The Service Line

Rebuilding that Expensive HVB-1

by Scott Kerr, KE1RR AC10-12478

I have to say that, of all my Collins gear, my KWS-1 and 30K-5 are two of my favorite pieces. When I first started collecting Collins gear, a fully functional set of Gold Dust Twins was high on my list. I don't know if that is due to the era that I grew up in, my love for black boxes full of tubes, or the art deco design. It is probably a combination of all three. But you soon learn that the KWS-1 is much like owning a boat. It is a joy when working, but it is going to need some tender care to keep it that way. It also has a tendency to develop a bad habit of smoking, and not the cheap run of the mill cigarette, but more like a very expensive cigar – the HVB-1 variety.

The HVB-1's very existence is really a conundrum. In talking with all of the Collins gurus, it is the only fuse in a high voltage line that we can think of. The primary of both the plate transformer, T503 and the Plate Filament Transformer (that feeds the filaments of the two 866-A rectifiers), are fused on the primary side with F501 and F502 respectively. Why then did the Collins engineers decide to put an expensive fuse on the 2,000 volt line in between the center tap of the filament transformer and the plate choke? This is not done on broadcast transmitters or the big linear amplifiers like the 204F-1. The only reason that I can think of is that the power supply is housed in a separate cabinet from the transmitter itself and the 2,000 plus volts run through a RG-58 cable up to the RF Deck. It may be that the possibility of a cable not hooked up correctly or knocked off the back of the KWS-1 carrying that much voltage produced an extra amount of caution in the design team. If anyone has first-hand knowledge of the reasoning behind this design, the author and staff of the *Signal* would love some feedback.

The Bussmann HVB-1 is rated at 2500 volts and 1 amp. The data sheet for the fuse states that it is a non-time delay fuse and will run at 110 percent of rated capacity for 4 hours and 135 percent for one hour. At 0.41 inches in diameter and 4.5 inches long, it is physically large for a fuse. The reason for the length is important to know. Voltages this high can, and will, arc over – or even form a sustained plasma current path - over the length of a standard fuse. The internal design of the HVB-1 fuse discourages this – more on this later.

Figure 1 - HVB-1

Anyone that has experience with the KWS-1 knows that anything wrong in the RF final amplifier stage will smoke the HVB-1 in a heartbeat. The price at www.Mouser.com is currently $22.74 each (Mouser part number 504-HVB-1). When troubleshooting the problem you could easily go through 4 or five of these things – and that is an expensive habit!! It might be tempting to just insert a standard fuse between the supporting connections with wires soldered to each end. After all the troubleshooting then put in a real HVB-1. Don't do it! The 2,000 plus volts will have no problem skipping right through the blown smaller glass fuse and causing all sorts of grief and damage! A look at the internal design of the larger HVB-1 use shows how that is discouraged - both by the length and the construction.

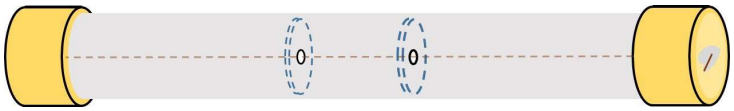

Figure 2 - HVB-1 Cross-section showing the wire baffles

A look at Figure 2 (left) will show that what appears to be a hollow tube with a fuse wire down the middle. The tube actually has two baffles in the center of the tube with small holes that discourage the plasma arcing across the space between the two end caps. It is these baffles plus the length between the caps that gives the fuse its HV properties.

So what can we do - other than spending $40-$100 dollars on fuses - while diagnosing a problem with the high voltage in our KWS-1? The answer is easy. Just rebuild the fuse. First you will need the correct fuse wire. Bussmann sells 1 amp fuse wire in ½ pound rolls for about $115 (www.mouser.com part number 504-BFW-1). This is enough wire to meet all of our members needs for a couple of years! We are working with Mark Olsen, KE9PQ, and wire will soon be available from him for $15.00 / 5 feet of wire. This should be enough to rebuild at least 10 fuses and the process is simple.

Bussmann MFW-1 Fuse Wire

First, before we start, I suggest that you consider making a little inexpensive temperature control for your soldering iron if you do not have a soldering station that controls tip temperature. This is easily done by buying a standard incandescent lamp dimmer at the local big-box store and mounting it in a metal double gang switch box with a cover plate. Mount an outlet for the iron on one side of the box and the dimmer on the other and cover it all with the appropriate plate.

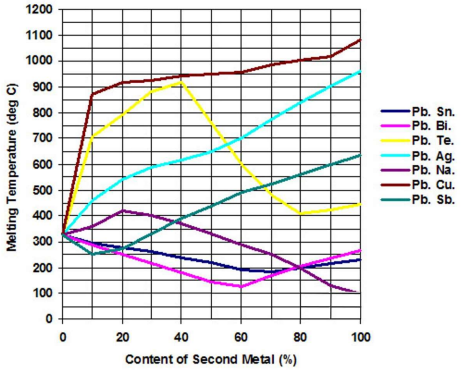

Figure 3 - Lead Alloy Melting Point

Temperature control during the re-soldering operation is going to be very crucial. We need to take a quick lesson in alloy metallurgy. The Bussmann fuse wire is made out of almost pure lead doped with about 1% antimony. As you can see from Fig. 3 (dark green) line for Pb-Sb, the melting point of the fuse wire is just slightly lower than the melting point of pure lead which is 327 degrees C. The antimony doping reduces the melting temperature until the doping reaches 10% and then it starts to increase again. The meting temperature of the typical 50/50 lead-tin solder can be seen to be about 220 degrees C. Therefore you need to keep your iron above 220 and below 300 deg. C. to be on the safe side as you work on repairing these fuses.

The next step in the preparation is to make a quick and dirty fixture to hold a few fuses as you work on them. I did this by taking a piece of 1 x 2 about 12 inches long and drilling two 3/8 inch holes spaced out about 1 1/2 inches for working room. Ream them out carefully until they fit the fuse body (about 0.380). Drill the holes down the exact center of the 1 1/2 inch wide side. The fuse body will then fit the radius of the fixture. Then I ripped the piece exactly in half. You can use a table saw, band saw or even a skill or jig saw to do the job. You wind up with two pieces that are then screwed back together at just one end. Or, you can stop the rip just short of the end. Prying open the unfastened end allows you to slip two fuses in and then clamp the entire piece in your vice with the fuses vertical. I would not try for three fuses in your fixture because this will make the fit very critical and the middle one will probably wind up loose. If you use a 1/8 inch blade to rip the piece, you may have to put a washer in between the two halves to keep the fixture halves parallel. Now you are ready to start. Of course you can do the following operations by hand holding the fuse in one hand and juggling the cap and the wire, but the fixture is a lot easier.

Step 1 – Heat up a medium tipped soldering iron to about 280 deg. C. and carefully remove the solder on each end cap using solder wick and the temperature controlled iron. If you are using the el cheapo controller from the hardware department, you will have to sneak up on the solder melt point and then make sure it will not melt the fuse wire. Alternatively use a de-soldering gun that has good temperature control (my favorite). Carefully lift up the wire end and remove the remnant fuse wire from the blown element. This, and the next, operation are best done before mounting in the fixture.

Step 2 – Try holding the fuse firmly in one hand and use a fingernail on the other hand to pry off one of the caps. It is likely that you will have to resort to using the vise and making a gap that will pass the fuse body and not the cap and use more force to get the cap off. Using a good quality knife blade to relieve the crimp on the cap first will help this process. Turn the fuse around and repeat on the other side. At this time I take a Sharpie and put a ring around the fuse to signify that this is a rebuilt fuse. I use these fuses for troubleshooting and then put in a 'real' one for normal operation. Each time you rebuild, you add another ring thus keeping track of the number of rebuilds. There is some residual contamination left in the fuse body in between the two baffles and this could eventually effect the performance of the fuse.

Using a just slightly damp Q-tip (DI Water from that good distilled drinking water you buy), clean the side walls of both ends of the tube to remove contamination from the previous blown element. DO NOT USE any alcohol or cleaner as this will leave a hydrocarbon behind that will lead to internal arcing and an eventual carbon track after the fuse blows. When you are finished cleaning the inner fuse bodies, mount the fuses in the fixture with the end clamped in the vise and the fuses out where you can work on them.

In the fixture - See Figure 4 (Lower right):

Step 3 – Using vinyl or Nitrile gloves so you do not contaminate the fuse wire with oils from the hand, cut off about 6 inches of fuse wire. Gently straighten (Do not pull hard enough to risk stretching) the fuse wire and place the new fuse wire stock on a clean paper towel. Be careful not to set it next to solder on your bench as the two look the same. Do not nick the wire!

Now, with the fuse held vertically with the fixture, carefully feed the fuse wire down through the tube threading it through the holes in the baffles in the center of the tube. This is not as hard as it first sounds. Make sure the fuse tube is exactly vertical and the fuse wire is VERY straight and it will slide right through.

Step 4 – Hold the newly inserted wire with your left hand with enough wire protruding up to work with and make sure the wire does not drop though the tube. Feed one cap onto the fuse wire from the top and - holding the wire from the top - press the cap back into place on the fuse body. Bend the fuse wire over at 90 degrees to keep it from falling back into the tube end. Be sure and leave enough wire sticking out the bottom that you can hold it easily while you are recapping that end. After soldering you will repeat this top operation on the bottom for as many fuses as you have in your fixture.

Step 5 – Here is the reason you have heated your iron to 280 degrees C. - or just hot enough to melt solder and not the wire. Since the end cap already has been soldered during its original assembly, the end cap is tinned. Just get some solder melted on your iron and then roll the tip of the iron into the solder well on the end cap (rolling from cap to just touching the fuse wire) and for a fraction of a second let your iron touch the wire until it wets - and you are done. It is important to get the cap up to melting temp first before touching the wire. You DO NOT WANT a cold solder joint. Trim off any of the excess fuse wire.

Now flip the fixture over in your vice and repeat the same operations on the lower wire and cap assembly. There - you have just saved yourself about 20 bucks per fuse.

In conclusion, always be safe. Never use a glass fuse to shunt a high voltage fuse. You are asking for disaster to happen.

The CCA has worked with Mark Olsen, KE9PQ, and he will be selling small quantities of the wire in an affordable 5 foot roll for about $15.00 shipped. That will make a lot of HVB-1 repairs and you will be money ahead.

Contact Mark at email: Mark (ke9pq@new.rr.com) or by phone at (920) 434-8097.

Figure 4. In the test fixture & feeding fuse wire in