 | 52 | 45 | 39 |
| 27 | 65 | 58 | 49 | 42 |
| 28 | 72.5 | 64 | 54 | 46 |
| 29 | 81.5 | 71 | 59 | 49 |
| 30 | 90.5 | 78 | 65 | 51 |
| 31 | 101 | 85 | 71 | 55 |
| 32 | 113 | 95 | 78 | 59 |
| 33 | 127 | 105 | 85 | 63 |
| 34 | 143 | 115 | 90 | 66 |

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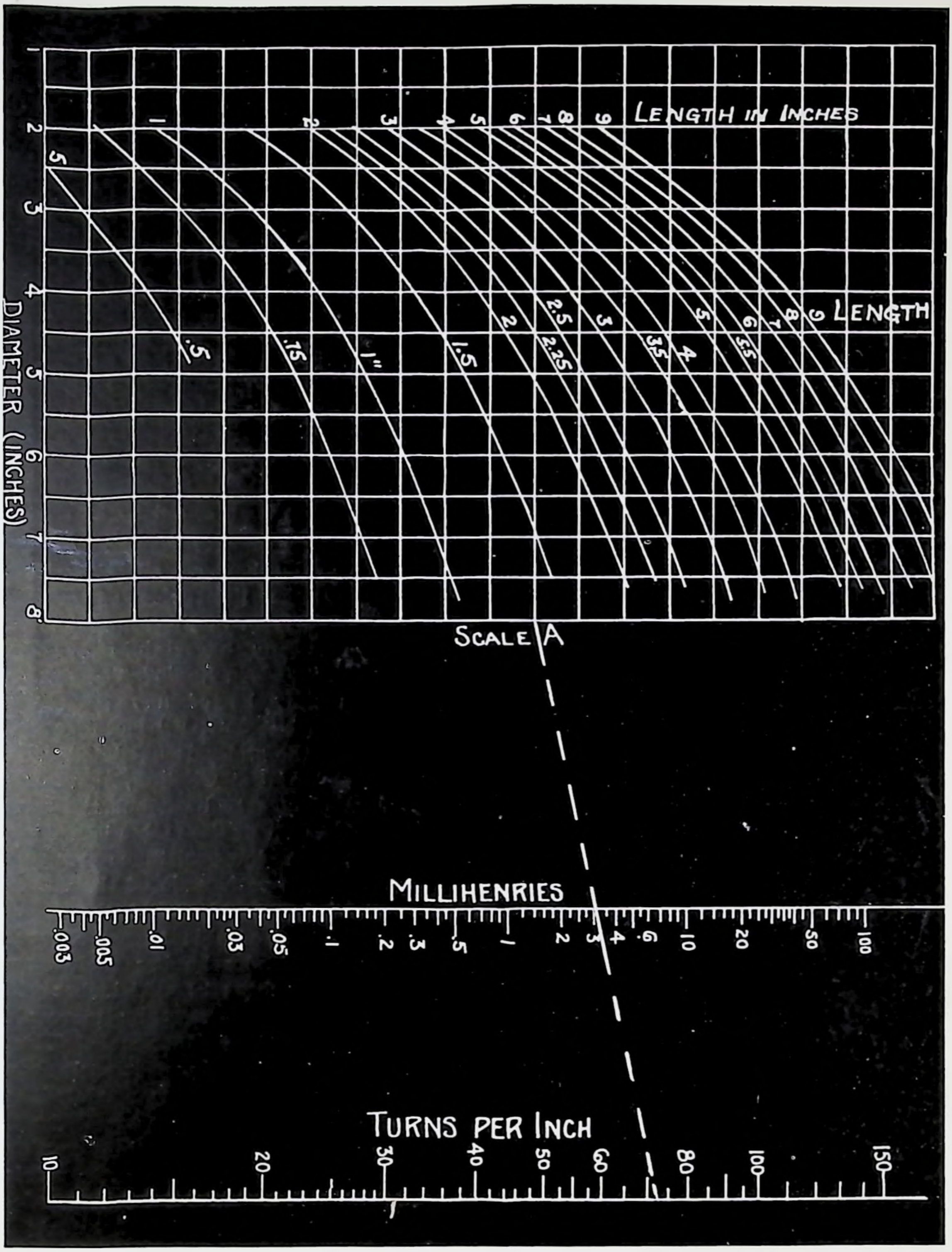
This page was prepared by RALPH R. BATCHER




## CHART 103. INDUCTANCE OF ONE-LAYER COILS (Cylindrical or Helical)

The dashed line illustrates the use of the chart for two different problems. View the chart, right side down.

Problem A. A 3 millihenry coil is to be wound of No. 31 D. S. C. wire. What dimensions are necessary? From the wire table we find that No. 31 D. S. C. winds 72 turns per inch, therefore, we draw the dashed line from 72 on the "turns per inch" scale, through 3 on the "millihenry" scale to the scale A. The horizontal line we are following crosses the 1.5-inch (length) curve right at a diameter of 7 inches and so on. Offhand we can write down:

| Length | Diameter |
|---|---|
| 6 | 2.2 |
| 5 | 2.5 |
| 4 | 3.1 |
| 3 | 3.5 |
| 2 | 5.1 |
| 1.5 | 7.0 |

Problem B. On a coil-form 4½ inches in diameter and only 2¼ inches long we are to wind a 3 millihenry coil. How many turns are needed? Starting at 4½ on the "diameter" scale, go up until the 2¼-inch length-curve is touched, then go right to "scale A". From the point at which scale A is touched, draw a line through the desired 3 millihenry point on the inductance scale as shown. This line touches the "turns per inch" scale at 72. Now use the wire table on page 16.

# An Accurate High-Range Ohmmeter

We will describe briefly a type of ohmmeter which will show continuity through resistances up to 3 megohms, readings at 1 megohm and thoroughly good readings up to 500,000 ohms. It is easily built, using standard parts, and is very useful, especially in servicing a.v.c. sets.

The device is really two ohmmeters, each complete with battery, series resistor and adjustable meter-shunt, but for economy the meter itself (Weston Model 301 with range of 0-1 Ma.) is switched from one circuit to the other, using a double-pole double-throw switch. The

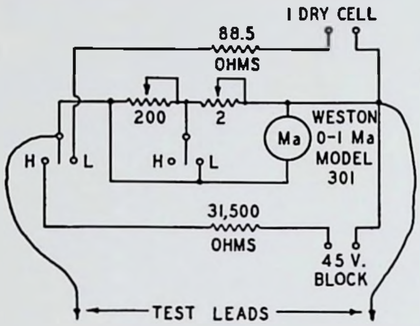



**Fig. 1. Two-range circuit. Switch blades must operate together. Left position for high range, right for low range, both off in center.**

connections, Figure 1, are such that accidents are very unlikely. The switch may be an ordinary knife switch or a GOOD sub-panel cam or jack switch—look out for leakage here.

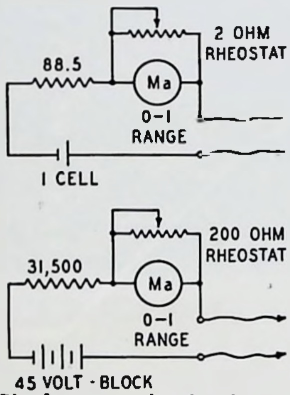
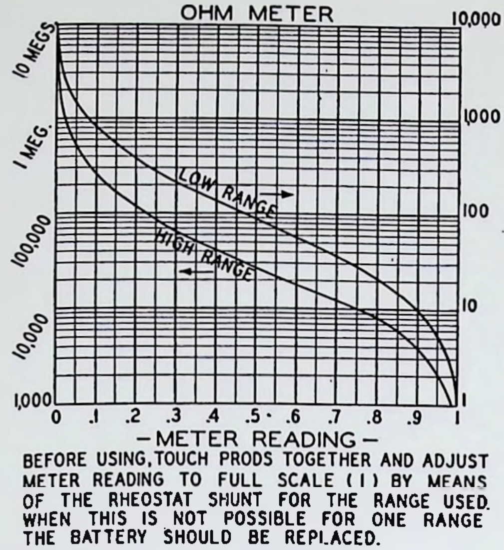



**Fig. 2. Single-range circuits, low range at top.**

If preferred, the meter can be built for one range, using the circuits in Figure 2. The constants are not changed.

In both figures it will be noticed that the calibrating (series) resistors are of




**The calibration chart, correct for all meters of this type.**

odd values. Accurate resistors of these values can be had on short notice at practically the list price of ordinary stock values from Shallcross and others. If there is any uncertainty or delay, please ask "Modern Radio". The shunting rheostats may be of any good wire-wound type but MUST be connected as shown. If the slider is not bonded back to one end of the winding, there is an excellent chance to burn out the meter. Fuse protection of the meter is not practical as the low-resistance range is spoiled by the resistance of the fuse.

### Accuracy of Calibration

Two meters of this type were carefully compared by having their curves graphed on a sheet 12 x 24 inches. The two lines did not vary by more than $\frac{1}{32}$" at any point on either scale. Thus it is safe to use the ready-made scale shown. Since the calibration curve printed here is small, "Modern Radio" will furnish to readers clean-cut blueprints or photostat copies of the scale from the original tracing, if desired. These trim nicely to about 6" x 7⅜". The photostats are black with white lines and do not soil readily.*

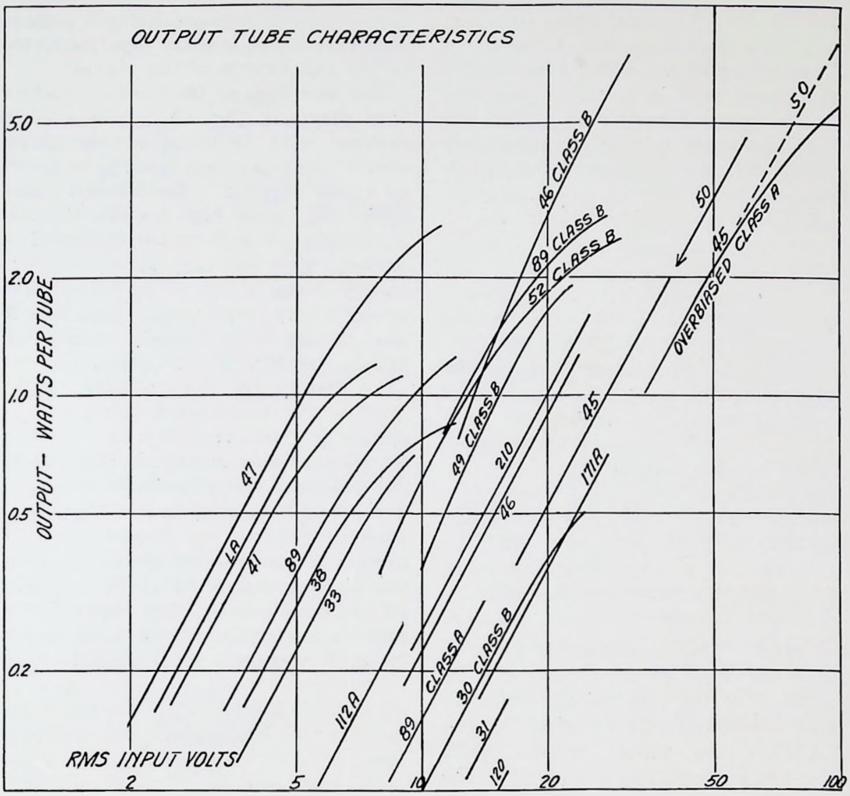
### Mounting

A very convenient case for the ohmmeter is a card-file box meant for 5" x 7" cards. It is somewhat deep but can be cut down if desired. The calibration chart can be put into the cover.

* Blueprints, 20 cents; photostats 50 cents; both postpaid. Modern Radio Co., 101 Allyn St., Hartford, Conn.

# POWER TUBES AT A GLANCE

• • •




## PERFORMANCE OF AUDIO OUTPUT TUBES WHEN OPERATING WITH MAXIMUM RATED VOLTAGE AND MOST FAVORABLE LOAD

These curves are reproduced through the courtesy of Dr. P. T. Weeks of Raytheon Production.

The tube performances are shown under the BEST conditions, at maximum rated voltage. The output given is for ONE tube. Class A tubes may be so used but Class A prime or Class B tubes must be used in push-pull pairs producing 2 to 2.3 times the output shown. The lower scale shows the audio grid input voltage necessary to drive the tube. When working Class A this represents little power regardless of voltage, but when working Class B the grid drive represents power. Thus in the chart a single 27 can easily drive a pair of Class A 50 tubes although they require a peak voltage of 50, but such a tube cannot drive a pair of 46 Class B tubes.

# Building Anti-Noise Antennas

## Abstracted from the First Edition

• • •

Man-made electrical noise dies off very rapidly as one goes away from lighting, power, telephone and trolley wires—a fact easily shown by walking about the neighborhood with a portable receiver. One therefore needs only to extend the ordinary antenna into a comparatively quiet region to have improved the signal-

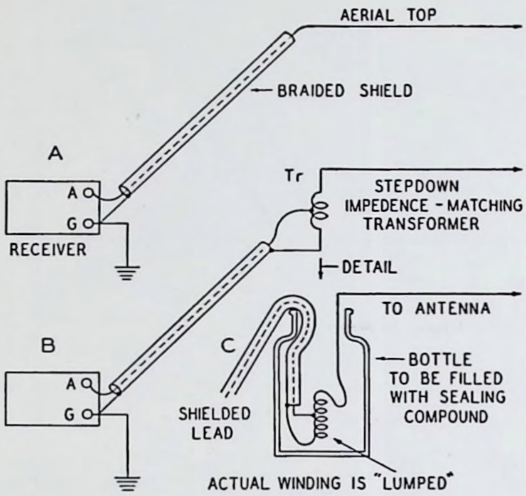



Fig. 1

noise ratio. The extension in no way reduces the noise pickup (noise collecting ability) of the original antenna; but it does something equally good by INCREASING the signal pickup, while leaving the noise-pickup unchanged. The larger signal permits one to turn down the volume control on the set to reduce its sensitivity to perhaps 1/5 of the previous value, and to reduce the noise in the same ratio. The noise is in fact reduced so much that many a bitterly-complaining set owner has been changed into one who heard no noise.

Since the long aerial is frequently sufficient, begin by stretching the noisy small antenna to 200 or 300 feet—not necessarily in one span but turning as necessary to avoid power and telephone wires, also houses wired without conduit.

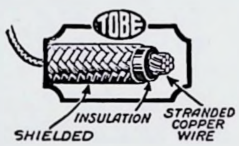
### Trick Leadins

Special leadins for anti-noise aerials are all arranged to have no pickup of either noise or signal. They can be led through a noisy space without difficulty. This leaves the antenna top (unshielded) as the sole source of the signal.

The simplest of the special leadins is that shown in Fig. 1A. It is a rubber-covered wire (without cotton or silk) over which is a metal braid to be grounded at the receiver. The losses in such a leadin are rather high because the leadin is, in effect, a soft-rubber-insulated condenser. This loss may be anticipated by simply using a lot of signal—which is to say a very large aerial. One may also use a very neat remedy suggested, I believe, by Mr. W. F. Cotter.

### A Detour On Transmission Lines

Since the losses in a low-grade condenser go down very fast as the voltage is lowered we can reduce the losses in our rubber-covered leadin if we can reduce the r-f. voltage in it. This may be done by using a very simple, small stepdown r-f. transformer at the top end of the lead as suggested at Tr in Fig. 1B (dimensions later). The signal is then sent along the shielded leadin at LOWER voltage and HIGHER current.




The idea may be simplified by thinking of the antenna as a high-impedance signal-generator (the top) tied to a low-impedance transmission line (the shielded lead). One will see the necessity of matching impedances by some stepdown device. Similarly at the receiver end of the line we must step up again to work into the high-impedance grid circuit of the first tube. The second transformer can frequently be avoided as will be shown later.

### The Antenna Transformer

As a good start, here are the dimensions of a step-down transformer to work out of a 100 foot top, and into a

35 foot shielded leadin.

Total turns—150 of No. 30 D. S. C., lumped on a 1″ tube and connected between antenna top and the shield of the leadin (see Figs.).

Tap—90 turns from grounded end, to be connected to the leadin wire (inner conductor).

Different shielded wires require minor changes in this transformer. Consider-

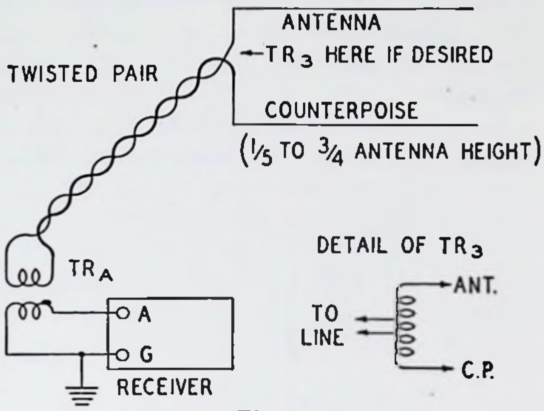



Fig. 3

able changes in length of either top or leadin also require changes. In practice, with leadins up to 50 feet long the tap should be made at ½ to ¾ of the way up from the grounded (shield) end of the winding. By adjusting the total number the best response can be thrown into different bands as desired, using antenna harmonics for high-frequency work on very large antennas. For broadcast reception the coil is so wound that (with everything connected) the system will have a resonance point (very broad) around 600 or 700 kc. Long wave (low-frequency) stations will be greatly aided by this resonance, while the droop at higher frequencies is well compensated for by the better sensitivity of most broadcast receivers at 1500 kc.

**Theoretical objection to this is possible if one speaks of a single frequency; but over a band the idea is o.k.**

### Simulating the Shielded Leadin

It is possible to simulate the shielded leadin with ordinary wire. In no case is the effect as good as with shielding.

A variation of the twisted leadin is shown in Fig. 3. Unless the top can be made quite long there should be a matching transformer TR3 at the top—the requirements in that regard being no different than in the simpler system described before. These antenna-counterpoise systems necessarily must fit into the yard or onto the house and accordingly are rather uniform in size so that for broadcast purposes TR3 may in all cases have 150 to 160 turns of No. 34 D. S. C. lumped on a ¾″ form. Taps for the downleads are provided 8 or 10 turns on each side of center. Since neither antenna nor counterpoise may be grounded a second transformer MUST be used to feed into the receiver. This second transformer TRA works into the original antenna coil of the receiver and as this is a low impedance we have a 1-to-1 transformer, meaning a pair of 30-turn windings scrambled on a 1″ form, one over the other. A few receivers use special input windings in the form of a small honeycomb coil intended to resonate the antenna at about 500 meters (600 kc.). TRA in that case may need to have from 50 to 200 turns in its secondary. One must cut and try until the response of the receiver is satisfactory over the band.

### The Receiver End of the Line

Practically all receivers which tap the antenna directly into the first tuned circuit will work satisfactorily without a step-up transformer when used with a shielded leadin under 70 feet. Above that one may use a step-up transformer which has 30 turns of No. 30 D. S. C. lumped on a 1″ form and connected across the input posts of the receiver. Taps at 15, 20 and 25 turns from the

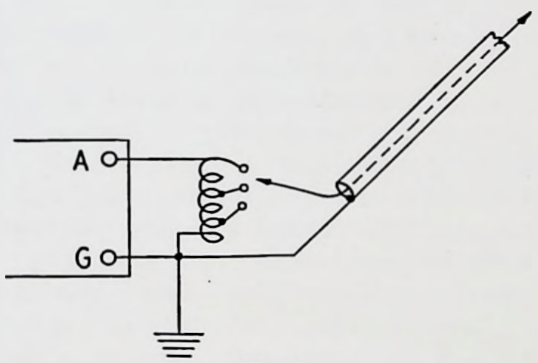



Fig. 4

ground end may be provided for the connection of the leadin wire, the right one to be found by trial. Fig. 4 shows the circuit.

**Use a separate driven ground for best results. In some cases it is best to ground the leadin shield (Figs. 1 and 4) at the antenna instead of the set, using a separate ground lead.**

# Simplified Automatic Volume Control

## Theory — Service

### (Abstracted from the First Edition)

Automatic volume-control is automatic sensitivity control. The sensitivity control is got, as most sensitivity control is got, by spoiling the efficiency of one or two of the r.f. or i.f. amplifying tubes, usually screen-grid type. When manual control is used the screen voltage or bias voltage of the r.f. amplifiers is varied by moving a slider on a resistance which supplies the voltage. With most automatic volume-controls of wide range and reliability, control is likewise got by varying the bias on some r.f. amplifiers but the bias is made and determined by the strength of signal and thus adjusts itself automatically. Thus if the antenna is receiving a fading signal the set automatically changes its sensitivity and the result is a steady loudspeaker output.

The machinery for an automatic volume control is seldom as complicated, in fact, as it looks to the inexperienced eye. For instance, we have in Fig. 1 the basic circuit of the automatic bias mechanism used by Philco. The tube is a 227 used as a two-element or half-wave rectifier. To the r.f. input terminals is attached a tuned-circuit or some other suitable source of r.f. signal voltage. Rectification of the r.f. produces a d.c. voltage drop across R, (the r.f. is by-passed by C). The d.c. voltage from R. to the chassis (indicated as ground) is supplied to the tubes being controlled, the connections giving polarity as shown. This automatic-bias varies with the r.f. signal. The normal bias for the tubes must be supplied as well, otherwise no signal means no bias—hence damaged r.f. and i.f. tubes. This normal bias may be got the usual way, that is with a cathode-to-chassis resistor, or better (as Philco gets it) from a resistor in the negative leg of the power supply, which resistor carries the plate current to all tubes except the power audio tubes. This keeps the normal bias essentially unchanged when the plate current of the automatically biased tubes (only two) is cut down by the automatic bias. The normal voltage got from the resistor (plate-current IR drop) suffers less than 20% reduction when large signals push the controlled tubes near to zero plate-current.

To make this clearer, in Fig. 2A is shown the essentially complete Philco

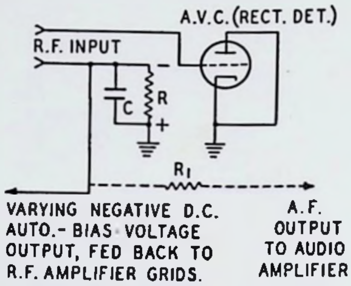



Fig. 1

a.v.c. circuit. The function of the 70,000 ohm $R_3$ resistor (between bias resistor R2 and Cathode) is to filter hum or possible a.f. feedback dropped across R2. C is an r.f. by-pass condenser 110 uufd. in capacity. R1 is an r.f. filter resistor keeping r.f. out of the audio system. The audio drop across RC is fed thru R to the grid of the following a.f. tube, which is an extra amplifier made necessary by the fact that the rectifier-detector does not amplify as an ordinary biased triode detector would. Because it performs a part of the work of the ordinary detector this extra audio stage is euphemistically called the "detector amplifier".

The rest of the Philco system would include additional filter resistors in the auto-bias line, their function (with by-passes) being to prevent audio or radio feedback to the r.f. tubes. Since the a.v.c. tube supplies a negative bias, the bias line feeds through the r.f. transformer secondaries to the GRIDS of controlled tubes, these tubes having their cathodes grounded. In a.v.c. systems giving a positive output (d.c.) the bias is, of course, fed to the CATHODES of the tubes to be controlled. This information should be checked against the diagram of any of the Philco a.v.c. receivers, 90, 95, 96, 111, 112 or 112x, to be found in a good service-manual such as Rider's Perpetual. The system is likely to give little trouble in either tubes or components: it is very easily applicable to an existing receiver.

### R. C. A.-Stromberg Circuit

Let us now consider the other very widely applied system, that is used by R. C. A., Stromberg and others.

The basic circuit is shown in Fig. 3A. Fig. 3B shows a partial equivalent circuit. Notice the Rp and R are a potentiometer across the B supply. The B plus end of R is grounded to chassis. The a.v.c. tube is biased to no plate current and the r.f. rectified by the tube increases the plate current in the usual rectifier-action manner. Thus the tube draws through R a current varying with the signal strength. As a result there is a voltage drop across R which also varies with the signal and is, therefore, suitable for use as an a.v.c. bias on the grids of an r.f. or i.f. amplifier.

In Fig. 3 I have shown the a.v.c. tube self-biasing with a cathode series resistor. This was done to simplify the diagram, it should not be regarded as an altogether satisfactory trick since it gives a.v.c. action of somewhat limited range. To obtain the full range a fixed bias should be supplied in some other manner.

The circuit of Fig. 3 as used or as applied to existing receivers is no small problem. Since R is grounded to chassis in common with the tubes to be controlled, it must start at the same negative potential as they, which means that we must move the cathode and grid of

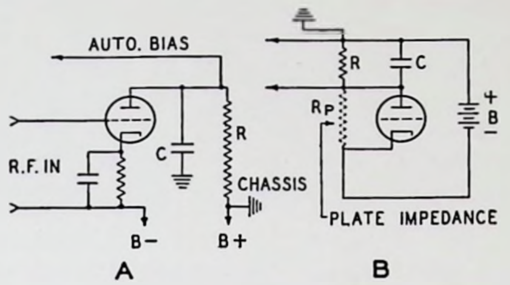



**Fig. 3.** R-200,000 ohms for 224's and C about .5 ufd.

the a.v.c. tube still further negative in order that a B voltage be available in the plate circuit of the a.v.c. tube. See Fig. 4 for the circuit as used in an R. C. A. receiver. Actually the a.v.c. tube gets its r.f. from an r.f.t. but here I indicate the r.f. drop as being across a grid-resistor for a reason that will be clear further along, and also for convenience and diagram simplicity.

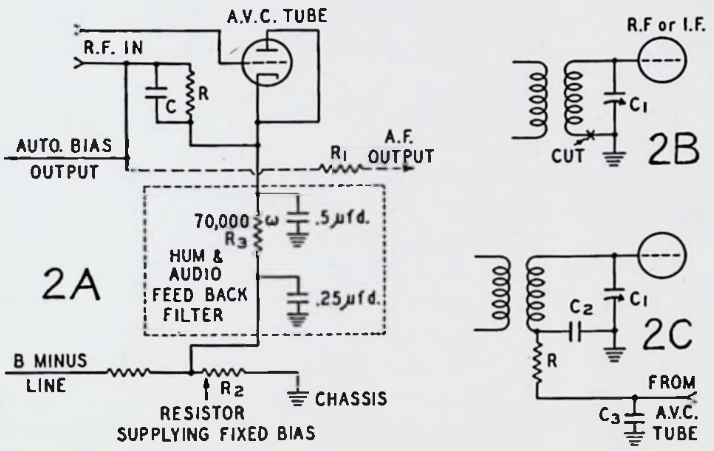



**Fig. 2**
A is the essentially complete Philco A.V.C. tube circuit.
B and C indicate the changes to be made in an r.f. amplifier grid circuit to apply the automatic control bias.
R of A is 200,000 ohms for 224's r.f. and C .00011 in Philco sets.

Notice in Fig. 4 that the cathode of the a.v.c. tube is moved negative from chassis by the voltage drop through the filter choke L. Thus the drop across L is the B voltage for the a.v.c. tube. Although hum might be introduced because of the conditions at the center of the power-supply filter the resistors R and R3 act as filters aided by C. However, after getting B voltage on a.v.c. we must also bias its grid to no plate-current, or near that point, so we must go further negative for bias. Hence the grid "line" picks up the voltage-drop across the second filter choke (at high hum level) L1 through resistors R1, R4 and R5. R4 and R5, with two .1 by-passes, filter out the hum in the filter system, and their size is 1 megohm each. These resistors take no current since the grid is biased well, negative in relation to cathode. Of course, if the bias is too high or too low the a.v.c. action will be interfered with, this is subject to an adjustment by means of the resistance

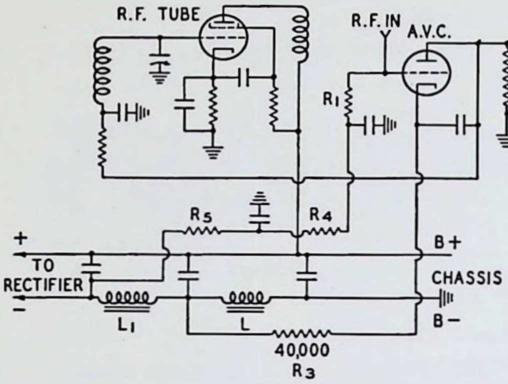



**Fig. 4. A practical triode A.V.C. tube circuit showing wiring through to the r.f. tube under control. A.V.C. is a 227.**

of L1 or else as will be described later. The main point now is to understand clearly how the additional voltages necessary for the a.v.c. tube are got at "below" chassis potential, and to realize without fail that such additional voltages must be supplied for the facts are as true of a battery set as an a.c. one, the only difference being the source of voltage.

## SERVICING A. V. C.

The first move in servicing an a.v.c. receiver is to make certain of the type of a.v.c. used, i. e., the basic circuit involved. This means that one finds out the important details leading to correct diagnosis of the kind and source of trouble. These important details are:

1. Is the a.v.c. tube independent of the receiving circuit, can it be removed as in Figure 4, without doing more than simply removing the a.v.c. bias? This found out, simple removal will give the performance of the receiver alone at full sensitivity. If something other than a.v.c. failure is affecting the set it can be located according to usual methods.

2. What type of a.v.c. tube circuit? In addition to the two triode circuits described in the May a.v.c. article* there is also the screen-grid tube a.v.c. and others shown herewith, Figures 7, 8, 9.

3. What sizes of resistors are involved in this a.v.c. circuit? A one megohm resistor subjected to accidental leakage current of 10 microamperes (.00001 Ma.) can subject the controlled tubes to 10 volts of undesired bias. With high resistors we may wisely look for insulation leakages, condensers with only 10 to 15 megohm resistance, etc.

4. Does the heater of the a.v.c. tube carry a potential different than the cathode? Is the heater at or near a.v.c. plate potential or what?

This information is to be read from the service diagram of the receiver or else it should be dug from the receiver itself.

The next step is to learn which tubes are under a.v.c. control: These are fairly certain to be the first r.f. amplifier and the first intermediate in the case of a super-het, the first two r.f. in the case of t.r.f. sets, or simply an intermediate in a super-het without t.r.f. These tubes may be checked with an analyzer or test kit like any other tubes and the effect of the control can be observed. To wit:

The probability is that the resistances "passing" the a.v.c. bias along will be too high to permit measuring a.v.c. bias with the analyzer voltmeters. Fortunately we don't need to measure this bias directly. We can SEE its effect on the plate-current of the tube under control. We check plate-voltage and screen-voltage, and find the operating conditions of the 224 or 235 are normal knowing from experience that NORMAL control-grid bias will cause from 3 to 5 Ma. of plate-current. Consequently with only the plate-current meter in use we can tell if bias is normal PROVIDED NO STATION IS TUNED IN. If a station will not tune through the analyzer cable an oscillator on correct frequency may be used to place a good signal on the tubes FOLLOWING the

* Copies may be had at the regular price.

one under check. If we are working on so simple a receiver that neither scheme is practical, we may directly excite the a.v.c. tube with the oscillator. In any case, the r.f. getting to the a.v.c. tube will cause it NORMALLY to produce an increase of bias for the tube being controlled, (which we are analyzing) and cause a plate-current decrease. Of course, this same check may be made "on the air" by opening up the cathode, or plate-circuit, of the tube being checked and inserting in series a milliammeter (the well-known tuning-meter) to watch these plate-current changes as caused by reception.

If we find the controlled tube has no change of plate-current with (supposed) operation of the a.v.c. tube we must have found the plate-circuit resistor of the a.v.c. tube open, shorted, or else an open or short along the bias distributing network connected to the a.v.c. tube. Presuming we are feeding the a.v.c. tube r.f., from oscillator or antenna, and should be getting a bias from it, we may locate the exact point of trouble by disconnecting condensers and shorting resistors that seem doubtful. If, as in the case of some Stromberg-Carlson receivers, the control bias is passed through 5 megohm grid-leaks, we cannot conveniently short a resistor it may be temporarily shunted with another of suitable size: 5 megohms temporarily shorted by from .5 to 10 megohms, etc.

To be able to check the high resistors is evidently necessary. Indications up to 20 megohms for condenser leakage tests, and good readings in the range of 3 megohms to 30,000 ohms will be got with a 300 volt, 1,000 ohm-per-voltmeter AND 300 VOLTS from a B supply.

In the R. C. A.-Stromberg triode rectifier a.v.c. tube circuit (see Fig. 4), a.v.c. bias is caused by the plate-current of the a.v.c. tube. Watching our r.f. tube plate-current as before, we can short-circuit the plate resistor of the a.v.c. tube—which test will cause the plate-current of the r.f. tube to rise to normal since all a.v.c. bias is in that way eliminated. If the plate-current of the r.f. tube does not rise, trouble MUST be elsewhere.

Insufficient bias on the a.v.c. tube is the only thing that will allow it to have excessive plate-current to cause too much "idle" a.v.c. bias. Its grid-line, see Figure 4, accordingly must be gone over for shorts or opens which prevent or drop out the a.v.c. tube's grid-bias.

Of course, one of the basic problems of working on an a.v.c. set revolves around the effectiveness of the a.v.c. It is frequently desirable to hear the receiver work at actual full sensitivity in order to avoid guessing at normal performance since once the a.v.c. takes hold sensitivity is, of course, reduced. To get the a.v.c. action out of the picture in sets whose a.v.c. tube cannot be removed without stopping reception, use little or no aerial and the weakest signal that can be heard.

## PICKING AUTOMATIC VOLUME CONTROL TUBES QUICKLY

Many tubes that will work perfectly in any other position are hopeless for automatic volume control. In some sets one has to go through many tubes to find a good one—even though the usual tube tests show them all to be o.k.

The trouble is that the usual tests tell nothing at all about the gas in the tubes, and it is exactly the gas-currents which spoil the tube for AVC work. Please don't have visions of a complicated gadget—it is dead simple. Merely add to your tube tester a switch which breaks the grid circuit of the tube which is being tested, and connect a 1-megohm resistor across the switch. This needs to be done only on those sockets which receive tubes of types used for AVC work. First test the tube as usual, then open the switch. If the tube is gassy there will be a grid current and when the 1-meg. is put in series a voltage will build up across it—and the plate meter will take a walk—throw that tube out and try the next one. Those suited for AVC will show little or no effect from the resistor.

Cheap tubes mostly look cheap after this test is made.

# The Practical Advisor

## For Serviceman and Amateur

## VOLTMETER and MILLIAMMETER RESISTANCE

The serviceman, experimenter and amateur have dozens of occasions for knowing meter resistance—the making of ohmmeters, the checking of resistances with a voltmeter, multiplying voltage scales and so on, require this information. It is not difficult to obtain.

A certain amount of arithmetic is necessary and Ohm's law is the basis of the figuring. The formula that serves the law is the familiar $E = IR$ where E is voltage, I current in amperes and R the resistance in ohms.


**Case No. 1**

The voltmeter in question is a 150-volt d.c. instrument. You possess a milliammeter of say 25 ma. full scale reading. Any source of voltage may be used but the accuracy of the milliammeter should be doubted at much less than quarter scale. Connect the milliammeter and voltmeter in series as in Figure 1 and connect to the source of voltage. Assuming a 45-volt B battery, a current indication of 7 ma. and the voltmeter showing exactly 44 volts. Then:

$$44 = .007 \times R$$

If I assume you do not know how to get the value of R from this equation, then the next step is to divide both halves of it by .007:

**(A)** $$\frac{44}{.007} = \frac{.007 \times R}{.007} \quad \text{or}$$

$$\frac{44}{.007} = R = 6{,}428 \text{ ohms}$$

Then if we wanted the "ohms per volt", the 6,428 would be divided by the 150 range of the meter to give 42.85 ohms per volt. Obviously then, if we were to raise the 150 voltmeter to 450 volts the additional 300 volts would require a resistance of 300 × 42.85.

**Precautions Necessary for Accuracy**

Keep both the milliammeter and voltmeter readings at quarter of scales or higher. The nearest accuracy will be obtained from meter observation at full scale on the voltmeter at least. In the case just given that would require 150 volts and a milliammeter capable of showing not less than 30 ma.

In calculating: 42.85 is not the exact result of dividing 150 into 6,428, nor is 6,428 the exact result of dividing .007 into 44 but the latter and former are both accurate within essentially .01%. That is the advantage of carrying a

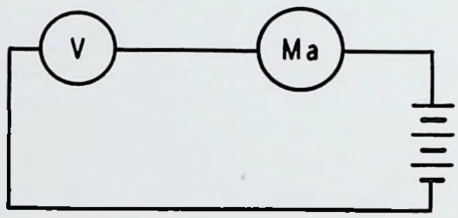



Fig. 1.

figure out to its fourth place. In the case of the 150 into 6,428 calculation, the remainder which would have made the fifth place was 50; i.e., 50/150 or ⅓ of .01%.

**Case No. 2**

You haven't the milliammeter.

So we must use another scheme which also is simple. It requires that you possess a resistor or two. The accuracy of your result will be dependent upon the resistor used but don't forget the accuracy of the meter involved, it renders important or unimportant the resistor's error.

The arrangement is shown in Figure 2. In this case we first read the battery voltage direct. Assuming the meter to

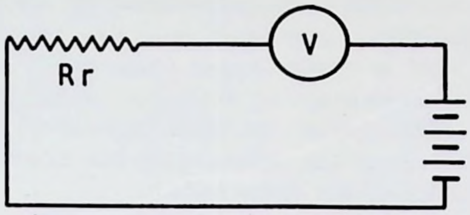



Fig. 2.

be a 50-volt unit, and that the battery shows 41 volts, insert the resistor R. Suppose the resistor is 1,500 ohms and is a standard Electrad, I. R. C., or other 10% accurate resistor. The meter plus the resistor gives a reading of 32 volts. By doing this we have divided E into two parts, Em the voltage of the meter and Er the voltage dropped across the resistor. Also our resistance is in two parts, Rm of the meter and Rr of the resistor. Thus our formula must show up this way:

$$Em + Er = I\,(Rm + Rr) \qquad \text{or}$$

$$32 + 9 = I\,(Rm + 1{,}500)$$

But we don't know two values necessary to clear the equation—we could solve it for one. Hence, we must use a stunt that will give an equation with only one unknown. Accordingly if E = IR then Em = IRm and Er = IRr. This is the same as saying the voltage for the meter is equal to the current for the meter times the resistance of the meter, and so on. The meter and the resistor Rr are in series so the same current passes through both. Thus, if we divide

$$\frac{Em}{Er} = \frac{IRm}{IRr}$$

and we have in the last half

$$\frac{I}{I} \times \frac{Rm}{Rr}$$

And since I into I goes once it is 1. 1 times Rr into Rm leaves Rr dividing into Rm without change of answer. Accordingly:

$$\frac{Em}{Er} = \frac{Rm}{Rr} \quad \text{or} \quad \frac{32}{9} = \frac{Rm}{1500}$$

and we have only one unknown left. So we multiply the both halves by the KNOWN part of the half containing the unknown so:

(B) $$\frac{1500 \times 32}{9} = \frac{1500 \quad Rm}{1500} \quad \text{or}$$

$$\frac{48000}{9} = Rm = 5333 \text{ ohms}$$

Once we find the meter resistance as above, the rest is accordingly as before.

There remains the worry as to accuracy. A 10% resistor may be marked 10% above or below its real value or somewhere in between. If you have several "1500" ohm resistors and each gives a different voltage on the voltmeter in the circuit of Figure 2, average the voltmeter readings (5 resistors, for example, would be 5 readings added together and divided by 5) and use the average as the figure for Em. When the resistors are of one manufacture this scheme has worked out within a per cent. but that is an accident—in any case the accuracy becomes nearer in the average.


If a precision resistor can be used (1% or better) one reading is near enough.

If in the case given the meter reading had proved to be 3 volts or some other absurdly low value in place of 32 a lower resistance should be used, sufficiently low in all cases to give about half the battery voltage on the meter. Once the meter resistance is known, the same scheme measures unknown resistors.

### Milliammeter Resistance

Milliammeter resistance determines the value of the milliammeter shunts for multiplying its scale. The resistance of the milliammeter must be guaged, however, in a slightly different manner than that of a voltmeter.

First: Since we know the current the milliammeter requires for full scale reading, we know how many ohms we must place in series with it to give full scale from a given battery voltage. Example: 45-volt battery, 10 ma. meter—

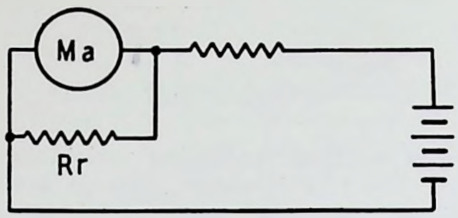



**Fig. 3. The series resistor is Rr as before, while the shunt (lower) resistor is Rs. In the example Rr is 4,500 ohms an Rs is ½ ohm.**

$$45 = .01 \times R \quad \text{or} \quad \frac{45}{.01} = R = 4500 \text{ ohms}$$

Accordingly we connect 4500 ohms or more in series with the milliammeter and the battery in preparation for learning the resistance of the meter.

Now if in Fig. 3 we find that the meter reads 9 ma. with Rs disconnected, and 7 ma. with Rs connected, it is evident that Rs takes the difference, 2 ma. or .002 ampere. Suppose Rs is ½ ohm. Then the voltage across Rs must be:

(C) $V = .002 \times \frac{1}{2} = .001$ volt

But since Rs is across the meter, we evidently have the same voltage across IT. The meter is reading 7 ma. or .007 ampere, which means that the meter resistance must be:

(D) $Rm = (.001) / (.007) = 1/7$ ohm

Practically meters are not of so low a resistance, but the example brings out the point that the correctness of the result depends on using a series resistor Rr that is much larger than either the meter resistance or the shunt resistance Rs. This keeps the total current in the circuit constant, whereupon the assumptions above are quite safe.*

### Shunts

and the voltage that runs 7 ma. through and the voltage that runs 9 ma. through the meter. If we want to raise the original 10 ma scale to 30, then when 7 ma. shows on the meter 14 ma. is going through the shunt. Then the voltage the meter requires, .001 volt, is equal to .014 × R the shunt resistor needed to multiply the meter range by 3.

$$\frac{.001}{.014} = Rs = \frac{1}{14} \text{ ohm}$$

Again, the precision of the resistor used determines what's what.

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* If the meter was of 3 ohms resistance we could still use the same battery and the 4,500 ohm series resistor but a ½ ohm shunt (Rs) would drop the reading too much and we'd use something like 5 ohms (if it were handy), though 3 or 10 would do. On the other hand, a cheaper meter of say 100 ohms would upset the proceedings completely.

# IMPROVED CATHODE BIASING

*By BOYD PHELPS

## (Abstracted from the First Edition)

It is very common in modern receivers to obtain the grid bias by inserting a resistance in series with the cathode and chassis ground, making the plate current flow through this resistance, and utiliz-

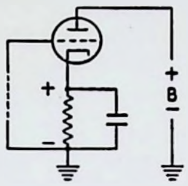



Fig. 1

ing the IR drop developed thereby for the desired control grid bias voltage as illustrated in Fig. 1.

A 2000 ohm cathode resistor by-passed by a 0.1 microfarad condenser (which at 800 cycles has a capacity reactance of 2000 ohms) would make a parallel combination having an 800 cycle impedance of about 1000 ohms, which would seem to cause neutralization of incoming signals impressed on the grid. (See Fig. 2)

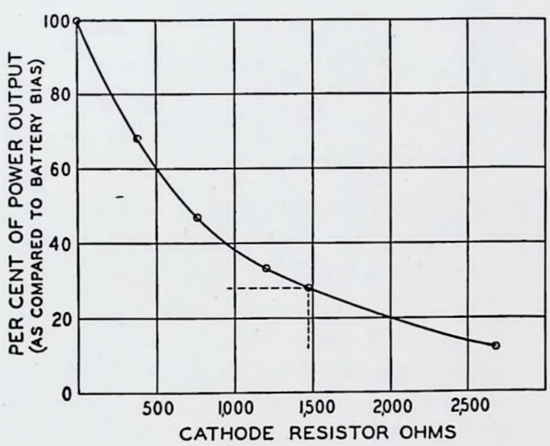



Fig. 2

### The Cure

The circuit shown in Fig. 4 is similar to Hatry's Fig. 3 in March "Modern Radio" and represents an interesting and cheap dodge to avoid the very large capacities that would otherwise be required to give fidelity on low tones. R1 is the same as before, R2 is

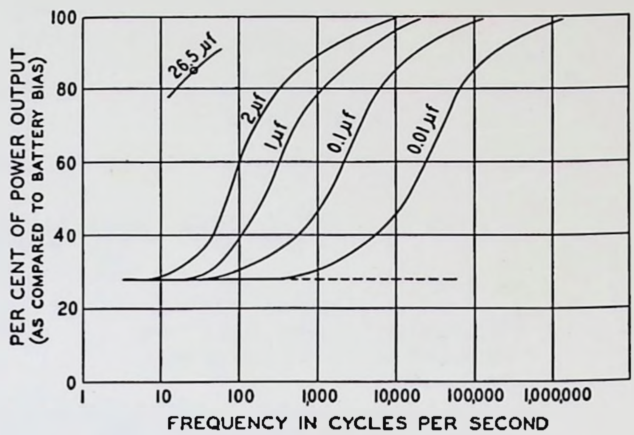



**Fig. 3. Unless one uses push-pull, or a circuit like Fig. 4, it is necessary to use high-capacity bypasses on audio cathode resistors. The common ½ to 1 mike is absurd—unless one has a poor filter and must get rid of hum and bass together!**

made high to force the "lows" through C2 rather than be allowed to pass through R1 and C1 which contain only partially cured low frequency fluctuations.

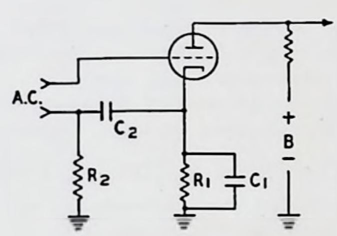



**Fig. 4. The cure. Keep C2 at 1 mfd. or more; C2 need not be above one-tenth mfd.; R2 can be anything above 40,000 ohms. Typical results appear below, measured at 60 cycles.**

| C1 | C2 | R2 | Output Percentage |
|---|---|---|---|
| | | (battery bias) | 100 |
| 1 mfd. | 1 mfd. | 100,000 | 100 |
| 0.1 | 1.0 | 100,000 | 97 |
| 0.1 | 0.1 | 100,000 | 68 |
| 1.0 | 1.0 | 50,000 | 97 |
| 1.0 | 1.0 | 33,333 | 74 |
| 0.0 | 0.1 | 100,000 | 67 |
| 0.0 | 0.0 | 100,000 | 28 |
| 0.1 | 0.0 | 100,000 | 30 |
| 1.0 | 0.0 | 100,000 | 35 |

* Phelps Precision Laboratory (Frequency Measuring and Monitoring), 3804 22nd Avenue S, Minneapolis.

# Handy Data

TABLE OF CONDENSER REACTANCES

| Frequency | 2 ufds. | 1 ufd. | ¼ ufd. | 0.1 ufd. | 0.01 ufd. |
|---|---|---|---|---|---|
| 50 cycles ........ | 1,592 | 3,184 | 12,700 | 31,840 | 318,400 |
| 60 cycles ........ | 1,325 | 2,650 | 10,600 | 26,500 | 216,500 |
| 1,000 cycles ........ | 80 | 159 | 635 | 1,592 | 15,920 |
| 10,000 cycles ........ | 8 | 16 | 64 | 159 | 1,592 |

# The 59 All-purpose Output Tube

## General Data

Filament—2 amperes at 2.5 volts.

Plate—30-35 Ma. at 250 volts.

Base—New 7-prong type.

Output Class A equals 45 with higher gain.

Output Class A prime equals 45 Class A prime or Class A '50 with higher gain.*

Output as pentode exceeds 47 with slightly lower gain.

Output Class B exceeds 46 with improved gain for the two stages (driver and output stage).

* See "Modern Radio" for July.

## The 59 as a Class A Triode

Grids No. 2 and 3 tied to plate, input to No. 1 (pin 7).

Plate 26 Ma. at 250 volts.

Grid No. 1 biased minus 28.

Mu 6.0.

Plate resistance 2400 ohms.

Mutual 2600 micromhos.

Power output 2 watts (per tube).

Power output A prime 14 watts per pair.

Lead resistance 5,000 ohms.

(When using autobias 500 ohms is correct for either Class A pairs or Class A prime pairs.)

## The 59 as a Class A Pentode

Grid—No. 3 tied to cathode, No. 2 used as screen, input to No. 1 (pin 7).

Plate—35 Ma. at 250 volts.

Screen—10 Ma. at 250 volts.

Grid No. 1 biased minus 18 volts.

Load resistance 7,000 ohms.

Amplification factor 100.

Plate resistance 4,000 ohms.

Power output 3 watts per tube, 6.3 per pair.

## The 59 as a Class B Triode

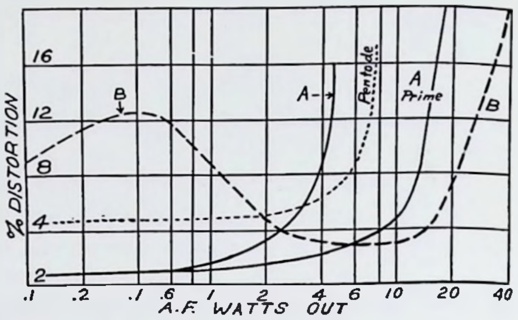
(Class A prime recommended instead)

Grid No. 3 tied to plate, input to grids No. 2 and 3 tied together.

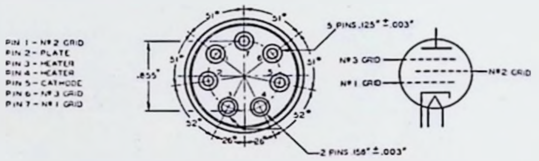
Plate current, small until grids are swung.

Output per pair, 18 watts at 5% distortion, 22 watts at 8%.

Distortion at low volume rises to 12% or more as in most Class B systems, minimum distortion 3% in region from 3 to 10 watts output—too high for home use.




Typical curves of Class A, Class A prime and Class B audio amplifiers. The curves shown here are for the 59 tube, data by Zenith Radio Corporation.



Base Connections of the 59 Tube

AVERAGE PER-STAGE GAINS OF TUNED R F. AMPLIFIERS WORKING IN 550-1500 K.C. RANGE

226 or 227, loss stabilized, 6 to 7.

226 or 227, neutralized, 10.

224 (depending on design), 30 to 50.

These gains are for a plate voltage of 180, and are exceeded at 250 volts, but fall off rapidly below 150 volts. Other triodes and tetrodes perform similarly. R.F. pentodes slightly exceed 224 performance.

At short waves the 224 and similar tubes fall off gradually to a "low" near 10 meters, then rise slightly at about 5 meters. The 58 does not have this dip and slopes down more slowly.

At long waves (including intermediate frequencies) gains run from 50 to 120 per stage.

# The Right Resistors for the Job • • •

Column R shows the standard radio resistor values in ohms; manufacturer's freaks are near enough to them to make the table useful in all cases. Columns 1W, 2W, and so on refer to size and mean "1 watt", "2 watt", etc. Example —a 1,500 ohm resistor is needed to carry 50 milliamperes. Start at 1500 in the R column, go to the right until you strike a figure slightly larger than 50, which this time means 55, under 5W. Thus a 5 watt resistor will do, but will be running at full rating, therefore hot. To run "warm" continue to the right until you strike a figure about 1½ times the load current—in this case 80, which is in the 10-watt size. To run "cool" go on to a current figure twice the current to be handled, in this case 112 in the 20 watt column. Other values can be "guessed in" as follows:

Sticking to one ohmage (resistance value); doubled current requires 4 times the rating in watts, tripling requires 9 times the rating. ½ the current calls for ¼ the wattage rating, cutting the current to ⅓ calls for 1/9 the wattage rating.

Sticking to one size of resistor (wattage rating); twice the resistance drops the current capacity to .7, three times the resistance drops it to .6 of the original. Half the resistance allows 1.4 times the current, one-third the resistance allows 1.7 times the current.

| OHMS | WATTS RATING (W) OR SIZE | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| R | 1W | 2W | 3W | 5W | 10W | 20W | 25W | 50W | 100W |
| 100 | 100 | 140 | 175 | 223 | 320 | 448 | 500 | 700 | 1,000 |
| 200 | 70 | 98 | 120 | 154 | 225 | 315 | 350 | 490 | 700 |
| 250 | 65 | 91 | 112 | 143 | 208 | 291 | 325 | 455 | 650 |
| 500 | 44 | 67 | 75 | 97 | 141 | 197 | 220 | 308 | 440 |
| 750 | 37 | 52 | 61 | 82 | 118 | 165 | 185 | 259 | 370 |
| 1,000 | 32 | 45 | 35 | 71 | 103 | 144 | 160 | 224 | 320 |
| 1,500 | 25 | 35 | 43 | 55 | 80 | 112 | 125 | 175 | 250 |
| 2,000 | 22 | 31 | 38 | 49 | 71 | 100 | 110 | 154 | 220 |
| 2,500 | 20 | 28 | 34 | 44 | 64 | 90 | 100 | 140 | 200 |
| 3,000 | 18 | 25 | 31 | 40 | 58 | 81 | 90 | 126 | 180 |
| 4,000 | 15.5 | 22 | 26 | 34 | 50 | 70 | 73 | 103 | 155 |
| 5,000 | 14 | 20 | 24 | 31 | 45 | 63 | 70 | 98 | 140 |
| 7,500 | 13 | 18 | 22 | 29 | 42 | 59 | 65 | 91 | 130 |
| 10,000 | 10 | 14 | 17.5 | 22.3 | 32 | 44.8 | 50 | 70 | 100 |
| 12,500 | 8.8 | 12 | 15 | 19.3 | 28 | 39 | 44 | 62 | 88 |
| 15,000 | 8.2 | 11 | 14 | 18 | 26 | 33 | 41 | 57 | 82 |
| 20,000 | 7 | 9.8 | 12 | 15.4 | 22.5 | 31 | 35 | 49 | 70 |
| 25,000 | 6.5 | 9.1 | 11.2 | 14.3 | 20.8 | 29 | 33 | 46 | 65 |
| 30,000 | 5.8 | 8.1 | 9.2 | 13 | 18 | 25 | 29 | 41 | 58 |
| 35,000 | 5.3 | 7.5 | 9 | 12 | 17 | 24 | 26 | 37 | 53 |
| 40,000 | 5 | 7 | 8.5 | 11 | 15.5 | 22 | 25 | 35 | 50 |
| 50,000 | 4.4 | 6.7 | 7.5 | 9.7 | 14.1 | 20 | 22 | 31 | 44 |
| 60,000 | 4.1 | 6 | 7 | 9 | 13 | 18 | 21 | 30 | 41 |
| 70,000 | 3.8 | 5.3 | 6.5 | 8.4 | 12 | 17 | 19 | 28 | 38 |
| 75,000 | 3.7 | 5.2 | 6.1 | 8.2 | 11.8 | 16 | 18 | 26 | 37 |
| 100,000 | 3.2 | 4.5 | 3.5 | 7.1 | 10.3 | 14.3 | 16 | 23 | 32 |
| 150,000 | 2.5 | 3.5 | 4.3 | 5.5 | 8 | | | | |
| 200,000 | 2.2 | 3.1 | 3.8 | 4.9 | 7.1 | | | | |
| 250,000 | 2 | 2.8 | 3.4 | 4.4 | 6.4 | | | | |
| 300,000 | 1.8 | 2.5 | 3.1 | 4 | 5.8 | | | | |
| 400,000 | 1.55 | 2.2 | 2.6 | 3.4 | 5 | | | | |
| 500,000 | 1.4 | 2 | 2.4 | 3.1 | 4.5 | | | | |
| 750,000 | 1.3 | 1.8 | 2.2 | 2.9 | 4.2 | | | | |
| 1,000,000 | 1 | 1.4 | 1.7 | 2.2 | 3.2 | | | | |

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