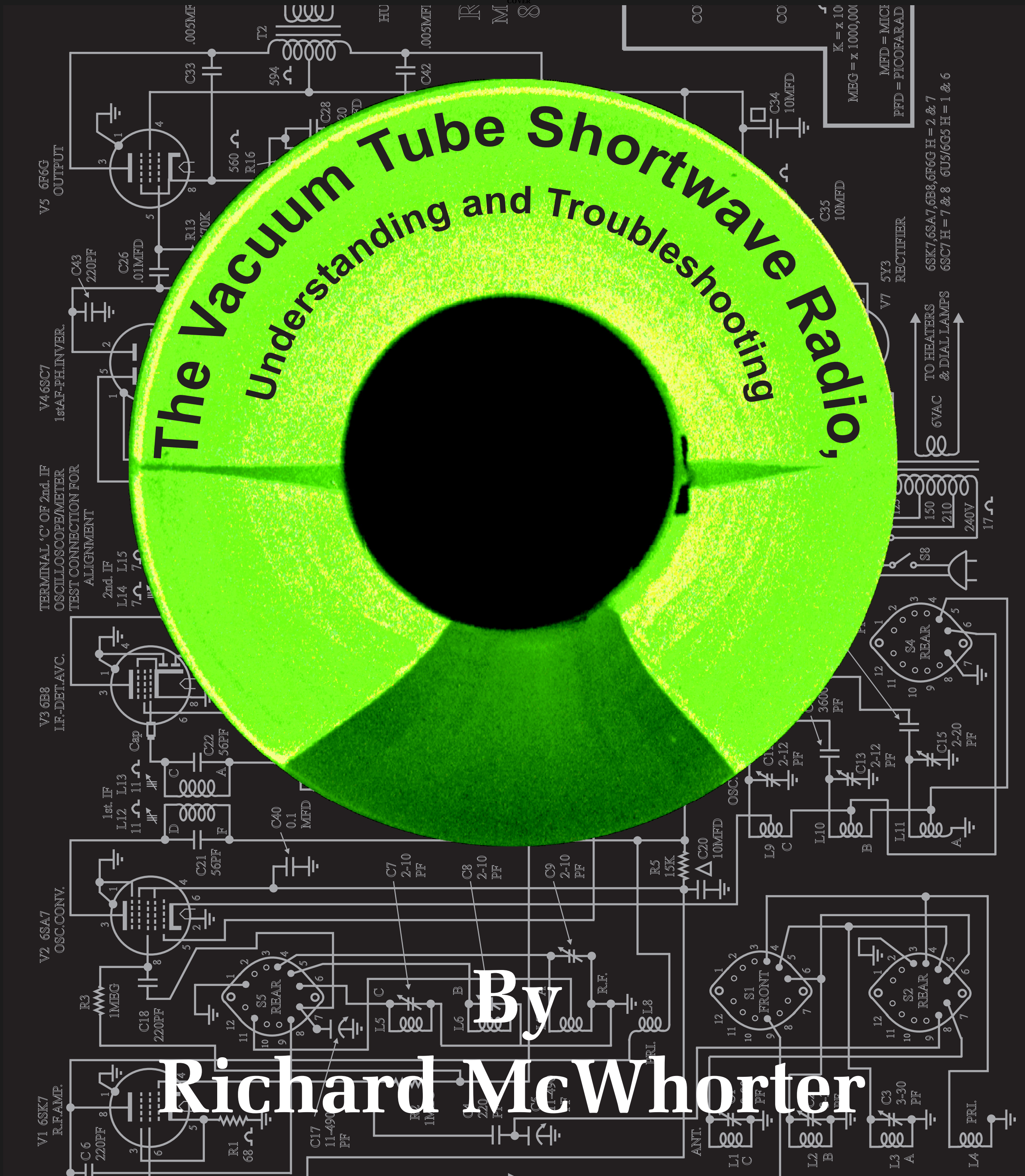
COVER
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Understanding and Troubleshooting
By
Richard McWhorter

The Vacuum Tube Shortwave Radio

Understanding and Troubleshooting

Richard McWhorter

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INTRODUCTION

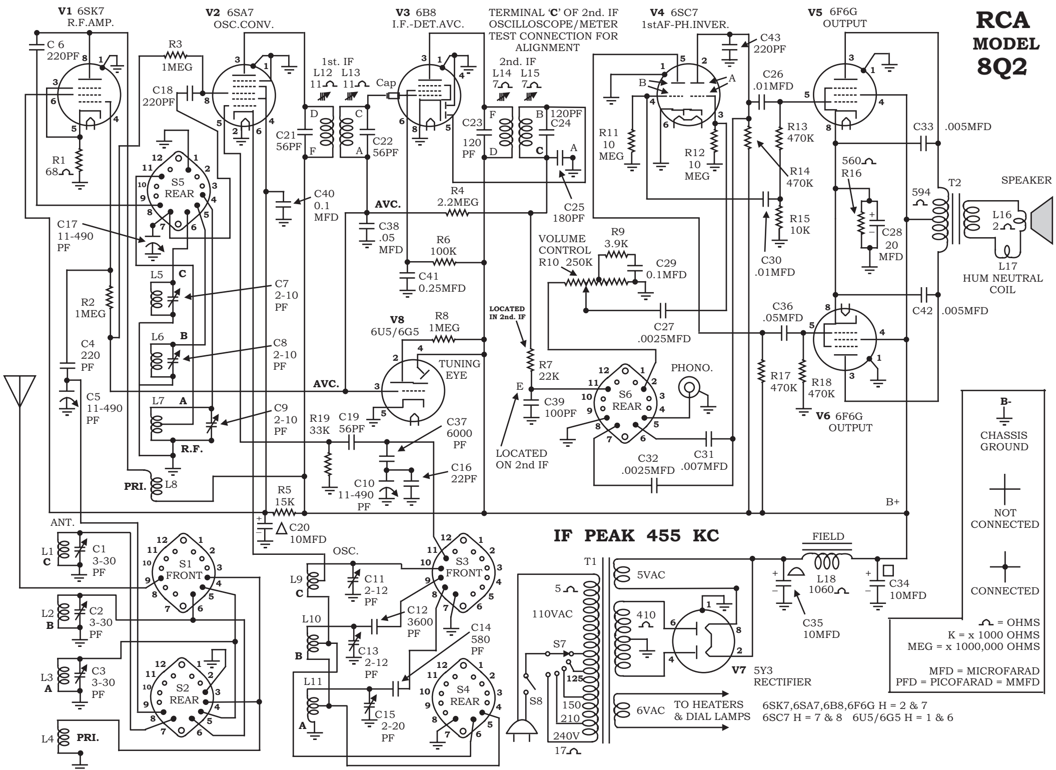
This book was written for people that have some basic knowledge of electronics and with a desire to learn about vacuum tube shortwave radio circuits. The shortwave radio used in this book is the R.C.A. model 8Q2. Some shortwave radios may have more vacuum tubes then does the 8Q2. In these radios some of the vacuum tubes perform only one function in a circuit. An example would be one tube for the oscillator circuit and another tube for the mixer circuit. Where as in the R.C.A. model 8Q2, the oscillator and mixer circuits are combined. All the vacuum tube circuits of the 8Q2 are representative of a very popular architectural design dating from the late 1930's through the early 1960's.

This book starts with the preparation and cleaning of the radio, a review of how vacuum tubes function, and then a chapter describing each circuit of the radio. The description covers the function of each circuit and the functions of all the components that make up the circuit. The remaining chapters are for repairing the radio, starting with, Continuity Testing, Part Replacement, Safety - Testing & Alignment, and Troubleshooting.

The chapter, Troubleshooting Guide, discusses several troubleshooting scenarios. These scenarios cover some of the most likely problems that may occur when repairing this type of radio (power transformer vacuum tube radio). There is a troubleshooting outline at the end of the chapter that provides the reader with an overall view of the scenarios.

The purpose of this book is to provide the reader with a practical reference circuit guide, for a large group of power transformer vacuum tube shortwave radios.

Below is the circuit wiring diagram for the R.C.A. model 8Q2.



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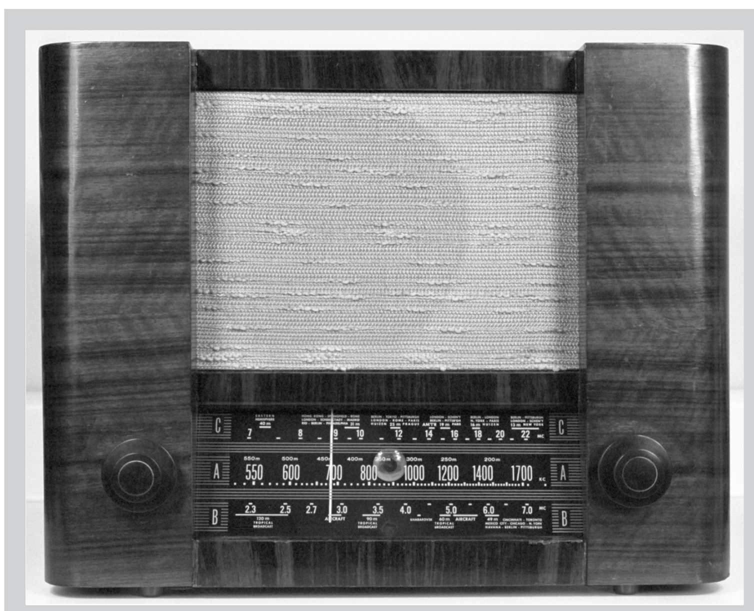
1
Shortwave Radio

The R.C.A. model 8Q2 Shortwave Radio

FIGURE 1-1 R.C.A. Shortwave Radio



The RCA Model 8Q2 pictured in Figure 1-1 is a 3 band table top radio, and its chassis is similar to that found in many console cabinet shortwave radios. The set covers the AM broadcast band, and two shortwave bands. The circuit design is representative of radio circuits found in the late 30s through the early 60s. Many of the electronic principles used in this radio are still widely used today.

Warning

Never plug an old radio into house current until it has been restored electrically. Most of the capacitors in these radios must be replaced and if power were to be applied before restoration, one or more of these capacitors could short and damage the radio. There are many steps that must be completed before it is safe to apply power to an old radio.

When it’s time to apply power to the radio for testing, tuning, or troubleshooting, please use extreme caution while working on the open chassis. Some circuits in this type of radio can develop **700 volts or more!** Working safely with power applied is discussed in Chapter - 11: Page - 103 "Safety." Until then **NO POWER** should be applied to the radio.

Triage

Cleaning

Before removing the radio chassis from its cabinet, rotate the tuning capacitors so that the fins are engaged completely. This will protect the fins from being accidentally bent when removing the chassis.

Cleaning the radio chassis is a very important step in restoration. The dirt and dust that has accumulated over the years can short out high frequency radio signals. This could stop the radio from operating or it can introduce noise into the radio circuits.

A small soft paintbrush, a vacuum, and a can of air works very well to remove dust and dirt. Take your time. Great care must be taken around parts such as coils, because they have very thin wire connections that can break easily.

It is very important that the variable tuning capacitors are cleaned thoroughly, but be careful not to bend the fins.

A thorough cleaning of the chassis will help the radio's performance and eliminate some potential problems. One example involves a repaired radio that was playing just great, when suddenly it stopped working. All of the tubes tested good. When tracing the signal through the radio, it stopped at the second I.F. transformer. There was a signal at its primary, but no signal at its secondary. This seemed to be an open I.F. coil, however, the ohmmeter showed everything to be normal. Removing the I.F. coil cover revealed an eighth of an inch of dust at the bottom of the can. After cleaning both I.F. cans the radio played great again.

Tube Testing

One of the most basic steps in repairing radios is to test the tubes. Old tube testers are still available.Good sources for old radio equipment and parts are Hamfests, collectors, antique electronic catalog stores and the internet.

Here are the results of the tube tests for this radio:

6SA7 AMP BAD, OSC GOOD.
6SC7 TRIODE 1 GOOD, TRIODE 2 BAD.
6SK7 GOOD.
6B8 TRIODE GOOD, DIODE 1 GOOD, DIODE 2 GOOD.
6U5 BAD.
5Y3 PLATE 1 GOOD, PLATE 2 GOOD.

The 6F6 tubes used in this radio are not listed because someone had substituted them with 6L6 tubes. Both 6L6s were replaced with new 6F6s.

Replace all the bad tubes with new tubes, and before installing any tube into the radio re-test the tube. Refer to Figure A-2 for the tube location on this chassis.

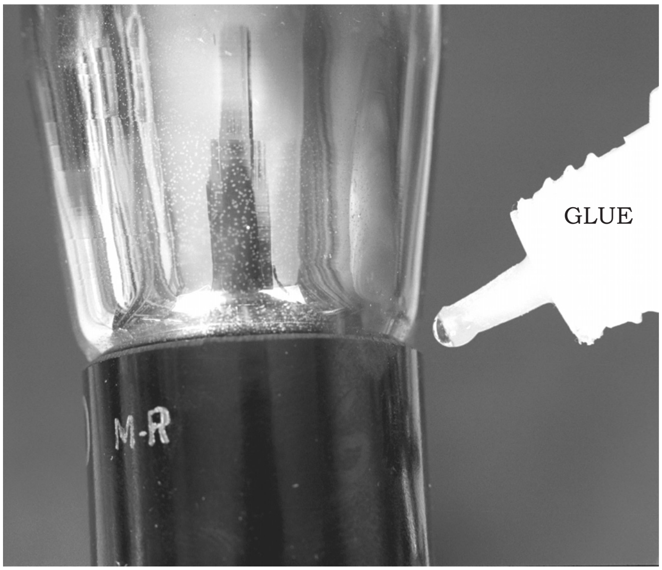


FIGURE 1-2 Loose Tube Base

If a loose tube base is found, one drop of instant glue on either side of the tube base restores the base to the glass as shown in Figure 1-2.

Just before installing a tube in a tube socket, clean the tube pins with WD-40® and wipe off the excess.

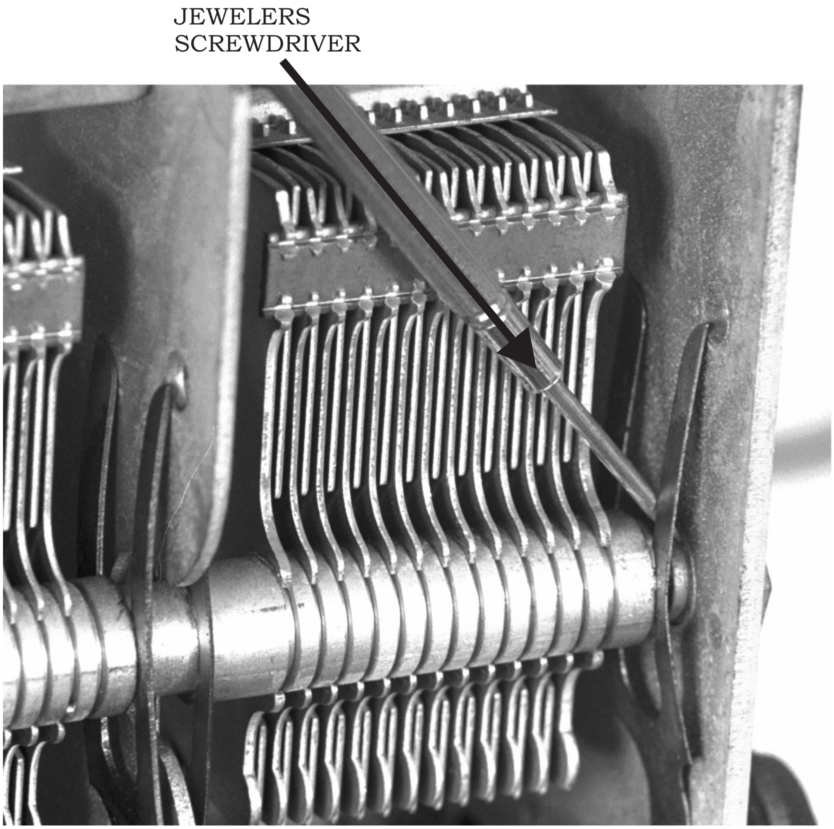
Moveable Parts to Lubricate

Avoid using too much lubrication. These compounds can migrate beyond the area of application and, in some cases, they may interact and degrade materials such as dial cords.

Lubricate all shafts for the volume control, the tone control, the tuning and the variable capacitor. Each shaft should be lubricated with a small amount of oil. Delivering just one or two drops to each of these areas can be a problem. One technique that works very well for me is to use a small common screwdriver, such as a jeweler's screwdriver. Place a drop of oil (or less) on the blade of the screw-driver. The oil can be easily guided to the point where the shaft rotates in the sleeve. When contact is made, capillary action will transfer the oil.

Variable Capacitors

FIGURE 1-3 Oiling the Variable Capacitor Shaft



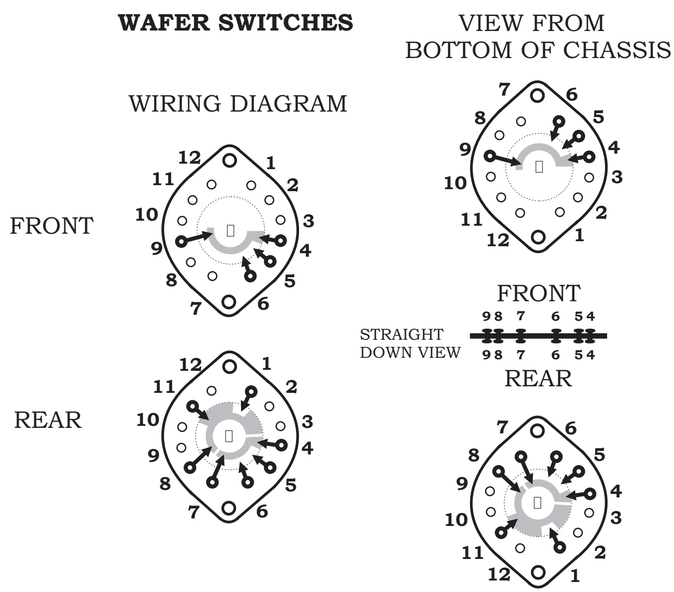
This screwdriver technique is shown in Figure 1-3, oiling the variable capacitor shaft. This technique maybe repeated as necessary.

Wafer switches, tone and volume controls

Wafer Switches are very common in these radios. Great care must be taken while working with them, because the insulating material is thin and brittle. This radio has six wafer switches, S1 through S6. S1, S2 and S3, S4 are double sided wafers and their construction is shown in Figure 1-4.

The wiring diagram shows the orientation of the wafers as they appear in the complete wiring diagram of Figure A-1. The bottom view is when the chassis is upside-down on the bench.

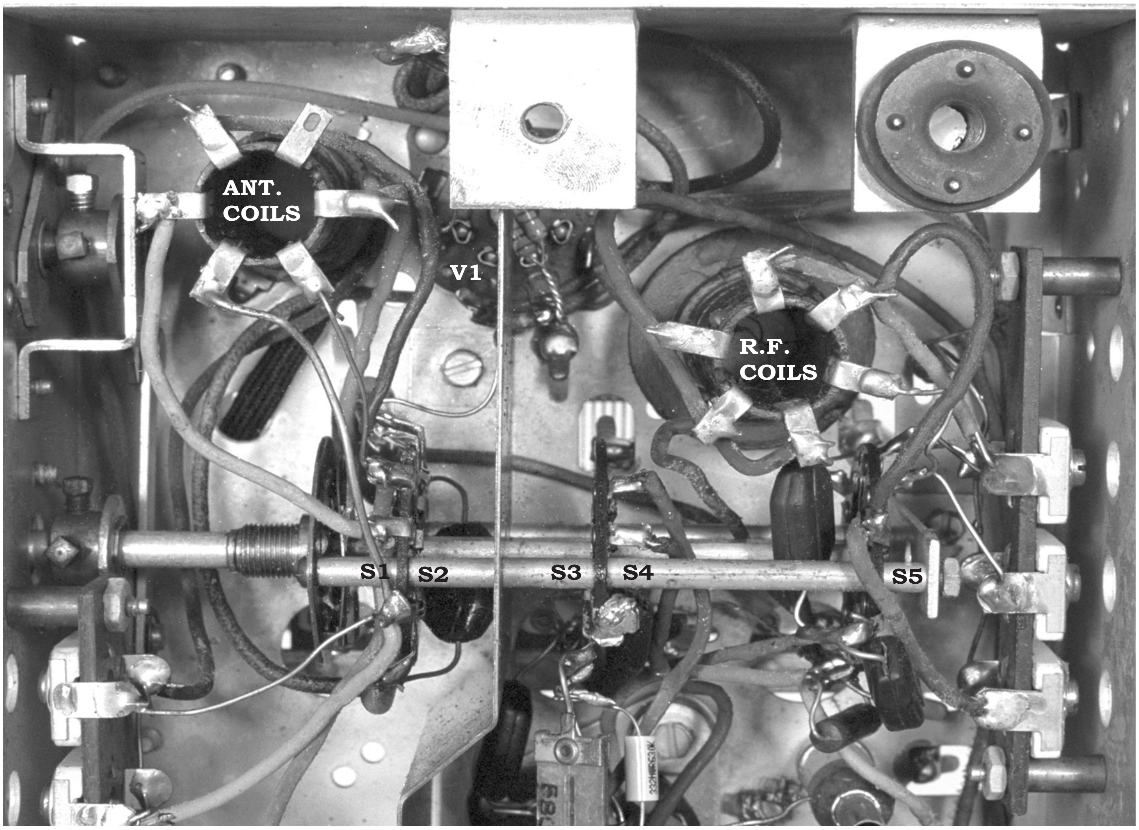
FIGURE 1-4 Wafer Switch



S1, S2, S3, S4, and S5 are all ganged together with a shaft that turns them simultaneously. S1 and S2 switches the antenna coils while S3 and S4 switches the oscillator coils, and S5 switches the R.F. coils. This entire complex is called the band switch.

Wafer switch S6 is the radio / phonograph switch and the tone control switch.

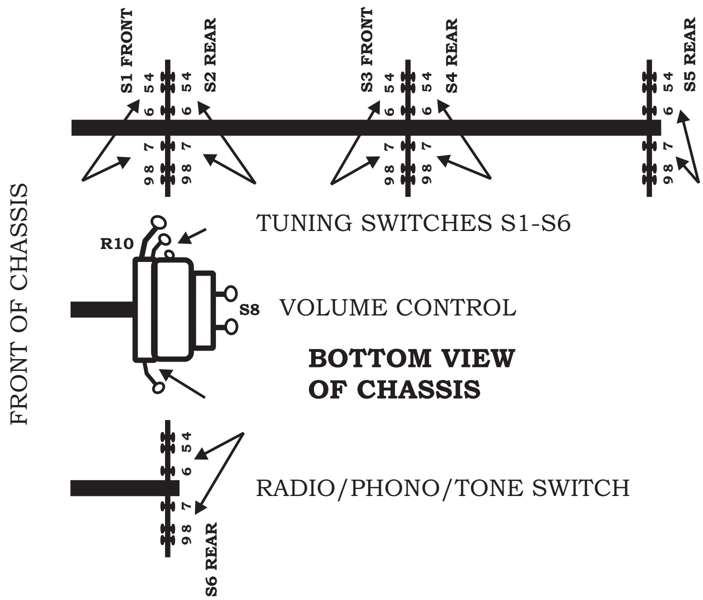
FIGURE 1-5 Band Switch



The band switch is pictured in Figure 1-5. Refer to Figure A-4 for the complete drawing of the chassis bottom view and to Figure A-15 for a picture of the entire bottom view.

All of the wafer switches and the volume control should be cleaned with a small soft brush and then lubricated. Over the years these parts have lost oils and have become dirty. A short spritz of WD-40® does wonders.

FIGURE 1-6 Lubricating Wafer Switches and the Volume Control



It is very important to avoid over lubrication and to only lubricate the intended item.

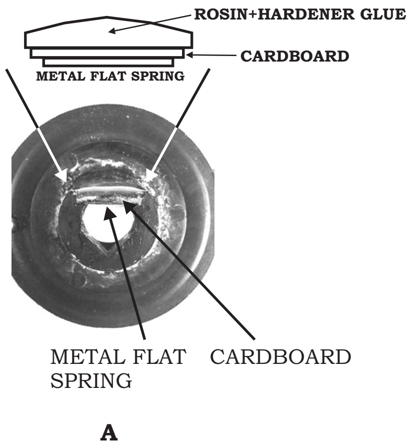
Figure 1-6 shows the tuning switches, the volume control R10, and the radio/phono/tone control switch. The arrows indicate the parts to be lubricated. Use the plastic tube on the spray nozzle of the WD-40® can, to give good control of the spray. If more control is needed, spray the WD-40® liquid in a small container and then use a cotton swab to apply the liquid.

WD-40® is a good product to clean and lubricate all the contacts of S1-S6, the carbon resistor inside the volume control and the wiper tap. It replaces the oils that were lost over the years, and as a result it helps the insulating material to return to its original shape.

Knobs

The 8Q2 radio had a knob with the flat part broken out and missing. This is not uncommon and the repair for this knob is shown in Figure 1-7.

FIGURE 1-7 Knob Repair



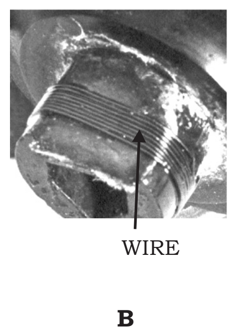


Figure 1-7 part A shows the three layers of the repair. The bottom layer is the flat metal spring that holds the knob tight to the shaft. The next layer up is a thin, cut to fit, piece of cardboard. The cardboard prevents the flat spring from being glued to the knob. The top layer is filled with a quick setting epoxy glue. The knob is placed in a small vice and positioned so that gravity holds the glue in place until it hardens.

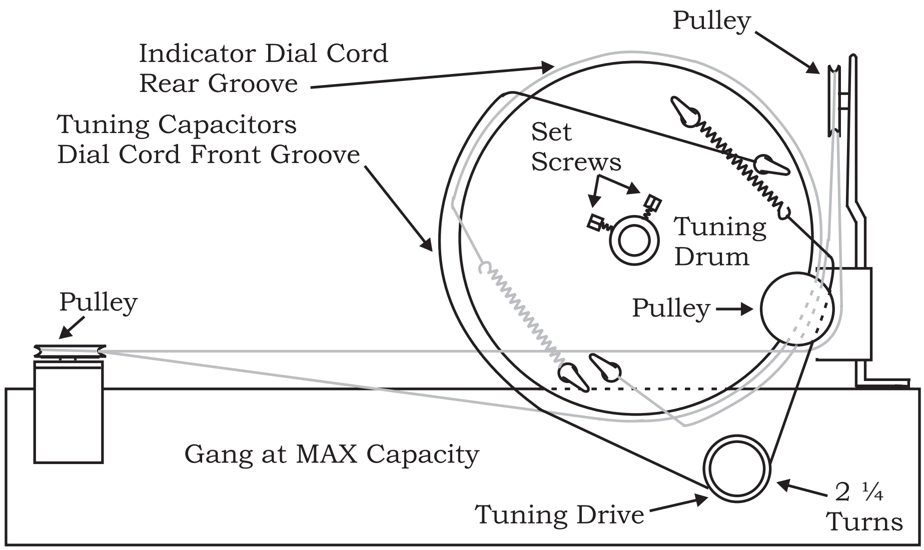
Figure 1-7 part B shows the knob after the glue has hardened. A small gauge wire is wrapped around the knob shaft. The wire is then attached to the shaft with instant glue.

Figure 1-7 part C shows the knob repaired. Black electrical tape is wrapped over the wire and glue, making the last layer around the knob shaft.

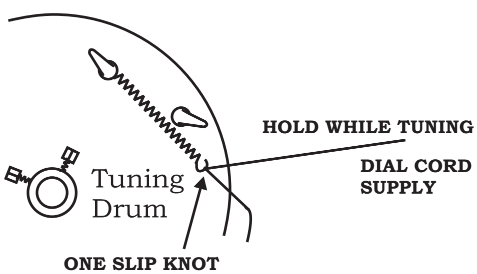
Dial Cord

Figure 1-8 shows the dial cord assemblies for this radio and manufacturer's information on stringing the dial cord.

FIGURE 1-8 Dial Cord



DRIVE CORD ASSEMBLE



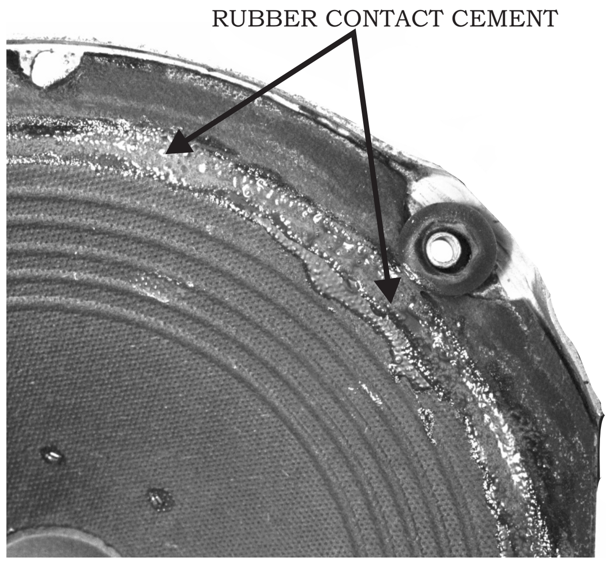
AFTER ADJUSTING THE DIAL CORD TENSION, GLUE THE KNOT WITH A DROP OF INSTANT GLUE.

FIGURE 1-9 Adjusting Dial Cord

After re-stringing the dial cord, the tension must be adjusted to ensure that the radio will tune properly. While holding the dial cord as shown in Figure 1-9, turn the tuning dial and adjust the slip knot for tension. When the radio tunes properly apply one drop of instant glue to the slipknot. When the glue has dried, the last step is to cut off the excess dial cord supply.

Speaker Repair

FIGURE 1-10 Speaker Cone Repair

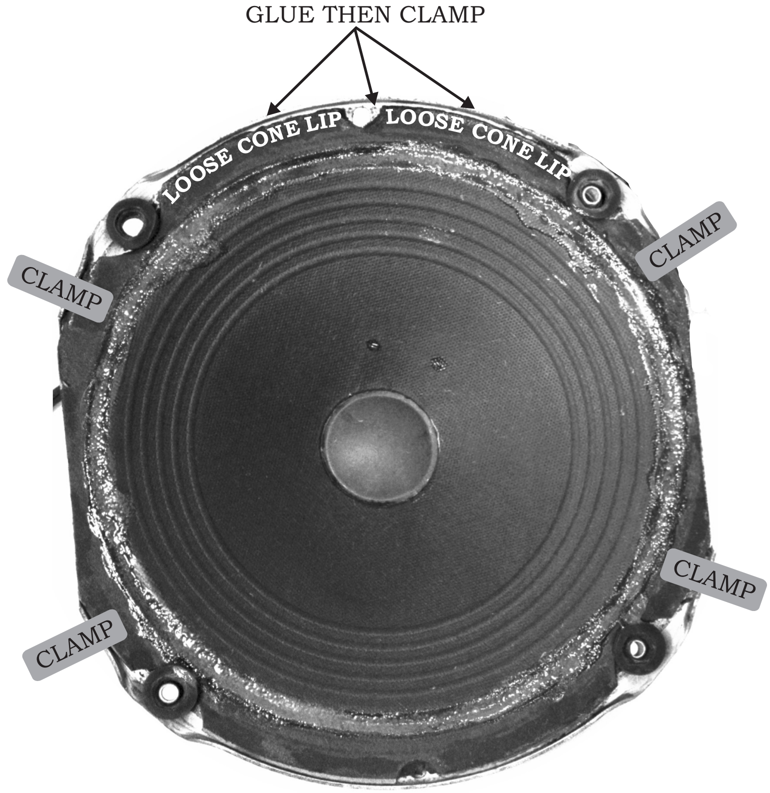


The speaker in the 8Q2 radio was in reasonably good shape. There were no big holes in the cone and it was in one piece. The corrugated ridges around the speaker, however, had several small holes and there were signs of vibration fatigue.

Placing the speaker so that the concave side is pointing straight up, apply a thin coat of a rubber cement around the corrugated ridges. The rubber cement will soak through the cone material, impregnating it, as shown in Figure 1-10. When this coat is completely dry, apply another thin coat if needed, and let dry.

The rubber cement does not look pretty, but it strengthens the corrugated ridges and will extend the life of the speaker for many years.

FIGURE 1-11 Speaker with a Loose Cone



The glue holding the speaker cone (lip) to the speaker shell had dried out. This causes annoying vibrating noises. Clamp the speaker cone in four places as shown in Figure 1-11. Then check the voice coil movement by gently pushing on the center of the cone to make sure that it does not rub. Glue and clamped (using two more clamps) the loose cone lip to the speaker shell. When the glue has dried, repeat these steps until the entire circumference of the cone has been glued.

If the speaker requires more than these simple repairs, send it to a antique speaker repair shop. These repair shops can be found in antique radio magazines and on the internet.

2
Vacuum Tubes

Vacuum Tubes

The 8Q2 RCA radio uses several types of vacuum tubes. The Diode (rectifier) is used in the Power Supply circuit. The Triode is used in the Inverter circuit. The Pentode is used in the Audio Output circuit and the R.F. Amplifier circuit. The Pentagrid Converter is used in the Oscillator Mixer Converter circuit.

It is very important to understand the function of each tube type.

This knowledge is key to understanding the function of a tube circuit, and how to troubleshoot it.

Diode

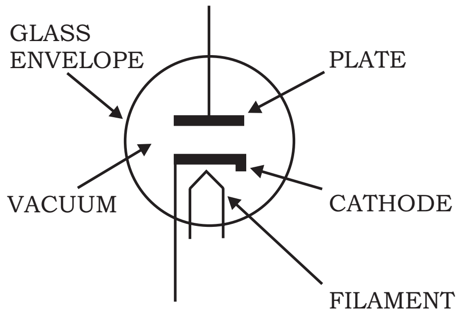


FIGURE 2-1 Diode

The schematic diagram for the tube type diode is shown in Figure 2-1. This tube has three parts, the filament, the cathode, and the plate. The filament heats the cathode causing it to emit electrons. The plate collects the electrons. The two active elements are the cathode and the plate.

FIGURE 2-2 Diode Construction

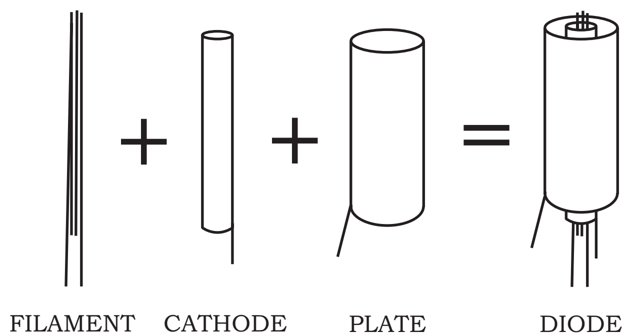


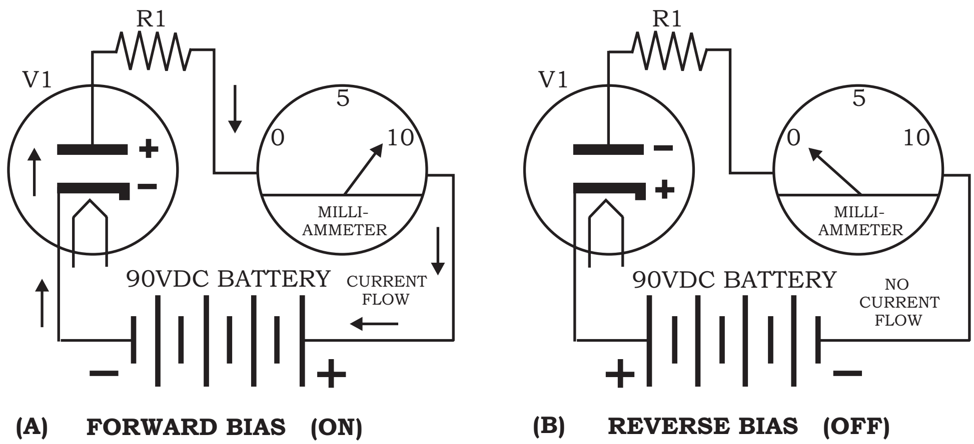
Figure 2-2 shows the construction of the diode (rectifier) tube. The filament is placed inside the cathode and then both are placed inside the plate. All three parts are housed in a glass envelope that is mounted on a base with the external connection pins.

The rectifier tube in the 8Q2 is the 5Y3. It has two diodes in one glass envelope. The 5Y3 does not have a cathode because in this tube the filament emits the electrons.

Refer to Figure A-3 for the Tube Socket Pin Count and refer to Figure A-12 for the Tube Base Diagram of the 5Y3.

Diode Function

FIGURE 2-3 Diode Function



The circuits in Figure 2-3 shows how the diode vacuum tube functions. The filament is connected to the filament voltage supply (not shown). Its function is to heat the cathode so the tube can function. In part (A) the negative side of the 90-volt battery is connected to the cathode. The positive side is connected to the plate through the milli-ammeter and resistor R1. This makes the cathode negative and the plate positive and is the only time that current can flow through the rectifier tube. This is shown in part (A) and is known as forward biasing.

Part (B) shows the positive side of the 90-volt battery connected to the cathode and the negative side connected to the plate. This makes the cathode positive and the plate negative. With this configuration no current can flow through the rectifier tube. This is shown in part (B) and is known as reverse biasing.

Electron-Ray Indicator Eye Tube

For a detailed description refer to Chapter - 6: Page - 63 "Eye Tube."

Triode

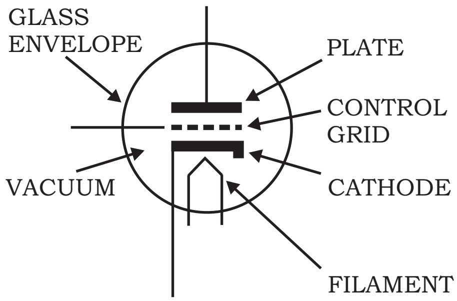
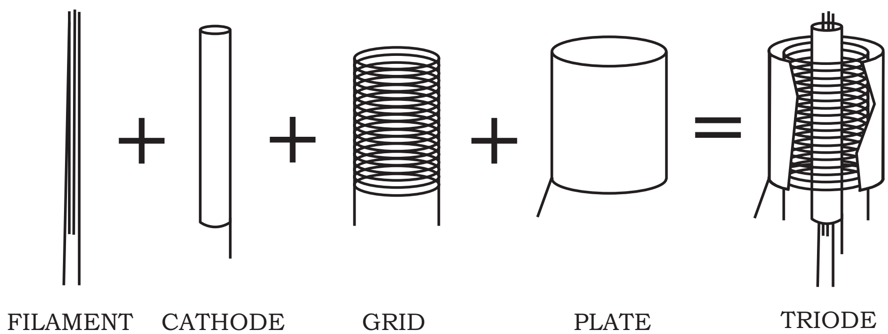


FIGURE 2-4 Triode

The schematic diagram for the triode tube type is shown in Figure 2-4. This tube has four parts: the filament, the cathode, the control grid, and the plate. The filament heats the cathode and the cathode emits the electrons. The control grid controls the electron flow from the cathode to the plate. The plate collects the electrons. The three active elements are the cathode, control grid, and the plate.

FIGURE 2-5 Triode Construction



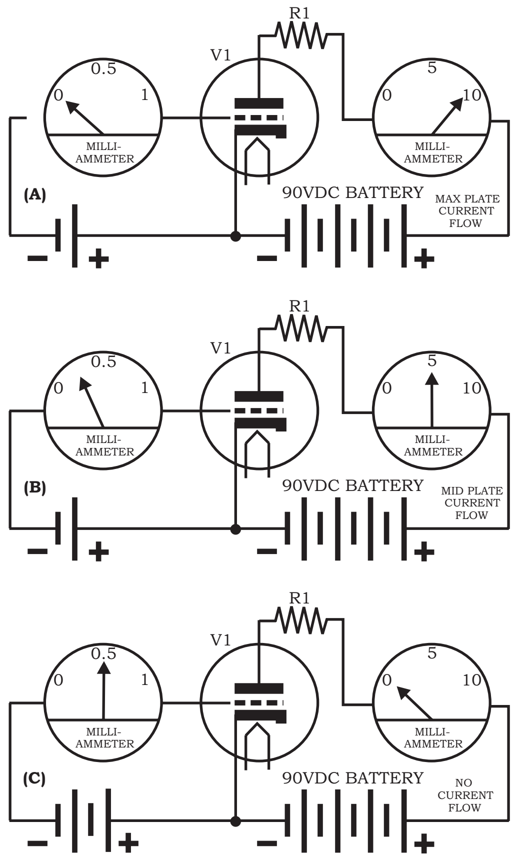
The construction of the triode is shown in Figure 2-5. The filament is placed inside the cathode and both are place inside the grid. Then all three are placed inside the plate completing the Triode.

The triode tube in the 8Q2 radio is the 6SC7. It is a dual triode having two triodes in one glass envelope.

Refer to Figure A-3 for the Tube Socket Pin Count and refer to Figure A-12 for the Tube Base Diagram of the 6SC7.

Triode Function

FIGURE 2-6 Triode Function



The function of a triode (V1) is shown in Figure 2-6. Part (A) shows no current flow through the control grid and the maximum current from the cathode to the plate is 10 milliamperes. When the grid bias battery is connected to the control grid as shown in part (B), it produces a small current through the control grid. The control grid current also produces a negative field around the control grid, reducing the electron flow from the cathode to the plate. The current from the cathode to the plate is now reduced to 5.0 milliamperes. In part (C) another control grid bias battery has been added. This increases the current flow through the control grid and also increases the negative field around the control grid blocking all electron flow from the cathode to the plate. This results in no current flow from the cathode to the plate (0.0 milliamperes).

The three parts of Figure 2-6 show the amplification process of the vacuum tube. A very small change of the control grid current produces a very large change in the current flow from the cathode to the plate.

Pentode

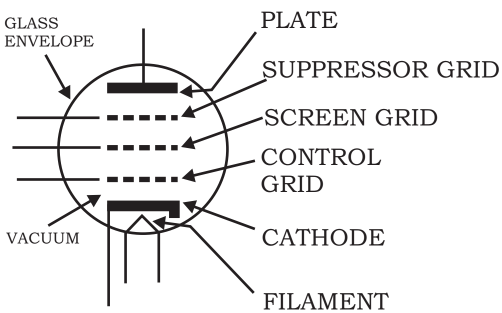


FIGURE 2-7 Pentode

The pentode has six parts. The filament, cathode, control grid, and the plate function in the same way as in the Triode. The suppressor grid is held negative and any electrons that bounces off the plate, are repelled by the suppressor grid back to the plate increasing the total current. The screen grid is held positive, decreasing the capacitances of the tube elements. Which then increases the frequency characteristics of the tube (6SK7, 6B8, 6F6).

Pentagrid Converter

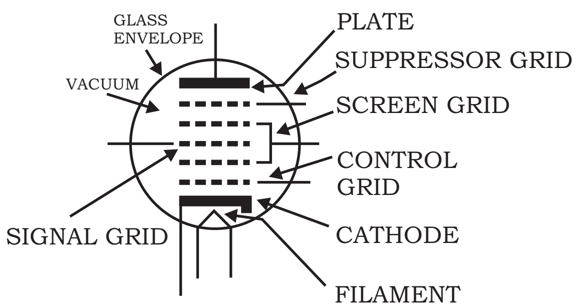


FIGURE 2-8 Pentagrid Converter

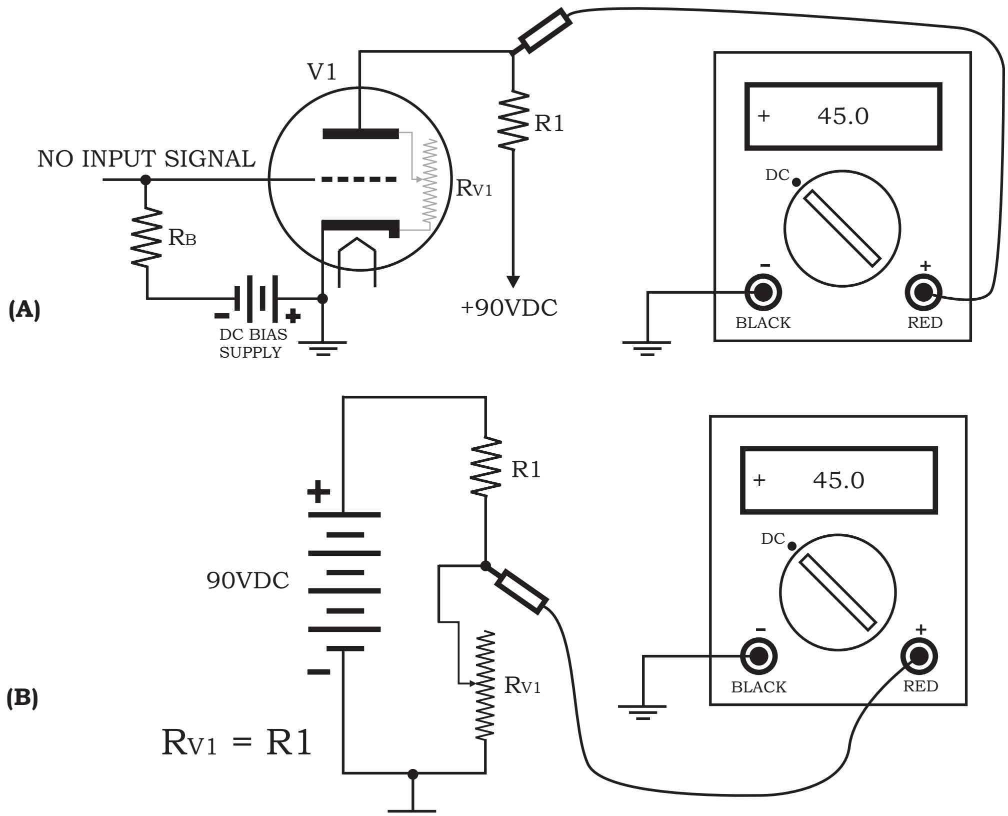
The pentagrid Converter has seven parts. The filament, cathode, control grid, screen grid, suppressor grid, and the plate function in the same way as in the pentode. The signal grid is between the screen grids. The signal grid is the radio frequency input to be mixed with the local oscillator on the control grid. These two signals mixing together create the intermediate frequency. Refer to Figure A-12 (6SA7).

Tube Biasing

The electrical force applied to a vacuum tube, for the purpose of establishing an electrical reference level for the operation of the device.

Class A Biasing

FIGURE 2-9 Class A Bias



The triode in Figure 2-9 part (A) is grid biased Class ‘A’. The control grid is held at a potential that makes the internal resistance of V1 equal to R1. The source of this potential is the DC bias supply and the bias resistor R_B. The tube’s internal resistance is shown as the variable resistor R_{V1}. The result is that the plate of V1 reads 45 VDC, one half of the B+ (90VDC). The equivalent voltage divider circuit is shown in Figure 2-9 part (B).

FIGURE 2-10 Class A with Signal

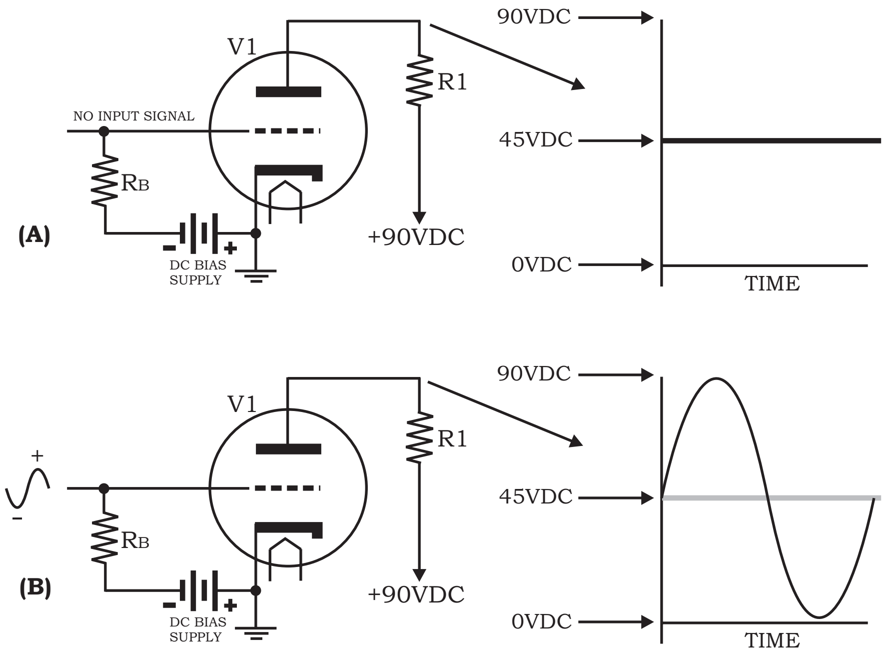


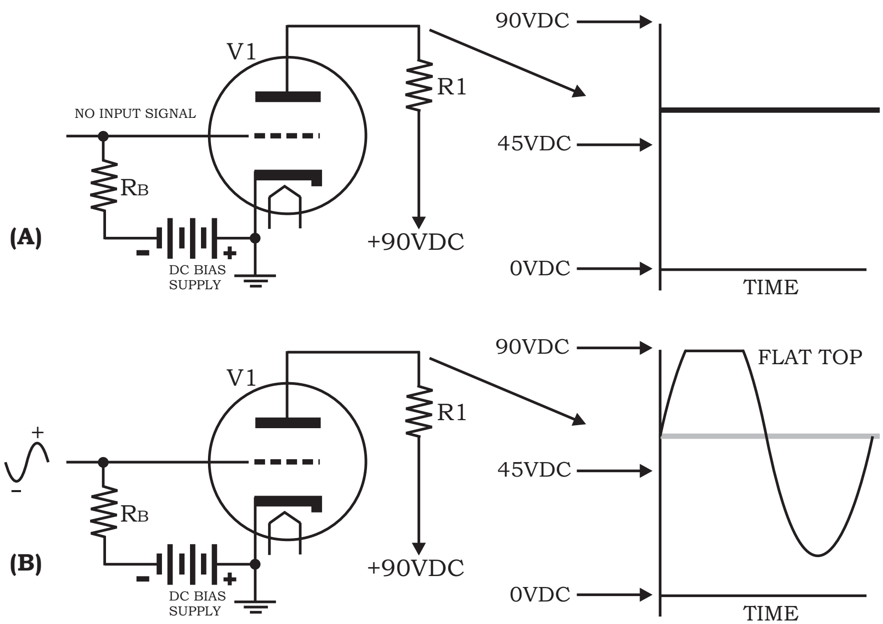
Figure 2-10 part (A) shows a graph of the output of V1 (voltage and time) with no input signal on the control grid. The output of V1 is a straight line at the 45VDC level. With a small sine wave signal applied to the control grid, as shown in part (B), the output is an amplified sine wave 180 degrees out phase with the input.

As the small sine wave signal makes the control grid more negative, V1 conducts less, thereby increasing the internal resistance of V1. This increases the voltage drop across V1, (plate to ground) increasing the voltage at the plate.

As the small sine wave signal makes the control grid more positive, V1 conducts more and decreases the internal resistance of V1. This decreases the voltage drop across V1, (plate to ground) decreasing the voltage at its plate.

The output increases to almost +90VDC and then decreases to almost 0VDC, a nice clean output.

FIGURE 2-11 Bias to Negative



If the biasing should become faulty, the output will be distorted. In Figure 2-11 something in the bias circuit has caused the negative bias supply to become too negative. This causes V1 to conduct less, increasing the voltage drop across V1 as shown in part (A). The graph shows the plate voltage above 45VDC.

When a signal is applied to the control grid and the signal becomes more negative, it cuts off V1 completely, causing a flat top distorted signal at its output (plate). The input signal is trying to drive V1 beyond the B+ power source. The result is a very distorted amplified signal, as shown graphically in Figure 2-11 part (B).

FIGURE 2-12 Bias Not Negative Enough

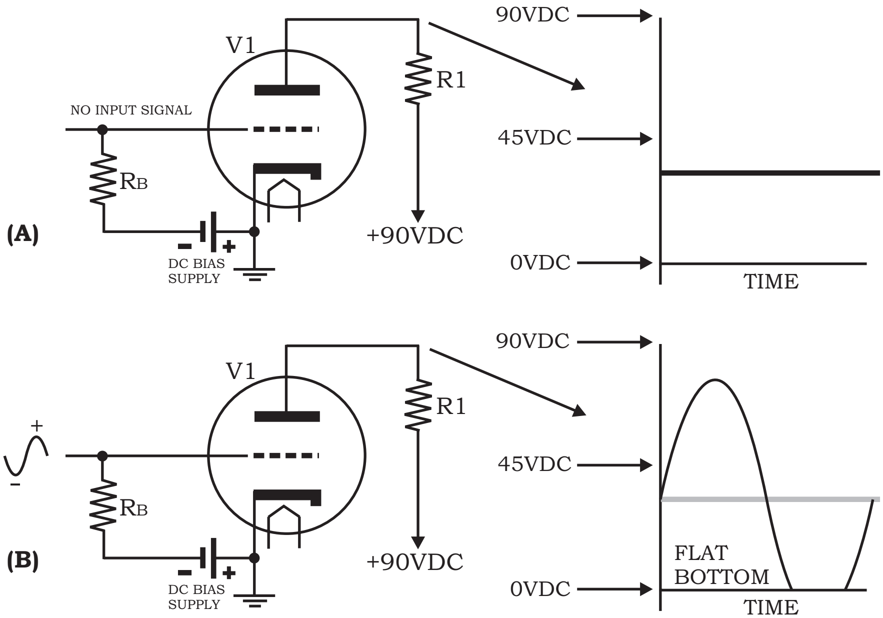


Figure 2-12 shows V1 when something in the bias circuit has caused the bias supply to become less negative. This causes V1 to conduct more, lowering the voltage drop across V1 as shown in part (A). The graph shows V1's plate voltage to be less than 45VDC.

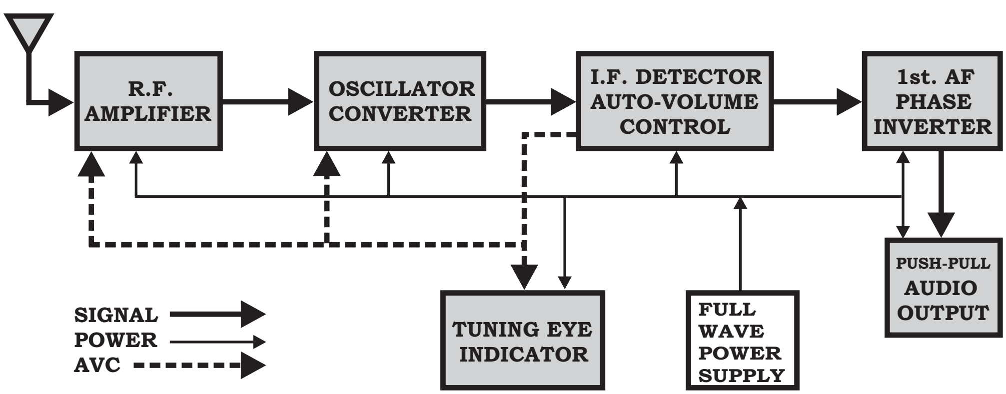
When a signal is applied to the control grid of V1 and the signal is going more positive, V1 goes into saturation (all the way ON). This causes a flat bottom as shown in Figure 2-12 part (B). The input signal is trying to drive V1 below 0VDC. This also causes distortion of the amplified signal.

3
Power Supply

Full-Wave Rectifier Power Supply

The power supply, furnishes the Direct Current (DC) to each section of the radio, and it is highlighted in Figure 3-1.

FIGURE 3-1 Full-Wave Rectifier Power Supply

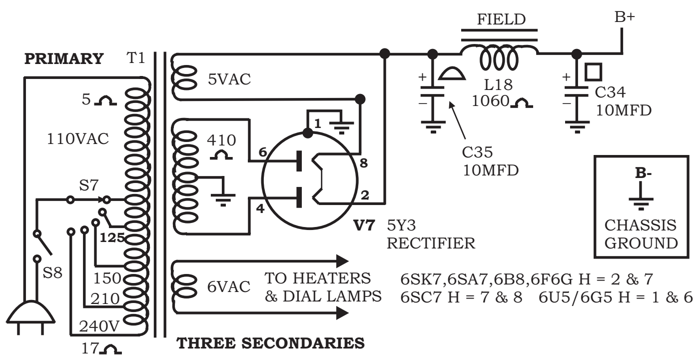


The AUDIO OUTPUT, I.F.-DET.AVC., OSC.CONV, TUNING EYE, and R.F.AMP. each receive about 270VDC, and the 1st.AF-PH.INV. receives about 62VDC. In most radios of this type the power supply uses a full-wave rectifier. This means that both halves of the Alternating Current (AC) sine wave (360 degrees) are utilized to produce the Direct Current (DC).

Why full-wave rectification?

Because of the number of tubes and circuits in a shortwave radio, a more robust power supply is needed. The full-wave power supply satisfies this need. The wiring diagram for the 8Q2 is shown in Figure 3-2. For the complete wiring diagram of this radio refer to Figure A-1.

FIGURE 3-2 Full-Wave Rectifier Wiring Diagram



Refer to Figure A-5 for the schematic and physical drawing.

The rectifier tube (V7) is a 5Y3 full-wave rectifier. Refer to Figure A-12 for the tube base diagram. The filament voltage is 5VAC and the maximum plate voltage is 350V RMS per plate. In this circuit V7 changes AC voltage into pulsating DC voltage. V7 has two rectifiers housed in one glass envelope. Each rectifier conducts electrons only when its plate is positive (forward biased). The electrons flow from the filament to the positive plate. When a plate is negative, there is no electron flow between the filament and the negative plate (reveres bias).

Function of the Full-Wave Rectifier

Transformer T1's high voltage secondary supplies the 700VAC to V7 at pins 6 and 4. T1's high voltage secondary center-tap is connected to chassis ground (B-). The voltage between pin 6 (or pin 4) and the chassis ground is about 350VAC at each pin. It is this 350VAC that is rectified into a pulsating 350VDC.

Figure 3-3 shows how V7 functions when pin 6 is positive. Plate A of V7 and the filament are forward biased, causing current to flow from the filament to plate A. The output is a 350VDC positive pulse, measured between the filament and chassis ground.

FIGURE 3-3 Full-Wave Rectifier, Plate A Positive

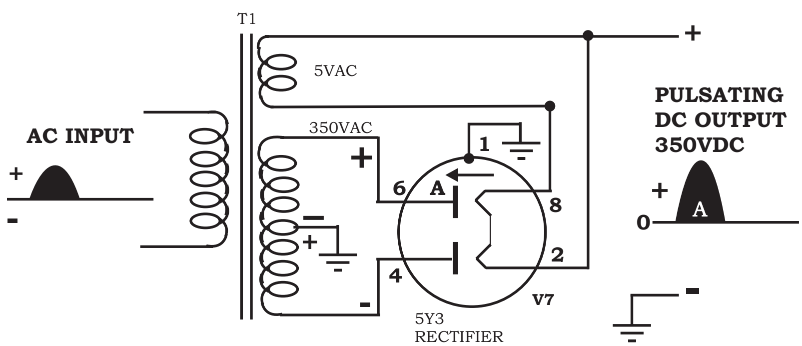
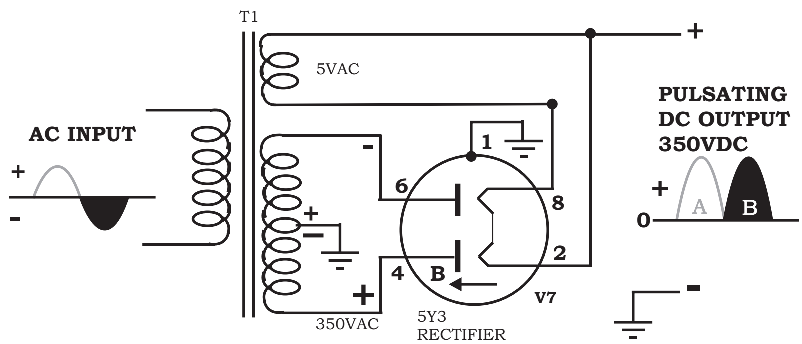


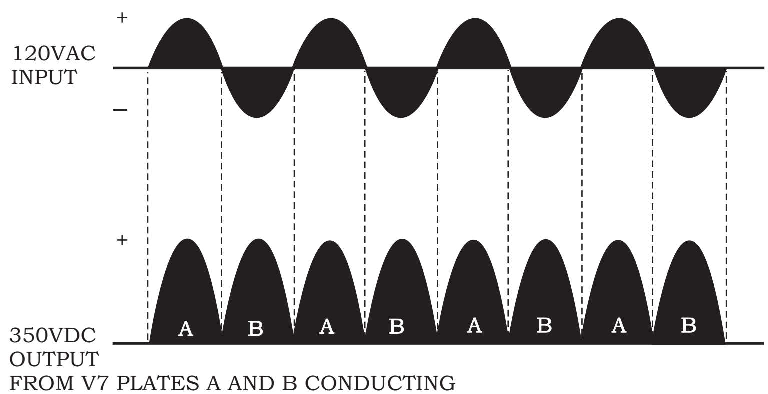
Figure 3-4 shows how V7 functions when pin 4 is positive. Plate B of V7 and the filament are forward biased, causing current to flow from the filament to plate B. Again the output is another 350VDC positive pulse, measured between the filament and chassis ground.

FIGURE 3-4 Full-Wave Rectifier, Plate B Positive



The end result is that both the positive and negative halves of T1's high voltage secondary are rectified producing a 350V pulsating DC. Figure 3-5 shows this relationship between the AC input and the output at the filament of V7.

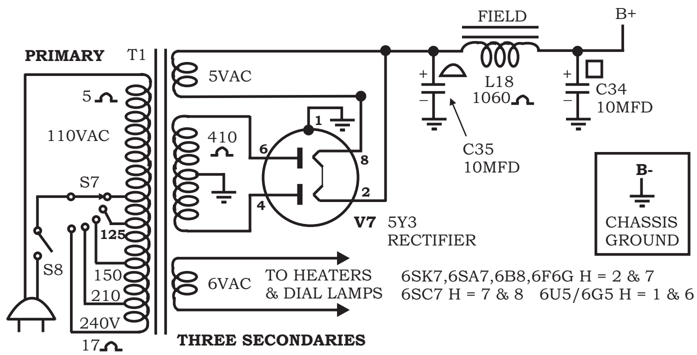
FIGURE 3-5 Input and Output of Power Supply



The output of the power supply as shown in Figure 3-5 is still not usable. This pulsating DC would cause a very loud hum from the speaker and would vary little when the volume control is changed.

What is needed is a filter circuit to smooth out the pulsating DC. Electrolytic capacitors (C35 and C34), field coils, and resistors are added to the power supply circuit to filter the pulsating DC. The field coil is located physically around the magnet of the speaker, refer to Figure 3-10, but it is electrically between C35 and C34 as shown in Figure 3-6.

FIGURE 3-6 Power Supply Diagram



Filtration

The purpose of Filtration is to fill in the gaps between each DC plus to produce an almost perfect DC output. In this power supply a very popular filter circuit is used, the **PI Filter**.

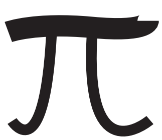


FIGURE 3-7 Greek Symbol for **PI**

The reason this filter is known as a **PI Filter**, is that the electrical construction of this filter resembles the Greek symbol, **PI**. The left leg of the symbol represents the electrolytic capacitor C35 and the right leg represents the electrolytic capacitor C34. The top of the Greek symbol represents the field coil in the 8Q2 radio, although in other radios this maybe a resistor instead of a coil.

FIGURE 3-8 Filtered DC

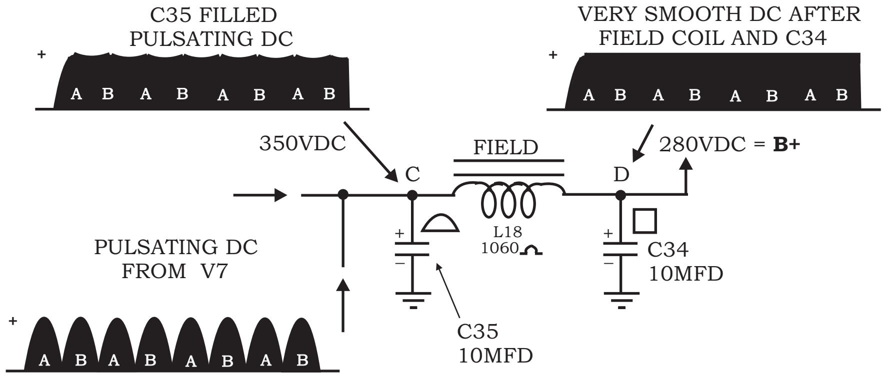
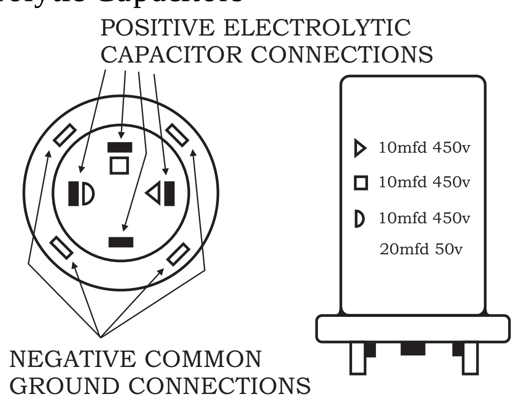


Figure 3-8 shows the function of the **PI filter**. V7 produces the pulsating DC and the capacitor C35 fills in gaps between these pulses (point C). The field coil and capacitor C34 complete the filtration, and at point D the 280VDC is very smooth and almost battery quality. This voltage is then distributed to the circuits of the radio as B+. The half circle and square in Figure 3-8 are the identifying marks on the metal can that houses each capacitor, C34 and C35 respectively. The negative grounds for C35, C34, (C28 and C20 are used in other radio circuits) are all connected to the metal can housing the four capacitors as shown in Figure 3-9. The metal can is mounted on the chassis, making the ground connections for all four capacitors, refer to Figure 3-11.

FIGURE 3-9 Electrolytic Capacitors



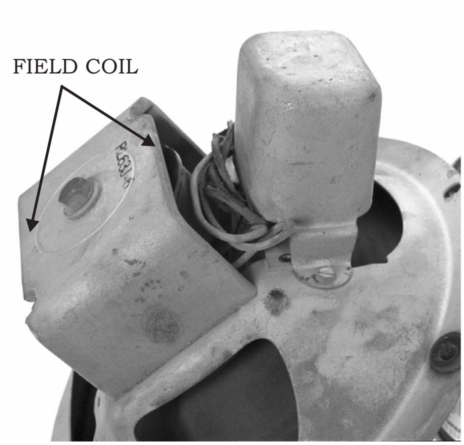
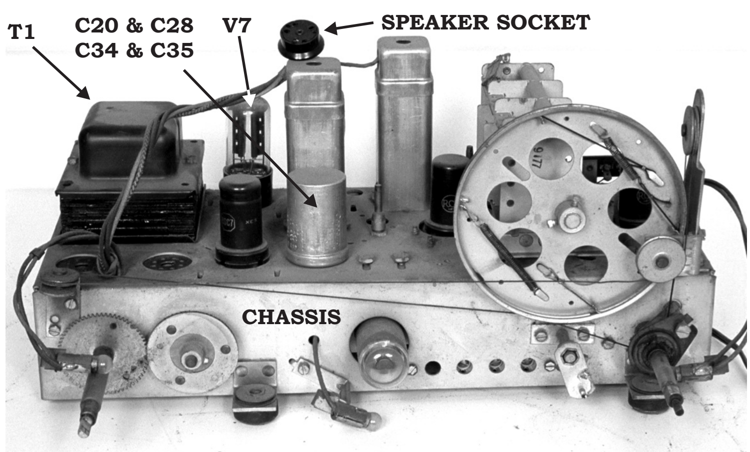


FIGURE 3-10 Field Coil

The field coil is located on the back of the speaker as shown in Figure 3-10. The field coil serves two purposes. First, it is part of the **PI filter**. Secondly, it supplies a strong magnetic field for the voice coil. This increases the audio performance of the speaker, both in quality and volume.

The location of the metal can that houses C34, C35, C20, C28, and the locations of transformer T1, rectifier tube V7 (5Y3), and the speaker socket are shown in Figure 3-11. Refer to Figure A-2 for the complete parts location for this chassis.

FIGURE 3-11 Radio Chassis



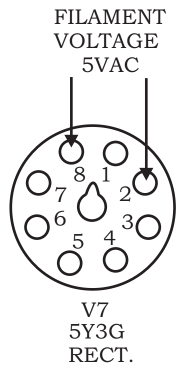
A list of voltages by pin number are shown in Figure 3-12. For a complete listing of all voltages, refer to Figure A-11. This information is very useful when troubleshooting because any large variations may indicate the problem area.

FIGURE 3-12 V7 Tube Socket Voltages

FILAMENT VOLTAGE IS MEASURED BETWEEN PINS 2 AND 8.

ALL OTHER VOLTAGES ARE MEASURED FROM PIN# TO CHASSIS GROUND.

ALL VOLTAGES MAY VARY +/- 20%.



PIN#	V7
1	0.0
2	F 349VDC
3	N/A
4	340VAC
5	N/A
6	341VAC
7	N/A
8	F 349VDC

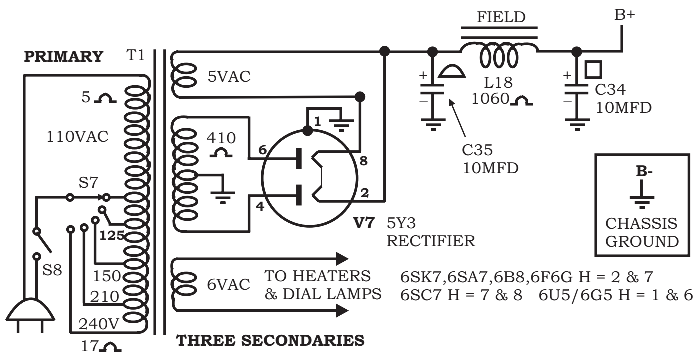
Locating Electronic Components

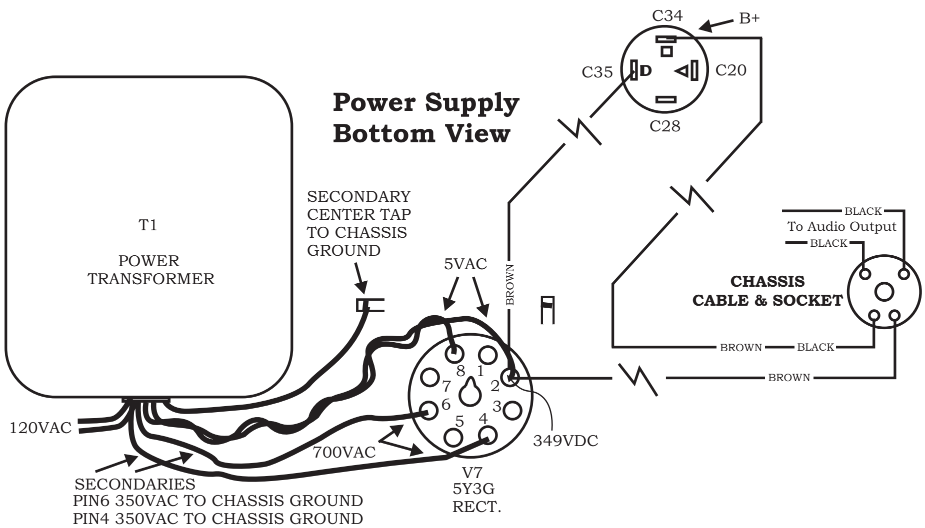
Locating electronic components is an easy process when you use the wiring diagram and the chassis drawing. But if you only have the wiring diagram, locating components is more of a challenge. Figure 3-13 on the next page has three parts. The top part is the wiring diagram for the power supply. The middle is a drawing of the power supply (bottom view), and the last part is the wiring diagram of the speaker and field coil. To locate C35, as an example, look at the wiring diagram (top) in Figure 3-13 and you will see that the positive side of C35 is wired to pin 2 of V7. Then look at V7's tube socket (middle) and locate pin 2, then just follow the wire to C35. The other wire on pin 2 is connected to the field coil through the chassis cable and speaker socket.

Using the pins of the tube sockets is a reliable way of locating electronic components. Refer to Figure A-3 for the pin outs of most tube sockets.

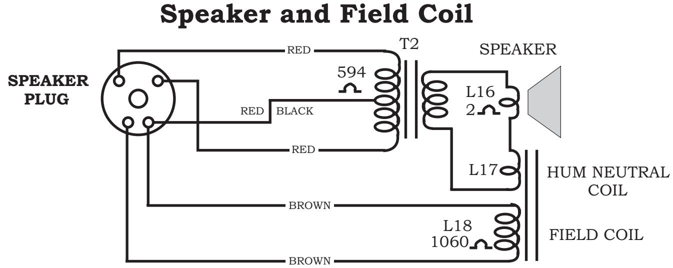
FIGURE 3-13 Power Supply Part Location

Power Supply Wiring Diagram





Speaker and Field Coil



Other Full-Wave Power Supplies

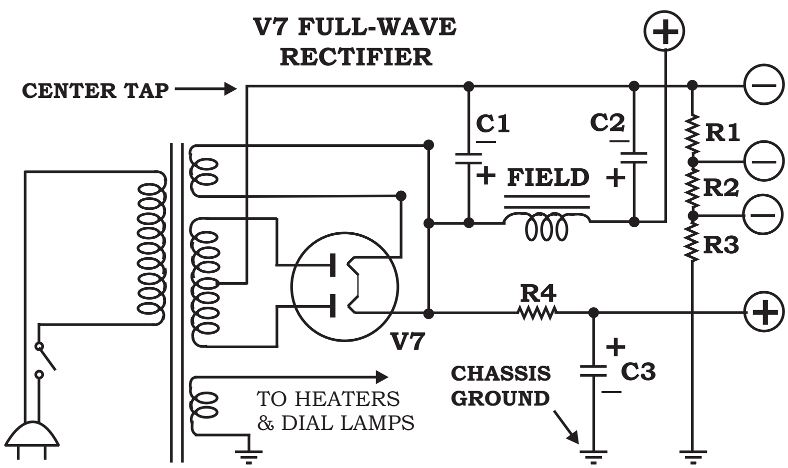
There are many different types of full-wave rectifier circuits. The power supply in this radio supplies only positive voltage and all of the electrolytic capacitors have a common chassis ground.

Some radios require power supplies that produce both positive and negative voltages. In these radios the basic operation of the full-wave rectifier is still the same as before, but the filtering circuit is configured differently. These filtering circuits usually have a PI filter (although it may look like its upside-down) and a voltage divider circuit.

The voltage divider is a series of resistors connected between the positive and negative of the DC power supply. The different voltages are developed across each series resistor, known as a voltage drop. These voltages are distributed to the circuits of the radio.

An example is shown in Figure 3-14. This power supply has a **PI filter** made up of C1, C2 and a field coil. The voltage divider consist of the series resistors R1, R2, and R3.

FIGURE 3-14 Full-Wave, Example A



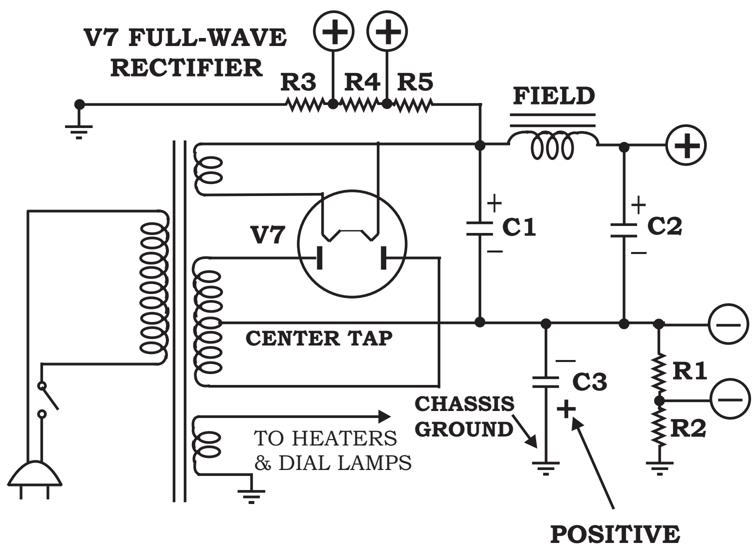
Electrolytic Capacitor Polarity

The replacement of the electrolytic capacitors in circuits like the one in Figure 3-14 becomes a challenge. The electrolytic capacitors are polarized, which means they have a positive and negative side. They must be installed properly with the positive side of the capacitor to the positive side of the circuit and the negative side to the negative side of the circuit. **This is very important because if these capacitors were to be installed backwards, the radio could be damaged, and the capacitors could explode!**

The center-tap of the secondary in Figure 3-14 is the most negative point in the power supply. Capacitors C1 and C2 have their negative sides connected to the center-tap, but this point is **not chassis ground**. One side of resistor R1 is also connected to this point and the other side of R1 is connected to R2, and R2 is then connected to R3 through to chassis ground. C3's negative side is connected to chassis ground. All the negative sides of the capacitors are orientated toward the center-tap. C1, C2 are connected directly to the center-tap while C3 is connected through chassis ground, then through R3, R2, and R1 and finally to the center-tap. The positive sides of all the capacitors are orientated toward V7's filament. The positive side of C1 is connected directly to the filament, C2 is connected through the field coil, and C3 is connected through resistor R4.

Another example of a full-wave power supply with both positive and negative outputs is shown in Figure 3-15. This power supply has a **PI filter** made up of C1, C2 and a field coil. The voltage divider consists of the series resistors R1, R2, R3, R4, and R5.

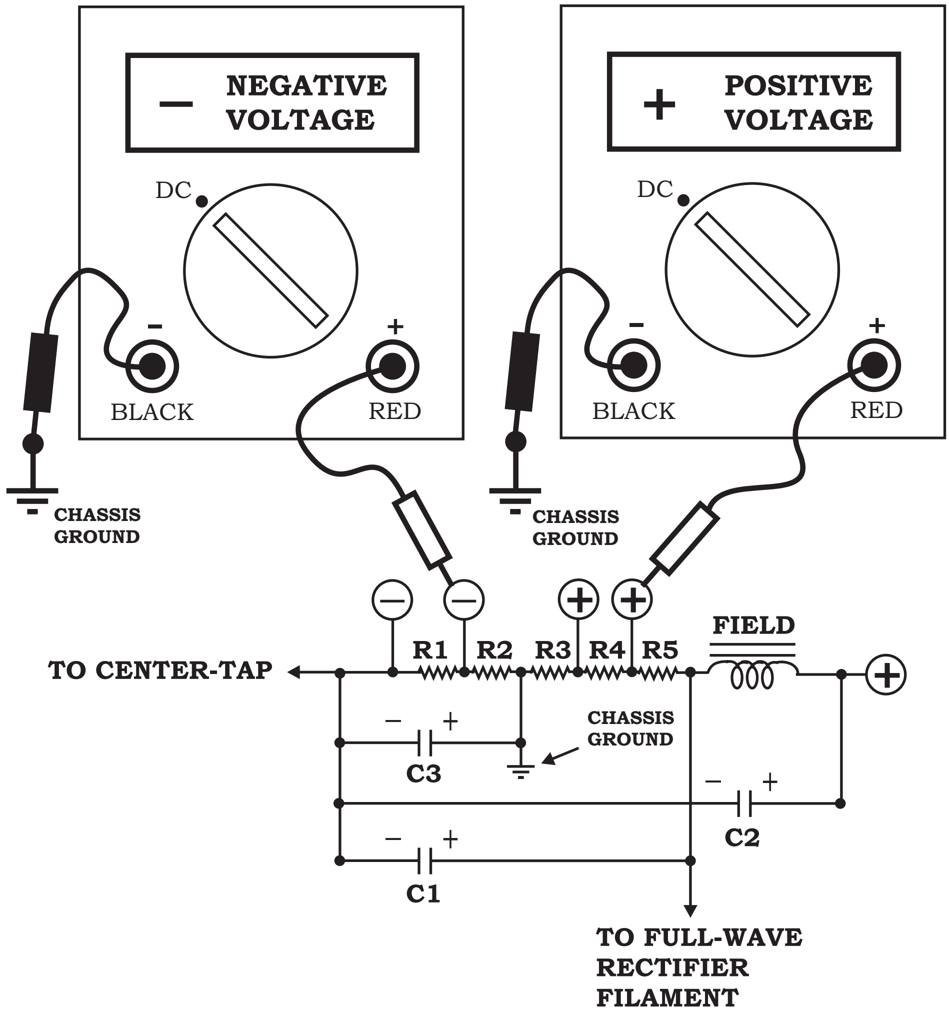
FIGURE 3-15 Full-Wave, Example B



The center-tap is the most negative point of this power supply. Electrolytic capacitors C1, C2, and C3 have their common negative leads connected directly to the center-tap. As in the previous power supplies the positive sides of the capacitors are orientated toward the filament of the rectifier tube V7.

The positive connections of C1 and C2 are the same as in Figure 3-14, but C3's positive connection is connected to the chassis ground. This seems to be very different from the previous power supplies. The key to understanding C3's positive connection is to understand the voltage divider circuit made up of resistors R1, R2, R3, R4, and R5. It is sometimes helpful to re-draw circuits making it easier to understand. Figure 3-16 is a re-drawing of the filter circuit in Figure 3-15.

FIGURE 3-16 Example B Filter

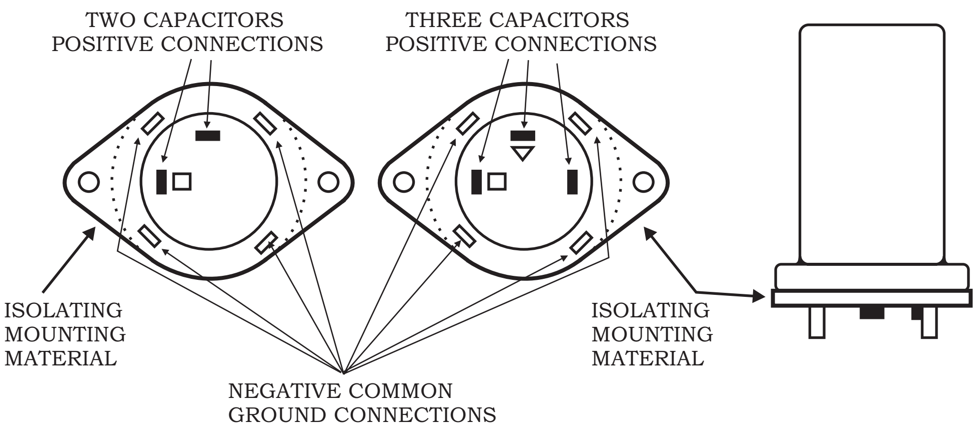


The drawing in Figure 3-16 shows the series of resistors R1-R5. R1 is connected to the most negative point, the center-tap, and R5 is connected to the most positive point of the power supply, the rectifier filament. This voltage divider circuit is connected to chassis ground at the connection between resistors R2 and R3. All the DC voltages are measured from chassis ground. All the voltage points to the left of chassis ground are negative and all the voltage points to the right of chassis ground are positive as show by the DC voltmeters. In this re-drawing of the filter circuit, it is much easier to see the polarization of all the electrolytic capacitors.

Electrolytic Capacitor Isolation

Some of the electrolytic capacitors in the power supplies of Figure 3-14 and Figure 3-15 must be isolated from chassis ground. Figure 3-17 shows the construction of two isolated electrolytic capacitor cans. These can be used in Figure 3-14 (C1 & C2) and Figure 3-15 (C1, C2 & C3) respectively. This drawing shows that the base of the metal cans has an isolating material that mounts the cans to the chassis, keeping the common grounds isolated from the chassis.

FIGURE 3-17 Isolated Electrolytic Capacitor



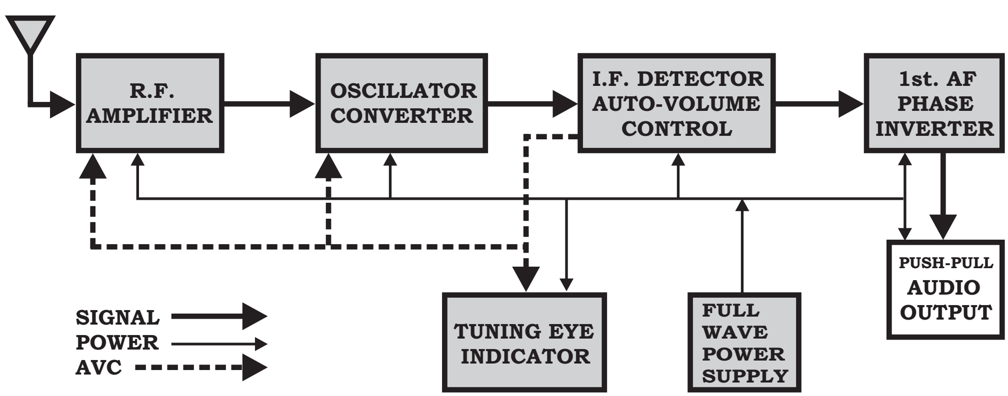
If a non-isolated electrolytic capacitor can was mistakenly used to replace the capacitors (C1, C2) or (C1, C2, C3) in the power supplies of Figure 3-14 or Figure 3-15, the non-isolated metal can would **short out the negative voltages of each power supply.**

4
Audio Output

Push-Pull Audio Output

The Push-Pull Audio Output produces a high volume, high quality audio output. The audio output circuit is highlighted in Figure 4-1.

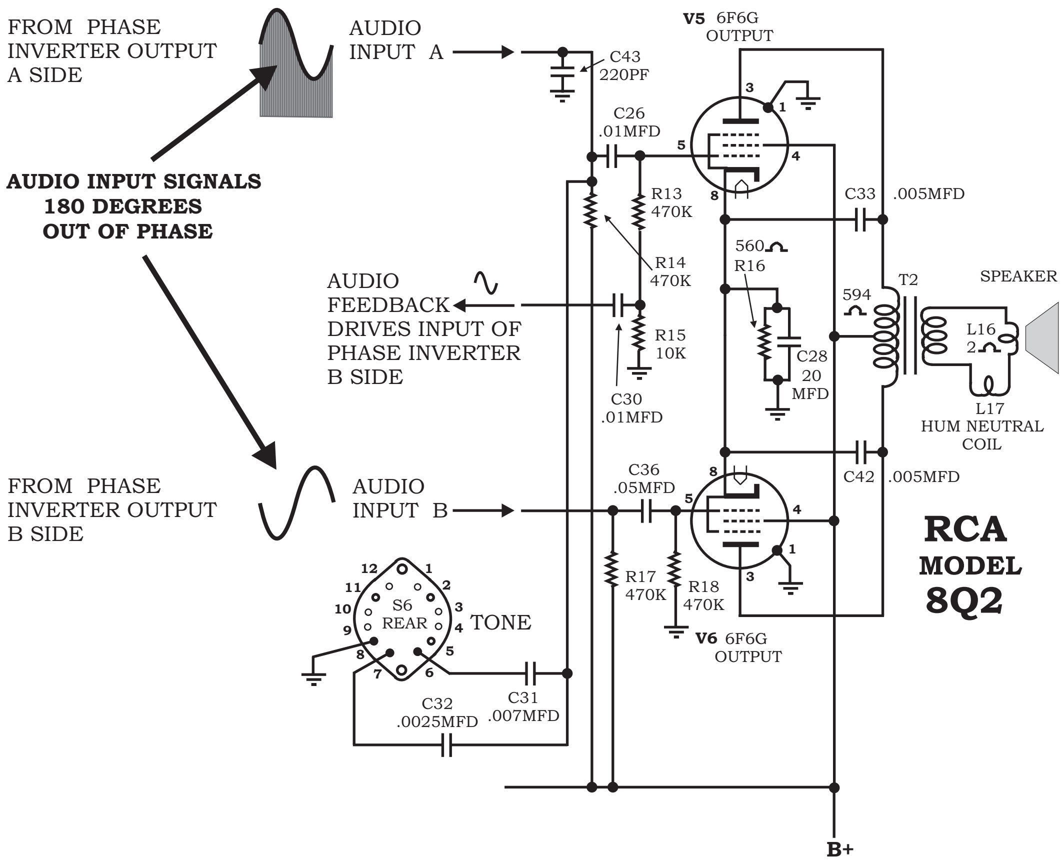
FIGURE 4-1 Push-Pull Audio Output



Push-Pull circuits require two audio input signals 180 degrees out of phase. In the 8Q2, the first AF (Audio Frequency) phase inverter circuit provides the two out of phase input signals.

The name Push-Pull refers to how the two output tubes function together. When one output tube is increasing its conduction (pushing), the other output tube is reducing its conduction (pulling) and then the roles are reversed. This circuit is shown in Figure 4-2. For the complete wiring diagram refer to Figure A-1. Refer to Figure A-6 for the schematic and physical drawing.

FIGURE 4-2 Push-Pull Audio Output Circuit

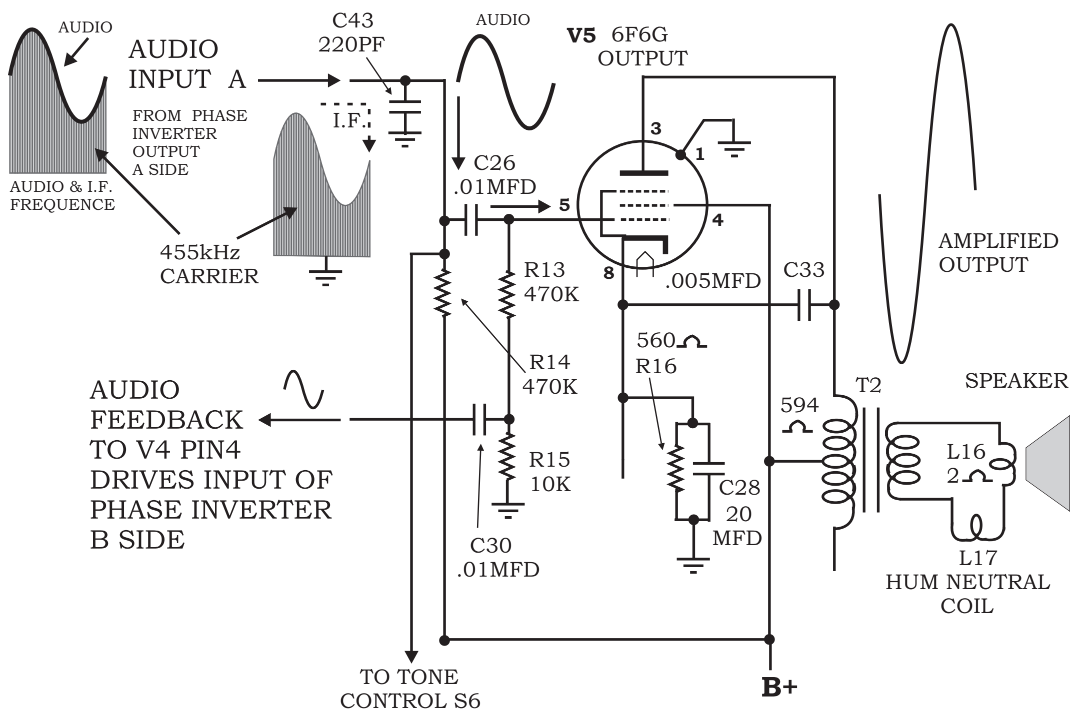


Function of the Push-Pull Output

The Vacuum Tubes used in 8Q2's output circuit are two 6F6G tubes. The 6F6G is a Power Amplifier Pentode and the filament voltage is 6.3VAC. The maximum plate voltage is 375VDC and it is a class A amplifier. Refer to Figure A-12 for the tube Base Diagram.

Audio Side A

FIGURE 4-3 Audio Input A



Input A is made up of one half of a 455kHz carrier and the audio information. The 455 kHz carrier is filtered to chassis ground through C43. The audio continues through C26 to pin 5 of V5, the control grid. V5 greatly amplifies the audio signal and the output of the plate (pin 3) drives the top half of the audio transformer T2, as shown in Figure 4-3. The amplified output of V5 is 180 degrees out of phase with audio input A.

Component Function, Side A

Some components in Figure 4-3 are connected to the Phase Inverter Circuit and the power supply (B+), these connections are not shown. Refer to Figure 4-2 for the complete push pull audio output circuit and Figure A-1 for the complete wiring diagram.

C43 supplies a filter path for the 455kHz carrier to chassis ground.

R14 is the load resistor for plate A of V4 pin 2, the 6SC7 Phase Inverter Circuit.

R13 and R15 are control grid biasing resistors for V5 pin 5, 6F6G. R13 and R15 are also the voltage divider resistors for the audio feedback circuit.

R16 the cathode resistor, and the electrolytic capacitor C28 develop a positive 22VDC on the cathodes of both 6F6G output tubes V5 and V6.

C26 isolates the positive plate A voltage of V4 pin 2 (70.2VDC) from the bias control grid voltage of V5 pin 5 (0.005VDC). C26 also passes the audio signal from V4 pin 2 plate A to the control grid of V5 pin 5.

C30 isolates the control grid bias B (-0.57VDC) of V4 pin 4 from the voltage divider bias between R13 and R15 (0.0001VDC). C30 also passes the audio feedback signal from the voltage divider to control grid B of V4 pin 4.

C33 gives the audio output a pleasing tone. It also shorts any remaining RF from the plate of V5 to chassis ground through R16 and C28. C42 has the same function for side B V6.

T2 is the Audio Output Transformer. Refer to Figure 4-6 for the physical location. V5's plate circuit drives the top half of T2 which drives the Speaker.

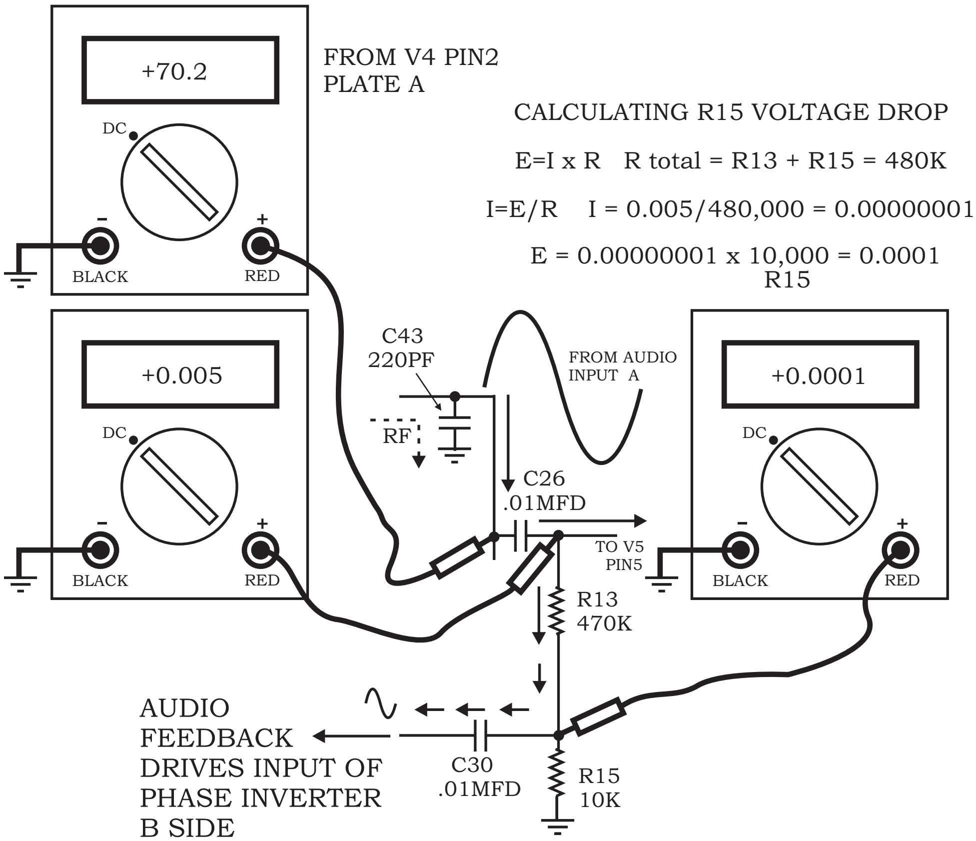
V5 (6F6G) is a Class A amplifier. It amplifies the audio signal on its control grid. The amplified output appears at the plate, pin 3.

L17 is a Hum Neutralizing Coil. It is made up of a few turns of wire wound around the field coil winding. The back EMF produced in L17 reduces the hum at the speaker.

Feedback Circuit

In many circuits there are two electrical components, DC (plate voltage or grid bias), and AC (RF modulated signal or Audio signal). Figure 4-4 shows both components. The DC is indicated by the DC voltmeters while the AC signal is indicated by the black arrows.

FIGURE 4-4 Feedback Voltage Divider Circuit

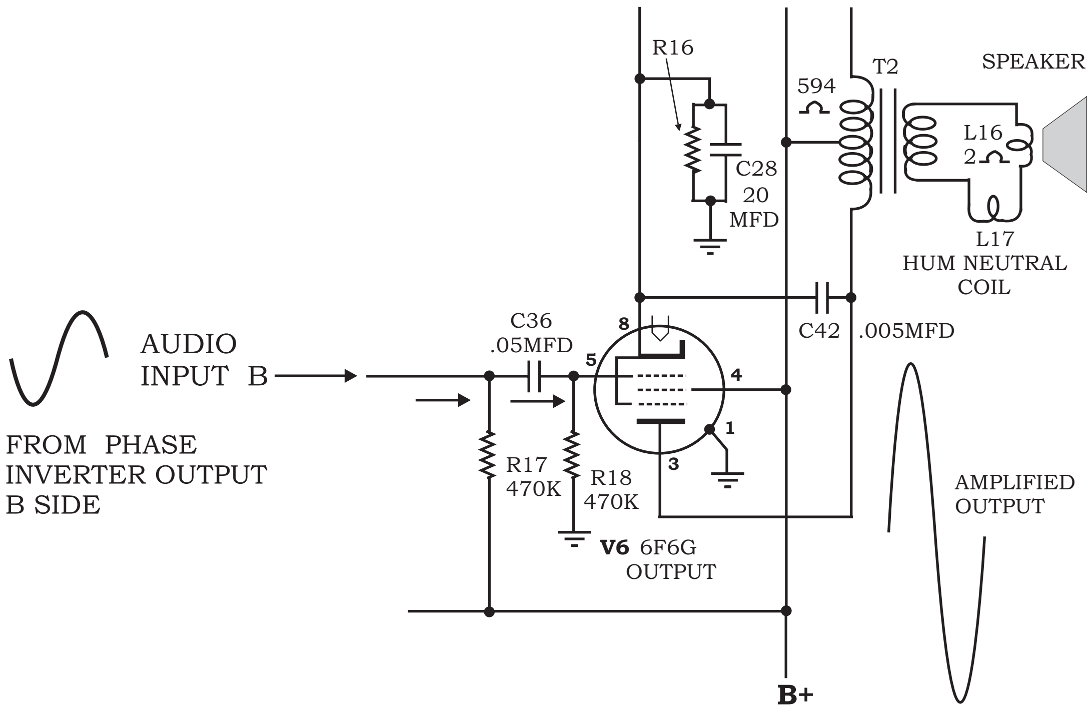


The voltage divider resistor R13 reads +0.005VDC at V5 pin 5, at the connection of R13 and R15 the value is +0.0001VDC, a fifty fold reduction. The AC audio signal will vary with the volume control, but the volume level will always be reduced by this proportion. This audio feedback signal is in phase with audio input A and it drives the B side of the Phase Inverter Circuit.

Audio Side B

Some components in Figure 4-5 are connected to the Phase Inverter Circuit and the power supply, B+. These connections are not shown. Refer to Figure 4-2 for the complete push pull audio output circuit and Figure A-1 for the complete wiring diagram.

FIGURE 4-5 Audio Input B



Input B is developed from plate B of V4 pin 5 and it is 180 degrees out of phase with input A. Audio input B's signal passes through C36 to the control grid of V6 which greatly amplifies the audio signal. The output of V6 (plate pin 3) drives the bottom half of the audio output transformer T2. This amplified output is also 180 degrees out of phase with audio input B.

Component Function, Side B

Refer to Figure 4-5, Figure 4-2, and Figure A-1.

R16 (cathode resistor) and the electrolytic capacitor C28 develop a positive 22VDC on the cathodes of both 6F6G output tubes (V5 A and V6 B sides).

R17 is the load resistor for plate B of V4 pin 5, the 6SC7 Phase Inverter Circuit.

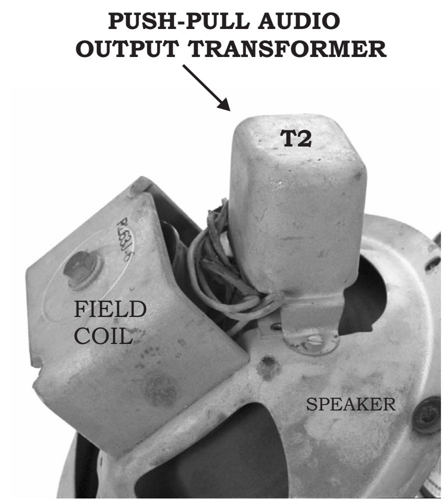
R18 is the control grid bias resistor for V6 pin 5.

C36 isolates the plate voltage B (73VDC) of V4 pin 5 and the control grid bias (0.005VDC) of V6 pin 5. It also passes the audio signal B to the control grid of V6 pin 5.

V6 (6F6G) is a Class A amplifier. It amplifies the audio signal on its control grid. The amplified output appears at the plate, pin 3.

T2 is the Audio Output Transformer. Refer to Figure 4-6 for physical location. The V6 plate circuit drives the bottom half of T2, which drives the speaker.

FIGURE 4-6 Push-Pull Output Transformer T2



Tone Control

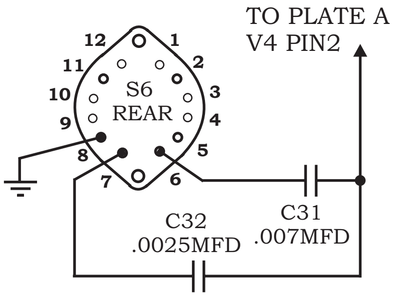
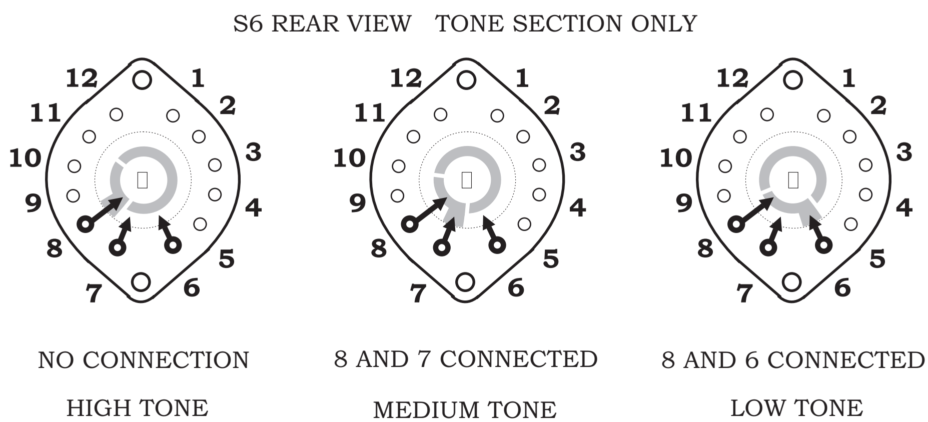


FIGURE 4-7 Tone Switch

Rotary switch S6 is the tone control and radio / phonograph selector switch. The tone control has three tone settings high, medium, and low. As the switch is rotated, a metal wiper makes electrical contact with one of three S6 switch terminals. The wiring diagram of the Tone Control circuit is shown in Figure 4-7. The physical drawing of the tone switch S6 is shown in Figure 4-8.

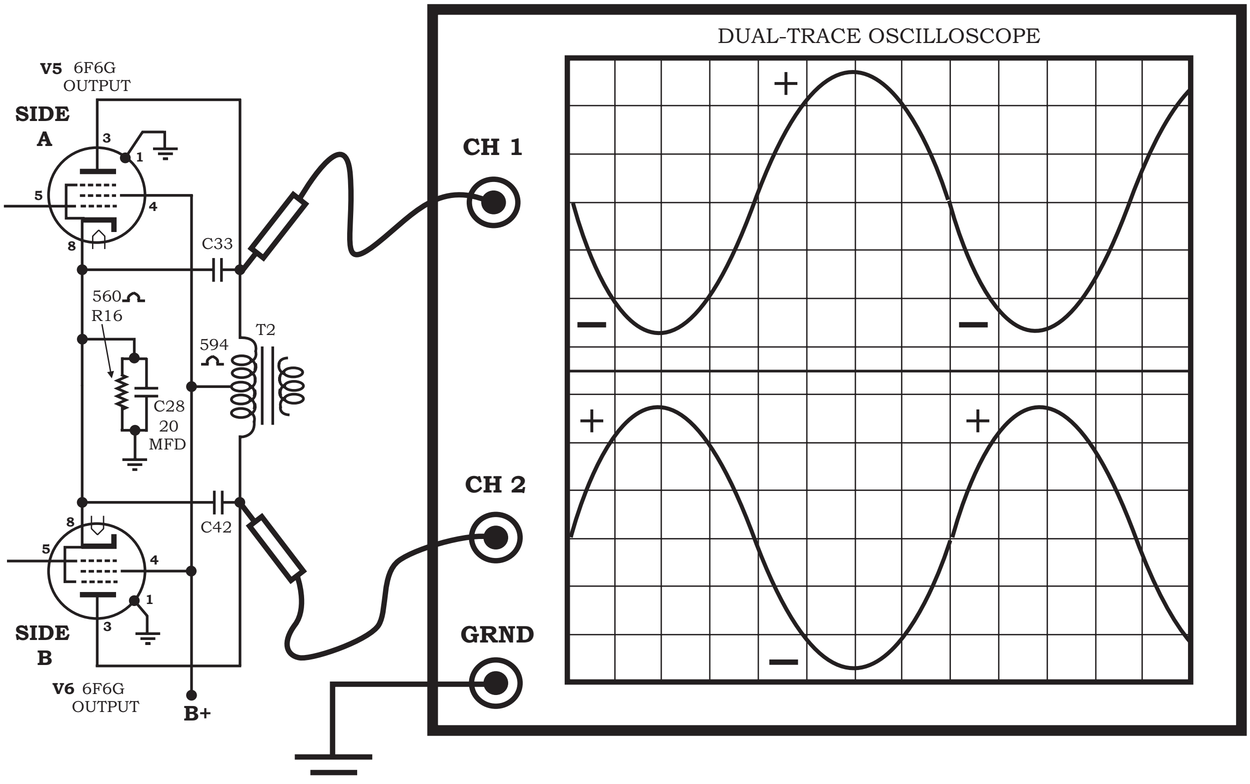
High tone is the connection at terminal 8. This is the chassis ground connection and there is no other component in the circuit. This results in the highest tone as shown in Figure 4-7 and Figure 4-8. By rotating S6 one click, terminals 8 and 7 are connected together. This connects C32 to chassis ground, adding a 0.0025MFD capacitor to audio input A, resulting in a medium tone. Rotating one more click, terminals 8 and 6 are connected together. This connects C31 to chassis ground, adding a 0.007MFD capacitor to audio input A. The result is a low tone.

FIGURE 4-8 Switch S6



Push-Pull Output Quality

FIGURE 4-9 Push-Pull Output



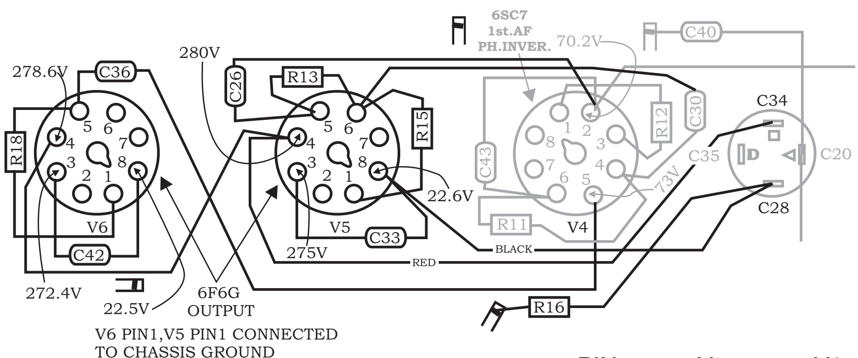
The push-pull circuit produces a high quality audio output. This is the result of the two audio output tubes working 180 degrees out of phase. The drawing of a dual-trace oscilloscope in Figure 4-9 shows this relationship. When the side A is most negative, side B is most positive and visa-versa. This results in the maximum DC potential across the primary winding of the audio output transformer T2. This push-pull configuration almost doubles the audio dynamic range, as compared to a single tube output, producing a high quality audio output.

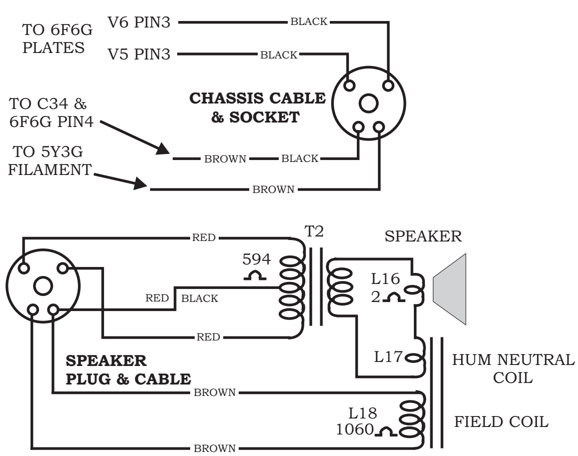
Both output tubes should be matched. When the specifications of each output tube match, both tubes will contribute equally.

A list of voltages by pin numbers of V5 and V6 are shown in Figure 4-10. For a complete listing of voltages refer to Figure A-11. All voltages may vary by +/- 20%. This information is very useful when troubleshooting and any large variations may indicate the problem area.

Refer to Figure A-3 for the tube socket pin count and refer to bottom view in Figure A-4 for the physical tube socket locations.

FIGURE 4-10 Voltage Listing of V5 and V6





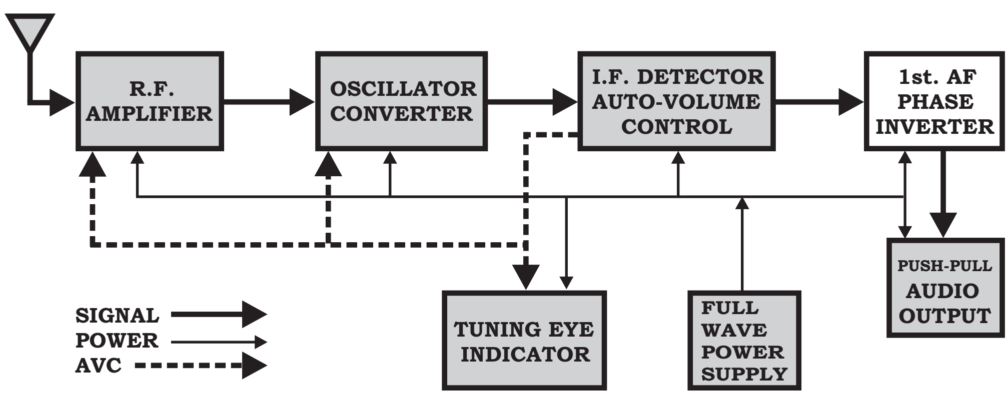
PIN#	V5	V6
1	0.0	0.0
2	F	F
3	275	272.4
4	280	278.6
5	0.005	0.005
6	N/A	N/A
7	F	F
8	22.6	22.5

5
Audio Phase Inverter

Phase Inverter

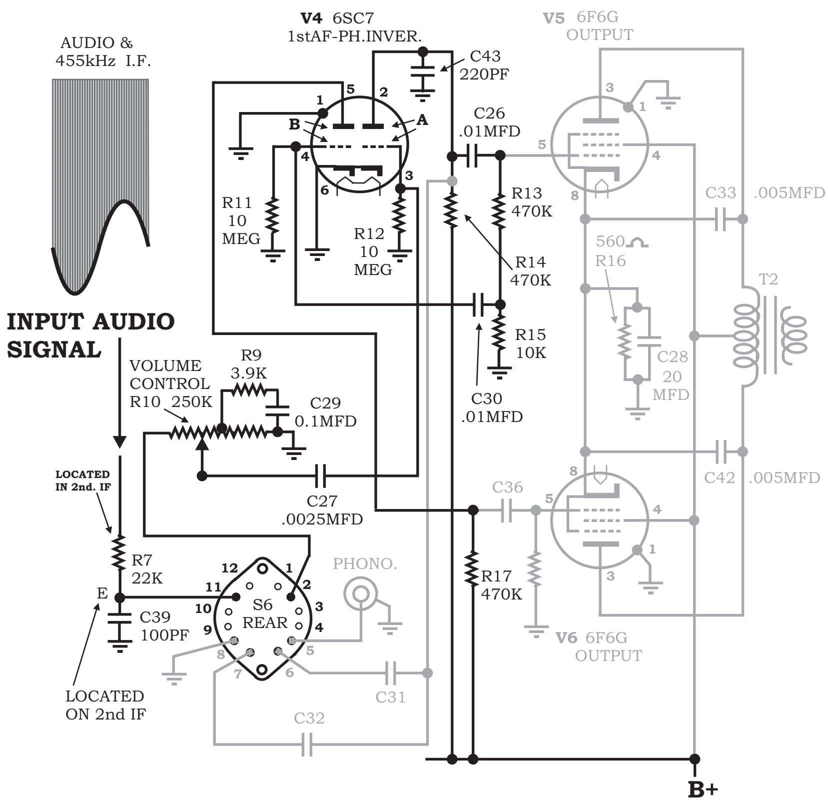
The AF (Audio Frequency) Phase Inverter, converts the input audio signal (from I.F. Detector) into two audio signals 180 degrees out of phase. The 1st AF Phase Inverter is highlighted in Figure 5-1.

FIGURE 5-1 Phase Inverter



The input signal is the negative half of the demodulated 455kHz intermediate frequency carrier. This is shown in the wiring diagram of Figure 5-2. This input will be converted into two audio signals 180 degrees out of phase. These signals then drive the push-pull audio output circuit.

FIGURE 5-2 AF Phase Inverter Circuit



For the complete wiring diagram, refer to Figure A-1, and for the physical location of V4, refer to the bottom view drawing of Figure A-4.

Refer to Figure A-7 for the schematic and physical drawing.

Function of the Phase Inverter Circuit

The vacuum tube used in this circuit is the 6SC7 (V4). This tube is a High-Mu Twin-Triode. The filament voltage is 6.3VAC and the maximum plate voltage is 250VDC (for each plate, A and B). Refer to Figure A-3 for the socket pin count and for the Base Diagram of the 6SC7, refer to Figure A-12.

Volume Control

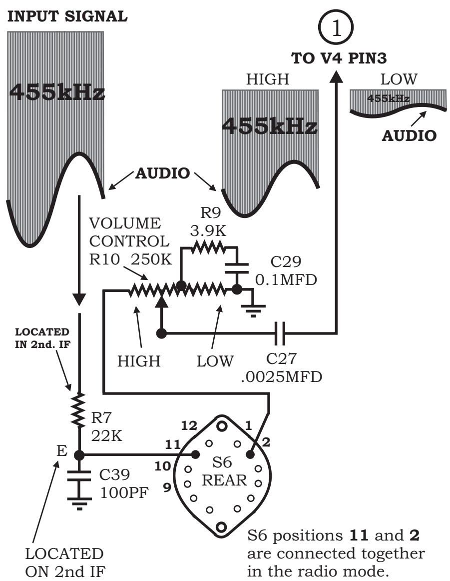


FIGURE 5-3 Volume Control

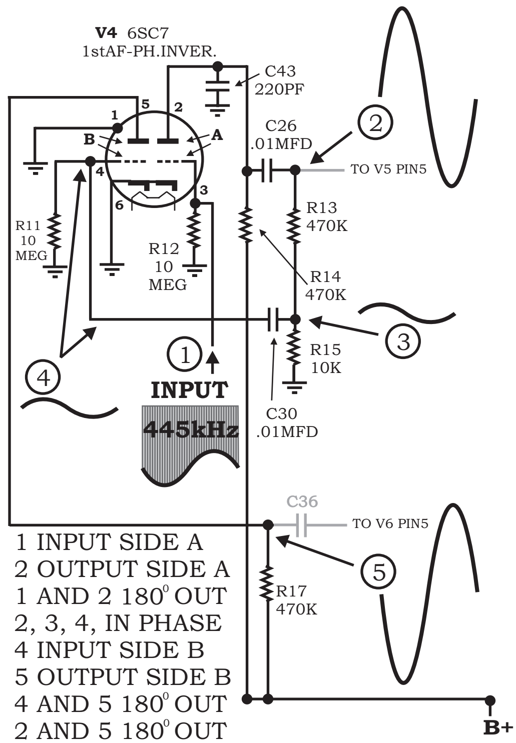
The input signal from the I.F. Detector is attenuated by resistor R7. At terminal E, capacitor C39 filters some of the 455kHz intermediate frequency to chassis ground. In the radio mode, terminals 11 and 2 of switch S6 are connected together, conveying the signal to R10. This signal is at the high volume side of the volume control, as shown in Figure 5-3.

When the volume control is turned, its wiper tap moves between the low and high side. This makes a variable voltage divider with one end connected to chassis ground (low volume). This results in the signal varying from low to high. The variable signal passes through C27 to the control grid of V4 pin 3.

R10 also has a stationary tap. One side of R9 is connected to this tap and the other side to C29. Then, the other side of C29 is connected to chassis ground, as shown in Figure 5-3. This circuit gives a pleasing tone to the audio at low volume.

The Phase Inverter

FIGURE 5-4 Phase Inverter Circuit



The input from R10 (point 1) is applied to V4's side A control grid. This is amplified by V4 side A and is output at the plate (pin 2). Capacitor C43 filters the 455kHz I.F. and allows the audio to pass through C26. This signal drives the audio output tube V5 (point 2) as shown in Figure 5-4.

Because of the amplifying action of vacuum tubes, the input signal is 180 degrees out of phase with it's output. When the control grid signal goes negative, causing the tube to conduct less, the plate voltage increase. When the control grid signal goes positive, causing the tube to conduct more, the plate voltage decreases. This causes the input signal at point 1 and the output signal at point 2 to be 180 degrees out of phase.

The voltage divider resistors R13 and R15 reduces the output signal by a factor of 50 (point 3). This reduced audio signal passes through C30 and is applied to V4's side B control grid at point 4 (points 2, 3, and 4 are in phase). Point 4's signal is amplified by V4 side B and is output at its plate (pin 5). The input signal at point 4 and the output signal at point 5 are 180 degrees out of phase, as shown in Figure 5-4. This audio output (point 5) passes through capacitor C36 and drives the audio output tube V6.

With one input signal at point 1, the phase inverter circuit produces two audio output signals that are 180 degrees out of phase (points 2 and 5). Which is the requirement to drive a push-pull audio output circuit.

Component Function

Refer to Figure 5-2 or Figure A-1.

R7 attenuates the 455kHz audio modulated signal that is applied to the high volume side of variable resistor R10.

C39 filters some of the 455kHz carrier to chassis ground.

R10 is the volume control. It varies the level of the input signal to the phase inverter circuit.

C27 passes the variable input signal to the phase inverter. C27 also isolates the volume control’s center tap from the bias voltage of the control grid of V4 pin 3 (-0.8VDC) side A.

R9 and C29’s time constant produces a pleasing tone at low volume.

R12 is the bias resistor for the A side control grid of V4 pin 3 (class A bias).

C43 filters out (removes) the 455kHz carrier from the audio output signal from the plate of V4 (side A).

R14 is the load resistor (current limiting and impedance matching resistor) for the plate of V4 (side A).

C26 isolates the positive plate A voltage of V4 pin 2 (70.2VDC) from the bias control grid voltage of V5 pin 5 (0.005VDC). C26 also passes the audio signal from V4 pin 2 plate A to the control grid of V5 pin 5.

R13 and R15 are control grid biasing resistors for V5 pin 5 (6F6G). R13 and R15 are also the voltage divider resistors for the audio feedback circuit.

C30 isolates the control grid bias B (-0.57VDC) of V4 pin 4 from the voltage divider bias between R13 and R15 (0.0001VDC). C30 also passes the audio feedback signal from the voltage divider to control grid B (V4 pin 4).

R11 is the bias resistor for the B side control grid of V4 pin 4 (class A bias).

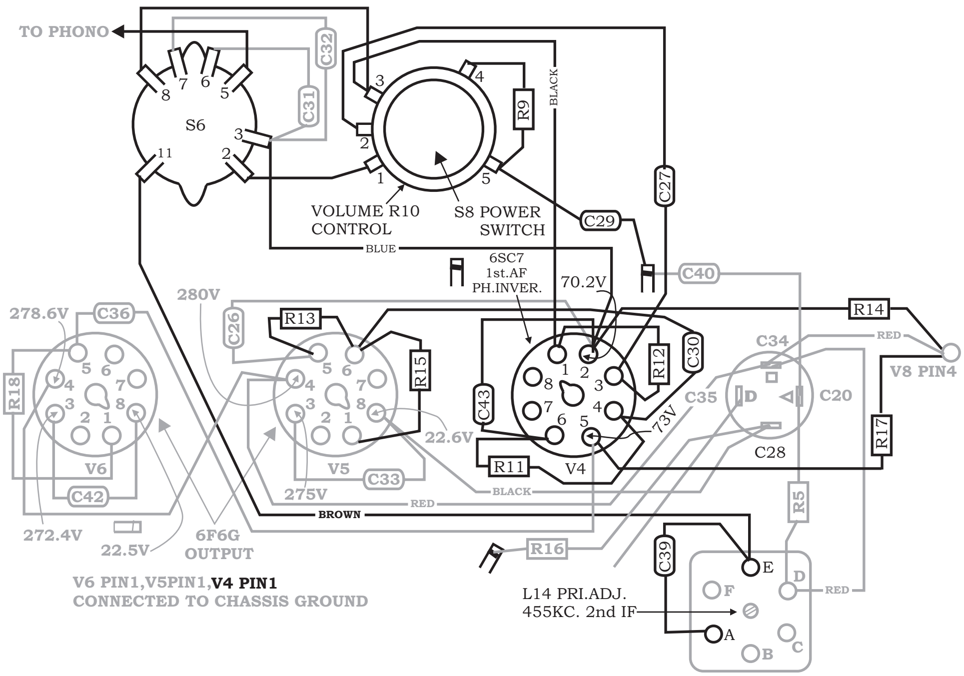
Component Function (continued)

R17 is the load resistor (current limiting and impedance matching resistor) for the plate of V4 (side B).

C36 isolates the plate voltage B (73VDC) of V4 pin 5 and the control grid bias (0.005VDC) of V6 pin 5. It also passes audio signal B to the control grid of V6 pin 5.

V4 is a High-Mu Twin-Triode Vacuum tube and in the phase inverter circuit, it produces two 180 degree out of phase signals that drives the push-pull audio output.

FIGURE 5-5 Voltage Listing of V4



PIN#	V4
1	0.0
2	70.2
3	-0.8
4	-0.57
5	73.0
6	0.0
7	F
8	F

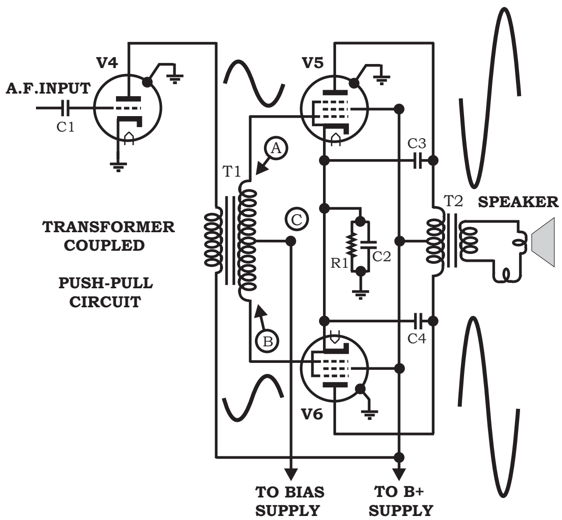
A list of voltages by pin number is shown in Figure 5-5. For a complete listing of all voltages refer to Figure A-11. All voltages may vary by +/- 20%. This information is very useful when troubleshooting. Any large variations may indicate the problem area.

Refer to Figure A-3 for the tube socket pin count and refer to the bottom view in Figure A-4 for the physical tube socket location.

Other Phase Inverter Circuits

Transformer Phase Inverter

FIGURE 5-6 Transformer Phase Inverter

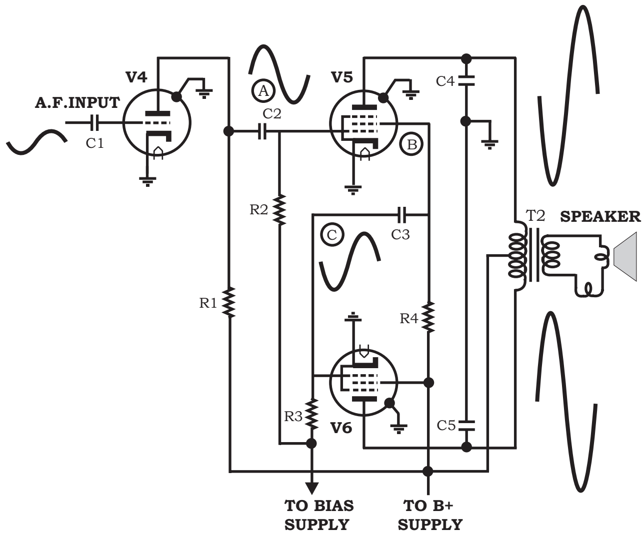


The audio input is applied to the control grid of V4. V4 amplifies this input which drives the primary of T1. This amplified signal is transferred to the secondary of T1. The secondary of T1 has a center tap (point C) connected to a DC control grid bias supply. This biases both V5 and V6 to class A operation.

Between points C and A, is the audio signal that drives V5, and the audio signal that drives V6 is between Points C and B. Both audio signals at points A and B are 180 degrees out of phase because of transformer action.

Screen Grid Phase Inverter

FIGURE 5-7 Screen Grid Phase Inverter



The input signal is amplified by V4 and it is then applied to the control grid of V5 through capacitor C2 (point A). Resistors R2 and R3 bias the push-pull audio output tubes V5 and V6 to class A operation. The output of V5 drives the top half of T2 and it is 180 degrees out of phase with the signal on V5's control grid.

Resistor R4 and the screen grid of V5 make up a voltage divider circuit. As V5 conduction varies with the audio, point B also varies in step (in-phase) with the output. This instep signal passes through capacitor C3 (point C) to the control grid of V6.

Both control grid signals at points A and C are 180 degrees out of phase, driving the push-pull output circuit.

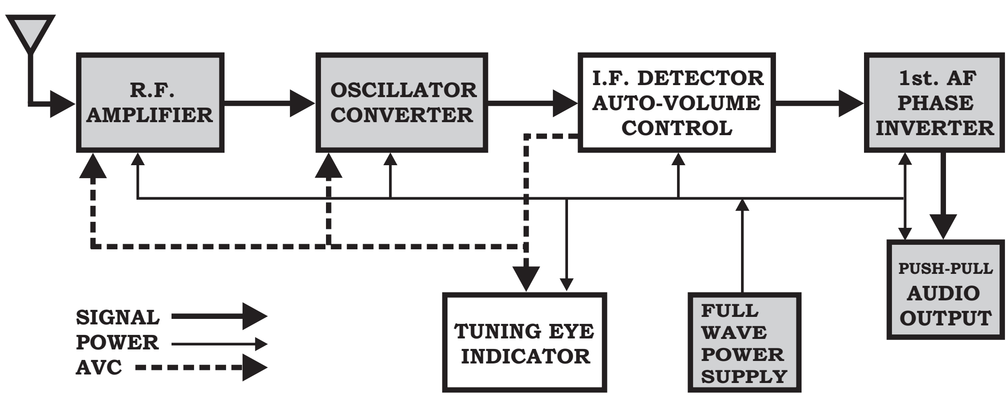
NOTES

6
I.F./Detector, Eye Tube

I.F./Detector AVC and Eye Tube

The Intermediate Frequency(I.F.) / Detector, the AVC (Automatic Volume Control), and the Eye Tube Indicator are highlighted in Figure 6-1.

FIGURE 6-1 I.F. / Detector AVC & Eye Tube



The I.F. / Detector Circuit amplifies the I.F. signal (455kHz Audio Modulated, Intermediate Frequency) and detects the audio signal (Demodulates the amplified signal). The tube used in this circuit is a 6B8 (V3). It is a Duplex-Diode Remote Cutoff Pentode Converter, the filament voltage is 6.3VAC and the maximum plate voltage is 300VDC. For the socket pin count refer to Figure A-3 and for the Base Diagram of the 6B8 refer to Figure A-12.

FIGURE 6-2 Chassis Back View

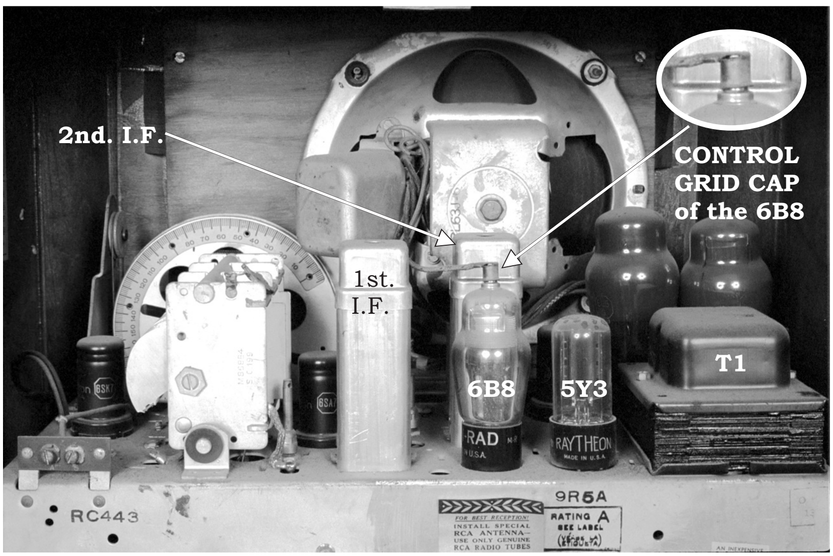


Figure 6-2 shows the location of V3. Besides the eight pin connections on the base, this tube has a connection on top. This connection is known as the cap and for the 6B8 is the connection for its control grid.

Figure 6-2 also shows the locations of the 1st. I.F. transformer and the 2nd. I.F. transformer, power transformer T1, and the rectifier tube 5Y3. For the physical location of all components refer to Figure A-2. Refer to Figure A-8 for the schematic and physical drawing.

The eye tube V8 is a 6U5/6G5, an Electron-Ray Indicator. This tube indicates the strength of the radio station signals as shown in Figure 6-3. The filament voltage is 6.3 VAC, and the maximum plate voltage is 285VDC.

FIGURE 6-3 Eye Tube Indicator

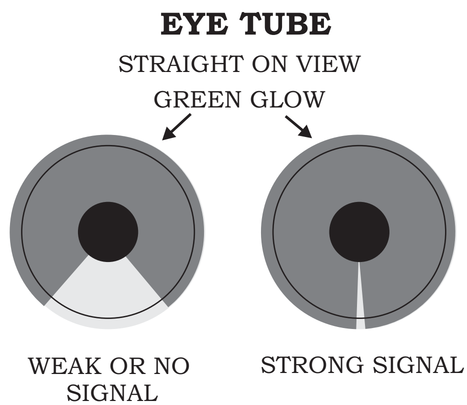
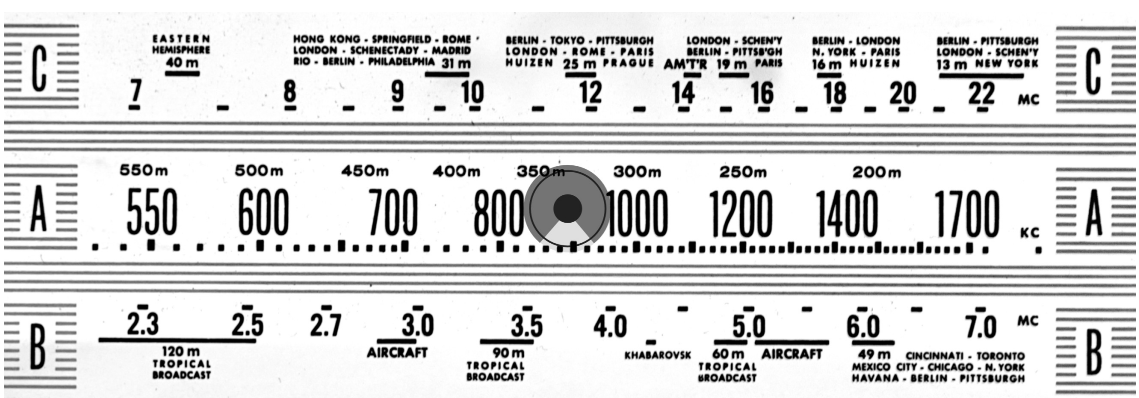


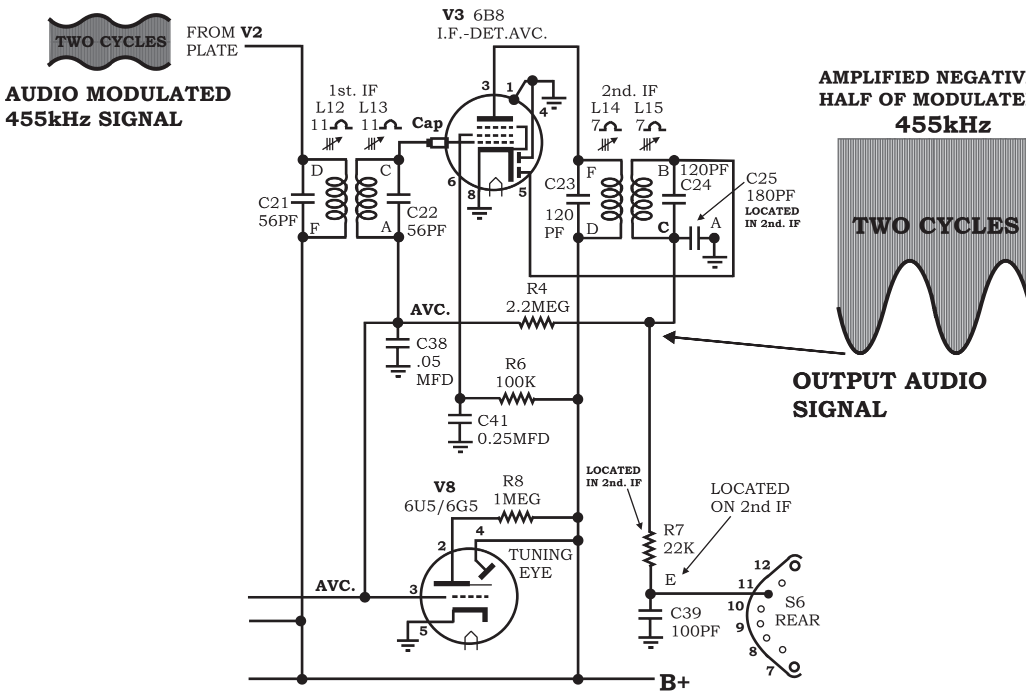
FIGURE 6-4 Slide-Rule Dial and Eye Tube



In this radio the Eye Tube is conveniently located behind the slide-rule dial as shown in Figure 6-4. Refer to Figure A-3 for the socket pin count and for the Base Diagram of the 6U5/6G5 refer to Figure A-12.

The audio modulated carrier from V2 is the input signal to the detector circuit. The output of the detector is the input for the inverter circuit. The wiring diagram for the I.F. / Detector AVC and the Eye Tube Circuit is shown in Figure 6-5. For the complete wiring diagram refer to Figure A-1.

FIGURE 6-5 I.F. / Detector AVC and Eye Tube Circuits

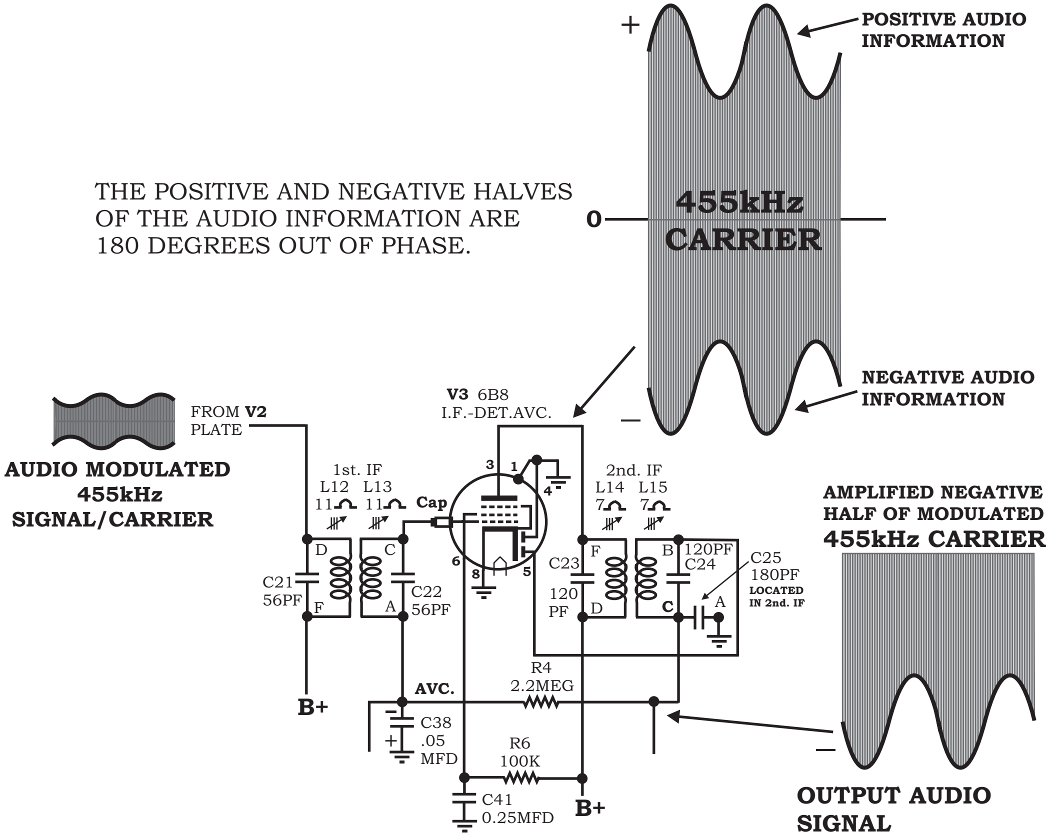


Function of the I.F/Detector AVC and Eye Tube Circuit

I.F.

The primary (L12 and C21) and secondary (L13 and C22) of the 1st. I.F. transformer are two High-Q tuned circuits. Both circuits are tuned to the I.F. of frequency 455kHz which effectively eliminates all other frequencies. The tuned signal from the secondary (L13) is connected to the control grid of V3 (grid cap) which greatly amplifies this signal.

FIGURE 6-6 I.F. / Detector



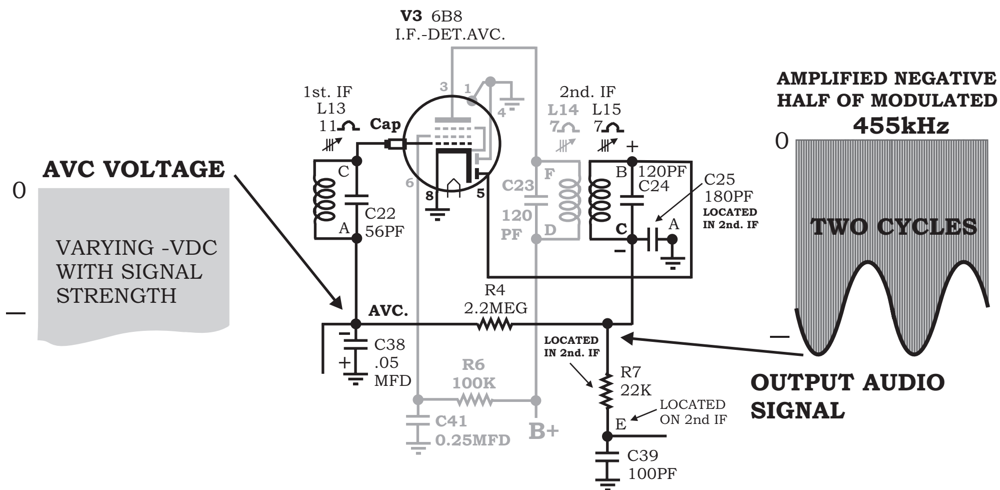
The output of V3 at its plate, drives the primary of the 2nd. I.F. transformer as shown in Figure 6-6. The amplified output of V3 is an amplitude modulated (AM) carrier. The audio information riding on the carrier, and both the positive and negative halves are 180 degrees out of phase. This means that the information (the audio signal) of both halves, adds up to a DC potential of zero.

L14, C23 (primary) and L15, C24 (secondary) of the 2nd. I.F. are high Q circuits also tuned to 455kHz effectively eliminating all other frequencies.

Detector AVC

The modulated signal from the 2nd. I.F. secondary (L15) is detected by the diode plate (pin 5) and the cathode (pin 8) of V3. This part of the circuit rectifies the modulated signal leaving only the negative half. This varying negative DC potential contains the audio information and is the source for the AVC and the audio signal in Figure 6-7.

FIGURE 6-7 Detector AVC



The automatic volume control (AVC) is negative because the diode plate of V3 pin 5 conducts only when it is positive. When terminal B of the 2nd. I.F. is positive, terminal C is negative which is the detected audio signal. Part of this signal passes through R4, and C38 stores and filters this negative voltage (AVC - DC voltage).

The RC time constant of R4 and C38 is long enough so that the AVC varies slowly. With a strong input signal, the negative voltage increases. This negative DC voltage is applied through L13 to the control grid of V3, reducing its gain, decreasing the audio signal.

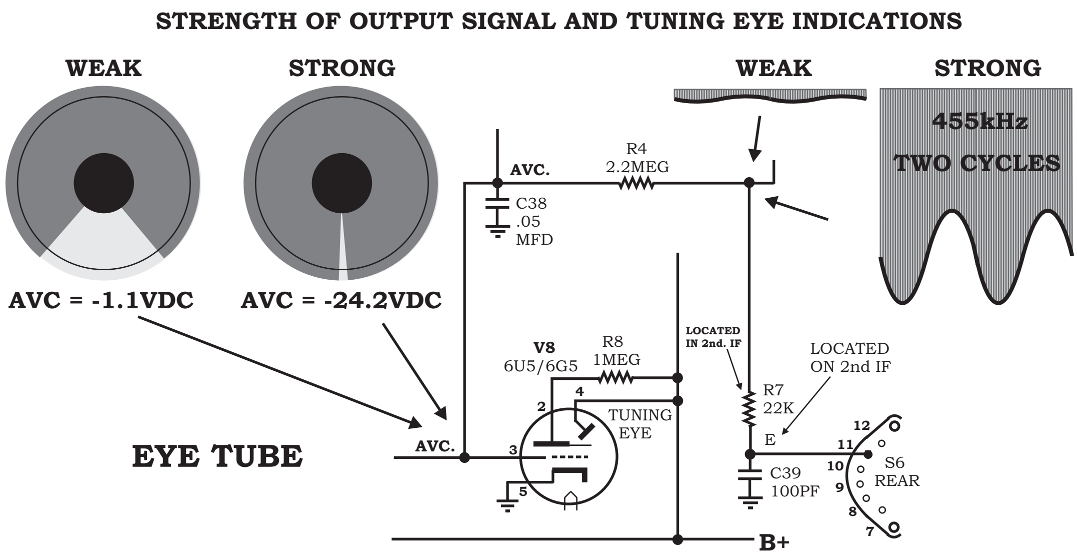
If the input signal becomes weaker, the negative voltage decreases. This decreasing negative DC voltage applied to the control grid of V3, increases its gain, increasing the audio signal.

This action results in automatic control of the volume. When a strong station is detected the gain is decreased. When a weak station is detected the gain is automatically increased.

Eye Tube

The negative AVC voltage is also applied to the control grid of V8 (pin 3), the Electron-Ray Indicator Eye Tube (6U5/6G5).

FIGURE 6-8 Signal Strength and Eye Tube



The eye tube is actually indicating the amount of negative AVC voltage. When the AVC voltage is -1VDC the eye is opened, and when the AVC voltage is -24VDC the eye is closed, as shown in Figure 6-8.

The eye tube is only an indicator, it does not influence or contribute to any other circuit. This tube may be removed without any change to the radio's performance.

Component Function

Refer to Figure 6-5 or Figure A-1.

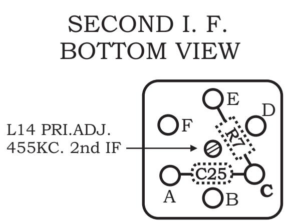
The 1st. I.F. Transformer's primary (L12, C21) and secondary (L13, C22) are very sharply tuned to the intermediate frequency 455kHz. This allows only the 455kHz modulated carrier signal to pass from the primary circuit to the secondary circuit, effectively eliminating all other signals.

The 2nd. I.F. Transformer primary (L14, C23) and secondary (L15, C24) are very sharply tuned to the intermediate frequency 455kHz. This allows only the amplified 455kHz modulated carrier signal to pass from the primary circuit to the secondary circuit, effectively eliminating all other signals.

C25 filters some of the modulated 455kHz signal to chassis ground. This capacitor is located inside the 2nd. I.F., refer to Figure 6-9.

R7 attenuates the amplified signal applied to the volume control R10. R7 is located in the 2nd. I.F., refer to Figure 6-9.

FIGURE 6-9 2nd. I.F. Bottom View



C39 filters some of the 455kHz signal applied to the volume control R10.

R4 and C38: R4 passes the negative DC voltage from the 2nd. I.F. terminal C to C38. C38 stores this negative voltage, making the AVC Automatic Volume Control voltage.

R6 and C41 maintains a positive bias on V3 screen grid (pin 3).

R8 supplies a positive potential on the plate of V8 pin 2.

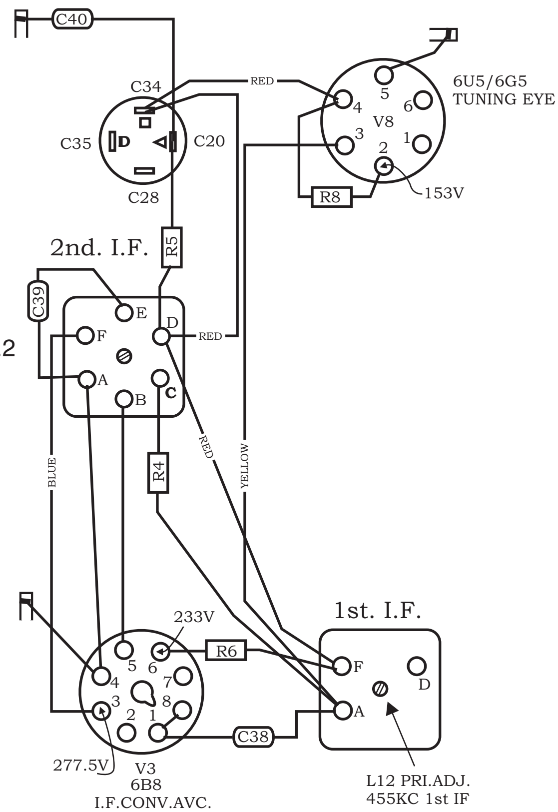
Component Function (continued)

V3 amplifies the 455kHz modulated signal and also detects the audio signal (de-modulating the audio signal).

V8 indicates the strength of the radio stations (AVC voltage).

FIGURE 6-10 Voltage listing for V3 and V8

PIN#	V3	V8
1	0.0	F
2	F	153
3	277.5	-1.1/-24.2
4	0.0	280
5	-16.0	0.0
6	233	F
7	F	N/A
8	0.0	N/A

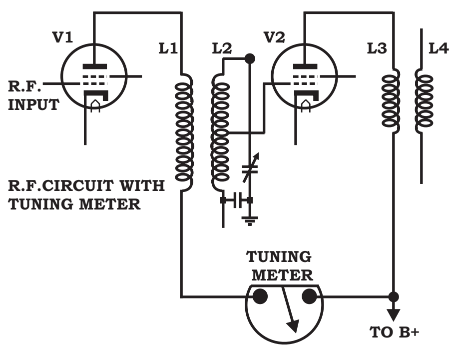


A list of voltages by pin number are shown in Figure 6-10. For a complete listing of voltages refer to Figure A-11. This information is very useful when troubleshooting, any large variations may indicate the problem area. All voltages may vary by +/- 20%. For the complete bottom view refer to Figure A-4.

Tuning Meter Indicator Circuit

Another type of strength indicator is the tuning meter. This meter is in series with L1 as shown in Figure 6-11. As tube V1's conduction increases or decreases, the tuning meter indicates this change. Unlike the eye tube, the tuning meter supplies a path for the B+ to the plate of V1. If the tuning meter was removed or if its coil was open the radio would not play. An impedance matching resistor (impedance matching the tuning meter coil) could be substituted to supply the B+ to V1 allowing the circuit to function.

FIGURE 6-11 Tuning Meter

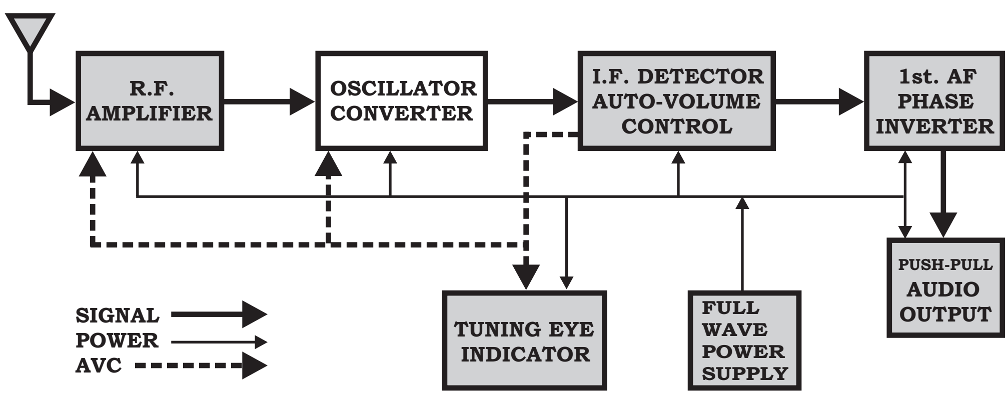


7
Local Oscillator

Local Oscillator Mixer Converter

The Local Oscillator Mixer Converter circuit is highlighted in Figure 7-1. This circuit converts the AM (Amplitude Modulated carrier) radio station frequencies to the 455kHz Intermediate Frequency (I.F.).

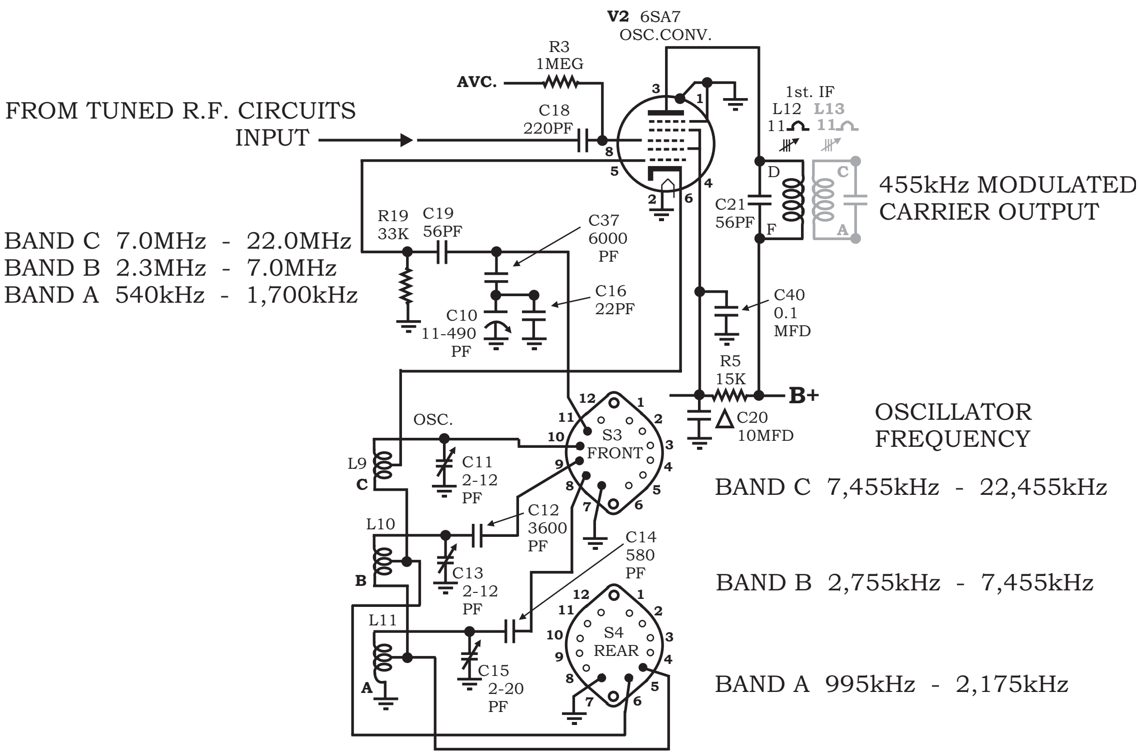
FIGURE 7-1 Oscillator Mixer Converter



The amplified radio frequency(R.F.) is the input to this circuit. The output of the Mixer Converter circuit is the I.F. -- a 455kHz modulated carrier. It is this signal that the I.F. / Detector Circuit, filters, amplifies, and demodulates.

The Vacuum tube used in this circuit is the 6SA7 (V2). It is a Pentagrid Converter, the filament voltage is 6.3VAC and the maximum plate voltage is 300VDC. Refer to Figure A-3 for the socket pin count. For the Base Diagram of the 6SA7 refer to Figure A-12.

FIGURE 7-2 Local Oscillator Mixer Converter Circuit



The wiring diagram of the Local Oscillator Mixer / Converter Circuit is shown in Figure 7-2. Refer to Figure A-1 for the complete wiring diagram. For the physical location of all components refer to Figure A-2.

Refer to Figure A-9 for the schematic and physical drawing.

Function of the Local Oscillator Circuit

Switch S3 and S4

The cathode of V2 has a chassis ground connection through the taps of the oscillator coils L9, L10, and L11, as shown in Figure 7-2. Starting at pin 6 of V2 there is a direct connection to the tap of L9. The ground connection continues through the bottom part of L9 to the tap of L10. This connection continues through the bottom part of L10 to the tap of L11, and then through the bottom of L11 to chassis ground.

Switches S3 and S4 are both on the same wafer and they change all the connections to the oscillator coils for each Band. Only one set of coils is used per band. L11 is in the circuit for band A, L10 is for band B, and L9 is for band C.

S3 switches the top (or output) connection of each coil. When the band switch is on band A, terminals 8 and 11 are connected together. For band B, terminals 9 and 11 are connected together, and for band C, terminals 10 and 11 are connected.

S3 also grounds the top (or output) of coils L11 and L10 when they are not in use. If the switch is on band B, terminals 8 and 7 are connected together grounding out L11 (band A). If the switch is on band C, terminals 9, 8 and 7 are all connected together grounding out L10 and L11, grounding out bands A and B.

S4 switches the ground connection for L10 and L9. The bottom of L11 is connected directly to chassis ground and is the band A connection. For band B, terminals 5 and 7 are connected together, grounding the bottom of L10. When the switch is on band C, terminals 5, 6 and 7 are all connected together, grounding the bottoms of L10 and L11.

The output for all the bands in this switching system is at S3 terminal 11. This terminal is connected to a series parallel capacitor circuit of C10, C16, and C37, which tunes all three bands. C10 is the variable capacitor that varies when tuning the radio.

The Oscillator

The result of S3 and S4 switching is shown in Figure 7-3. Band A is shown in the oscillator circuit. To change bands, remove band A's circuit and substitute the other circuits. All three bands function the same.

FIGURE 7-3 Oscillator

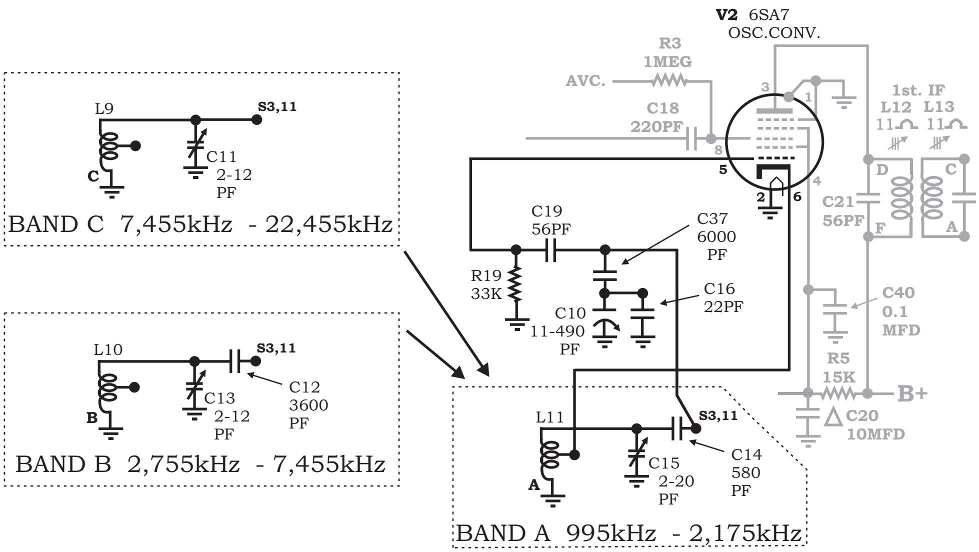


FIGURE 7-4 Tuning Circuit

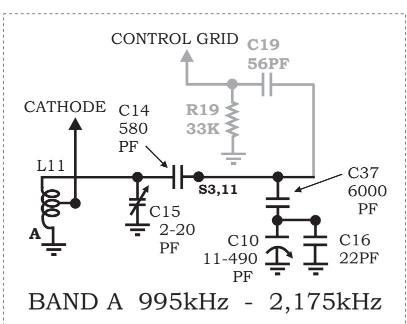


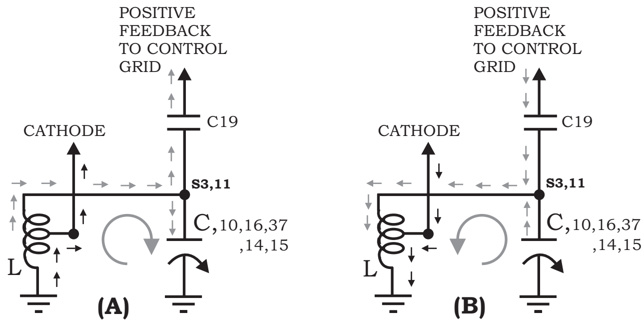
Figure 7-4 shows all the capacitors and coil for band A. Capacitors C10, C16, and C37 are connected to the specific capacitors and coil for each band.

All the capacitors (C10, C16, C37, C14, C15) effectively make a single variable tuning capacitor, for the tuned circuit.

Tuned Circuit

Figure 7-5 shows the resulting tuned circuit from Figure 7-4.

FIGURE 7-5 Tuned Circuit



When current starts to flow through V2 (Cathode to Plate), electrons flow through the bottom part of coil L. This causes the magnetic field to expand and cut across the windings of the top part of coil L, increasing electron flow at the top of coil L. This electron flow is applied to the control grid which causes V2 to conduct more, as shown in Figure 7-5 part (A). Also capacitor C is being charged. This process can only continue until V2 reaches maximum conduction.

At this point the magnetic field of coil L collapses inducing an electron flow in the opposite direction. This is applied to V2's control grid causing V2 to reduce its conduction even more, as shown in Figure 7-5 part (B). This process can only continue until V2 reaches minimum conduction and capacitor C discharges through coil L.

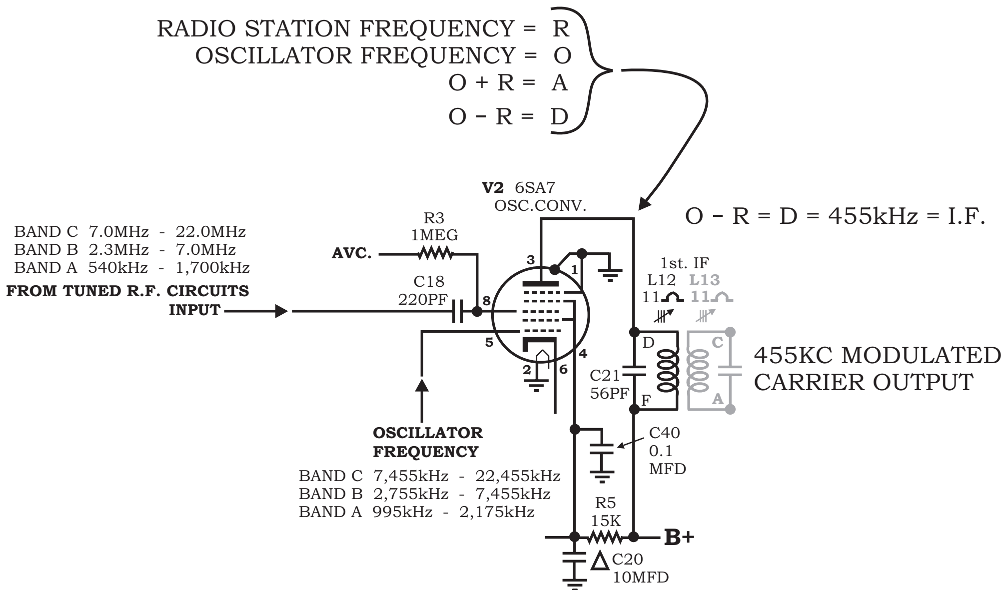
This completes one cycle (oscillation), and at this point the process starts over.

The choice of coil L determines the band's frequency. The variable capacitor C varies the frequency with in the radio band.

This circuit continues to oscillate because of positive feedback. This is the electron flow on the control grid of V2. It is always in step, controlling and reinforcing the electron flow through V2.

Function of the Mixer Converter Circuit

FIGURE 7-6 Mixer Converter Circuit



The mixer converter circuit combines two signals to produce the 455kHz modulated Intermediate Frequency (I.F.).

The oscillator frequency is applied to the control grid of V2 pin 5. The amplified radio frequency is applied to the signal grid of V2 pin 8. These two signals are mixed together creating four major frequencies at the output of V2's plate. The frequencies are the oscillator frequency (O), the radio station frequency (R), the oscillator plus the radio frequency ((A)dded together), and the oscillator frequency minus the radio station frequency (the (D)ifference) -- which is the intermediate frequency of 455kHz.

The 1st. I.F.'s primary and secondary circuit are sharply tuned to 455kHz eliminating almost all unwanted frequencies. Only the filtered 455kHz modulated signal passes through to the I.F. amplifier and detector circuit.

Component Function

Refer to Figure 7-2 and Figure A-1.

R3 is the bias resistor for the signal grid. The bias voltage is supplied from the AVC circuit.

C18 isolates the signal grid bias (DC) of V2 from the R.F. circuit (V1 plate DC). It also passes the R.F. signal from V1 (AC) to the signal grid of V2.

R19 is the bias resistor for the control grid of V2.

C19 isolates the bias (DC) of the control grid from the tuning circuit (L and C). It passes the positive feedback (AC) to the control grid of V2.

C10, C16 and C37 make up the variable capacitor tuning circuit for the local oscillator.

L9 and C11: band C circuit.

L10, C13 and C12: band B circuit.

L11, C15 and C14: band A circuit.

S3 switches outputs of L9, L10, and L11 to the control grid of V2 pin 5.

S4 switches chassis ground to the bottom of L10 and L11.

C40 supplies a R.F. path for V2 pin 4 to chassis ground.

R5 Is a B+ voltage dropping resistor.

C20 Is an electrolytic filter capacitor.

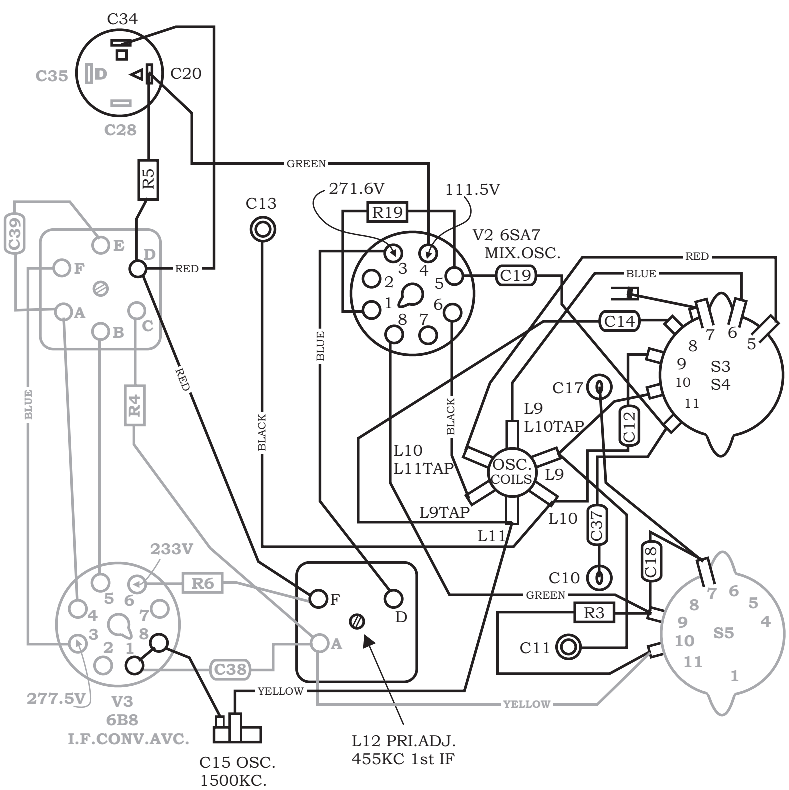
L12, C21 1st. I.F. primary 455kHz tuned circuit. Load for V2's plate pin 3.

V2 Is a 6SA7 the Local Oscillator Mixer / Converter Tube.

A list of voltages by pin number is shown in Figure 7-7. For a complete listing of voltages refer to Figure A-11. All voltages may vary by +/- 20%. This information is very useful when troubleshooting and any large variations may indicate the problem area.

Refer to Figure A-3 for the tube socket pin count. Refer to Figure A-4 for the physical tube socket location, bottom view.

FIGURE 7-7 Voltage Listing of V2



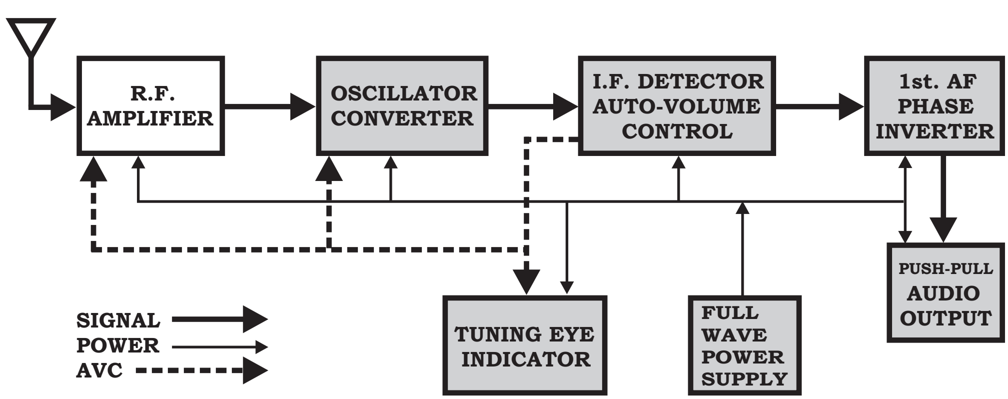
PIN#	V2
1	0.0
2	F
3	271.6
4	111.5
5	-15.8
6	0.006
7	F
8	-13.3

8
R.F. Amplifier

Radio Frequency Amplifier

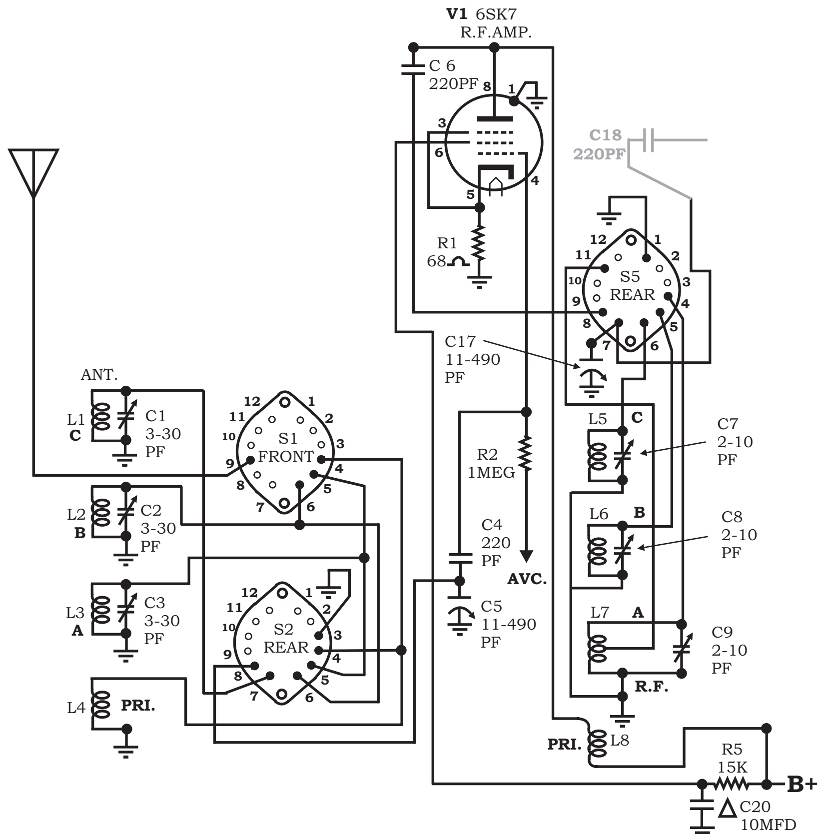
The Radio Frequency (R.F.) Amplifier amplifies the radio station signal from the antenna (input) and outputs this amplified signals to the Oscillator Converter Circuit. The Radio Frequency Amplifier is highlighted in Figure 8-1.

FIGURE 8-1 Radio Frequency Amplifier



In this radio, both the input and the output of the radio frequency amplifier are tuned R.F. circuits. Each radio band (A, B, and C) has its own pair of input and output tuned circuits.

FIGURE 8-2 Radio Frequency Amplifier Circuit



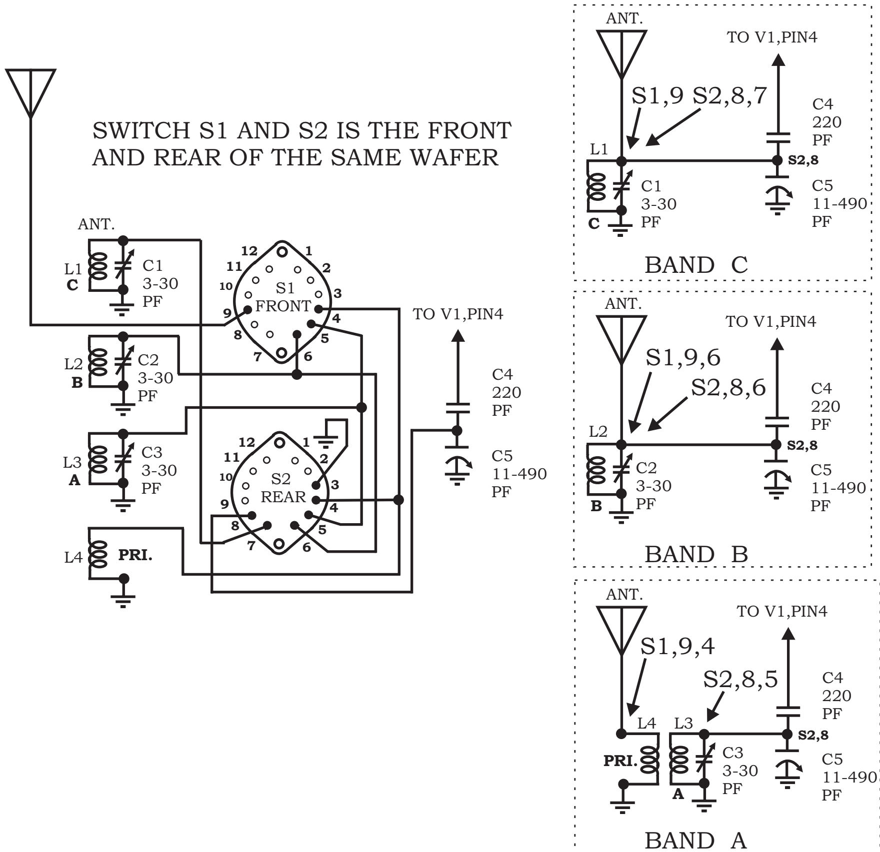
The Vacuum tube used in this circuit is the 6SK7 (V1). It is a Remote Cutoff R.F. Pentode. The filament is 6.3VAC, and the maximum plate voltage is 300VDC. For the Base Diagram of the 6SK7 refer to Figure A-12.

The Radio Frequency Amplifier Circuit is shown in Figure 8-2, and for the complete wiring diagram refer to Figure A-1. For the physical location of V1 refer to Figure A-4. Refer to Figure A-10 for the schematic and physical drawing.

Function of the Radio Frequency Amplifier Circuit

Antenna Tuning

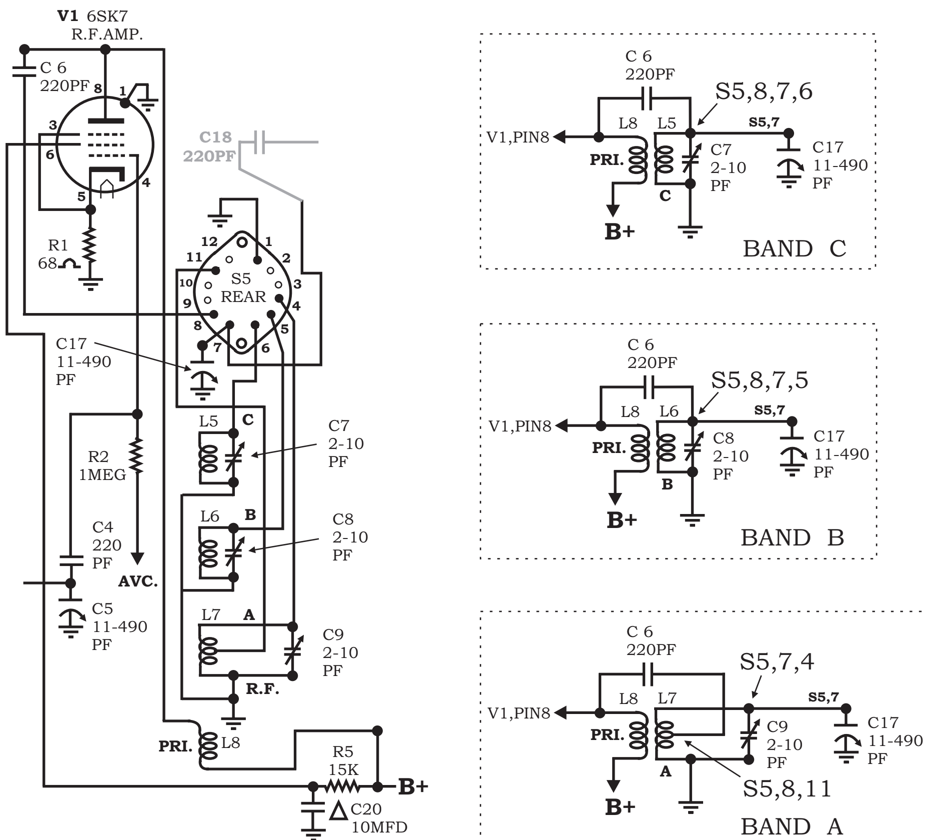
FIGURE 8-3 Antenna Tuning Coils and Switches



When the band switch is on band A, L4, L3, and C3 are connected in the circuit as shown in Figure 8-3. In band B, L2 and C2 are connected in the circuit and L4, L3, and C3 (S2, 4, 5) are connected to chassis ground. In band C, L1 and C1 are connected in the circuit and L4, L3, C3, L2, C2 (S2, 4, 5, 6) are all connected to chassis ground. All three bands have their output at S2, 8 and tuned by C5. This signal is transferred through C4 to the control grid of V1 pin 4.

R.F. Amplifier and Output

FIGURE 8-4 R.F. Amplifier and Tuned Output



The signal on the control grid of V1 is greatly amplified and is output at the plate (pin 3) through L8, the primary of all three R.F. coils. When the band switch is on band A, L7 and C9 are connected in the circuit as shown in Figure 8-4. In band B, L6 and C8 are connected in the circuit and L7, C9 are connected to chassis ground. In band C, L5 and C7 are connected in the circuit and L6, C8, L7, C9 are all connected to chassis ground. All three bands have their output at S5, 7, and are tuned by C17. This signal is transferred through C18 to the signal grid of V2 pin 8 of the oscillator mixer converter circuit.

Component Function

Refer to Figure 8-2 or Figure A-1.

S1 switches the antenna connection to the antenna-tuned circuits.

S2 switches the antenna-tuned circuits.

L1 and C1, band C antenna-tuned circuit.

L2 and C2, band B antenna-tuned circuit.

L3 and C3, band A antenna-tuned circuit.

L4 primary for L3, band A only.

C5 tunes all bands for the antenna-tuned circuits, when tuning the radio.

C4 transfers antenna-tuned signal to control grid of V1 pin 4.

S5 switches the R.F. output tuned circuits.

L5 and C7, R.F. tuned output circuit for band C.

L6 and C8, R.F. tuned output circuit for band B.

L7 and C9, R.F. tuned output circuit for band A.

L8 primary for all R.F. output coils.

C7 tunes all bands for the R.F. output tuned circuits, when tuning the radio.

C18 transfers the R.F. tuned output to the signal grid of V2 pin 8.

C6 transfers the amplified antenna-tuned R.F. from V1 pin 3 plate to the R.F. tuned output circuits.

R1 cathode resistor, grid biasing and current limiting.

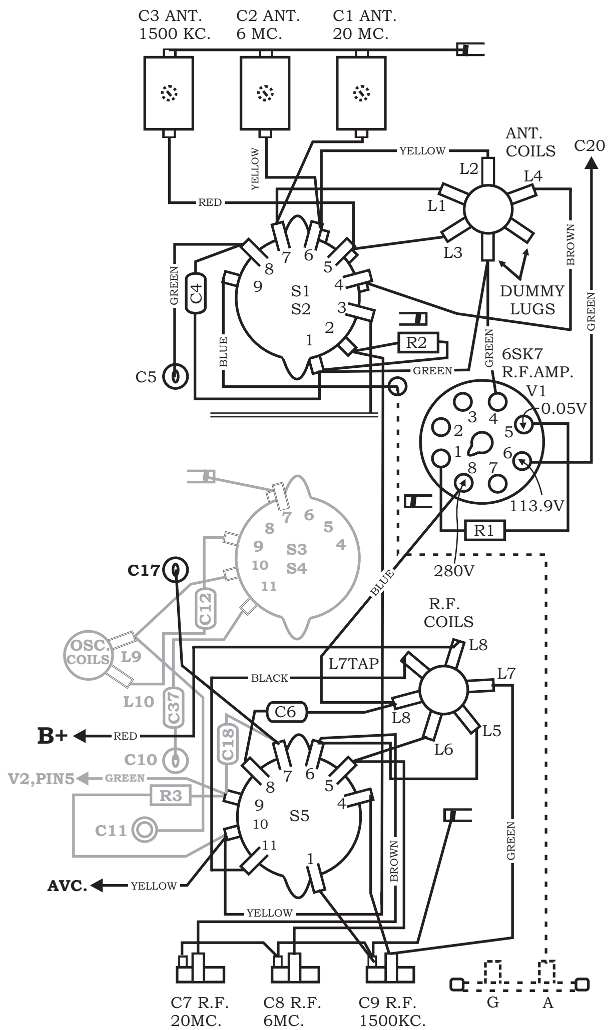
R2 control grid biasing resistor, DC source is the AVC.

V2 amplifies the R.F. and outputs this to the Primary of L8.

A list of voltages by pin number of V1 is shown in Figure 8-5. For a complete listing of voltages refer to Figure A-11. All voltages may vary by +/- 20%. This information is very useful when troubleshooting because any large variations may indicate the problem area.

Refer to Figure A-3 for the tube socket pin count, and refer to Figure A-4 for the physical tube socket locations, bottom view.

FIGURE 8-5 Voltage listings of V1



PIN#	V1
1	0.0
2	F
3	0.049
4	-17.8
5	0.049
6	113.9
7	F
8	280

9

Continuity Testing

Continuity Testing
Transformers, Coils and Resistors

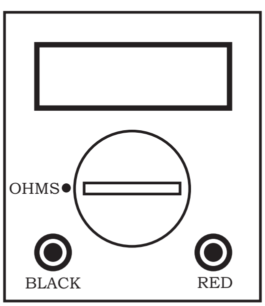


FIGURE 9-1 Ohmmeter

Before ordering a set of vacuum tubes or replacing the capacitors it is a good idea to test all transformers, coils, and resistors first. If the power transformer is burnt out, the cost to replace it may be more than what the radio is worth. Other parts that would be very difficult to repair or replace are the I.F. transformers, the oscillator, R.F., and the antenna coils. If there are too many bad parts, then the radio may be a candidate for the used parts box.

A typical digital ohmmeter illustrated in Figure 9-1 maybe used to test all the transformers, coils, and resistors.

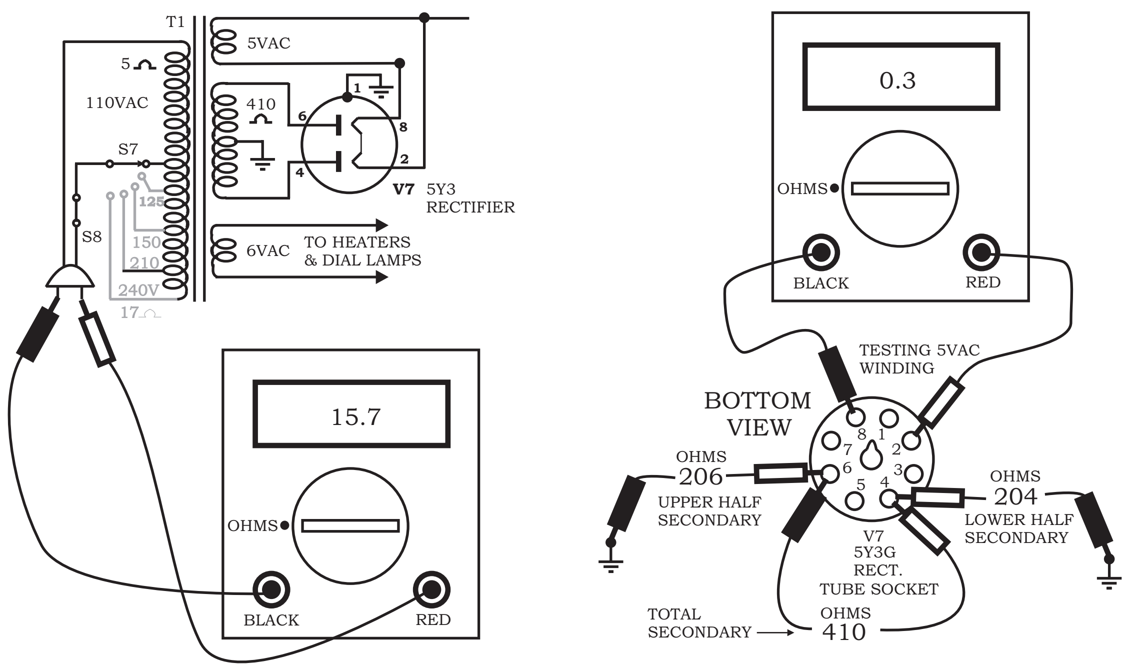
Remember, the radio **should not be plugged into AC power!** There are many tests and repairs that must be completed before it is safe to power up the radio!

With the wiring diagram and drawings for your radio, remove all of the vacuum tubes and place the radio chassis on the workbench upside down. For the complete wiring diagram of the 8Q2 radio refer to Figure A-1. For the bottom view refer to Figure A-4.

Test Points

Test Points for the Power Transformer

FIGURE 9-2 Power Transformer Test Points



The power plug is a convenient place to start. Figure 9-2 shows the procedure for testing the primary side of T1. With the radio power switch (S8) in the “on” position, connect the ohmmeter leads to the power plug prongs. The primary side of T1 in Figure 9-2 shows a value of 5 ohms. Because the line cord and the switch contacts all add resistance to this circuit, this test point reads 15.7 ohms. If this test point reads very high or very low in ohms, use the ohmmeter to test each component separately. The plug and line cord, S8, S7, and the primary of T1.

*Note: Power switch might read open if the contacts are dirty.

The test points for the high voltage secondary and the 5VAC secondary of T1 are shown in Figure 9-2. These test points are found at the rectifier tube socket (V7) and with the 5Y3 tube removed, this ensures that only the 5VAC winding is measured.The 5VAC secondary winding is measured across pins 2 and 8, and it reads about 0.3 ohms. The high voltage secondary is measured across pins 4 and 6 (410 ohms). The secondary tap is connected to the chassis ground. Each side of the secondary is measures from chassis ground and pin 6 (206 ohms) and pin 4 (204 ohms).

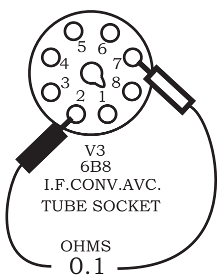


FIGURE 9-3 6VAC Test Points

The 6VAC secondary winding test points are shown in Figure 9-3. To ensures that only the winding of the 6VAC secondary is measured, remove all the 6V tubes. This secondary can be measured between pins 2 and 7 of V3, measuring about 0.1 ohms. All of the 6V tube filaments are wired in parallel and should measure the same at each 6V tube socket. Refer to Figure A-12 for the tube base diagrams for the tubes in this radio. Note that the 6SC7 filament connections are 7 and 8, and the 6U5/6G5 filament connections are 1 and 6.

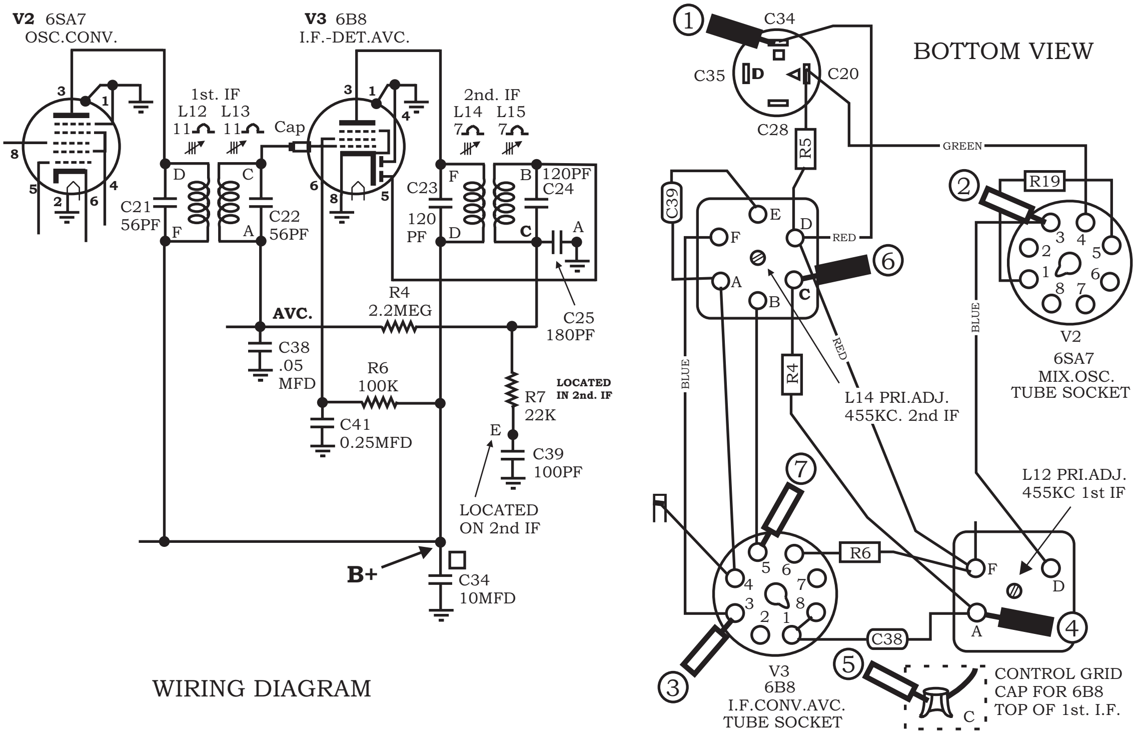
If any of T1's windings are open, the power transformer must be replaced. A suitable replacement must have the same specifications as T1 or better. Refer to Chapter - 10: Page - 98 "Power Transformer Replacement" for a detailed replacement procedure.

If the maximum current output specifications of the replacement transformer is less then the original (T1), the replacement transformer will run hot and eventually burn out.

Conclusion: you must use an equal or higher rating.

Test Points for the I.F. Transformers

FIGURE 9-4 I.F. Transformer Test Points

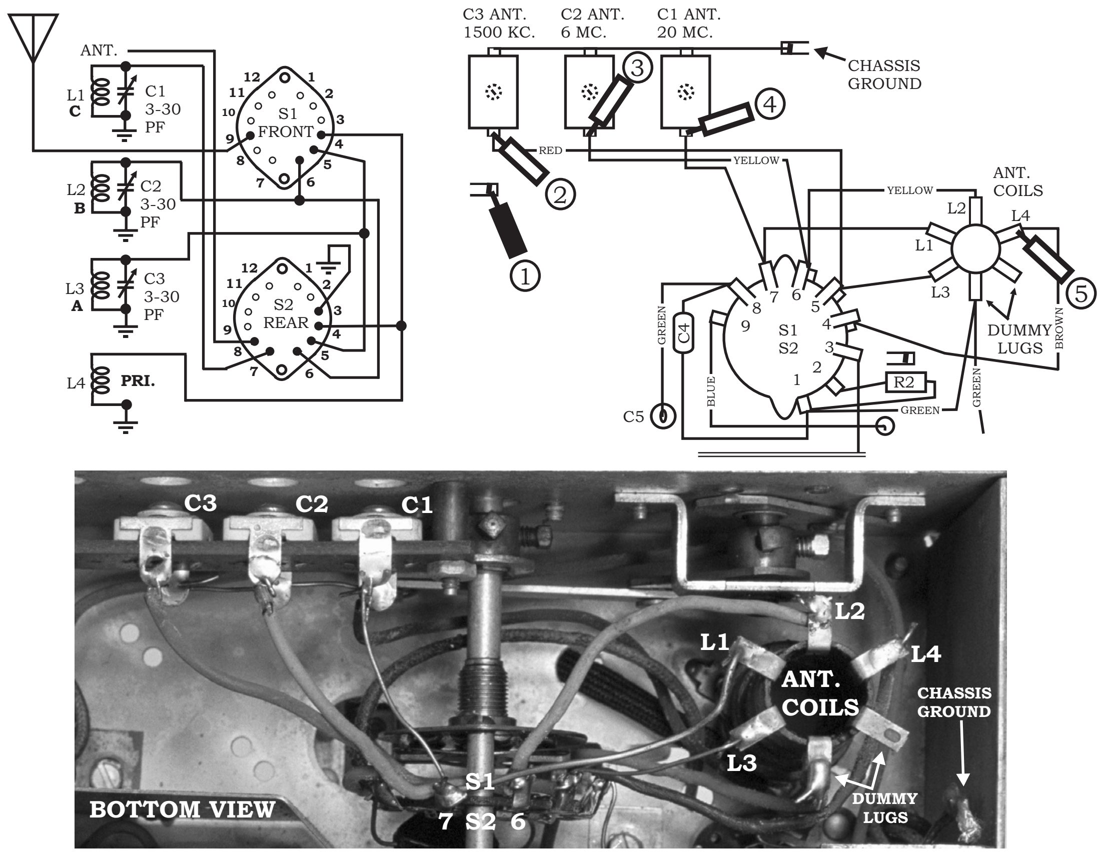


The test points for both I.F. transformers are shown in Figure 9-4. Test points 1 and 2 test the primary of 1st. I.F. transformer. The ohmmeter is connected between the positive terminal of C34 and pin 3 of V2, (11 ohms). Test points 1 and 3 test the primary of the 2nd. I.F transformer, and the ohmmeter is connected between the positive terminal of C34 and pin 3 of V3, (7 ohms). Test points 4 and 5 tests the secondary of the 1st. I.F. transformer. The ohmmeter is connected between terminal A and the control grid cap of the 1st. I.F., (11 ohms). Test points 6 and 7 tests the secondary of the 2nd. I.F. transformer. The ohmmeter is connected between terminal C of the 2nd. I.F. and pin 5 of V3, (7 ohms).

If an I.F. transformer is found to be bad refer to Chapter - 10: Page - 97 "I.F. Transformer replacement."

Test Points for the Antenna Coils

FIGURE 9-5 Antenna Coil Test Points



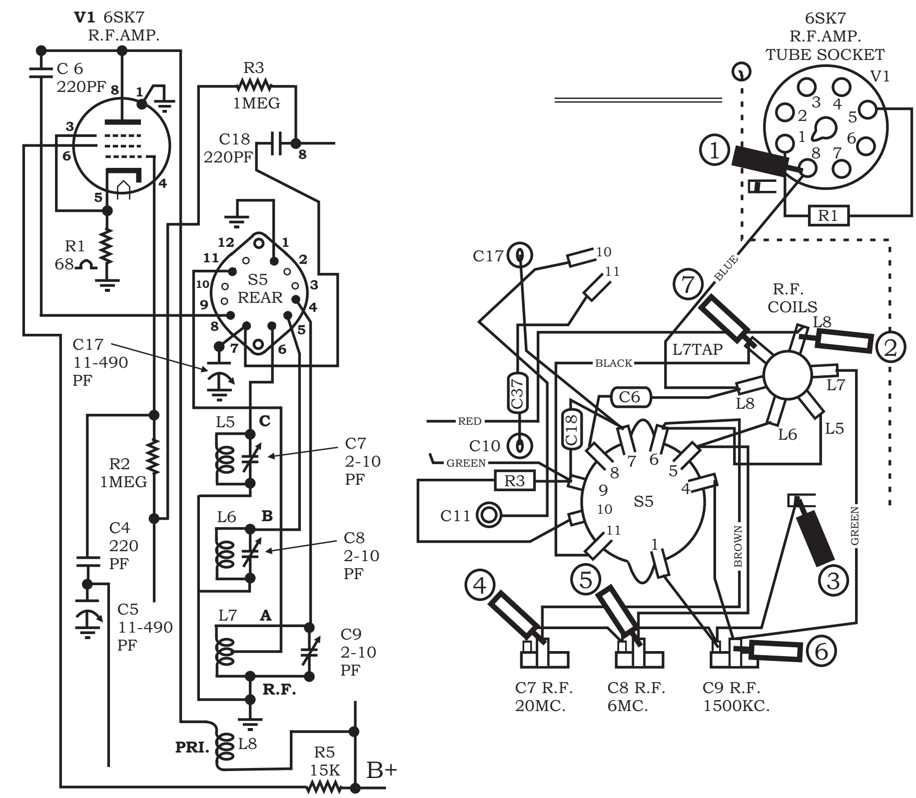
All readings are with the band switch set to band A. All of the antenna coils have one side connected to chassis ground as shown in Figure 9-5. Connect one test lead of the ohmmeter to chassis ground (test point 1). The other lead will be connected to the test points 2, 3, 4, and 5.

Test points 1 and 2 test L3 (4.0 ohms).
Test points 1 and 3 test L2 (1.5 ohms).
Test points 1 and 4 test L1 (0.3 ohms).
Test points 1 and 5 test the Primary (36.7 ohms).

Test Points for the R.F. Coils

FIGURE 9-6 R.F. Coil Test Points

WIRING DIAGRAM BOTTOM VIEW



All readings are with the band switch set to band A. Test points 1 and 2 have one test lead of the ohmmeter connected to pin 8 of V1 and the other lead is connected to the bottom side of L8, or the positive side of C34 (98.6 ohms).

Test points 1 and 2 test coil L8 (98.6 ohms).
Test points 3 and 4 test coil L5 (0.4 ohms).
Test points 3 and 5 test coil L6 (1.6 ohms).
Test points 3 and 6 test coil L7 (4.1 ohms).
Test points 3 and 7 test coil L7 tap (0.8 ohms).

FIGURE 9-7 R.F. Coils Bottom View

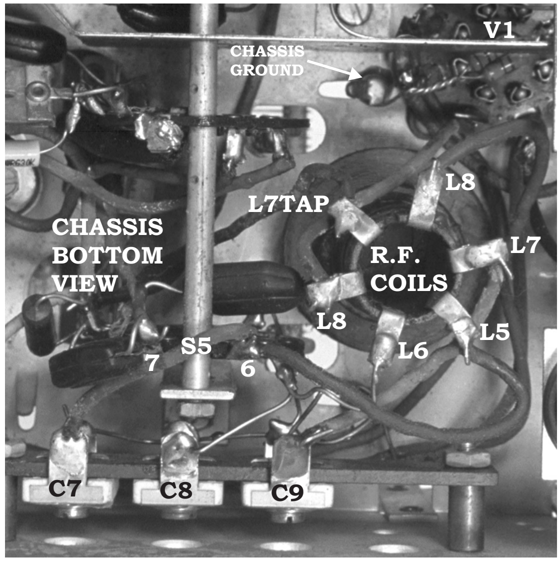
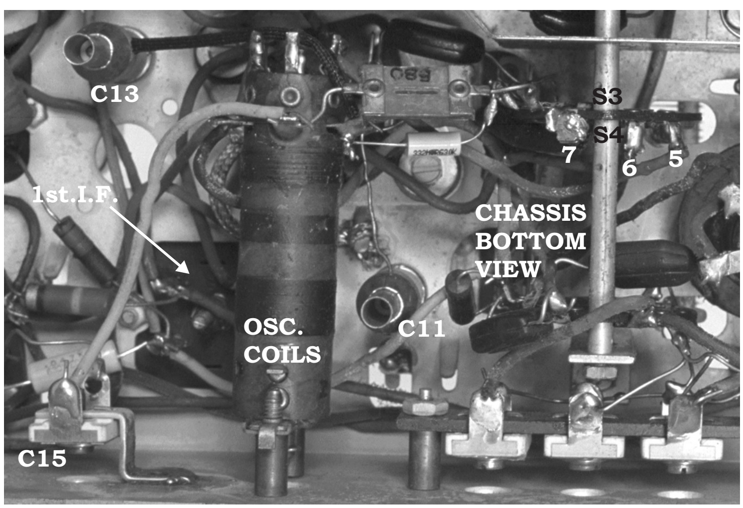
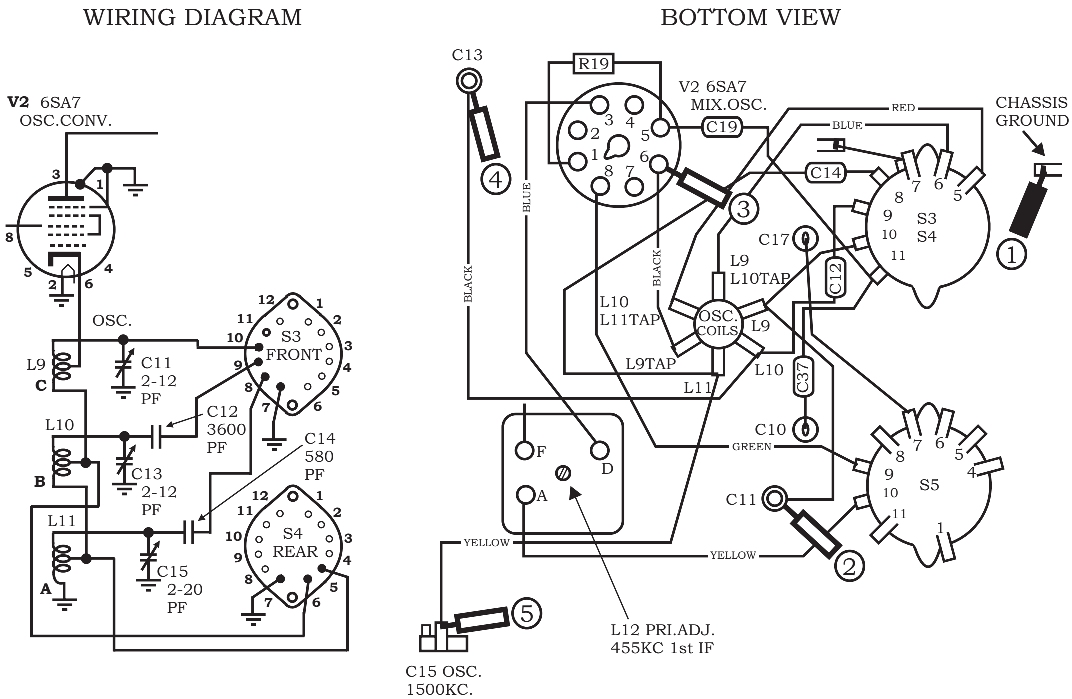


FIGURE 9-8 Oscillator Coils Bottom View



Test Points for the Oscillator Coils

FIGURE 9-9 Oscillator Coil Test Points



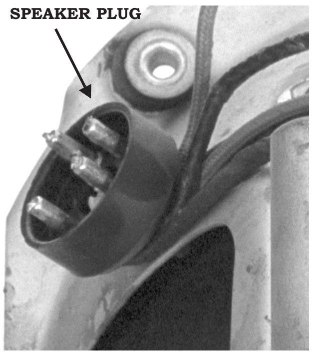
All readings are with the band switch set to band A. The oscillator coils L9 and L10 are connected to chassis ground through their center tap connections, ending at the bottom of coil L11, as shown in Figure 9-9. Connect one test lead of the ohmmeter to chassis ground (test point 1) and the other lead is connected to the test points 2, 3, 4, and 5.

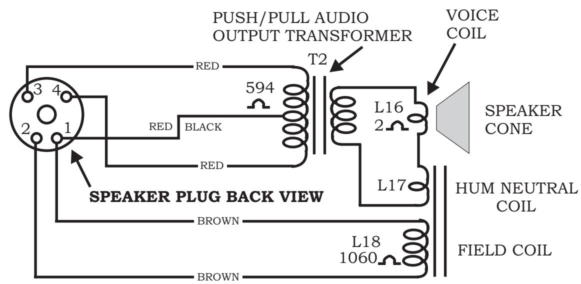
Test points 1 and 2 test L9, and the bottom of L10 and L11 (1.0 ohms).
Test points 1 and 3 test the bottom of L9, L10, and L11 (1.0 ohms).
Test points 1 and 4 test L10, and the bottom of L11 (1.8 ohms).
Test points 1 and 5 test L11 (3.8 ohms).

If any antenna, R.F., or oscillator coils are found to be bad refer to Chapter - 10: Page - 99 "Coil Repair" and Chapter - 10: Page - 100 "Coil Rewinding."

Test Points for the Speaker

FIGURE 9-10 Speaker Socket Diagram





The illustration in Figure 9-10 show a picture of the speaker plug mounted on the back of the speaker. It also has a wiring diagram of all the components of the speaker.

The electrical components to be tested are the push / pull audio output transformer, the voice coil, the hum neutralizing coil, and the field coil.

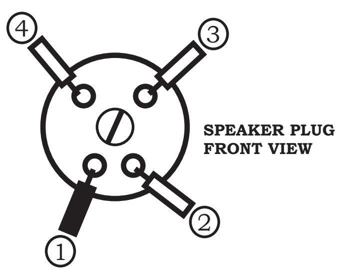


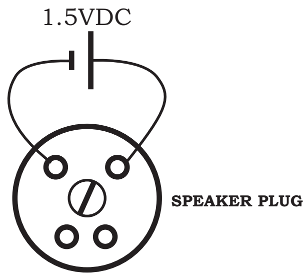
FIGURE 9-11 Speaker Test Points

Connect one lead of an ohmmeter to test point 1 as shown in Figure 9-11. This makes an electrical contact with both the audio transformer and the field coil as shown in the wiring diagram of Figure 9-10.

Test points 1 and 2 test the field coil (1,093 ohms).
Test points 1 and 3 test the top half of the audio transformer primary (290 ohms).
Test points 1 and 4 test the bottom half of the audio transformer primary (322 ohms).

Sometimes there is no accessible electrical connection to the secondary of the audio output transformer, the hum neutralizing coil, or the voice coil. If the test points (1 and 3) and (1 and 4) are good a 1.5 volt battery can be used to test the remaining coils.

FIGURE 9-12 Voice Coil Testing



This procedure is shown in Figure 9-12 and also refer to the wiring diagram in Figure 9-10.

If one side of the connection is removed and then reconnected repeatedly, a small clicking sound should be heard from the speaker. This clicking sound confirms that all the remaining coils have continuity.

If the audio transformer is bad refer to Chapter - 10: Page - 99 "Audio Transformer Replacement."

Testing Resistors

Test all the resistors with an ohmmeter and replace the resistors that are out of tolerance with resistors of matching specifications. A higher wattage replacement resistor may be used, if it will physically fit in the circuit. If a resistor reads low, always check the wiring diagram for other components that may be in parallel with the resistor under test.

10
Part Replacement

Capacitors

After the continuity testing has been completed, capacitor replacement is essential. There are three types of capacitors in most radios, the Pico Farad Mica Capacitors (Micro-Micro Farad), the Micro Farad Wax Capacitors, and the Micro Farad Electrolytic Capacitors.

Mica

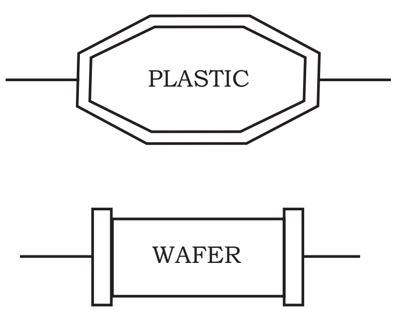
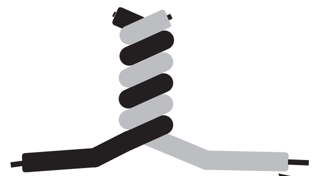


FIGURE 10-1 Mica Capacitors

Two types of Mica capacitors are used in the 8Q2 R.C.A. radio, the plastic and the wafer as shown in Figure 10-1. To test these capacitors disconnect one side and then check the capacitances with a capacitor tester. If a replacement is required, the exact capacitances must be matched and the working voltage must be the same or higher.

Gimmick

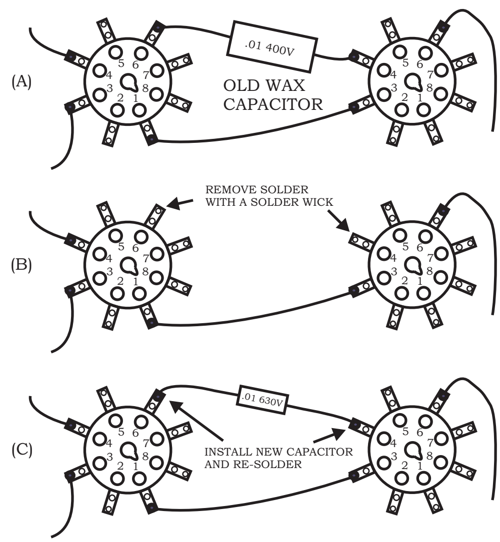
FIGURE 10-2 Gimmick Capacitor



There is another type of Pico Farad capacitor known as a Gimmick. It consists of two insulated wires twisted together as shown in Figure 10-2. This type of capacitor is not used in the 8Q2 radio, but if one is found in your radio do not unwind the wires. These capacitors are probably good if the insulation is intact. If it must be replaced, look in your wiring diagram for the value of the capacitance.

Wax Capacitors

FIGURE 10-3 Complete Replacement

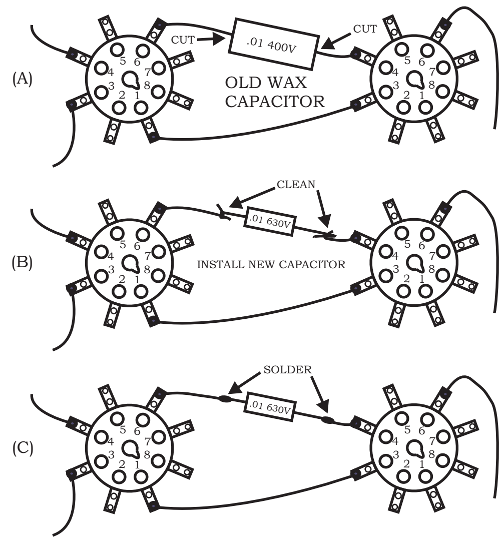


Over the years the wax has melted causing the capacitors to fail. All wax capacitors need to be replaced with new capacitors that have the same (or very close, less then 1MFD within 5%, more then 1MFD within 10%) capacitance, and the same or higher voltage rating. Using capacitors that are all rated at 630 volts will simplify your inventory.

One way of replacing these capacitors is to replace them completely as shown in Figure 10-3.

Part (A) shows the capacitor that is to be replaced in the chassis. Part (B) shows that the capacitor has been removed, but be careful not to break the tube pins. The solder on the pins of the tube sockets has been removed and cleaned, using a solder iron and a solder wick. Part (C) shows the new capacitor installed and soldered.

FIGURE 10-4 Cut and Replace



Another method of replacing capacitors is shown in Figure 10-4. Part (A) shows the old capacitor to be replaced. Part (B) shows that the old capacitor has been cut out and the remaining wire ends cleaned. The wire ends can be cleaned using a small file or a fingernail file. Then 1/4 of an inch of the old capacitor wire ends are bent back. The new capacitor is installed by bending the new wire ends with the old. The excess wire is cut off and then both bends are closed. Part (C) shows that both connections are soldered together.

This cut and replace method is easier and is less likely to damage the tube pins. The new capacitors are all bipolar and can not be installed backwards.

Electrolytic Capacitors

Electrolytic capacitors are polarized and must be installed correctly. If these capacitors were to be installed backwards, this could result in damaging the radio and the capacitors could explode! Electrolytic capacitors must be installed with the positive side of the capacitor connected to the positive side of the radio circuit. The negative side of the capacitor must be connected to the negative side of the radio circuit. This is the common chassis ground connection in the 8Q2.

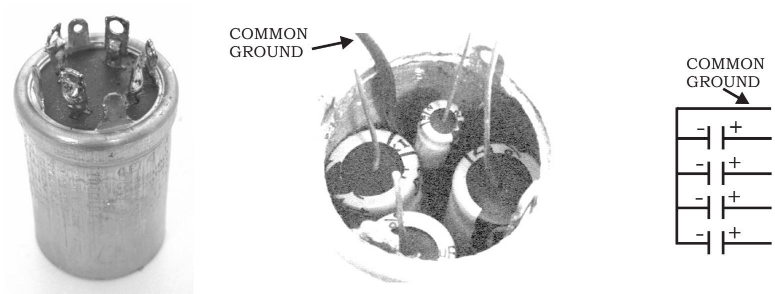
For a detailed description of electrolytic capacitors with a common chassis ground, refer to Chapter - 3: Page - 27 "Filtration."

For a detailed description of electrolytic capacitors without a common chassis ground, refer to Chapter - 3: Page - 36 "Electrolytic Capacitor Isolation."

The R.C.A. 8Q2 radio has a single metal can housing four electrolytic capacitors (C20, C28, C34, C35), refer of Figure A-2 and Figure 3-11.

To save room in the chassis, hollow out the metal can and then install the new capacitors inside. This method is shown in Figure 10-5.

FIGURE 10-5 Electrolytic Capacitor Replacement



(A) **(B)** **(C)**

Figure 10-5 part (A) shows the electrolytic can removed from the chassis. Using an electric drill, drill many holes through the bottom insulating material, being careful not to damage the metal can. Using dental tools and a screwdriver remove all the material from the inside of the can.

Part (B) shows the new capacitors installed in the metal can. C20 is a 20MFD at 50V. C28, C34, and C35 are all 10MFD at 450V.

Part (C) shows the wiring diagram of the electrolytic capacitors. All the negative ends are connected together with an insulated wire for the common ground connection.

With the metal can mounted on the chassis, the common ground wire is soldered to a common ground chassis terminal. An isolated terminal strip was added (four isolated terminals) close to the metal can. The positive sides of each capacitor is connected to an isolated terminal, and then each power circuit is connected to the appropriate terminal.

If there is room to install the electrolytic capacitors under the chassis make sure that the old capacitors are completely disconnected.

Spare Parts

Sometimes parts that are needed for a repair are no longer available and with out a good spare, there is no way to repair the radio.

FIGURE 10-6 Zenith Model 6S439 Chassis

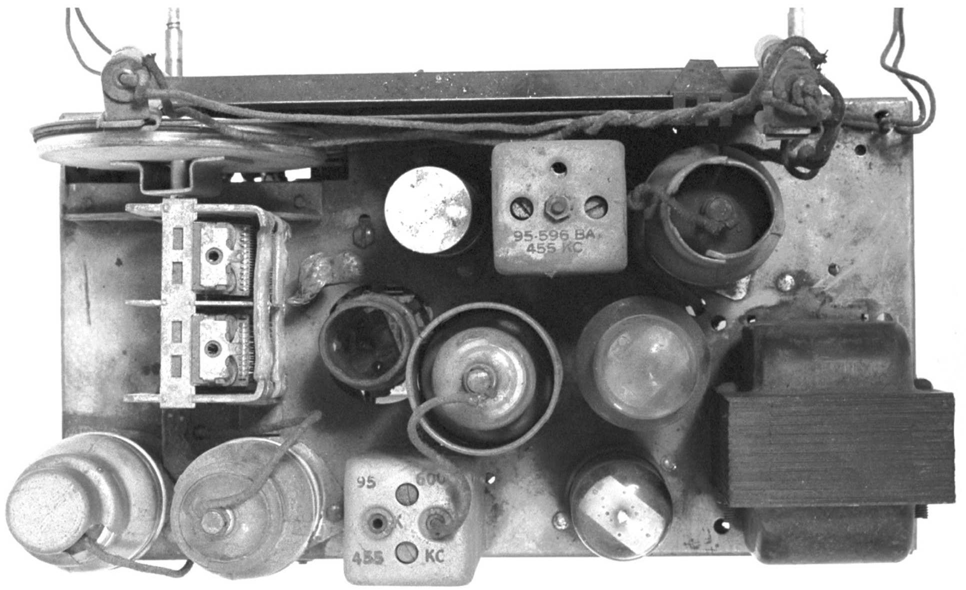


Figure 10-6 shows a radio chassis used for spare parts, a Zenith Model 6S439. After all the tubes are tested, the good ones are cleaned and labeled for the used tube supply. All the coils,I.F. transformers, and the power transformer are tested for continuity. Then all the good parts are removed and labeled for future use.

Before using any spare part always re-test the part.

FIGURE 10-7 Spare Parts

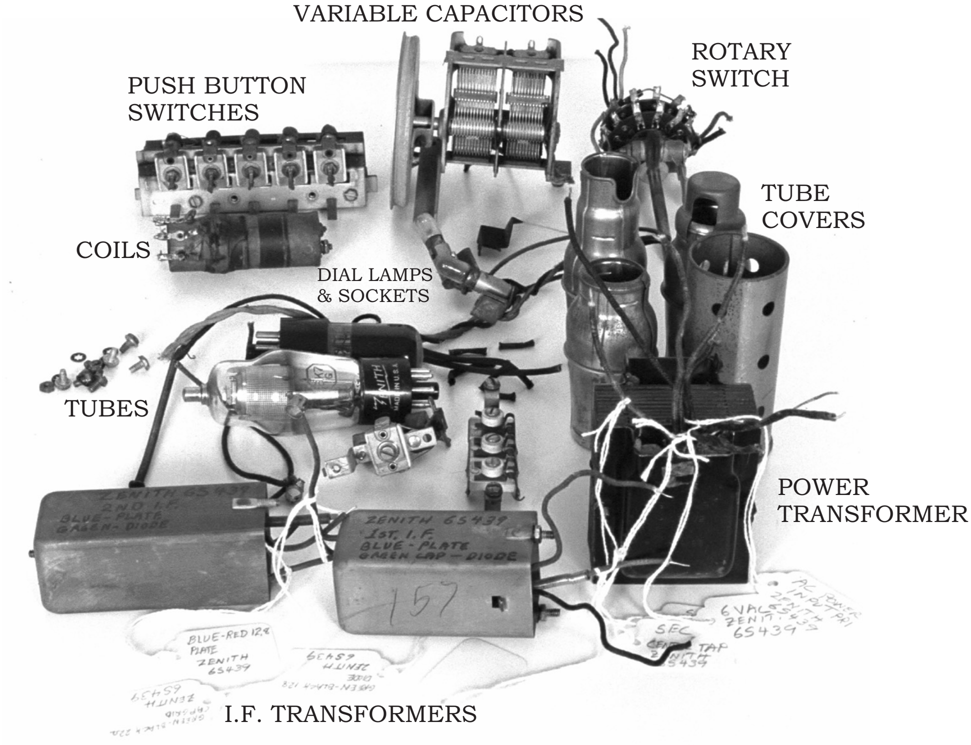
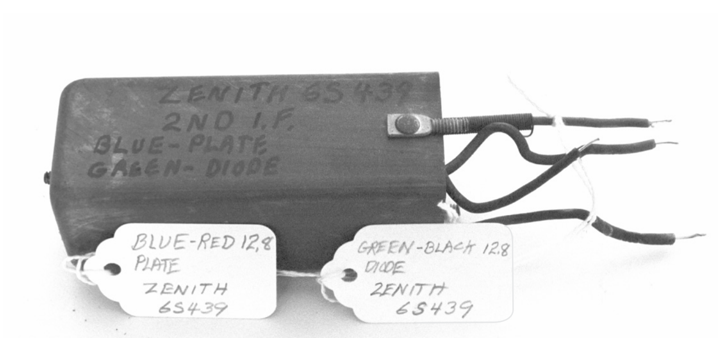


FIGURE 10-8 2ND. I.F. Transformer



The problem is determining if a spare part will work as a replacement.

Figure 10-7 shows all the parts that were removed from the chassis. Figure 10-8 shows some of the information that will determine how and where it may be used. The left tag shows 12.8 ohms between the blue and red wire. The blue and red wires are the primary connections, the blue wire is connected to the plate of the vacuum tube. The green and black wires also read 12.8 ohms and are the secondary connections. The green wire is connected to the diode of the detector vacuum tube.

Using Spare Parts

I.F. Transformer replacement

If the 1st. I.F. transformer were bad in the 8Q2 R.C.A., and it could not be repaired, a replacement must be found. **The replacement part must match or exceed the specifications of the original part.**

Refer to Figure A-1 for the wiring diagram of the 8Q2 radio. The 1st. I.F. primary and its secondary read 11 ohms. Also, the intermediate frequency is 455kHz (the replacement must match the I.F. frequency exactly). The primary is connected to the plate of a 6SA7. The tube manual shows a maximum plate voltage of 250VDC and a maximum plate current of 3.5 milli-amperes. The replacement must match the ohms, I.F. frequency, plate voltage and current required by the 1st. I.F. transformer.

The 2ND. I.F. transformer of the Zenith 6S439 may be a suitable replacement, refer to Figure 10-8. The intermediate frequency of the 2ND. I.F. is 455kHz (this must match exactly). The resistance of the primary and secondary both read 12.8 ohms; this is reasonably close. The wiring diagram for the 6S439 shows the primary (blue wire) of the 2ND I.F transformer is connected to the plate of a 6K7G. The tube manual shows a maximum plate voltage of 250VDC and a maximum plate current of 7.0 milli-amperes. This exceeds the current specifications for a 6SA7, so the Zenith 2ND. I.F. transformer would be a suitable replacement for the 1st. I.F. transformer of the 8Q2 R.C.A. radio.

The Zenith I.F. primary should be installed with the Blue wire connected to the plate of the 6SA7 (pin 3) and the Red wire connected to B+. The secondary of the I.F. will need to be physically re-configured. The green wire is connected to the grid of the 6B8, which is the grid cap. A hole must be drilled at the top of the I.F. can for the green wire. Add enough wire to it so that the gird cap will reach the top of the 6B8. The Black wire is connected to the A.V.C. circuit (6U5/6G5 pin 3).

Power Transformer Replacement

If the power transformer of the 8Q2 radio needed to be replaced, the replacement power transformer must match or exceed all the voltages and currents of the original. The primary (input) is 120VAC and there are three secondaries windings: a 5VAC, a 6.3VAC, and a 700VAC with a center-tap (refer to Figure A-1).

The 8Q2 radio has one 5V tube (5Y3), seven 6V tubes (6SK7, 6SA7, 6B8, 6U5/6G5, 6SC7, 6F6G - 2), and three 6V dial lamps. The tube manual shows, the 5Y3 requires 2.0 amperes. The 6F6G requires 0.7 amperes (X 2=1.4 amperes). The five other 6V tubes require 0.3 amperes each (5 X 0.3=1.5 amperes). The three 6V dial lamps add 0.75 amperes (3 X 0.25=0.75), for a total of 3.65 amperes.

The total amount of current through the 6V tubes (cathode to plate) is 75.5 milli-amperes (refer to Figure A-4). This specification is for the high voltage secondary.

From all this information, here are the specifications for a replacement power transformer.

Primary: 120VAC input.

Secondaries:
5VAC at 2.0 amperes (filament current of the 5Y3)
6.3VAC at 3.65 amperes (total tube filament current + dial lamps)
700VAC (with center-tap) at 75.5 milli-amperes (total cathode current)

If the replacement power transformer voltages match the original, and the replacement is from a chassis with the same number of tubes or more, this usually means that it is a suitable replacement. New power transformers are still available from electronic catalog stores.

Audio Transformer Replacement

If the audio output transformer needs to be replaced in the 8Q2 radio, the replacement must match the specifications of the original. In this radio the audio output is a push-pull circuit, refer to Chapter - 4: Page - 37 "Push-Pull Audio Output." This means two output tubes, and requires the primary of the audio output transformer to have a center-tap.

For the resistance readings of the audio output transformer refer to Chapter - 9: Page - 89 "Test Points for the Speaker."

The replacement transformer must match a power output of 3.2 to 11 watts with an output load from 7,000 to 10,000 ohms per-side. Push-Pull audio output transformers are available from electronic catalog stores. These replacement transformers have multi-taped primaries to match a variety of output tubes. They also have multiple secondary taps to match a variety of speakers.

Coil Replacement

The only source is from another radio chassis of the same model; this is usually very difficult to find. If a coil is found to be open, first try repairing it. If it cannot be repaired, other choices are to replace or to rewind the coil.

Coil Repair

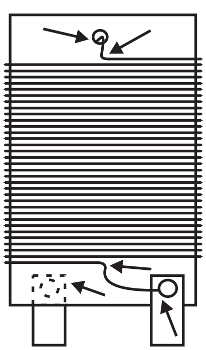
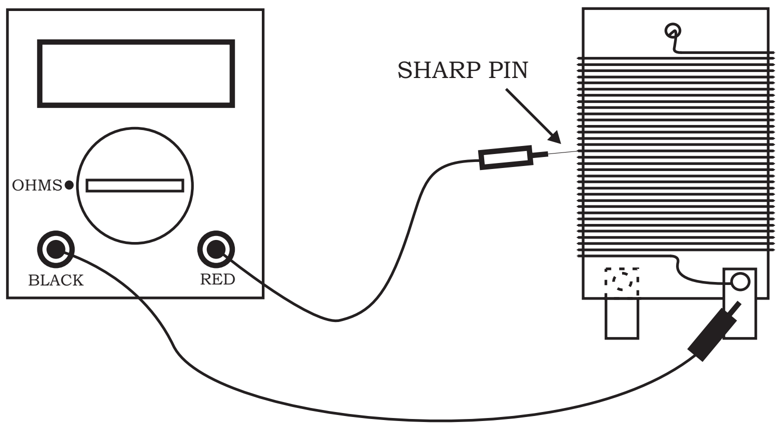


FIGURE 10-9 Weak Points of Coils

If an open coil is found, some times it is possible to repair the coil. Usually the open is at one of its weak points. This is shown by the arrows in Figure 10-9. First try re-soldering the lug connections and retest with an ohmmeter. Other weak points are the beginning and ends of a coil. Inspect all weak points with a magnifying glass, looking for discoloration. A dental tool is very useful for gently tugging on the weak points. If the open is found, clean the two ends by removing the insulation with a small file. Support the wire end with your finger as you gently rub the file against the wire, then solder the cleaned ends together. If the two ends can not be soldered together, a small extension to one of the wires may be necessary.

FIGURE 10-10 Coil Open Between Beginning and End



If the coil is open between the beginning and end of the coil, a sharp pin can be used to find the open. This is shown in Figure 10-10. One test lead is connected to a coil terminal. The other test lead has an attached pin to penetrate the wire insulation, being very careful not to break the coil wire. When the open is found clean both ends and solder.

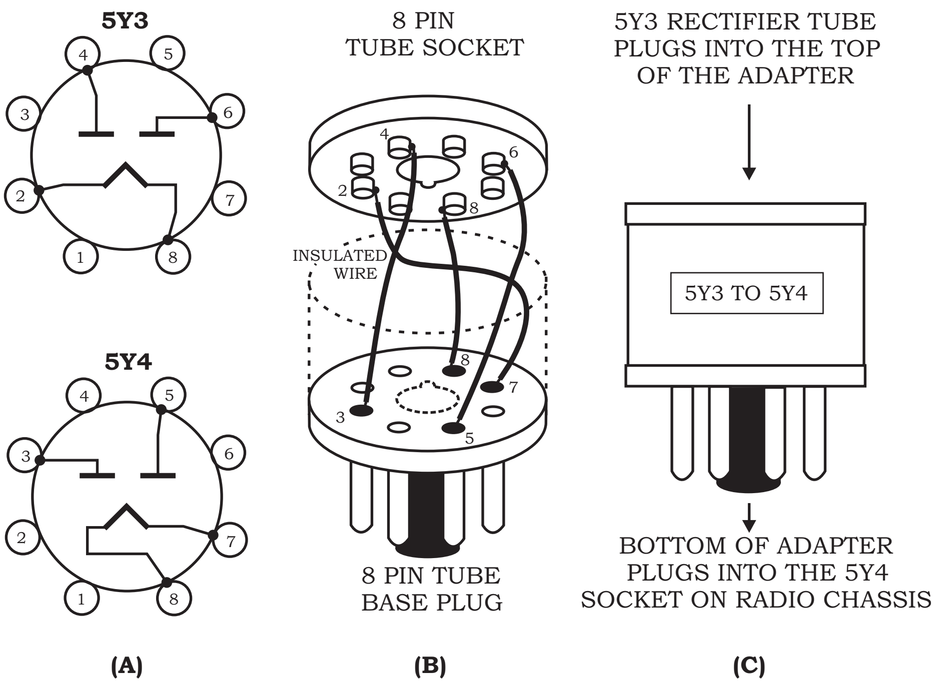
Coil Rewinding

If the coil has multiple openings, it will have to be rewound. Count the number of turns and acquire the same gauge wire. Remove the old wire and rewind the coil with the same number of turns, with the same gauge wire, and wind in the same direction. Many gauges of wire are available from electronic supply stores.

Tube Adapters and Re-Basing

The lack of availability of some tubes may make it necessary to adapt some tubes from your existing tube supply. One shortwave radio on the work bench stopped working because the 5Y4 rectifier tube had burnt out. There were no 5Y4 tubes in the spare tube supply and none were available from the web catalog stores.

FIGURE 10-11 5Y3 to 5Y4 Tube Adapter

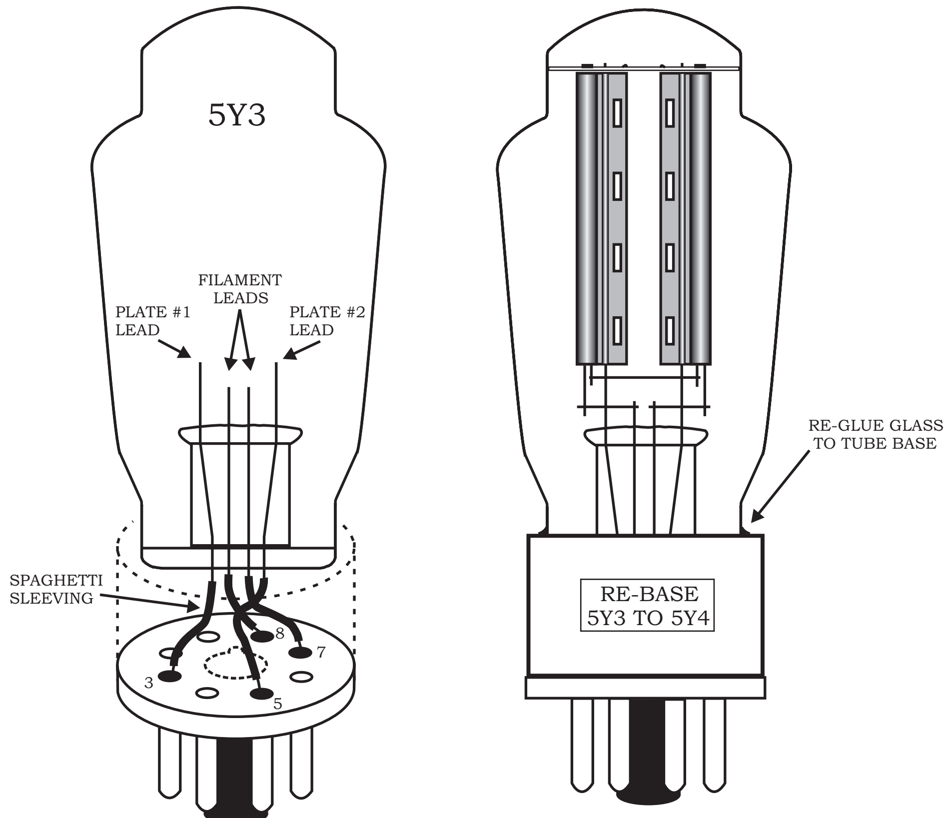


While continuing the search for a 5Y4, an adapter would solve this problem temporarily. Using the information from a tube manual, the specifications of a 5Y3 match and slightly exceed the specifications of a 5Y4 rectifier tube.

In Figure 10-11 part (A) shows the base diagrams for the 5Y3 and 5Y4 tubes. Figure 10-11 part (B) shows an 8 pin tube socket wired to an 8 pin tube plug. The tube socket pins 2, 4, 6, and 8 are wired to the tube plug pins 7, 3, 5, and 8, respectively. Figure 10-11 part (C) shows the completed and labeled adapter. The 5Y3 plugs into the socket at the top and then the unit is plugged into the 5Y4's socket in the radio chassis.

This adapter allowed me to continue testing while waiting to acquired a NOS 5Y4 from one of the web catalog stores.

FIGURE 10-12 5Y3 to 5Y4 Re-Basing



5Y3 RE-BASED TO 5Y4

Figure 10-12 shows a 5Y3 re-based to a 5Y4 rectifier tube. The appropriate wires from the 5Y3 are reconnected to the tube base plug in the 5Y4 configuration. All the wires are insulated using spaghetti sleeving. After testing the tube in a tube tester, label the base of the re-based tube.

Re-basing is much more critical for the R.F. circuits. If an adapter is used, the extra length of wire in the adapter will de-tune the R.F. circuit.

11
Safety, Testing & Alignment

Safety

Some of the circuits in the R.C.A 8Q2 radio develop 700 volts or more. Refer to Chapter - 1: Page - 2 "Warning."

Safe Working Environment

It is very important to have a safe working environment. Work on a wooden workbench because wood is a good electrical insulator. This makes it a safe place to work on open radio chassis. Use a large, clear plastic floor mat in front of the workbench. Standing on the floor mat electrically insulates the feet from the floor. This eliminates the feet from becoming an electrical path to earth ground. Avoid colored floor mats because the materials used to color the mat may be a conductor of electricity.

The author's workbench has two movable magnifying florescence lamps at each end of the bench. These movable lamps are very useful when examining or working on a radio chassis.

Power On Handling RULES

When power is applied to the chassis ONLY WORK WITH ONE HAND. This will eliminate the possibility that two points of your body will provide a path for electrons. This means that the hand that you are not using (to do testing, measuring voltages, signal-tracing, etc.) should be behind your back or in your pocket. Never, ever, place the non-testing hand on lamps and/or anything that conducts electricity. Whatever test is to be preformed on a radio chassis, prepare for the test before applying power.

Powering Down the Radio

When the radio is turned off, this does not necessarily mean that all the B+ power is gone. Sometimes a significant amount DC voltage can remain in the radio circuits. Always measure the B+ voltage before accessing any radio circuits. If the B+ voltage remains, use a Bleeder resistor across B+ and B- to bleed off this voltage.

Isolation Transformer

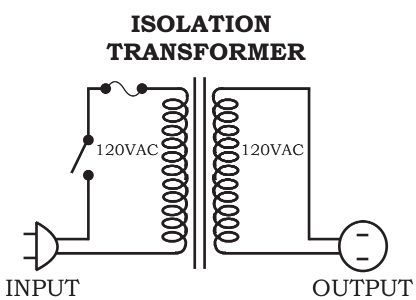


FIGURE 11-1 Isolation Transformer

The first thing to put on your workbench is an isolation transformer, it is a very important **safety item**. Use it every time power is applied to a radio chassis **with out fail!** The schematic symbol for an isolation transformer is shown in Figure 11-1. The input to the isolation transformer is 120VAC house current (commercial power) and the output is 120VAC. This is because the ratio between the primary and the secondary is one to one. There is NO electrical connection between the primary and secondary windings. This means that any radio chassis plugged into the isolation transformers output will receive 120VAC and it is completely isolated from commercial power.

Variable Transformer

FIGURE 11-2 Isolation & Variable Transformer, & Chassis

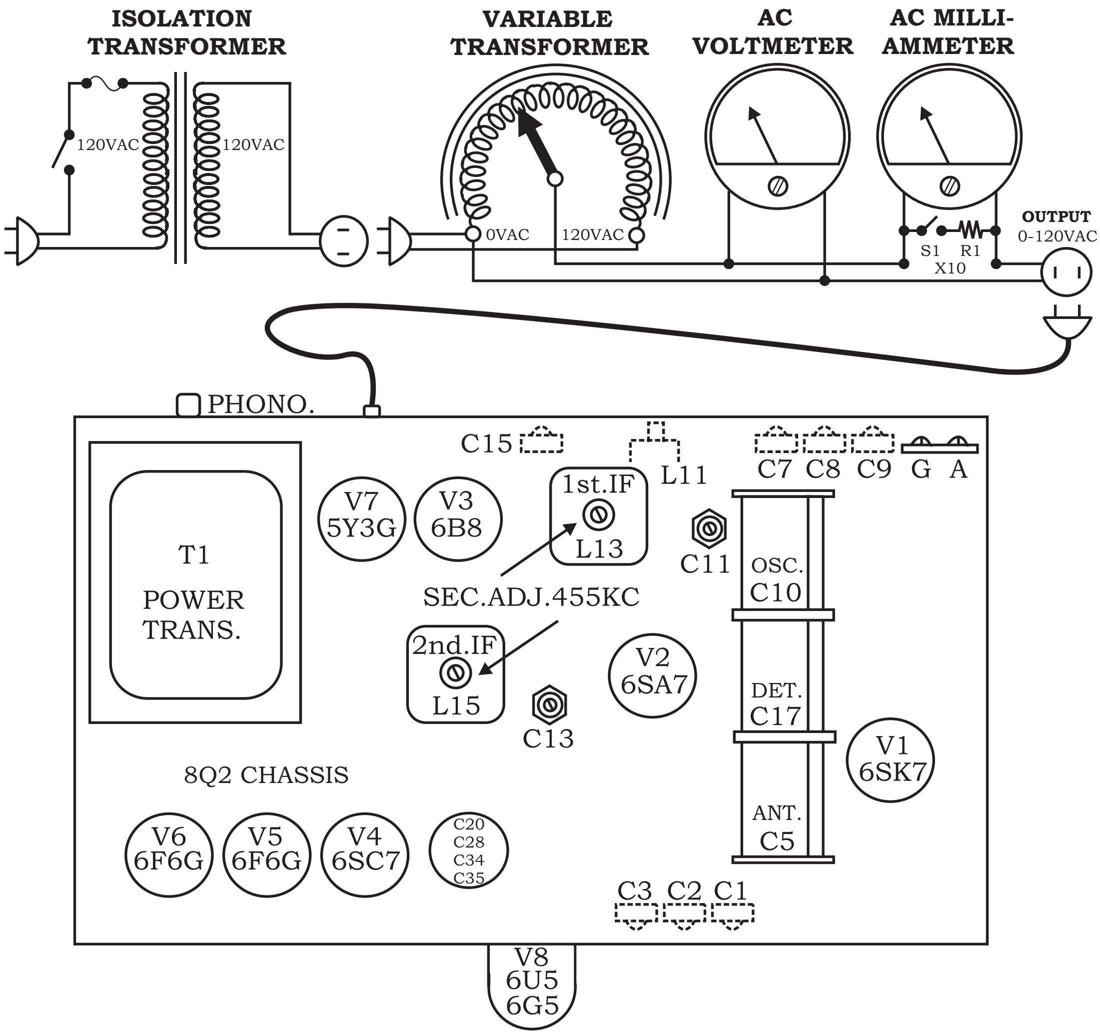


Figure 11-2 shows the connection configuration of the isolation transformer, the variable transformer, and a radio chassis under test. The variable transformer (3 ampere minimum) is ALWAYS plugged in to the isolation transformer.

The chassis under test is plugged into the output of the variable transformer. The variable transformer will vary the AC voltage from 0VAC to 120VAC. An AC voltmeter is in parallel with the output to monitor the voltage and an AC milli-ampere is in series with the output to monitor the current. This configuration allows for the safe control of the power being applied to the chassis.

Testing The Radio Chassis

Initial Chassis Power Up

After all the wax capacitors, electrolytic capacitors, out of tolerance resistors, and all the bad vacuum tubes have been repaired, along with any repaired or replaced coils and transformers, it is now time for the initial power up test of the radio. Refer to the wiring diagrams and drawings for your radio.

Chassis Setup

Place the radio chassis on the workbench with all the tubes and knobs installed. Set the radio band switch to band A, the AM broadcast band. Turn the power switch on and the volume control up (clockwise) one-quarter turn.

The radio must be electrically complete. For this radio the speaker cable / socket from the chassis must be plugged into the speaker plug (refer to Figure 3-11, Figure 3-13 and Figure 9-10). Also, an antenna wire must be connected to the antenna terminal ‘A’ on the radio chassis, refer to Figure A-2. An insulated antenna wire of 10 feet is sufficient for this test.

Check that all the vacuum tubes are plugged into their correct sockets. Make sure that the power is off on the isolation transformer, and that the variable transformer is set to 0VAC. Plug the radio chassis power cord into the variable transformer, refer to Figure 11-2.

Power Up Test

The total AC power used by the R.C.A 8Q2 radio is 75 Watts at 120VAC (0.625 amperes), refer to Figure A-4. At no time should the radio exceed this maximum current. If the current is exceeded or it is very low, proceed to Chapter - 12: Page - 119 "Current."

Set the variable transformer to 0VAC and power ON the isolation transformer. Slowly rotate the variable transformer so that the AC voltmeter reads 40VAC, while always watching the AC milli-ampere meter. At this voltage the ammeter reads 190 milli-amperes. The pilot lamps and the tube filaments should be glowing dimly and there is no sound from the speaker. Rotate the variable transformer to 60VAC. The current meter now reads 255 milli-amperes (0.255 amperes) but still no sound coming from the speaker.

Rotate the variable transformer to 80VAC, the ammeter now reads 0.45 amperes. The pilot lamps and the tube filaments are glowing brighter. The radio is now playing and has been tuned to a local station. Stay at this voltage for approximately 15 minutes to see if the current is stable.

Rotate the variable transformer to 100VAC, the ammeter now reads 0.55 amperes. The radio is now playing louder and the eye tube is barely glowing green. Stay at this voltage for about 15 minutes to see if the current is stable.

Rotate the variable transformer to 120VAC, the ammeter now reads 0.62 amperes. The pilot lamps and the tube filaments are now glowing at their proper brightness. The radio is now playing louder, and the eye tube is now glowing bright green. Stay at this voltage for about 30 minutes to see if the current is stable.

If your radio is not playing at this point, refer to Chapter - 12: Page - 118 "Where to Start?."

If the radio plays, check the function of the other bands. Set the band switch to band ‘B’ and tune through the entire band, and do the same for band ‘C’. During the day a few stations should be heard somewhere on each band. If you are not sure if the bands are working try this test after sundown. There should be a dramatic increase in the number of stations heard. Rotate the variable transformer to 0VAC and power OFF the isolation transformer. If the power consumption of your radio is normal and one or more of the bands are not working at this point refer to Chapter - 12: Page - 128 "Normal Current."

Alignment

Overview

The purpose of aligning the radio is to peak its performance on all bands and to calibrate the dial for accuracy. This is accomplished by injecting a calibrated, modulated signal into the R.F. section of the radio and reading the results. The alignment procedure for the 8Q2 is typical for this type of radio. Refer to the wiring diagrams and drawings for the alignment procedure for your radio.

FIGURE 11-3 Alignment Equipment

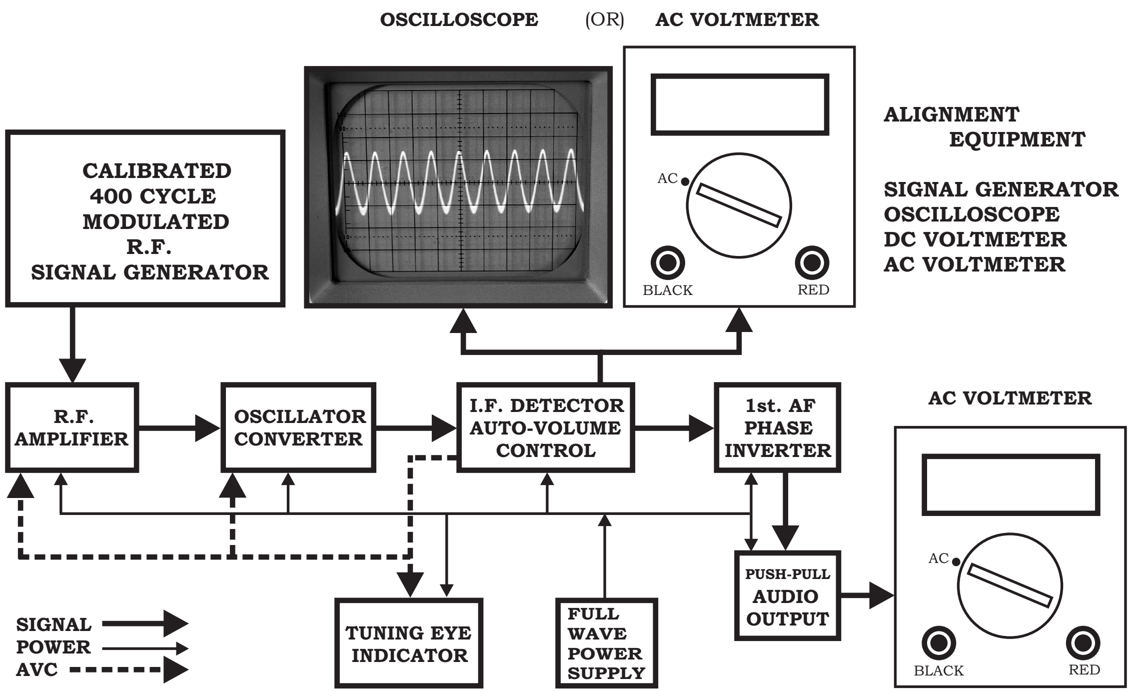


Figure 11-3 shows the alignment equipment required to align most superheterodyne radios. The R.F. signal generator is capable of generating an R.F. frequency from 100Khz through 20Mhz. This signal is also modulated with an audio signal, usually 400 cycles.

There are two test points shown. One point is in the detector / AVC circuit, where an oscilloscope or an AC voltmeter may be used to measure the signal. The other point is the speaker audio output using an AC voltmeter.

Alignment Test Points

FIGURE 11-4 2nd. I.F. Terminal C Alignment Test Point

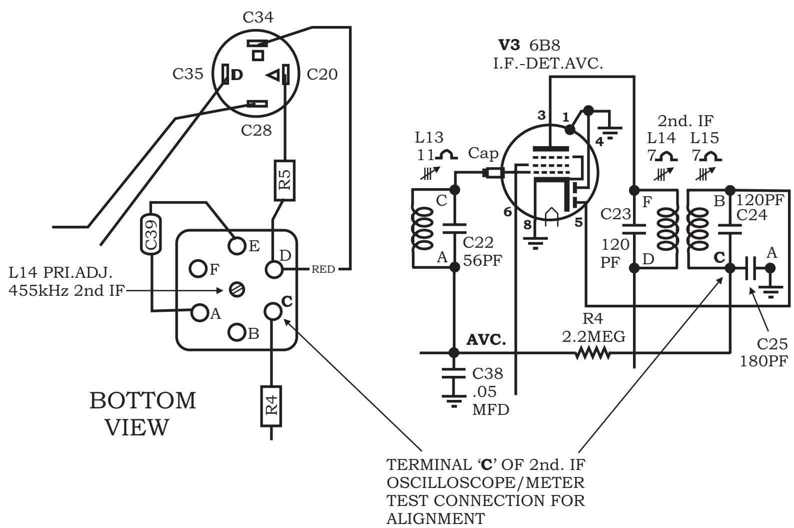


Figure 11-4 shows the test point for an oscilloscope or an AC voltmeter. Point C is connected to the input of the oscilloscope and its other lead is connected to chassis ground.

If the voltmeter is used, one lead of the AC voltmeter is connected to terminal C and the other lead is connected to chassis ground.

FIGURE 11-5 Speaker Alignment Test Point

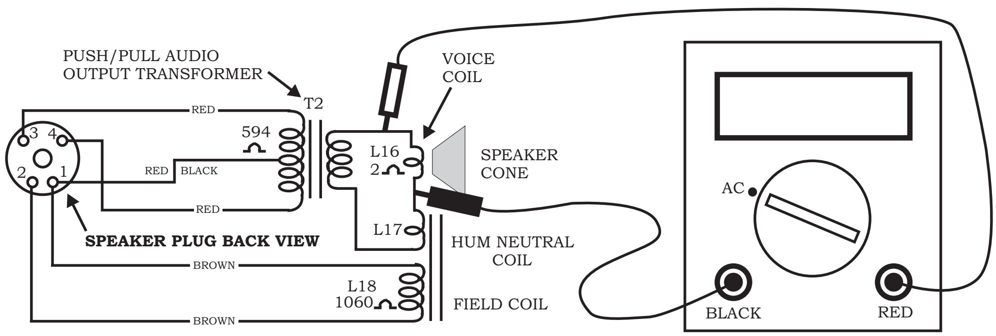


Figure 11-5 shows the test point connections at the speaker. The AC voltmeter test leads are connected across the speaker voice coil. If this method is used, the volume control must be at maximum after the injection signal is applied, and at minimum before the injection point is disconnected. This is to avoid a very loud click that may damage the speaker.

Signal Generator

Depending on the test to be performed, the signal generator is connected to various injection points in the R.F. circuit. For the 8Q2 radio, the shielded lead of the signal generator is connected to common ground of the radio.

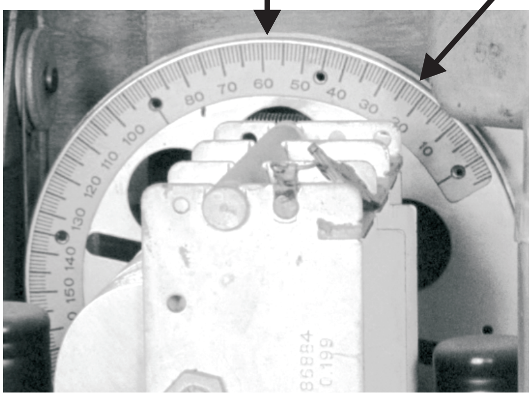
The output lead (center) of the signal generator may be connected in series with capacitors or resistors depending on the injection point of the alignment test as specified in the alignment instructions. The output of the signal generator should be kept at the lowest possible level so that the AVC circuit does not activate.

If the output level is too high the AVC will automatically attenuate the signal making it difficult or impossible to align the radio.

NOTE #1:

The R.C.A. 8Q2 radio has a separate alignment dial calibrated in degrees as shown in Figure 11-6. In some of the alignment procedures the instructions require the alignment dial to be set at a specific degree setting. The corresponding dial frequency is also given.

FIGURE 11-6 Alignment Dial



NOTE #2:

Some capacitor adjustments may have more than one peak in level. Sometimes the lower peak is desirable and sometimes the higher peak is desirable. This will be marked with two symbols (* and ^) respectively.

* If more than one peak is obtained, use the lower-level peak.
^ If more than one peak is obtained, use the higher-level peak.

NOTE #3:

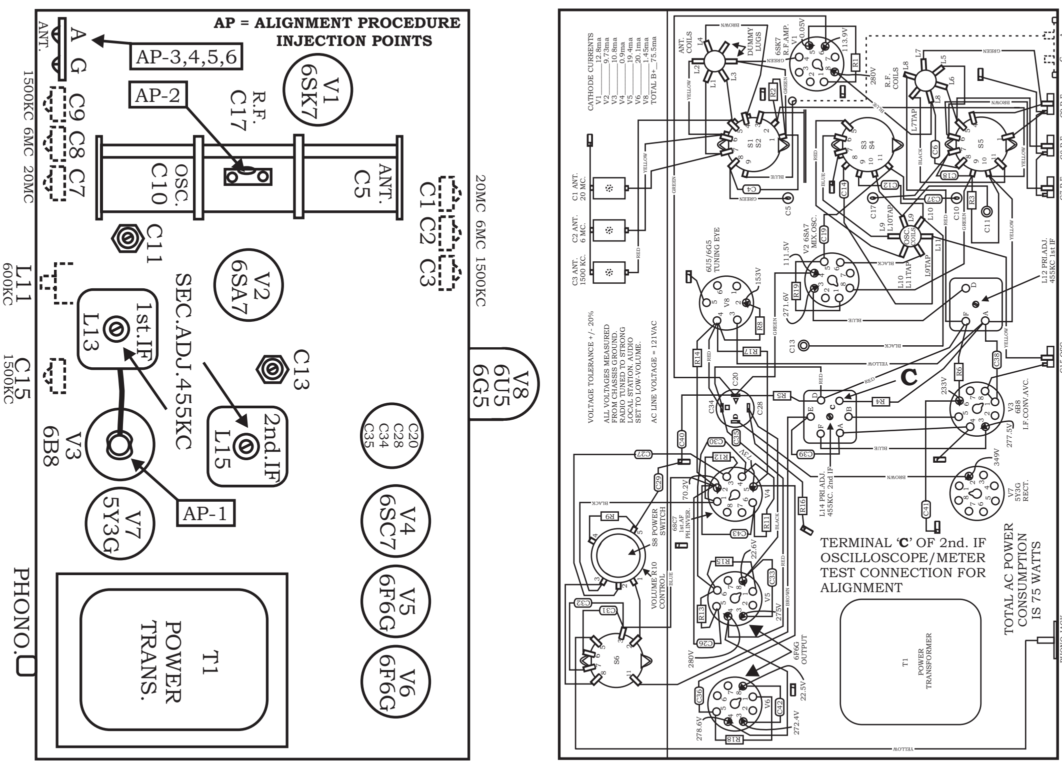
With the power OFF, position the radio chassis so that the top and bottom are easily accessible, refer to Figure 11-7, and stabilize the chassis so that it cannot fall over. Connect the oscilloscope or voltmeter to a test point as described in Chapter - 11: Page - 109 "Alignment Test Points."

NOTE #4:

For each alignment procedure connect the signal generator to the appropriate injection point. Power ON the isolation transformer and rotate the variable transformer to 120VAC. Let the radio warm up and then perform the procedure (USING ONLY ONE HAND). After its completion, turn the power OFF and rotate the variable transformer to 0VAC. Never change any connections to the radio while power is applied. Repeat NOTE #4 for each procedure.

Refer to Figure A-1 for the complete 8Q2 wiring diagram. Refer to Figure A-2 for the 8Q2 chassis part location. Refer to Figure A-4 for the 8Q2 chassis drawing bottom view. Refer to Figure 11-7 for the alignment procedure injection points.

FIGURE 11-7 Alignment Procedure Injection Points



Alignment Procedure - 1

Connect the output of the signal generator in series with a 0.01 MFD capacitor to the grid cap of the 6B8, refer to Figure 11-7. Tune the generator to 455kHz, modulated at 400 cycles. Tune the radio to a quiet spot on band ‘C’. Adjust L14 and L15 (2nd. I.F.) for maximum peak output.

Alignment Procedure - 2

Connect the output of the signal generator in series with a 0.01 MFD capacitor to middle section of C17, refer to Figure 11-7. Tune the generator to 455kHz, modulated at 400 cycles. Tune the radio to a quiet spot on band ‘C’. Adjust L12 and L13 (1st. I.F.) for maximum peak output.

Alignment Procedure - 3

Connect the output of the signal generator in series with a 200 PFD capacitor to antenna terminal ‘A’, refer to Figure 11-7. Tune the generator to 600kHz, modulated at 400 cycles. Tune the radio 600kHz (148 degrees) on band ‘A’. Adjust L11 (oscillator) for maximum peak output.

Alignment Procedure - 4

Connect the output of the signal generator in series with a 200 PFD capacitor to antenna terminal ‘A’, refer to Figure 11-7. Tune the generator to 1500kHz, modulated at 400 cycles. Tune the radio 1500kHz (28 degrees) on band ‘A’. Adjust C15* (osc.), C9^ (R.F.), C3 (ant.) for maximum peak output.

Alignment Procedure - 5

Connect the output of the signal generator in series with a 300 ohm resistor to antenna terminal ‘A’, refer to Figure 11-7. Tune the generator to 6.1MHz, modulated at 400 cycles. Tune the radio 6.1MHz (29 degrees) on band ‘B’. Adjust C13* (osc.), C8^ (R.F.), C2 (ant.) for maximum peak output.

Alignment Procedure - 6

Connect the output of the signal generator through a 300 ohm resistor to antenna terminal 'A', refer to Figure 11-7. Tune the generator to 20 MHz, modulated at 400 cycles. Tune the radio 20 MHz (23 degrees) on band 'C'. Adjust C11* (osc.), C7^ (R.F.), C1 (ant.) for maximum peak output.

This Completes the Alignment of the 8Q2 R.C.A. Radio. The alignment procedure provided by the manufacturer is the best method to align your radio.

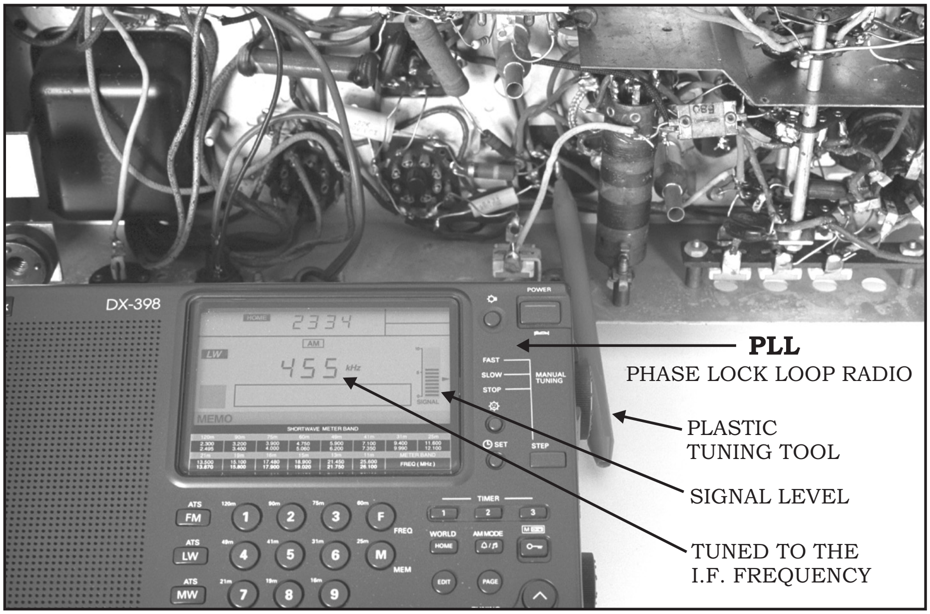
Below is a typical manufacturer's table for alignment procedures.

TABLE 11 - 1 Alignment Procedures for the R.C.A. Model 8Q2 Radio

Alignment Procedure	Connect output of signal generator to	Tune signal generator to	Turn/Tune Radio dial to	Adjust the following for maximum peak output
1	Grid Cap of 6B8 through series 0.01MFD	455kHz	Quiet point on the 'C' band	L14 and L15 2nd. I.F.
2	Middle section of C17 through series 0.01MFD	455kHz	Quiet point on the 'C' band	L12 and L13 1st. I.F.
3	Antenna Terminal 'A' through series 200PFD	600kHz	600kHz (148 degrees) 'A' band	L11 (osc.)
4	Antenna Terminal 'A' through series 200PFD	1,500kHz	1.500kHz (28 degrees) 'A' band	C15* (osc.) C9^ (R.F.) C3 (ant.)
5	Antenna Terminal 'A' through series 300 ohms	6.1MHz	6.1MHz (29 degrees) 'B' band	C13* (osc.) C8^ (R.F.) C2 (ant.)
6	Antenna Terminal 'A' through series 300 ohms	20MHz	20MHz (23 degrees) 'C' band	C11* (osc.) C7^ (R.F.) C1 (ant.)

Alignment II

FIGURE 11-8 Phase Lock Loop Radio



If your radio plays very well on all bands, another method of aligning the radio may be used. This general method requires a Phase Lock Loop (PLL) radio that can be tuned from 150kHz through 550kHz and it must have a signal level indicator. An R.F. attenuating feature would be nice, but it is not a must. The radio the author uses is a Radio Shack DX-398 AM, FM, shortwave radio. In this procedure the radio is used as an I.F. frequency locator and signal strength indicator as shown in Figure 11-8.

The R.C.A. 8Q2 radio played very well on all bands. But, if you noticed that frequencies are off by the same amount on all the band's (in this case 5kHz's), this usually means that the Intermediate frequency is off frequency.

Step #1

Attach the antenna and position the radio chassis so that the top and bottom of the chassis can be easily accessed and is stable. Power on the isolation transformer and rotate the variable transformer to 120VAC. Let the radio warm up.

Step #2

Using the PLL radio tuned to 455kHz (the radio's Intermediate Frequency), position it in close proximity with the chassis. The next step is to find what frequency the radio’s I.F. transformers are tuned to. On the AM band of the radio, (band ‘A’ for the 8Q2) tune in a strong local station in the middle of the AM band. Tune the PLL radio on either side of 455kHz until the signal level indicates a peak. The 8Q2 chassis peaked at 450kHz.

Step #3

Now tune the chassis a little to one side of the AM station, and then with the PLL radio find the frequency again. If the frequency is increasing (but weaker) you are moving the chassis dial in the correct direction. If the frequency decreases you are moving the chassis dial in the wrong direction. Repeat this step until 455kHz (or the I.F. for your radio) is obtained. At this point tune the chassis I.F. transformers for peak output.

Step #4

To calibrate the dials on all bands, use the PPL radio to find radio stations as close as possible to the manufactures frequency specifications. Adjust the appropriate coils or capacitors so that the frequency of the chassis dial matches the PLL radio. Be careful on the shortwave bands to check adjacent stations, because some shortwave stations broadcast on several different places on the same band.

Turn power OFF and rotate the variable transformer to 0VAC.

12
Troubleshooting Guide

Troubleshooting Guide

The Key and Purpose

The best troubleshooting tool is Knowledge.

A thorough understanding of how the Radio Circuits function is the key to troubleshooting.

The purpose of troubleshooting is to systematically locate the problem circuit/s, then isolate and repair or replace the bad component/s.

Where to Start?

Two staggered short lines will mark the beginning of a subject and the following two long lines across the page will mark the end of that subject.

Read chapter 12 entirely and then refer to the “Troubleshooting Outline” on page 157 for troubleshooting scenarios and troubleshooting levels.

Acquire the wiring diagrams and drawings for your model radio. Most are now available on CDs or ONLINE.

Place the radio chassis on the workbench so that it is stable, all the components are accessible, and the radio is electrically complete. Plug the power cord of the radio chassis into output of the variable transformer. The variable transformer should always be plugged into the isolation transformer’s output (secondary), and its primary side should be plugged into commercial power, as shown in Figure 11-2.

Re-check all the vacuum tubes to make sure they are plugged into the correct sockets. Always clean the tube pins any time a tube is out of its socket. Refer to Figure 1-2.

Before applying power to any chassis please review the safety section in Chapter - 11: Page - 103 "Safety." The acronyms “**PHR**” (Power On Handling Rules) and **“PDR”** (Powering Down the Radio) will appear throughout this chapter. Please review both procedures in Chapter - 11: Page - 104.

When applying power to the radio, always start at 0VAC and increase the voltage slowly while watching both the voltage and the current meter. If the radio’s maximum current is reached before 120VAC is reached, power down (**PDR**) immediately and refer to Chapter - 12: Page - 122 "High Current."

When taking any readings of any kind, always verify the readings by taking them more than once. If you are measuring voltages, take all the measurements and write down the results. Then do this again, comparing the second results with the first results. If they do not match, measure again until the correct reading is obtained. An incorrect reading of any kind will cause a misleading conclusion while troubleshooting.

Sometimes there may be more than one problem in a radio. One strategy is to identify the most serious problem first, like high or low current, because it may mask other problems. After clearing the first problem, if another problem appears, continue clearing each problem one at a time.

Current

The amount of current the radio is consuming is a good indicator if the radio is in trouble. The R.C.A. 8Q2 specifications show this radio should consume 75 Watts of AC power.

To calculate the current use this expression: [P=E x I], P power in watts (75) = E in volts (120) x I in amperes (?). Solving for I, [I=P/E]. I= 75/120 equating to 0.625 AC amperes. Always check the specifications for your radio.

On initial power-up there are three possible current levels. The current may read low, it may read correctly, or it may read high.

No or Low Current

Something is open. Refer to Figure A-11 for the voltages by tube and pin number. Refer to Figure 12-5 or Figure A-1 for the wiring diagram of the 8Q2 radio. Use the manufacturer drawings for your radio.

No Current

If there is no current, power down (**PDR**) the radio and make sure that all the power connections are correctly connected together. Refer to Figure 11-2. No current indicates a complete open somewhere in the 120VAC input circuit. Re-check (with an ohmmeter) the power cord, the on/off switch S8, and the primary winding of the power transformer T1, then re-test. Refer to Chapter - 9: Page - 82 "Test Points for the Power Transformer." If the primary of T1 is open, refer to Chapter - 10: Page - 98 "Power Transformer Replacement."

Low Current

If the current is low, with power on (**PHR**), check to see if all of the filaments of the tubes are lighted.

All Tubes Lighted

If all the tubes are lighted, this may mean that the B+ is low or it is open to most of the radio circuits. Measure the B+ voltage at the positive terminal of capacitor C34 and check all the tube plate voltages and write down the results. Turn power OFF (**PDR**).

C34, No B+

Review Chapter - 3: Page - 23 "Full-Wave Rectifier Power Supply." Compare the measured results with the manufacturer supplied voltage readings. If the reading at C34 is low, retest the rectifier tube. With an ohmmeter recheck the field coil and all the secondaries of T1. Refer to Chapter - 9: Page - 89 "Test Points for the Speaker" and Chapter - 9: Page - 82 "Test Points for the Power Transformer."

If the field coil is open try a repair. If it cannot be repaired find a replacement speaker from the used parts supply. The replacement must match the specifications of the field coil. If you do not have a replacement speaker, a choke coil with the same specifications of the field coil may be substituted. Then the original speaker must be replaced with a permanent magnet speaker.

If any of the secondaries of T1 are open, it must be replaced. Refer to Chapter - 10: Page - 98 "Power Transformer Replacement."

After the repair is complete return to Chapter - 11: Page - 106 "Testing The Radio Chassis."

B+ at C34, No Plate Voltage

Compare the measured results with the manufacturer supplied voltage readings. If there is B+ at C34 (280VDC) and there is no plate voltage at either V5 or V6 the primary side of T2 associated with the no voltage is open. If both plates of V5 and V6 read no voltage the center tap of T2 may be open. If either scenario is true T2 must be replaced. Verify by testing the continuity of T2’s primary again. Refer to Chapter - 9: Page - 89 "Test Points for the Speaker." To replace T2 refer to Chapter - 10: Page - 99 "Audio Transformer Replacement."

If V4 pin 2 reads low or no voltage, the resistor R14 is open or its connection to B+ is open. If V4 pin 5 reads low or no voltage. The resistor R17 is open or its connection to B+ is open.

If V3 pin 3 reads no voltage, the primary of the 2nd I.F. is open or its connection to B+ is open. Verify by testing the continuity of the primary, refer to Chapter - 9: Page - 84 "Test Points for the I.F. Transformers." If the primary is found to be open refer to Chapter - 10: Page - 97 "I.F. Transformer replacement."

If V2 pin 3 reads no voltage, the primary of the 1st. I.F. is open or its connection to B+ is open. Verify by testing the continuity of the primary, refer to Chapter - 9: Page - 84 "Test Points for the I.F. Transformers." If the primary is found to be open refer to Chapter - 10: Page - 97 "I.F. Transformer replacement."

If V1 pin 8 reads no voltage, the primary of L8 is open or its connection to B+ is open. Verify by testing the continuity of the primary, refer to Chapter - 9: Page - 86 "Test Points for the R.F. Coils." If the primary is found to be open refer to Chapter - 10: Page - 99 "Coil Replacement" and Chapter - 10: Page - 99 "Coil Repair" and Chapter - 10: Page - 100 "Coil Rewinding."

After the repair is complete return to Chapter - 11: Page - 106 "Testing The Radio Chassis."

Tubes Not Lighted

If some tubes are not lighted, turn power OFF (**PDR**). If all of the six-volt tubes are not lighted, the six-volt secondary of T1 may be open. If only one or two six-volt tubes are not lighted, re-test those tubes and clean their pins, refer to Figure 1-2. If the rectifier tube is not lighted, re-test the tube. If it is good the five-volt secondary may be open. With all the tubes removed re-check all the secondaries with an ohmmeter. Refer to Chapter - 9: Page - 82 "Test Points for the Power Transformer." If any of the secondaries are open the power transformer must be replaced. Refer to
Chapter - 10: Page - 98 "Power Transformer Replacement."

After the repair is complete return to Chapter - 11: Page - 106 "Testing The Radio Chassis."

High Current

Something is drawing too much current (short circuit). Refer to Figure A-11 for a list of voltages by tube and pin number (manufacturer supplied). Refer to Figure 12-5 or Figure A-1 for the wiring diagram of the 8Q2 radio.

Current is Very High

Power down (**PDR**) and let the tubes cool off. This radio has a power transformer so the removal of the tubes may be used to try and isolate the high current draw.

Remove Rectifier Tube

Remove the rectifier tube, in this radio it is the 5Y3. Slowly power up the radio (**PHR**) and check the AC current, **then power off (PDR) the radio**.

Current is Now Low (rectifier tube is removed)

This means that the short is in the power supply or the B+ feed is shorted somewhere in the radio. With the power off (**PDR**) recheck all the electrolytic capacitors. If an electrolytic capacitor is found to be installed improperly, remove it and throw it in the trash, then install a new one correctly.

Review Chapter - 3: Page - 23 "Full-Wave Rectifier Power Supply", Chapter - 3: Page - 33 "Electrolytic Capacitor Polarity" and Chapter - 3: Page - 36 "Electrolytic Capacitor Isolation."

If the electrolytic capacitors are installed properly, un-solder the B+ lead/s feeding the radio circuits. With an ohmmeter test the un-soldered lead/s. Normally, the ohm readings should be open or infinity (for the 8Q2, this is read from chassis ground).

Most of the time if there is a short on one of the B+ leads, it can be read with an ohmmeter. An example would be something like this, please refer to wiring diagram Figure A-1. One of the B+ leads reads about 15K ohms and all the others read infinity. Looking at the wiring diagram, the one lead that reads about 15K ohms turns out to be the B+ lead that is connected to resistor R5. Checking across all the components along this lead, the ohmmeter shows that C40 only reads a few ohms but it should read infinity. This is the shorted component. Replacing C40 clears the problem and now this B+ lead reads infinity.

It is possible that the bad part only breaks down with power. If you suspect this scenario re-install the rectifier tube and reconnect one of the B+ lead and apply power (**PHR**), then power down (**PDR**). Repeat this until the B+ lead causing the high current is found.

Clear the short, then return to Chapter - 11: Page - 106 "Testing The Radio Chassis."

Current is Still High (rectifier tube is removed)

Power down (**PDR**) the radio. This may mean that the power transformer has an internal short. To test this, un-solder and insulate (electrical tape) all the secondary windings of the power transformer and then power up slowly (**PHR**), then power down (**PDR**).

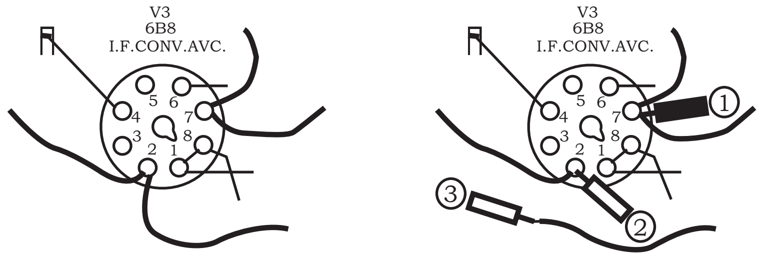
If the current is still high, the transformer must be replaced, refer to Chapter - 10: Page - 98 "Power Transformer Replacement."

If the current is now low, this means that the short is in the chassis. Remove all tubes and reconnect the secondaries one at a time. Power up slowly (**PHR**) between each re-connection, then power down (**PDR**). Repeat until the short circuit is found (high current is back). Un-solder this secondary and with an ohmmeter locate the short in the circuit. A standard troubleshooting method is to open up the problem circuit at its mid-point.

An EXAMPLE would be something like this. Lets say that the problem was found to be in the six-volt filament circuit. All the tubes have been removed and the six-volt secondary of the power transformer has been un-soldered again. The ohm readings will be taken across (parallel) the filament pins of the six-volt tube sockets. Looking at the wiring diagram the tube 6B8 is about in the middle of the parallel circuit. Un-solder one filament wire from the 6B8's tube socket (from pin 2 or pin 7).

With an ohmmeter measure across pins 2 and 7. This is test point 1 and 2 in Figure 12-1. If a short is found, this is the path with the short. If test points 1 and 3 indicate a short, this is the path with the short. In both cases try and cut the next path in half again until the short circuit is found. When the short has been found and cleared, re-solder all filament leads and re-test.

FIGURE 12-1 Six-Volt Filament Short Circuit



REMOVE ONE OF THE FILAMENT WIRES FROM PIN2 OR PIN7

Clear short then return to Chapter - 11: Page - 106 "Testing The Radio Chassis."

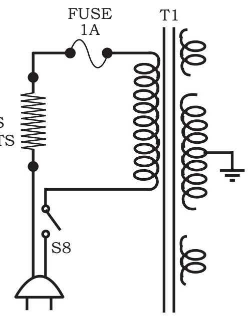
Current is a Little High, Almost Normal (all tubes installed)

In some circumstances there still can be a problem when the radio plays very well but the current reads a little high. If the power transformer operates too hot, it may mean that the AC input is too high or there is an internal short in the transformer.

T1 Runs Hot, but steady

The transformer does run hot, but it remains at a steady heat. The R.C.A. 8Q2 did run a little hot, the specifications for the 8Q2 show that it was designed to operate from 105VAC to 125VAC at 75 watts. Adding a resistor in series with the AC line reduces the AC voltage across the primary of T1. The added resistor must be one that keeps the voltage across the primary of T1 with in the radio’s specifications. The middle of the radio’s VAC specification is the optimum objective. Most of the time the author’s commercial power measures about 121VAC, which is on the high side of the radio’s specifications.

FIGURE 12-2 Add 8-Ohm Resistor & Fuse



FUSE ADDED FOR SAFETY
ADD 8 OHMS 40 WATT
RESISTOR TO LOWER
121VAC TO 116VAC

Figure 12-2 shows how an 8-ohm, 40 watt resistor is connected into the primary circuit of T1. A terminal strip was added inside the chassis for mounting the 8-ohm resistor. After the resistor is electrically connected in the circuit it must be mounted so that no wires are physically touching the resistor. This is because the 8-ohm resistor may produce a high enough heat to melt wire insulation. With power applied to the radio **(PHR),** the voltage drop across the resistor is 4.58VAC, dissipating about 2.6 watts. The voltage drop across the primary is 116.42VAC, which is just about in the middle of the 8Q2's specifications. T1 now runs cooler and there is no noticeable change in the radio's performance. A one ampere inline fuse was added for safety. Power off (PDR).

Return to Chapter - 11: Page - 106 "Testing The Radio Chassis."

T1 Runs Hot, and Increasing in Temperature

If T1 continues to get hotter, this usually indicates two possibilities. One, the radio circuit/s are consuming too much power. Two, a winding in T1 is shorted internally.

The following steps may be very time consuming, because T1 must be cool at the start of the test to determine the result of the test.

Remove all of the vacuum tubes and power up the chassis **(PHR).**

Is T1 still running hot and increasing in temperature? Yes

This may mean a shorted winding in the power transformer T1. Power down (**PDR**) the radio then disconnect and insulate all secondary leads of T1. Power up the radio (**PHR**) and if T1 continues to increase in heat the power transformer has an internal short and it must be replaced. Power down (**PDR**) the radio and refer to Chapter - 10: Page - 98 "Power Transformer Replacement." After replacing the power transformer return to Chapter - 11: Page - 106 "Testing The Radio Chassis."

Is T1 still running hot and increasing in temperature? NO

If T1 does not run hot, there is a short circuit in the radio chassis. Power down (**PDR**) the radio and install the rectifier tube, then power up the radio **(PHR).**

If T1 runs hot with only the rectifier tube installed, this means the short is in the power supply components or one of the B+ leads of the radio circuits. Refer to the wiring diagrams Figure 12-5 or Figure A-1. Power down (**PDR**) the radio, then
disconnect and insulate all the B+ leads (for the 8Q2, C34). Power up the radio **(PHR).** If T1 still runs hot the problem is in the power supply, refer to Chapter - 10: Page - 98 "Power Transformer Replacement."

If T1 does not heat up, the problem is in the B+ leads to the radio circuits. Power down (**PDR**) the radio. Reconnect one B+ lead and power up the radio **(PHR)** to see if T1 heats up. Power down (**PDR**) the radio. Repeat this step, reconnecting one B+ lead at a time until T1 heats up. Power down (**PDR**) the radio and un-solder the B+ lead causing the problem. Continuity test all the circuits associated with this B+ lead.

Refer to Chapter - 9: Page - 81 "Continuity Testing."

Clear the short then return to
Chapter - 11: Page - 106 "Testing The Radio Chassis."

Normal Current

Normal current is when the current that the radio consumes matches the manufacturer's specifications and the power transformer runs warm but does not over heat. If all the continuity tests are good, all the vacuum tubes are good, and all the wax capacitor and electrolytic capacitors have been replaced correctly, there is a greater then 95% chance that the radio will play.

If the dial readings are reasonably accurate, and if the radio plays very well on all bands you may decide not to align the radio. However without an alignment the radio will not play up to manufacturer's specifications.

Does The Radio Play On All Bands?

Yes

Refer to Chapter - 11: Page - 103 "Safety" and
Chapter - 11: Page - 108 "Alignment."

NO

Does The Radio Play On Any Band? **Yes**

Power down (**PDR**) the radio and make sure that the radio is electrically complete and the antenna is connected. Position the radio chassis on the workbench so that the inside of the chassis is easy to access for continuity testing, taking voltage readings, and signal-tracing.

If any of the radio bands operate, this means that all the I.F. coils are good. The oscillator coils, R.F. coils, and the antenna coils are also good for the bands that operate.

Power down (**PDR**) the radio and replace the oscillator tube with a known good tube. Sometimes the oscillator tube will not function on one or more bands.

Another scenario of a bad oscillator tube is when the radio plays on all bands, but after the radio warms up the high frequency bands stop operating. Another symptom is when the tuning drifts as the radio warms up (the radio needs to be re-tuned). In either case the oscillator tube is suspect and should be replaced.

Power up (**PHR**) and re-test the radio. If it now plays on all bands refer to Chapter - 11: Page - 103 "Safety" and Chapter - 11: Page - 108 "Alignment."

If the radio still does not play on all bands, power down (**PDR**) the radio and recheck all the antenna, R.F., and oscillator coils for the inoperative band/s.

Refer to Chapter - 9: Page - 85 "Test Points for the Antenna Coils", Chapter - 9: Page - 86 "Test Points for the R.F. Coils" and Chapter - 9: Page - 88 "Test Points for the Oscillator Coils."

If any coils are found to be open refer to Chapter - 10: Page - 99 "Coil Replacement", Chapter - 10: Page - 99 "Coil Repair", and Chapter - 10: Page - 100 "Coil Rewinding."

If all the coils are good, replace the PF capacitors for the inoperative band/s.

EXAMPLE: Lets say that band ‘B’ for the R.C.A. 8Q2 does not play and all the coils are good for that band. Refer to Figure 12-5 or Figure A-1 for the model 8Q2’s wiring diagram. Refer to Figure A-4 for the locations of coils and capacitors. Re-clean variable capacitors C2, C8, and C13 with a soft brush and a can of air. Re-clean the wafer switches S1, S2, S3, S4, and S5. Replace the capacitor C12 (3600PF).

When replacing any PF capacitors in the antenna, R.F., or oscillator circuits, the replacement capacitor must be exact. If C12 were replaced with a 4000PF capacitor, band ‘B’ would have a lower range of frequencies. If C12 were replaced with a 3000PF capacitor, band ‘B’ would have a higher range of frequencies.

Power up (**PHR**) and retest the radio.

If the radio still does not play on band ‘B’, power down (**PDR**) the radio. Re-check and re-clean all of the ‘B’ band components. Inspect and continuity check all of the ‘B’ band wafer switch connections and components. Trace out and inspect every wire and solder connections in the ‘B’ band circuit.

Refer to Chapter - 7: Page - 67 "Local Oscillator Mixer Converter" and Chapter - 12: Page - 143 "Oscillator Problem" and Chapter - 8: Page - 75 "Radio Frequency Amplifier" and Chapter - 12: Page - 132 "Signal Tracing."

When the band/s have been repaired refer to Chapter - 11: Page - 106 "Testing The Radio Chassis."

Does The Radio Play On Any Band? **NO**

Power down (**PDR**) the radio and make sure that the radio is electrically complete, and that the antenna is connected. Position the radio chassis on the workbench so that the inside of the chassis is easy to access for continuity testing, voltage reading, and signal tracing.

Prepare the chassis for taking voltage readings. From the information supplied by the manufacturer of the 8Q2, all of the voltage readings are taken from chassis ground. The negative lead of the DC voltmeter is connected to the chassis and the positive lead will be moved to each test point. Refer to Figure A-11 for the voltage listings by tube socket and pin number. Refer to your radio's manufacturer for this information.

Power up the radio (**PHR**), measure all the tube plate voltages, and write down the results. Then power down (**PDR**) the radio.

If all the plate voltages are correct, proceed to Chapter - 12: Page - 131 "All Voltages Read Correctly, but the Radio Does Not Play"

If all the voltages are low, there may be a problem with the power supply. Refer to Chapter - 3: Page - 23 "Full-Wave Rectifier Power Supply." Refer to Chapter - 9: Page - 82 "Test Points for the Power Transformer."

If only one plate voltage reads low, review the appropriate chapter for that circuit, and perform the continuity tests for that circuit. Re-check every component and every solder connection in the circuit. There is a reason that the voltage is low for that circuit only.

Refer to Chapter - 11: Page - 106 "Testing The Radio Chassis."

All Voltages Read Correctly, but the Radio Does Not Play

Power down (**PDR**) the radio and make sure that the radio is electrically complete, and the antenna is connected. Position the radio chassis on the workbench so that the inside of the chassis is easy to access for continuity testing, voltage reading, and signal tracing.

The center terminal of the volume control is a good test point to determine if audio circuit is functioning. Power up the radio (**PHR**) and turn up the volume control 1\4 turn. Holding a small screwdriver by its insulated handle, touch the center terminal of the volume control. This will inject a small 60-cycle audio signal into the audio circuits, and a 60-cycle hum should be heard from the speaker. Power down (**PDR**) the radio.

Is a 60-Cycle Hum Heard at the Speaker? Yes

This means that the audio is functioning enough to produce some noise at the speaker. The audio may still have problems, like distortion. However, if any signal was being produced by the front end (antenna, R.F., oscillator / mixer, and I.F. circuits) the radio would play. If all the tubes and plate voltages are good, signal trace the front end.

Review Chapter - 8: Page - 75 "Radio Frequency Amplifier", Chapter - 7: Page - 67 "Local Oscillator Mixer Converter", and Chapter - 6: Page - 57 "I.F. / Detector AVC and Eye Tube."

Refer to “Signal Tracing” on page 132.

Is a 60-Cycle Hum Heard at the Speaker? NO

This means the audio circuit has a problem and the front end (antenna, R.F., oscillator, and I.F. circuits) of the radio may or may not be functioning. If all the tubes and plate voltages are good signal trace the audio circuits.

Review Chapter - 5: Page - 47 "Phase Inverter", and Chapter - 4: Page - 37 "Push-Pull Audio Output."

Refer to “Signal Tracing” on page 132.

Signal Tracing

When to use signal tracing?

- The radio does play, but it is noisy. A signal tracer is very useful in locating the source of noise in the audio or R.F. circuits of the radio.
- The radio does not play on one or more bands. The signal-tracer is used to detect either an R.F. or A.F. signal at various test points in the (8Q2 type) radio circuits. Where the signal stops, the defective component/s are associated with that section, or the previous section.

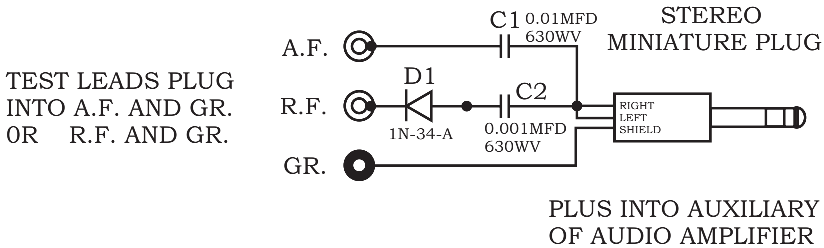
What equipment is used to signal-trace radio circuits?

- An oscilloscope is one piece of test equipment that may be used to signal-trace radio circuits. The oscilloscope can measure voltages (AC/DC), signal frequency, and signal distortion. Oscilloscopes are also used in accurate radio alignments. The only drawback is that oscilloscopes are expensive.
- A signal-tracer is another piece of test equipment that may be used to trace R.F. or A.F. signals in radio circuits. The signal-tracer is an audio amplifier with a diode (detector) that can be switched in and out of the input circuit of the audio amplifier. The signal-tracer is inexpensive to build, and is a very useful tool for troubleshooting.

Building a Signal-Tracer

Just about any audio amplifier can function as a signal-tracer. A transistor or tube type audio amplifier may be adapted for signal-tracing. The adapter has two test leads, and a phono plug that connects to the audio input of the amplifier. Between the test leads and the phono plug is a network that protects the amplifier from high voltages. It also has two plugs that allow for A.F. or R.F. signal-tracing. The wiring diagram for a signal-tracer adapter is shown in Figure 12-3.

FIGURE 12-3 Signal-Tracer Adapter



The red test lead connects to either the A.F. (audio frequency) or the R.F. (radio/455kHz frequency), and the black test lead connects to ground. The miniature plug, at the right, is plugged into the auxiliary input of an audio amplifier. The author uses a small transistor audio amplifier purchased from a local electronic store.

What determines which inputs (A.F. or R.F) are to be use?

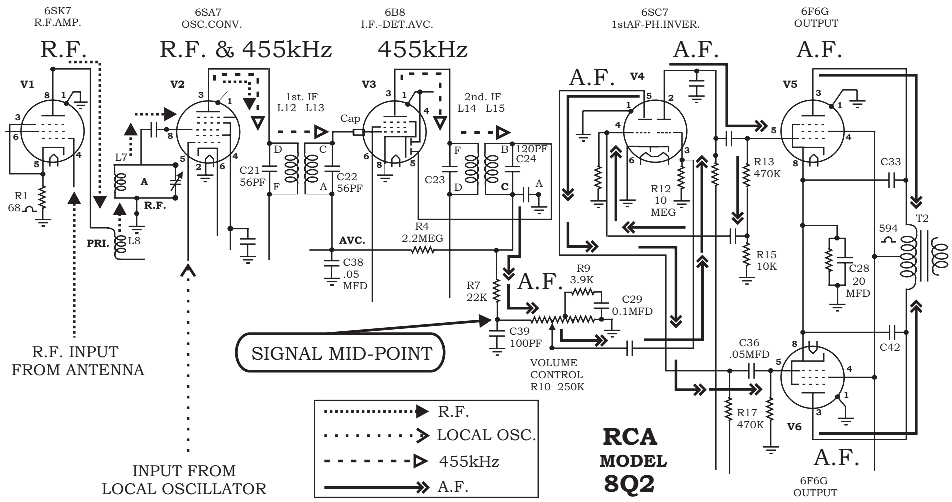
The signal at a test point determines whether or not the A.F. or R.F. test plug is used. Refer to Figure 12-4 for a circuit drawing of the signal types, and Table 12 - 1 on page 142 for a list of test points and their signal types.

Signal-tracers are available at electronic supply stores and on the internet. Other signal-tracer wiring diagrams and signal-tracer kits are also available on the internet.

Using the Signal-Tracer

Figure 12-4 shows the signal flows that can be traced by using a Signal-Tracer or an Oscilloscope.

FIGURE 12-4 Signal Flow



Where to Start Signal-Tracing

It is always a good troubleshooting practice to start in the middle of the signal flow. Refer to FIGURE 12-4,'Signal Flow" on page 134 and Table 12 - 1, "R.C.A. Model 8Q2 Radio Signal-Tracer Test Points," on page 142 for the signal flow and signal test points respectively.

The signal mid-point is marked in Figure 12-4. At this point is an audio frequency (A.F.) signal and it is on the high side of the volume control. This point is also part of the detector circuit. Before this point, the signal-tracer would be setup to use the R.F. input to detect radio frequency/455kHz. After this point the signal-tracer is setup to use the A.F. input to trace the audio signal.

Connecting the Signal-Tracer to the circuit

For the 8Q2, the black lead of the signal-tracer is connected to chassis ground, and the red lead is connected to the signal mid-point.

Power up the radio (**PHR**) and turn on the signal-tracer's audio amplifier. Set the band select switch to band 'A' (standard broadcast band), tune through the band while listening to the signal-tracer.

NOTE:

If you have not used a signal-tracer before, practice on a working tube radio. Use the wiring diagram for the practice radio to locate the test points.

Does the Signal-Tracer Detect Audio at the MID-POINT? Yes

If the signal-tracer is playing at this point, the problem is forward in the inverter circuit or the push / pull output circuit. Reposition the signal-tracer's red lead to about the middle of the audio circuits.

EXAMPLE: The next trace point is V4 pin 2.

If the signal-tracer plays at the new test point, the problem is probably in the push / pull output circuit. If the signal-tracer does not play, the problem is probably in the inverter circuit. Power down (**PDR**) the radio. Remember to change the vacuum tube with a new tube in any suspect circuit.

Review
Chapter - 4: Page - 37 "Push-Pull Audio Output",
Chapter - 9: Page - 89 "Test Points for the Speaker",
Chapter - 5: Page - 47 "Phase Inverter",
"Does The Radio Play On Any Band? NO" on page 130,
Chapter - 11: Page - 103 "Safety",
Chapter - 11: Page - 106 "Testing The Radio Chassis."

Does the Signal-Tracer Detect Audio at the MID-POINT? NO

If the signal-tracer does not play at the mid-point, the problem is in the front end of the radio (antenna, R.F., oscillator, or I.F. circuits). Refer to Figure 12-4 and Table 12 - 1. Change the signal-tracers red lead input to R.F. and choose a test point about in the middle of the R.F. / 455kHz circuits.

EXAMPLE: The next trace point is V2 pin 3. At this test point both an R.F. and a 455kHz I.F. signal should be present.

Does the Signal-Tracer Play at V2 pin 3? Yes

This means the problem is forward of the V2 pin 3 test point.

EXAMPLE: The next test point is V3 pin 3. If the signal-tracer does <u>not</u> play at V3 pin 3 the problem is in the 1st.I.F. circuit. Power down (**PDR**) the radio.

Review Chapter - 6: Page - 57 "I.F. / Detector, Eye Tube" and
“Does The Radio Play On Any Band? NO” on page 130.

If either the primary or the secondary of the 1st.I.F. transformer are open and can not be repaired, it must be replaced. Refer to Chapter - 10: Page - 97 "I.F. Transformer replacement."

If the signal-tracer does play at V3 pin 3 the problem is forward. But if it does not play at the signal mid-point, the only part between these two test points is the Sec.I.F. transformer. One radio that the author was troubleshooting had this problem. The I.F. ohmed out okay so the author opened up the I.F. can and found a 1/8 of and inch of dust at the bottom. This dust was shorting out the 455kHz signal. After cleaning the I.F transformer, the radio plays great again.
Refer to Chapter - 1: Page - 2 "Cleaning."

If either the primary or the secondary of the Sec.I.F. transformer are open, and can not be repaired, it must be replaced. Refer to Chapter - 10: Page - 97 "I.F. Transformer replacement."

There should be two major signals at test point V2 pin 3, an R.F. and a 455kHz signal. If the oscillator is not operating, the signal-tracer will still detect the R.F. signal. If this is the case, there will be no signal at V3's GRID CAP and forward. If the 1ST. I.F. is good, the 455kHz signal is missing because the local oscillator is not oscillating. Refer to "Is the Local Oscillator Functioning?" on page 138.

Does the Signal-Tracer Play at V2 pin 3? NO

This means the problem may be in the antenna, R.F., or oscillator circuits.

EXAMPLE: The next trace point is V1 pin 3. At this test point, only an R.F. signal should be present.

If the signal-tracer plays, while tuning through the AM band, the problem is forward in the oscillator circuit. Review Chapter - 7: Page - 67 "Local Oscillator Mixer Converter." Refer to "Is the Local Oscillator Functioning?" on page 138.

If the signal-tracer does not play while tuning through the AM band, the problem is in the R.F circuit. Power down (**PDR**) the radio, then connect a wire antenna to V2 pin 8, this will bypass the R.F. circuit. Power up the radio (**PHR**) and if the radio plays the problem is in the R.F. amplifier circuit. Power off (**PDR**).

Review Chapter - 8: Page - 75 "Radio Frequency Amplifier."
"Does The Radio Play On Any Band? NO" on page 130
Refer to Chapter - 9: Page - 86 "Test Points for the R.F. Coils."

Is the Local Oscillator Functioning?

The local oscillator is one of the most important and critical circuits in the radio. If it is not functioning on one or more bands, the 455kHz (I.F.) frequency will not be generated and the radio will not play.

Remember, when troubleshooting any tube circuit, always replace the tube in that circuit with a known good one. This is particularly true with the Local Oscillator Circuit. It is not uncommon for an oscillator tube to test good in a tube tester, yet it will not function in the oscillator circuit.

How to determine if the local oscillator is oscillating.

Using Circuit Information

Review Chapter - 7: Page - 67 "Local Oscillator Mixer Converter" and refer to Chapter - 7: Page - 74 "Voltage Listing of V2." Power up the radio (**PHR**).

One key indicator in determining if the oscillator is functioning is the control grid bias of the oscillator tube. For the 8Q2 this V2 (6SA7) pin 5. If the bias voltage is negative this usually indicates that the oscillator circuit is functioning.

To measure this voltage a high impedance voltmeter is required. This test instrument should have at least a 10MEG ohm input impedance. An ordinary voltmeter with only a few thousand ohms per-volt impedance would short out the grid voltage. Power down (**PDR**) the radio.

Using an Oscilloscope

This is one of the best instruments to use to determine if the oscillator circuit is functioning. The test point is the plate of the oscillator tube. For the 8Q2 this is V2 (6SA7) pin 3.

Using a PLL Radio

A Phase Lock Loop (PLL) radio may be used to detect oscillator frequencies. If a non-modulated carrier (a quiet signal, approximately the I.F. frequency plus the dial setting) is found, the oscillator is functioning.

Refer to Figure 12-5 or Figure A-1 for the 8Q2 wiring diagram.

Power up the radio (**PHR**) and set the test radio to band ‘A’ (AM standard broadcast band). Tune the test radio between 650kHz to 700kHz. This should ensure that the oscillator frequency will fall within the band. The for the 8Q2 the oscillator frequency should be approximately 455kHz above the dial setting.

Position the PLL radio in close proximity of the test radio. Let the PLL radio scan through the AM band. When the signal is found it should peak the PLL radio signal strength indicator and no sound should be heard from the PLL radio. Move the PLL radio away from the test radio and the signal strength should decrease.

If no quiet signal is found the oscillator is not functioning.
Review Chapter - 7: Page - 67 "Local Oscillator Mixer Converter" and “Does The Radio Play On Any Band? NO” on page 130.
Refer to Chapter - 9: Page - 88 "Test Points for the Oscillator Coils."

The 8Q2 radio has three bands and the PLL radio can be used to scan all three. Without changing the dial settings, and changing only the band switch, here are the results for the 8Q2. For band ‘A’ a quiet frequency was found at 1135kHz, for band ‘B’ a quiet frequency was found at 3.385MHz, and for band ‘C’ a quiet frequency was found at 9.365MHz.

If this is the first time you have tried to find an oscillators frequency with a PLL radio. try practicing with a tube radio that is working. Power down (**PDR**) the radio.

Noise

The most common types of noises are 60-cycle hum and static noises. A signal-tracer is a good tool to use in locating sources of the noise. Refer to Figure 12-4 for the signal flow and refer to Table 12 - 1 for the signal test points.

What Radio Components Can Produce Noise?

Resistors and capacitors can produce noise. Transformers with shorted windings can produce noise. Dirty components, like I.F. transformer cans and variable capacitors, can also produce noise.

The component most likely to produce noise is the vacuum tube. The tube can produce a static noise known as micro-phonics. To find a vacuum tube with micro-phonics power up the radio (**PHR**) and lightly tap lightly on each tube with the eraser end of a wooden pencil. When a static noise is hear in step with the tapping, the noisy tube has been found. Power down (**PDR**) the radio. Vacuum tubes can also produce a 60-cycle hum. This could happen if the filament makes electrical contact with the cathode.

Open Grounds

Open grounds are another common source of noise. With an ohmmeter check all the ground connections and re-solder any loose or open connections. When in doubt, re-solder all the ground connections. Some ground connections are bolted together. Unbolt the connection, clean the bolt, the washer, the nut, and the ground connection, then reassemble and tighten.

The 60-Cycle Hum

If the 60-cycle hum does <u>not</u> vary when the volume control level is changed, the hum is a result of a filtration problem in the power supply. Refer to Chapter - 3: Page - 23 "Full-Wave Rectifier Power Supply" and Chapter - 9: Page - 82 "Test Points for the Power Transformer."

If the 60-cycle hum does vary when the volume control level is changed, the audio amplifier is amplifying the hum. Using a signal-tracer, start tracing the noise at the signal mid-point. Refer to “Where to Start Signal-Tracing” on page 134.

Static Noise

If the static noise does not increase as the volume control level is increased, the noise maybe originating from the audio amplifier or the power supply.

Carbon resistors can produce noise when the carbon has fractured. When power is applied to the circuit the fractured gap fries. Capacitors can also produce noise when the two plates start to short together.

Re-check all resistors and capacitors and ground connections. If none are found to be out of tolerance, use a signal-tracer to locate the source of the noise. Refer to “Where to Start Signal-Tracing” on page 134.

If the static noise does increase when the volume control level is increased, the noise is originating from the front end (antenna, R.F., oscillator / mixer and I.F. circuit) or the noise is being amplified by the front end.

Clean all electrical components thoroughly. Re-check all resistors and capacitors and ground connections. If none are found to be out of tolerance, use a signal-tracer to locate the source of the noise. Refer to “Where to Start Signal-Tracing” on page 134.

Thunder Storm Noise

If the noise sounds like a thunder storm, and signal-tracing the noise shows it to be everywhere, the problem may be mica capacitors in the IF transformers. Refer to “Replacing IF Mica Capacitors” on page 153.

FIGURE 12-5 RCA Model 8Q2

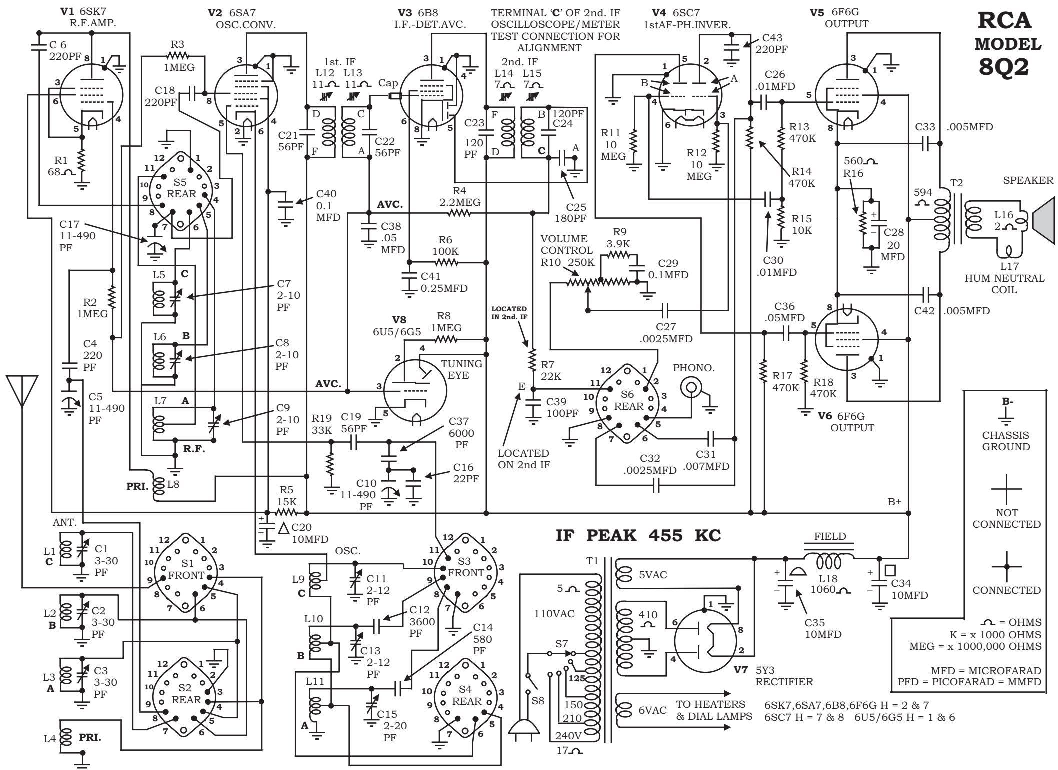


TABLE 12 - 1 R.C.A. Model 8Q2 Radio Signal-Tracer Test Points

Vacuum Tube	Output - Plate Test Points	Input - Grid Test Points	Signal at Test Points
V6	PIN 3	PIN 5	A.F.
V5	PIN 3	PIN 5	A.F.
V4	PIN 2 PIN 5	PIN 3 PIN 4	A.F.
V3	PIN 3	GRID CAP	455kHz
V2	PIN 3	PIN 8	R.F. & 455kHz
V1	PIN 8	PIN 6 NOT USABLE	R.F.

Oscillator Problem

The Philco 37-650 Story

A customer's Philco 37-650 radio had been playing perfectly for about three weeks and then it stopped working. The only station it would receive was a very strong local AM station, and both shortwave bands would only receive a little noise. This was disappointing because the author had just called the customer a day or so before, to make arrangements to deliver the radio.

Locating the faulty circuit

A PPL radio tuned to 470kHz (the IF frequency for the 37-650) revealed that the IF frequency was only present when the radio was tuned to the strong local station. Replacing the oscillator tube (6A8G) with a known good tube made little difference. With the radio off and unplugged, an ohmmeter showed that all the coils and resistors checked good in the oscillator circuit.

With power on (**PHR**), the voltage readings (from chassis ground) from every tube pin revealed that several voltages at the oscillator tube were reading very low.

NOTE:

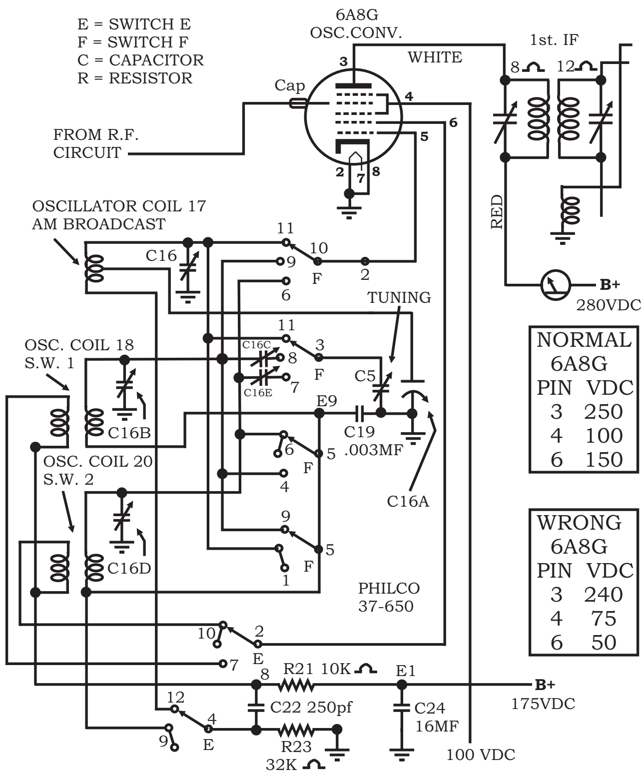
A very helpful practice when the radio is operating correctly, is to record the voltages of every tube pin and power point in the radio. If the radio should stop playing, having all the voltage readings will be invaluable in the trouble-shooting process.

The normal voltage readings for the 6A8G are pin 3 = 250VDC, pin 4 = 100VDC, and pin 6 = 150VDC. Now the readings were pin 3 = 240DVC, pin 4 = 75VDC, and pin 6 = 50VDC. Pin 3 is 10VDC low, this is within specifications. But pin 4 is 25VDC low and pin 6 is 100VDC low, a definite problem.

Troubleshooting the oscillator circuit

With the power off (**PDR**) and unplugged, another check with an ohmmeter still showed that all the coils were good and none of their primaries or secondaries were shorted together.

FIGURE 12-6 Philco 37-650 Oscillator Circuit

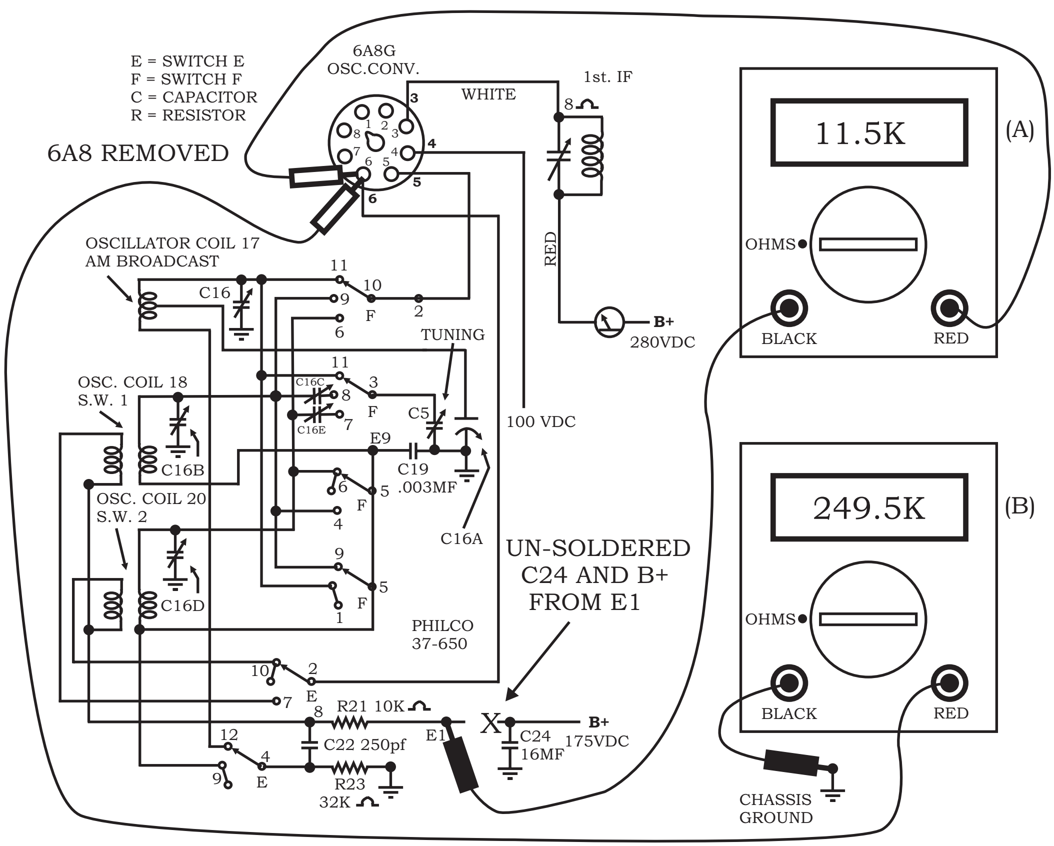


With the oscillator tube removed, and with power on (**PHR**), another voltage reading showed that the voltages were all back to normal or a little high. This means that the functioning of the tube is causing the drop in the voltages. With the oscillator tube reinstalled and with the power on (**PHR**), the voltage on the control grid read positive. If the oscillator was functioning the control grid voltage would be negative, not positive. Figure 12-6 shows the oscillator circuit for the Philco 37-650 (band switch set on the broadcast band). At this switch setting the control grid (pin 5) of the 6A8G is connected to the secondary of coil 17 and then through resistor R23 to chassis ground.

Locating the fault in the circuit

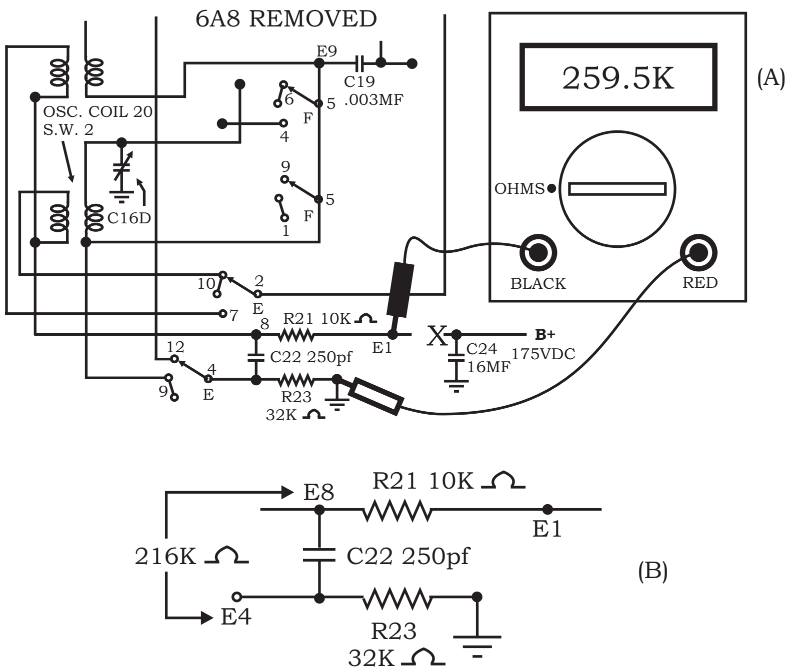
Because of the ground connection through R23, the control grid should never reach a positive potential.

FIGURE 12-7 Locating the Fault



In Figure 12-7 the oscillator tube has been removed, the B+ wire has been un-soldered from E1, and the radio is off and unplugged. Ohmmeter (A) shows a reading of 11.5K ohms which is within tolerance. But moving the meter to (B), shows a reading of 249.5K ohms to chassis ground and it should read infinite ohms.

FIGURE 12-8 Locating the Short to Chassis Ground



In Figure 12-8 part (A) shows a reading of 259.5K ohms. Again this should read infinite ohms. It was beginning to look like capacitor C22 may have a high impedance internal short, as shown in part (B) of Figure 12-8.

If the resistance of R21 and R23 are subtracted from 259.5K ohms the result is about 216K ohms. The next problem was getting to capacitor C22 to replace it, capacitor C22 is located on wafer switch E and there is less then one half inch between switch E and a metal shield. The Philco 37-650 has three modular units (oscillator, RF, and antenna units), and each unit has two wafer switches. All six wafers are ganged together and move in unison.

FIGURE 12-9 Bottom View of Modular Units

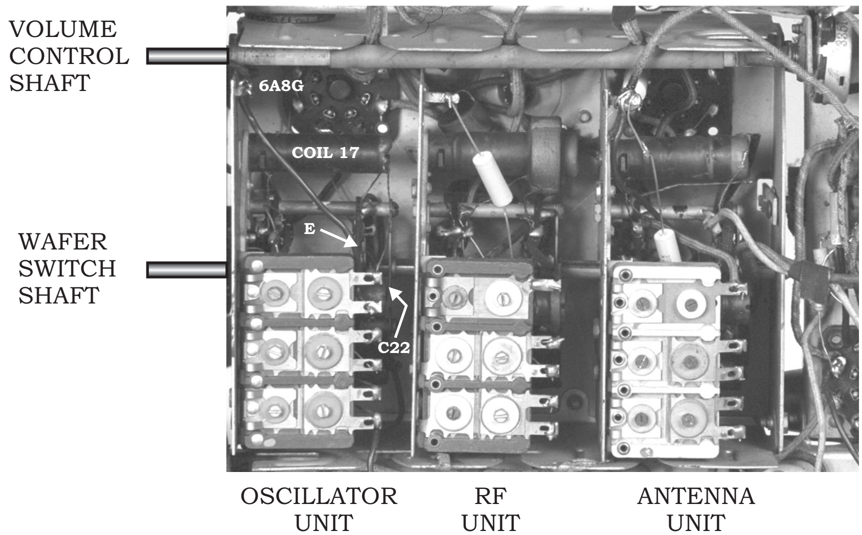


Figure 12-9 Shows the bottom view of the three modular units. Figure 12-10 shows the oscillator unit removed from the chassis and a drawing of switch E.

FIGURE 12-10 Oscillator Unit

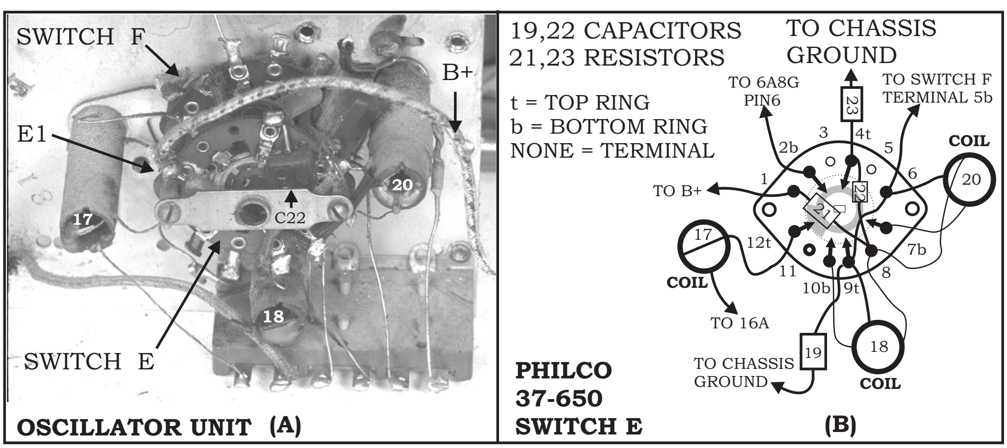


FIGURE 12-11 216K Ohms Across Capacitor C22

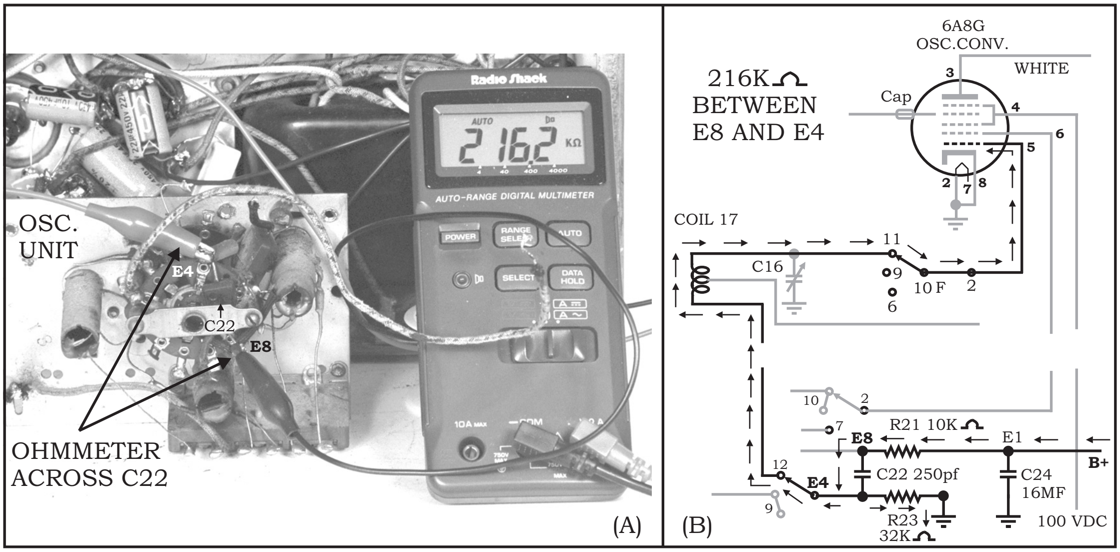


Figure 12-11 part (A) shows an ohmmeter reading of 216.2K ohms across E4 and E8 of wafer switch E. The wiring diagram in Figure 12-11 part (B) shows the electrical path that the B+ is now taking in the oscillator circuit. The resistors R21 and R23, plus the 216.2K short all together makes up an unwanted voltage divider circuit. The B+ at E1 is 175VDC. Using ohms law, R1+R23+216.2K= 259K ohms, 175/259K= 0.0006 current, and 0.0006x32K= 19VDC at terminal E4. Most of this 19VDC is applied on the control grid of the 6A8G causing it to go into saturation (maximum electron conduction).

The screen grid (pin 6) of the 6A8G is acting as the plate circuit for the oscillator circuit, refer to Figure 12-6. Because of the 6A8G is in saturation, the voltage at the screen grid is 100VDC low.

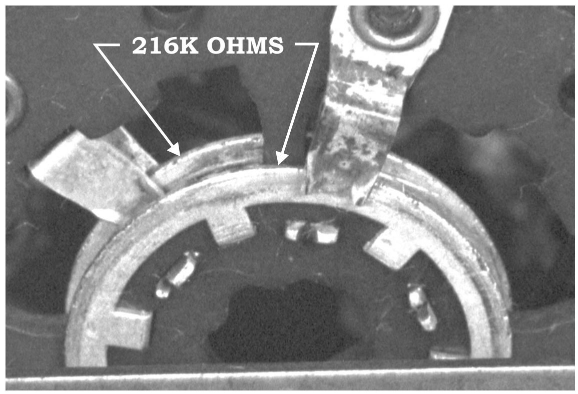
Capacitor C22 was removed from terminals E4 and E8, then tested on a capacitor tester and it was found to be good, no internal 216.2K short. But reading across terminals E4 and E8 with an ohmmeter revealed that the 216K ohm short was still there.

Obviously, this was very disappointing.

Fault located

After removing several coil wires from the terminals of wafer switch E and insulating several contacts with small pieces of thin plastic, the short was gone. However this was not very good news.

FIGURE 12-12 216K Ohm Short Location

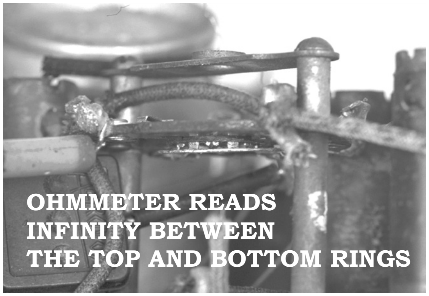


The short was in the rotating part of wafer switch E. The 216K ohm short is between the top and bottom contact rings as shown in Figure 12-12. The likelihood of finding another oscillator unit for the 37-650 was not very high. A thorough search of all the popular webs sites for Philco radio repair confirmed this fact. No one had a chassis, an oscillator unit, nor a wafer switch for a 37-650.

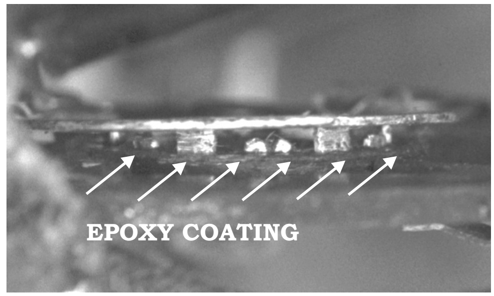
Some of the ideas to resolve this problem were to wire the switch so that the radio would always play on the broadcast band while searching for parts. Another idea was to try and fix the switch first, because there really was not anything to lose.

Repairing the Wafer Switch

FIGURE 12-13 Repairing Switch



(A)



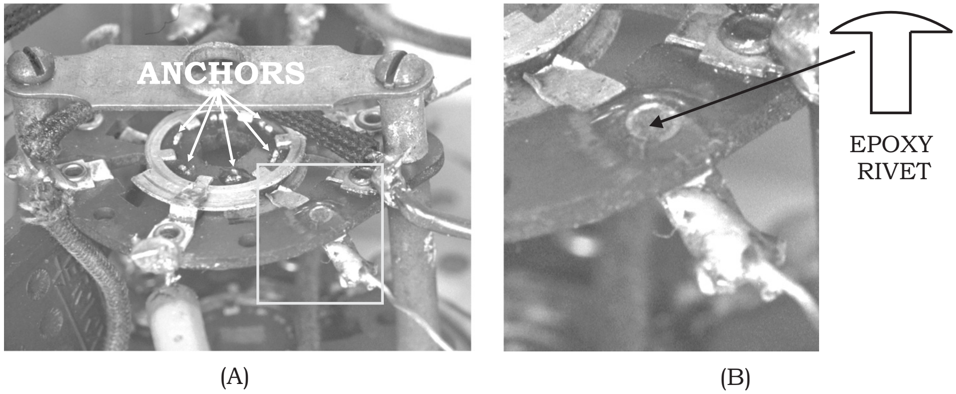
(B)

Only one connecting terminal (E2) had to be removed so that the bottom ring was free of all long connectors. Connector E2's rivet was removed using a high-speed hand-held grinding tool, then it was set aside. The bottom ring was pried apart using a knife with a very small, thin blade as shown in Figure 12-13 part (A). Good luck happened here--, the 216K short was gone on the first try. The whole oscillator unit was turned over so when the epoxy was applied, it would hold the epoxy in place on the insulator ring.

The epoxy used was a slow curing 90-minute epoxy. The epoxy was applied using a thin wire with a very small drop of epoxy at the end. A magnifying glass helped in guiding the drops onto the insulating ring as indicated by the arrows in Figure 12-13 part (B). This step was repeated many times until the epoxy coated the insulating ring. The epoxy was allowed to cure for 24 hours.

After the epoxy had cured the bottom ring was pressed back into position. A test with an ohmmeter revealed a reading of infinite ohms between the top and bottom rings.

FIGURE 12-14 Re-Installation of the Connector



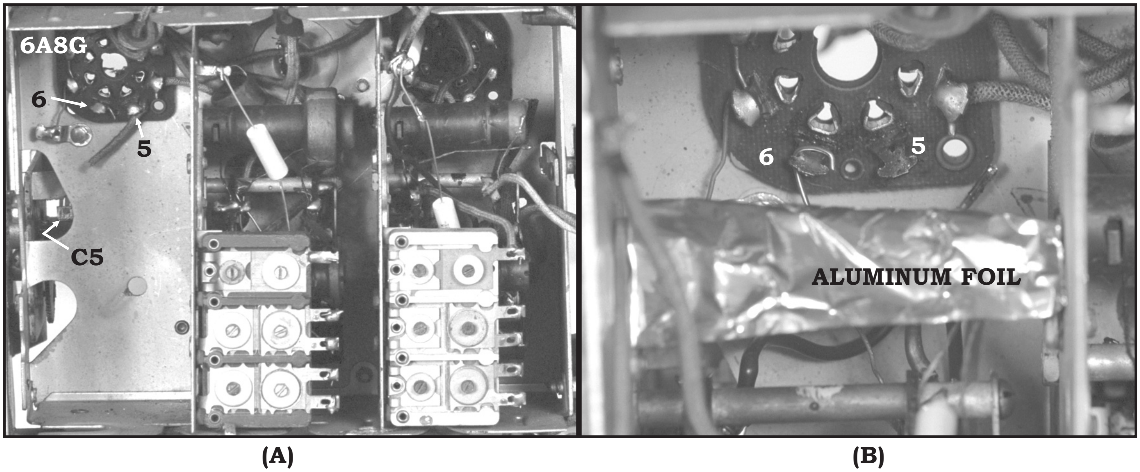
A small drop of epoxy was applied to the protruding anchors of the bottom ring to secure it to the insulating material as shown in Figure 12-14 part (A). Figure 12-14 part (B) is an enlargement of the re-installed connector. Epoxy was pushed through the center of the existing metal rivet and then more epoxy was mounded on top. This formed an epoxy rivet, securing the connector to the insulating material.

The repair of the wafer switch was now complete. All of the oscillator unit resistors and capacitors were replaced. All the coil wire connections were reconnected and re-soldered. Refer to Figure 12-6. A thorough test with an ohmmeter was preformed on all the circuitry on both wafer switches (E and F). All of the circuitry checked good.

Re-installing the oscillator unit

In order to remove the oscillator unit, two wires were cut. Because of the tight quarters there was a real possibility of causing damage to one or more of the coils with the soldering iron. Refer to Figure 12-6 and Figure 12-14. The wire cut was from pin 5 of the 6A8G to wafer switch F terminal 2. The other wire was from pin 6 of the 6A8G to wafer switch E terminal 2.

Figure 12-14 Clean Connections and Install Oscillator Unit



The cut wires are shown in Figure 12-14 part (A). Before the oscillator unit was re-installed, the remaining wires and excess solder were removed from pin 5 and pin 6 of the 6A8G.

On the oscillator unit the wires on wafer switch F terminal 2 (to pin 5) and wafer switch E terminal 2 (to pin 6) were replaced with slightly longer wires. The oscillator unit was re-installed in the chassis where the two wires were positioned to connect to pin 5 and pin 6. Using a needle nose pliers, both wires were marked for length. The oscillator unit was removed and the wires cut to the proper length and cleaned. If these wires were left too long the frequency of all the bands would be low. It may oscillate so low that the radio could not be aligned correctly.

Figure 12-14 part (B) shows the final installation. Aluminum foil was placed over coil 17 to protect it from the heat of the soldering iron. After all the connections were soldered, the foil was removed and the radio was aligned to the manufacturer’s specifications.

This was a difficult and somewhat rare problem. However, it is a good example of troubleshooting in a systematic way to locate the problem circuit and then isolate and repair the bad component.

Replacing IF Mica Capacitors

Symptoms

The noise they make is very similar to the sound of lightening strikes in a thunder storm. The radio plays well, but it is very noisy. This noise could also be described as a frying and popping sound.

Removing and Replacing

FIGURE 12-15 Zenith Mica Capacitor IF Transformer

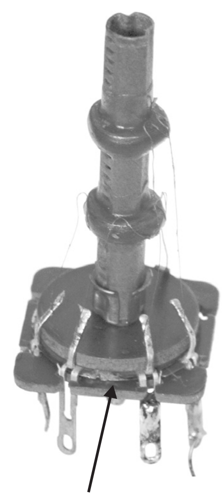
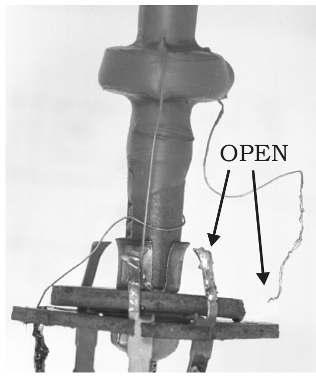


Figure 12-15 show a Zenith IF transformer before the mica capacitors have been replaced. It has been remove from the radio and the mica capacitors are intact.

Sometimes the wiring diagrams are not accurate as to the capacitance values of the mica capacitors. So it is a good practice to measure the capacitance of the mica capacitor before they are removed.

FIGURE 12-16 One Side of Coil Removed from Mica Capacitor



In Figure 12-16 one side of the coil has been removed. Measure across the mica capacitor and write it down on the diagram. Do this for both the primary and secondary of the IF transformer.

FIGURE 12-17 Mica Wafer and Contact Paddles

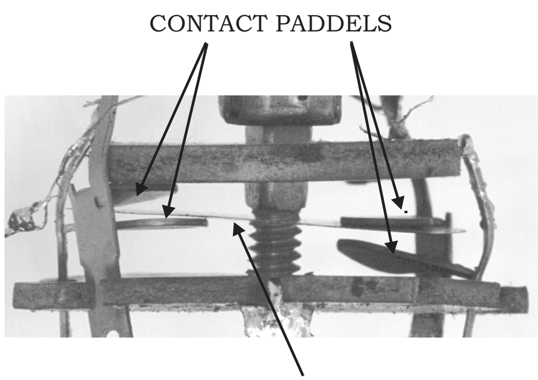
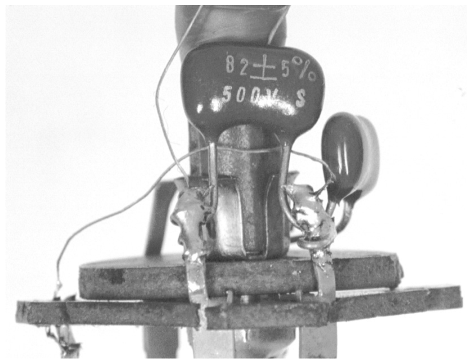


Figure 12-17 shows the construction of mica capacitor in the base of the IF transformer. For each capacitor there are two contact paddles on either side of the mica wafer. Remove the mica and cutoff the contact paddles so that they do not short together when the base is reassembled.

FIGURE 12-18 Capacitors Replaced



The Figure 12-18 shows the replacement capacitors installed. The IF transformer is re-installed in the radio and aligned to the manufacturer's specifications. This procedure must be repeated for each IF transformer with mica capacitors.

The next two figures on the next page shows another manufacturer's IF transformer that uses mica capacitors. The procedure for replacing and repairing the IF capacitors is the same.

FIGURE 12-19 Mica IF

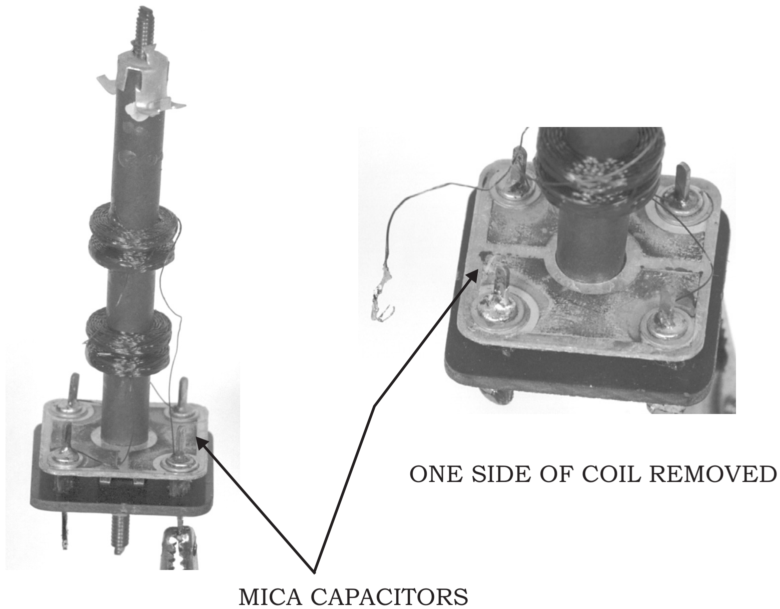
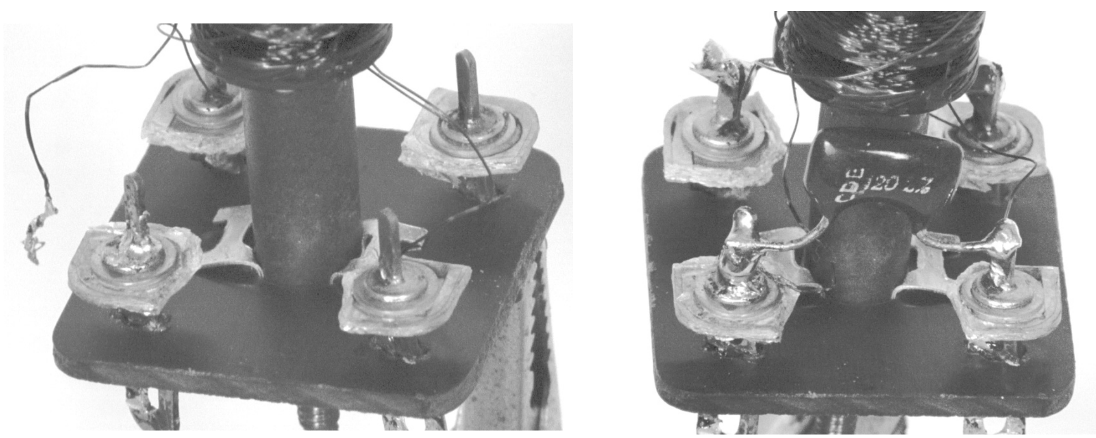


FIGURE 12-20 Mica IF Repaired



MICA CAPACITORS REMOVED

REPAIRED

Troubleshooting Outline

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Current **119**
- No or Low Current **119**
  - No Current **119**
  - Low Current **120**
    - All Tubes Lighted **120**
      - C34, No B+ **120**
      - B+ at C34, No Plate Voltage **121**
    - Tubes Not Lighted **122**
- High Current **122**
  - Current is Very High **122**
    - Remove Rectifier Tube **122**
      - Current is Now Low (rectifier tube is removed) **123**
      - Current is Still High (rectifier tube is removed) **124**
  - Current is a Little High, Almost Normal (all tubes installed) **125**
    - T1 Runs Hot, but steady **125**
    - T1 Runs Hot, and Increasing in Temperature **126**
      - Is T1 still running hot and increasing in temperature?
    - Yes **127**
      - Is T1 still running hot and increasing in temperature?
    - NO **127**
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  - Does The Radio Play On All Bands? **128**
    - Yes **128**
    - NO **128**
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      - Does The Radio Play On Any Band? NO **130**

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APPENDIX

8Q2 MODEL NOTES:

An 8 ohm 40 watt resister was added in series to the primary circuit of T1. Refer to Chapter - 12: Page - 125 "T1 Runs Hot, but steady."

After the radio was repaired and aligned to the manufacturer's specifications, a review of the radio's circuit showed a potential problem. If capacitor C6 were to short, B+ would be applied to the primary of L8 and one of the secondaries (L5,L6, or L7) to chassis ground through wafer switch S5. This would burn out the primary, or a secondary, or both. Because of this potential problem C6 was replaced.

The class 'A' control grid bias of V5 and V6 is read by placing the negative test lead of the DC voltmeter on the cathode (pin 8) and the positive test lead on the control grid (pin 5). This control grid bias voltage reads a -21.49VDC.

OTHER NOTES:

If your radio has push buttons, they should be cleaned and lubricated. Follow the same cleaning and lubricating procedures for the wafer switches. Refer to Chapter - 1: Page - 2 "Cleaning" and Chapter - 1: Page - 4 "Moveable Parts to Lubricate" and Figure 1-6.

Some radios with EYE tubes have a cable that connects the radio chassis and the EYE tube together. The plate resistor for the EYE tube may be located inside the tube socket for the EYE tube at the end of this cable.

If the speaker for your radio needs to be re-coned, check the field coil and voice coil before shipping. If either is open, contact the vender to see if they can make these repairs.

Refer to Figure 11-2, formula for X10 switch. Ra= resistance of ammeter, Rt= Ra / 10, R1= ((Ra x Rt) / (Ra - Rt).

FIGURE A-1 8Q2 WIRING DIAGRAM

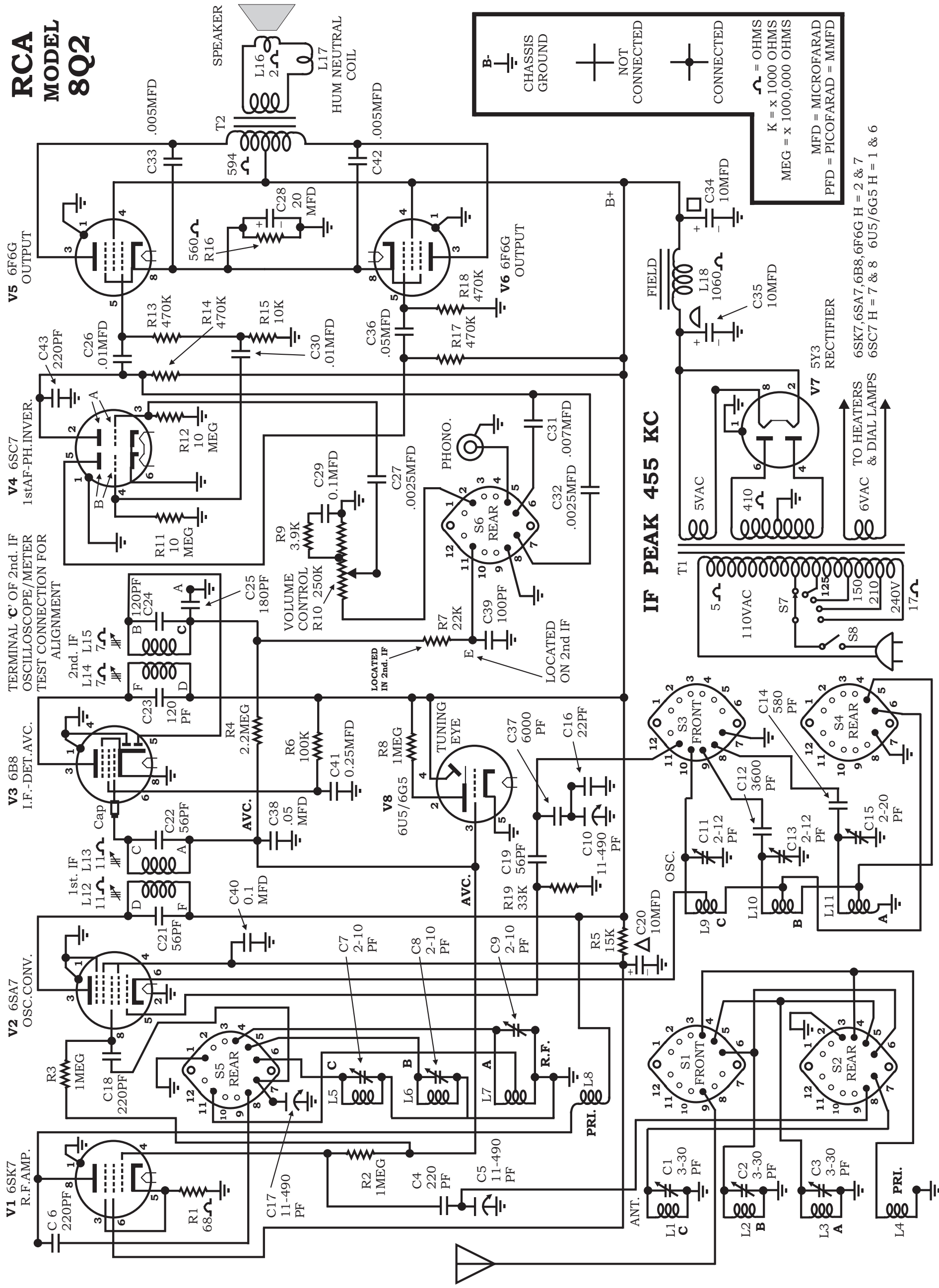
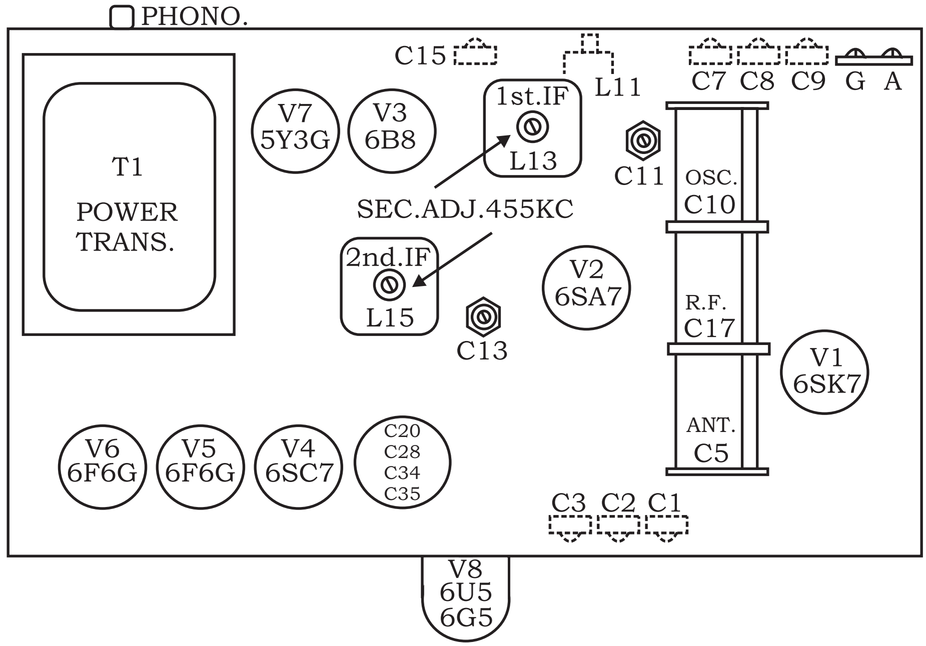
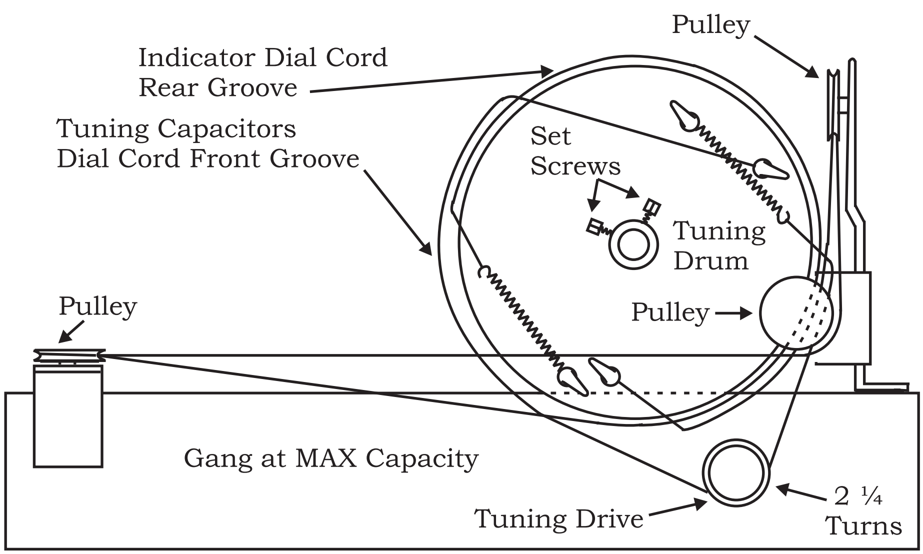


FIGURE A-2 Chassis Parts Location





DRIVE CORD ASSEMBLE

FIGURE A-3 Tube Sockets Pin Count

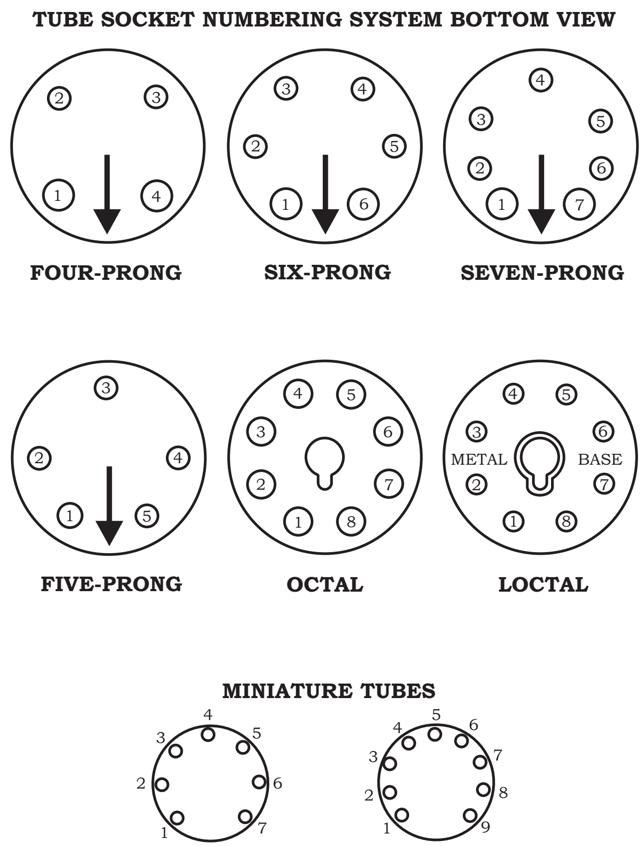


FIGURE A-4 Chassis Drawing Bottom View

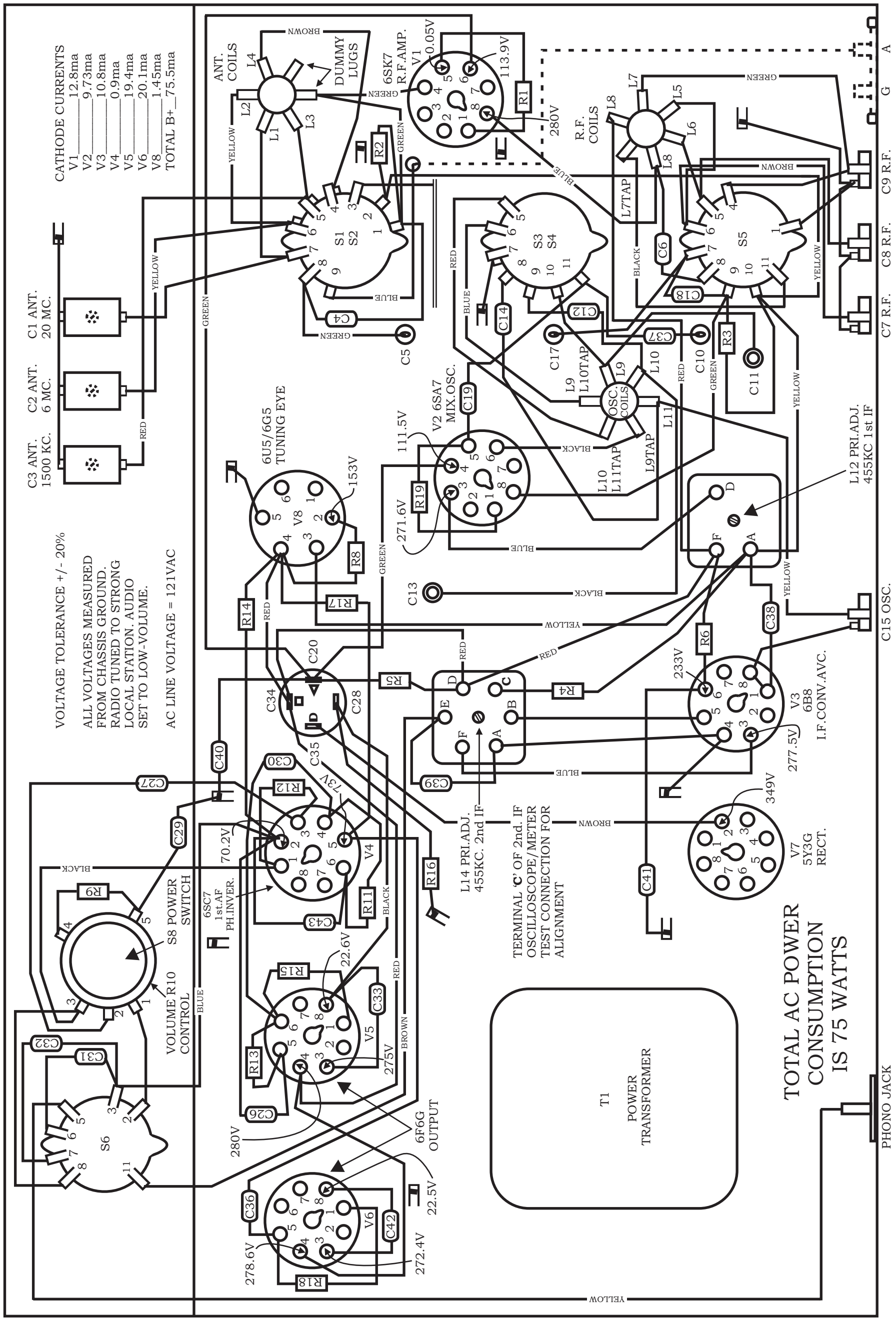
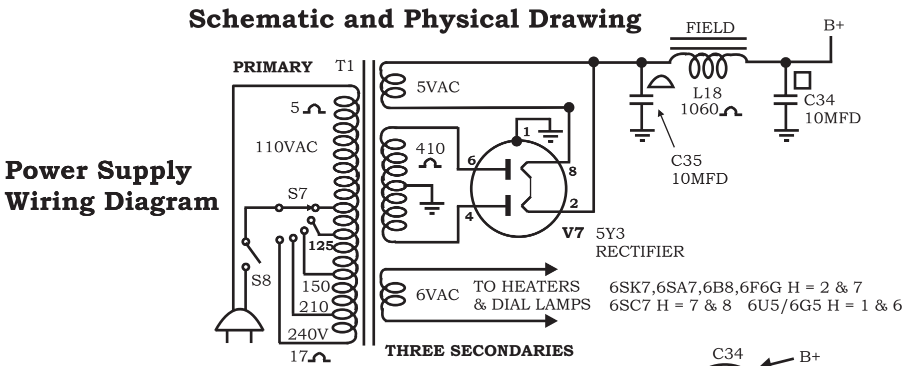
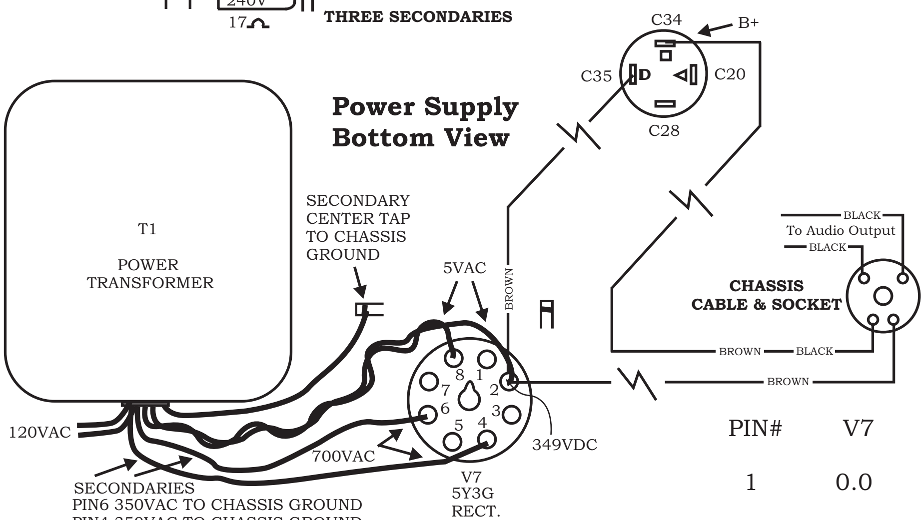


FIGURE A-5 Power Supply Circuit S&P Drawing





PIN#	V7
1	0.0
2	F 349
3	N/A
4	340AC
5	N/A
6	341AC
7	N/A
8	F 349

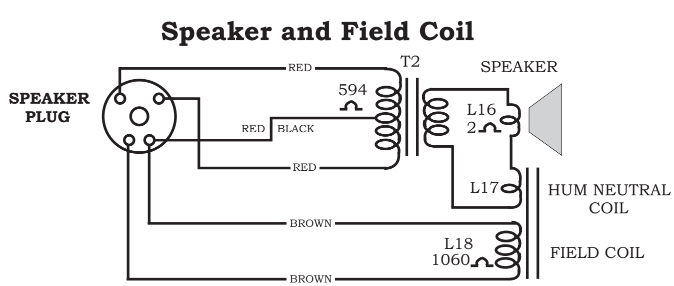
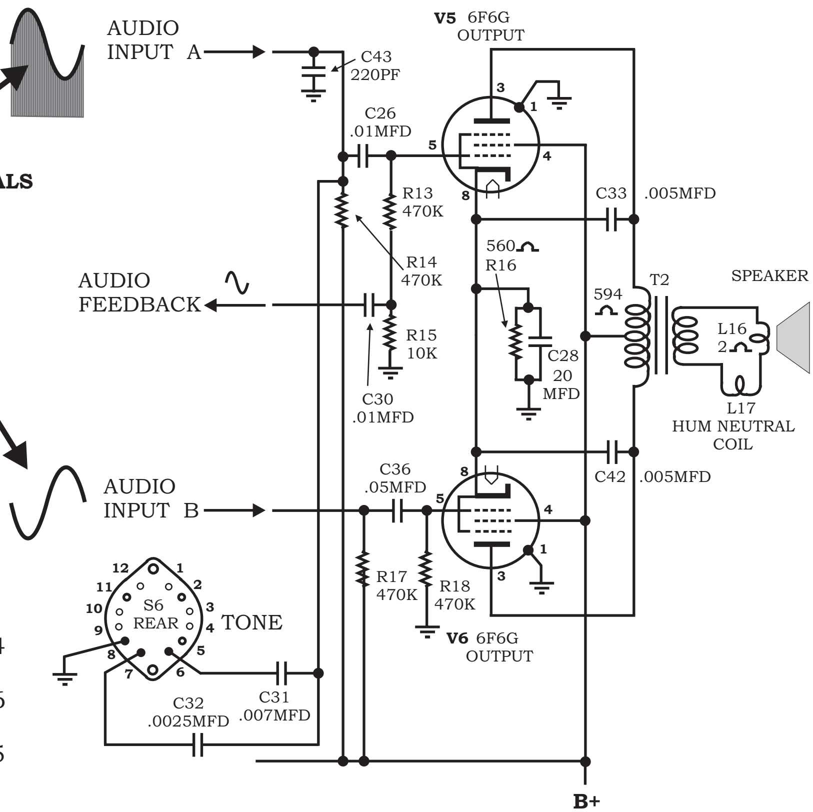


FIGURE A-6 Push-Pull Audio Output Circuit S&P Drawing

AUDIO INPUT SIGNALS
180 DEGREES
OUT OF PHASE



PIN#	V5	V6
1	0.0	0.0
2	F	F
3	275	272.4
4	280	278.6
5	0.005	0.005
6	N\A	N\A
7	F	F
8	22.6	22.5

Schematic and Physical Drawing

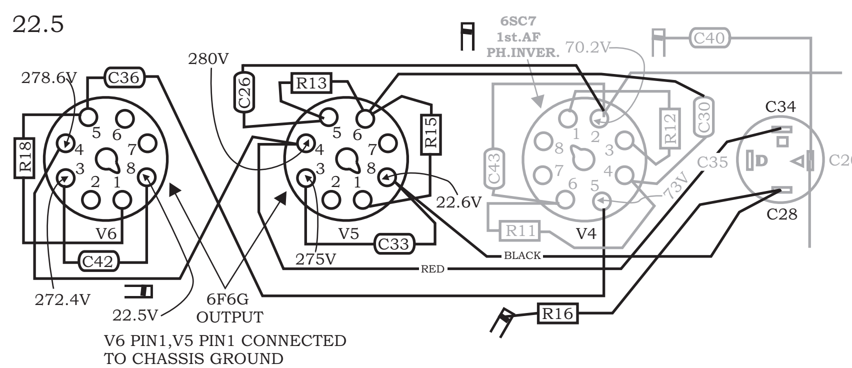
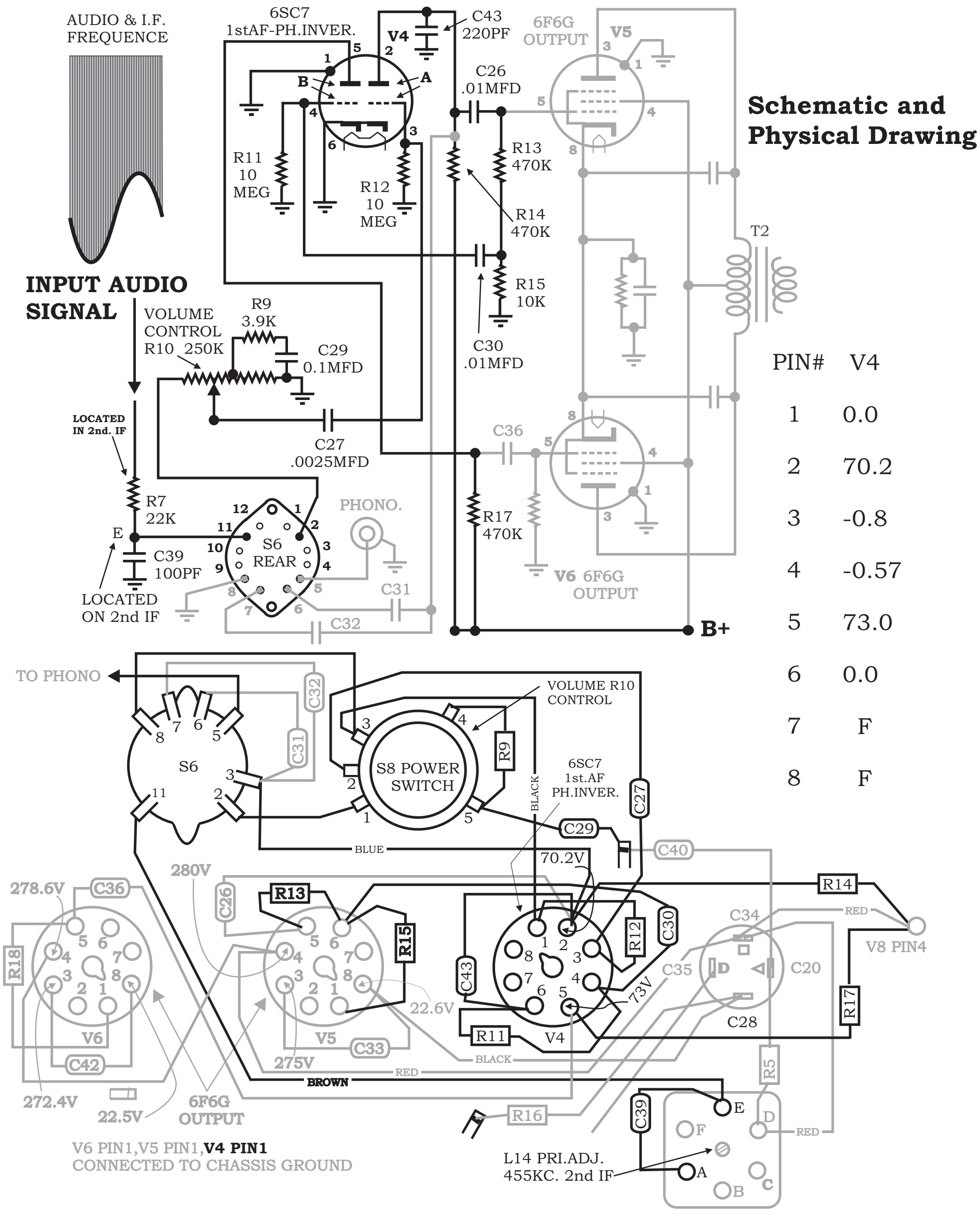


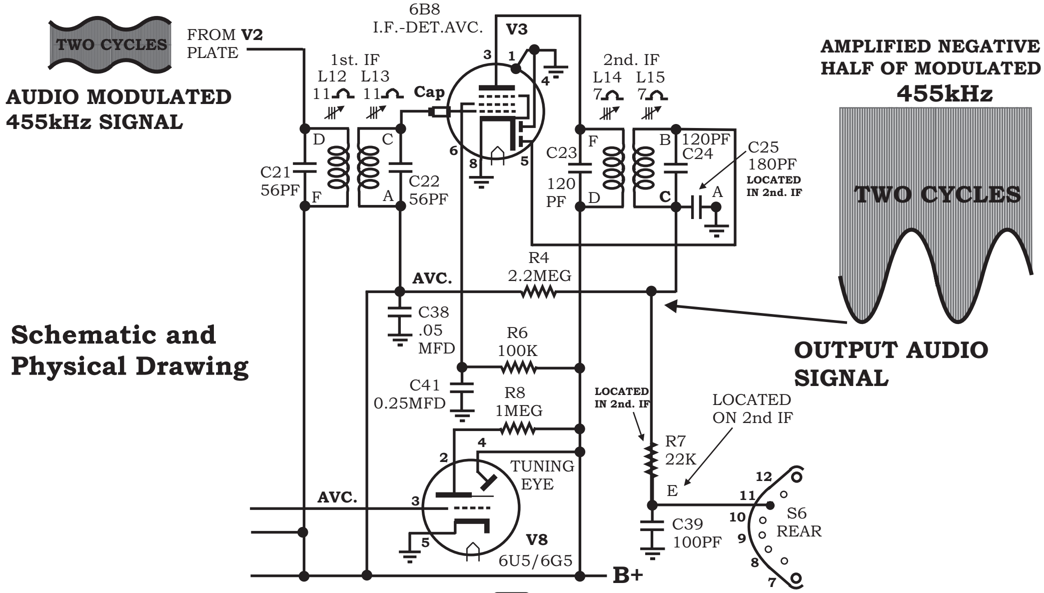
FIGURE A-7 A.F. Inverter Circuit S&P Drawing



Schematic and Physical Drawing

PIN#	V4
1	0.0
2	70.2
3	-0.8
4	-0.57
5	73.0
6	0.0
7	F
8	F

FIGURE A-8 I.F. Detector & Eye Tube Circuit S&P Drawing



PIN#	V3	V8
1	0.0	F
2	F	153
3	277.5	-1.1/-24.2
4	0.0	280
5	-16.0	0.0
6	233	F
7	F	N/A
8	0.0	N/A

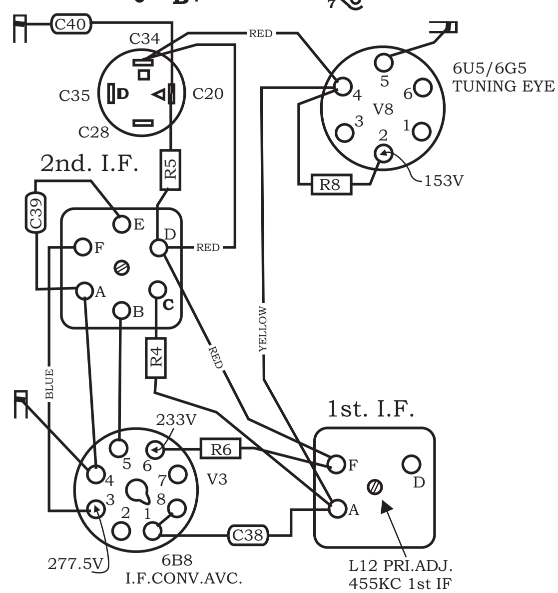
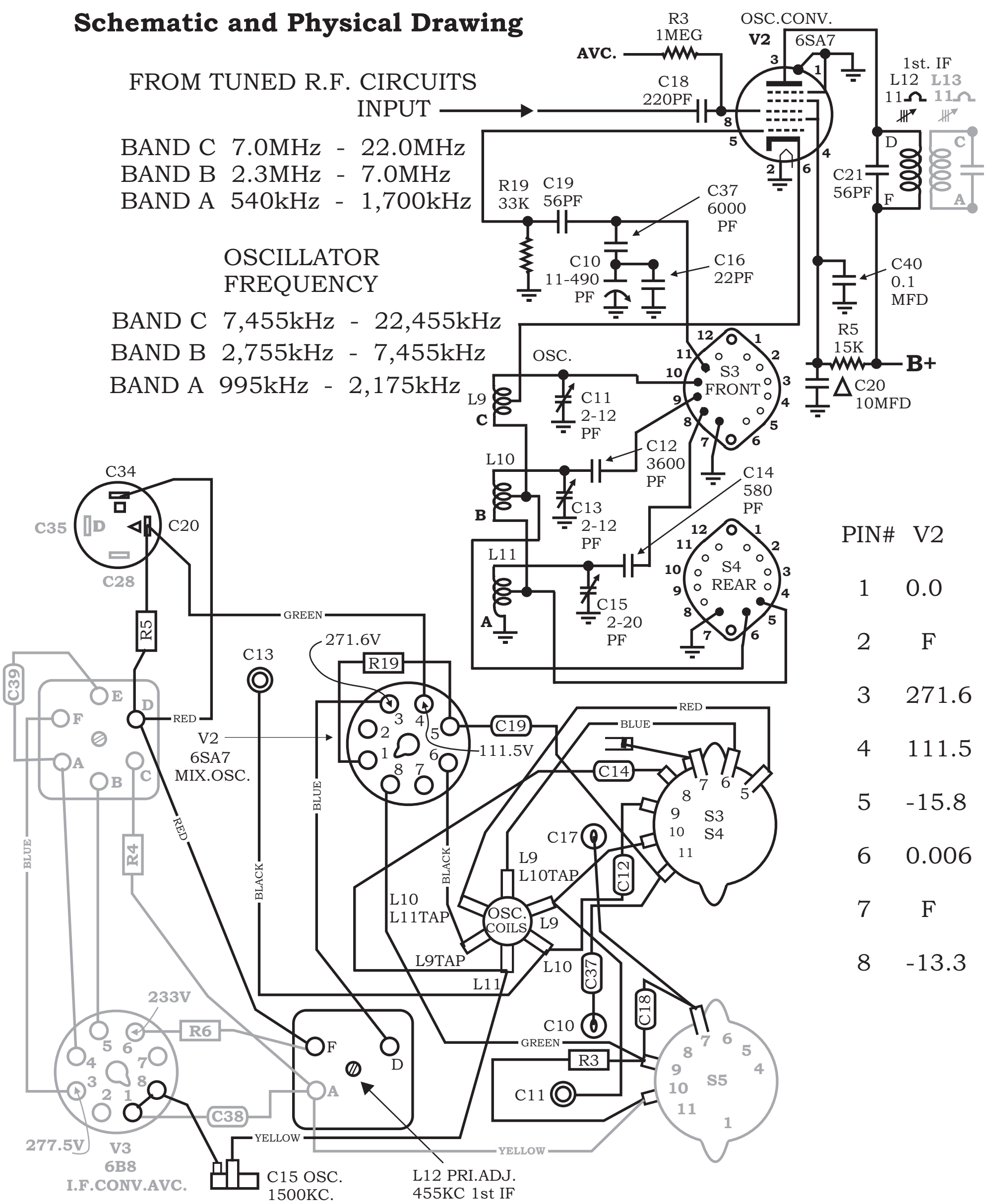
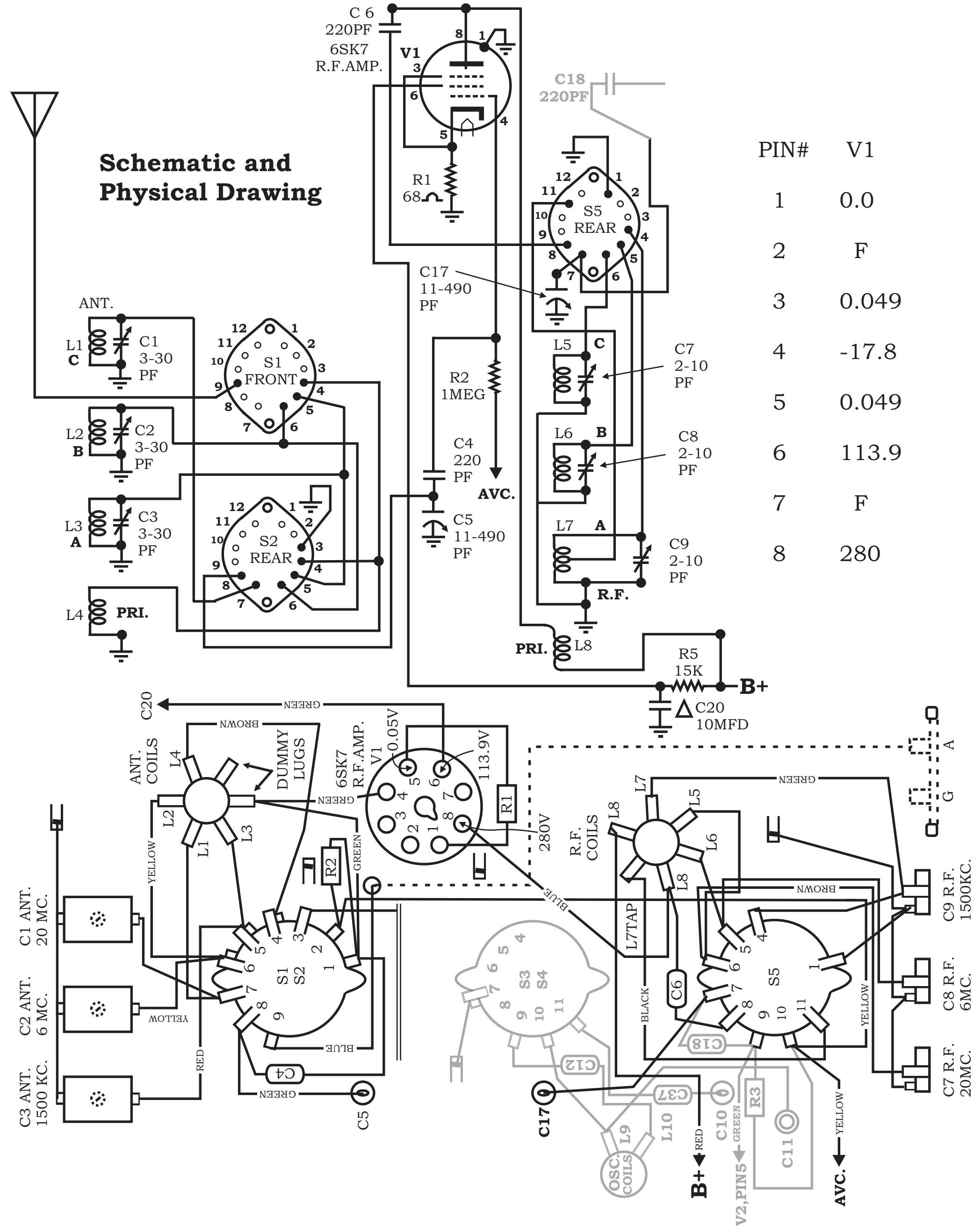


FIGURE A-9 Local Oscillator Mixer Converter Circuit S&P Drawing



PIN#	V2
1	0.0
2	F
3	271.6
4	111.5
5	-15.8
6	0.006
7	F
8	-13.3

FIGURE A-10 Radio Frequency Amplifier Circuit S&P Drawing



PIN#	V1
1	0.0
2	F
3	0.049
4	-17.8
5	0.049
6	113.9
7	F
8	280

FIGURE A-11 List of Voltages by Tube and Pin number

AC LINE VOLTAGE EQUAL TO 121VAC
ALL VOLTAGES MEASURED FROM CHASSIS GROUND.
ALL VOLTAGES ARE DC VOLTS UNLESS OTHERWISE MARKED. RADIO TUNED TO STRONG LOCAL STATION.
AUDIO SET TO LOW-VOLUME.
ALL VOLTAGES MAY VARY +/- 20%.

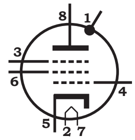
IN-LINE 8 OHM RESISTOR INSTALLED

PIN#	V1	V2	V3	V4	V5	V6	V7	V8
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	F
2	F	F	F	70.2	F	F	F 349	153
3	0.049	271.6	277.5	-0.8	275	272.4	N/A	-1.1/-24.2
4	-17.8	111.5	0.0	-0.57	280	278.6	340AC	280
5	0.049	-15.8	-16.0	73.0	0.005	0.005	N/A	0.0
6	113.9	0.006	233	0.0	N/A	N/A	341AC	F
7	F	F	F	F	F	F	N/A	N/A
8	280	-13.3	0.0	F	22.6	22.5	F 349	N/A

FIGURE A-12 Tube Base Diagrams

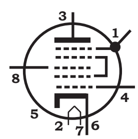
TUBE BASE DIAGRAMS

V1
6SK7



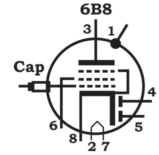
BASE DIAGRAM 8N
R.F. PENTODE
R.F. AMPLIFIER

V2
6SA7



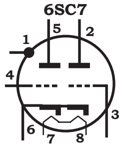
BASE DIAGRAM 8R
PENTAGRID CONVERTOR
OSC.CONV.

V3
6B8



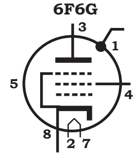
BASE DIAGRAM 8E
DUAL DIODE/PENTODE
I.F.-DET.AVC.

V4
6SC7



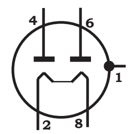
BASE DIAGRAM 8S
DUAL TRIODE
1st.AF-PH.INVER.

V5/V6
6F6G



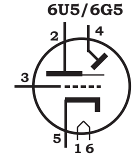
BASE DIAGRAM 7AC
PENTODE
AUDIO OUTPUT

V7
5Y3



BASE DIAGRAM 5T
FULL WAVE
RECTIFIER

V8
6U5/6G5



BASE DIAGRAM 6R
CATHODE-RAY
INDICATOR TUBE

FIGURE A-13 Capacitor and Resistor parts list

CAPACITORS

C1.....Trimmer 3-30 pf
C2.....Trimmer 3-30 pf
C3.....Trimmer 3-30 pf
C4.....220 pf
C5.....Variable tuning 11-490 pf
C6.....220 pf
C7.....Trimmer 2-10 pf
C8.....Trimmer 2-10 pf
C9.....Trimmer 2-10 pf
C10...Variable tuning 11-490 pf
C11...Trimmer 2-12 pf
C12...3,600 pf
C13...Trimmer 2-12 pf
C14...580 pf
C15...Trimmer 2-20 pf
C16...22 pf
C17...Variable tuning 11-490 pf
C18...220 pf
C19...56 pf
C20...10 mf 450v
C21...56 pf IN 1st.IF
C22...56 pf IN 1st.IF
C23...120 pf IN 2nd. IF
C24...120 pf IN 2nd. IF
C25...180 pf IN 2nd. IF
C26...0.1 mf
C27...0.0025 mf
C28...20 mf 25v
C29...0.1 mf
C30...0.01 mf
C31...0.007 mf
C32...0.0025 mf
C33...0.005 mf
C34...10 mf 450v
C35...10 mf 450v
C36...0.05 mf
C37...6000 pf
C38...0.05 mf
C39...100 pf
C40...0.1 mf
C41...0.25 mf
C42...0.005 mf
C43...220 pf

RESISTORS

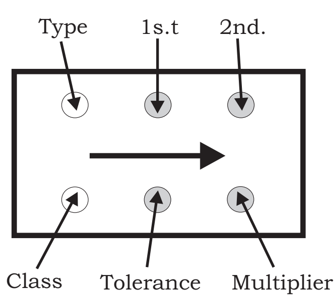
R1.....68 ohms ¼ watts
R2.....1 megohm ½ watts
R3.....1 megohm ½ watts
R4.....2.2 megohms ¼ watts
R5.....15K ohms 2 ½ watts
R6.....100K ohms ½ watts
R7.....22K ohms 1/10 watts
R8.....1 megohm ½ watts
R9.....3.9K ohms ½ watts
R10...250K ohms Volume Control
R11...10 megohms ¼ watts
R12...10 megohms ¼ watts
R13...470K ohms ¼ watts
R14...470K ohms ¼ watts
R15...10K ohms ¼ ohms
R16...560 ohms 2 watts
R17...470K ohms ¼ watts
R18...470K ohms ¼ watts
R19...33K ohms ¼ watts

CAPACITOR COLOR CODE PF=MMF

COLOR	VALUE	MULTIPLIER	TOLERANCE
SILVER		0.01	10%
GOLD		0.1	5%
BLACK	0	1.0	20%
BROWN	1	10	1%
RED	2	100	2%
ORANGE	3	1000	3%
YELLOW	4	10000	
GREEN	5		5%
BLUE	6		
PURPLE	7		
GRAY	8		
WHITE	9		10%

RESISTOR COLOR CODE

COLOR	VALUE	MULTIPLIER	TOLERANCE
SILVER		0.01	10%
GOLD		0.1	5%
NO COLOR			20%
BLACK	0	1.0	
BROWN	1	10	1%
RED	2	100	2%
ORANGE	3	1000	3%
YELLOW	4	10000	4%
GREEN	5	100000	
BLUE	6	1000000	
PURPLE	7	10000000	
GRAY	8	100000000	
WHITE	9	1000000000	



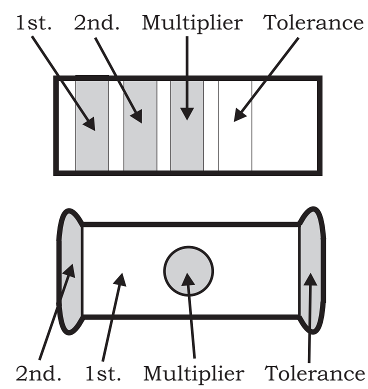


FIGURE A-14 Electronic Symbols

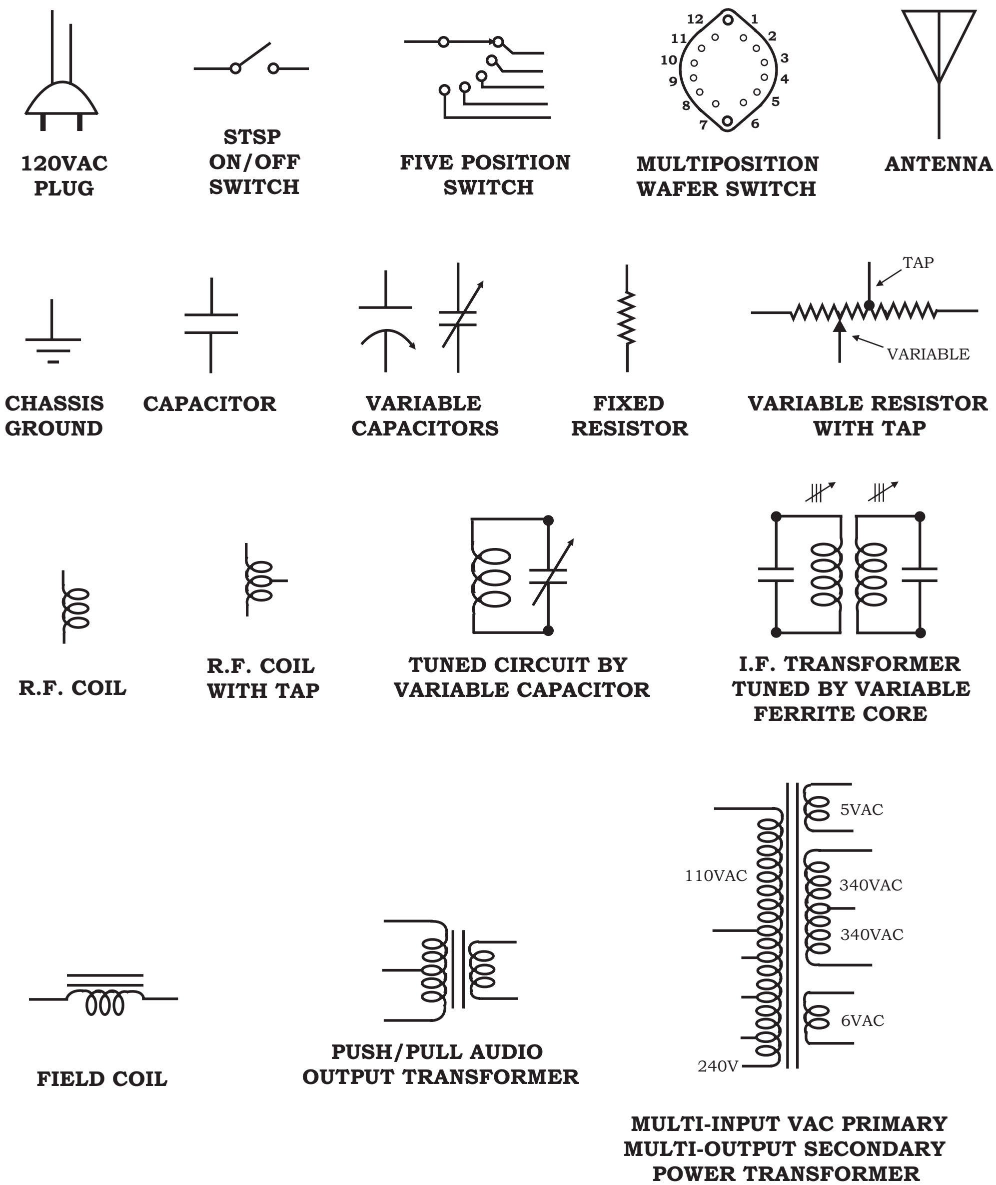
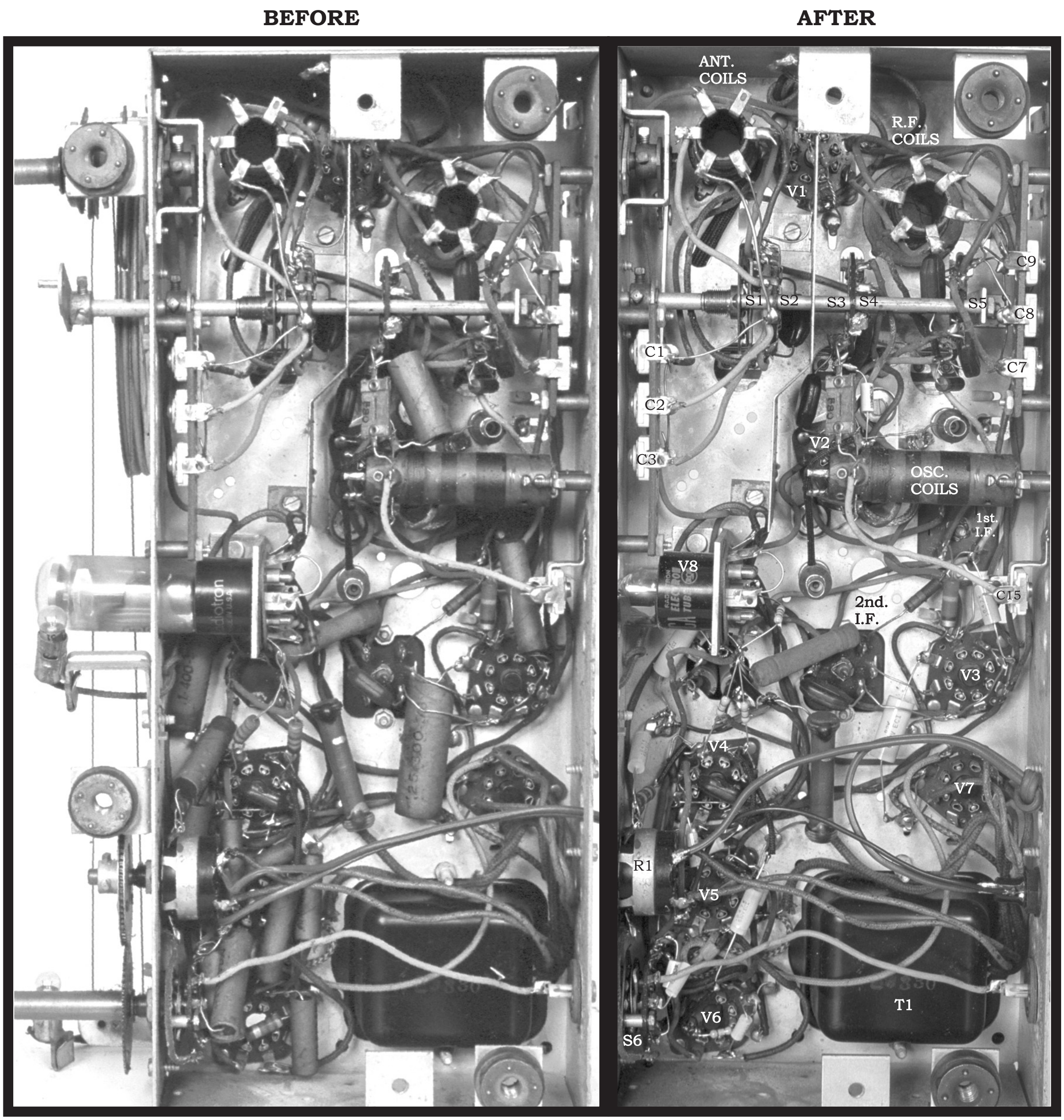


FIGURE A-15 Capacitor Replacement, Before and After



GLOSSARY

AF	Audio frequency.
Alignment	The process of adjusting components of a system for proper interrelationship. Tuning the I.F. transformers to the intermediate frequency.
Alternating current	A flow of electrons, which reaches maximum in one direction, decreases to zero, then reverses itself and reaches maximum in the opposite direction.
Ammeter	An instrument for measuring either direct or alternating electric current. Its scale is usually graduated in amperes, milliamperes, microamperes, or kiloamperes.
Amperes	A unit of electrical current or a rate of flow of electrons. One volt across one ohm of resistant causes a current flow of 1 ampere.
AVC	Automatic Volume Control
B+	A 1920's term for the highest DC voltage supplied to the radio. The 'B' stands for battery.
Bleeder resistor	Used as a safety measure to discharge a filter capacitor after the circuit is de-energized. For a radio power supply a 100K ohm bleeder resistor is adequate.
Bias	The electrical force applied to a vacuum tube, for the purpose of establishing an electrical reference level for the operation of the device.

Capacitance — The property which permits the storage of electrically charges when potential differences exist between the conductors.

Capacitor — A device consisting essentially of two conducting surfaces separated by a insulating material or dielectric such as air, paper, mica, glass, plastic film, or oil.

Cathode — The element of a vacuum tube that emits electrons.

Ceramic — A claylike material, consisting primarily of magnesium and aluminum oxide, which after molding and firing is used as insulating material.

Chassis ground — A connection to the metal structure that supports the electrical components, which make up the unit or system.

Class A — An amplifier in which the grid bias and alternating grid voltage are such that the plate current flows at all time.

Commercial power — 120 volts AC.

Control grid — The electrode of a vacuum tube, upon which a signal voltage is impressed to regulate the plate current.

Current — The movement of electrons through a conductor. Measured in amperes, and its symbol is I.

Cycle — The change of an alternating wave from zero to a negative peak to zero to a positive peak and back to zero.

Demodulate	Extract information from a carrier.
Detector	The circuit or component that extracts the information from the carrier.
Direct current	An essentially consistent value current that flows in only one direction.
Duplex-diode	Two diodes.
Electrolytic capacitor	A capacitor consisting of two conducting electrodes, with the anode having a metal oxide film formed on it. The film acts as the dielectric or insulating medium.
Electron-Ray Indicator	Also “magic eye”. A tube which indicates visibly on a fluorescent target. Used as a tuning indicator.
EMF	Abbreviation for electromotive force.
Farad	The capacitance of a capacitor in which a charge of 1 coulomb produces a change of voltage in the potential differences between its terminals.
Filament	The element of electronic tube that resides in side that cathode. This element heats that cathode to proper operating temperature.
Filtration	A circuit of components, which may consist of resisters, inductors, or capacitors which offers comparatively little opposition to certain frequencies or to direct current, while blocking or attenuating other frequencies.

Forward bias A rectifier tube biased so that there is almost no opposition to current flow. Plate is positive.

Full-wave rectifier A rectifier that produces a DC current on both halves of and a AC cycle.

Gimmick A capacitor formed by twisting two insulated wires together.

Grid bias A constant potential applied between the grid and the cathode of a vacuum tube to establish an operating point.

Held negative A point in an electrical circuit connected to a non-variable negative source.

Held positive A point in an electrical circuit connected to a non-variable positive source.

Hertz A unit of frequency equal to one cycle per second.

High-Mu A vacuum tube with a high amplification factor.

High-Q Having a high ratio of reactance to effective resistance.

IF / I.F. Abbreviation for intermediate frequency.

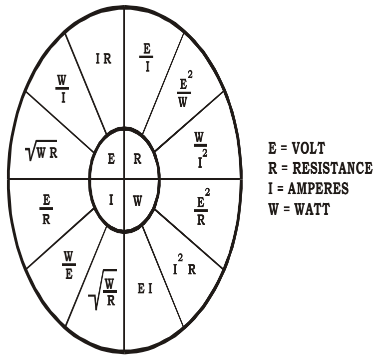
Infinite ohms Boundless; having no limits whatsoever.

Intermediate frequency Abbreviated IF. Is a new frequency derived by mixing to other frequencies together. Also known as a beat frequency.

Kiloampere 1000 amperes.

Kilocycles	1000 Hertz.
Load resistor	A resistor in the plate circuit of a vacuum tube that matches the tubes impedance.
Microamperes	One millionth of an ampere.
Microfarad	One millionth of a farad.
Milliampere	One thousandth of an ampere.
Modulate	To vary the amplitude, frequency, or phase of a wave by impressing one wave on another wave of constant properties.
Noise bypass	An electrical device that provides a path to remove any unwanted disturbance within a dynamic electrical system.
Ohmmeter	A direct reading instrument for measuring electric resistance.
Ohms	One ohm is the value of resistance through which a potential difference of one volt will maintain a current of one ampere.

Ohm's Law



Oscilloscope — An instrument for making visible the instantaneous values of one or more rapidly varying electrical quantities in respect to time.

Parallel — Connected to the same pair of terminals, so that the current can branch out over two or more paths.

Phase Inverter — A circuit that changes the AC phase from the original input.

Pico farad — One millionth of a microfarad. (.000000000001) Also micro-microfarad.

Plate — The principal electrode to which the electron stream is attracted to in an electronic tube.

PHR — Chapter - 11: Page - 104 "Power On Handling RULES"

Polarized — An electronic component with a positive and negative poll.

Push/Pull circuit — A circuit that contains two like elements which operate 180 degrees phase relationship.

Rectifier	A device which converts an alternating current into a unidirectional current.
Remote Cutoff	Vacuum tube used in R.F. amplifiers. The control grid wires are farther apart at the center than at the ends. Therefore it's amplification dose not vary in direct proportion to the bias. Some plate current will flow regardless of the negative bias on the grid.
Resistance	A property of conductors, which determines the current produced by a given difference of potential.
Resistant load	The impedance to which energy is being supplied.
Resistor	A device, which resists the flow of electrons in a circuit.
Resonant circuit	A circuit which contains both inductance and capacitance and is tuned to a certain resonance frequency. The resonant frequency can be raised or lowered by changing the inductance and / or capacitance values.
Resonant frequency	The frequency at which a given system or object will respond with maximum amplitude when driven by an external sinusoidal force of constant amplitude.
Revers bias	A rectifier tube biased so that there is almost no current flow. Plate is negative.
RF / R.F.	Abbreviation for radio frequency.
RMS	Root-mean-square. True AC power.

Saturation An electronic device in electron maximum conduction.

Schematic A diagram of the electrical scheme of a circuit, with the components represented by graphical symbols.

Screen grid A grid placed between a control grid and the plate and usually maintained at a fixed positive potential.

Series The connecting of components end to end in a circuit, to provide a single path for the current.

Service type The function of a vacuum tube, class A amplifier, class B amplifier, rectifier, detector, converter, oscillator, etc.

Signal grid The signal grid receives the radio frequency signal to be mixed with the local oscillator's frequency. This mix produces four frequencies. One begging the intermediate frequency which is filtered and amplified by the IF circuits.

Superheterodyne receiver A receiver in which the incoming modulated R. F. signals are usually amplified in a preamplifier and then fed into the mixer for conversion into a fixed, lower carrier frequency (called the intermediate frequency). The modulated by I.F. signal undergoes very high amplification in the I.F. amplifier stages and is then fed into the detector or demodulation.

Suppressor grid The grid placed between the screen grid and the plate in a vacuum tube.

Tap	A fixed electrical connection to a specific position on the element of a potentiometer, transformer, filament, etc.
Tuning	The adjustment relating to frequency of a circuit or system to secure optimum performance. Commonly, the adjustment of a circuit or circuits to resonance.
Vacuum tube	An electronic tube evacuated to such a degree that its electrical characteristics are essentially unaffected by the presence of residual gas or vapor.
Volt	The unit of measure of the electromotive force.
Voltage	Electrical pressure, the force that causes current to flow through an electrical conductor.

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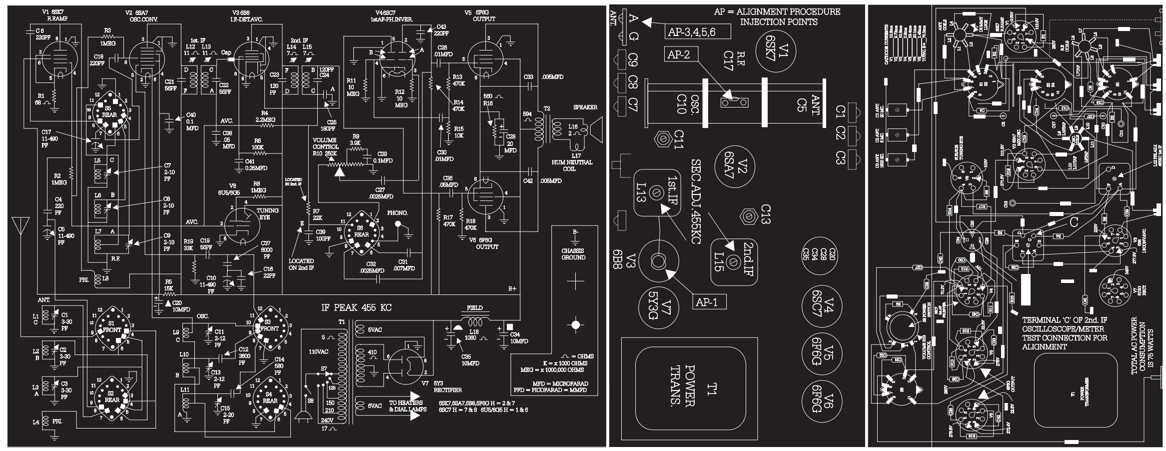

Richard McWhorter's fascination with radio technology began when he discovered that he could jam his brother's radio with a crystal set. He built several five-tube radio sets from scratch while in high school. He entered the Air Force after college and received excellent training in electronic circuit design and troubleshooting. After obtaining an FCC First Class Radio Telephone Operator License, with a Ship Radar Endorsement, he entered the telephony industry where he spent 30 years. His experience in that industry has depth and breadth ranging from Test and Acceptance Engineer on digital central offices to Software Engineer, Software Instructor (machine, assembly and high level languages), Digital Cellular Technical Instructor and Code Owner (CCS7 Table Control Software Engineering). Since leaving the telephony industry, he has been working as Broadcast Engineer and writing books.

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