Resistors in your Old Radios

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Overview

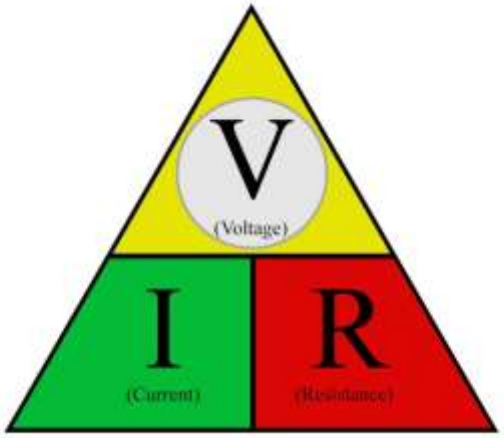
- Physical Description
- What they do, ways to describe them
- How to test them
- Resistor types
- How they fail
- Resistors "*in their element*"
  - What matters ?
  - Symptoms of a failed resistor.
- Should you resist re-resisting?

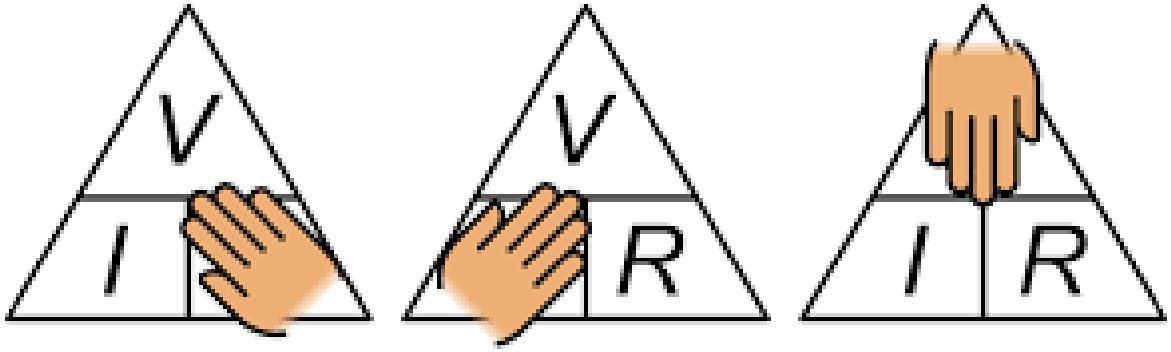
PHYSICAL DESCRIPTION

Ohms

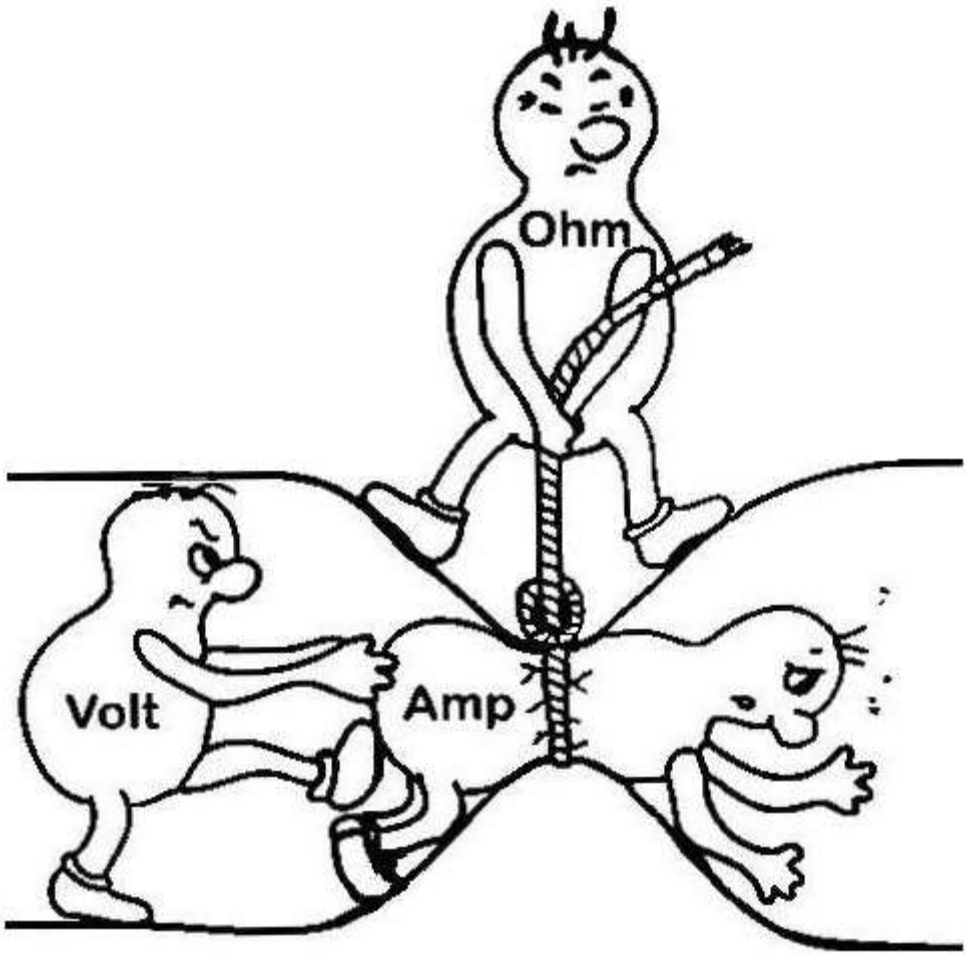
- Georg Ohm (a German scientist) discovered the relationship between voltage and current in conductors: "Ohms Law".
- It is serendipity that the Greek letter Ω is called "Omega". It's now used as a shorthand for ohm.
- An Ohm is small, so we often use:
  - 1,000Ω = 1kΩ (sometimes 1M in old literature);
  - 1,000,000Ω = 1MΩ (sometimes 1MEG in old literature)

If you know the voltage across a known resistor, ohms law allows you to calculate the current.



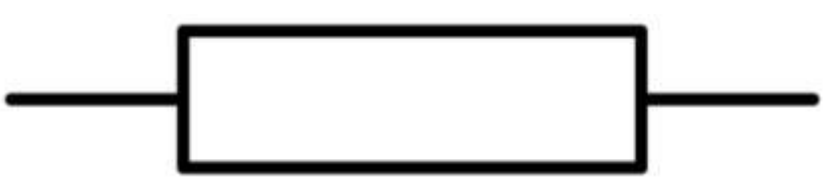


$$R = \frac{V}{I} \qquad I = \frac{V}{R} \qquad V = I \times R$$

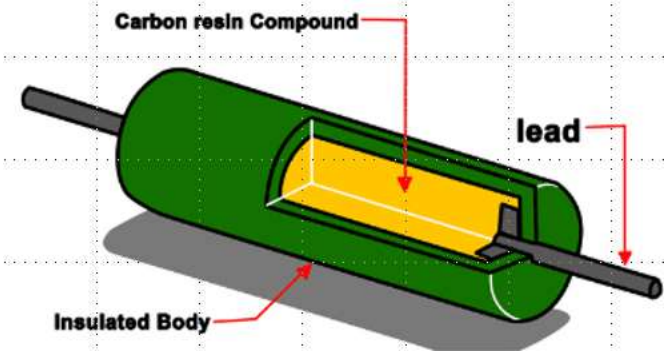

Ohm
Volt
Amp

Ohms Law

- Ohms Law holds for many materials over a wide range of voltages.
- Sometimes, resistance is a nuisance.
  - Wires have small resistances, but we'd like no resistance.
  - Insulators have huge resistances, we'd like an infinite resistance.
- If we want a specific resistance, we use a **resistor**.



Physical Construction of Resistor



A not-so-good conductor, like carbon or Nichrome, able to dissipate heat

Wire: good solderable conductor, like copper

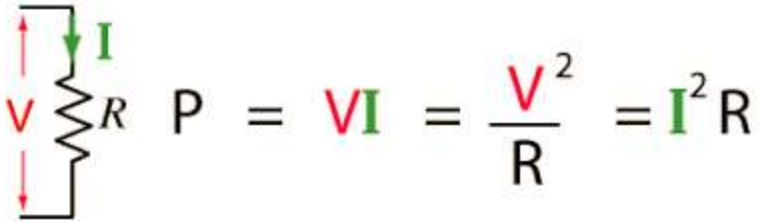
Wire: good solderable conductor, like copper

The not-so-good conductor should have stable properties, be easy to connect to, be able to withstand high temperature (under operation or soldering)

Carbon or a thin film of metal or oxide, or resistance wire, sometimes wound into a coil to make it compact.

A resistor inherently gets hot. It is important that the resistor is large enough to dissipate the power without burning up.

Voltage (V)… Current (I)… Resistance (R)…. If you have 2 out of the 3, you can calculate power.



$$P = VI = \frac{V^2}{R} = I^2R$$

Main Fixed Resistor Characteristics

- Resistance (in Ohms)
- Tolerance (allowable resistance range in percent)

Usually marked on the resistor

- Maximum Power Dissipation (Watts)
- Maximum Voltage (usually not an issue)
- Temperature coefficient
- Usually, only resistance and tolerance are indicated on a resistor. You can determine the power from it’s physical size.

Resistor Noise Characteristics

- The laws of thermodynamics dictate that *all* resistors fundamentally produce noise (proportional to their temperature), called Johnson/Nyquist noise.
- John Johnson and Harry Nyquist measured, documented and explained this noise at Bell Labs in 1926 ← *Boy, a lot of stuff came out of Bell Labs!*

- Noise is usually way too small to be an issue, but it can be measured.

$$P = k_{\mathrm{B}}\, T \Delta f$$

P is the noise power available from a resistor
k is Boltzmann's constant: 1.38065E-23 J/K
T is temperature (Kelvin)
Δf is bandwidth (Hz)

Resistor Noise Characteristics

- All resistors and conductors, made of any material, produce *exactly* the same *Johnson* noise power.
- But, some resistors produce more noise when DC current flows through them.
- A very bad resistor can produce objectional noise in a sensitive circuit.
- If you need low noise with DC current flow: Metal film resistors and wire-wound resistors are good. Carbon composition resistors can be bad.

- Why did the engineer solder a resistor to his stove?
- He wanted an *ohm on the range*!

(Sorry, I couldn't *resist*!)

ELECTRICAL DESCRIPTION OF A RESISTOR

What does a Resistor do?

- A resistor causes a voltage drop when current is passed through it.
- A resistor causes a well defined current flow when a voltage is present across it.
- It can be used to reduce voltage. (eg: power supply, filament dropping resistor)
- It can turn a changing current into a changing voltage. Or vice-versa. (eg: plate load)

What does a Resistor do?

- When paired with a capacitor, it can make a filter (high pass or low pass) (eg: power supply or AGC circuit)
- Two resistors (or a potentiometer) can make a voltage divider. (eg: volume control)
- A resistor can set the bias (operating point) on a tube (eg: cathode resistor)

What does a Resistor do?

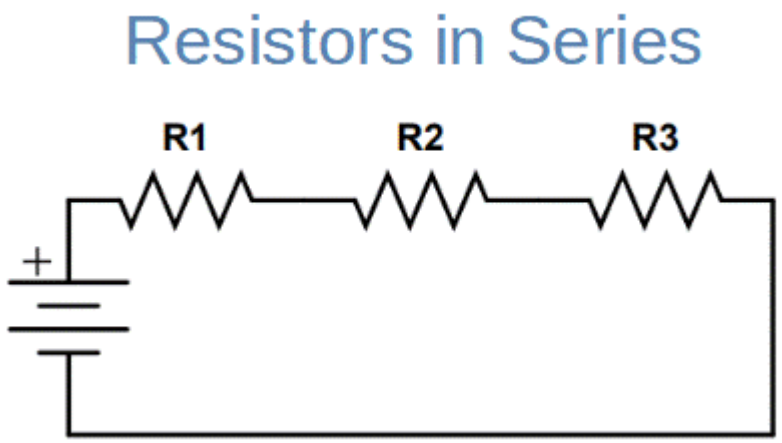
- A resistor can limit current to prevent damage.
- A resistor can act as a fuse.
- Resistors can help decouple different stages from each other.
- A resistor can transfer a voltage with no current flow. (grid resistor)

What does a Resistor do?

- For today, you can class resistors into:
  - Grid resistors
    - Gets bias to the grid of a tube.
    - Not critical, always low power.
  - Plate resistors
    - Somewhat critical. Low or medium power.
  - Cathode resistors
    - These determine the operating point (bias point) of an amplifier, they are critical.
  - Power supply dropping resistors
    - These determine plate voltages and aid in ripple rejection.
    - High power, critical.

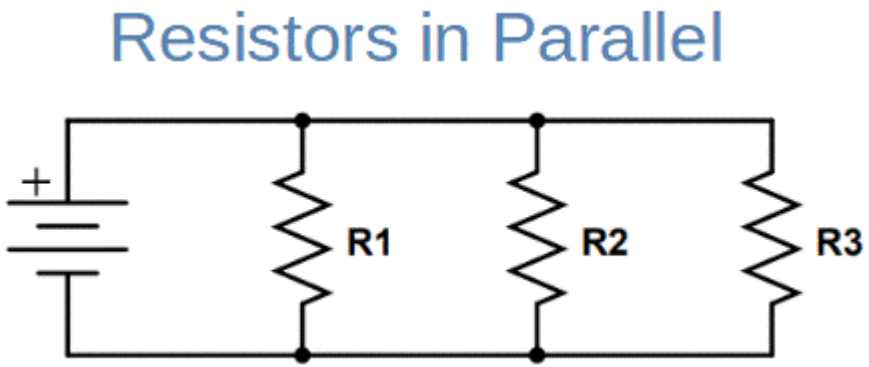
Resistors in Series

- If you put two resistors in series: Total resistance is the **sum** of their resistances.
- Overall power rating is double if they are the same value and size.
- So: place a 10 ohm resistor in series with a 20 ohm resistor: you get 30 ohms.



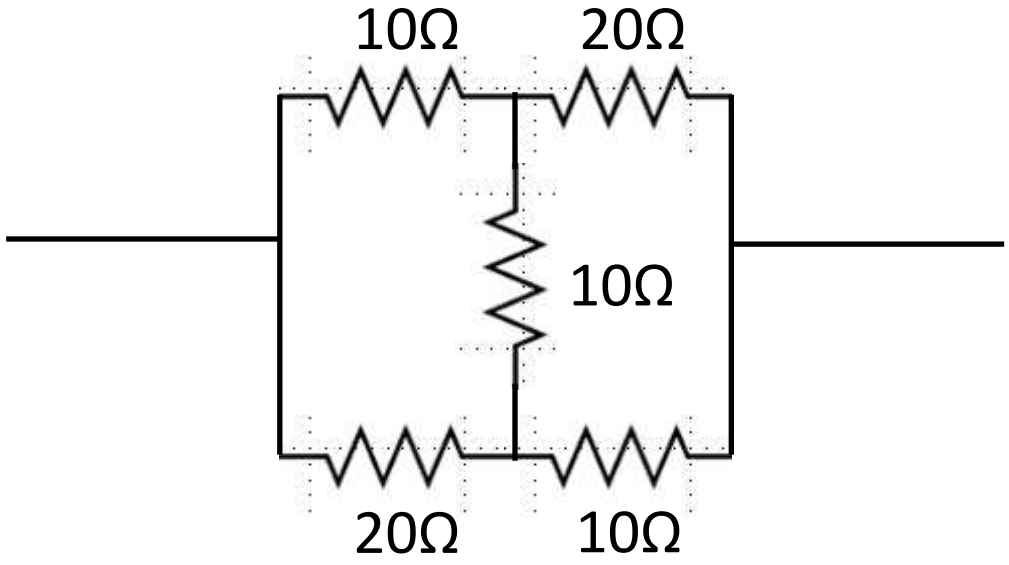
Resistors in Parallel

- If you put resistors in parallel: Total Resistance is $\frac{1}{Rt} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3}$ or $R = \frac{R_1 R_2}{R_1 + R_2}$
- Total power rating is doubled if they are the same resistance.
- So: a 100 ohm and a 300 ohm resistor in parallel is equivalent to 75 ohms.



A Challenge…

- What is the total resistance of this circuit?



Hint: It is not easy!!!!
Another hint: the answer is an even number.

HOW TO TEST A RESISTOR

Testing Resistors

- A resistor can get hot under normal operation. If a small resistor is getting quite hot, it is a sign of trouble.
- Faults elsewhere in a circuit can cause resistors to heat excessively and burn out.
- When resistors burn out, they almost always turn into an open circuit.
- Burnt-out resistors often look charred and may be fragile or falling apart.

To test a resistor

- Ohmmeter. Any multimeter has an “ohms” function.
- Note that you might have to disconnect the resistor from the circuit *(always de-energized, and discharge the capacitors, too)* to get an accurate value, as the circuit could provide an alternative current path.


If you laughed at this
FLUKE
233 REMOTE DISPLAY TRUE RMS MULTIMETER
FUTILE
MΩ
HOLD
MIN MAX
RANGE
OFF
A
COM
VΩ
you are a nerd.

TYPES OF RESISTORS
PART 1 “FIXED”

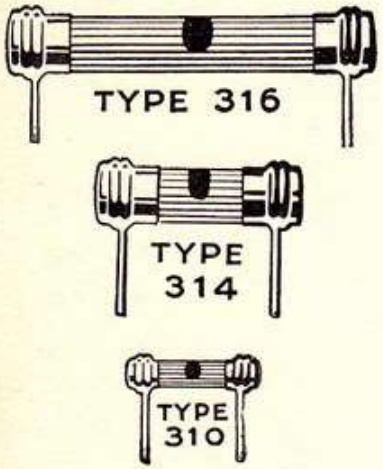
Types of Resistors

- Old
- Carbon Composition
- Metal Film, Metal Oxide, Carbon Film
- Wire-wound (power resistors)
- Ceramic, carbon, wirewound
- Rheostats, Potentiometers, Trimmers
- Temperature Dependent
- Light Dependent

Old

- Usually carbon composition, but lots of other technologies.
- Grid-Leak Resistors.

CENTRALAB CARBON RESISTORS



All resistances have flexible wire leads 1½" long, and are R.M.A. color-coded. Types 316 and 314 individually labelled and packed in cartons of ten.

Type 316 Resistor, size ¼"x1¾", rating 1.5 watts..... **$0.20**

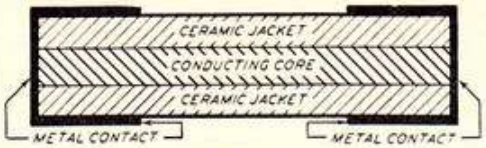
Type 314 Resistor, size ¼"x1", rating 1 watt..... **.18**

Type 310 Resistor, size ¼"x⅝", rating .5 watt..... **.15**

Resistance in Ohms

100	1,500	14,000	125,000
200	2,000	15,000	150,000
300	2,500	17,000	200,000
400	3,000	20,000	250,000
500	3,500	25,000	300,000
600	4,000	30,000	400,000
750	5,000	40,000	500,000
800	6,000	45,000	750,000
900	7,500	50,000	1 Meg.
1,000	8,000	55,000	1.5 Meg.
1,100	9,000	60,000	2 Meg.
1,200	10,000	70,000	3 Meg.
1,300	12,000	75,000	4 Meg.
1,400	13,000	100,000	5 Meg.

Carbon Resistor Cross-Section



This magnified cross-section illustrates important and exclusive features of Centralab Resistor design. These are:

1. Center core of resistance material is surrounded by a dense shock-proof ceramic, providing strength and protection against humidity.
2. Core and jacket are fired together at 2500 degrees F. into a single solid unit, hard and durable as stone.
3. Pure copper covers the Resistor ends for wire lead-contact.
4. Because resistance is small in diameter and uniformly distributed for entire length, Centralab's specific resistance per unit length is low.

CENTRALAB HANDY RESISTOR RACK

Keeps your resistor stock in order. Made of heavy sheet steel lacquered finish. Easily accommodates 60 Type 316 or 120 Type 310 resistors. Color code chart integral with rack.

Supplied free with order for the following assortment of 40 resistors:

Type 316: 250, 500, 750, 1000, 1500, 2500, 4000, 5000, 7500, 10M, 15M, 20M, 25M, 30M, 40M, 50M, 75M, 100M, 150M, 250M ohms.

Type 310: 100, 300, 500, 750, 1M, 100M, 125M, 150M, 250M, 300M, 400M, 500M, 750M ohms, and 1, 1.5, 2, 3, 4, 5 Megohms.

List Price of Assortment..... **$6.00**

Resistor Rack Only..... **.75**

AIR CELL "A" BATTERY CONVERSION RESISTOR PLUG

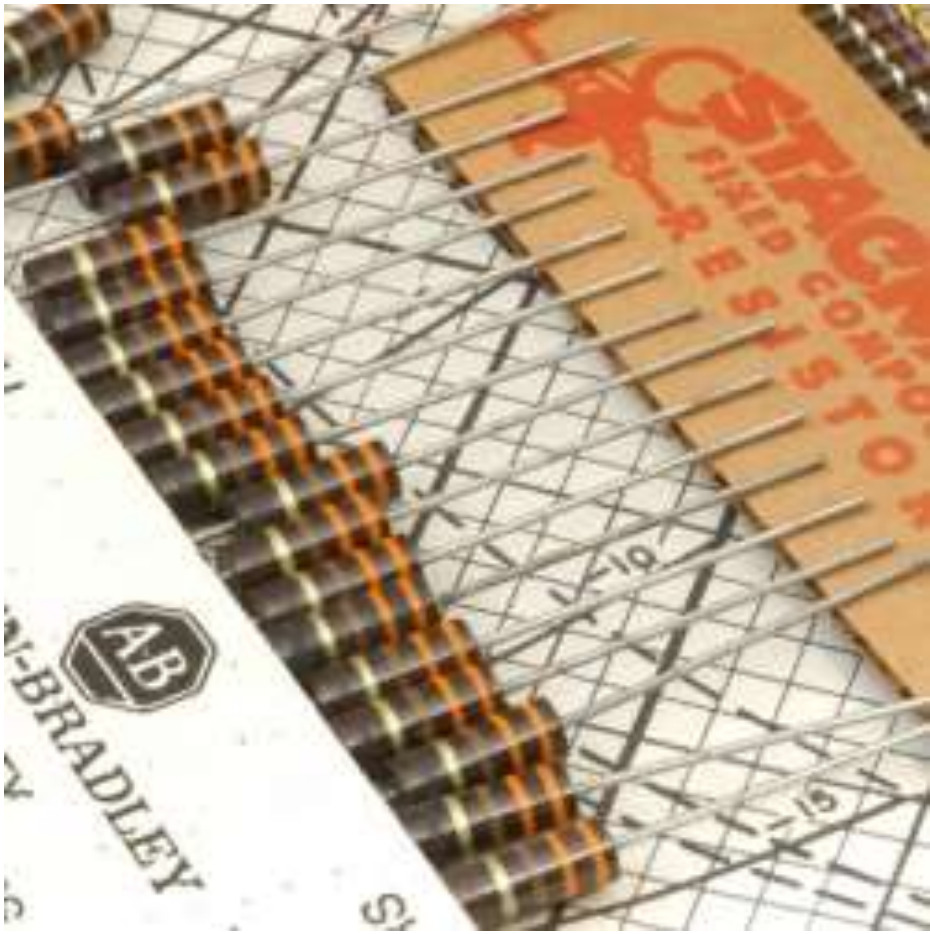
Necessary to replace ballast tube in converting battery operated receivers to use Eveready Air Cell. Plugs last forever—nothing to burn or wear out. Correct plug for each receiver must be used. See chart below.

Part No.	Make and Model
408-001	SILVERTONE 1712, 1713, 1714, 1854, 1857.
408-002	SILVERTONE 1710, 1711, 1711A, 7090, 7090A.
408-003	COLONIAL 659: SILVERTONE 1850, 1851.
408-005	AIRLINE 77, 95: SENTINEL 660, 6200, 6234, 6241.
408-006	PHILCO 38, 38A: SENTINEL 7700, 7732, 7741.
408-007	PHILCO 39, 39A, 38, 38A with type IC6 translator tube.

List Price..... **$1.00**

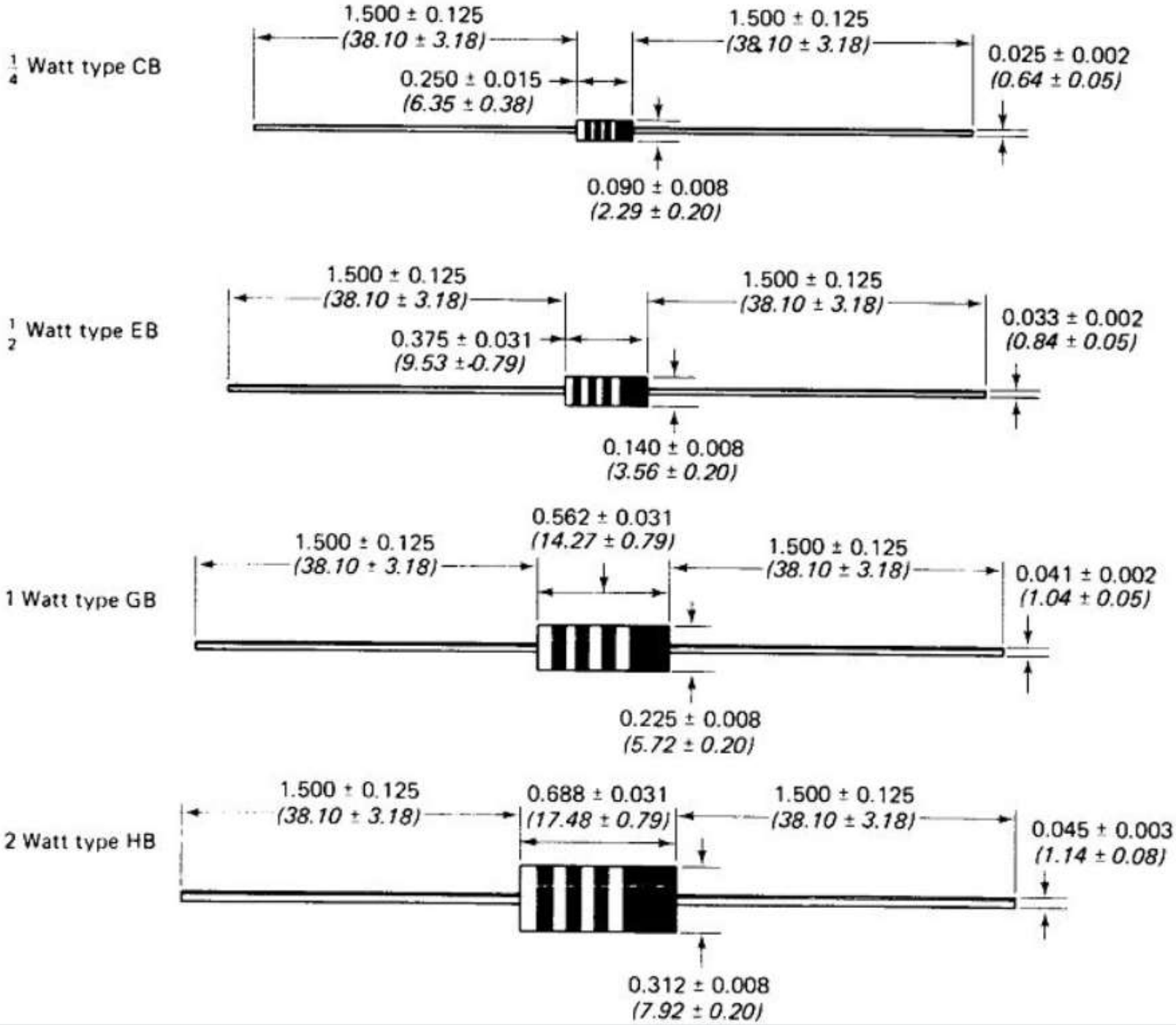
Carbon Composition

- The most common small resistors we are likely to see in old radios.
- Have been mostly replaced by film resistors. A film resistor is a good replacement, though it won't "look right".

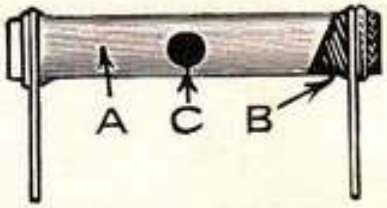


How Much Power?

- It’s a little difficult to determine resistor power. Power is determined by physical size.
- Generally, larger resistors can take more power. A resistor bolted to the chassis is a high power resistor.

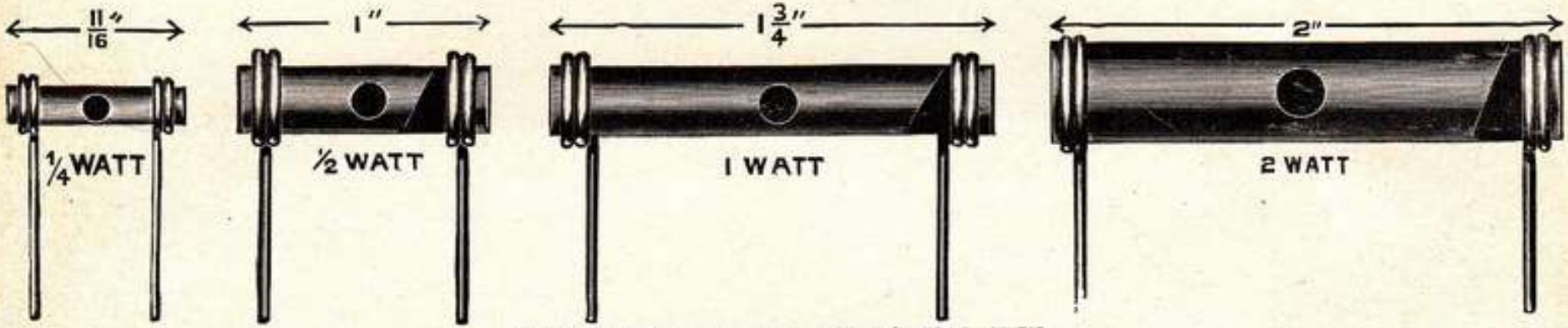

1/4 Watt type CB
1.500 ± 0.125
(38.10 ± 3.18)
1.500 ± 0.125
(38.10 ± 3.18)
0.250 ± 0.015
(6.35 ± 0.38)
0.025 ± 0.002
(0.64 ± 0.05)
0.090 ± 0.008
(2.29 ± 0.20)
1/2 Watt type EB
1.500 ± 0.125
(38.10 ± 3.18)
1.500 ± 0.125
(38.10 ± 3.18)
0.375 ± 0.031
(9.53 ± 0.79)
0.033 ± 0.002
(0.84 ± 0.05)
0.140 ± 0.008
(3.56 ± 0.20)
1 Watt type GB
0.562 ± 0.031
(14.27 ± 0.79)
1.500 ± 0.125
(38.10 ± 3.18)
1.500 ± 0.125
(38.10 ± 3.18)
0.041 ± 0.002
(1.04 ± 0.05)
0.225 ± 0.008
(5.72 ± 0.20)
2 Watt type HB
1.500 ± 0.125
(38.10 ± 3.18)
0.688 ± 0.031
(17.48 ± 0.79)
1.500 ± 0.125
(38.10 ± 3.18)
0.045 ± 0.003
(1.14 ± 0.08)
0.312 ± 0.008
(7.92 ± 0.20)

R. M. A. STANDARD COLOR CODE CHART



A—Body color represents first significant figure.
B—End color represents second significant figure.
C—Dot color represents the number of ciphers following the first two figures.

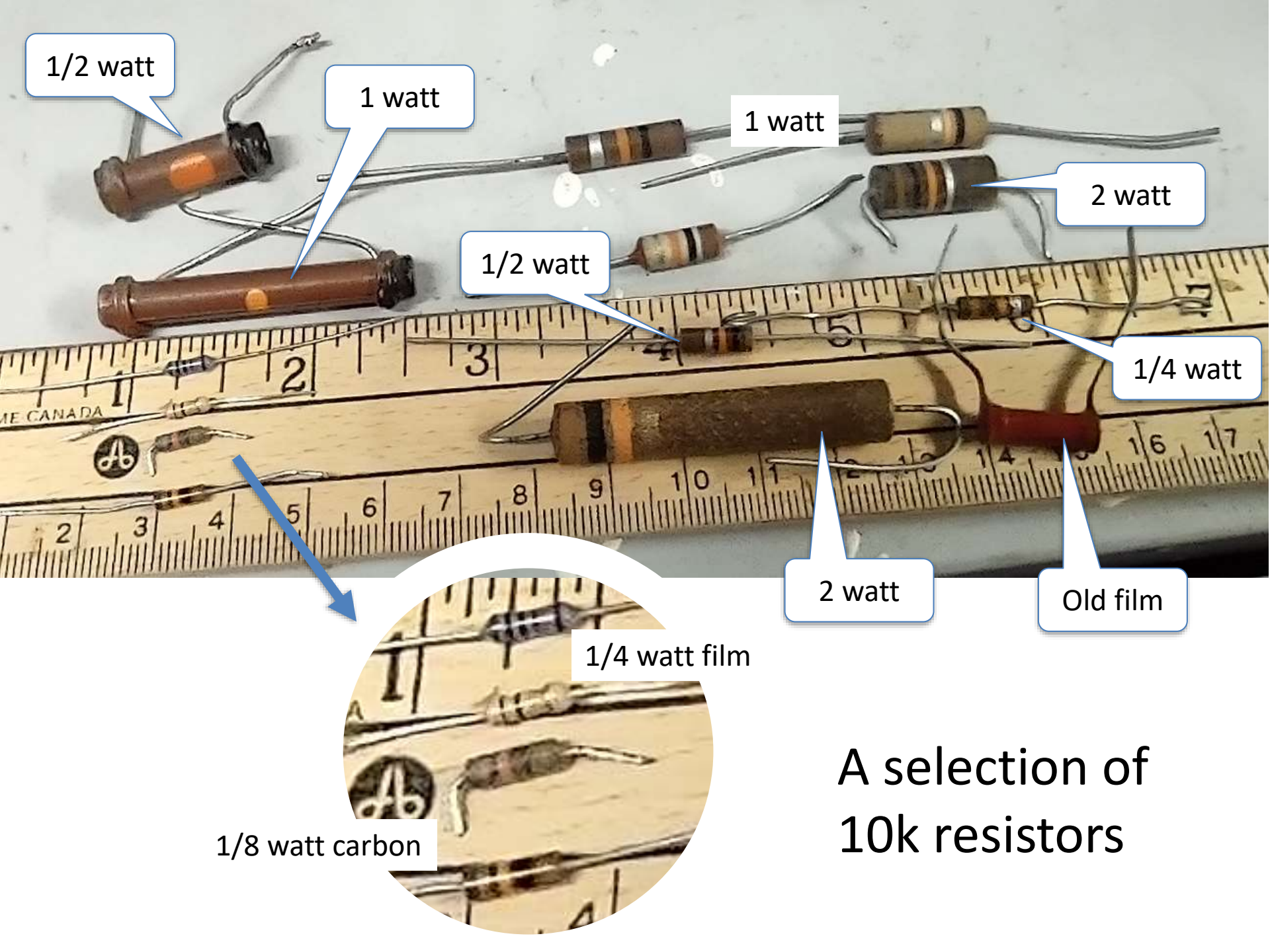
A Body Color		B End Color		C Dot Color	
0	Black	0	Black	.0	Black
1	Brown	1	Brown	0.	Brown
2	Red	2	Red	00.	Red
3	Orange	3	Orange	000.	Orange
4	Yellow	4	Yellow	0,000.	Yellow
5	Green	5	Green	00,000.	Green
6	Blue	6	Blue	000,000.	Blue
7	Violet	7	Violet	0,000,000.	Violet
8	Gray	8	Gray	00,000,000.	Gray
9	White	9	White	000,000,000.	White



THE ILLUSTRATIONS ARE ACTUAL SIZE

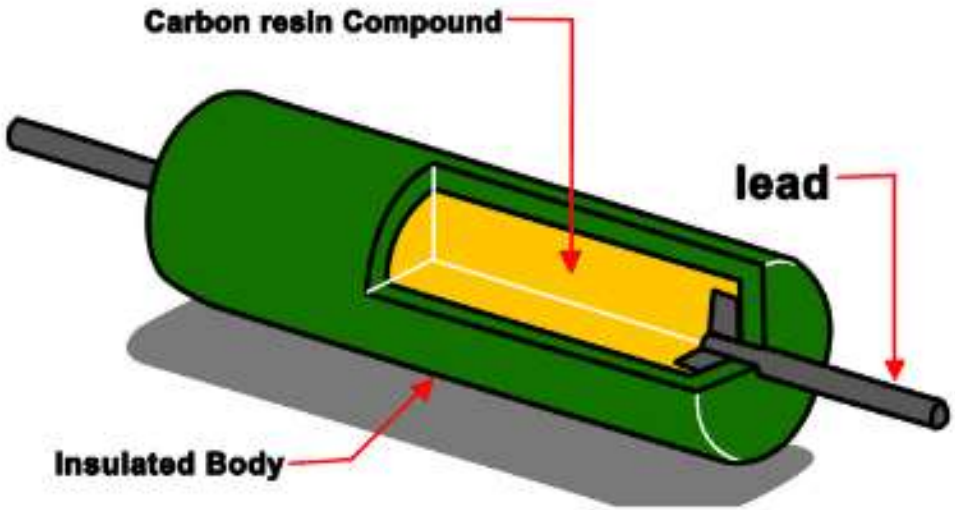
Power	Length	Diameter/width		
.25W	1/4	3/32	250V	Ohmite Little Devil / Stackpole / AB
.5W	3/8	9/64	350V	Ohmite Little Devil / Stackpole / AB
1W	9/16	7/32	500V	Ohmite Little Devil / Stackpole / AB
2W	11/16	5/16	1000V	Ohmite Little Devil / Stackpole / AB
.5W	13/32	1/8		IRC BT
1W	23/32	1/4		IRC BT
2W	1 1/4	1/4		IRC BT
.5W	5/8	3/16		IRC BW (wirewound)
1W	1 1/4	1/4		IRC BW (wirewound)
2W	1 3/4	21/64		IRC BW (wirewound)

5W/8W	1"	5/16		Ohmite / IRC Brown WW
10W/12W	1 1/4"	5/16		Ohmite / IRC Brown WW
20W	2"	7/16		Ohmite / IRC Brown WW
25W	2"	9/16		Ohmite / IRC Brown WW
50W	4.5"	9/16		Ohmite / IRC Brown WW
5W	7/8"	3/8		IRC Ceramic Blocks
10W	1 7/8"	3/8		IRC Ceramic Blocks



A selection of 10k resistors

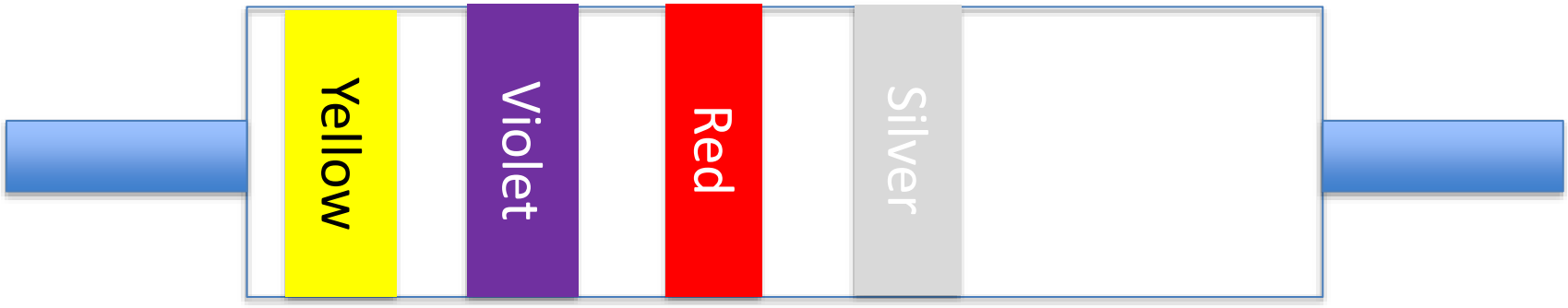
What is Carbon Composition Resistor?



Color	Value	Multiplier	Tolerance
Black	0	$\times 10^{0}$	±20%
Brown	1	$\times 10^{1}$	± 1%
Red	2	$\times 10^{2}$	± 2%
Orange	3	$\times 10^{3}$	± 3%
Yellow	4	$\times 10^{4}$	-0,+100%
Green	5	$\times 10^{5}$	± 0.5%
Blue	6	$\times 10^{6}$	± 0.25%
Violet	7	$\times 10^{7}$	± 0.10%
Gray	8	$\times 10^{8}$	± 0.05%
White	9	$\times 10^{9}$	± 10%
Gold	–	$\times 10^{-1}$	± 5%
Silver	–	$\times 10^{-2}$	± 10%
None	–	–	±20%

Color Code of Carbon Resistor

E4U Electrical 4 U



4

7

2 (# of zeros)

10% tolerance

4700 ohms

How to Remember the Colours?

- In high-school, we learned some rather rude mnemonics. (I'll not repeat them here)
- Here's a cleaner one:

Better Buy Resistors Or **Your** Grid Bias Voltages Go West

Black=0 Brown=1 Red=2 Orange=3 **Yellow=4** Green=5 Blue=6 Violet=7 Grey=8 White=9

- Or, just remember a rainbow: red-to-violet.

En Français: Ne Mangez Rien Ou Je Vous Brûle Votre Grande Barbe


CS516888
Hey! It's a 74kΩ 2% rainbow!!!
Bill Abbott

Power Resistors

- Generally, any resistor more than 1 watt or so is “power”.
- Can be composition, ceramic, or film, but are often wirewound.
- They are reliable, but high temperature operation does take a toll and they do fail!

Power rating may be marked on the package, but often you guess based on the size.

Power Resistors

Power	Length	Diameter/width		
5W/8W	1"	5/16		Ohmite / IRC Brown WW
10W/12W	1 1/4"	5/16		Ohmite / IRC Brown WW
20W	2"	7/16		Ohmite / IRC Brown WW
25W	2"	9/16		Ohmite / IRC Brown WW
50W	4.5"	9/16		Ohmite / IRC Brown WW
5W	7/8"	3/8		IRC Ceramic Blocks
10W	1 7/8"	3/8		IRC Ceramic Blocks

Power Supply Resistor Strips

Not very reliable IMO


Big Honkin' Resistors

Reference

- Tom Devey pointed me to a useful reference:
- The Resistor Handbook (Author: C. J. Kaiser)
- https://archive.org/details/resistorhandbook0000kais
- Also, by the same author:

  The Capacitor Handbook

  The Inductor Handbook

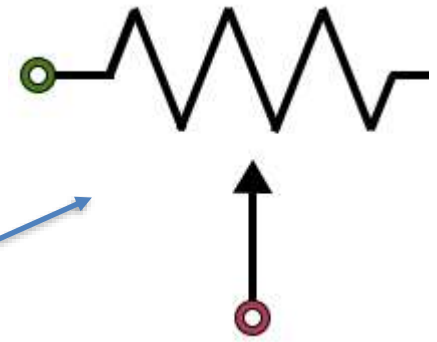
TYPES OF RESISTORS
PART 2 “VARIABLE”

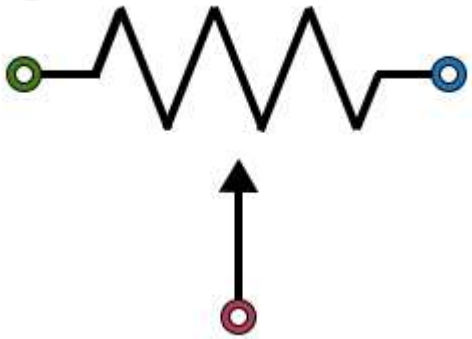
So many things to specify

- Resistance, power.
- Physical size (~ power).
- Linear vs. log taper.
- Taps along resistive element.
- With/without switch. Switch type.
- Multiple pots on the same shaft or concentric shafts
- Size/shape of shaft (or screwdriver adjust)

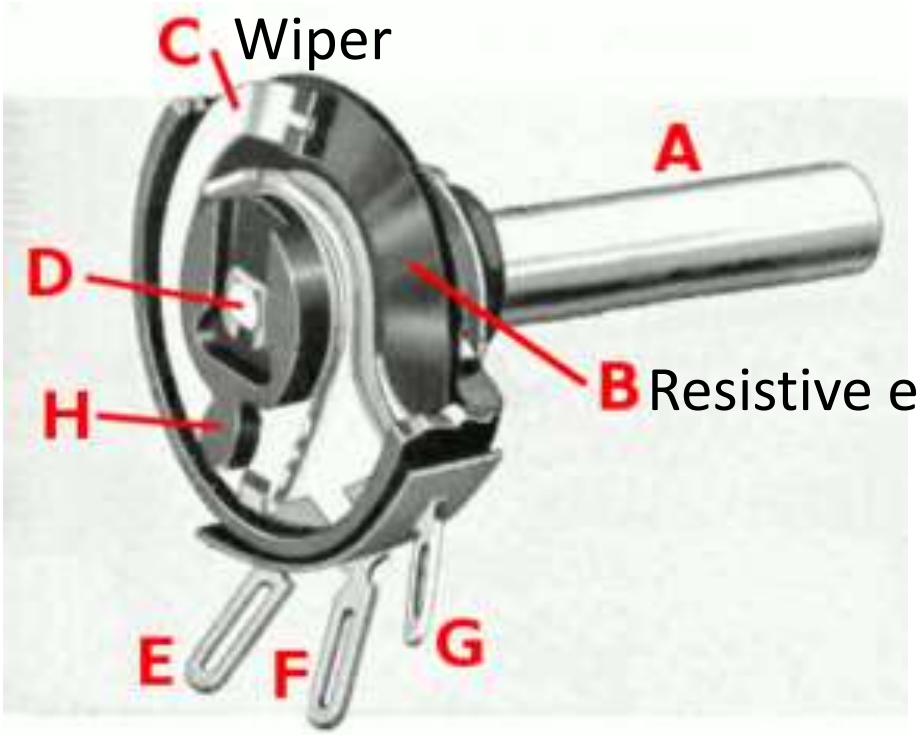
Pot, anyone?

- A rheostat has 2 terminals.
- A potentiometer has 3 terminals.
- You can use a potentiometer as a rheostat.
- A potentiometer is inherently a variable voltage divider.





Basic Construction



Filament Rheostats

Low resistance, wire wound

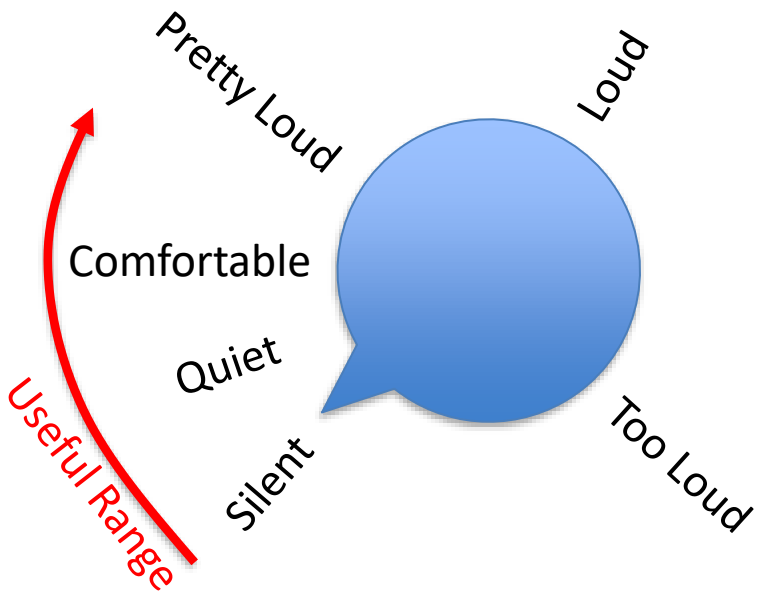
Adjustable Resistors

Handy for odd values.
You can't really adjust then in a live circuit

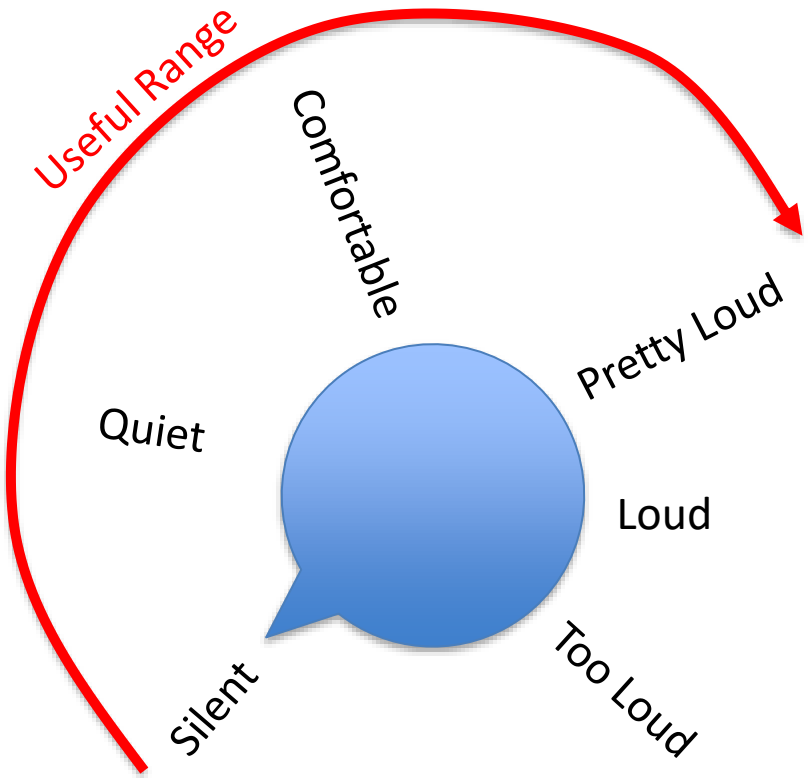
Slide Potentiometers

Tapped Potentiometers

- Used for volume controls.
- Listening tests show that at low volumes, music sounds better when bass and treble are boosted.
- Tapped volume controls allow this to happen (though generally only the bass is boosted).
- You can replace a tapped pot with a regular pot, it should be fine, barely noticeable.

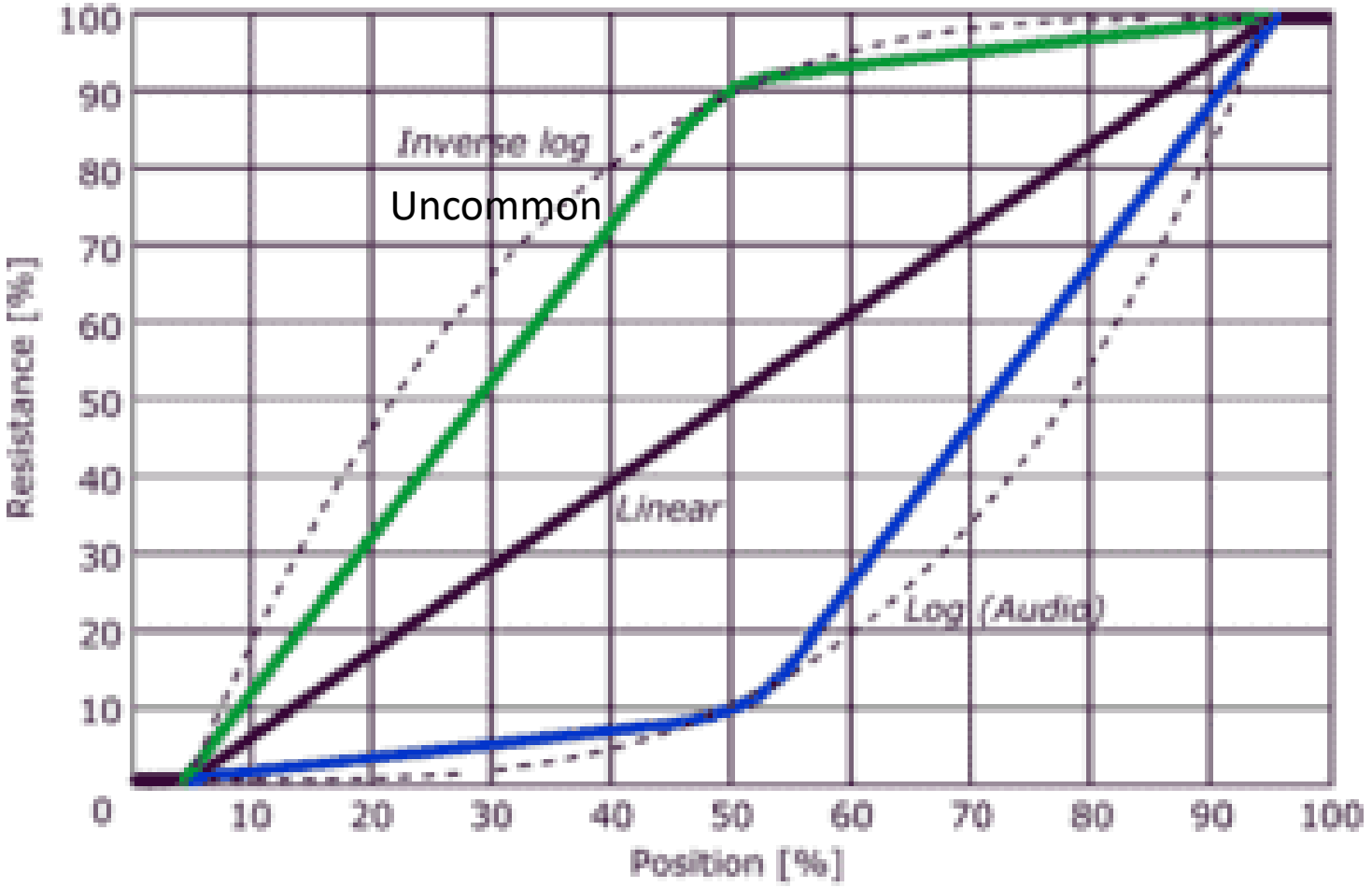


LINEAR TAPER



LOG/AUDIO TAPER

Taper


Inverse log
Uncommon
Linear
Log (Audio)
Resistance [%]
Position [%]
0
10
20
30
40
50
60
70
80
90
100

Multiple Functions

Two pots with concentric shafts
EG: Volume and Tone control + a switch

Two ganged pots (1 shaft)
Used in stereo equipment

Tapped Volume Control + a switch

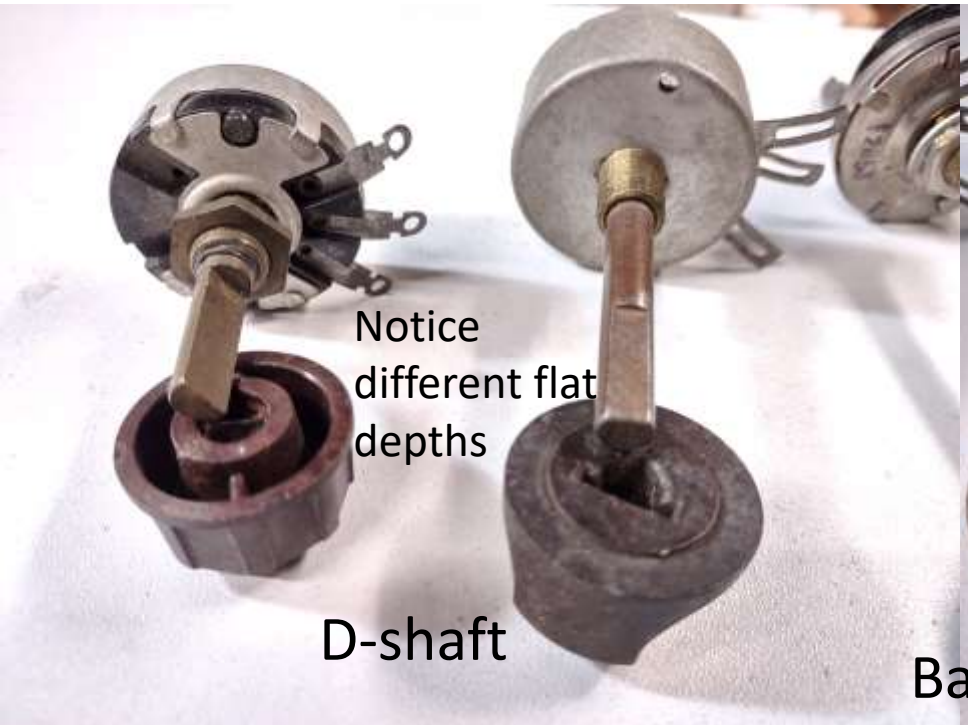
Potentiometer Shafts

Round: For knobs with set-screws

Split: For push-on knobs without a metal spring

“D” shaft: For push-on knobs with a metal spring, also knobs with set screws.

Universal: One shaft fits all.



Potentiometer Service

- You may be able to fix your potentiometer!
- Most common problem with a pot is noise or intermittency.
- Check for presence of DC.
- Cleaning the resistive element can work wonders.
- If you need to replace, getting a suitable replacement might be difficult. Consider mixing and matching.

DC on Volume Controls

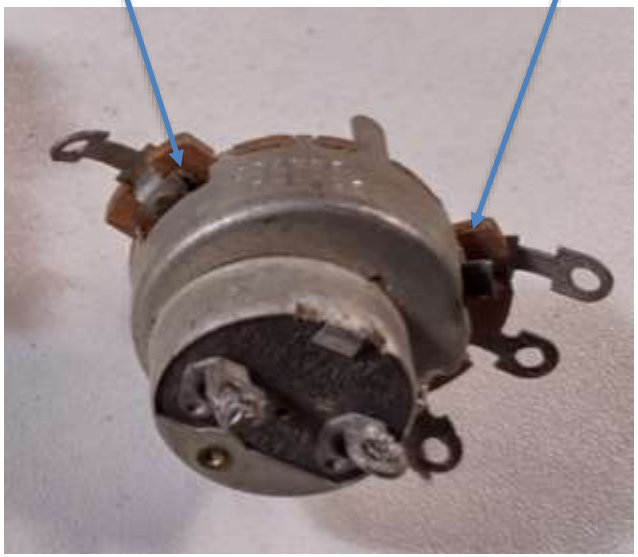
- DC on a volume control can make it noisy as it is turned.
- A good design has capacitors that block DC, but not all designs do that.
- Measure DC voltage across any pair of terminals across the pot, ideally it should be zero (for any position). If not, check nearby capacitors. If there are none, consider adding a blocking capacitor.

Pot Cleaning

- Cleaning the resistive element in a pot can work wonders on a noisy pot.
- Any good spray-type contact cleaner like DeoxIT will work.
- The liquid must get into the pot. If you cannot find a point of entry (near the terminals, for example), you may need to loosen the cover.

Spray in here

Or spray in here



Loosen these tabs to get spray into the back

The FrankenPot

- Complex pots can be difficult to find.
- If you have two similar pots, one with a good switch, one with a good (or desired value) resistance, consider disassembling them and putting the best parts together.
- Usually just a matter of carefully bending tabs.


2500 OHMS
TAPER-C1
PLAIN

TYPES OF RESISTORS
PART 3 “MISCELLANEOUS”

Temperature Dependent Resistors

- Thermistors ← temperature dependent resistors.
- Can be positive (PTC) or negative (NTC) tempco.
- Sometimes used in transistorized equipment to compensate bias currents for change in temperature.
- Globar resistors ….

Globar Resistors

- High resistance when cold, low resistance (one fifth) when hot. NTC
- Bias stabilization.
- Prevention of surge currents through cold tube filaments.


MODEL
FR066
Globar® RESISTOR
FOR
DEGAUSS CIRCUITS
VDR
Voltage
Dependent
Resistor
used in
Automatic
Degauss
Circuits for
Color TV
For
RCA,
G.E.,
Zenith,
Magnavox,
Curtis
Mathes,
Wells
Gardner
Warwick
WORKMAN Electronic
SARASOTA FLORIDA PRODUCTS INC


MODEL
FR.49
Globar® RESISTOR
.49Ω hot
at 3 amps
FOR
RCA #942922-2
TEAR
HERE


MODEL
FR35
209X125
Globar® RESISTOR
35Ω hot - 600ma
FOR G. E.
#RRWO
TEAR
HERE
WORKMAN Electronic
SARASOTA FLORIDA PRODUCTS INC


MODEL
FR43
250 - 150
Globar® RESISTOR
5-8Ω @ 450ma
43Ω hot - 600ma
FOR CROSLEY,
SENTINEL,
ARVIN, ETC.
FR43
WORKMAN Electronic
SARASOTA FLORIDA PRODUCTS INC

Light Dependent Resistors

- Resistance value depends on light level. (Lower resistance at higher light levels)
- Fairly slow (compared to photodiodes or phototubes)
- They are non-linear resistors! Can introduce distortion.
- CdS, CdSe are typical, though there are more exotic materials as well.

Line Cord Resistors

- Some early AC-DC sets (1930's) used resistance wire in the line cord to drop the voltage for the filaments.
- The advantage was that they kept the heat out of the radio.
- But, they are fragile and frequently fail because of flexing. Also a fire hazard.
- Recommend replacing them with a capacitor! (or a diode).

Articles on Replacing Line-Cord Resistors

- http://ovrc.org/compendium/2005_1_spring.pdf
- http://ovrc.org/compendium/1999_1_spring.pdf
- http://rabjohn.ca/data/documents/Replacing-Filament-Resistors-v2.pdf
- http://rabjohn.ca/data/documents/RabjohnNomogramJPG.jpg

Ballast Tubes

- Are they tubes? Are they resistors?
- Behaves like a temperature dependent resistor.
- Resistance goes up with temperature (PTC), giving them a constant-current like characteristic.
- Used to regulate the current into a filament (despite fluctuations in supply voltage). Often had pilot lamp taps.

OVRC tube stock has some ballast tubes. Contact me if you're interested.

FAILURE MODES

In My Youth

- I had a simple technique for fixing radios: If it (anything) smoked, I replaced it.
- This approach generally works quite well for capacitors.
- This is not a good strategy for resistors. If a resistor is getting too hot, the fault is usually elsewhere.

Electrical Failure Modes

- Pretty simple: as they age, a resistor's value tends to increase. Some can go open-circuit.
- Resistors often fall victim to failures elsewhere in the radio: a shorted cap will often burn out a resistor.
- Excess current can cause the wire in a wire-wound resistor to melt.
- Heat can cause the carbon in a carbon resistor to burn.
- If the plastic around the resistor degrades because of heat, the resistor may fall apart.
- Moisture can cause resistance value changes.
- Resistors seldom drop in value.

Carbon elements are susceptible to moisture absorption and such moisture absorption can cause the resistance to change as much as 20 percent. That resistance shift can be reversed if the device is baked at high temperatures (100°C) for 92 to 100 hours.

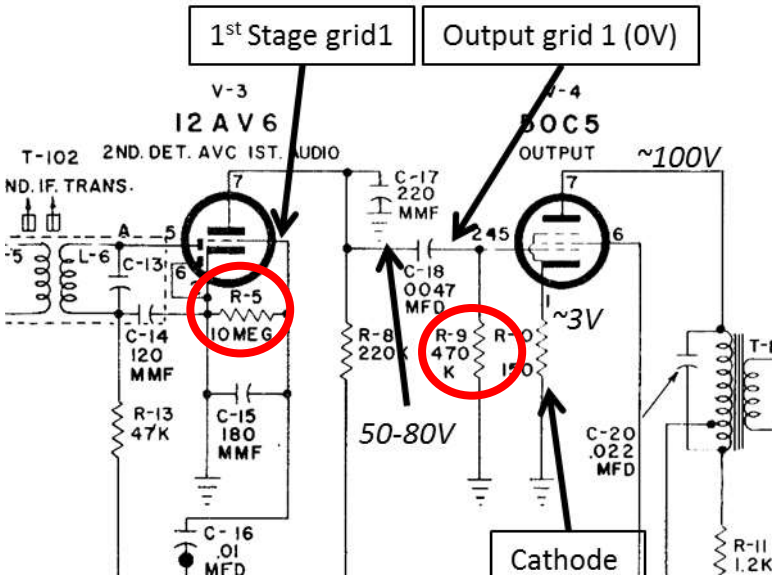
RESISTORS IN THEIR ELEMENT

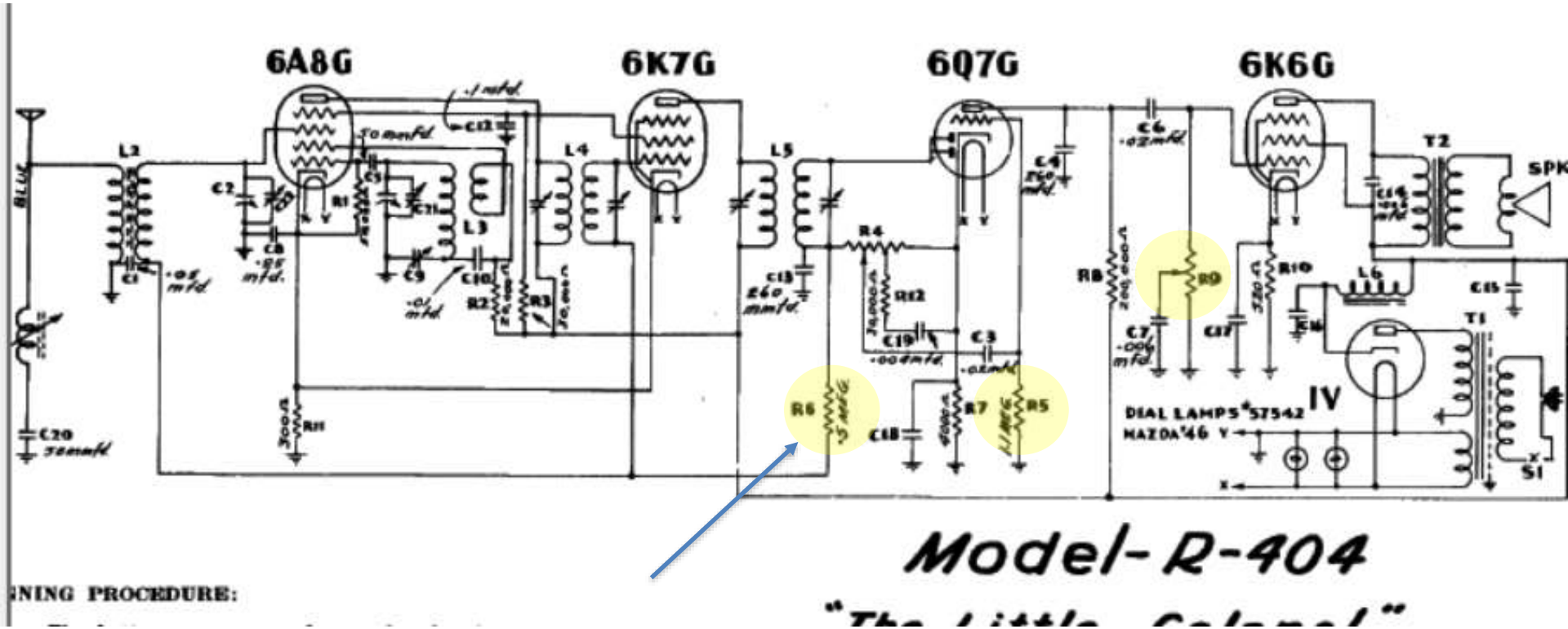
- I’ll try to answer:
  - What symptoms are caused by a bad resistor
  - What to look for in a replacement
  - How to test in-circuit
- It all depends on where the Resistor is used

- **DANGER HIGH VOLTAGE. CAN BE LETHAL.**

Grid Resistors

- Supply voltage (or set voltage) on the grid.
- High value, low power. Very low current.
- An open grid resistor will usually cause the tube to not turn on, or under-bias. Distortion, low gain.
- Value is not critical.
- Grid-leak.



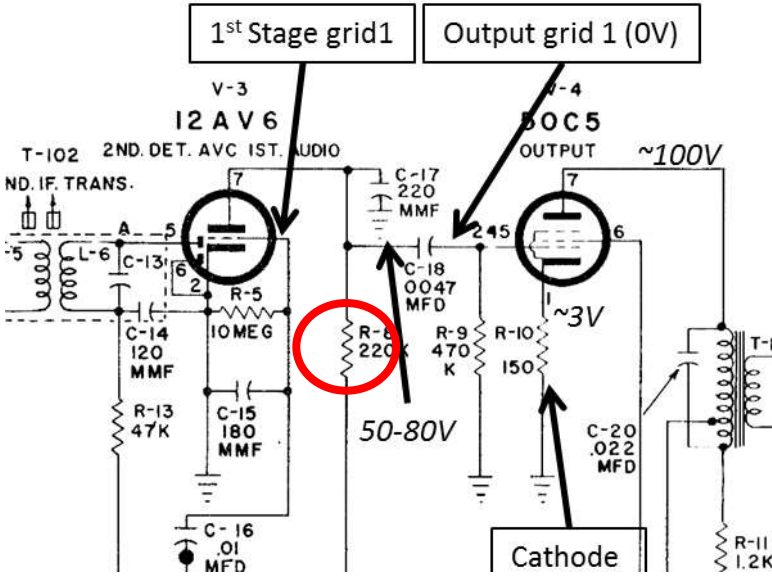


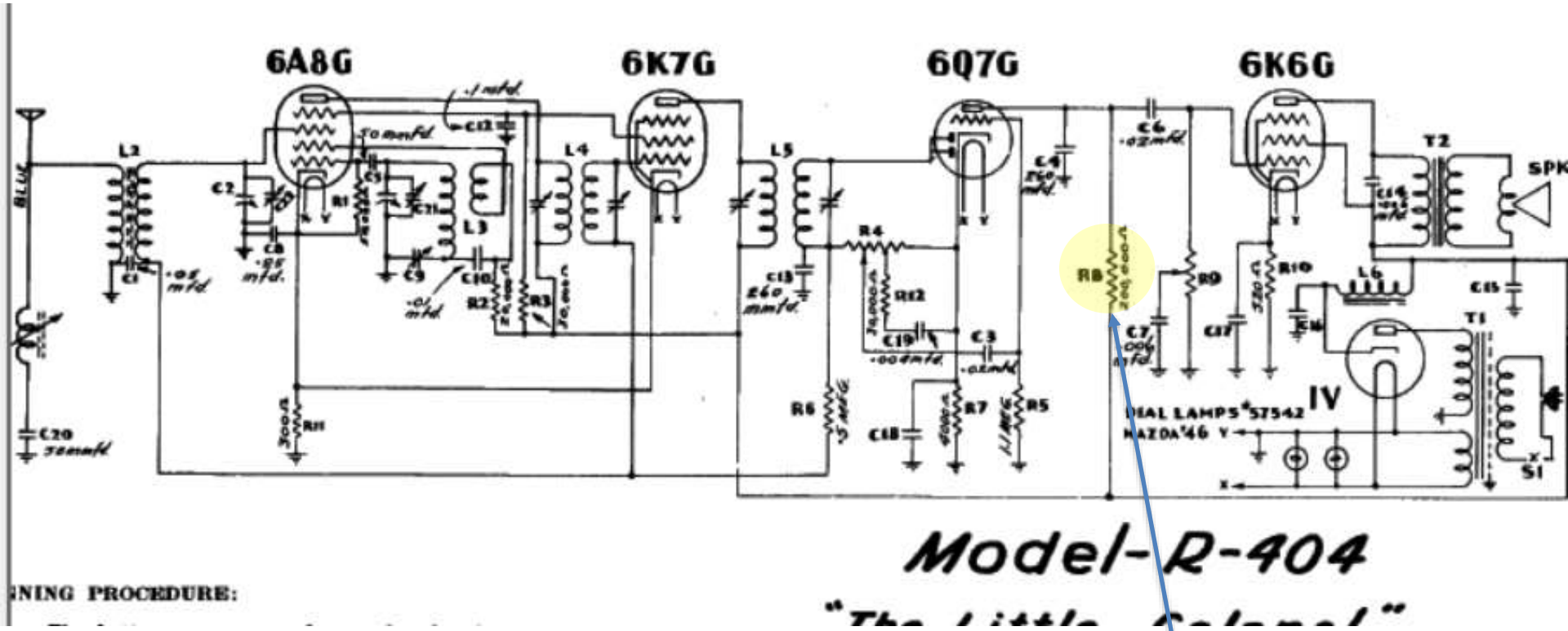
This sets the AGC speed.

These are all grid resistors

Plate Resistors

- Supplies DC to the plate of a tube.
- Too high: tube will be “starved”. Too low: gain will be low.
- Value is a little critical, best to keep it within 20%. Usually a half watt is enough, but it depends on the size of the tube.
- If it goes open, that stage will have no gain.





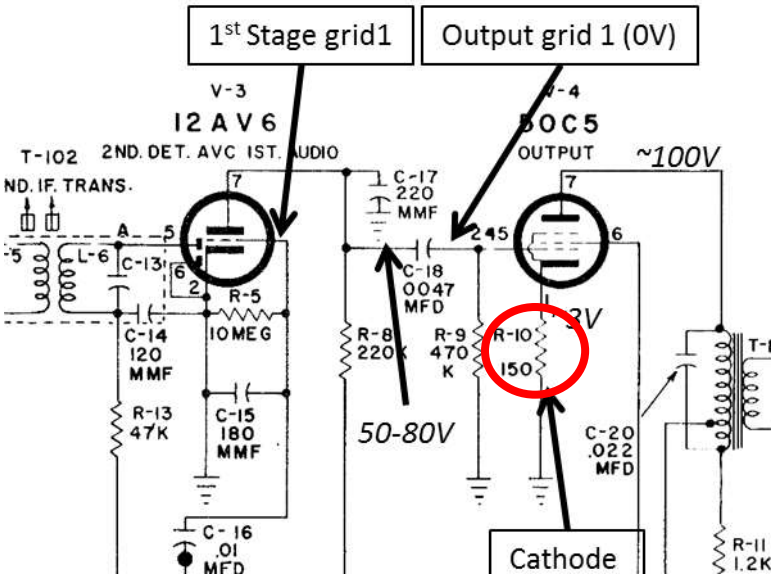
Model-R-404

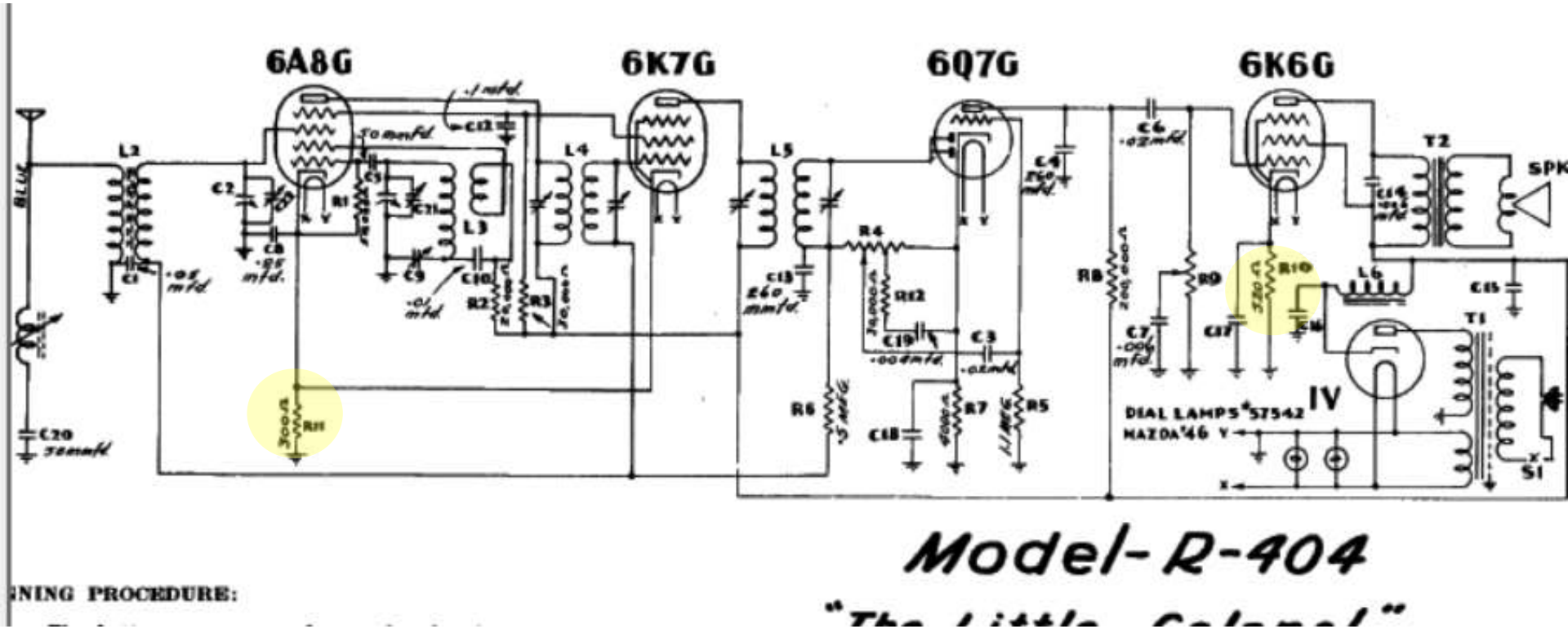
"The Little Colonel"

NING PROCEDURE:

Cathode Resistors

- They set the plate current.
- Try to keep within 10%.
- Often larger than a half watt (on an output tube). Refer to tube manual for current, then calculate power.
- If resistor is too high, plate current drops, which could cause lower gain or output distortion.





Cathode Resistors

Bleeder Resistors

- A bleeder presents a fixed load on the power supply, preventing it from going too high. Can improve regulation.
- Discharges the capacitors (eventually).
- Often a tapped power resistor that provides several voltages.
- High power resistor. Not too critical, but they help define power supply voltages, so use 20% rule of thumb.

Dropping Resistors

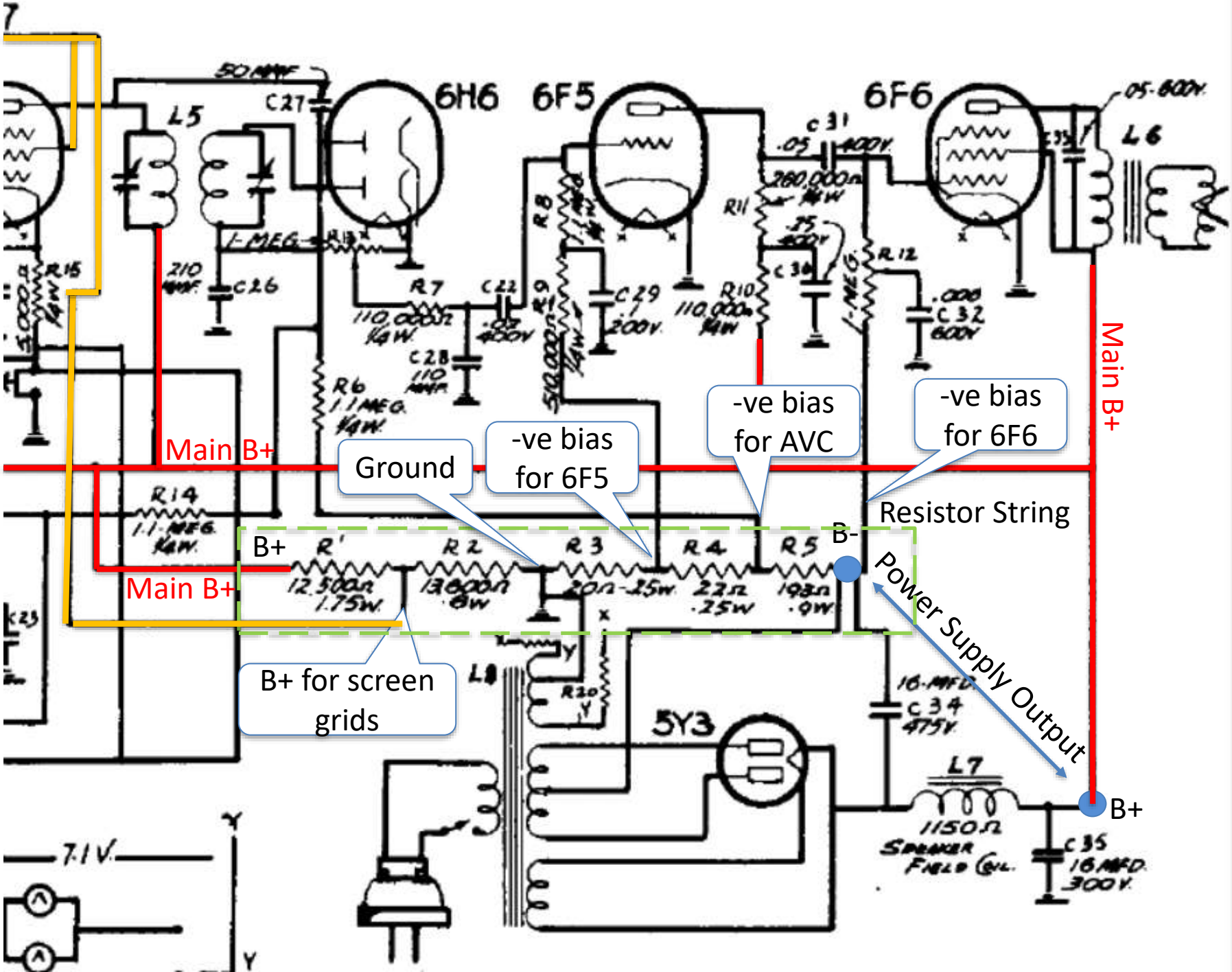
- Drop the power supply voltage for different functions in the radio (eg: lower voltages for screen grids or audio stage plates)
- With the filter capacitors, makes a low-pass filter that reduces power supply ripple (hum)
- Can also be used to generate negative(grid) voltages when placed in series with the –ve side of the power supply.
- Often a high-power resistor, stay within 20%.

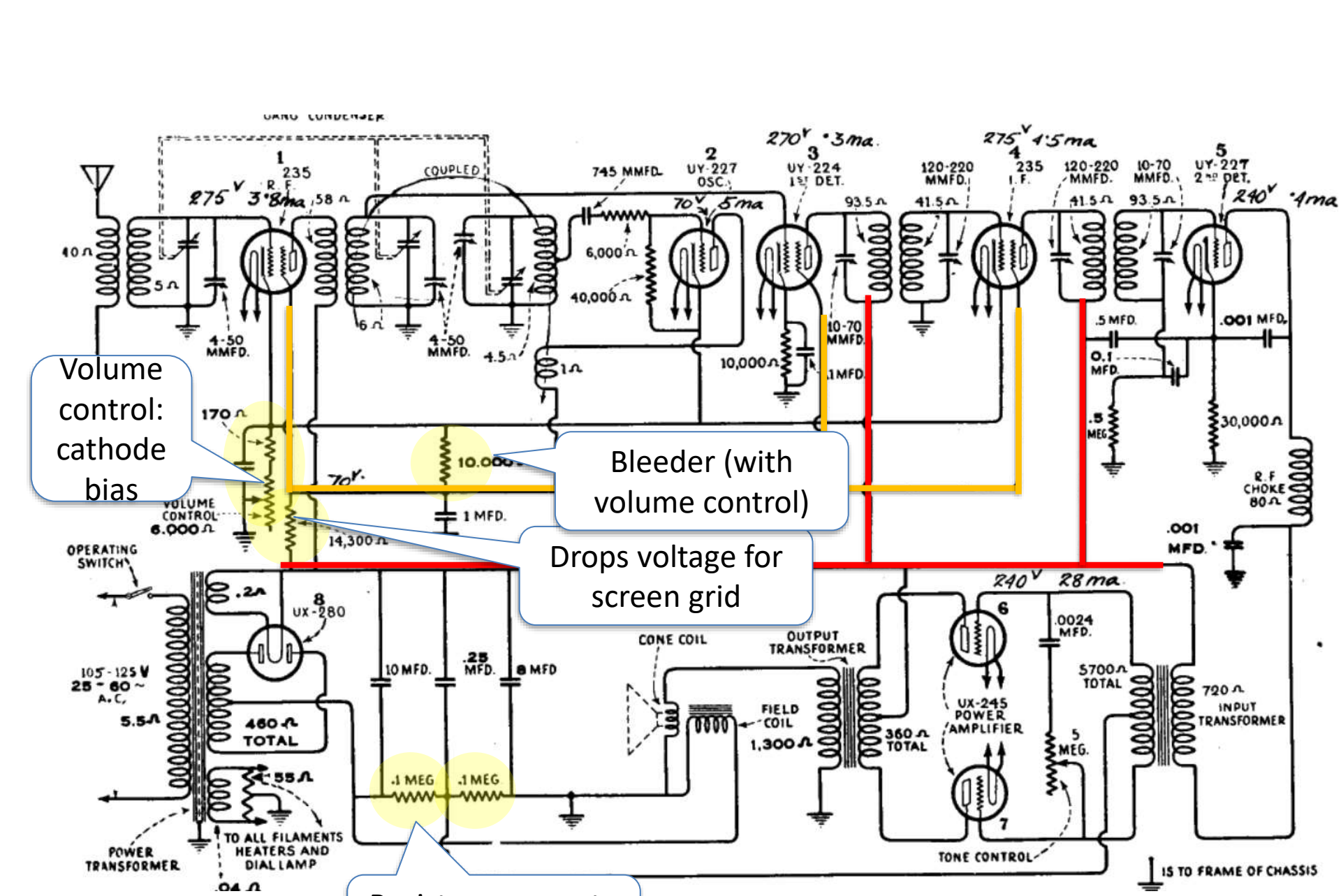
Power Supply Resistors

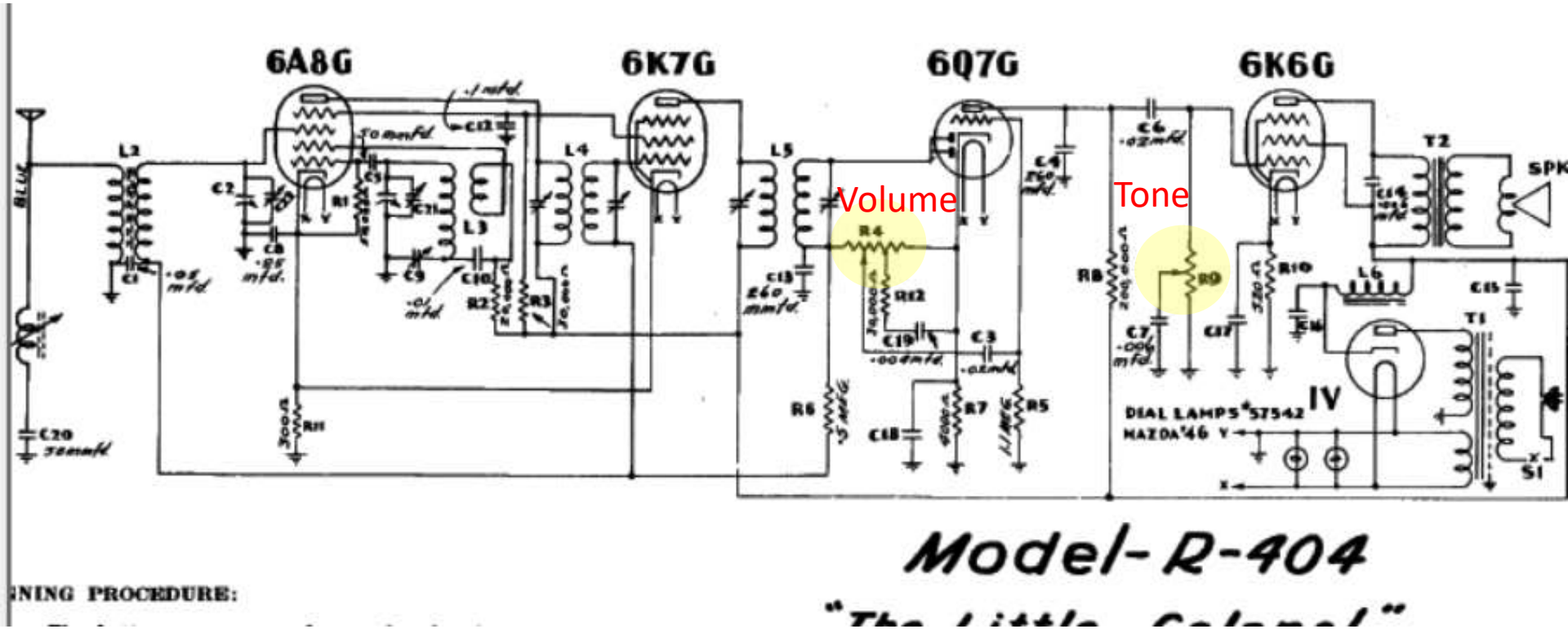
- If one is open, radio will likely appear dead.

Bleeder/Supply Dropping Resistor

- Often one resistor assembly, or could be several discrete resistors.
- A burnt-out section can be replaced with a power resistor (as has been done here).


6H6
6F5
6F6
5Y3
L5
L6
L7
L8
C27
C26
C28
C29
C31
C32
C34
C35
R1
R2
R3
R4
R5
R6
R7
R8
R10
R11
R12
R13
R14
R15
R20
Main B+
Main B+
Main B+
Ground
-ve bias for 6F5
-ve bias for AVC
-ve bias for 6F6
Resistor String
B+
B-
B+ for screen grids
Power Supply Output
7.1 V.
1150Ω
SPEAKER FIELD COIL
16 MFD. 300V.
16 MFD. 475V.


Volume control: cathode bias
Bleeder (with volume control)
Drops voltage for screen grid
Resistors generate negative voltages
275 V 3.8ma
COUPLED
745 MMFD.
70 V 5ma
270 V .3ma.
275 V 1.5ma
240 V .1ma
240 V 28ma
170 Ω
10,000
1 MFD.
14,300 Ω
VOLUME CONTROL 6,000 Ω
OPERATING SWITCH
UX-280
105-125 V 25-60 ~ A.C.
5.5 Ω
460 Ω TOTAL
55 Ω
TO ALL FILAMENTS HEATERS AND DIAL LAMP
POWER TRANSFORMER
10 MFD.
.25 MFD.
8 MFD
.1 MEG
CONE COIL
FIELD COIL 1,300 Ω
OUTPUT TRANSFORMER
360 Ω TOTAL
UX-245 POWER AMPLIFIER
.0024 MFD.
5700 Ω TOTAL
5 MEG.
TONE CONTROL
720 Ω INPUT TRANSFORMER
.5 MFD.
.001 MFD.
0.1 MFD.
.5 MEG
30,000 Ω
R.F. CHOKE 80 Ω
IS TO FRAME OF CHASSIS



Variable Resistors

Volume control may be “tapped” to provide tone contouring at low volumes.

Resistor Substitution Box

- Dial-a-resistor.
- Allows you to select any of a range of resistors.
- Like a well calibrated rheostat.

Resistors Sources

- Resistors are inexpensive and easily available from many sources.
- Gervais Electronics (on Industrial Ave) has a good selection of low and high power resistors.
- You can buy a kit of 600 quarter-watt metal film resistors (20 each of 30 values 10 ohm to 1Meg) for about $7 (Universal Solder, among others)
- Potentiometers are more difficult to procure. Tapped pots are very difficult to source.

Can you Resist?

- I do not replace all resistors “across the board”, only those that are bad.
- “Hot” resistors (power supply resistors) are the most likely to go. Best to have a selection of power resistors on hand. Values like: 100, 150, 220, 270, 330 ohm, 1K, 2K, 3K, 5K in 2- 5- or 10 watt sizes.

Will He Ever Stop Talking: Conclusions

- If you're fixing old radios or electronics, you'll encounter some dead resistors.
- Fortunately, most of the time they are not too critical and easily available ('cept pots) and easily replaceable.