An approach to repairing an "All-American 5"

Gord Rabjohn

February 2016

I received a "Federal" "All American 5" (AA5) bakelite radio (Figure 1) from a friend at Christmas. While I repaired it, I decided to record the thought process that I used to repair this radio.

Warning! Working on any line-powered equipment is dangerous. Working on old line-powered radios is even more dangerous, because voltages are higher, components and insulation may be broken, and the standards from yesteryear were not as safe as they are now. Furthermore, capacitors store voltage and can deliver a lethal charge even if the radio is unplugged. This article does not attempt to explain techniques needed to work safely. Do not attempt the procedures outlined in this article unless you are confident that you know and understand how to do this safely. The author and the Ottawa Vintage Radio Club accept no responsibility for damages, harm, injury, loss of property or life caused by following these procedures, regardless as to whether there were errors or omissions in the procedures.

I realized that I usually do not use sophisticated test equipment for a basic AA5, so that was my approach: I did not look for a schematic, and I did not use anything other than basic test equipment.

I usually do not start with sophisticated test equipment to repair a basic AA5. So, here's a technique that does not need a schematic, and uses nothing more sophisticated than a volt-ohm meter, a tube tester and a tube manual. I give a suggested general procedure, and in italics I include the application of this procedure on my Federal radio. I hope that this article spurs discussion on the general subject of radio repair: others may have clever procedures or different experiences than I record here. Please share your experiences thru the OVRC newsletter. I include a schematic (Figure 2) of a simple AA5 radio (not this Federal) in this article with some notes to make it easier to follow.

1. Look at it physically. Are all tubes present? Is the line-cord in reasonable shape? Is there any sign of smoke or mouse nests? Are any parts missing? I may not even take the chassis out of the cabinet at this point. *My Federal was squeaky clean, but needed a new line-cord.* You may want to "reform" the electrolytic filter caps before plugging the radio in, which requires an external current limited supply.

2. If the aforementioned inspection does not reveal anything obvious, then plug it into a current-limited AC supply and turn it on. I use a 100 watt clear lightbulb in series with the line cord. I also use an isolation transformer to reduce (not eliminate) the shock hazard. Thg.

3. Turn the radio on. The current limiting bulb should glow for a few seconds and get darker. If it glows brightly, inplug the radio, and use an ohmmeter to find the short. Do the filaments light up? If not, then check all the tube filaments with an ohmmeter (they should read 10-50 ohms). If they are all good but do not light, then suspect the line switch. If there are metal tubes in which the filaments are not visible, then look at the glass tubes; if their filaments light, then you can be fairly certain that all the filaments are OK (since they are connected in series). *The filaments that I could see in my Federal all lit up. The dial lamps did not, and these should be replaced, otherwise the rectifier tube filament will burn hotter than it should.*

4. When the tubes warm up, a low glow should return in the current limiting bulb. If the bulb glows too brightly (sorry about the imprecise language) after the tubes warm up, then suspect a shorted

capacitor, probably the power supply filter capacitor. If there was no indication of increased current after warm-up, then suspect the rectifier tube (35Z5, 35W4) or the output tube (50L6, 50C5), or maybe the output transformer or an element in the power supply. *The Federal behaved as it should.*

5. Have a good look at under the chassis. A capacitor should never self-heat. If a capacitor appears burnt or gets warm, it is leaky and should be replaced. Look for cracked or overheated resistors. If a resistor is getting too hot, smoking or looking burnt, it is probably caused by a nearby shorted capacitor; you may want to replace that resistor after finding the shorted capacitor.

6. Turn the volume to maximum and tune for stations. Are there any signs of life? You may need to connect an antenna in order to receive anything. At this point, there are several possible symptoms:
a. You hear absolutely nothing, not even a faint hum. Suspect the rectifier tube (35W4, 35Z5) or the output tube (50L6, 50C5), maybe the output transformer or speaker, or an element in the power supply. Or the cathode resistor on the output tube. The speaker and transformer can be checked with an ohmmeter (unplug the radio!): you should hear a tiny click in the speaker when the ohmmeter (on a low resistance scale) is connected to the primary or secondary of the transformer).
b. You hear a low hum but no stations. Touch the middle terminal of the volume control or the first audio stage grid with an insulated screwdriver. Touch grid 1 of the output stage with a screwdriver. If you hear no change to the hum or a click, then suspect something in the audio section (50L6, 12SQ7 or 50C5, 12AV6). Otherwise, suspect the converter or IF section. *In my Federal, touching the volume control did nothing. Touching the grid of the 12SQ7 with a screwdriver did nothing. But touching the grid of the 50L6 caused a hum. So, I concluded that the 12SQ7 was dead. I tested it, and it was completely dead, which is unusual; usually there is some residual life in a tube with an intact filament. Just for fun, I put 12V on the filament and the filament drew about 300mA, twice what it should. This indicated that air had leaked into the tube, which is uncommon in my experience. This was a metal tube, so the filament was not visible. If it had been a glass tube, I would have seen that the filament was not glowing.*
c. You hear a loud objectionable hum. Suspect the filter capacitors. The best way to check for an open filter capacitor is to place a known good filter capacitor (value is not too critical, 15uF to 40uF is what I use, at least 200V) in parallel (observe polarity) with the existing capacitor. Beware: there is lethal voltage present. If the hum does not change, then the filter capacitor is probably OK, you need to look elsewhere. By the way, you can get filter capacitors from discarded compact fluorescent lamps.
d. You can tune in stations, but they are weak or distorted. This is tougher, go to step 7.
e. The radio sounds fine at low volume, but at high volume, it buzzes and sounds distorted. Suspect the speaker. Look for rips or tears. Press the cone in gently and listen for rubbing, friction, grinding. It should be smooth and silent. Or, the output tube is improperly biased. Check the cathode resistor value, and for voltage on the control grid.
f. As you tune, there are whistles as you tune in the stations. Suspect a decoupling capacitor (a capacitor to ground) in the converter or IF section.
g. The radio works perfectly. Or maybe the volume control or station selector is scratchy (clean it with alcohol or contact cleaner).

7. I find that most problems can be diagnosed with a DC voltmeter. You will need to find “ground”; the most reliable place to find ground is on the filter capacitor negative terminal, which will be connected to one side of the AC line.
a. You should see about 120VDC on the cathode of the rectifier. If not, a filter cap is shorted or the rectifier tube is worn out. Check the capacitors before replacing the rectifier tube.
b. The output tube should have ~110VDC on the plate (if not, check the output transformer) and screen grid (if not, suspect the power supply). Make sure that there is no voltage (less than 1V) on the

control grid (1st grid, next to cathode). If there is a positive voltage, then the control grid coupling capacitor is leaky and must be replaced.
c. The first audio stage should have ~40-100V on the plate. If it is too low, suspect the plate resistor. If it is too high, suspect the tube. *(This was the case in the Federal)*
d. The converter and IF amplifier plate and screen grids (2nd grid) should have a healthy voltage of 80 to 100V. If the plate voltage is not there, then suspect the IF transformer.
e. If the voltages are wrong, trace the path from the suspect node back to the power supply. A low voltage could be caused by a shorted decoupling capacitor, or an open series resistor.
f. Check the values of resistors. As they age, their values almost always increase. In general, resistor values are not critical, and even a resistor that has doubled in value could still work.
g. Also check the primary resistance of the IF transformers. They should be low (under 50 ohms).

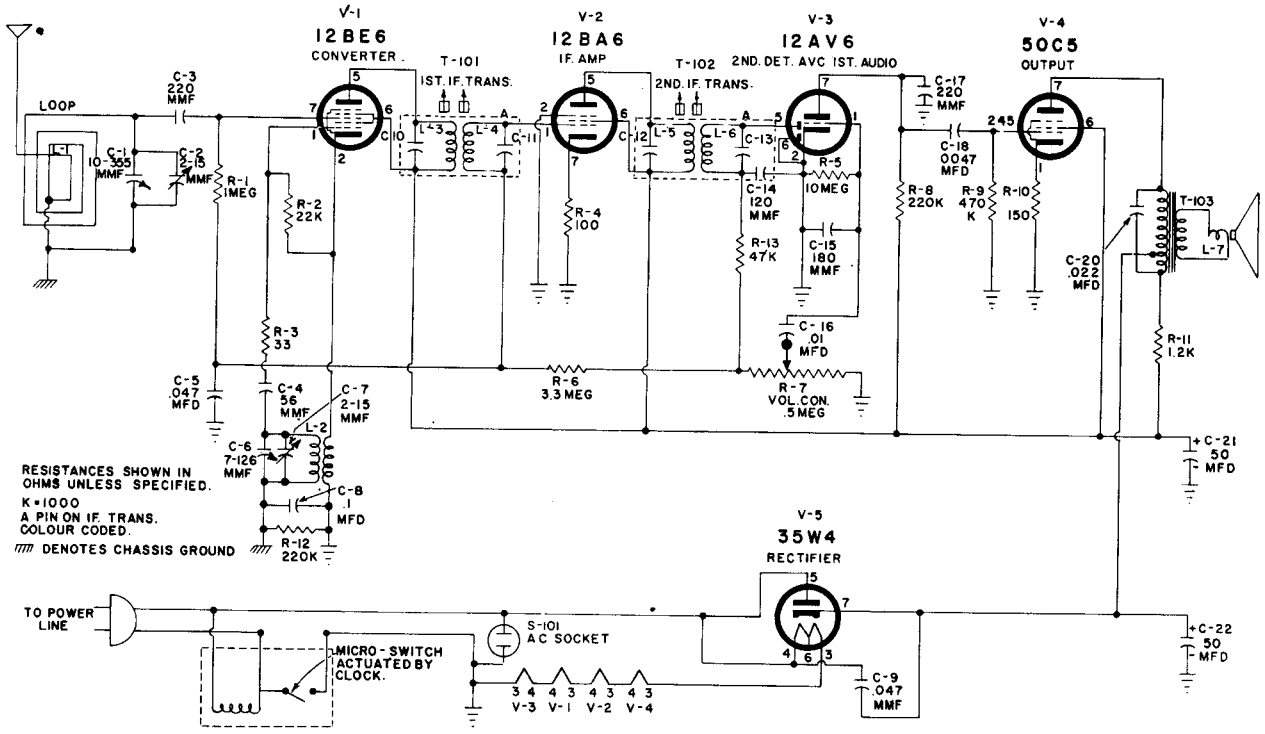
8. A radio that works, but not very well, is more difficult to assess. Was it just a poor radio, or is there more performance to be gained? The AGC voltage (the voltage that feeds the IF amplifier grid thru the secondary of the IF transformers) can indicate the health of the RF and IF stages. This voltage should be roughly -10V when tuned to a local station (and should be 0V when no stations are being received). If everything else looks right but AGC voltage is low, try aligning the IF transformers. *On the Federal, once I replaced the 12SQ7, it worked "a bit". With an antenna, it picked up a few stations weakly. I checked the AGC voltage, and even with an outside antenna it was under -1V. This tells me that something was causing the RF/IF gain to be very low. I tested the 12SK7 IF and 12SA7 converter tubes, I verified that their voltages were correct, and I checked the continuity of the antenna coil and IF transformers, all was well. Besides, the radio was working, so the converter's local oscillator was alive. Having eliminated everything else, I tried adjusting the tuning on the IF transformers, by adjusting the trimmer capacitors for maximum volume when tuned to a station. Voila, this brought performance back!*

9. Hopefully, by now the radio works. If it doesn't, or if it doesn't work well, you'll need to employ a more rigorous technique. I'd recommend:
a. Acquire a schematic.
b. The schematic should have DC voltages listed; check them all out, and work back towards the power supply.
c. Use an audio generator and modulated RF generator to inject signals into the radio, starting at the speaker and working backwards.

10. If the radio is going to be regularly used, or if it will leave your collection, or if it belongs to someone else, you should do a safety audit. There are serious personal liability issues if the radio you repaired catches fire or shocks a user. AC-DC sets are particularly risky in this respect. This web site gives a good treatment of this issue: http://antiqueradio.org/safety.htm I recommend:
a. Replace the line-cord with a modern three prong plug with the ground connected directly to the chassis, or a polarized plug.
b. Make sure the power switch interrupts the "hot" side of the line cord (the narrow blade in a polarized plug), and that the "hot" side goes to the rectifier plate. *In my Federal, the switch interrupted the "cold" (ground) side. This means that when the radio is off, most of the circuitry is connected to the "hot" side of the line, making it a shock hazard for anyone poking into the radio with a metal object. I rewired it correctly.*
c. I recommend adding a 1A fuse as the first component that the "hot" side of the line cord connects to.
d. Check the voltage on the grid of the output tube. If it is over 1V, replace the blocking capacitor.

These are the tricks that I use to fix the AA5. As a general rule, I do not replace all the capacitors: I replace only the ones that need replacing. I do this because I like the radio to retain as much of it's original character as possible. Besides, most of these radios will rarely get used.

List of figures:



Schematic Circuit Diagram