MODERN RADIO SERVICEMAN'S Pocket Book . .

CONTENTS

25¢

GENERAL PURPOSE TRIODES

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

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

(FOR LEAK OR BIAS DETECTION WITH THESE TUBES SEE PAGE 5)

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 Triode	Screen	←	Plate A Triode
" No. 2	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	←	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	←	Catnode
" 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)

AUDIO OUTPUT TUBES

TYPE	210 Triode	220 Triode	231 Triode	233 Triode	238 Pentode	LA Pentode	241 Pentode	242 Pentode	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	T-8	S-12	S-14	S-12	......	S-17	S-17	S-17	S-17	←	S-17	S-21	Dome	←	←
Base	4 Pin	4 Pin	4 Pin	5 Pin	5 Pin	5 Pin	6 Pin	6 Pin	4 Pin	5 Pin	←	5 Pin	4 Pin	6 Pin	←	←
Pin No. 1	Grid	Grid	Grid	Grid	Screen (to + 135)	Grid	Screen (to + 167)	Screen (to+250)	Grid	Inner† Grid	←‡	Grid	Grid	No. 2 Grid§	←¶	←‖
" No. 2	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	Plate	←	Plate	Plate ([illegible])	Plate	←	←
" No. 3	F+ or −	F +	F +	F +	F + or −	F + or −	F + or −	F + or −	F + or −	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	None	Outer† Grid	←‡	Screen (to + 250)	None	Cathode	←	←
" No. 6	None	None	None	None	None	None	Grid	Grid	None	None	←	None	None	No. 3 Grid§	←¶	←‖
Cap	None	None	None	None	Grid	None	Grid	Grid	None	None	←	None	None	No. 1 Grid§	←¶	←‖
Filament V	7.5	3 to 3.3	2.0	2.0	6.3	6.3	6.3	6.3	2.5	2.5	←	2.5	7.5	6.3	←	←
Filament A	1.25	0.125	0.13	0.26	0.30	0.3	0.65	0.65	1.5	1.75	←	1.75	1.25	0.4	←	←
Input Grid Bias	− 39	− 22.5	− 22.5	− 13.5	− 13.5	− 11.0	− 12.5	− 16.5	− 56	− 33	0	− 16.5	− 84	No. 1 at − 18	No. 1 at − 20	No. 1 and 2 at 0
Mu	8	3.3	3.8	70	100	100	215	220	3.6	5.6	Varying	150	3.8	135	4.6	Varying
Plate Res	5,000	6,300	4,950	50,000	100,000	50,000	120,000	100,000	1,670	2,380	"	6,000	1,800	80,000	3,000	"
Mutual Cond	1,600	525	760	1,450	975	2,000	1,800	2,250	2,100	2,350	"	2,500	2,100	1,600	1,570	"
Plate V	425	135	135	135	135	165	167	250	275	250	400	250	450	160	160	180
Plate Mils	18	6.5	6.8	14.5	9	17	16.5	34	36	22	6 Each	31	55	17	17	3 Each
Load	10,000	6,500	9,000	7,000	13,500	8,500	......	......	4,600	6,400	1,450 × 2	7,000	4,350	9,000	6,000	3,400 × 2
Audio M. Watts	1,600	110	150	700	525	1,200	......	......	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.

Screen Grid, Pentode Bias-Type Detectors, Also Special Detectors

(FOR TRIODE DETECTORS SEE PAGE 2)

(FOR GRIDLEAK DETECTION SEE NOTE BELOW)

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. Tho 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.

Comparison of Receiver and Transmitter Plate-Supply Rectifiers

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	350 550**	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 as for 50 Watt Triodes	....	....
Max. Diameter	2 1/16"	2 1/16"	1 13/16"	2 1/16"	2 7/16"	2 7/16"	2 7/16"		....	....
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		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.

SEMI-OBSOLETE SPECIAL AND TRANSMITTING TUBES

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.

211E — Western Electric 250-watt transmitting tube, not usually available.

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.

852—75-watt transmitting tube for short waves.

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

886—Same as 876 but for 2.05 amps.

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

861—500-watt size of the 860 (amp.).

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

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

Sparton-Cardon Tubes

484—3-volt triode similar to '27.

401—3-volt triode similar to '01A.

573—3-volt triode similar to '50.

586—Triode between a '10 and a '50.

485—Like 484.

182—Triode between a '12 and a '71.

182B—Equals the '71.

183—Between 182 and 182B.

Cardon rectifiers can be replaced by standard type.

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.

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.

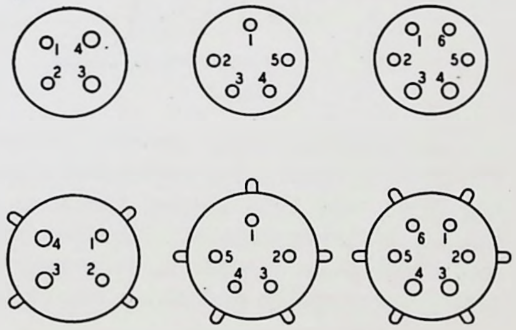
Triple-Twins

The "Triple-twin" tube (Speed 295) is a '56 and a '50 in one bulb and used with an external resistance-coupling. The tube can replace a '47 with improved fidelity. Five-pin base and top cap.

Cap—Input grid. Pin 1, plate of small triode; pin 2, output plate; pins 3 and 4, both filaments; pin 5, cathode of small triode and grid of large triode. Total drain (both sections) plate 56 ma. at 250 volts, filaments 4 amps. at 2.5 volts, output 4.5 watts into 4,000 ohms. The 293 is a 1,250 milliwatt triple-twin working at 180 volts plate and 6.3 volts filament.

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

To be used with table facing this page.



ANTI-NOISE ANTENNAS

An anti-noise antenna is one designed to minimize local crackles and buzzes generated in the lighting and telephone circuits of any town by the operation of all sorts of switching devices, by defective contacts and by motor brushes and the like.

The simplest of anti-noise antennas is a long aerial—if properly placed. Because of the general conviction that long aerials aggravate noise the idea may as well be properly shellacked before going any further. With obsolete 1, 2 and 3 tube regenerative receivers a short aerial DID reduce both noise and interference. Those antique sets had little selectivity except such as was due to

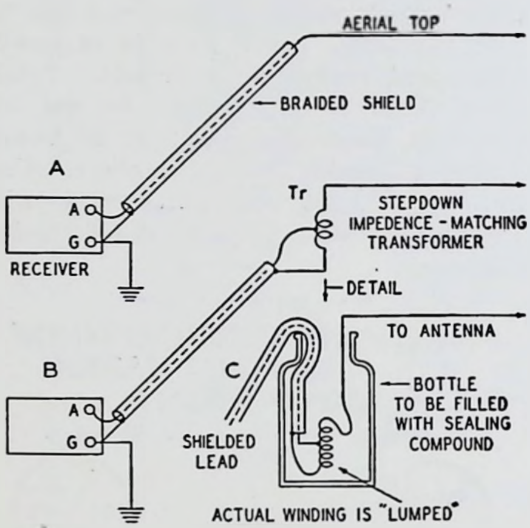


Fig. 1

regeneration; a small antenna lowered the general input level (noise and signal together) and thus caused the user to run up his regeneration. The resultant improvement in selectivity decreased interference greatly and noise somewhat. Furthermore, the regenerative grid-leak detector was easily blocked by noise-splashes and this too could be partly avoided by using a small antenna and reduced input level. Obviously neither of these reasons for reducing the antenna applies to present receivers.

Where is Noise?

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-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.

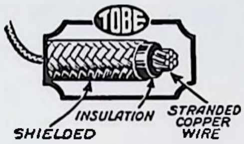
Since the long aerial is frequently sufficient, begin by stretching the noisy small antenna to 200 or 300 feet—not necessarily in one span but turning as necessary to avoid power and telephone wires, also houses wired without conduit. Observe that a long aerial can change other things besides the noise. In several cases interference from a strong high-frequency local broadcasting station was reduced because the original antenna had been near-resonant to the station. Of course a loading coil would have done that, but would not have suppressed the noise. On the other hand a very long aerial can aggravate cross-talk in receivers using '24 type r-f. amplifiers. The cure for this is a wave-trap tuned to the local signal, but the cure is not necessary in a well-designed modern receiver equipped with variable-mu tubes.

Certain locations have only one quiet direction—up! This is the problem of the city apartment-house square, where wiring is all about. Only height offers real hope of quiet; height and a trick leadin.

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. If this top has been properly placed outside the noisy space improvement is automatic.

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 step-down 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 step-down 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. Considerable 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 re-

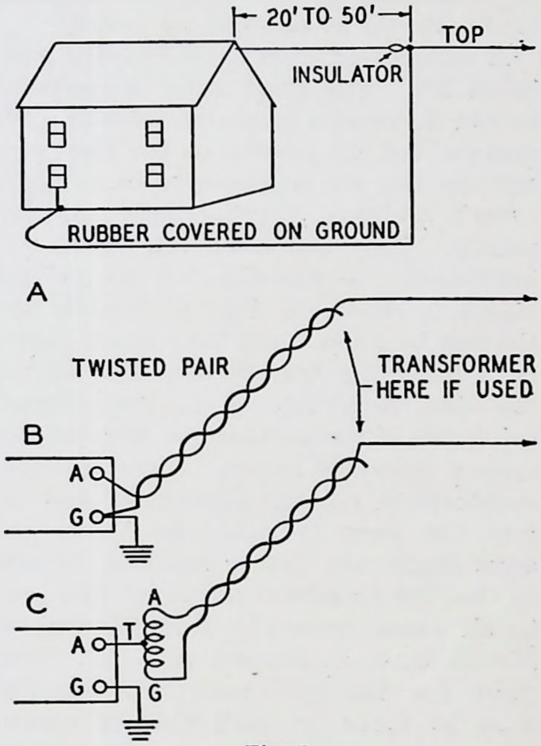


Fig. 2

ception 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.

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. In Fig. 2A the lead is dropped to the

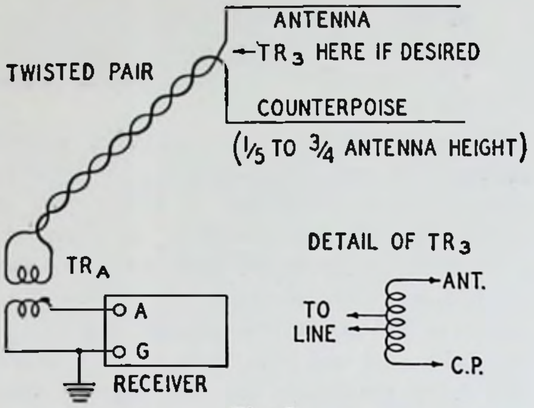


Fig. 3

earth and follows it through the noise area to the house. Where this is sufficient a long aerial with an ordinary leadin should be as good or better.

A second imitation is the twisted leadin of 2B. The dead wire is supposed to run at exactly opposite polarity (180 degrees out of phase) to the live wire and the two are expected to cancel each other's pickups, leaving only the top pickup. The success of this scheme is indifferent. 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.

One warning — antenna-counterpoise systems MUST NOT ENCLOSE THE SOURCE OF NOISE. Put both or neither on the roof.

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

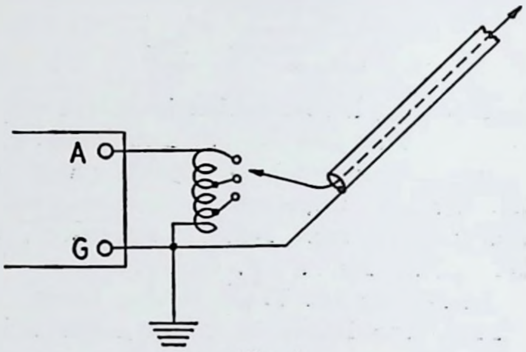
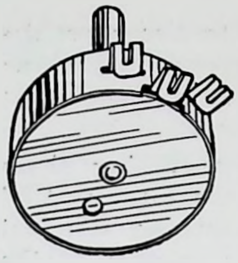


Fig. 4

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.

The Worthless Waterpipe

There isn't any use in keeping noise out of the antenna post and letting it get in by the ground post. Grounding to a waterpipe is equivalent to connecting to a noise-reservoir. A large network of pipes radiates about the neighborhood and is everywhere surrounded by noisy house wiring. Noisy devices, such as the telephone, are grounded on these pipes. A good independent ground tends to end this noise-input. The best benefit cannot be gotten from the special antennas and leadins unless this precaution is taken.



Volume Control Simplified . . .

. . . in Amateur and Broadcast Receivers

• • •

Every volume control replacement is costing the set owner 50% more than necessary because manufacturers have made no attempt to standardize electrically and mechanically, nor has fierce competition seemed to persuade set manufacturers of the wisdom of a return-mail service on replacement of freak parts.

These imbecilities of the set manufacturer are no excuse for similar soft-brained groping among us who repair. We can standardize within limits and do reliable, satisfactory work at reasonable prices. However, we have two problems: 1. to educate the customer to understand that substitutes are a necessity for quick service and, 2. to educate ourselves into the ability to make intelligent substitution.

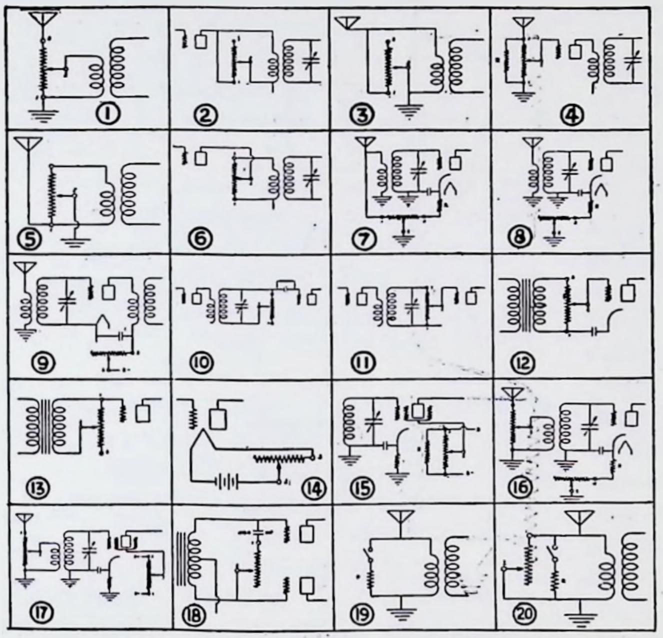


Fig. 1

Courtesy Electrad.

CIRCUIT	RHEOSTAT USED	SETS NOW IN USE WHICH EMPLOY THE CIRCUIT
1, 2, 3, 4, 5, 6, 7,	15,000 ohm reverse taper	133
8 and 9	75,000 regular taper	60
10, 11, 12, and 13	500,000 reverse taper	67
14	10 ohm regular	52
15	50,000 ohm uniform	31
16	Twin 15,000 ohm (Antenna) 50,000 ohm (Cathode)	no data
17	Twin 15,000 ohm (Antenna) 50,000 ohm (Screen)	no data
18	1 megohm	no data
19	1 to 60 ohms (See text)	no data
20	15,000 ohm reverse taper, (R is as in 19)	no data

This idea is not original with "Modern Radio"; in fact Electrad has cooked the whole thing down to 20 diagrams which are shown as Fig. 1.

Circuits 1 to 7 inclusive offer the prize example of standardization advantage, for all seven can be satisfied with a single type of volume control, one of 15,000 ohms built to give the practical equivalent of a logarithmic resistance curve (R against rotation angle). This is the so-called "tapered" volume-control. Designed to produce increased volume as its arm is rotated to the right this control hits about 3,000 ohms in center position; it has 13,000 ohm on the right half of the turn, 2,000 on the left.

Circuits 1, 3, 5 and 7 can be installed in most receivers. The best circuit is 7 but 5, 3 and 1 are sometimes a necessity. 7 carries the same defect as 3 and 1 in that any of these three circuits results in a shorted antenna winding with the consequence of detuning of the first tuned-circuit at low volumes on strong stations. If the town is filled with locals this tuned circuit should be aligned while the volume control is set as near the short-circuit (lowest volume) position as possible. The receiver will be "out" for DX but the local selectivity, which is usually most important in such cases, will be high. Use your own judgment, accept no rules save those dictated by your observation of your customers' wants. Always install circuit 7 if possible as it reduces tube sensitivity along with antenna input: the overall result being much quieter reception.

All these circuits must be wired correctly to have them control locals properly. Notice Fig. 2A: here the wire lengths A and B are interposed between the volume control resistance and the antenna coil. When the control is set for lowest sensitivity (volume), and the antenna coil seems to be short circuited, they can represent more than enough ohmage (reactance) to allow the 50 kilowatt WTIC in Hartford to have full volume for any average living room if the receiver has about 20 microvolts sensitivity. But in 2B the antenna is shorted through the arm of the volume-control, the lowest reactance that can be got. Control is adequate. To use circuit 2B it may be necessary to disconnect the regular antenna-coil ground from the chassis so that the circuit gets to chassis only at the volume-control.

A final precaution regarding these circuits: In Fig. 2B the placement of the receiver coil and antenna terminal are frequently such, in relation to the volume-control, that both the leads from the control to the coil and from the control to the antenna will be long and nearly parallel. If so, capacity transfer will produce an effect that 2B wiring cannot overcome. In this case both the antenna lead and the coil lead may have to be run through grounded metal braid. Act according to results.

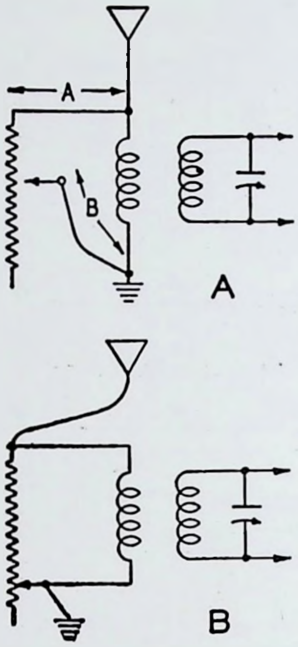


Fig. 2 Wiring Precautions.

Circuit 5 avoids the shorting of the antenna coil and consequent broadness of input circuit tuning when the control is set for low sensitivity. However, the end 3 of the antenna coil is left ungrounded by the control and some signal will get to it by capacity effect from the antenna lead. In a sensitive set with partial shielding this permits signals to leak through. This may be stopped by stopping the capacity effect—which is done by putting metal braid (grounded to chassis at both ends) over that part of the antenna lead which is inside the set. With this circuit the receiver should be aligned with the volume control set for ¾ full volume.

The chief and important point is that circuits 1, 3 and 5 can be, to the advantage of the receiver and its owner, installed in dozens of receivers now containing more complicated controls. In fact some receivers in Hartford will not reduce WTIC's volume to a suitable point without disconnecting the antenna, whereas the installation of an antenna volume-control such as has been described is sufficient of a change to eliminate this inconvenience. I recommend unreservedly that receivers equipped with only screen-grid voltage control of volume be changed to antenna circuit volume-control forthwith, whereever a strong local station is proving the former method inadequate.

Some receivers are designed to use antenna potentiometers of 2000 to 5000 ohms. A good universal potentiometer for this use is the Yaxley No. 52,025, which has 25 ohms in the left third and 2000 in the remainder of the travel of the slider.

There is one exception to all this. Some receivers have large antenna coils built honey-comb style and designed to resonate below 700 kc. This is in order to raise the low-frequency sensitivity of the receiver. Here the antenna potentiometer resistance can spoil the effect of the resonance bump. In such sets stick to the volume control devised by the manufacturer unless the lower broadcast frequencies are of little importance to the set owner. The manufacturer ought to have used sense enough to do his "bumping" elsewhere in the receiver—but who are we to argue?

Control by Change of D-C. Voltage

Voltage-governing controls operate by changing, (1) screen voltage, (2) cathode bias, (3) plate voltage, (4) filament voltage. This may be done automatically or manually. The automatic volume controls will be left for a later paper.

1—Screen-voltage control, whether used alone as in circuit 15 of Fig. 1, or in combination with an antenna-input control as in 17 is seldom satisfactory against strong signals because of screen-overloading and cross-talk and should be replaced by circuits 1, 3, 4 and 5. If this is done as explained before, the original control is left at maximum. If the screen control cannot be replaced because of instability or a trick antenna circuit replace the old control with an equal or higher resistance, which may be nearly anything from 5,000 to 50,000 ohms, depending on the arrangement of the B supply. It is simple to find out whether a high-resistance voltmeter shows the proper range of screen voltage.

2—Cathode bias control is shown in its simplest form in circuit 6 and in combination with antenna-input controls in circuits 7 and 16. The 75,000 ohm regular taper potentiometer is correct for one tube and may be used for several. In manufactured sets one finds scores of kinds which give no better control—better senseless originality than no originality at all! It takes about 13 volts cathode bias to cut off a '24 tube. This can (almost) be provided by a high cathode resistor but the 30 volts required to cut off '35 and '51 tubes is hardly obtainable in this way. A much better scheme is that of Fig. 3, which raises the voltage across the control resistor by putting through it some current directly from the B supply. Suppose that we intend to use a 5000 ohm

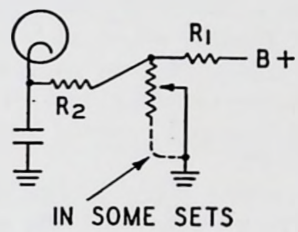


Fig. 3

control and to take the current from an 80 volt point on the B supply. To produce 13 volts across a 5000 ohm control we must put about 2.6 Ma. through it. At 80 volts this requires a total resistance of 30,000 ohms, and as we already have 5,000 in the control R1 must be 25,000 ohms. Similarly it is easy to calculate the series resistance needed to draw enough current through a 7,500, 10,000 or 15,000 ohm control so as to produce 30 volts across it. Usually the supply will need to be taken from some point in the B system which is at 140 to 250 volts "above chassis". The current which is "bled" through the control should be either considerably larger (3 times or so) than the plate current or else much smaller (¼ as much).

There must be a provision in all cathode controls to prevent reducing the bias to zero when turning the control

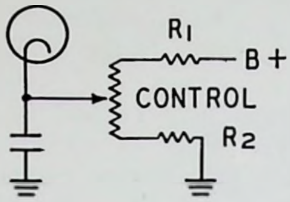


Fig. 4

to "full on". This is done by the resistance R2 in Figs. 3 and 4. In Fig. 3 it should be about 250-350 ohms for one tube and half as much for two. In Fig. 4 use whatever value is needed to produce 1½ volts across it (use high resistance voltmeter) when the control is turned to full on.

3—Plate voltage control (circuit 9 of Fig. 1) is inexcusable with modern tubes. The circuit of diagram 6, though not controlling d-c. voltage, can also be condemned as it ruins the selectivity of the associated tuned circuit, which can also be said of circuits 6, 10 and 11. They should be replaced by the circuits discussed in Part 1, which at least protect the first tube from overload. Study the wiring before cutting into it—nothing should be changed in some sets, such as the Fada 70.

Twin volume controls (as in circuits 16 and 17) were born of the easy overloading of the '24 tube—and of inadequate care in wiring layout, as mentioned in Part 1. The general data of Fig. 1 fit most receivers but there are exceptions such as the Victor 32 which requires abnormally low resistances and the Radiola 48 which requires such high resistances that there must be a metal static shield between! Infrequently one meets a combination of an antenna control and an audio-shunt control (combine circuit 12 with 1, 2, 4, 5 or 7). The antenna control is usually sufficient.

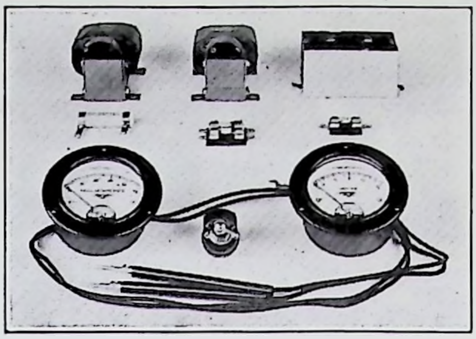
4—Filament control of volume went out with the 201A tube. That's that.

Other Types of Controls

Audio controls such as 12 and 13 appear in modern receivers with automatic volume control. The correct control is specified in Fig. 1, but lower resistance values may be used in emergency. Circuits 19 and 20 represent one type of local-distant switching circuit, but the result depends on the input transformer and the wiring layout. One must cut and try. Other local switches simply disconnect the antenna, allowing some signal to get in through the switch capacity, or a shunt consisting of two wires twisted together. In a few cases a tuned circuit is opened to reduce efficiency.

Circuit 18 is the best form of tone control. The proper capacity will be found to lie between .0025 and .01 while the resistor may be between 500,000 and 1,500,000 ohms maximum.

The main point of all this talk is that a stock of just 6 volume controls will fit every job of the experimenter and will satisfy 9 out of 10 of the repairman's customers—only the 10th man is forced to say that you delayed him—the rest build business.



A Tester for

• • ELECTROLYTIC
• • CONDENSERS

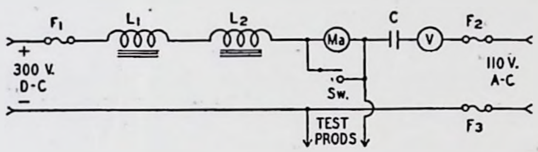
Because electrolytic condensers are relatively short-lived devices the modern service shop certainly cannot get along without a tester for electrolytic condensers. Do not take this to be a condemnation of electrolytics—present low prices justify their use in filter circuits where their relatively high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

SHORT CIRCUITS

(Samples from "Modern Radio".)

We can't afford to overload the plate until groceries are cheaper.

A kilovolt is a thousandth of a megavolt, which makes it sound less shocking.

Times are so hard here that one man was seen cutting grass with half a lawnmower.

As we understand the advertisements, all the tube makers invented all the kinds of tubes.

It pays to advertise—but it must be tough on the announcer's conscience.

A $37.50 broadcast receiver is worth approximately $37.50.

We've just been told of a simple way to improve the tone of old broadcast receivers. One removes the output tubes and warms them gently until the bases can be removed. That's all.

A push-pull UX-250 amplifier makes a very nice heater for an incubator.

Valuable papers is anything the wife threw out when cleaning.

Radio receivers are portable now—the finance company carries 'em.

One of our friends has found a Central-American bug that eats the printing off of Radiola labels. It is not known who financed this attack on RCA.

WHAT YOU'VE MISSED IN "MODERN RADIO"

(But look at the note below.)

Modulation Improvement.
An Accident-proof Meter.
Why 100% Modulation Sets Don't Do It—And How to Make Them.
Keeping a Retail Store Out of the Red.
The Successful Metal-chassis Receiver.
Saving $$ in Meters and Tubes.
Degenerative Feedback and the Pentode.
The 1-Meter Laboratory.
Transmitting Antennas Simplified.
Edge Noise Cures.
The Painless Mathematician.
The Crystal's Rival.
Modulating Tetrodes.
Making Harmonic Oscillators for the Test Bench.
Making Output Meters Cheaply.
Simplified Coil Matching.
Saving Transmitter C Batteries.
Curing Interlocking.
Autodyne Superheterodyne.
Tank-circuit Resistors.
*An Oscilloscope for $2.85.
*Perpetual Triode and Tetrode Charts.
*More Than a Monitor.
*Curing Hum on Carrier.
*A 500-watt, Two-tube, Crystal-Con-
Crystals.
trolled Transmitter.
*Better and Simpler Transmitting Amplifiers.

But fortunately—the articles starred are still available in back copies at 25c each—and recollect, that the ones NOT starred are ALL SOLD OUT!

AUTOMATIC VOLUME CONTROL

Basic Circuits and their Service

• • •

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

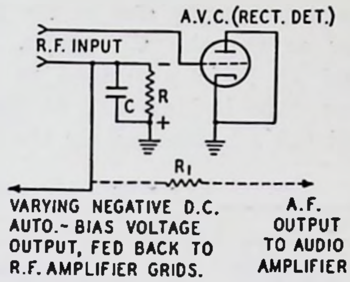


Fig. 1

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 in-

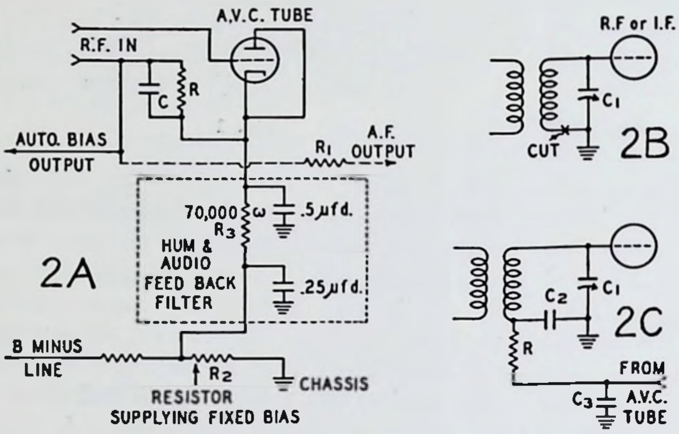


Fig. 2
A is the essentially complete Philco A.V.C. tube circuit.
B and C indicate the changes to be made in an r.f. amplifier grid circuit to apply the automatic control bias.
R of A is 200,000 ohms for 224's r.f. and C .00011 in Philco sets.

creases 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

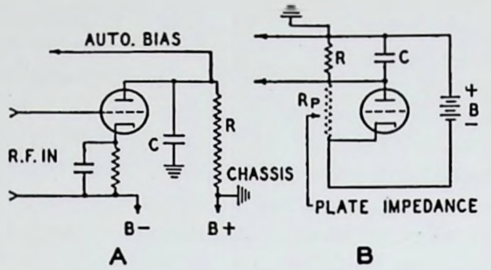


Fig. 3. R-200,000 ohms for 224's and C about .5 ufd.

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.

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 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.

Time Constants

The "time constant" of an a.v.c. system is primarily the time constant of r.c. in the diagrams. This time constant determines the response to change of the system and to what degree it filters off a.f. ripples and smooths fading. A system has a low time constant if it immediately gives full background when the receiver is tuned off a station: likewise it has a relative high time constant if tuning off a station it lags sufficiently for background to increase slowly: a slow increase is advantageous in tuning from station to station without quick rises of noise between stations but it is disadvantageous in not being able to follow fairly quick fading of the station. The magnitude of the time constant may be altered at one place in the above diagrams by increasing the capacity of C since a time constant in seconds is got from the formula RC, R in ohms and C in farads. In multiplying R times C we can use C in microfarads if we divide the result by 1,000,000. For instance, .5 mfd. times 200,000 ohms gives 100,000/1,000,000 or .1 second time constant for r.c. However, we aren't through with our time constant until we have also figured in the capacities and resistors affecting the automatic bias line. These in one receiver are .1 and 500,000 ohms on each tube controlled, and in series or additive for the first tube as in Fig. 6. What makes this lag or time constant is the discharge of the condensers through the resistors and likewise their charge.

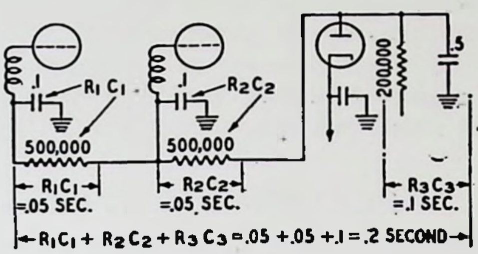


Fig. 6.

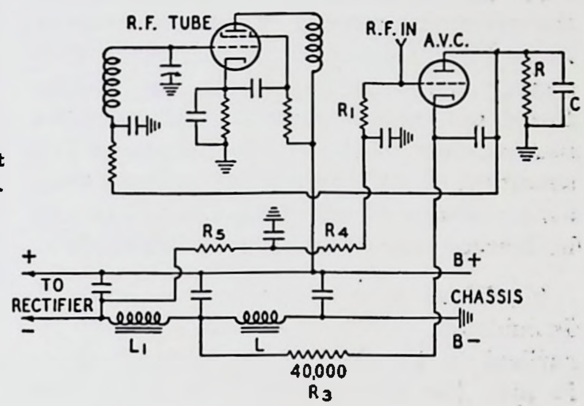


Fig. 4. A practical triode A.V.C. tube circuit showing wiring through to the r.f. tube under control. A.V.C. is a 227.

The time constant of the r.c. combination is usually defined as the time it takes C of r.c. to lose 63% of its charge. If the charge is made at 30 volts then when the total time constant is .2 second the receiver will go to 17 volts at the end of .2 seconds and about 10 volts in .2 more seconds. A long time constant may mean a full second of wait for return to level after leaving a strong local station so that the weaker one gradually builds up to normal volume. Likewise leaving a weak station to hit a strong one the a.v.c. will first allow too much volume and then the volume will drop to normal a.v.c. level. All these things must be compromised with to reach a suitable practical time constant. And we must also make certain that the time constant is great enough so that the condensers never get a charge from a rapidly changing audio ripple or else the ripple will modulate the r.f. tubes.

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 one under check. If we are working on

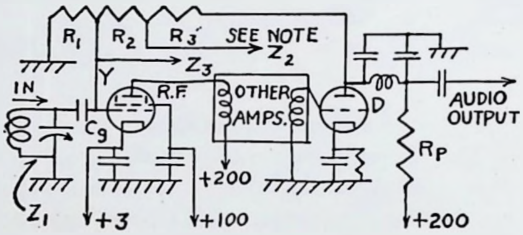


Fig. 7. A limited-range system easily added to existing receivers. If the tube to be controlled is a '24 and the detector is a '27 the voltages will be about as shown and the resistors will be about as follows: Rp—250,000 ohms, R1—1 meg., R2 and R3 each 2 megs. Change these resistors to adjust control action. The lead Y need not be connected as shown. If preferred, cut at Z1, transfer Cg to this gap and connect Y to lower end of tuned coil. If a second r.f. stage is to be controlled use lead Z2 in same manner. If an i.f. stage is to be controlled use lead Z3 through a ¼ meg. resistor to the i.f. grid. Many variations are possible.

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

* Copies may be had at the regular price.

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

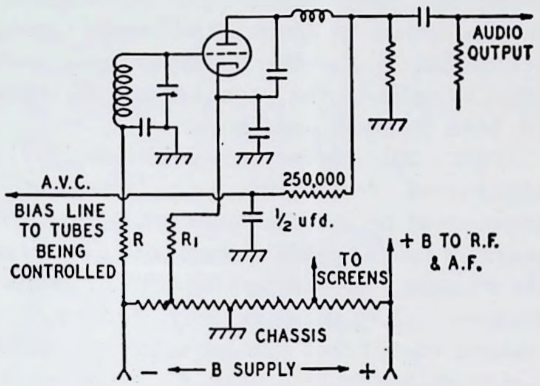


Fig. 8. The detector tube used as A.V.C. tube. The diagram is largely self-explanatory. R1 would be of the usual size, 25,000-40,000 ohms and R would be 100,000 to 500,000 ohms. R is purely an a.f. filter condenser and R1 is a part-bias resistor for the detector. Sizes of suitable by-passes are familiar from dozens of existing circuits. The layout of voltage divider is shown to make clear the obtaining of required detector voltages.

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.

When two amplifier tubes are under control both, of course, should be checked if control appears to be missing from one, since if one is being controlled properly we have immediately isolated the portion of the circuit which is in trouble.

To be able to check the high resistors is evidently necessary. Indications up to 20 megohms for condenser leakage

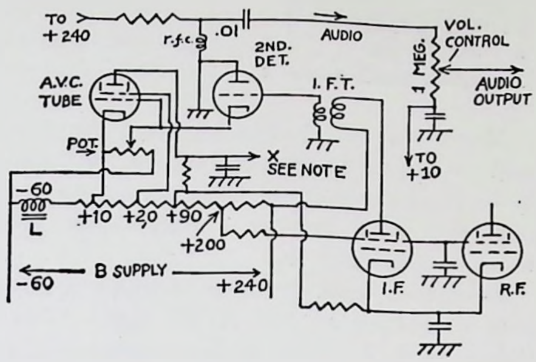


Fig. 9. The A.V.C. system of a typical superheterodyne. The a.c. and d.c. cathode voltages of the second detector are applied to the input grid of the type 24 A.V.C. tube whose rectified output is applied to the input grids of the i.f. and r.f. tubes from the lead X through the secondaries of the i.f. and r.f. input transformers feeding these tubes. These transformers are omitted for simplicity. The potentiometer permits adjustment of the point at which the A.V.C. action "takes hold", compensating for differences between '24 tubes. By-pass condensers, unless otherwise marked are either ½ or 1 ufd.

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. Lack of resistance scale is no difficulty, as comparison with good resistors is easy and good resistors are cheap these days.

A.V.C. Tube Troubles

If the test previously described gives one a 224 operating at normal plate and screen voltages but without plate-current one knows that the control-grid voltage is too high for a normal tube. This control-grid bias is supplied in part normally and the rest by the a.v.c. We accordingly may short the control-grid to chassis in some sets, thereby cutting out the a.v.c. bias and putting normal bias on the tube, to get normal plate-current. Otherwise we may short the control-grid to cathode, have no bias whatever, and raise *abnormal* plate-current to learn that everything but bias is O. K. If changing the a.v.c. tube has no effect on

(Please turn to page 25.)

• HUM-M-M-M-M •

In Broadcast and Shortwave Receivers

• • •

Many an old A. C. operated receiver, and (whisper this) some of the new ones have more hum level than an unsuspecting ear will believe. Sometimes this hum can be got at.

Receiver hum nearly always comes into existence in the A. F. end. When it has an R. F. birth it directly modulates the carrier of a 'phone and thus identifies its birthplace.

The A. F. end of a receiver begins with the detector tube just as the R. F. end ceases with the detector tube, hence any suggestions for reducing hum level in either the r. f. or a. f. system must include the detector.

If the detector tube uses a grid-leak the problem is changed slightly since then the sensitivity of the A. F. system is multiplied by the operating amplification constant (mu) of the detector tube at the operating voltage. All of which means that the input of the A. F. amplifier (grid of detector) is sensitive to A. F. magnetic or capacitive fields three A. F. stages worth. So—

Any transformer-coupled A. F. amplifier not ending in push-pull tubes and having 3/1 A. F. transformers has an overall amplification constant of approximately 2,490 or 6,040 depending upon the mu of the final tube being 3.3 or 8. (See Fig. 1.) If push-pull amplification is used the overall amplification constant given can be divided by three generally. No wonder then sometimes a big hum difference is noticed if detector tubes are changed. And no wonder that at times shielding the detector tube and the grid-side of the grid-leak and detector prove wise precautions.

Fig. 1 depicts the audio amplifier, indicates how the gain figures are arrived at. The main fact immediately to assimilate is that .4 millivolt (.0004 v.) of A. F. on the detector grid will give 10 volts in the speaker, and 10 volts of hum is good loud hum.

Once the detector grid-circuit is eliminated from the hum-factors we move over to the plate-circuit. Here we work into the grid-circuit of the first A. F. tube and through the A. F. transformer. Overall gain only 310 or 750 (based as before) but nevertheless sufficient to prove bad as I have found in several cases. The hum started by the detector plate-circuit gets into it from the power-supply, is part of the B current. The path of this hum is through the A. F. transformer primary and the plate resistance (Rp) of the detector tube. Condenser C thus should be regarded as having two jobs: 1. to let detector A. F. currents around the B supply; 2. to short-circuit hum coming from the B supply so that it cannot go to the tube transformer circuit. Hum "originating" in the detector plate-circuit does not change volume or pitch if the detector grid is shorted to ground. This hum can be eliminated to a great degree by increasing the capacity of C from .5 or 1 to 4, or better 8, mufd. if

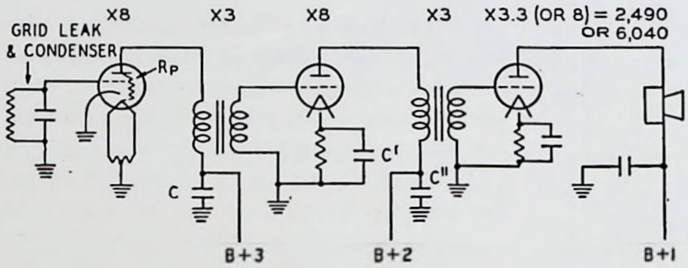


Fig. 1. The audio part of a set of a few years ago. Since we are interested in audio only the detector's tuned input circuit is not shown, for it disappears at audio frequencies.

the voltage divider is a potentiometer as in Fig. 2, but the cheaper and simpler rig is to connect a series resistor between the first A. F. B voltage and the detector circuit. If the A. F. voltage is 100 and the detector voltage is required to be 40 a series resistor suitable will be about 40,000 ohms. Such a resistor by-passed by 1 mufd. gets in as good licks against hum as 8 mufd. on the detector B voltage from the potentiometer tap. The scheme is shown in Fig. 2.

The next hum source works in the grid-circuit of the first A. F. tube and

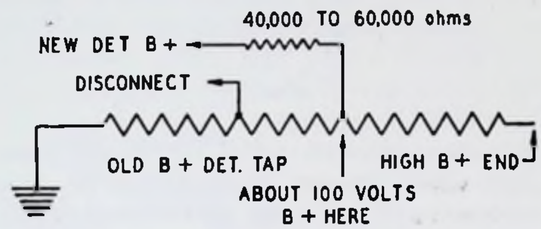


Fig. 2

hence into a gain of only 72 or 190. This suspicious character is the bias resistor R' (See Fig. 1), of 500 to 2500 ohms depending upon the number of tubes biased by the one resistor. Condenser C' by-passes this resistor for A. F. currents (and R. F. too sometimes) and occasionally is not built in the receiver. R' provides the bias because the plate current passing through it causes a voltage drop across it. Likewise hum in the B supply riding on the plate current also causes a voltage drop. Just as the bias voltage gets to the grid so does the hum voltage although not as easily because of the inductance of the A. F. transformer secondary. If C' is large enough, about 30 mufds. for a 2,500 ohm resistor, it will effectively by-pass the hum.

Here I must interrupt to explain other phenomena that may occur. A receiver not equipped with this by-pass may have left handedly been saved from hum by ruining A. F. tone; for hum from the detector circuit is part of the A. F. signal and leaving off C' tends to kill bass amplification for the A. F. signal. (See page 18 for a detailed explanation of degeneration.)

Obviously 30 mufd. (or 120 mufd. if R' is 500 ohms) is both too costly and too bulky to be used. But for the simple labor of installing a resistor and 1 mufd. we can have a low-cost hum filter for the grid-circuit as shown in Fig. 3.

This brings our hum gymnastics down to the plate-circuit of the first A. F. tube. Here the hum is working into a gain not over 10 to 24. The B supply filter would need to be very terrible to send strong enough hum into such a small step-up and arouse much fuss. But if it did, an A. F. choke of 30 henrys should be interposed between the voltage divider and the condenser C". C" then should be at least 2 mufd.

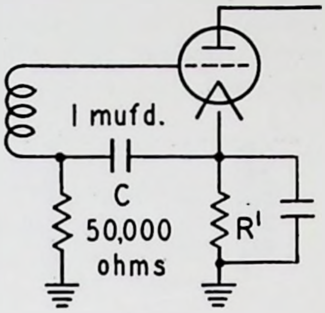


Fig. 3

So much in general for antique circuits. Remember that a power detector working into such a two-stage amplifier as that of Fig. 1 needs a Fig. 3 filter worse than does the first A. F. stage since it represents the earliest place in the line-up and hum from its bias resistor may be working into a gain of 800 to 1500, no small hazard.

Later receiver design has taken full advantage of these facts. Several modern receivers will hum lustily if the power detector bias by-pass is removed and some will act roaringly if the first A. F. bias by-pass ceases working.

BROADCAST SCHEDULES OF RADIO STATION KUP
San Francisco Examiner

Sked	Service	Time (GMT—PST)		Frequency
A-1*	Press	0900	1:00 A.M.	6440 and 8350
B-1*	Stocks	1200	4:00 A.M.	6440 and 8350
C-2*	Press	1500	7:00 A.M.	6440 and 8350
D-1†	Weather	1648	8:48 A.M.	6440 and 8350
E-3*	Press	2100	1:00 P.M.	11340 and 16700
F-2‡	Financial	0030	4:30 P.M.	11340 and 16700
G-4*	Press	0300	7:00 P.M.	6440 and 8350
H-2†	Weather	0400	8:00 P.M.	6440 and 8350

S-S Special schedule announced on 0300 GMT 7:00 P.M. Press.

Note: *Daily except Sundays and holidays.
†Daily.
‡Daily except Saturdays, Sundays and holidays.

The staff at KUP stand continuous watch for calls on 36 meters between the hours of 4:00 P.M. and 8:00 A.M. PST. On 18 and 26 meters, 8:00 A.M. to 4:00 P.M. Also on 600 meters, 500 kc. distress.

PRACTICAL TONE CONTROL*

• • •

An amplifier and speaker may give perfect tonal reproduction according to all engineering standards but still not appeal to many people, while other amplifiers having very poor response curves may be called good. Since radio is sold to please the individual purchaser rather than to establish a standard tone quality, it is just as logical to adjust tone as to adjust volume. Dealers should make certain every receiver they sell is tone control equipped, and service men will

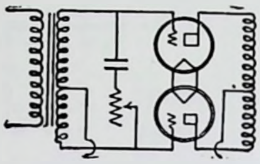


Fig. 1

find this a profitable and easily installed accessory on the older sets having sufficient high frequency response to insure a variable effect.

To avoid misunderstanding, explain to your customer that any good modern receiver is designed to give uniform output at all audible frequencies when the tone control is adjusted at the brilliant or high frequency position. This may be apparent to the era, however, only when the output volume is loud. A low frequency sound must have far greater

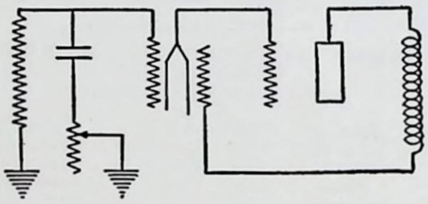


Fig. 2

energy than a high frequency sound to make the same impression on the ear. Consequently, as the volume level is reduced, the ratio between the low and high frequency changes as apparent to the ear, with the high frequencies predominating. Tone control compensation is then required by adjusting out the "highs" until the desired ratio is again restored. The general rule of operation,

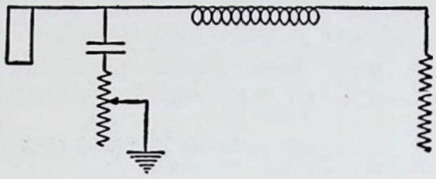


Fig. 3

therefore, is to adjust at the "high" position when the set is adjusted at loud volume as for dancing, or in large rooms, and toward the "low" position as the volume is reduced or the set used in a small room.

From this explanation, it is obvious there is no disadvantage in the simple tone control circuits that seem to change the volume as well as the tone. The

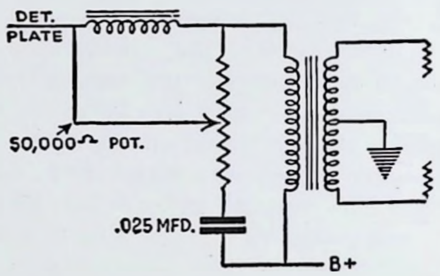


Fig. 4

better the high response of the amplifier, the greater will be the volume control effect, since tone is controlled by reducing the "highs" until the desired balance with the "lows" is obtained, and not by boosting the "lows". Actually boosting the "lows" is a difficult problem requiring careful engineering in the original design of the amplifier, and can seldom be accomplished with satisfaction by any attachment made later. Even when incorporated in the original design, it can have no practical advantage over a simple tone control on a full range amplifier when the tone and volume con-

* From the Centralab Volume Control Guide.

trol knobs are properly adjusted.

The most widely used and simple circuit is (shown in Figure 1. A one megohm uniform-taper rheostat) is shunted, in series with a fixed condenser, from grid to grid of the push-pull output tubes. The condenser capacity commonly used is .01 ufd. If greater high frequency cut off is desired, use a larger capacity, such as .02 ufd., while less cut off results from a smaller capacity, such as .005 ufd.

While Figure 1 illustrates a '45 output, the same parts and connections are used with a pentode push-pull, except that the condenser capacity should be about .004 ufd. The proper connection for a single pentode is shown as circuit 24, and the same connection is used with a single '45 or '50. All of these grid circuit applications, which we recommend as best, use the same one megohm control with a condenser capacity of about .01 ufd. for the '45 and about .004 ufd. for the pentode.

Some receivers locate the tone control in the detector plate per Figure 2. The rheostat should have a maximum resistance of 500,000 ohms. The condenser capacity is about .05 ufd. The arrangement of Figure 4, also located in the detector plate, is designed to boost the "lows" as well as cut the "highs". The inductances and capacities are part of the receiver design. The control is a 50,000 ohm, uniform-taper potentiometer.

Some tone controls have been located in the plate circuit of the output tubes, either pentode or '45. This circuit is not recommended because the high voltage and possible surges in this location may break down the condenser or the control. Where such trouble requires replacement parts, substitute the arrangement of Figure 1 or Figure 2.

AUTOMATIC VOLUME CONTROL

(Continued from page 21.)

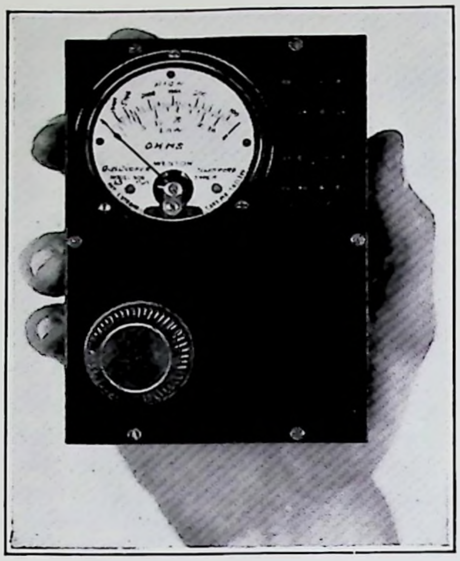
this condition several troubles may exist as said before.

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.

AN IMPROVED OHMMETER • • • •



A 2-range ohmmeter by G. H. Cooper. With a self-contained one-cell battery it gives useful ranges of 1 to 100 and 100 to 10,000 ohms. The upper tip-jacks are the ones labelled A and B in the diagrams and are for the high (series) range. The two lower jacks are for the low (shunt) range, the shunt circuit being made by the split jack D, as shown in the diagrams. The knob at the lower left is the clarostat used to effect zero compensation. The meter is a Weston Model 506, range 0-1.5 ma.

Commercial ohmmeters have an odd habit of costing money, and of not providing a sufficiently low range for much of the circuit work having to do with filament wiring, shorted windings (r.f. or power), or bad switch contacts. About the only simple way to gain two

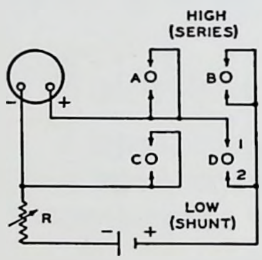
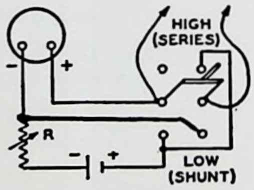


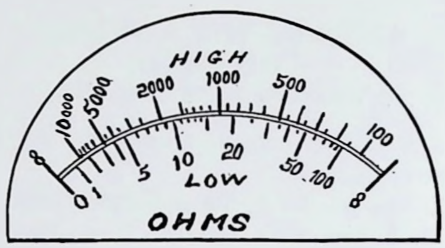
Diagram of the Cooper meter. The eight arrowheads represent the special pinjack springs.



Equivalent diagram showing how a switch may replace the special jacks of the Cooper meter.

ranges that cover most of the ordinary problems is to use one series range (high) and one shunt range (low), as has been explained.

In the ohmmeter pictured in this article Mr. George H. Cooper of Hartford has provided two very useful ranges, (1 to 100 and 100 to 10,000 ohms) without any complications, with an extremely simple circuit and in most compact form. The diagrams and the photographs explain matters fully. The scale has been reproduced here so that others may build their own. It will be well to check a few points on each scale to make sure that nothing has gone askew. All zero adjustments are made with the clarostat so as to bring the pointer to the right end of the scale. This can be done either

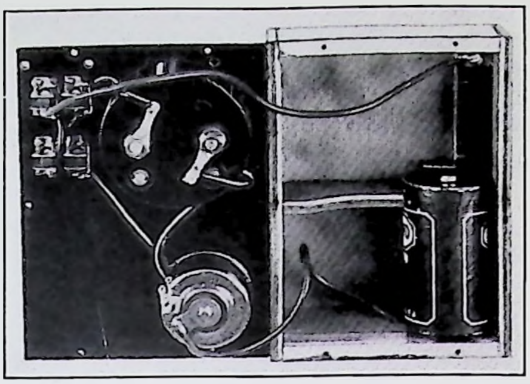


The scale of the Cooper meter. "Modern Radio" can supply these on heavy paper. Send five 3 cent stamps for any number up to 10. They fit the Weston 506 meter, 0-1.5 ma.

with the test leads plugged into the "high" tip-jacks and touched together, or else with the leads plugged into the "low" tip-jacks and separated. The same adjustment is usually good for both arrangements.

Three of the jacks could just as well be ordinary tip-jacks although they are actually made specially. The fourth jack has the two springs insulated from each other (D1 and D2) so that it closes the shunt-circuit for the low range when the cord tip enters and connects D1 to D2. The special springs can be obtained through "Modern Radio", but it is also possible to use an ordinary switch or else to rebuild a five-prong "wafer" tube-socket as shown in still another sketch.

The box is of $\frac{3}{16}$" ply-wood and measures 3½" x 5" x 1½" outside. The meter is mounted by small machine screws passing through drilled holes in the flange. To avoid this, increase the

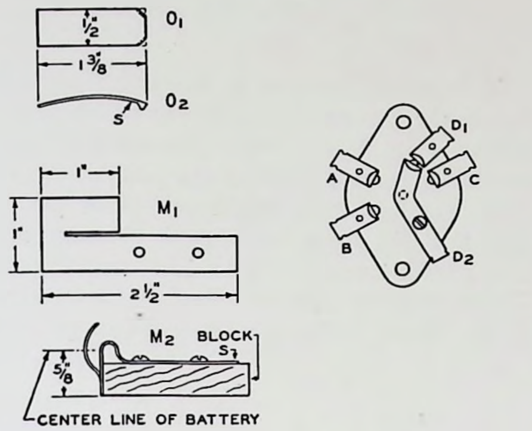


The inside of the ohmmeter, showing the two-spring jacks. Except for jack D the springs of each may be connected together to lower contact resistance.

box and panel to 4" x 5½" and use the clamping ring supplied by Weston.

The scale is intentionally thrown off VERY slightly so as to allow compensation for any meter errors by using a shunt (fixed) of 250 to 1,000 ohms. Don't use the shunt unless you have really good resistors to check against and the clarostat does not suffice.

Observe, by the way, that the ranges given are the USEFUL ranges—not imaginary ranges that are at the extreme ends of the scale. A type which goes into the megohm region will be shown later in "Modern Radio."



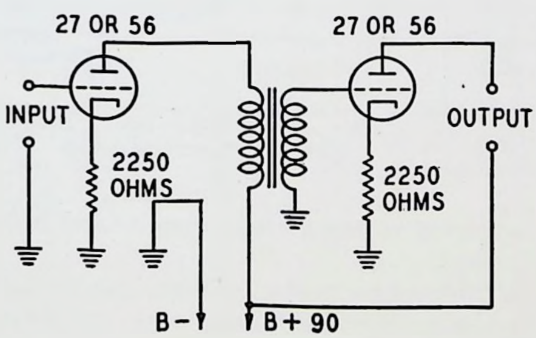
Dimensions of the brass contact springs used to hold the flashlight battery. M1 is bent to shape M2 and screwed to the block which measures ½" x ½" x 1⅞". 01 is bent to shape 02. The wires are soldered on at the points S.

A 5-pronged socket with a special spring (D2) added, will give the same action as the special tip-jacks. The lettering is as before. D2 is held by a screw through the unused prong-hole, and may also be secured at the center rivet (dotted) of the socket.

Mr. Cooper has agreed to supply panels to those not mechanically inclined. These will be 4" x 5½" as above, with all drilling, countersinking and cutting done and the eight clips screwed into place, also the woodscrews supplied. The price is $3.00. Having seen his work, we know it to be well worth the price and will be pleased to forward any orders. If it's inconvenient for a reader to secure any of the other parts, we will be pleased to advise.

Modern Radio Co. 101 Allen St. Hartford, Conn.

MODERN RADIO QUIZ-MATIC



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Do you know what a Quiz-matic is? Read Modern Radio to find out. There's one a month and each carries a prize—with only ten minutes work required.

★

• IMPROVED CATHODE BIASING •

* By BOYD PHELPS

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 utilizing the IR drop developed thereby for the desired control grid bias voltage as illustrated in Fig. 1. The plate current flows from cathode down through the resistor to ground which is the most negative part of the series plate circuit. Therefore the cathode is positive with respect to ground and the average grid voltage is negative with respect to cathode.

If a "C" battery is used instead, an increase in plate voltage would cause a very considerable increase in plate current that might shorten the life of the tube, but with the cathode resistor system this is more or less automatically taken care of because the increased plate current causes a great IR drop which is a proportionately greater bias tending to bring the plate current back to normal for the increased plate voltage. Conversely, decreased plate voltage or current will not cause "cut-off" bias but only reduced bias in proportion. Thus far we have a review of a clever idea disclosed in patent number 1,403,932 to R. H. Wilson.

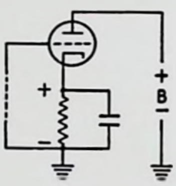

Fig. 1

At about this time and the early days of Prof. Hazeltine's Neutrodyne, the writer experimented with circuits similar to Fig. 1 for neutralizing purposes, but of course without the by-pass condenser across the resistance.

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.

Actually, Fig. 1 is not quite so simple and was found not to be a good circuit for complete neutralization as a reduction of a.c. plate current caused a reduction of a.c. grid voltage and this reacted on the plate current again so other circuits shown in patent number 1,829,013 granted to the writer were found better suited.

Returning to the cathode bias resistor, as it is increased from zero (without a

TABLE OF CONDENSER REACTANCES

Frequency	2 ufds.	1 ufd.	1/4 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

Fig. 2

* Consulting Engineer, Box 247, Hicksville, L. I.

by-pass condenser) there is a very rapid reduction of over-all amplification of the stage due to this neutralization effect. (See Fig. 2)

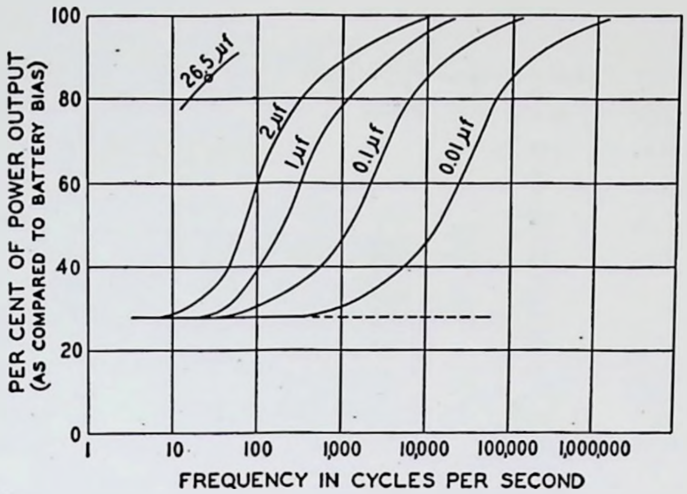

Fig. 3. Unless one uses push-pull, or a circuit like Fig. 4, it is necessary to use high-capacity bypasses on audio cathode resistors. The common ½ to 1 mike is absurd—unless one has a poor filter and must get rid of hum and bass together!

For example, the particular chassis used formerly had a 1470 ohm resistor in series with the cathode and the output (without by-pass condenser) fell to 28% of the power output obtained when the same bias was obtained from a battery, or a loss of 72% on all frequencies.

Hatry and others have noted that reducing the size of the by-pass condenser results in the loss of low frequencies, but the above indicates that with no condenser at all this does not result in distortion but rather a sort of neutralization of all audio frequencies resulting in uniform low signal output on all frequencies. Therefore, adding condensers across the cathode bias resistor must bring up the level of the high frequencies first, which is not contradictory but merely another way of saying the same thing and a better bias for what is to follow.

A number of measurements and calculations were made with various shunt capacities at various input frequencies and illustrated in Fig. 4. It may be rather surprising to some folks to learn that the common one and two microfarad condensers should show up so poorly but it is so. To have the output drop to not less than 85% of normal at 50 cycles due to the effects discussed would require about 26½ microfarads!

The Cure

The circuit shown in Fig. 5 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 1470 ohms as before, R2 is 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.

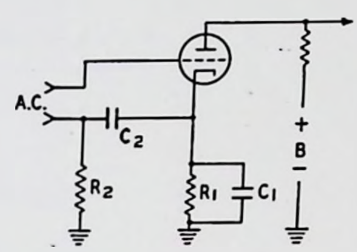

Fig. 4. The cure. Keep C2 at 1 mfd. or more; C2 need not be above one-tenth mfd.; R2 can be anything above 40,000 ohms. Typical results appear below, measured at 60 cycles.

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

The final circuit seems to have good response on low audio frequencies, is cheaper than any other method producing equivalent results without batteries, introduces no new difficulties, and in fact, has many possible other uses as it better isolates the grid from motor-boating and other evils often encountered by common couplings.

The R. M. A. Color-Code for Resistors

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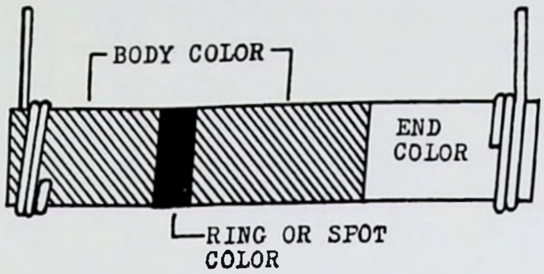
Most manufacturers are gradually changing over to the R. M. A. standard system of marking resistors by color-bands to indicate the resistance in ohms, as is explained below. A few still show a bad-boy pride in being freakish but may get over it later.

The R. M. A. system gives each resistor stripes of color which—if you have a tremendous memory—will let you tell the resistance at a glance. Most of us are not Japanese memory wizards, hence the thing is put in tabular form



below. Note that the body color appears TWICE.

The BODY COLOR gives the first number	The END COLOR gives the second number	The RING COLOR tells how many zeros to put after the numbers
Black—not used here	Black means ... 0	Black means—add no zeros
Brown 1	Brown 1	Brown—"and 1 zero" (or "multiply by 10")
Red 2	Red 2	Red—"and 2 zeros" (or "multiply by 100")
Orange 3	Orange 3	Orange—"and 3 zeros" (or "multiply by 1,000")
Yellow 4	Yellow 4	Yellow—"and 4 zeros" (or "multiply by 10,000")
Green 5	Green 5	Green—"and 5 zeros" (or "multiply by 100,000")
Blue 6	Blue 6	Blue—"and 6 zeros" (or "multiply by 1,000,000")
Violet 7	Violet—7	
Gray 8	Gray 8	
White 9	White 9	

Examples:

A resistor has a green body, white end and black ring. From the table the first number (green body) is 5, the second number (white end) is 9 and there are no zeros to be added because the ring is black. Therefore it is a 59 ohm resistor. If the ring had been green it would have been "59 and 5 zeros" or 5,900,000 ohms.

Example number two:

The colors for a 67,000 ohm resistor are to be found. The first number is 6, therefore the body color is (first column) blue. The second number (second column) calls for a violet end, and the 3 zeros call for an orange ring.

It should be observed that any color always calls for the same number; thus red may mean a 2 in the first place, a 2 in the second place—or 2 zeros.

The Right Resistor 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.

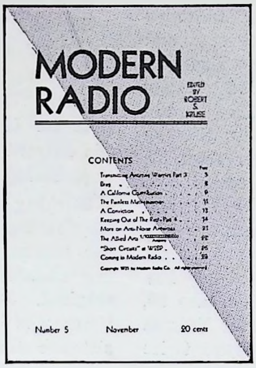
Sticking to one size of resistor (wattage rating); twice the resistance drops the current capacity to .7, three times the resistance drops it to .6 of the original. Half the resistance allows 1.4 times the current, one-third the resistance allows 1.7 times the current.

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				

RATED CURRENTS (MILLIAMPERES)

Of Course

IT'S DIFFERENT



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