It's Broke Jeb - What Now?

First, with a small friendly grin and all due respect, if you are asking that question – and we do hear it asked – you probably as a first course of action should enlist help from someone with more experience.

Where to start when you have an apparently dead unit depends on what it is but there are some common denominators. Let's start with those.

If it's dark and just plain won't turn on:

It may sound silly, but plug something else into the plug where you had the radio plugged in and make sure you have power.

Give the unit a good inspection to make sure that everything is there and that your 5 year old grandson has not pulled the fuse holder out to play with it. Seriously, make sure the fuse is there, it is the correct size and ohm it out with a good continuity checker. I have seen fuses that looked perfect and were open.

Next: With the power supply attached if it is separate, and with everything unplugged, turn on the power switch and check the resistance between the hot and the neutral power plug blades. While you are at it, check to make sure the ground stud – if there is one - is actually connected to chassis ground. If the resistance between the hot and neutral blades is somewhere in the 10s to 100rds of ohms range, then you probably have a good primary circuit on the power supply. If that reading is open, you have a bad plug, AC cord, or power switch – or even worse a blown or open primary on the power transformer. There could also be strapping issues on equipment with remote or voltage options. Regardless, you now know where to start looking. Manual time.

If you got a normal resistance reading consistent with the DC resistance of a power transformer primary, then all is good up to the transformer.

Let's assume the primary circuit checked out and the unit was still dark. The power transformer is now highly suspect. By dark, we mean no noise and no panel lamps showing – no activity at all. Confirm this by checking the lamps and also using a good AC voltmeter to look at the LV secondary and the filament (and lamp) winding AC voltages with the unit turned on.

With a completely dark and quiet rig, it is highly likely that you have now found the problem.

It is a receiver and lights up but will not play:

First, (and you have read the manual – right?), make sure the unit is connected correctly, the speaker or headphones connected, the mute function is in operate mode and that the antenna is connected. Some receivers have rear mounted chassis connections for external muting or other control functions and these can be tricky to deal with.

Let's assume you have the rig connected correctly now and that it lights (Lamps and filaments lit) and that the receiver does not work. Here is where having read the manual and understanding the architecture of the receiver and the conversion scheme is going to help you. It is not test bench time yet.

Make sure the receiver is turned on, it is in operate, and not standby, mode and set it to AM mode for now. Band Switch to a lower band like 75 meters, Calibrator on, frequency to the middle of the band and set on an even exact 100 kHz dial setting. Now we are going to use your dead receiver as a test set.

Turn the RF gain up all the way. BFO "Don't Care". Rotate the AF Gain all the way up to the max. You should hear a small amount of hum. No receiver has a perfect 100 db down hum spec. If you hear hum and you can change the level with the AF gain control, the B+ is working at least some, the final AF Audio Amp is working and the audio stages before the final audio amp and after the volume control are probably OK. If you hear hum in the speaker, but no signals and you cannot make the audio hum bigger with the volume control, the problem – at least one of them – is located in between the gain control and the audio output amplifier.

Now, with the audio AF gain all the way up, (some hum apparent in the speaker) turn on the BFO or the Product detector and you should hear an increase in broadband or white noise, indicating the oscillator is running. This is just a basic check and just note the result. This noise is generated by the oscillator and is a product of the IF broadband noise and the oscillator noise. If you hear it, it is a good indicator that, not only is the oscillator running but that the product detector is passing signals.

Now, let's go to the front end of the receiver. The calibrator is on. Tune across the calibrator and see if the S-Meter reacts and you can peak the S-Meter on the nose of the calibrator signal. If there is no reaction on the S-Meter, then the calibrator signal is not making it through the RF amp front end stage or the calibrator is not working. If you have hum in the audio, you have B+. If you have B+, you should have a calibrator. If the receiver is totally deaf, then it is unlikely that there is a simultaneous failure of the receiver and the calibrator. Let's assume the calibrator is working. Now you know that the failure is somewhere between the RF stage and the IF stage just prior to the product detector. That leaves a lot of territory.

While tuning for the calibrator, turn the RF gain all the way down. The indicated S-Meter reading should rise to almost full scale. This S-Meter reading is actually just an indication of the DC level of the AGC line. In some equipment it is a little more indirect – like the bridge circuits in the S-Line series, but the theory still applies. If you turn the RF gain all the way down (CCW) and the S-Meter does not rise to almost full scale, you have an AGC problem and this indicates the main issue may be in that area of the receiver. Remember that the applied AGC (usually to the RF stage(s) and the first couple of IF stages) is a combination of fixed internally generated AGC bias and then the derived variable signal strength related AGC signal.

Now, we have snooped on the audio, the BFO/Product Detector, the Calibrator, the RF gain stage and the AGC line. Let's bring in some reinforcements. Turn on another receiver that is physically close to the one that is in trouble. Using your manual, find the frequency of the HF injection oscillator and find the injection frequency for the band that you have selected. Tune the good receiver to that frequency and use a gimmick to wrap a wire around the injection oscillator tube and clip it to the antenna jack of the good receiver. Make sure you can hear that injection oscillator running. Mute the bad receiver or turn it off temporarily to make sure you know what you are listening to. Now you know the HF fixed first conversion (we are assuming dual conversion) oscillator is running. Now, tune the good receiver to the PTO frequency range, connect the same kind of gimmick and run the PTO through its range and you should get a birdie blip as the PTO crosses the frequency of the good receiver. You now know you have, or do not have a good PTO. While you are doing this you can also listen to a harmonic of the xtal calibrator and you know for sure it is running.

Things are starting to fall in place now. If you have two good oscillators running and you have AGC action and noise from the BFO and Audio controllable hum, you now know that the problem lies in one of the mixers or the early IF stages.

Now that you know where to look, open the lid and just for taking the simple route, make sure that the tubes are lit in the suspect area (explore the temperature carefully if in doubt – some run very dark). If they are all running in the now identified suspect area(s), try a quick tube sub for the stages in doubt. There should be no more than three or four.

If this fails, you still have it narrowed down. Get your tube extenders out and pull the tubes in the suspect areas one at a time and go through the tube voltage and resistance measurements from the manual table of Rs and Vs for each tube pin. Pay particular attention to the supply voltages during these checks and that will sort out whether you may have a general power supply issue. Most Collins manuals have this tube pin resistance and voltage chart.

If you have a scope or an RF millivolt meter, and you have not identified the problem by now, while you have the tube extender in the socket(s), explore the RF signals on the grids and plates starting from RF to IF and make sure you see the appropriate signal that you can turn on and off with the calibrator.

And that is the way you use a dead receiver to diagnose itself. After you are finished, and if it is not a tube, you will need to go to the next level that assumes you have some repair experience and a modicum of test gear. It is now time to open the receiver up and get down to business.

Now, let's take a look at what happens when you have a dead transmitter.

If it is completely dark, see the comments above regarding a completely dark receiver. They all apply. Then, it is bench time. Isolate the power supply. With an S-Line, unplug the power supply and carefully and double checking, identify the AC switch lines in the power supply connector and make a jumper for those female pin holes. First, with the PS not plugged in, go through the primary checking steps mentioned above. You have checked the fuse and now the primary, so it is time to plug the supply in and with the AC switch lines jumped, use a VARIC or a Surge Suppressor with a switch to control the AC power.

Turn the supply on and carefully explore the DC outputs (HV, LV, Bias and Filament) to see if the supplies are all there and working correctly. Having explored the supply, and knowing its condition, you can turn your attention to the transmitter itself. If you are working on a combined PS Transmitter like the 32V series, then your supply checking job is the same, just start by isolating the supplies and pulling the rectifiers and thoroughly checking the supplies before going on to the transmitter.

Now, we take a bit of a different approach. After making sure that the supplies are good, and doing a very thorough visual inspection, other than the most high level tube checking and substitution we are going to stop here. Transmitters should be worked on only by folks that are more advanced than those that need this article. There are safety issues, technical test equipment issues and just plain training to do the job properly.

If you do not know how to proceed from here, please get help from someone that does. You are going to need good test equipment, a troubleshooting background and the technical knowhow to use them.

For other than the most cursory of repairs, and particularly if you have been significantly working on RF stages, I suggest that transmitters should always be checked on a spectrum analyzer before putting them back in operation.

If you have found this article enlightening and want to go further with transmitter restoration and repair, I encourage that, but encourage you to get a mentor and get the training to do it right.

Graphic Credit - WB4HFN Website—Collins Repair

New to Me - Where to Start ?

The answer to that question is, of course, "At the beginning".

Before you ever consider running a piece of equipment that is new to you (and this includes one that has been on your shelf for 15 years), you should do some very basic things.

Then, before you even touch the radio, take a moment and sit down and read the operator's manual. Particularly review the sections on installation, Operation and Theory of Operation and Maintenance. I can't tell you how many people have come to me asking what is wrong with a perfectly good radio because they did not know how it worked, had not read the manual, and had not installed or operated the equipment correctly.

If you are not familiar with the fundamental operation of the equipment – keep going until you are. If need be, get a mentor, or step back and do a little basic radio theory studying. This entire effort will reward you in spades even if everything works and you are just going to go ahead to install and operate a working radio.

Good – That being done, you are ready to take a look at your "new" challenge. The operative word here is "look"!

So, how to do that? First, clean it. Unless you are just trying to find out if a less than pristine piece is even worth putting any effort into, stop right here and clean it. You are going to do that anyway, so do it now. It will reveal many secrets as you go and it will make the inspection and maintenance job easier - and besides, it is motivating for me to see the result. I am not talking major restoration – if that is needed, just get it clean. More on cleaning in a different writing.

Now, it's clean. Time to start the inspection. Take the cabinet off and get ready for some serious observations. As you remove the cabinet components, make a To Do list of things to be replaced or polished up or fixed as needed.

First, pull and carefully inspect and compare the actual installed fuse values for all fuses to the required values in the manuals and subsequent service bulletins. Make sure you understand the history of the fusing. Install the correct fuses. It is very common to find the incorrect value installed. Sometimes it is out of a previous "necessity" due to lack of availability, and sometime – worse yet – it is due to some idiot installing a 20 amp fuse in a 5 amp application because it was blowing and they wanted to do a little power-on trouble shooting. VERY BAD idea.

I once bought a cheap KWM-1 that was a cosmetic doll, but supposedly had let the smoke out of its power supply transformer. I was told the unit did not work and that the power transformer had "burned up". The price was right. Long story short, the owner had given the transmitter to a ham friend that "had more skill than the owner did at repair" and this worthy had put a 20 amp fuse in the power supply main fuse port to run it long enough to do some measurements. BAD IDEA. The transformer had let out its smoke pretty badly. The guy then had quit there telling the owner he had a bad transformer and returning the equipment - which I then bought.

My inspection found the 20A fuse which promptly got replaced with the correct value. Careful winding inspection and measurements looked pretty normal. Measurement of the caps looked normal. The power supply – completely separated from the KWM-1 - was then AC switch jumped and brought up on a Variac. Guess what? It played like a champ and still does to this day. Collins uses high quality transformers – Thank goodness.

Now, obviously the transceiver itself was highly suspect. The unit was opened and visually inspected. Looked perfect - and like new in there. Hmmmmmmm. Then, the schematic was refreshed in my head, and a few critical measurements were made at the power connector. B+ to ground. Filament string. . . etc. Wow… ZERO ohms to ground.. More quick measurements on all pins showed zero ohms (and I mean HARD zero) to ground everywhere. Dang – never seen that before.

Now, more inspection found nothing but the normal Collins workmanship. Internal tube resistance chart measurement and pin to ground measurements showed hard ground everywhere…and I mean everywhere. More inspection and more head scratching.

Then, in the course of very critical inspection I bent a disc ceramic out of the way of looking at another test point and walla – the culprit. The culprit was that 20 amp "Diagnostic" fuse used by Mr. Repairman. Out from inside of the braided spaghetti tubing that shrouded the main harness, was just the slightest amount of green copper corrosion goo rearing its ugly head. Pushing back the braided harness protective tubing revealed a complete melt down of the harness where the heat was contained by the spaghetti tube. The insulation was burned off, the wires all fused together, and the harness was toast and zero ohms to ground on all lines. While that transformer was smoking under that load (and holding Mr. Repairman's attention), the harness was burning up.

Fast forward through a complete teardown of the chassis components to get to the main harness. Correct rebuild of the harness using the correct color coded wire and spaghetti tubing, and then rebuild of the set using almost all the originally carefully removed components, and the unit can be seen in operation today in my shack.

Enough said? Do not ever up the size of a fuse. Find the problem first. In the course of the teardown, I found the original problem. Either in some exploratory work, or just from movement and shock with time, a B+ disc ceramic cap had gotten bent further over letting its hot lead touch a ground point. It was just an intermittent B+ short that had started the entire episode and just some simple inspection and diagnostic measurements would have located a very easy to fix problem. Just bend the cap back out of the way.

Now, on to the **Second** step in the inspection process. We all know what that great Collins Radio quality workmanship looks like. Start at one corner of the underbelly, and work your way across and over to the other corner looking for signs of the last guy that was in there.

Make a note of areas where the rig has been repaired. Which stage and what was done. Look for cold solder joints. Look for things that you just would not want to leave there. Find out where the rig has been repaired and make a list. Get to know the rig from the inside out.

If there are things on that list you do not understand – make a note. If there are things that you know should be fixed before you ever run the radio – fix them. That is, fix them if you are qualified. More on that also later.

Specifically, make sure that the line cord is safe and the grounds are good. Notice I did not say make sure there is a three wire AC line cord. Many of the older pieces of Collins have two conductor line cords. Some of those cords are in remarkably good and beautiful condition due to their original quality and good storage and considerate use over time. Let's keep as many of those original as we can on historic pieces. Just make sure you have a good AC ground on the chassis. You should have that anyway for lightning and RF safety reasons.

Never bend a rubber older line cord in a tight bend and wrap it up or store it. Stress and ozone will do a number on it and you will lose it. Never leave a cord in the sunlight behind a radio. (And while we are on that subject, be conscious of where sunlight is shining on your old plastic dials, or they will yellow. This includes coming in through the

rear of the radio through the vents and shining on the dial from the inside. My KWM-1 desk sits in front of a window and the sun shines through the back on those nice old dials. I use a towel over the radios when they are not in use and the towels hang over the back.

If the AC cord is unsafe, replace it with a three wire quality cord of the proper appearance.

Alright, we have checked for proper fusing. We have cleaned up the rig. We have done a very thorough inspection and first pass emergency repair and we have made sure the AC line is good and safe.

Now, what we do next depends on what you absolutely know for sure about the history of the radio. Was it supposed to be working? Do you trust what you know? How long has it been in storage since it was "working"? Transmitter or receiver? Internal or external power supply? Bottom line, the next thing we are going to do is make some measurements and find out if the power supply lines look normal. After that we will apply some power – carefully.

If it is a power supply, measure from the AC inputs to ground and make sure everything makes sense there. Look for leakage from internal noise and RF suppression bypasses that are often across the AC line. Also look at the output lines or pins and check the resistance to ground and or across isolated supply pairs. Use the schematic to do an equivalent circuit to find out what it should be. This will mostly be determined by bleeders and voltage dropping networks. Note that when you first apply ohmmeter leads to power supply output leads, you will get an unstable and changing reading due to the filter caps charging. Let this settle and then take the reading.

It is a superb idea to always short out all filter caps in a power supply before working on the supply or connecting test leads. This will protect you and your Fluke. ALWAYS short out high voltage capacitors before you work on a HV supply. This includes HV caps that have been sitting on the shelf. If left un-shorted they can build up a charge just sitting there for a long time.

If you find a B+, Bias Supply or other supply line that looks low resistance, find out why before powering up the supply. Suspect a leaky or shorted capacitor, damaged shunt resistors or bleeders or even problems in the metering circuitry. Physically look at all electrolytics for swelling or popped vents.

P.S. *NEVER TRUST bleeder resistors* to have clamped a supply to zero. Bleeders can open up. It's very common.

If your unit under repair is a transmitter or receiver that has an external power supply, turn your observation measurements around and look into the power plug. Check across the filament lines. That will be a very low resistance and a function of the tube line-up, but it will not be zero. You can get a real good idea of what it should be by looking at the filament string wiring and pulling out your handbook and looking at the filament currents involved and doing a little Ohm's Law math.

Look at the schematic and calculate the resistance to ground of the B+, the Bias and other supplies. This is easier than it sounds. There is, with the filaments off, or tubes out, usually almost no load on the B+ and Bias lines. There may be an occasional voltage divider network to ground and that should be noted and the equivalent found. Lower than expected reading are grounds for further snooping and usually indicate leaky bypass or electrolytic caps. Again, you may see some drifting readings at first due to caps charging. Let that settle before taking a reading.

OK, you now have supplies and units that at least should not make serious smoke. It's time to pair things up and do the bench "install" wiring that you need to run or key your units. After taking care of that business, plug the supply into a VARIAC and start by bringing the unit up to about 40 % of full AC line and let it sit there for a while as your eyes and nose do some judicious snooping.

If you are bringing up an older unit that has Mercury Vapor rectifiers in it, I suggest that you either seriously age the tubes with just full filament power on them before starting, or that you start by substituting a more modern non-mercury tube. Or, you can do what I do, and always trouble shoot with solid state diodes. I do not bring the unit up to full AC input until those are removed and then replaced with tube rectifiers with their higher series voltage drop. This process – one way or the other – takes the ambiguities and danger of Mercury Vapor flash-over out of the equation - and that is a good thing.

Let's stop here for a moment and say some things about reforming electrolytics. This is a controversial subject depending on who you talk to. There are those who would just replace all those "old" electrolytic caps that have been in the equipment since maybe even the 40s or earlier. It is common to see people offering Capacitor Kits for each model and recommending replacement. The position of many who are experienced at maintenance and deal with the older Collins is that complete re-tubing, or complete recapping is almost never called for.

There are many 40s or 50s and later Collins Radios running with the original electrolytic capacitors in them. Leaving aside the occasional culprit Black Beauty paper or dipped Silver Mica caps that now have known failure modes and deserve a preemptive strike, the electrolytics are statistically hanging in there. Electrolytics – over time – suffer from two main deterioration modes. They can, given manufacturing defects, poor storage or mistreatment, dry out and that is irreversible. The components that Collins used were of the highest quality, and many were Mil grade. They are very capable of going this long without serious drying. If they have been overheated, stored for long periods at high temperatures, or otherwise damaged, drying can be accelerated. The main deterioration mode is depolarization. The electrolyte depolarizes. When this happens, the electrolyte goes up in conductivity increasing leakage and leading to higher dissipation (DC) in the cap. Depolarization can be non-uniform with in the physical layers of the cap. This leads to hot spots if the caps are run, and hot spots lead to further damage and increased leakage. Depolarization is completely normal. It happens in all electrolytics. It was recognized very early on and it was recognized that even NOS caps depolarized on the shelf. Many people do not know that this is normal and that there is a mil spec on how to reform electrolytics before they are used after long storage – in or out of a radio.

NOTE: If reforming is done to the mil spec, reforming is very effective and essentially brings the cap back to "As New" condition. Bringing a radio up on a Variac, or depending on the operational voltages that occur during normal use, to reform caps is not effective. While regular use is very helpful and severely retards depolarization (that is one reason we should use our radios regularly), it does not solve the problem.

Correct reforming involves controlled incremental increases in applied voltage to a KNOWN leakage current level, waiting and monitoring the decay of this leakage, increasing the applied voltage again to the leakage limit and again waiting for it to decay and then continuing this process until the applied voltage reaches the rated MAXIMUM applied voltage for the cap as built. Notice that the reforming must go to maximum rated and not just to the "Working Voltage". Older caps particularly have two ratings… Working and maximum. The old adage should be repeated here also that you should never use an electrolytic in an application where the actual applied voltage is significantly below its "Working Voltage" rating. Doing this limits the self-reforming and encourages eventual depolarization. Cathode bypass electrolytics are commonly found in this underused situation and, indeed, they fail more often.

Let's get back to reforming. The Mil Standard Spec MIL-HDBK-1131, can be found on the CCA website and is a gold mine of knowledge. It will give you the allowed leakage for a given capacitance and voltage rating and it will tell you what level of leakage to allow during reforming. Over the years, the spec has been rewritten many times, mostly driven by the practicality of the new more modern electrolytes and

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New to Me (Cont'd)

the construction technology. The spec has gotten simpler and less informative. The older versions from the war period and right after are the most informative and also the most applicable to our components. Try and find as old a copy as you can get.

I would suggest first trying to reform the caps in any supply or radio you bring up. If successful (to the mil spec and not just to a quickie VARIAC job – very hurtful sometimes), you will have an original radio that will play for many many years to come and you will not have to molest your baby. But, if the caps will not reform to spec leakage at RATED voltage, then it is replacement time.

It is worth noting that from my personal experience, there are almost 80 pieces of Collins gear operating here from time to time. My collection, use and maintenance of Collins has spanned now almost 30 years. I have replaced less than 6 or 7 electrolytics and I have mil-spec reformed a lot of leaky caps successfully and then watched them play happily for 20 more years. Yes, I replace black beauties. I do this preemptively sometimes, and other times I wait for symptoms. Yes, I replace suspected Silver Micas when they have high DC bias on them. I never preemptively replace electrolytics. This entire electrolytic replacement thing is highly overrated and often done by people whose technical skills, and the resulting appearance, are not up to Collins Standards.

This is a good place to take a break. The new to you radio has now been inspected, the fuses are correct, it has been cleaned, and it has been inspected and checked for cursory power related problems and brought up to rated AC input one way or the other. Hopefully, given how that all happened, no smoke yet.

Now it is time for some functionality checks and that gets to be a much broader subject with more branches on the tree. Stay tuned.

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Hope you find Collins in your Christmas stocking or under the tree. May you face the "New to Me" question often in the New Year.

- - - - - - CCA PRIVACY POLICY - - - - - -

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Scott Kerr
CCA IT/Web Design and support

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