

“Help – save me, please!”

At least these are the words I imagined every time I walked by the Collins 75A-3 that sat in my workshop. The receiver was purchased a few years ago and had remained there, on the bottom of my surplus equipment shelf, for all that time. My conscience was getting rubbed raw looking at this wonderful piece of gear just languishing there. So with a lot of trepidation, Collins 75A-3, serial number 1268, was hoisted up onto the workbench on August 13, 2014.

The receiver came with its original manual and equipment inspection tags showing its release from manufacturing March 4, 1954. It appeared complete and with no extra holes drilled into the cabinet or front panel.

Here is the story of its repair back to an operational condition.

Initial Inspection and Power Application: Despite my inclination to plug it in and see what would happen, I resisted the urge. Old electrolytic capacitors that have dried up have a tendency to short and can present an extremely high load. A quick visual inspection confirmed that the wiring in the power supply had undergone some repair in the past; including a replacement of the dual 40 uFd can capacitor (C65A/B), which looked fairly new.

After checking the fuse for proper amperage rating (it wasn't), the 5Y3 rectifier was removed and line voltage was applied. All tubes (except the 5Y3 of course) lit up confirming the 6.3 Vac secondary was functional. A quick voltage check of the secondary high voltage windings indicated proper ac voltage at the anode pins of the 5Y3 socket.

A lot of hams insist on bringing these up on a Variac, but my experience has shown this is unnecessary if you ensure a proper fuse is in place. (I once found a fuse that had been wrapped with aluminum foil in a receiver – I guess the previous owner had decided to risk the power transformer and save a trip to get a replacement fuse.) In this case it was almost as bad, the required 2-ampere fuse had been replaced with a 5-ampere fuse.

The radio was turned on with the 5Y3 plugged back in while monitoring the DC output voltages. Both the B+ and -50 Vdc bias were present with a very noticeable level of ac ripple. This confirmed the 5 Vac secondary and electrolytics were basically functional. So far so good.

My initial inspection determined:

1. Power supply seemed to be functioning, but with some ac ripple in the output,
2. Some modifications or repairs had been made in the past,
3. Workmanship of repairs above average in terms of soldering and parts placement,
4. All tubes have good filaments,
5. Chassis and cabinet is dirty, but no evidence of being in a smoking home,
6. No rust or corrosion except for some minor corrosion on the tube shields, screws, and backs of controls,
7. All knobs are in place; main tuning knob missing one set screw,
8. Two-wire line cord looks original, but appears in good condition,

9. Only the standard 3 kHz mechanical filter was installed,
10. It includes the 4:1 reduction for main tuning knob,
11. Likely Service Bulletin 3B has been installed as there was a 6DC6 tube in V1,
12. Homebrew (?) product detector is plugged into the NBFM accessory socket, and
13. A 100 kHz calibrator is installed but it interjects a high degree of noise when turned on.

Cost Assessment: Being a frugal ham on a fixed income I always make an assessment of the gear I obtain and any costs that might be necessary to repair them. I had bought this radio for \$200 with an intention of making it into a vintage AM/CW receiver. The lack of a 500 Hz mechanical filter CW was disappointing – but the 75A-3 has a crystal phasing filter that, if operating properly, can yield a reasonable pass band for CW operation.

While I was pretty sure I could easily sell this radio ‘as is’ and recover my costs, I decided that perhaps putting upwards of another \$150 in parts would not be an unreasonable thing to do. I never count my labor because I repair these vintage radios for the fun of it, but I also don’t want my hobby to eat a hole in my pocket. I’ll describe my costs as the repair to the radio progresses.

Capacitor Replacement: I wanted to replace the paper capacitors and electrolytic capacitors before I attempted any further repairs of the 75A-3. A cost effective source for capacitors is Just Radios (www.justradios.com). Here is a list of all of the capacitors I ordered from Just Radios.

Capacitor Type	Component Identifier from Manual
0.1 uF Orange Dip	C74, C81, C96, C98, C100, C84
5 uF Electrolytic	C83
50 uF Electrolytic	C94
22 uF Electrolytic	C97
0.5 uF Orange Dip	C103
40/40 uF Dual Electrolytic	C95 A/B (see text)

Table 1. Suggested Capacitor Replacements for 75A-3

There are other pricier options (kits on eBay, etc.) but at about \$34.00 my purchase from Just Radios seemed a cost effective solution and is about half of what the kits cost. You can reduce the cost further by using discrete capacitors for C95 A/B and mounting these below the chassis. I don’t like doing this as stuffing large caps into an already crowded chassis makes for more difficult troubleshooting down the road.

The replacement for C95 A/B is not an exact fit for the twist lock can, but rather a clamp mounted can by Richey (<http://www.justradios.com/DUALsection.html>). The clamp mount fits in place of the original fiber wafer mount and the body of the Richey cap is encased in plastic. This serves to ensure the negative terminal is isolated from chassis ground, which is necessary since the negative side of the dual capacitor ‘floats’ above chassis ground to develop the -50 Vdc bias for the ALC circuit.

An 'exact fit' replacement capacitor is also available for about \$45 (eBay), but since the Richey clamp mounted can was very close in size and has excellent electrical specifications I decided to go that route.

Limited Functional Testing: While waiting for the capacitors to arrive I hooked up a speaker and tried to get some signals through the radio. It was working near the 1600 kHz portion of the broadcast band in the CW mode only; no signals were coming through in the AM Mode. In the CW mode it appeared that the crystal-phasing unit was functioning, as was the CW noise limiter. I noted that: The S-Meter would not zero without an input signal; and, the BFO was functioning.

So now I have some additional items added to my list:

- 14. Repair AM Mode, and
- 15. Repair AVC and/or S-Meter circuits.

Cleaning: I usually do some cursory cleaning along the way as I repair a radio. That way I can stop troubleshooting for a while when presented with a thorny issue; do some cleaning; and let my brain chew on the problem. Here is a picture of how I usually clean the top of a chassis.



Figure 1. Cleaning Technique

I'll take a small piece of paper towel, wad it up, grab the wad with forceps, hit it with a drop or two of 409 or Simple Green, and rub the dirt and grunge away while carefully paying attention to avoid destroying any chassis markings or decals. Once clean I'll replace the paper towel wad with one that has a dab of rubbing alcohol to remove the cleaning residue. Here you can see an area I've cleaned just around the octal calibrator socket to show how effective this is.

Documentation Search: During my repairs research of radios on the Internet is usually part of my due diligence. It helps point me in the direction of popular modifications and add-on circuits. Looking on the Internet it seemed that a product detector was a popular addition to this radio.

I looked back in the folder that the manual came in and sure enough there was a hand drawn sketch for a product detector along with some notes for it's installation. Yikes! I might have to reverse these modifications to get back to the original wiring.

Unfortunately, the notes for the product detector modification were cryptic. However, from the circuit diagram and articles on the Internet it appeared rewiring of the CW/AM/FM mode switch, the BFO circuit, and the audio input circuit were typical modifications to include a product detector in the NBFM socket. Since I didn't want to have a product detector or use this receiver for SSB, I decided to reverse engineer these product detector modifications and see if that would restore AM operation.

After a few minutes of circuit tracing, reverse engineering the product detector wasn't necessary. Someone previous to me had already accomplished that task as seen by the obvious soldering.

AM Detection: So what was unique in AM Mode that would cause it to malfunction? I pulled out the circuit diagram and identified that separate limiting is used for CW (V16) and AM/FM (V10). As soon as I grabbed V10 and started to reseal it, some static came through the speaker. After a couple of additional jiggles of V10 the AM/FM noise limiter began conducting and I heard a nice normal background noise level in the speaker. See figure 2.

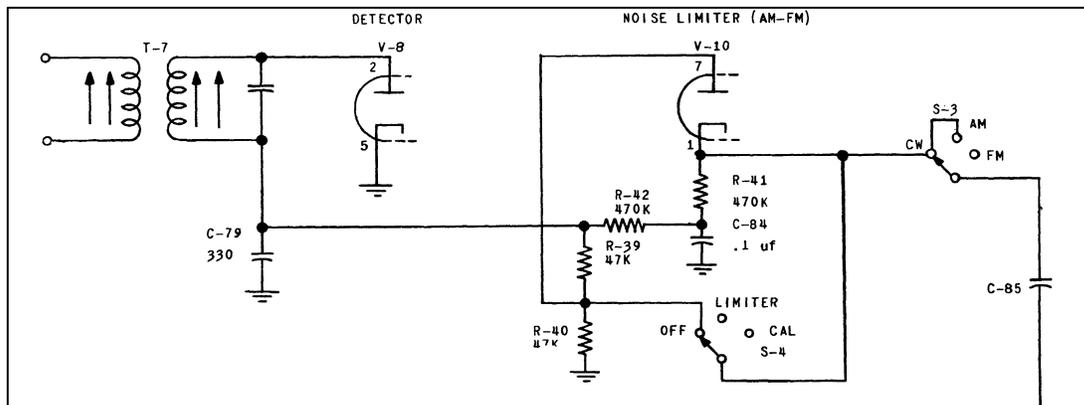


Figure 2. AM Detection and Noise Limiter

At this point all tubes were removed, tested, marginal ones replaced, pins cleaned and reinstalled.

Tube Replacement: I replaced marginal tubes V9 (12AX7); V8 and V10 (6AL5s); and V18 and V5 (6BA6s). The tubes I purchased were NOS and cost me \$32.00. So far, with the capacitors, I've invested \$66.00 in repair parts.

Now that I had AM signals going through the radio there appeared to be some overloading and distortion. This pointed me back to item 15. on my documented list, namely AVC issues. Of all of the circuits I hate to troubleshoot, AVC is one of them. Thankfully, the 75A-3 AVC is a simple and fairly straightforward AVC system. See figure 3.

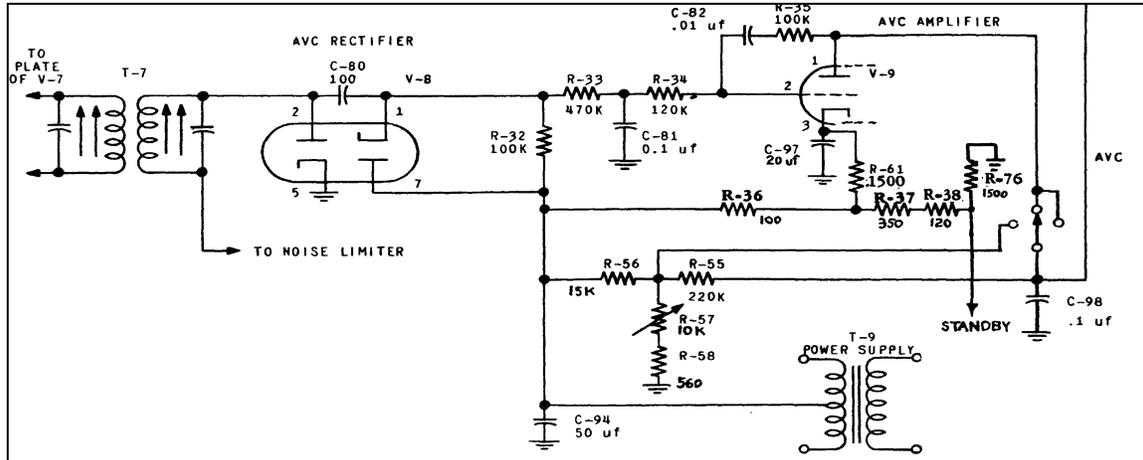


Figure 3. AVC and RF Gain Circuit

In CW mode, AVC is disabled and the gain of the RF and IF stages is determined by the voltage at the junction of R-56 and R-57 (RF Gain Control). Note that the left side of R-56 has a -50 Vdc bias applied. Thus the AVC line should read between -20 Vdc (RF cutoff) and perhaps -1.8 Vdc (at max RF Gain – the manual says it should be -1.7 Vdc) when the receiver is in CW mode and the AVC voltage is measured at the extreme ends of the RF Gain's position. The actual readings were -17.5 and -2.1 Vdc, respectfully.

Normally the set point for no signal AVC is that for maximum RF gain (when AVC is disabled, i.e., in CW mode) and that was the case for this radio (about -2.1 Vdc). The AVC would swing to perhaps -5 Vdc on strong AM signals, so I surmised that the AVC detector (2nd half of V8) and AVC amplifier (1st half of V9) was working, but the set point was off.

Since the AVC was working, after a fashion, I decided to wait for the capacitors, and then dig into the distortion and AVC and S-Meter issues as I suspected they were all inter-related. I also suspected that replacing C81, C97 and C98 might resolve the distortion. But I added other items to my list of concerns:

16. AM distortion when RF Gain is at maximum.
17. PTO tracking.

PTO Tracking Spread: I discovered the PTO tracking issue while reseating all of the tubes, checking voltages and playing with the radio. Its not excessive and I'm hoping I can recover it by adjusting L26 (see figure 4. below) that is in the PTO. If not, there is an excellent article here on rebuilding the PTO from the now, I'm sorry to say, defunct magazine Ham Radio.

(http://www.collinsradio.org/wp-content/uploads/2012/04/New_Life_for_51J_PTO.pdf)

The 70E-12 PTO should tune between 1.955-2.955 MHz or exactly 1 MHz total with exactly 10 turns of the shaft. In my case it took 10.100 turns of the shaft to change the frequency 1 MHz or an absolute error of 10 kHz. That is not acceptable as the fiduciary only allows for an adjustment of +/- 4 kHz.

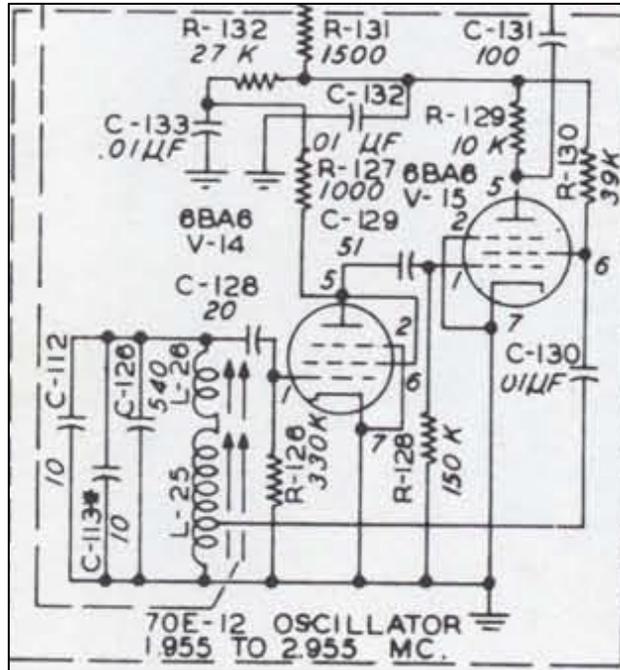


Figure 4. 70E-12 PTO Circuit

While I was checking the PTO tracking I also checked the PTO's stability. From a cold start to 20 minutes later it drifted down in frequency ~ 80 Hz and then stabilized into a cyclic drift of about +/- 2 Hz per minute, which seems more than acceptable for a radio built more than 60 years ago.

Service Bulletin 3B and Mystery Components: While confirming SB 3B was installed properly I found two components that seemed strange. I'll discuss those, but if you have a 75A-3, I'd suggest you make sure SB 3B is installed. It provides additional RF sensitivity and reduced cross-modulation and IMD performance. This service bulletin can be accessed at the Collins Collector Association's web site: (http://collinsradio.org/archives/service_bulletins/75A-2_SB_3B.pdf)

The mystery components are T3 and C57 in the diagram below (Figure 5.).

The first mystery component is T3, the mixer output transformer. It has a Barker and Williamson identification decal and does not appear to have any Collins part numbers stamped into its side. However, it appears to be an exact fit to the chassis and has the A, C, F, E, D pins clearly stamped in its phenolic base. Perhaps Collins used B&W as one of its suppliers in those days. The soldering on the pins looks original.

The other is C57. Per the parts breakdown in the manual this is supposed to be a ceramic capacitor, yet it is a paper capacitor. It eludes me as to why a paper capacitor was used here and I replaced it with a good quality ceramic capacitor. Strangely, the soldering on the capacitor looks original so I suspect it was installed at the factory.

Also, there was no 100K resistor (R68) across terminals A-C of the mixer's primary transformer. This resistor would serve to lower the Q of the primary so perhaps if Collins went out to B&W to supply

T3 they had them include the resistor inside the can. I'm not going to risk T3 by removing it just to satisfy my curiosity and I didn't add R68 back into the circuit.

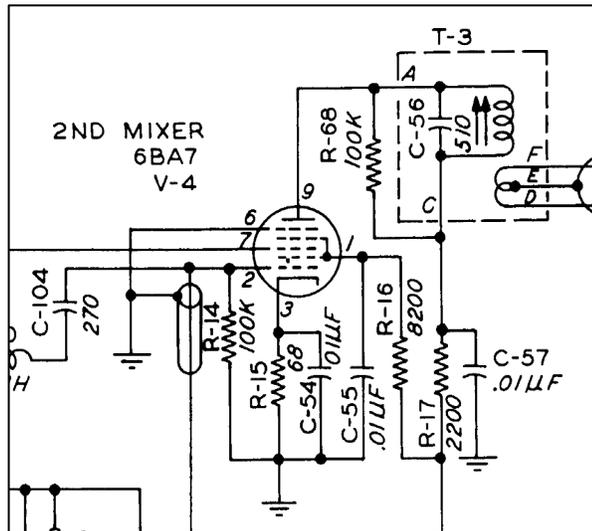


Figure 5. Mystery Components

Distortion, AVC and S-Meter: After receiving and installing the capacitors the audio distortion on broadcast AM stations at maximum RF gain went away. Additionally, the a/c hum that was observed before replacing C95A/B was corrected. Measured ac ripple on the high voltage is less than $\frac{1}{2}$ Vac RMS. I had tested all of the paper capacitors and none of them even registered a reading on my capacitor bridge.

Incorrect AVC set point was the result of R58 (see figure 4.) shifting its value to 760 Ohms instead of 560. When it was replaced the AVC set point returned to -1.7 Vdc in accordance with the manual. This ensures maximum gain in weak signal conditions.

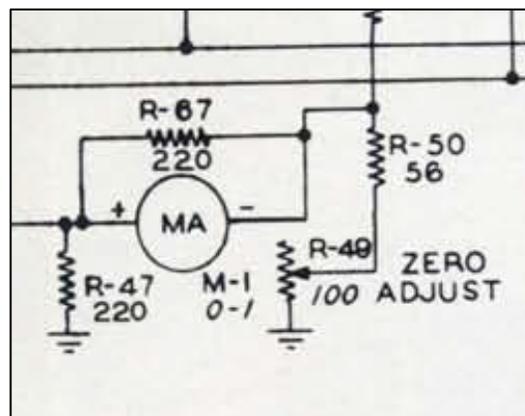


Figure 6. S-Meter Circuit

The S-Meter still wouldn't quite adjust to zero even after getting the AVC threshold established where it should be. I changed R50 (see figure 6) to 75 Ohms and was able to zero the S-Meter. However, the meter was still too sensitive. A 100 uV signal provided an S-Meter reading of between 15-20 dB over S-9, instead of the nominal S-9 signal. I experimented with different values of shunt resistors and selected one that was about 100 Ohms to get a value of S-9 with an RF input signal of 50 uV, which is the industry standard for today's radios.

Note: I could have probably resolved the S-Meter zeroing and sensitivity by going back into the control, cathode, and screen grid circuits of V5, V6, and V7 and change resistors that had aged a bit there, but because I already had a good MDS (see below) I decided this was the easiest path.

Along the way I checked overall sensitivity. The receiver breaks AVC threshold with a 1 to 2 uV signal (band dependent) and has a minimum discernable signal (MDS) at 0.1 uV on 160-20 meters and about 0.2 uV on 15 and 10. This compares favorably with my 75A-4's sensitivity and MDS.

Alignment: The reason I'm taking on the alignment is I want to see if the IF stages are in agreement with the mechanical filter and if the crystal in the crystal band-pass filter has aged and shifted frequency. Obtaining a replacement 455 kHz crystal for the crystal band-pass filter might be problematic and expensive.

The alignment went textbook smooth. All adjustments were performed in accordance with the manual. The adjustments for the crystal oscillators are fairly broad, so don't expect sharp peaks; the same goes for the antenna and the RF section trimmers and padders. Surprisingly, most of the adjustments were minimal.

I measured the frequency output of each crystal oscillator and 'shifted' the frequency to coincide with the specified frequency output (see the manual for a discussion of this). That way, when you go from band to band the 'zero set' adjustments will be minimized.

It appears the crystal in the crystal band-pass filter hadn't aged too much and it works properly but I did need to reset its zero phase point in accordance with the alignment procedure in the manual.

Crystal Calibrator: The excessive noise, that was stronger than the ambient noise of the receiver, was fixed. This is usually the fault of poor bypass filtering and I replaced both of the 0.01 uF ceramic capacitors with new, high quality, ceramic disc capacitors.

PTO: In hindsight I should have probably lived with the inability to get a good zero with the fiduciary across the tuning ranges. A strong recommendation – taking a PTO out of a Collins receiver is not for everyone. If you don't have the tools, equipment, or patience I'd suggest you avoid this work.

In discussion with Howard Mills, he recommends removing the PTO to get to the tuning slug. After doing this I agree. The locknut on the PTO adjustment screw is likely galled and it is virtually impossible to loosen it while the PTO is installed. In my case the locknut was galled and frozen to the adjustment screw. I cut it off with a Dremel tool after I had removed the adjustment coil L26 from the PTO assembly.

Here is the method I used to remove the PTO.

1. Preset the receiver to 3.7 MHz with 00 on the black scale under the fiduciary zeroed.
2. Remove tuning knob (you will need a very small Bristol tool for this).
3. Remove 4:1 gear reduction mechanism.
4. Loosen front panel from chassis by:
 - a. Removing phasing knob (set at 12 o'clock before loosening screws)
 - b. Set selectivity knob to 0 and remove knob
 - c. Set BFO to 12 o'clock, make pencil mark on top of shaft where it enters BFO transformer, remove BFO knob
 - d. Filter selector, set to B, then loosen clamp that is nearest to front panel
 - e. Remove band change knob
 - f. Set antenna trimmer knob to 12 o'clock and remove
 - g. Remove wires going to PTO where they connect on the chassis
 - i. Green – filament
 - ii. Red – 150 Vdc
 - iii. White – ground
 - iv. Coax – PTO output
 - h. Remove the 6 panel screws
 - i. Remove V18 and its shield

Now the front panel can be separated from the chassis and you can gain access to the four $\frac{1}{4}$ inch sheet metal screws that hold the 'U' shaped bracket that is affixed to the PTO to the sub-panel that holds gear mechanism.

There are two methods to gain access to these screws. One is to remove the dial. In my case the Bristol setscrews on the dial were galled and could not be broken loose. If that is the case, then use a small $\frac{1}{4}$ inch wrench to remove the screws. The one on the top left facing the receiver is behind a gear and it may not be possible to remove the screw – that is okay, just leave it in its hole.

If it falls out of the hole – mine did, it is difficult to gain access behind the gear and get it back in. I solved that by wrapping some # 30 magnet wire to the threads of the screw, feeding the magnet wire into the hole, and while gently teasing the head of the screw with a narrow screwdriver, I managed to pull the screw back into its hole.

After all of the screws are loose but before they disengage from the 'U' bracket remove the spring that holds the brass coupler from the tuning shaft to the PTO shaft. This is right in front of the PTO.

Finish removing the machine screws and then remove the PTO out of the top of the chassis.

Once you have it out you can solder some longer temporary leads to the red, green, and white wires and tack them back where they came from. Attach a frequency counter to the coax, I'd suggest using a 10X probe, turn on the receiver, and measure the frequency. It should be close to 2.455 MHz.

See figure 7. *Note, during this part I reattached the front panel back to the chassis to prevent any inadvertent contact with the front panel switches and the chassis.*

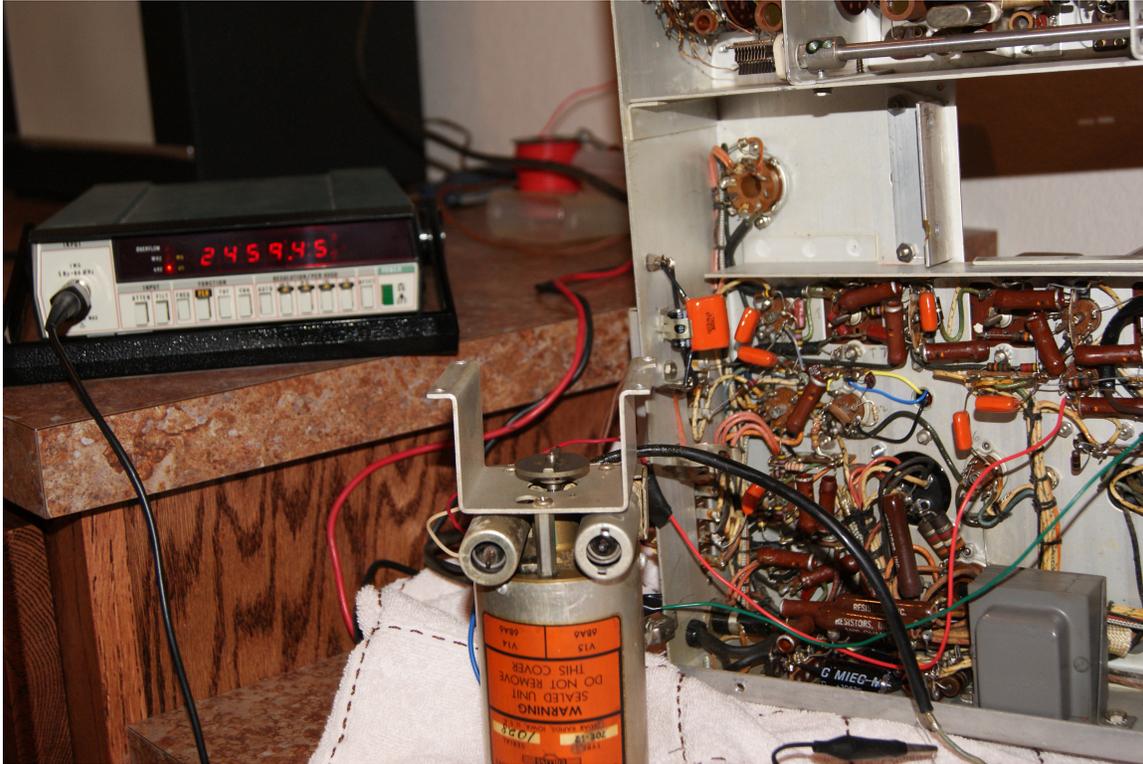


Figure 7. PTO Removed

In the Internet article referenced above they made an elaborate jig to hold the PTO and measure the dial revolutions. I found that was unnecessary. A small piece of masking tape was marked at one end of the desired frequency range (either 1.955 or 2.955 MHz) with a small dot under the force fit pin that holds the brass coupler spring. See figure 8.



Figure 8. Turn Index

In my case the powdered iron slug did not have sufficient adjustment to get 10 exact turns of the PTO to coincide with exactly 1.000 MHz of frequency change so I removed one turn from L26 at the end where it attaches to L25.

Since I had cut the galled lock off L26's tuning slug, I put a couple of drops of clear nail polish on the slug's adjustment screw to lock it in place and let it set for 24 hours with the hex nut so as to sufficiently dry.

Before installing the PTO, set it to its center frequency of 2.455 MHz and loosen the Bristol set screws that are on the coupler plate that attaches to the PTO so that the coupler plate can turn freely on the PTO shaft without turning the shaft.

Reinstall the PTO and remount the front panel by reversing the steps above. When you attach the brass coupler, do not tighten the Bristol set screws. Leave the back plate of the coupler so it will turn freely – this will aid in the alignment step to follow.

PTO Alignment to Dial: Ensure the main turning dial is exactly 3.700 MHz with the fiduciary in its zero (centered) position. Connect your frequency counter to the PTO's output and confirm it is exactly 2.455 MHz. If not, screw one of the Bristol screws down on the back coupler plate until the main tuning knob will turn the PTO. Then turn the main tuning knob so the PTO's output is exactly 2.455 MHz. Loosen the set screw and return the main tuning to read exactly 3.700 MHz. Once the PTO is at 2.455 MHz when the main tuning dial reads 3.700 MHz tighten both setscrews on the back coupler plate.

PTO Tracking Results: I was able to achieve +/- 2 kHz agreement with the dial over the entire range of the PTO which is well within the fiduciary's range of +/- 4 kHz.

Cosmetics: The rest of the chassis was cleaned; knobs were removed, cleaned and polished with plastic polish; and the tube sockets were spray-painted with hammer tone aluminum paint.

I decided not to replace the paper frequency dial on the drum. Even though it was old and yellowed, all of the lettering was readable and I kind of like the old yellowed look.

Figure 9 shows a picture from the rear just before it was installed in the newly sprayed cabinet. You can see the black Richey electrolytic and its clamp that was used to replace C95 A/B.

The cabinet was in good condition, but the paint was dirty and discolored. The panel was nearly pristine without the paint discoloration and dirtiness that the cabinet had. After trying to clean the cabinet, I decided to purchase some spray touchup paint from Surplus Sales in Nebraska (<http://www.surplussales.com>). They have paint that matches the St. James Gray (number 270). Not cheap, at \$24 including shipping, but it allowed me to restore the cabinet back to a color that matched the panel.

Before I sprayed it with the Collins paint, I touched up the deep scratches with some primer and then gave the entire cabinet a light overspray with Rust-Oleum stone texture spray paint in black. That restored the wrinkle texture nicely. Figure 10 shows the final results.

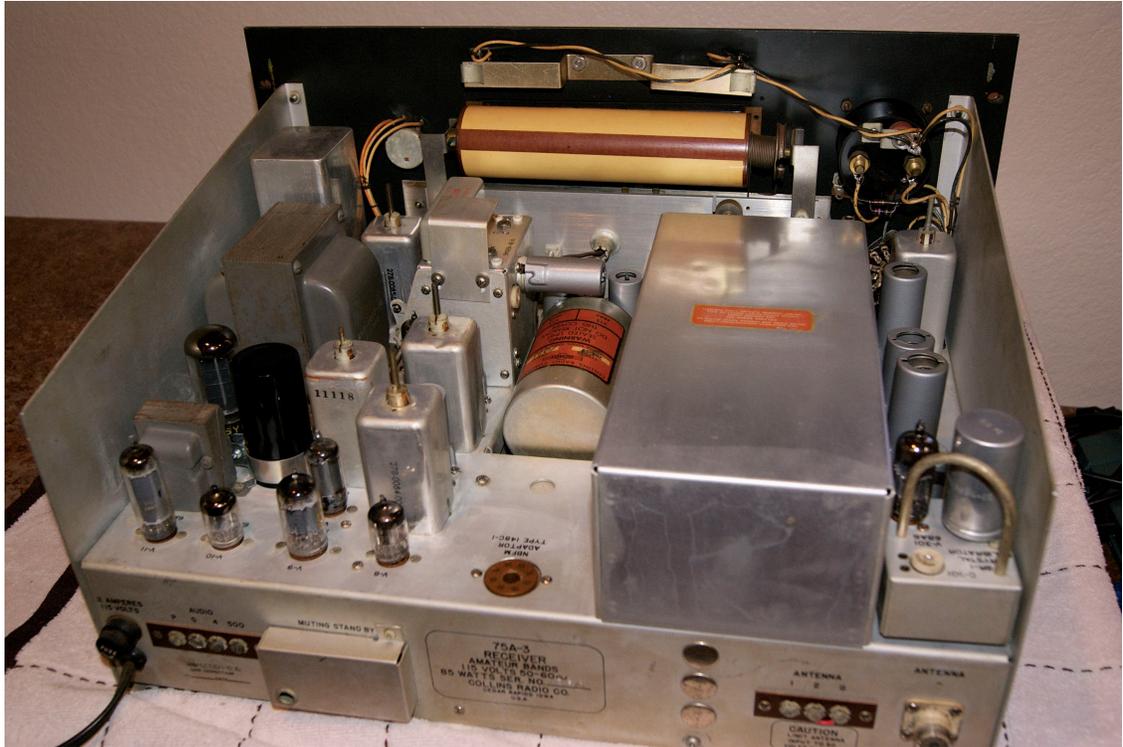


Figure 9. Chassis View



Figure 10. Completed 75A-3

Conclusions: The repairs returned this receiver to its operational status. Some were easy, but the PTO was a difficult process. I'll likely use it in the operating position I have dedicated to vintage

AM/CW and pair it with my 1954 Viking II. The receiver cleaned up quite well and since less than \$100 was spent, I consider it a cost effective repair. I have been very happy listening to CW and AM with it and plan to put it on the air for the next ARRL Straight Key Night.