30S-1 Bias Supply Overhaul

by Bill Carns

Forward

I think all of us enjoy opening up a piece of Collins equipment and finding the appearance totally factory original. I know that I do.

Time is now taking its toll - and more and more we find that when opened up, we are looking at modern yellow or blue electrolytics and modern silicon diodes.

Although some would say that I am some kind of nut case, I always smile when I find that clear sign of originality and Collins workmanship still in place.

I will go out of my way to save and reform older electrolytics and I never cease to be amazed when I test components that have been removed on a preemptive strike by someone else, only to find them good as new.

The reality is though that some components do age, and sooner or later they need to be replaced. One such part is the venerable Selenium Rectifier. In their best hour – and original state – they were not a real good diode when looked at and compared to modern silicon parts. In fact, even the best Selenium diodes age and have a known degradation with time.

The Sarkes Tarzian Model 50 selenium diodes that were used by Collins in the 516F-2 and 30S-1 bias supplies are now pushing 50 years old or more - and most have started down that degradation slope. However, there are a lot of them out there that still remarkably look very good. More on that later.

Recently I was helping a friend repair his 30S-1 and one of the issues was the bias supply. You could just barely get the idle current set back to the book specification and the bias pot was at the end of its travel more or less.

Obviously it was time to do a little rebuilding and snooping to see what had changed. This article is the story of that repair (as well as a tutorial on the Bias & Relay Shelf removal). During that repair I decided to try and make myself feel better by "saving" those nifty 50s looking Model 50 diodes.

So, read on and see what ensued. Take a look at the outcome. Those new "Model 50s" will live on a long time and show their charm to several new owners over the coming years.

And, No Torrey, I am not going to see a psychologist.. I tried that and it did not help even one little bit. ☺

March 2016

~ Includes relay shelf removal technique ~
~ Includes overhaul/restoration of Model 50 Selenium rectifiers ~
~ Includes 3 new views of detailed component placement for relay & bias shelf ~

While the main purpose of this article is meant to be the proper access and overhaul of the bias supply components that age in the 30S-1, contained herein is also the correct technique for removal of the shelf from the main cabinet in order to work on any portion of that relay shelf and circuit area.

This could include execution of SB-1, replacement of any of the wired in relays, or replacement of any other relay shelf related components. We often see workmanship that is less than stellar which results when people attempt to work under that shelf with it left in place. While the removal looks like it is a daunting task, it in fact was well thought out by Collins and is not that bad.

In fact, once you know how to remove and care for it while "loose", then it is not a huge task to get it out where you can do good work.

This all started when a friend called me asking for help with a 30S-1. He brought it down to my shop, and that day we found several problems that had resulted from previous shoddy work. By afternoon we had the amp up and running. Nice 30S-1.

Unfortunately, once we had adjusted the bias for the idle current, I observed that the potentiometer was all the way at the end of its run – and just barely allowing the tube to be cut off down to the point that the idle current was low enough to be where it belonged.

This indicated to me that the bias supply negative voltage was not up to full required level of about -100 volts coming out of that little simple supply. A quick check of the configuration showed that a.) The 50 ufd 150WV filter caps were original & 2.) The rectifier diodes CR207 & CR208 (as well as the soft start diode CR205) had 1N4007 diodes just strapped across the terminals of the original selenium diodes - - It was evident that the wiring had never been removed from those selenium rectifiers, so no one could have ever tested or assured that they were not leaky.

I was looking at a scab on job where the leakage from the original selenium rectifiers was still in play and thus (along with potentially bad caps) the lower bias output. I am being hopeful that the transformer is not damaged somehow. The shelf has to come out and some parts removed and replaced.

Figure 1 below shows the shelf in place and you can see those parallel installed diodes. Bad plan.

Figure 1. Rear of Relay and Bias Supply Shelf

So, let's start.

SHELF REMOVAL

Begin with some protective strikes: *Believe it, or not, that shelf is designed to come almost all the way out of the cabinet for maintenance.*

1. **Remember to disconnect the AC power input before starting this work!**

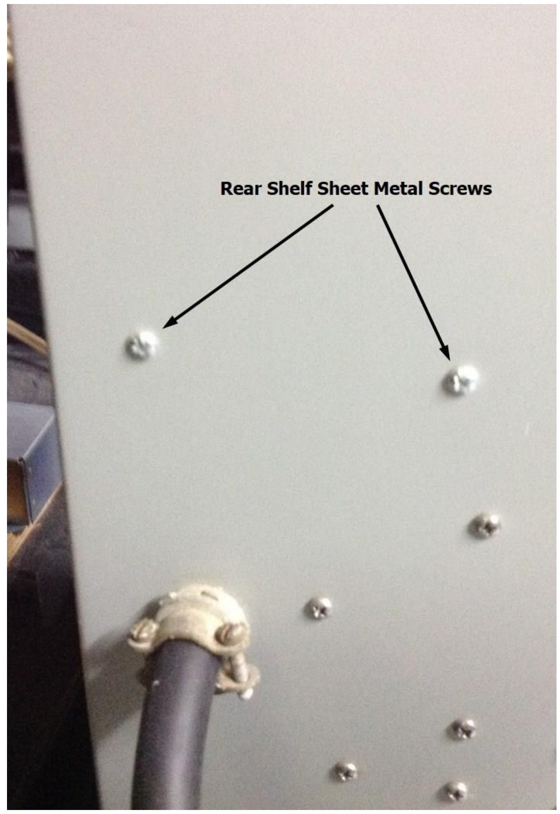
2. Remove the HV rectifiers, the time delay tube K202, V203 (ALC) and all of the fuses and fuse covers. Keep those fuse covers straight (as well as the fuses) as to where they came from. Some covers do not fit all holders, especially if a fuse holder has ever been changed.

3. Remove the AC Mains cover (I hope you still have it - or you should make one!) and remove the AC Mains wiring and fold it down out of the way. Document the color codes & position before removal.

Taking out the shelf for maintenance:

1. Look at the rear underneath lip of the shelf and you will see two sheet metal screws coming from the rear outside through clear drilled holes in the case and seating into the shelf rear lip. Note these are sheet metal screws and use all the precautions regarding over tightening (and restarting) when they go back in. Keep all screws identified and where they will go back where they came from. Eyeballing where they are from the inside, carefully go around to the back and make sure you are working on the same two screws. Loosen them about half way out but where they are still holding the shelf.

2. Now, come around to the front and remove all of the outside panel attach screws (There are 5) except the upper right side screw. Just loosen that about half way.



3. Now, go around to the rear and remove the two rear inner lip sheet metal screws that you loosened before. The back of the shelf will fall down a bit but not far (held by harness and the front screw.)

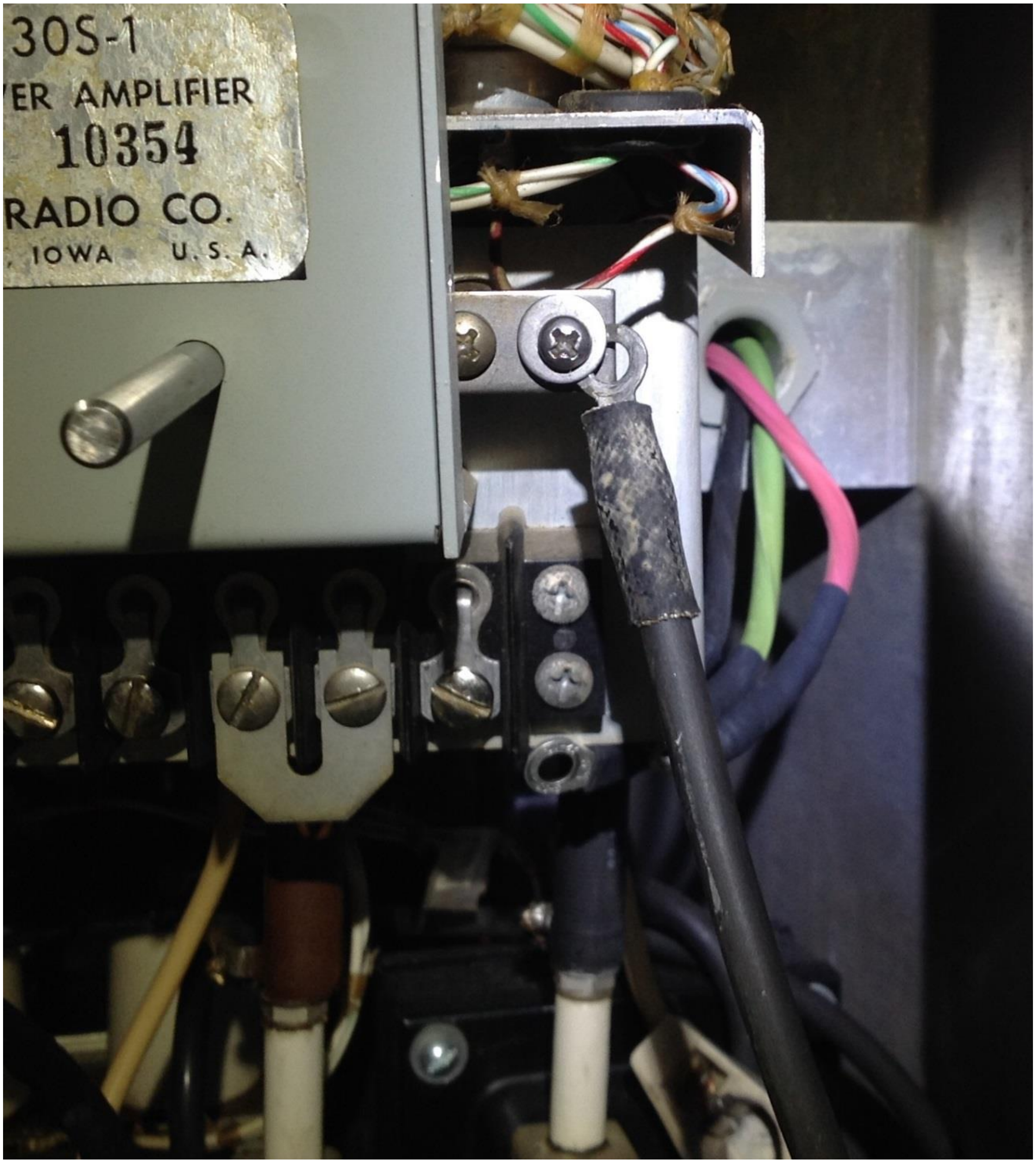
4. Go get a nice big and soft bath towel and fold it in quarters and lay it in on top of the choke/cap/rectifier area.

5. From the front and, while holding the front of the shelf with your left hand, remove the last upper side screw and the shelf will drop down more in the front.

6. Carefully slide the front of the shelf/panel to the left while clearing a bracket and HV wire that will be revealed. Pull it forward a couple of inches where you can keep it there. I used another smaller towel folded between the cabinet frame and the right edge of the shelf assembly to protect both.

7. You will be looking at a High Voltage lead that goes to a screw terminal on the door "dead fall" shorting switch S206. That screw that holds the HV wire on the switch terminal bar is threaded into the bar so you can just temporarily remove the screw without worrying about a blind nut falling down somewhere. Remove the cable and then restore the screw in the threaded hole.

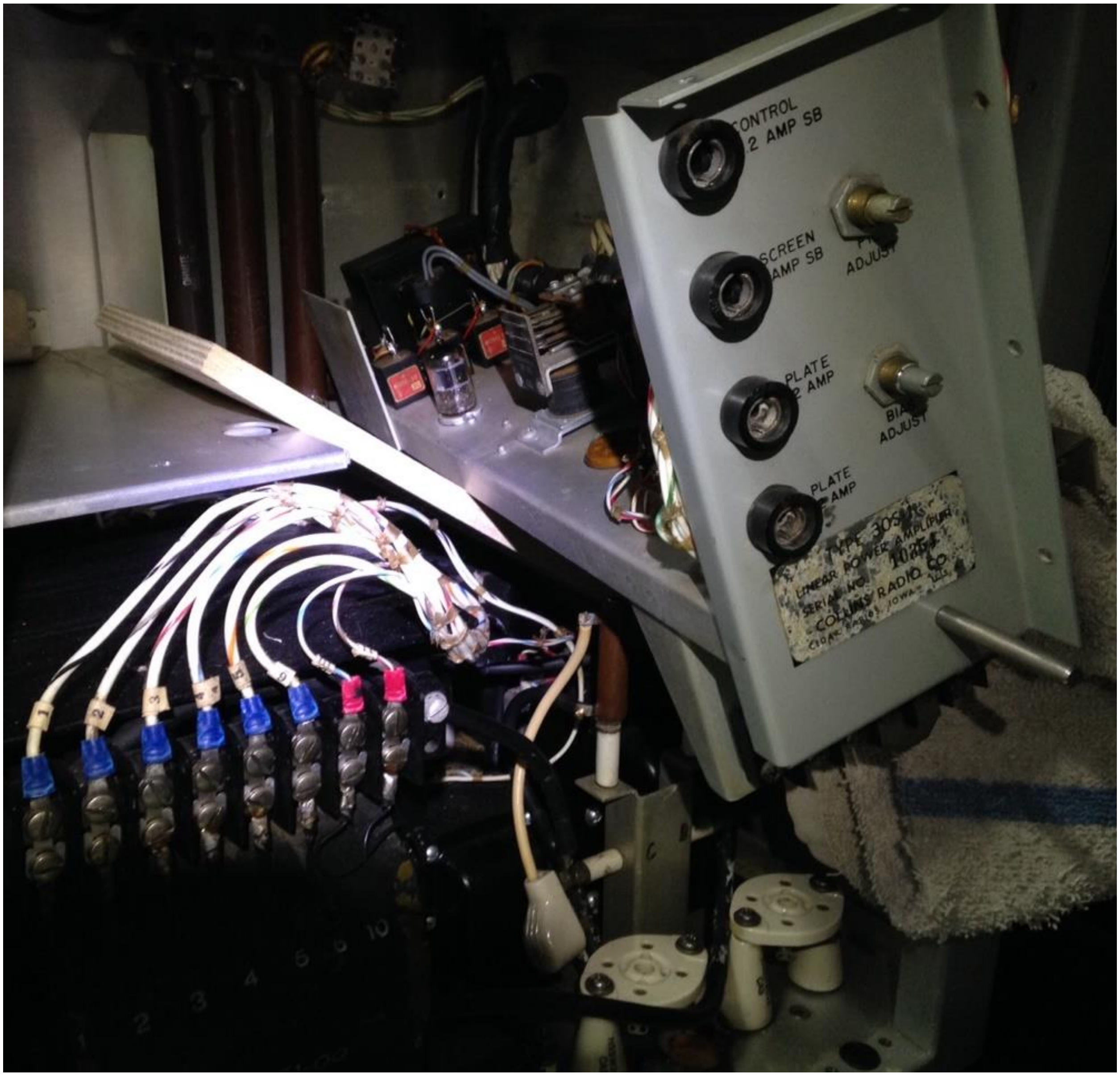
Figure 4. High Voltage wire here shown already unbolted
- and just clamped for picture



8. That HV wire is going to want to flip back and hide behind the frame. Before it does that put about a 6 inch piece of blue painters tape around the cable up where it will show, so you will not forget to hook it back up when this all goes back together.

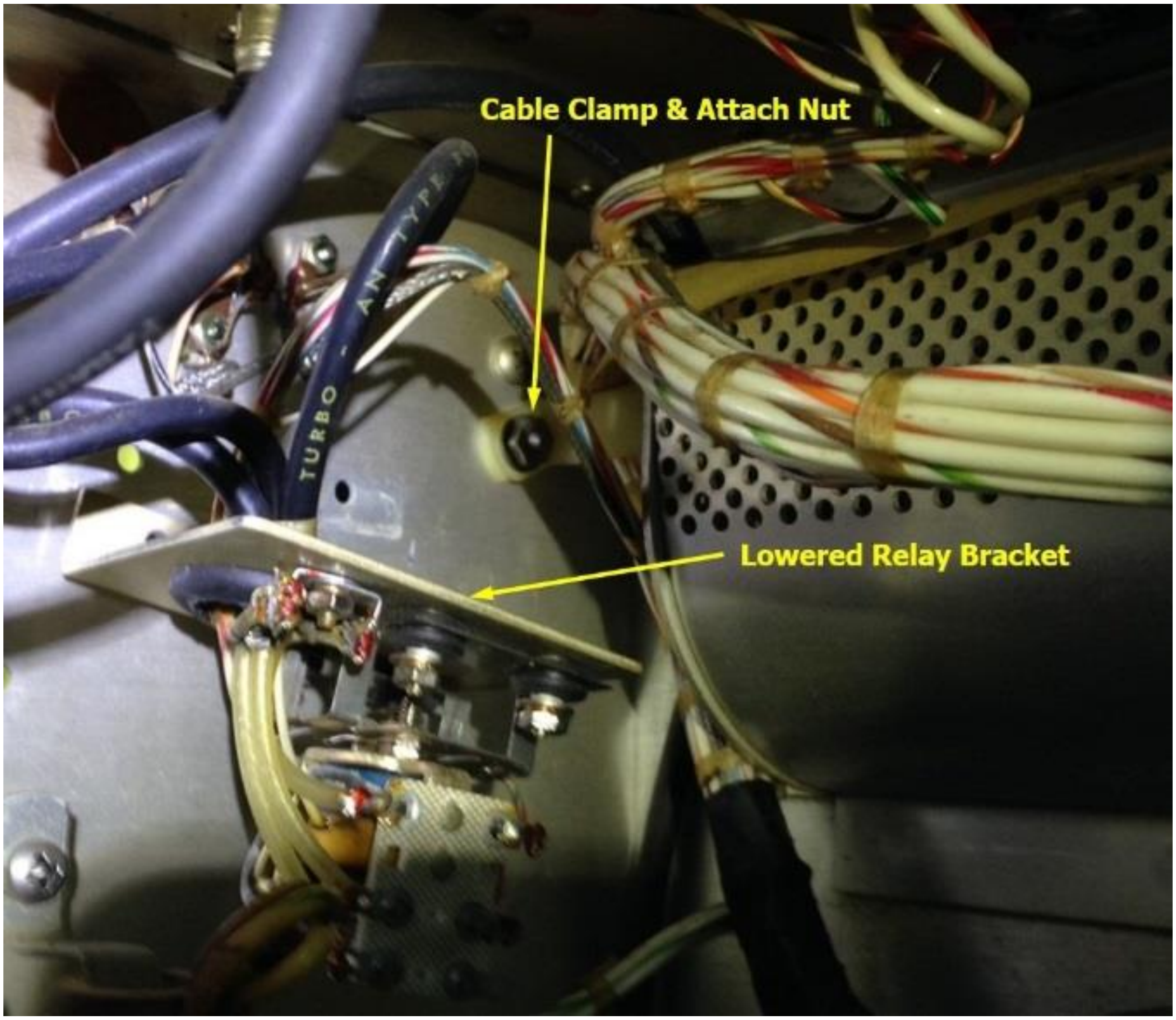
9. Now, go ahead and pull the shelf out until the face of it is about 4 or 5 inches in front of the cabinet frame.

Figure 5. Shelf in position 4 or 5 inches out from frame & before harness release



10. Referring to figure 6 below, look clear back in the rear corner vertically and you will see where the harness (that is keeping the shelf from easily coming forward any further) is running behind that intake air sheet metal that forms the right lifting handle. There is a cable clamp holding the harness back in that corner. We are going to take that off and it is not as bad as it looks.

Figure 6. Rear Harness Cable Clamp & Attachment Nut

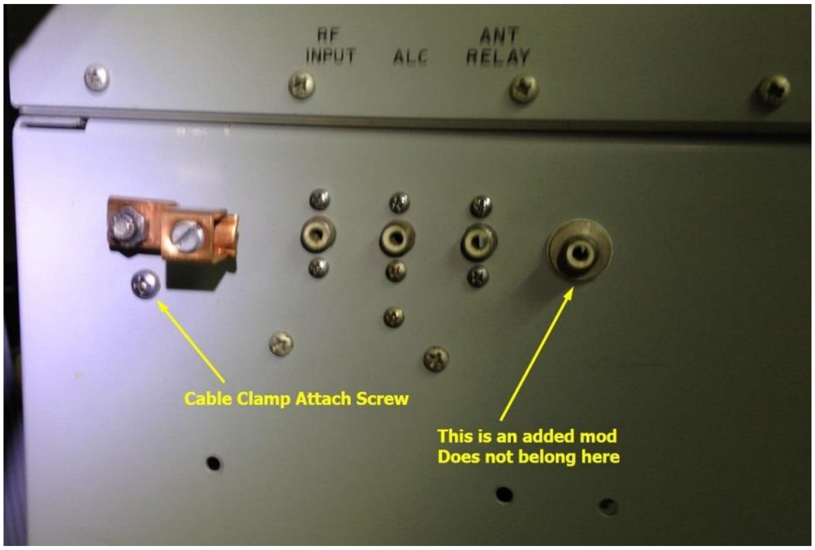


Clearing the harness

11. Look at the little relay mounting bracket that is just to the right of the bleeders up high. Identify the screws (more sheet metal screws) and go to the rear and remove the two screws which will let that relay bracket drop down on its wiring harness. Now you can move it slightly to the left as you work in there.

12. You are going to need a partner for the next step and also to replace that relay bracket and replace the cable clamp that we are about to take off. If you do not have a partner, then DO NOT take that relay shelf out and DO NOT take the cable clamp off. Just work on the shelf where it is.

13. Have your partner identify the larger Phillips head screw that is just under the ground stud on the rear of the amplifier on the left. That large Phillips screw goes to the cable clamp.



14. *Recommendation! Get another very light medium sized towel and tape it about 4 inches below the nut on the inside. Tape it across the back and then across the side so it makes a catch basin for the nut and washer. Let it rest on the protection towel you already have in there. You will be glad you did this. Looking for that nut back there is a booger and it is stainless so a magnet does not work well.*

15. *Also, take a felt tip marker and put just the smallest line on the harness above and below the edges of the cable clamp so that you can get it back where it belongs during the reinstallation work. This will ease the re-installation.*

16. When you are ready inside to keep that nut from spinning (and to capture the nut and washer) have your partner unscrew the Phillips screw until the nut, washer and cable clamp release.

17. Now, making sure that the harness comes out from behind the vent, you can move the shelf on out where you can easily turn it over on either side and work on it.

The shelf is now out where you can work on it and I am ready to start the bias supply repair. Figure 8 shows the shelf pulled all the way out (about 50% out of the cabinet) and resting on its temporary "bench" that spans from the 516F-2 shelf to a cabinet bracket on the right inner side panel.

For completeness here, I am also presenting better component placement figures than are available in the Collins manuals. For some reason, the manuals do not even show a bottom view of this shelf.

My thanks to Chris Farley, KC9IEQ for taking these good pictures of an early pre-SB-1 30S-1 shelf. Note that if you have an early 30S-1 that has had SB-1 accomplished in the field, there will be a terminal strip mounted in one of the removed K206 mounting holes – on which are terminated the wiring runs from the harness to K206/C220 (removed). If you have a post SB-1 production 30S-1, there is no terminal strip required and the harness was redone to just run the wires on through.

Figure 6.

30S-1 Relay Shelf & Bias Power Supply
Top View

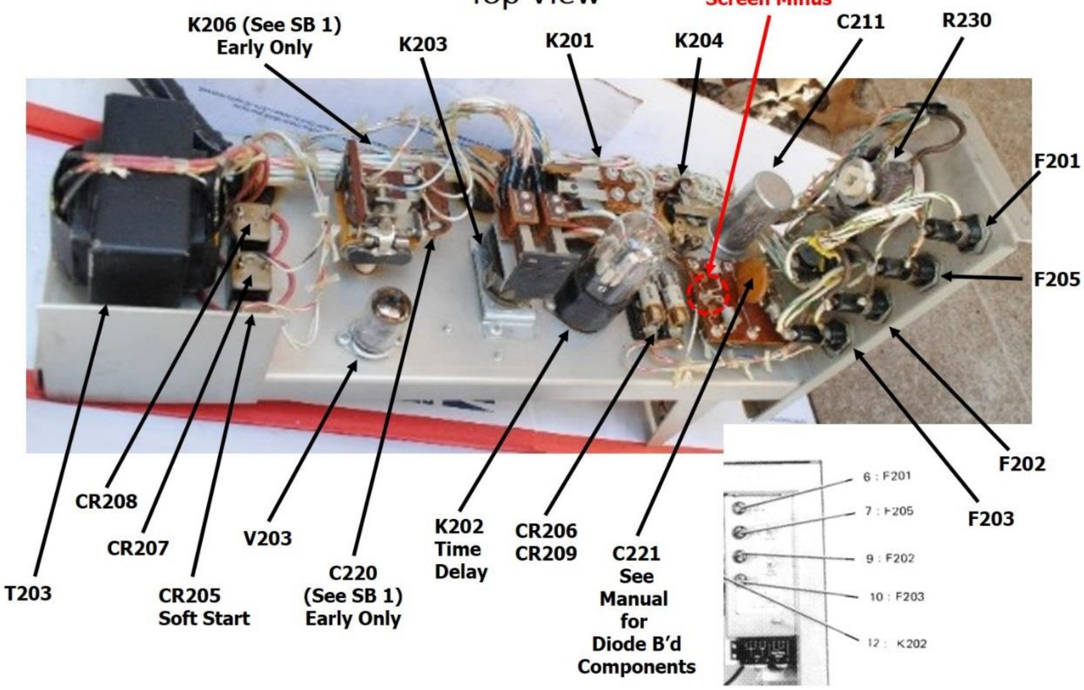
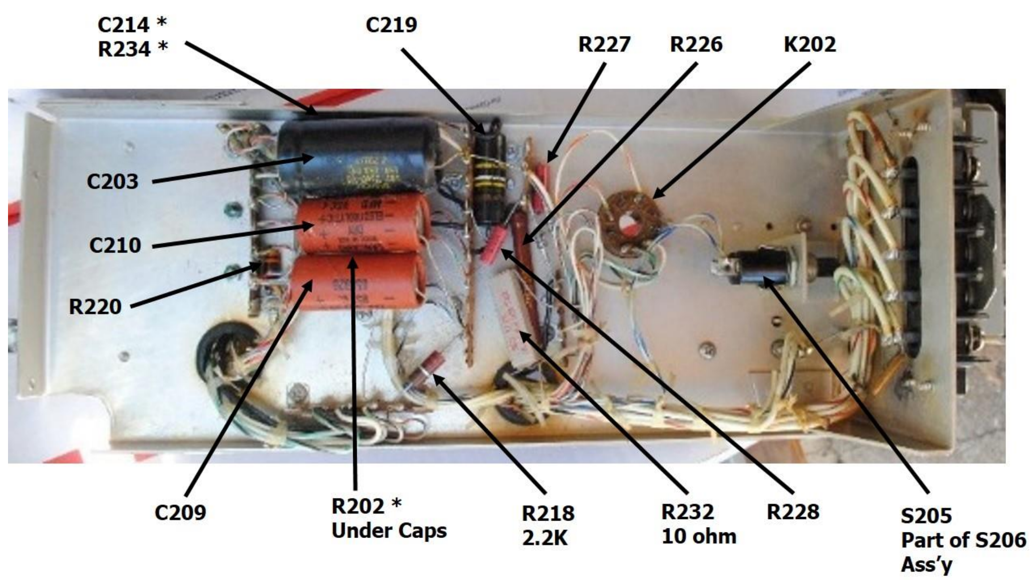


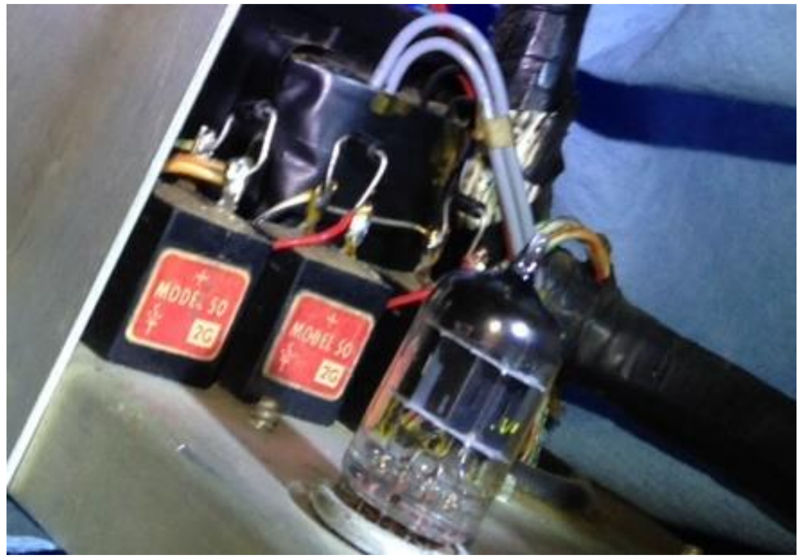
Figure 7.

30S-1 Relay Shelf & Bias Power Supply
Underneath View



* Indicates hidden below other components

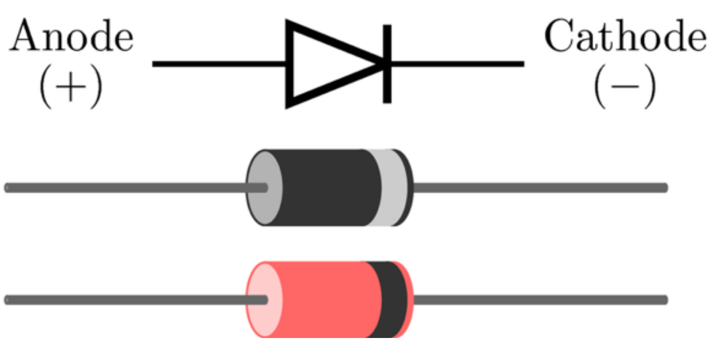
Figure 8. Annotated front view showing the shelf pulled as far out as it will go ~ Shown resting on a temporary rear wood shelf and front Styrofoam prop.



Back to the problem at hand. The amplifier is working well, but the bias control is at its maximum full CCW negative bias setting and the tube is just under control at an idle current of 150 mA. The area shows signs of previous work. Parallel 1N4007 diodes have been added right over the top of the selenium rectifiers CR207 & CR208. This is not a good practice as it leaves any leakage and compromised diode characteristics in place under the good characteristic of a new diode.

Important background: Don't fall into the "Polarity Traps" of an older selenium rectifier and/or a "Negative Bias" supply.

You should make note of a fossil marking tradition that dates back to the early days of electronics. If you look at any modern diode, there will be a band around the cathode end of the diode indicating that this terminal should be kept negative for forward conduction to occur.



Be aware that early selenium rectifiers were marked just the opposite. If you look at the red leads (secondary of the bias transformer T203), **on the schematic** for the 30S-1, they go to the cathodes of the two rectifier diodes, CR207 and 208. This is as it should be for a negative supply. BUT, if you look at the actual original selenium rectifiers in the amplifier, you will see that the red transformer secondary leads actually go to the terminal of the rectifiers that is marked with the + sign – indicating what would be – in modern convention – the anode. This is because the older diodes were marked opposite to how they are marked now – if a plus sign were to be added on a modern diode. This "polarity" marking anomaly carried on well into the 70s for the selenium rectifiers. Early semiconductor diodes from the very early 50s also carried this confusing marking. By the 60s, semiconductor diode marking had sorted itself out – thank goodness.

As a result, when working on any original selenium rectifier supply, be very careful how you install the selenium rectifier and also do not get caught in the "reversal trap" when replacing the selenium with a semiconductor diode.

Also note that, because this is a negative supply, the filter capacitors C209 & C210 have their positive leads in common at what would normally be ground on a normal negative bias supply, BUT – in the unique 30S-1 screen supply and control grid power supply relationship - the **screen** (+ end) is at ground and the 4CX1000 cathode is at minus screen supply. This means that the control grid bias (common filter capacitor point) must be returned to the Screen negative supply point. Note (as mentioned earlier) the fact that the red transformer secondary wiring goes to the close terminal on the + marked close side of the rectifiers. They are correctly installed – less the fact that someone overlaid new diodes on the old.

Look at the schematic and read the manual if you do not understand this supply relationship. It is almost impossible to troubleshoot a 30S-1 amplifier if you do not clearly understand what Warren Bruene did with those power supplies. It's beautiful.

Getting back to the supply repair – Unfortunately we are not going to know what is really (for sure) causing this reduced DC bias voltage until we repair the diodes and replace the filter caps. Only at that point will we know if there is some damage to the T203 transformer windings.

One other possibility is if the resistor ratio on R218, R219 & R220 has aged and changed – contributing to the reduction of available negative bias. That was very hard to check before, but now that the shelf is pretty much out in the open, let's take a look. . . . . . .

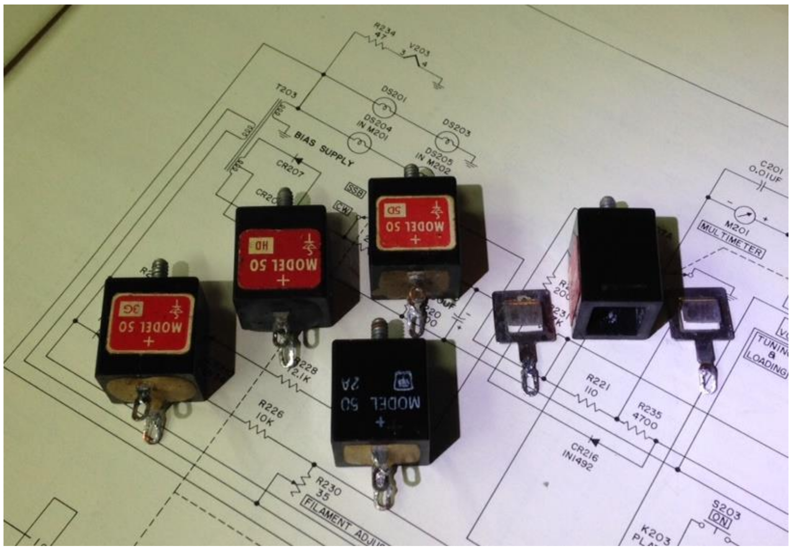
Well, unfortunately – it ain't gonna be that easy. R218 and R220 are within tolerance and both measure just about 8% high. Since both are high, this is not significantly contributing to the problem although it is making the available range a bit less and this does not help.

There are two paths to now go down here. The three selenium rectifiers can be removed entirely and the holes used to mount up a 6 insulated lug terminal strip. Then, the wiring can be put back on the terminal strip and the 1N4007 diodes correctly installed on the terminal strip. This "first path" leaves the amplifier looking very unoriginal in the bias supply top view. I do not like that – being the purist that I am.

So, regarding the repair, we are going to take the "road less traveled" – or the second path and rebuild the selenium rectifiers so that they look completely original. It is not all that hard to do.

As long as I am in here I am also going to take a hard look at the filter caps C209 and C210. Again – it's worth repeating, note polarity. As I said, since this is a negative supply, we will be returning the common plus end of the two electrolytics to the negative screen supply tie point.

About those selenium diodes: Referring to the photo below, you can see that the original selenium (CR207 & CR208) is contained and potted into a Bakelite black housing that has an embedded stud mount on the bottom and a cavity revealed on the top. The picture below shows several styles of the original Sarkes Tarzian Type 50 diodes as well as the same diode type after the innards have been removed. To the full right you can see the salvaged contacts that will be reused to solder in, and hide, the 1N4007 before we repot the cavity with a newer epoxy.

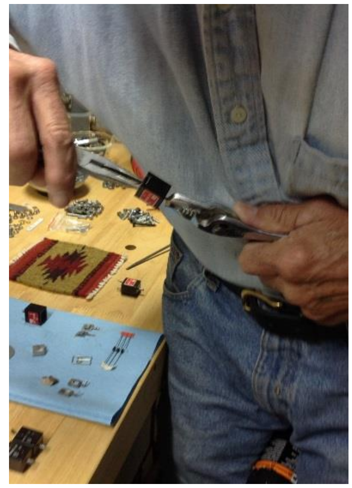


Note: if you try and test these selenium rectifiers with an ohm meter as you might a modern diode, be aware that the forward voltage of a typical single selenium layer is about 1 volt at room temperature and the reverse breakdown is about 25 volts. To get the required breakdown for this application the Model 50 uses 8 "diode plates" for a breakdown of about 200V and thus a forward somewhere around 8 volts. This forward knee is pretty soft, so if you make a test pass with a VOM that uses 2 cells for the OHMS scale, then you are going to get some meaningful data – sort of. If you use one of the cheaper VOMs, and it uses just one cell for the OHMS scales, then all you will see for the S.T. Model 50 we are talking about is what appears to be an open diode.

With all but a few of the very late Type 50 diodes that were potted with a more durable epoxy, the originals – and in all likelihood the ones you will be working with - will have the much softer original potting compound that is thermally unstable up over about 50 degrees C. My thanks to Scott Johnson, W7SVJ for this info.

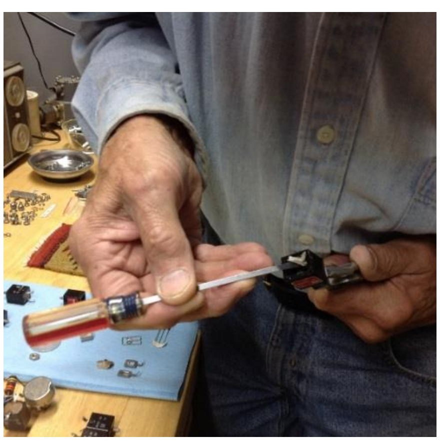
So, put a nut on that stud and use it to hold the diode with a pair of pliers. Then use your heat gun up close and personal (don't be afraid to toast the case) and heat the entire case up. Keep bringing up the temp and after a few minutes start tugging at one of the contacts with a pair of needle nose pliers. That potting compound will get powdery and lose its strength. It will not flow, but just give up the ghost. Pull out the contact straight up and the work on the second one while you keep applying the heat. In the process of pulling the contacts out to be saved for later, the entire potting compound "cap" will usually just pop off.





After you have both contacts out and the top compound popped off, you will be looking at the selenium laminated (or layered) structure. Take the needle nose pliers (use fine ones) and grip down on either side of the pile of laminates and pull the entire structure out while the case is still hot. At this point you will have an almost empty cavity. Stop heating and start cleaning the cavity out - first using a small screwdriver and then a small pen knife blade. The almost powdered compound will all come out. Now, it's time to put the new diode back together.

Here is a handy guide for keeping the temperature in the correct range. Bakelite blisters and starts to break down at 190° C. The potting compound used on almost all of the Sarkes Tarzian selenium rectifiers breaks down well at about 60° C. If you touch something that is 50° C, you can touch it, but not for long. If you touch something that approaches 100° C, you will not be able to stay there at all. As you start heating the case of the old rectifier, stay away from the label side and rotate the diode through three sides starting with the gun about 5 inches away. Heat for a couple of minutes trying for absorption and soak uniformity. You do not want to get just the outside case hot. Then after a couple of test feels that will tell you where you are, close the distance down to about 2 inches and rotate faster. When you know you are over 50° C, start pulling parts out.



Finish cleaning up the salvaged contacts by warping them enough carefully to pop out the locked in old compound and then carefully bend them back so that they are flat. Leave the little leaf sticking out and parallel to the entire contact blade. If you have not already done it, use solder wick and remove any excess solder or wire from the lugs.

We are going to solder in a 1N4007 in such a way that one lead goes around the little pop out locking blade close to the bottom of one blade and then the other goes around the other contact blade close to the top. All wires and the diode will be down in the cavity - soon to be buried in new epoxy. Form the leads so that the contact blades are exactly just a hair wider than the cavity short direction, and the diode is positioned from lower front to upper back diagonally across the cavity as shown in the next figure. Use smooth bends when forming the diode leads as this makes the assembly easier to adjust for width and parallel contact lugs. Solder it up and then test fit the new diode contact assembly in the cavity. Remove it and set it aside. Observe the photo of the diodes being soldered for approximate lead length. Too short is worse than a bit too long.

Now, make sure there is a little tension that will hold the diode where it belongs and lay it aside for insertion after you prepare the epoxy and pre-coat the front and back inner sides.

Note: To be consistent with the older appearance and case/marking convention, we will be installing the new silicon diode (1N4007) with the cathode marking band on the + marked side of the case (paper label side for those with labels). I am also putting a sticker on the inside lid of the 30S-1 where it will be seen to document what has been done.

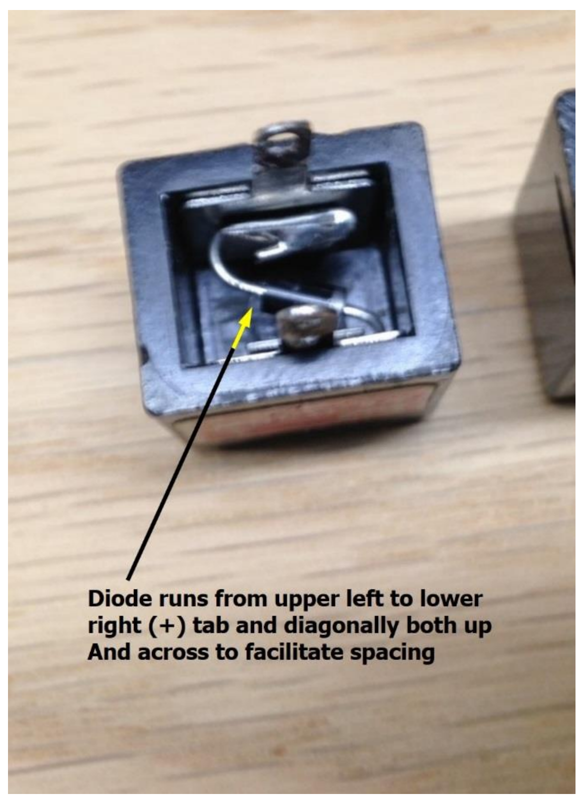
Maintenance Record:
Bias Supply restored March 2016 ~
Includes rebuild of S.T. Model 50 Selenium
Rectifiers. Original diode structure replaced
with 1N4007 Silicon Diode internally.
MARKINGS for polarity **& install polarity**
left original as per the selenium markings
~ Note: + is the Cathode ~ K0CXX

Assembling the new rebuilt "Faux Selenium" 1N4007 diodes

Take all of the empty cases and carefully rough up the inside wall being careful to not apply a lot of pressure to the sidewall. Set all of the "empties" aside. Find a slab of plywood or board that will be the setting up fixture and drill enough holes in the board so that you can line up the cases with the studs down in the holes so the epoxy can cure. Make the holes just slightly smaller than the outer thread diameter so that you can roughly screw the cases into the board. Also note that when soldered (and flat) the two contact lugs are not facing the same direction. They will be after being bent into position.

Now, finish soldering up as many sets of salvaged contacts and 1N4007s as you will need. Use the diagram and pictures as a guide and make the little "Z" diagonal structure shown that will then fit into the cavities. DO NOT FORGET TO HEAT SINK the little diodes for their protection while soldering.

Finished Diode structure and placement in the cavity for fit (Below)



If you are shaky and old like me, use a short piece of shrink tubing over each top of the solder lug to make sure you do not get epoxy on it. You can cut it off later when the epoxy is cured. Do NOT run the tubing all the way down. Leave room for the epoxy. The tubing should go down to just at the bottom of the solder lug proper. Shrink the tubing so you can push on it later without moving it down. I did not do that and I wish I had.

Testing: Using a good grade epoxy (not fast curing), mix a small test batch of epoxy and test fill one extra empty salvaged diode housing. I used Locktite Long Cure which sets in about 30 minutes and comes to holding strength in 3 hours and full cure in 24 hours. (It also has a yellowish cast to it which mixes well with a small amount of brown pigment for that tan color. See below.)

> *Note: Each cavity is almost exactly 2 mL in volume less the contact and diode assembly. I would mix up about 4 mL of epoxy for each unit you are doing so it is controllable. The Locktite dispenser holds 25 mL of product so about 1/8 of a stroke of the applicator will give you enough for one cavity taking into account the losses during mixing and loading.*

You do not need to bother with putting in the contacts on this test. You are just going to test for shrinkage during curing so you know how full to make the cavity when you fill the final product. Come back tomorrow and check the test cavity and decide how much you need to overfill for shrinkage. At the same time that you test for shrinkage, mix a small amount of brown pigment or oil based paint into the epoxy if you are anal about the color – like I am. A little goes a long way. If you use the Locktite Long Vure I recommend, there is now no need to test. The shrinkage is zero.

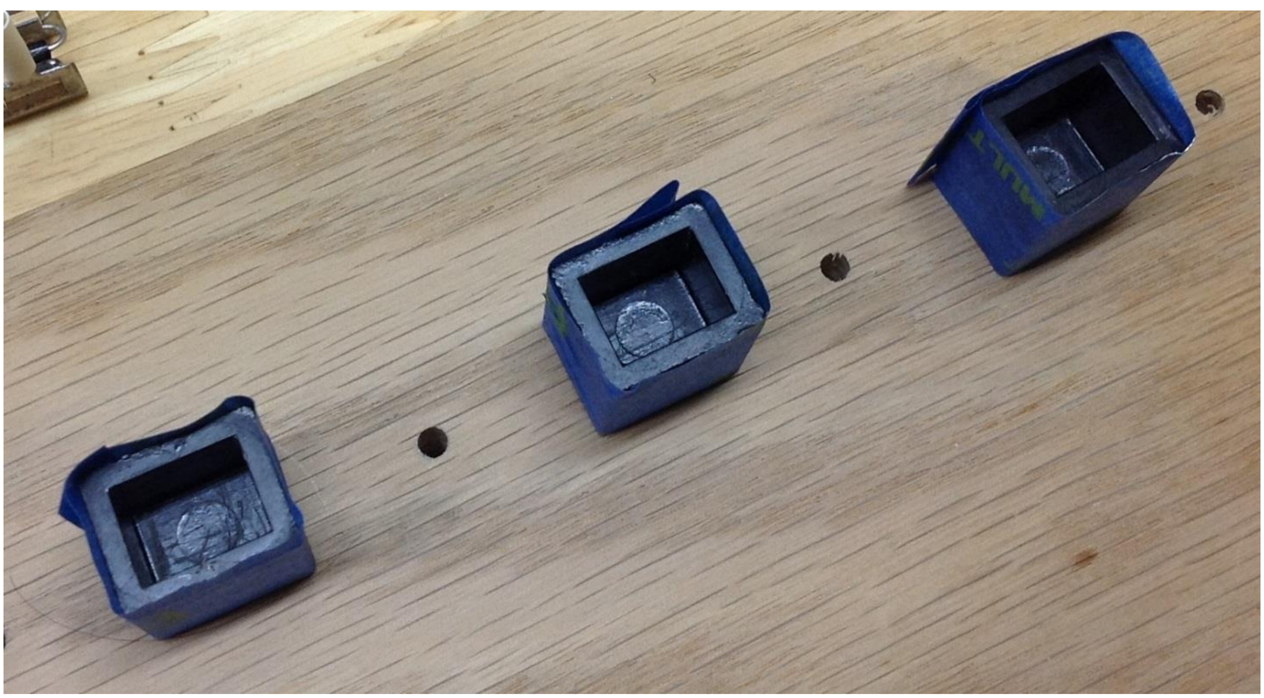
While the test is curing, talk with your local large animal vet and convince him you are not a druggie and get a few new large animal 60 mL syringes to use to place the final epoxy potting. You need the wider needle opening version. 60 mL syringes can be bought on the internet or eBay for about $2.50 each. They are real handy. My vet sold me some for the same price.

Time for the final assembly of the 1N4007 diode stuffed Model 50 product.

Now, cut a couple of strips of tinfoil that are just as wide as the long edge of the case. A width of ¾ inches works well. It gives you just a little overlap so that you do not have to be super careful about the alignment. Grab a roll of masking tape or painters tape and cut as many rectangles of foil as you have labels to cover. Make the rectangles just cover one side of the cover. Finally, cut as many strips of tape 4 inches long as you have cavities and put one of those pieces of foil on each piece of tape on the sticky side in about the middle of the tape (the long way). You are going to use that foil to protect that nice label you are trying to save from being destroyed when you pull off the tape after curing. See above picture.

> *Hint: Cut the tape 4 inches to start with and then tuck each end around and down so it will stick to the work surface sticky side up. Then place the foil about in the middle. Then, after the foil is in place, pick the tape up by the foil area where it will not stick to your fingers and trim the tape back to three inches long. This will save you a lot of grief trying to hold that sticky tape while you place the foil.*

Now, place each piece of tape against the housing making sure you align the foil with the label side - *But, make the top of the tape protrude about 1/8 inch above the cavity lip.* Finish wrapping the tape around all sides of the case keeping it all parallel and pulled tight to both sides of the label so you do not pull the alignment. Then make sure you wind up with a small protrusion all around the top. Now you have a little "dam" that will hold back the top fill of the epoxy after you determine how much extra to allow for shrinkage. If you apply the correct amount of epoxy you will not need much of that lip, but it is there for protection and to help you ID the label face of the package.



Plan on mixing up enough epoxy to fill the units you have prepared. Then 2X it for losses and loading of the syringe. More is better and you do not want to run out. Put just the smallest amount of pigment into the mix and get it thoroughly mixed and the light brown color you want. You can always add more. Do not overdo the pigment. It does not take much and you do not want to destroy the chemistry of the epoxy.

Have everything ready because once you mix that epoxy and get the color right, you will have to move right along so that the epoxy does not start to stiffen up in the syringe in-between the "Half Fill" load and the final top off.

When you load the syringe, make sure to tape the tip over temporarily before you load, or you will have epoxy running out of the tip before you are finished loading. When you are finished loading the syringe, hold the syringe laterally, and quickly take off the tape on the tip. JUST BARELY start the plunger (this will start to push out some epoxy so have a paper towel ready) and then – after wiping off the forced out amount, turn the syringe tip up and allow the air to come to the top. This will take a minute, but the tip will clear and the big bubble will go to the top and then you can push the plunger all the way in until epoxy starts to come out again. It is now ready to use. Stand it on its plunger handle if you need to "Park it" for a moment.

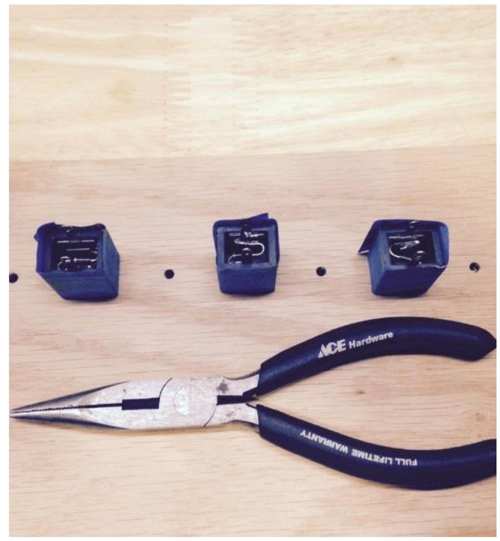
With all of the prepped cases screwed into the board, quickly take a Q-Tip shaft and some epoxy and wet the inside of the long faces where the contacts will fit. Do not get epoxy right up to the top. Stay down about 1/16 inch.

Now, using the syringe that you have loaded, fill each of the cavities just half way up. DO NOT OVERFILL AT THIS POINT – Just half will do. When you have enough in the "half full" step, you can "break the flow" by stopping pushing and then raising the syringe straight up until the epoxy beaks the little remaining thread and it fall straight back into the loaded cavity. Do not pull the syringe away until that thread breaks or you will drag a string of epoxy out of the cavity.

When the cavities are loaded half full, place one 1N4007 diode assembly into each cavity making sure that you center the contacts against each long face internally and that the tabs are parallel and vertical. **Check the polarity before you push the assembly down into the epoxy - MAKE SURE that you have the cathode band of the new 1N4007 placed towards the label (Red + side on most diodes) side of the case.** You can identify the label side by the small amount of foil sticking up above the inside of the tape on the case. Pre-stress the solder tabs by making the spacing just slightly bigger than the cavity (but parallel) prior to placement. Once you pour that final epoxy in there, you are not going to be able to move the solder lugs around too much without destroying the parallel geometry and/or getting epoxy up on the lugs – a soldering no-no! Get them the way you want them before the epoxy pour and then leave them alone except for the smallest of adjustments.

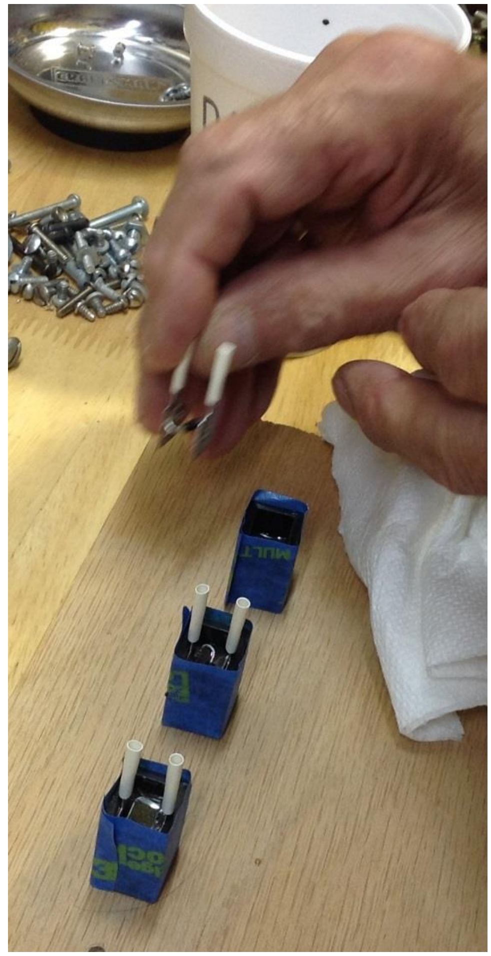
Fill the final amount carefully and slowly so it has time to settle, or you will wind up over-filling and using that tape dam.

Completing the Process



Above – Trial fit before and after taping

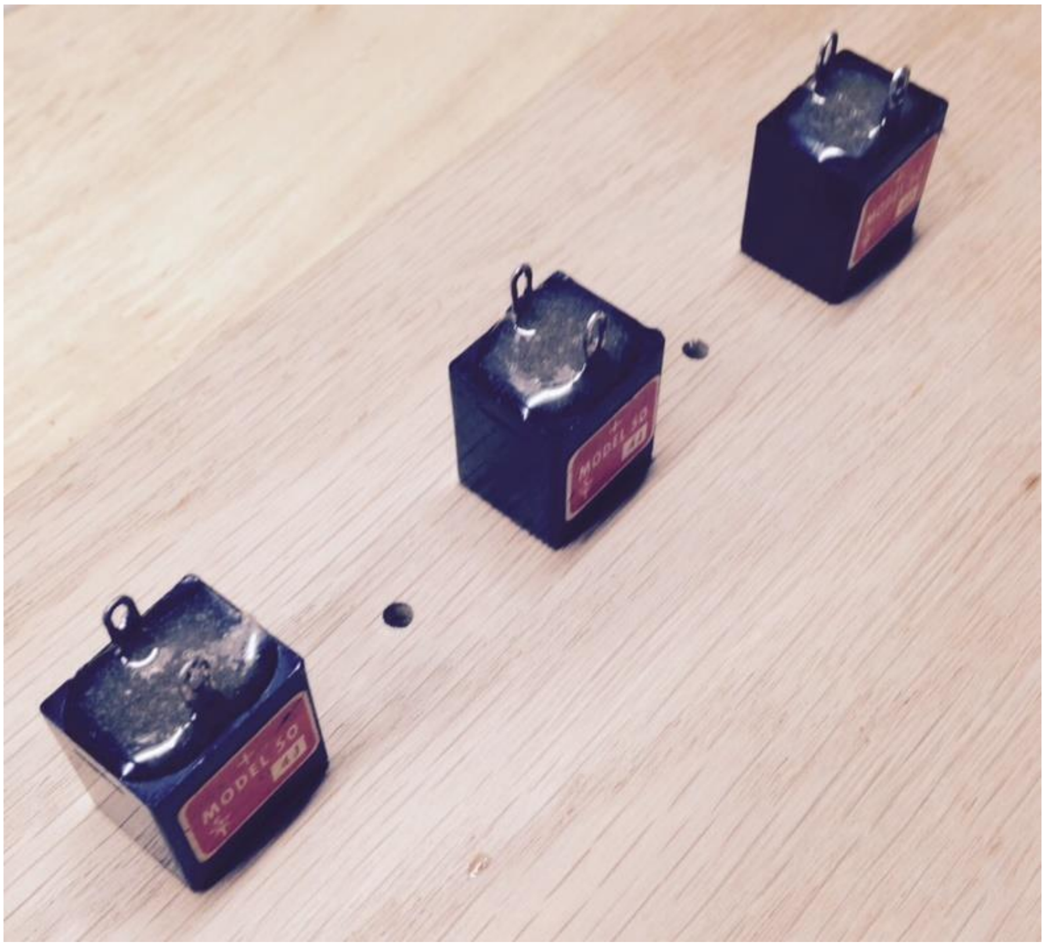
Ready for business – Left, the taped units waiting for pre-fill


MULT


BROWN
LOCTITE

Now, slowly inject the final needed amount of epoxy into the center from one side of each cavity. Apply it slowly so that the epoxy has time to flow into and under the diode connections and not make bubbles. Be careful not to bump the contacts or get epoxy on the contacts.

Now, be patient. Tomorrow is another day. While you watch "paint dry", you can start taking apart whatever it is that you are replacing those diodes in. For me it is that bias supply. Wait at least two days until you solder on the new diodes that you have made.



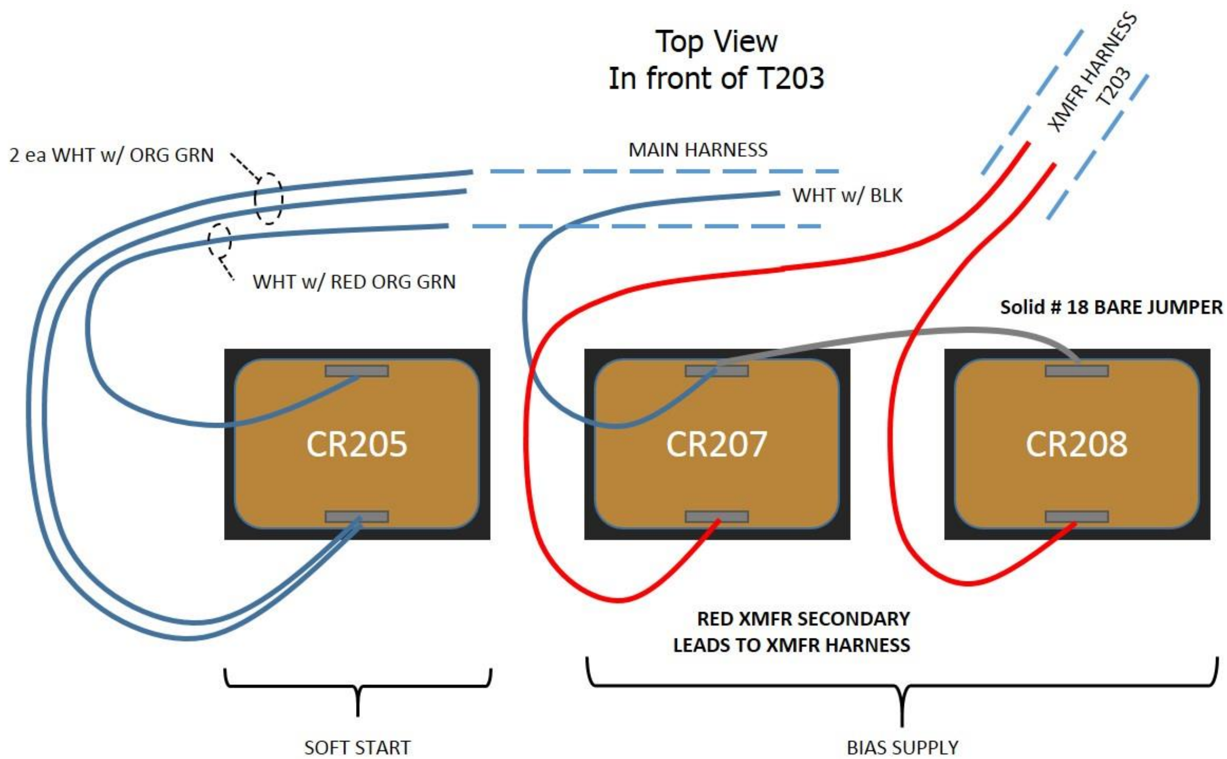
Ready for final component install and wiring of the bias supply

Using the replacement rebuilt faux Model 50s, the bias supply can now be reconstructed – returning it to its original look. Given that we started this journey low on negative bias, we get a bonus because, with the much lower forward voltage of the silicon 1N4007s, the resulting available negative bias will go up by about 7 volts just from that impact. What will happen due to the replacement of the diodes and the filter caps remains to be seen. I will say that the selenium Model 50s that I took out (paralleled with 1N4007s) were leaky, so this should also add up to a better bias pot range.

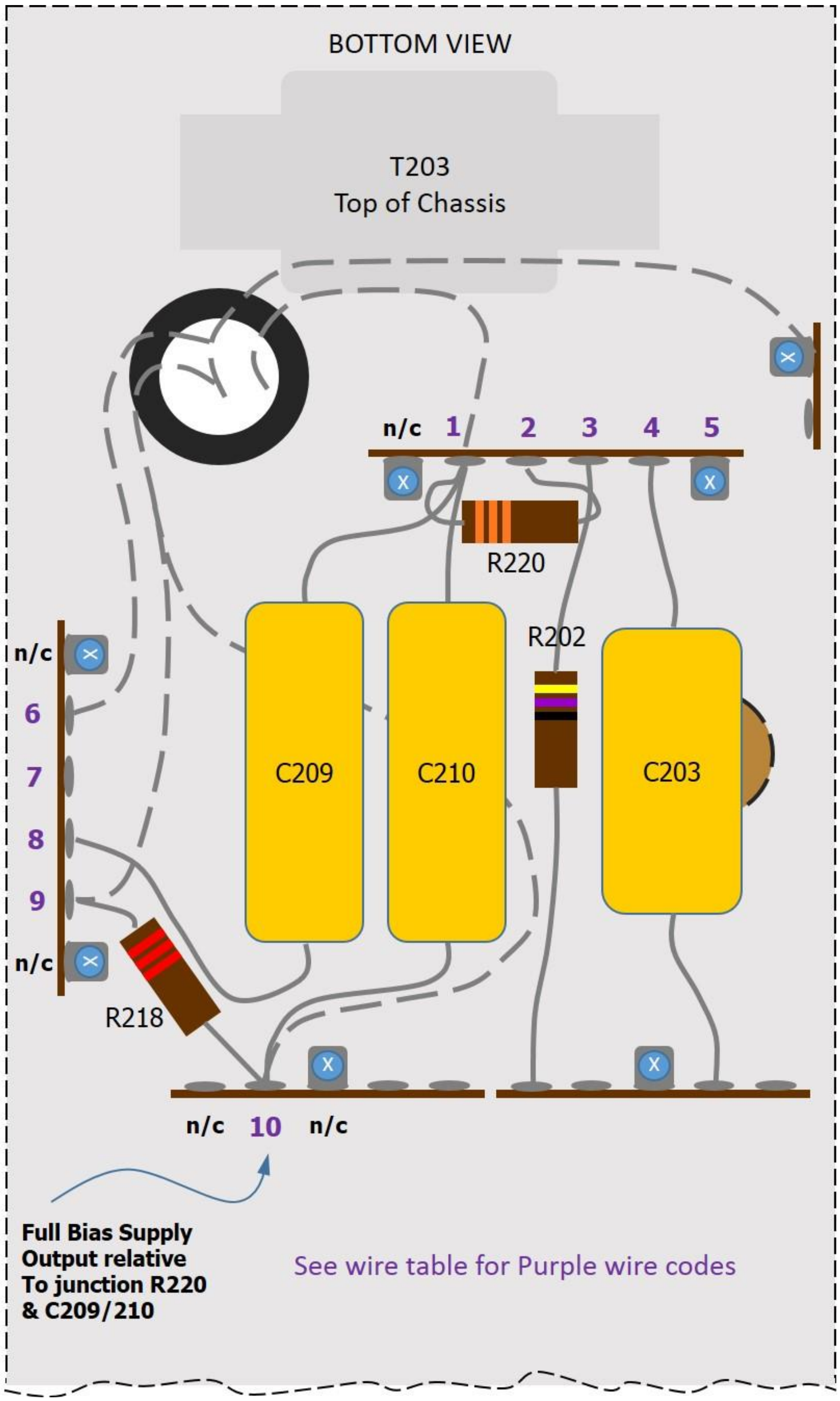
Those original filter caps were removed and carefully checked on a Sprague Tel-Ohmike TO-5 and they were in excellent condition - No discernable leakage on the 6 mA scale at 200 Vdc applied. The Power Factor was also measured and hovering around zero.. Not too bad for their age (1983 date code). I could just not bring myself to putting in a new Chinese mini-electrolytic from the 21st century.

Below I have documented both the topside diode wiring and also (and more importantly) the bottom view wiring so that a unit can be returned to stock condition if it has been molested. The Collins Radio Manuals for the 30S-1 are sadly lacking - particularly in details about the undershelf wiring and component placement.

Figure of Diode Wiring for Replacement Diodes (See Below)



Capacitor wiring aid diagram w/ color codes (See below table)



Wiring Code Table showing Terminal Lug Number (Purple)						
Lug No.				Color		
	Quan. Of Wires		Wire	1st Code	2nd Code	3rd Code
1	3+ below	Bias Return	RED	YEL		
	+2 Caps +R		WHT	RED	BLU	
			WHT	RED	BLU	
2	1 + R		Wht	RED	GRN	
3	1 + R		WHT	RED	ORG	GRN
4	1 + Cap		WHT	ORG	GRN	
5	3	GND	SH'LD Gnd			
			WHT	ORG		
			WHT	ORG	BRN	
6	3		BLK (Small)			
			WHT	BLK		
			WHT	BLK	GRN	
7	3		BLK (Small)			
			WHT			
			WHT			
8	2 + Cap		WHT	BLK	GRN	
			WHT	BLK	GRN	
9	1+R		WHT	ORG		
10	2+R+Cap	Bias Negative	WHT	BLK		
			WHT	BLK	BLU	

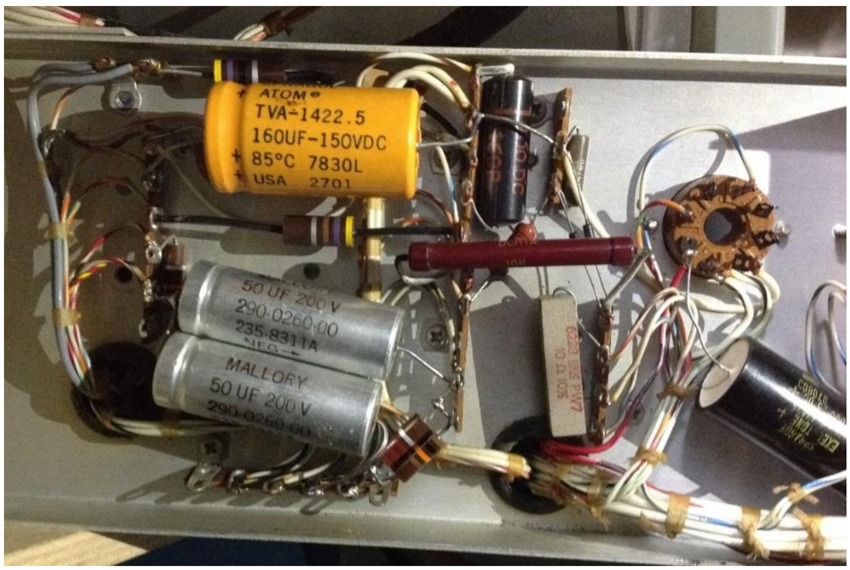
After the rewiring and replacement of the diodes and the capacitors, it is now it is time to reverse all those instructions and put the harness back where it belongs, **then replace the HV lead (You do not want to forget that!)** and then the shelf.

Use an old aircraft install trick and get yourself two nice awls. When you are aligning (and holding) the self in there and starting screws, use the owls to find and hold the back holes in alignment.

Do not start those sheet metal self-tapping screws with a screwdriver. Get the holes aligned and start the screws by hand or you will wind up "re-tapping" new threads and after a couple of times having that done, those holes will strip out. When it comes time to put that cable clamp screw back in there, have your partner push a number 6 screw about 1 inch long through the hole and, from the inside, you put the clamp (in the correct position on the cable) and then the washer and then the nut down over the longer small screw.

That makes it really easier to find and get all the hardware where it belongs. Then, while you hold your finger around the clamp, washer, and nut, have them carefully pull the longer small screw out and slowly push the Pan Head Phillips #8 screw that belongs there back in the hole while you feel "center" and start to thread on the nut. Have them push the screw in with a screwdriver seated so it will not turn. Once started, then have them start to turn the driver in and tighten the screw. Leave that taped in "Catch Rag" in there just in case. It may take a couple of shots of trying to get that nut back on and you don't want to be chasing hardware around back in that blind area.

Be careful about getting the harness in the rear through cutout and make sure you so not pinch any wires between the wall and the shelf. Here is what it looks like all put back together and reinstalled in the cabinet.



30S-1 Shelf Top & Bottom view as repaired

Below Shelf back in place (with that “original” look)

__Time for a test run.__

For the purpose of checking out the supplies, just terminate the input RF port with a 50 ohm small dummy load to make sure no instability occurs, and then terminate the output in the normal 1 - 3 KW 50 ohm load.

This will allow powering up the amp and checking all of the supplies and the amp keying. Then, set up the idle current and make the bias voltage measurements to make sure the supply is back to normal operation. No RF will applied for now. Test leads can conveniently be run out the back through the 516F-2 shelf cable access hole and a VOM set on top of the amp while measurements are made.

Test Results

V_{C209} (Total Negative Voltage Available)	- 91.0 Vdc
V_{C208} (Bias Applied to Tube)	- 47.5 Vdc @ 150 mA idle(Tube 1)
V_{R219} (Bias Range R219 CCW to CW)	- 78V to - 33.0 Vdc
Bias Supply Ripple*	

* Measured from C209 referred to GND

<u>Commentary – or Shame on Me</u>

These results were as expected and I went ahead and set the idle current up at 150 mA. Thus encouraged, I left the amplifier keyed for a while and monitored the idle current. It was drifting up with time and that is not as it should be. Inspection of the applied bias indicated that the bias itself was stable.

I suspected immediately that this tube – unknown to the owner and unknown to me – was a bit gassy. Time to do a little heat soaking with just the filament on and see if that helped.

I ran the amp – just the filaments for about 8 hours - and this morning I decided to apply the HV again and key it up and see if the idle current had stabilized.

This is where the shame on me comes in.

This was after all a completely unknown tube to both of us. We also knew that the previous owner had had difficulty with the amp and had tried to fix it himself. That having failed, the 30S-1 (and that tube) sat for 15 years before he finally sold the amp to Dwayne.

When I got involved, among other issues – now resolved – I knew that the bias supply was dinged. Shame on me.

Fortunately, my external biasing test harness was still in place and I also had the multimeter set on Grid Bias.

I lit off the HV and, before I could even key the amp, the plate flashed over to the grid and the grid meter and my test meter went sideways in a hurry. BAD! I hit the big off switch and pulled that tube….all the time fearing that I had just blown up that newly rebuilt bias supply. Good luck prevailed and all is well in that department.

But, there was collateral damage and it was aggravated by the fact that three fuses had been increased in order to capitalize on the installed 4CX1500B – Another bad plan.

So, as I said – shame on me. The first thing you do with a NOS long in storage – or unknown high power HV tube is Hi Pot test the darn thing plate to grid. If it is gassy, leaky, or has elements sagged from lateral long term storage, the Hi Pot tester will tell you right now. I got careless because it had run for a brief period a few months ago in my presence and I skipped that important step.

Now I am waiting for another NOS tube and doing diagnostics on the supplies. Tomorrow we will start the testing process for the amp itself all over again. This time I will not be skipping the Hi Pot testing. Stand By.

Supplementary Information

Model 50 notes:

> Any Selenium rectifier current density is usually about 50 mA/cm^2 of active area **1)**
> The Model 50 plates are almost exactly 1 cm^2
> Breakdown Voltage of a typical Selenium plate structure is 25 Volts per plate
> The Model 50 has 8 plates and is rated at 200 Volts reverse breakdown

Note 1) - Many of the Selenium rectifiers that have the blue plates typically have extended plate area for heat dissipation and this area should not be counted in the active area. Only plate, or layer, contact area counts when estimating the current density of a Selenium.

Good luck Mike