

## DOES YOUR AMPLIFIER NEED CLEANING?

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In June of 2009, we published an article entitled, “IS YOUR AMPLIFIER RUNNING HOT?” In that article we discussed the construction of a temperature sensor that measures the ‘relative’ ambient air temperature that exits an Amplifier. We also discussed the term ‘relative’ and made a suggestion that the temperature be periodically noted during idle times as well as during times of use. The project utilized a cooking thermometer that was ‘borrowed’ (translation: clandestinely acquired, never to be returned) from the YXL. The thermometer has an alarm function that can be set based on temperature readings that were noted. This in turn could alert the operator if there might be an issue arising as far as temperature was concerned.

Well, over the past year it was noticed that the idle temperature of one of our Amplifiers was beginning to creep up. Not a big one time jump; just a subtle degree here and there, until it was evident that the Amplifier was running on average about 11 degrees (F) hotter during standby than it was a year ago. What changed? Did the fan loose some umph? Was the operating position adding to a blockage of the Amplifier’s air inlet? Were ‘critters’ actually taking up residence in there somewhere?



After close inspection through the air inlet and exhaust vents it became evident. A light to moderate coating of dust particles had been deposited all over the inside of the cabinet. Not just on the fan blades, but on the circuit boards, the coils, the air variable capacitors, and especially the Tubes. Yikes! Dust on the Plate and Tuning capacitors? Dust filling

the RF compartment? Dust on the relays and band switches? What to do? It was decided that the temperature sensor had performed its job brilliantly, but it was time for a follow on project to clean the inside of the Amplifier.

Now; for a word about safety. Yes, I know; you have been working around HV for decades and owned, worked on, or built more Amplifiers than most of us will ever have the privilege to operate. But I would be remiss not to mention that if you are new to the hobby or new to HV and HF, there are certain safety procedures that should go without saying. However, I will mention them here. Besides, it never hurts to hear it again no matter the experience level.

First, plan your project well. Have all the tools and materials required before even approaching your Amplifier. Try not to work on your equipment when you are in a hurry and distracted, had too much coffee, or when you are tired. Have your Amplifier's Owner's Manual handy. I will make the assumption that you have read it thoroughly. Hasn't everyone?

Second, never remove the Amplifier cover without first turning off all front panel power switches and completely unplugging the unit from the power source; i.e. pull the cord from the Amplifier to the shack outlet. Then disconnect all cables, control wires, etc. at the Amplifier. I normally elect to leave a ground wire attached.

Third, most tube type HF Amplifier Power Supply circuits have very large capacitors that stay charged for some time. Therefore after step one and two, take a break while the caps discharge thru the bleeder resistor system BEFORE removing the cover. Consult your manufacturer's documentation BEFORE removing the cover. A good safety practice is to monitor the Amplifier's HV meter; if your Amplifier has one. If not, wait 2X longer than the recommended manufacturer's bleed down time for the power supply caps to discharge. No harm in waiting; possible harm if you don't.

Fourth, don't be afraid to ask for assistance or to have a more experienced operator present.

Fifth, if it does not feel safe, it probably isn't.

Now; back to the project at hand. This is a simple project designed for some of the less experienced of us who like to perform hands on work with our equipment. It helps us understand the workings, keeps us involved in design techniques, and provides a good level of self accomplishment. It is a good way to stay sharp at our hobby. Oh sure you could pay someone to perform this operation, pack up the Amplifier, ship it off at a premium, wait several days or weeks, and risk damage. Or you could do it yourself, add to your knowledge base, and save some money....to replace that cooking thermometer you 'borrowed' from the YXL to complete the previous project, right?

Ok, I can hear it now. "Why don't you just take that thing out back and give 'er a swift blow out with the shop's air compressor? 150 PSI oughta get 'er done!"  
Uh....nah, don't think so. We will explain why later.

It is important to always have all the tools at hand before beginning a project. It is not possible to anticipate every single requirement. However, a visual inspection of the Amplifier revealed the need for:

A Phillips Screwdriver Set

A Small Cup (for scores of Amplifier cover screws and washers)

A Good Light Source

A High Voltage Shorting Lead (A Chicken Stick with Alligator Grounding Clips)

A Hand Vacuum Cleaner with Small Brush Attachment

A Can of Compressed Air (Computer Grade....not shop air or your kid's floaty pump)

A Roll of Scotch Type Tape

A Mentor or Helper (In this case, my teenage Daughter who proved to be invaluable)

A Damp Bath Towel (A what? That will become evident later.)

Now for the fun part. After a refresher read through of your owner's manual, unplug the main power cord of the Amplifier from the shack supply. We actually took a picture to prove that this step was performed. Even though the Amplifier is equipped with a safety inter lock switch, we actually unplugged the cord from the RFI AC Line Filter connected to the shack power. Even though you know the 'gun' is not loaded, would you point it at your foot and pull the trigger? If you answered yes, you might want to let your Mentor or Helper take over and you take on the role of Assistant.



Next, disconnect any control cables, coax, and wires attached to the Amplifier. We usually elect to leave a ground wire connected.

The next step is one that is often overlooked and can be a source of frustration later. Determine what size screw driver tip is required BEFORE any attempt is made to loosen the cabinet screws. Nothing more maddening than to damage a small screw or even

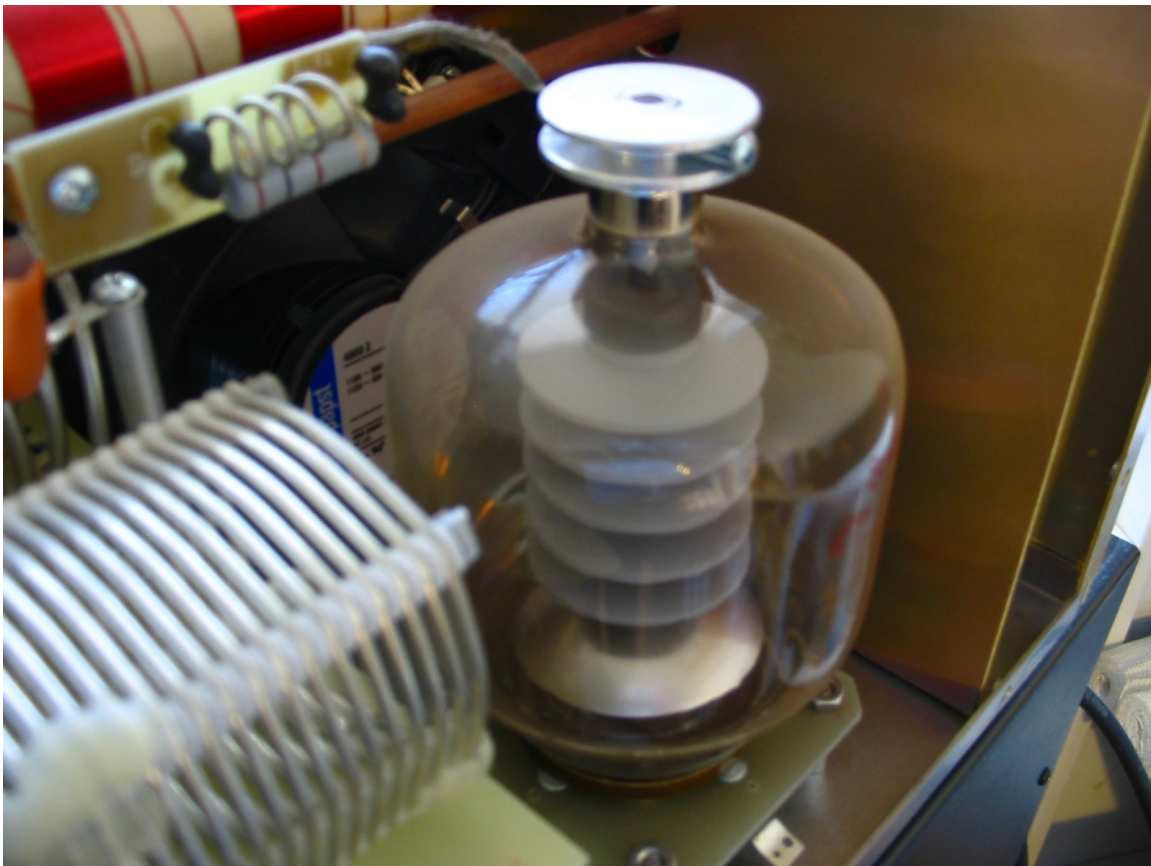
worse; ruin a beautiful cabinet with a large screw driver gouge in the silk screened paint. It is perfectly ok to use a small power screw driver to loosen the screws. Exercise great care in using a power tool to reinstall them. I prefer to use a human powered hand screw driver for re-installation. It is a pain, but you will not want to tighten down the screws all the way when reinstalling the cover...will explain later.

As with many Amplifiers, there were numerous screws and washers keeping the cover in place; 21 of each, to be exact. Place those small screws and washers into the small cup as they are removed...a great job for the helper. You know; if you drop one or knock one of them off the work bench what will happen don't you? It auto-magically hides in the most inaccessible spot imaginable. Communicate with your assistant about each step in advance. This saved us some time and frustration when it was pointed out by my helper that one last screw had remained installed and was hindering an attempt to remove the cover; which was still stubbornly attached to the chassis. The covers are usually manufactured from thin gauge light weight aluminum and can be easily bent. Take extra care...because some of the small vent slits can have sharp edges on the inside and can inflict nasty grid square looking lacerations to the fingers. Not that I would have any real first hand knowledge of how quickly this can happen or how painful it can be or anything.....

My Daughter was a no-brainer choice for a helper. She is very interested in wireless technology; as are most teenagers. You know....'cell texting'. In any event, once the cover is removed, there might be a temptation to just give those big ole electrolytic capacitors or those beautiful 3-500Z tubes a great big hug.

**BUT WAIT!**

Remember that those cute capacitors and tantalizing tubes can present quite a 'volt-jolt' if not properly prepared to receive that love and affection. I once had an old timer show me how to treat Tube Anode Caps and HV Power Supply Capacitors before jamming my hands into harms way. He suggested that a 'Chicken Stick' be used to insure that all stored energy was dissipated. A Chicken Stick is a foot or so piece of PVC tube or wood or fiberglass broom handle with a high voltage test lead wire running through the center length ways. On one end of the wire is attached an insulated alligator grounding clip and on the other end a small threaded eye screwed into the end of the stick part; making electrical contact with the HV wire. This is used to safely ground out the HV leads of Power Supplies and Tube Anodes as a last measure of safety. Even though I left the Amplifier unplugged over night...not a bad idea to have one more layer of precaution. Besides, why does 'Billy Bob' the power company guy use such a heavy duty pole when he is right there in the bucket just an arms length away from the fused knife switch at the transformer? Just in case, that's why. Trust your well being to a \$5 bank of bleeder resistors? Nope. These 'sticks' are also available commercially.



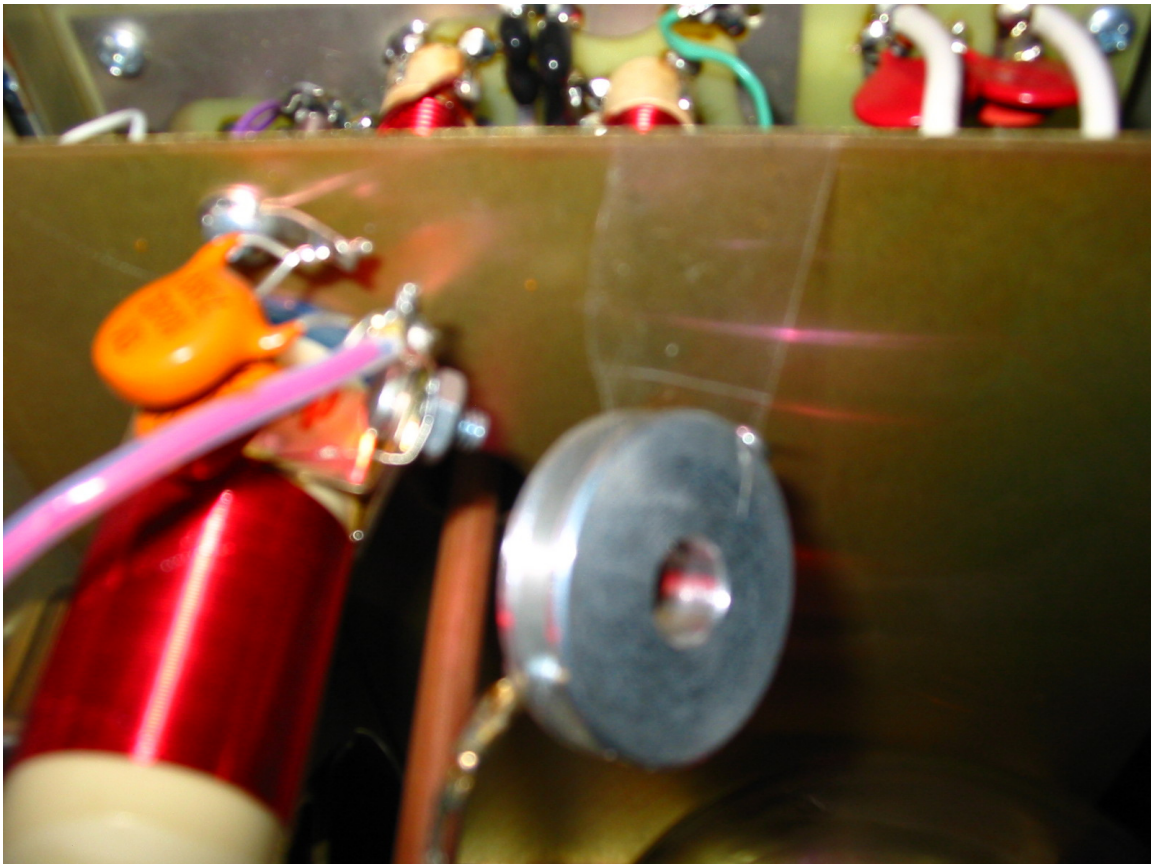
Once it has been determined that any danger of stored electrical energy has been eliminated, inspect the inside of the Amplifier and develop a plan on how each group of components and compartments will be cleaned. At this point we should mention that there are a few NEVERS.

- NEVER USE ANY COMPRESSED AIR OTHER THAN THAT WHICH IS DESIGNED FOR USE IN COMPUTERS. CANNED AIR FOR ELECTRONICS THAT HAS HAD THE DUST, OIL, AND MOISTURE REMOVED. FOLLOW THE DIRECTIONS ON THE CAN. THE CAN SHOULD NEVER BE

OPERATED UPSIDE DOWN AND TO THE POINT WHERE A FROST CAN BE SEEN ON THE CLEANED SURFACE. IF THIS OCCURS, ALLOW THE CAN TO WARM BACK TO ROOM TEMPERATURE BEFORE PROCEEDING FURTHER. FROST BITE IS A POSSIBILITY WITH THIS PRODUCT; SO EXERCISE CAUTION AND FOLLOW DIRECTIONS!

- NEVER USE ANY LIQUID CLEANER OR WATER, ESPECIALLY ANY FROM A 'SQIRT BOTTLE' OR AEROSOL CAN DIRECTLY INTO THE AMPLIFIER. ELECTRICAL CONTACT CLEANER IS ACCEPTABLE FOR USE ON THE BAND SWITCHES. HOWEVER, YOU MUST FOLLOW THE MANUFACTURERS GUIDELINES ON ITS USE. WE WILL NOT COVER THAT HERE.
- NEVER INSERT ANY HARD OBJECT BETWEEN THE PLATES OF THE AIR VARIABLE CAPACITORS TO CLEAN THEM. THIS COULD CHANGE THEIR VALUES AND PRESENT A DISASTROUS ARCHING POTENTIAL. THIS CAN BE DONE BY A PROFESSIONAL SERVICE WHICH USES SPECIAL TOOLS AND CHEMICALS.
- NEVER INSERT ANY HARD OBJECT BETWEEN THE TURNS OF ANY PLATE OR TANK COILS TO CLEAN THEM. THIS COULD CHANGE THEIR VALUES AND PRESENT A DISASTROUS ARCHING POTENTIAL. THIS CAN BE DONE BY A PROFESSIONAL SERVICE WHICH USES SPECIAL TOOLS AND CHEMICALS.

Now that you have a plan, begin by removing the Tube Anode Caps. Use a small piece of Scotch Type Tape to secure the Anode Heat Sink Cap out of the way.



Follow your Amplifier's Owners Manual for the safe removal of the Tubes. Tubes should never be rocked back and fourth excessively to remove them and only in special circumstances based on the design, like certain X-Ray Cathode Tubes, should one ever be rotated out of the socket. You should be able to remove the Tube(s) by applying gentle upward force from around the base of the glass envelope; straight up and out. NEVER use any screw driver or other instrument to remove a Tube unless the manufacturer specifically advises or provides a specialized instrument for that purpose. Now where did I put that Owner's Manual?

Once removed, it is a good idea to inspect the Tube(s) over a soft surface like a bed or over a thick blanket on the work bench. There is nothing like dropping one of these babies over a concrete shop floor, right? Even a floor covered with thin carpet and padding is not much consolation to a delicate Grid and Cathode when dropped from a work bench height. Treat your Tubes like a new born babe. Keep a firm grip; but not crushing.... never to be dropped or bumped hard.

Visually inspect the Anode Cap Terminal to insure the set screw is still tight to the feel. Not all Amplifier Power Tubes will have a terminal cap over the Anode connection. It happens that in this example Amplifier the 3-500Z's do have a cap and hex set screw tightened over the top Anode PIN. Look at the bottom PINS as well, to make sure they are tight, not discolored or exhibit arch marks, and are not bent. When the Tube is gently and slowly rotated in your hands, are there any foreign objects rolling around inside the glass envelop? If yes, consider your self lucky that you did not get to experience an ear shattering arch over or a catastrophic envelope failure. You will probably want to have the Tube professionally tested and it should be replaced with one from your spares. I assume you have spares...kept with that Amplifier Manual, right?

The proper way to clean the outside glass envelope on a Power Amplifier or Transmitting Tube is NEVER submerge the tube in any liquid. NEVER spray a liquid directly onto the tube.

Remember that damp bath towel; emphasis on damp?

While firmly holding the tube over a padded surface, wipe away any dust and debris using a rotating method. NEVER rotate the tube by the Anode PIN or by the bottom PINS. Hold on to the glass envelope as you rotate the tube in the damp towel. Not dripping wet....just damp enough to remove the dust. It should become squeaky clean in just a minute or so. Now check the top Anode and bottom PIN area for any residual dirt that may have become lodged there during the envelope cleaning. What a thing of shinning beauty, right?

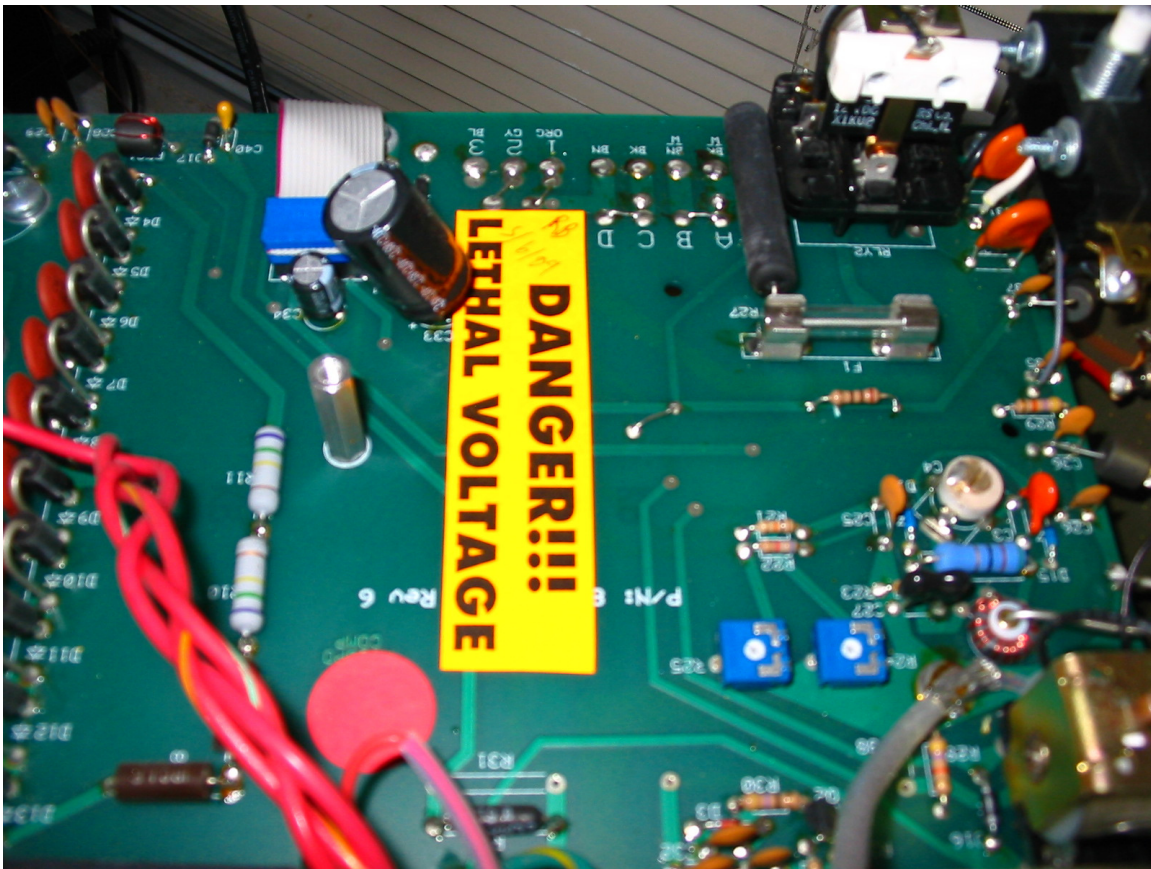


Now set aside the cleaned Tube(s), preferably in the foam shipping carton in which they arrived. Don't still have that? Then place them gently, not touching, between two pillows. Remember they are round...and will roll away.

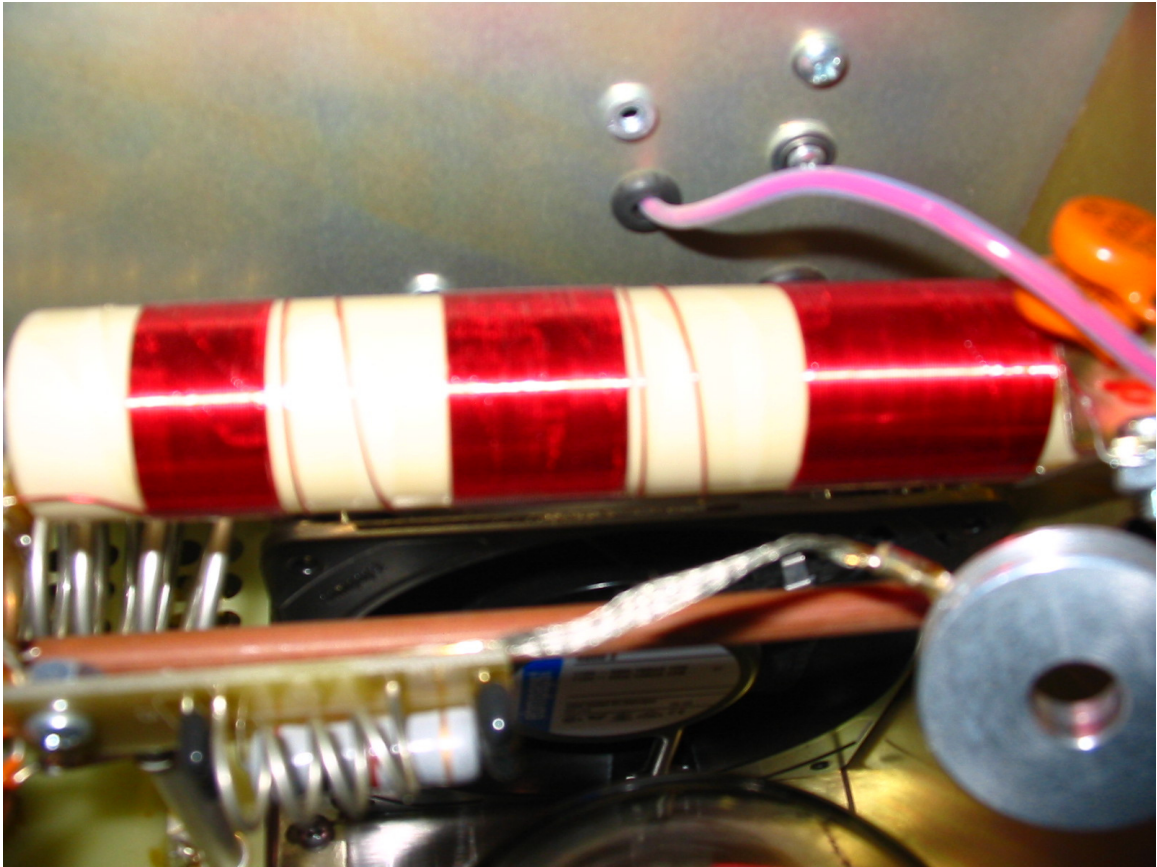
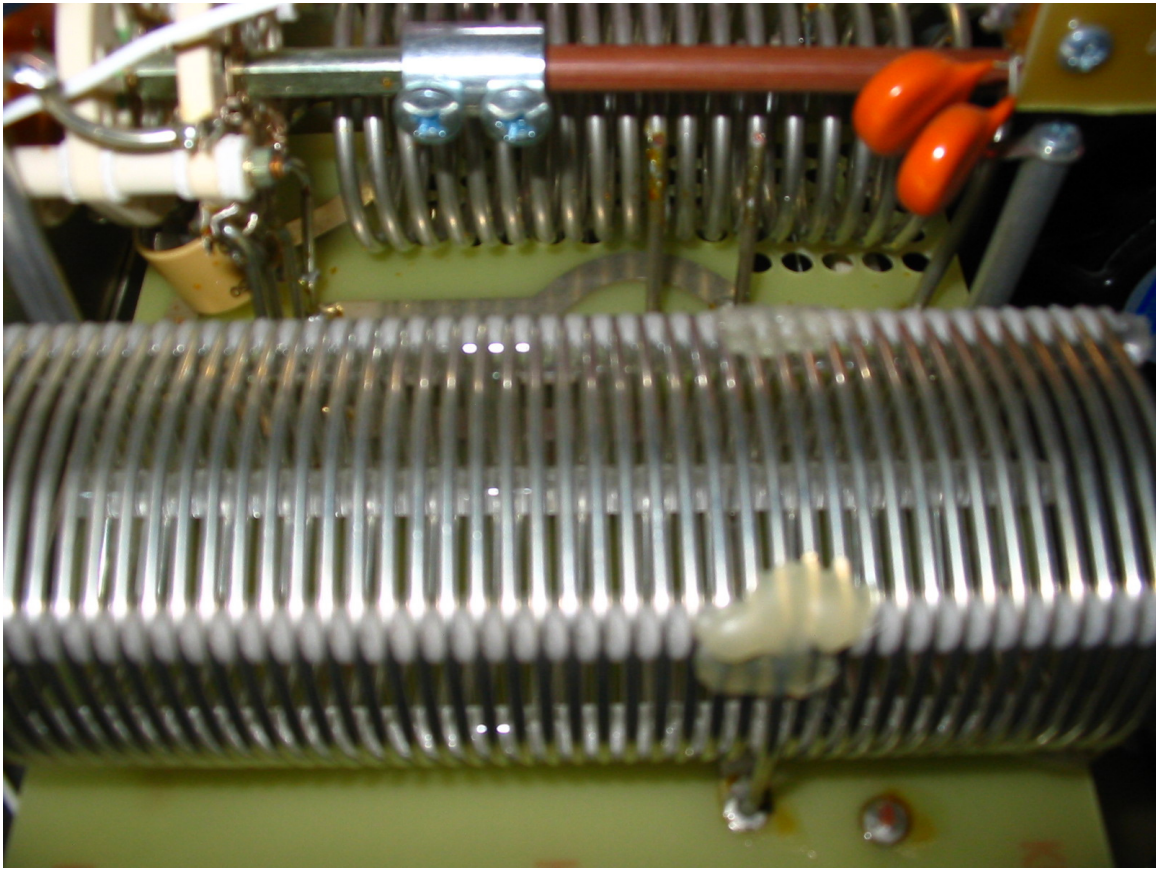
Well, good so far, right? Now proceed to clean out the Amplifier itself. I decided to try and vacuum as much dust out from inside the cabinet as possible with a small hand held computer vacuum and little soft brush. The vacuum has about a  $\frac{3}{4}$ " diameter flexible hose and a very small and soft brush. You can make an attachment like this for your floor vacuum using a dishwasher to sink disposal drain hose kit and simply attach a small artists brush to the end of the hose. Use PVC adapters to fashion a coupling to your floor vacuum's suction hose.

I began with the heaviest deposit of dirt...the fan blades. Then moved to the transformer and power supply area because that is usually in the air stream as well. I noticed the rectifier board had a nice collection of dust on the diodes. Remember, heat is the enemy of most solid state rectifiers. The board cleaned up just like new with the little vacuum brush.





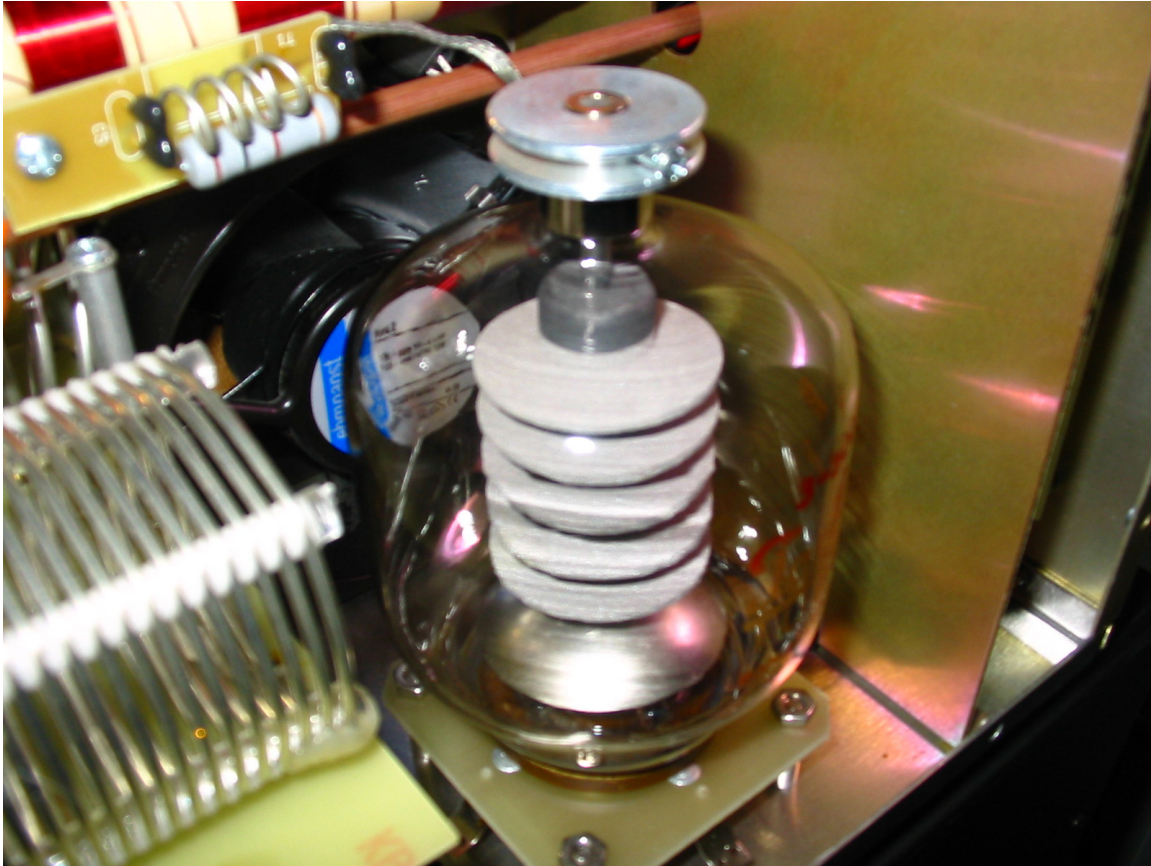
After removing as much from these areas as possible with the vacuum, I turned my attention to the RF compartment. This is where the air variable capacitors, coils, and tubes reside. Using the soft brush on the hand vacuum, I cleaned as much from each large component as possible. I did not poke anything between the plates of the air variable capacitors. Once the vacuuming was complete, I proceeded to the canned air. Beginning with the fan, I sprayed short bursts on the fan blades to remove any dust film and to make them spin rapidly. While the fan is spinning, listen closely. Does the fan sound like the grinding gears of the neighbor's antique pickup truck? If so you may have an obstruction or the fan bearings may be worn out. Replace if needed. Blow off the fan from both directions to clean both sides of the blades. Next, blow off the transformer, rectifier, and capacitor compartments. Move to the RF compartment and blow off the Tube Socket(s), the coils, and last the air variable capacitors. You may need to have more than one canned air in order that one is allowed to return to room temperature while the other is in use. They become quite cold to the touch. The contents can also leave an icy condensation on surfaces if sprayed for more than a few seconds at a time. It will also cause frost bite to your fingers!



During the blow out of the bottom cabinet area, we discovered a small piece of red hook up wire left over from the manufacturing process that was loose and still inside the cabinet. It came from the RF compartment, flew between the fan blades, and lodged against one of the power transformer feet. Yikes! That could have gotten 'ugly in a hurry' if lodged in the Tube socket or shorted between the air variable plates! So take your time and look around while the cover is still off. Don't forget to blow off the band switches and open frame relays as well as any dummy load resistors and heat sinks.



After you are satisfied that the Amplifier is cleaner than when you started its time for re-assembly. Begin with re-insertion of the Tube(s). Notice that the bottom PINS are not evenly spaced. There is usually one PIN off by itself. This is done purposely to provide for a 'keying method' which allows the Tube(s) the proper PIN alignment in the socket. You want the PINS to be in their correct socket locations, believe me...it makes a difference. Visually inspect the socket and find that lone PIN hole. While supporting the tube over the socket, rotate or orientate the Tube(s) until you feel the Tube drop into the socket. This will be about a 1/16" drop, not dramatic but enough to know it is oriented properly. Once that is determined, push the Tube straight down, applying gentle even force on the top of the envelope, not on the Anode PIN. The Tube should 'seat' smoothly and bottom out. Do not rock the Tube or attempt to rotate the Tube once you begin the downward seating. Next, reconnect the Tube's Anode cap connection and remove any tape previously used to secure it out of the way. Whew... job well done so far. Nice and shiny clean.



After a careful cleaning the cover should now be ready for re-installation. Remember the sharp air vent slits? Before re-installing the cover, take a moment to inspect the inside of the Amplifier once more. Did you leave anything inside? Screw driver, brush, pets? Once you are satisfied that everything is good to go, slide the cover back onto the cabinet chassis.

Oh no, the cover does not exactly fit! Not to worry. Most covers have some spring tension and remember that the safety inter lock switch will probably cause the cover to not seat flat in that area without a cabinet screw. Now, about that re-assembly and those cabinet screws. Anyone that has ever changed a flat tire will tell you that you should NEVER tighten all the way down, each individual lug nut; one at a time. They are started and 'snugged' up one at a time and then one last final tightening is done in a cross pattern. It is the same with the nearly two dozen cover screws. This is a good time to have your assistant help with cover screw hole alignment. I elected to begin by placing the first screw closest to the safety interlock switch but leave that last turn loose. Next I move to the front bottom sides of the cabinet, leaving the screws loose, move to the rear bottom, and then the top. Once all the screws are in, I then tighten them down by hand. Check for any holes missing screws. It happens. The covers will rarely fit properly if the first several screws are tight. There is almost always one last hole that has to be aligned just right. Use the method that best works for you, no set rule here.

Now for the moment of truth; re-connection and power up. Begin working in reverse order, make sure all front panel switches are in their off position. Next re-connect all cables, wires, and coax. Only then plug the Amplifier back into the shack's power grid. I

usually choose to test the metal chassis to make sure there are not power wires shorted to ground. Use a 120 VAC neon test light to see if the cabinet might be energized. Carefully turn on the Amplifier's power switch and watch and listen. Re-test the cabinet ground. Allow the amplifier to warm up and note the stand by idle temperature. We were able to see a marked difference before and after cleaning.

Remember dust acts like a thermal insulator, keeping heat energy in and not allowing the cooling system to dissipate it properly. Heat is the enemy of many electrical devices and especially Glass Vacuum Tubes. A once a year cleaning for Amplifiers that run often may be in order. Remember, stay safe and run cool.

73

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