Trainwreck Express Assembly Instructions

WARNING! - Please Read this Information Carefully:
Tube amplifiers use **POTENTIALLY FATAL HIGH VOLTAGE AND CURRENT**. If you are not familiar with high voltage circuits, **PLEASE DO NOT RISK YOUR LIFE BY ATTEMPTING THIS BUILD**. If you are in any doubt as to your ability to complete this kit, please contact a qualified technician.

Required Tools and Supplies

Safety Glasses (if you need "reader" safety glasses, order Pyramex brand from www.safetyglassesusa.com)
Soldering station (or 40W soldering pencil)
60/40 rosin core electronic solder (.032-.060" diameter); 63/37 is easier to work with for some
Vacuum De-soldering tool (Soldapult), get one even if you have a vacuum desoldering station
Needle-nosed pliers and locking hemostats
Wire cutters (small flush cutting)
Complete set of nut drivers
Standard flat blade screwdriver
Small flat blade screwdriver
Phillips screwdrivers (#1 and #2)
Multi-gauge Wire strippers
Digital multi-meter (DMM) and leads
Chopstick
5W or greater Cement Bleeder Resistor on Alligator clip leads (for draining caps)
Light bulb current limiter (see startup section)
Steel 12" ruler
Drill Press

Recommended Tools and Supplies

Amp Cradle
Surgical Forceps and tweezers
Soldering Flux
Magnifying bench light
Pressurized Aerosol air
Caig Deoxit contact cleaner
Erasable marker
Pencil and Paper
Parts organizers
Adjustable clamps
Rubber bench pad (keeps you from dinging the amp up while in work)
Rubber Floor pad (prevents you from grounding to a cement floor)
Set of startup tubes
Can of Compressed air
Spring punch
Hammer- metal and rubber

Optional Tools and Supplies

Analog Signal Generator
Oscilloscope and 10X leads
Heated Wire stripper
Dummy speaker load box
Variac
Electronic bench vise
Vacuum desoldering station
Greenlee Chassis punches, Heatsinks for delicate components (Diodes)

Table of Contents

1. Introduction:

My name is Ron Worley and like so many people I was blown away by the tone of the Trainwreck Express, particularly as so ably demonstrated by Glen Kuykedall in his YouTube videos. I decided to write this guide as a way to help me logically figure out how to build a Trainwreck. It took countless hours of pouring through old posts on the Amp Garage Forum, posting lots of annoying questions myself and endless amounts of study of the Francesca and Undocumented '90 Express pictures from the Trainwreck Files section of the forum. By doing all of this, I've gained a pretty good understanding of how Ken Fischer (KF) did what he did and some idea of why. I certainly can't claim that I understand all of the nuances of the circuit itself or why he used the component values that he did. Therein is the magic of the Wreck……

I've taken the liberty of using the pictures and layouts that are what I consider public domain by being posted on the forum. The pictures are from Allyn Meyers (Allynmey) and HeeBGB, the cabinet design is KF's as drawn by me using measurements from a real Wreck cabinet, the wiring layout document is an updated version that I did in Visio to clean things up, and the component board drawings are by Todd Hepler (Preamp board) and Nik at Ceriatone (I edited the layout down to just the PS section), and some great scale Visio layouts by Barry Witt. I also developed the chassis drilling template and the accompanying parts Bill of Material (BOM). The appendix of Dana's Ken Fischer Tribute Amp build notes is directly off the Amp Builders Guild website. Since I'm not using this for profit, and only as a contribution to the Amp Garage community, I did not seek expressed written consent for use of their respective content. I've also likely made numerous mistakes / false assumptions / asserted incorrect information, etc. Feel free to send me a correction e-mail at: flapsjr@hotmail.com

The order of the steps that I used to construct the amp is my opinion of a logical sequence to do things. It was based on a combination of my sense of logic and the way some of my parts happened to flow from suppliers. You can change the order as you like, but there are some obvious steps that have to be accomplished in sequence.

Before you begin, make sure that you are comfortable with proper soldering technique. Always tin your leads with solder for stranded wires- it will make things immeasurably easier as you go. Make sure that you have a proper wattage iron or an adjustable heat soldering station to prevent overheating components and insulation. If you overheat the wire when soldering to a lug, the insulation will melt and shrink / pull away from the wire. This will not only look bad, it can potentially cause shorts and other bad electrical stuff.

Cleanliness during the build pays off… Use a can of compressed air that most computer and big box retail electronics stores sell to clean keyboards with. Bits of insulation, wire, solder, metal shavings, etc. all can get lodged in some electrically bad places… and the results can be catastrophic. Be particularly mindful of the areas under the boards and in the tube sockets.

Sourcing Parts:

Source your parts using the attached BOM; YMMV on components, depending on how accurate you are trying to be relative to a real Trainwreck. Regarding hardware, I suggest using 100% stainless steel everywhere to prevent any future corrosion issues. It's more expensive, but worth it. It does however strip more easily than harder steels, so go easy on the torque. The only things that aren't typically stainless are the Star washers on the pots, the sheet metal screws for the chassis bottom panel and the #4 chassis screws that KF used to attach the Preamp tube sockets (I use machine screws instead).

Here are some component-based comments from members of the Amp Garage forum- they are a matter of personal opinion, so take them as such:

-Some guys usually use 1W carbon film by default for all resistors. Francesca is predominantly 1/2W with a couple 1W in the PI and larger wattages in the PS and V4 / 5 Screen / Grids.

-The 9.1k Dropping Resistors need to be 3 Watt Metal Film. Some have used 2 watt, but the consensus is that it isn't enough. The 1.5k V4 / 5 Grid Resistor is Carbon Film and doesn't need to be 2 watt. 1 watt will probably be sufficient and some use only a 1/2 watt for these with no reported ill effects. The "5W " 1K Screen resistors on V4 / 5 are actually wire epoxy 7W Mouser "Greenie" on Francesca and seems to be the choice of most of the experienced builders.

-The 100K Bleeder resistors need to be 2 watt. They are used to drain the power supply caps when the amp is turned off. Francesca used Carbon Comp, which is OK given that it's not in the signal chain. Some feel though that the better power handling and fire resistance of Metal Film make it a better choice.

-One of the secrets is the right output transformer...Ken liked Heyboer trannies in the later years, but used Pacific and perhaps others in the pre '90's amps. Chris at ToneSlut (www.Toneslut.com) originally provided accurate Heyboer trannys for a reasonable price, but for now RJ at RJ Guitars (www.rjguitars.net) is supplying them (and Pacific trannys) until Chris can take back over.

-The chassis must be aluminum, not steel- ground current flows through the chassis and the metal composition effects resistance. Also a steel chassis would affect the magnetic fields of all the transformers; aluminum does not. Chassis can be sourced through either Allyn Meyers (www.ampbuildersparts.com) or Nick at Ceriatone (www.ceriatone.com). Bud chassis covers are available at Allied Electronics or Mouser. Use 14 #6X3/8" screws to hold the bottom plate to the chassis.

-The 47K Bias resistor can be up-rated to 56K to help get a hotter bias.

-All tubes can be fitted with 2 O-rings per tube to dampen mechanical / microphonic vibration.

-1/8" cork drawer liner w/self adhesive backing can be attacked to the chassis cover (between chassis and cabinet) to help reduce microphonics / mechanical vibration issues.

-Two 6"x1"x1/4" pieces of weather stripping are located inside chassis about an inch apart between preamp (V1/2/3) heater wires and the chassis back, three 3-4" side by side pieces are on the Chassis cover over the PS Cap stack and a 17" inch piece placed between the top and bottom of the faceplate and the cabinet front to fill in the gap space.

-If you look at pictures of real Wrecks you will find all carbon film resistors in the preamp. Carbon Comp are noisy, drift a lot and aren't the best to use in that part of the amp.

-All of the OD caps are rated a 600v when 400v ones would have worked just fine in some sections.

-Fly-back protection Diodes are mounted on the power tubes to increase reliability against voltage spikes.

-A 50 watt OT is used for a 36 watt amp, a 300ma PT is used when 225ma would work fine. By using the over spec'd parts, you aren't putting a strain on the components like you would if you were running a 400v cap at 395v. Plus, the specified trannys just sound right….

-Cabinets can be either bought or built- see the section "Building the cabinet"

-Boards are tough to source- Dana Hall (UR-12) was supplying them, but has indicated that he is not anymore. If you want to build your own boards, the perf board the KF used is seemingly impossible to find anymore, as is the 1/8" thick electrical grade XXX phenolic stuff Dana uses. Here are the dimensions for the holes: The hole size is 3/23" (.130") and the spacing is .265" from center to center. The Turret part that works with these dimensions is Keystone # 1540-4. Mouser has them for $0.16 ea in qty of 100, and you will need to by the special staking tool to set them into the board. RJ at www.rjguitars.net is now supplying great blans and finished boards.

Glen's comments on parts:

"So far my Express appears VERY close to Francesca. The smoothing cap on phase inverter on mine is a brown silver mica looking cap. On Francesca it's the blue one. Mine has "Aerovox Mallorys" not just "Mallory", not sure what's up with the model differences.

My amp seems to have a center tap on the heater circuit, as it has no double resistors on the output tube socket heater leads. Can't find any different values as far as resistors or caps but I can't see everything from the pictures.. The color coding is a bit different on the wiring.

The B+ resistors grouped together on the power supply board has some jumpers underneath, instead of all being visible on top. Mine has the later black OPT. Different brand of output tube sockets, mine are brown not the nicer looking ceramics that appear to be in Francesca.

My "choke" resistor has the lettering face up and it says "8335 TRW PW25 1K 10%". My feedback cap heat shrink-wrapped up at the presence pot appears to be 100k I think, it's covered up on Francesca.

On my amp the bias feed has an additional terminal on the PS board. It seems that the bias supply feeds under the board, has a terminal just on the other side of the big resistor and then the white wire goes from there to the preamp. On Francesca that wire goes straight from the bias cap terminal, then fishes under the big resistor. I don't know what the bright caps on mine are. Ken told me day before yesterday the stronger of the two bright caps is a 500pf.

My original Express uses the cheap plastic Lorlin rotary switch. A 12 throw double pole unit configured for 3 positions. Both poles wired in parallel to optimize the current capability of the cheap switch. As cheap as the Lorlin is I have never had any problems with it in my original Express. Since the part is currently available (Mouser) I went with the Lorlin in my two clones. The only difference is the new ones are all grey, where the original was half black and half grey. The Lorlin in my original was a 12 pole, but configured for 3 positions, with the other 9 switch contacts clipped off flush with the unit. I copied that too in my two clones. With the Lorlin you take them apart to configure how many positions you have.

Question (about his two clones): Out of curiosity, did you get down to the finest detail with things like the Rubycon capacitors, Mallory polyester ODs, sealed potentiometers, etc? I'm hoping I can build an Express this summer, and I've read varying opinions on what REALLY matters and what doesn't as much.

Glen's response: To be honest I really don't know what matters the most either. Though I have my opinions and to a certain extent I think EVERYTHING matters in these things. There are some "knowns" in these things, and some "unknowns". I choose to find everything I possibly could, but probably at the top of the list for me were the Pacific transformers and BUD chassis. Not that other transformers aren't totally fine, but I was specifically copying my original that HAS Pacifics.

I couldn't find any Rubycons and I used CGE pots which aren't sealed but neither were those in my original. I liked the fact that the CGEs were fairly decent and you can solder to them which helps copy the layout more closely. Also I got a vendor to hand pick some that very closely match the values in my original, some of which were a bit different then marked.

I used two original thin-aluminum BUD chassis with screw-on bottom plates, just like the original. Also I used original spec Pacific transformers like my original. A few other details I copied on my original were NOS Cinch tube sockets, Lorlin output selector, Mallory PVC signal caps in the proper .02, .002, and .1 values (instead of the more easily found .0022s and .022s), PVC wire in matching colors, original spec board material and flea clips, NOS 25 watt 1k resistor that matched the original perfectly, Switchcraft jacks, fairly high flux content leaded solder, Cherry cab, two wood chassis reinforcement dowels, window weather stripping.

I matched the layout and lead dress of my original down to within a millimeter or two, and the mechanical placement of everything to at least 1mm, and I used the same tubes I favor in my original, etc. I only used shielded cable on the input lead, and both amps are 100% stable with all knobs cranked to 10 even with the bottom plate taken off.

Other than just yesterday upping the PI cap to 250pf, they are 100% copies with no other changes. If it weren't for the date codes on some of the caps and the pot and switch brands, these amps could probably be passed off as originals if you saw the chassis inside.

2. Pre-Assembly Steps

Drilling the chassis:

-Drill out the Preamp and PS boards for the standoff bolts (#6 machine screws)- use the pictures in this document and on the Amp Garage forum to make sure you have the correct holes. Also note that a #6 drill bit is not the same size as a #6 machine screw- they have different numbering conventions.

-Emboss the chassis with your chosen name on the back edge by the impedance switch using Harbor Freight (or other supplier) letter punches. To avoid bending the chassis, it might be smart to have a small anvil placed inside the chassis as you punch the letters.

-Layout the chassis holes using the template below. Use the actual component boards and transformers as templates for their mounting holes because your components may vary; use a graphite pencil to mark the hole positions. Use a T-square to insure that things are properly oriented and square with the chassis.

-Check all hole positions and measurements. Check three times, mark twice and drill once. Make sure to set your power tranny about ½" to ¾" from the front edge of the chassis or it will hit the front panel and you won't be able to slide the chassis in all the way.

-Mark the hole positions using a spring set punch, followed by reinforcement with a pointed tip hand punch and hammer.

-Using a drill press, drill out #6 holes for component board standoffs, ground lugs (including V4, V5 tube socket mounts) and #10 holes for transformers. For the boards, I measure and drill one corner hole of each board based on the drilling template. I then use the actual boards themselves as templates by using a #6 machine screw to hold that one drilled corner in place, align the boards parallel with the chassis edges then hit the opposite corner with my spring punch to set the corners. Drill that hole and insert another #6 screw, then mark the rest of the holes with the spring punch. Remove the boards to drill out the marked hole to avoid damaging the boards.

-Transformer wire holes should be sized to match the grommets chosen to fit wire bundles. The PT grommet will be bigger (a 3/4" hole for me), OT grommet holes are smaller (7/16" for me). Based on experience (that of almost ruining a perfectly good chassis), use a Greenlee chassis punch for these holes to prevent making a mess. #6 machine screw hardware can be used for the preamp tube sockets rather than the #4 sheet metal screws used by KF.

-If you are using the Allyn Meyers chassis and use a normal 16 AWG power cord, you need a larger chassis strain relief. You will have to make the specially shaped hole larger by ***carefully*** using either a file or the appropriate expensive chassis punch.

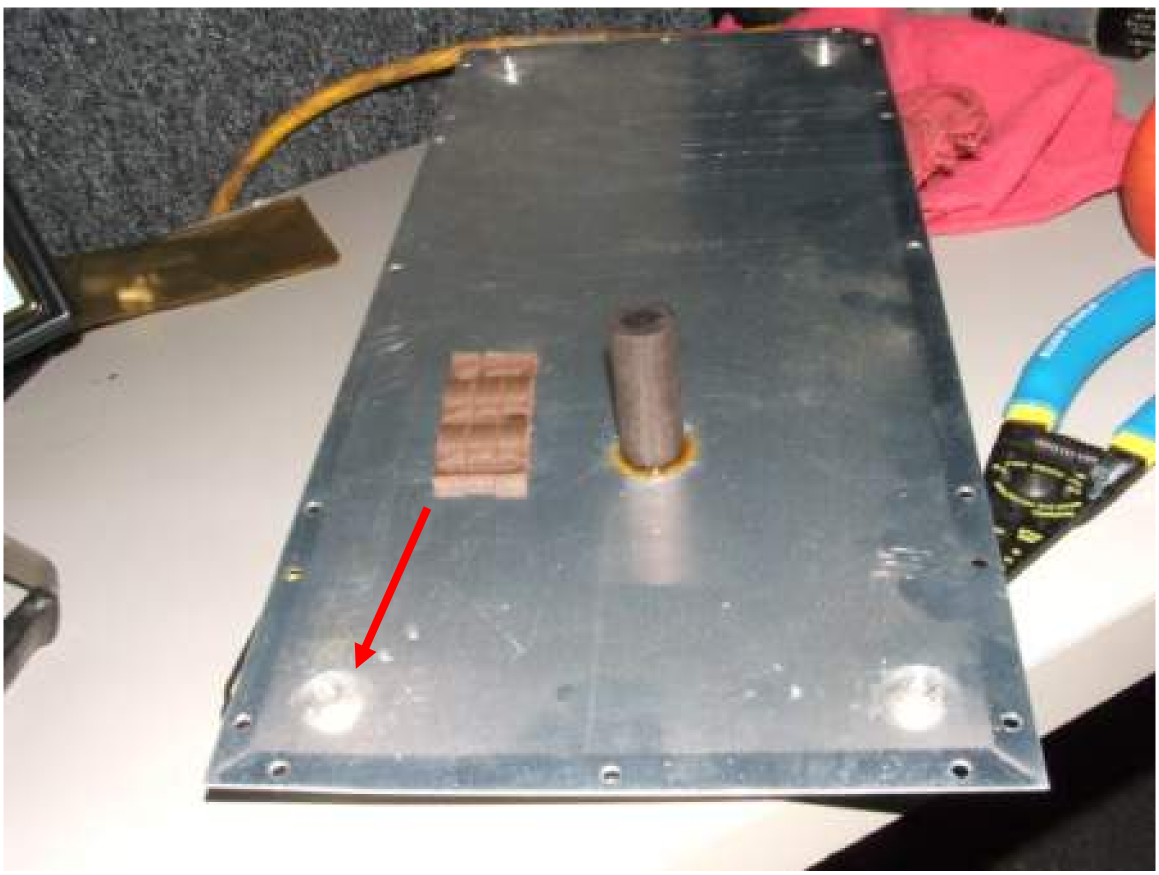
-Two of the PS board standoff holes need to be drilled with a #6 countersink bit, which should use a #6 oval head machine screws (or flat head if you don't care about possible tranny interference). See the diagram below annotating which screws need to countersunk.

-Mount the standoffs to the chassis using #6 machine screws and star-type lock washers. I put a lock washer on both the outside of the chassis and the inside to make things stay tight.

-Dry-mount the boards onto the standoffs. You need to drill out the hole for the #6 machine screw and may have to make minor hole "accommodations" on the boards (unless you are perfect / lucky) - use a reamer to enlarge / clean out the board mounting holes. Don't mount the boards permanently yet- you will want to mount the components and wires that go under the boards outside the chassis to make things easier.

-Mount the Chassis bottom plate at this point to avoid doing it after the amp is done (I forgot to do it myself, and it was rather embarrassing- I had metal chips all over my nearly completed amp). You will have to drill out approximately 8 holes- 3 on the front and rear edges each, and one on each end of the chassis. All those metal filings don't play well with the electronics, so doing this now is crucial. Another thing to beware of is where the holes are drilled relative to the mounted components- the 3/8" #8 metal screw will extend in deep enough to hit components, particularly by the pots. After you drill the pilot holes in the chassis, use a screw to tap the thread into the aluminum. An option to prevent possible electrical shorting is to grind off the tips of the screws flat- this shortens them, and makes them not sharp around wiring.

-Somewhere on the Amp Garage forum I read that KF applied 1/8" adhesive backed cork to the chassis cover to help with vibration induced microphonics when the head was on a speaker cabinet. I don't know if this is right or urban legend- but made sense to me given the instability and sensitivity of the Trainwreck, so I did it anyway. YMMV.



-If you're using an authentic KF-approved Bud Chassis, use "nutserts" for mounting to the cabinet. Use 1/4-20 screws to insert in the "nutserts" through the cabinet if you want it to be TW "Correct". If you're using the Ceriatone or Allyn Meyers chassis, the mounting bolts are threaded through the nuts fastened to the lip of the chassis. You will have to use some metal snips to remove a tab of metal on the bottom plate above where each chassis nut is to allow these machine screws to screw into the nuts. See picture above for details.

Glen's comments on component placement and board mounting:

"The boards in the wreck are tricky to place correctly. Heck everything is tricky mounting-wise. One detail is fitting the power supply caps between the two boards for a little clearance on both sides but still with one of the caps almost touching one of the reverse-mounted power transformer mounting screws but not skewing the cap upwards or something odd.

On the mounting screws that are near the caps you actually mount it with the screw head inside the chassis. Then the Mallory 40uf cap has an indentation ringed area that you align almost over and next to the screw which nets you about 1/16-1/8 more needed clearance.

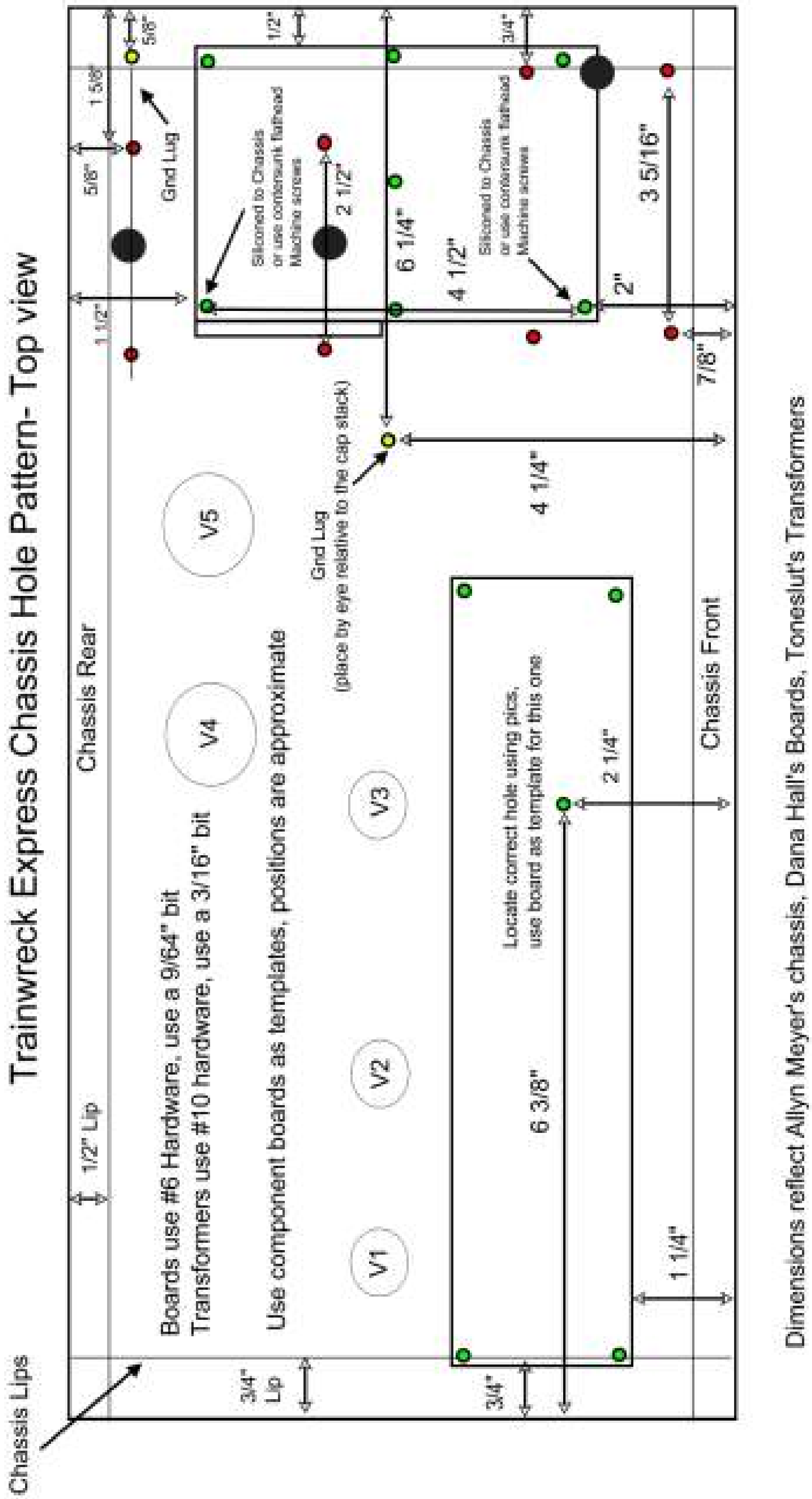
Then you also have to be careful with the transformer bolts where they come though over near where the big power resistors are in a row on the PS board. You don't want the board terminals underneath shorting out against the transformer bolts. Anyway, the only real way to do it is to have the boards cut and the caps and transformers on hand to line it all up.

Truly, on the original wreck things are very tight and if you are copying it, being off by as small as 1/8" could cause issues. I used the original style flea clips and board materials, which have some complications. Mainly that the flea clips extend a bit far underneath the board so you need to make sure that nothing hits a mounting bolt underneath.

Even the layout of the PS board in the bias section is partially the way it is because of clearance requirements underneath. In an original Express some of the transformer bolts go one way and some the other to gain clearance. Also I had issues with the mounting bolts on the transformers coming into contact with the core stack bolts themselves. I didn't think that any contact was good there since the transformer company made effort to insulate the bolts from the metal with insulating washers. So, again I had to carefully work with the exact transformer mounting bolt locations (even egg out the holes to shift things a hair washers are your friend!) so that I had clearance up top at the core stack and clearance underneath the chassis where the boards were.

Anyway, this stuff took a lot of work and almost as much as it took to wire them up. Still you may be able to find easier ways since you are not going for a millimeter for millimeter copy. In some ways Ken did things the hard way, but I questioned nothing and copied it, warts (or at least complications) and all.

Yep, I also have troubles getting clean holes for the transformer leads, but I covered up a little slop with some grommets so you can't see it. In the end I had to file and egg out (slightly) a few mounting holes like for the board standoffs. However the little washers cover it all up so you can't see it once it's all done. And I was using a spring loaded center punch to mark it".


Trainwreck Express Chassis Hole Pattern- Top view
Chassis Lips
Chassis Rear
Chassis Front
1/2" Lip
3/4" Lip
3/4"
5/8"
1 5/8"
5/8"
1 1/2"
1/2"
3/4"
Gnd Lug
Siliconed to Chassis or use contersunk flathead Machine screws
Siliconed to Chassis or use contersunk flathead Machine screws
2 1/2"
6 1/4"
4 1/2"
2"
3 5/16"
7/8"
Gnd Lug (place by eye relative to the cap stack)
4 1/4"
V5
V4
V3
V2
V1
Boards use #6 Hardware, use a 9/64" bit
Transformers use #10 hardware, use a 3/16" bit
Use component boards as templates, positions are approximate
Locate correct hole using pics, use board as template for this one
2 1/4"
6 3/8"
1 1/4"
Dimensions reflect Allyn Meyer's chassis, Dana Hall's Boards, Toneslut's Transformers

Mounting mechanical components:

-If you're using a painted chassis, ensure that all ground points are clean to bare metal before installing any hardware. Use a scraper and small wire brush to remove any coating or overspray on painted chassis. Four areas will need scraping; the speaker jack holes, input jack hole, V4 and V5 mount holes (closest to the preamp board) and the ground holes by the fuse holder and in front of where the cap stack will be located (between the Preamp and PS boards). If you're using the Allyn Meyers bare aluminum chassis, this step is not necessary.

-Install preamp tube sockets. The preamp tubes are mounted with pin 9 facing the preamp board.

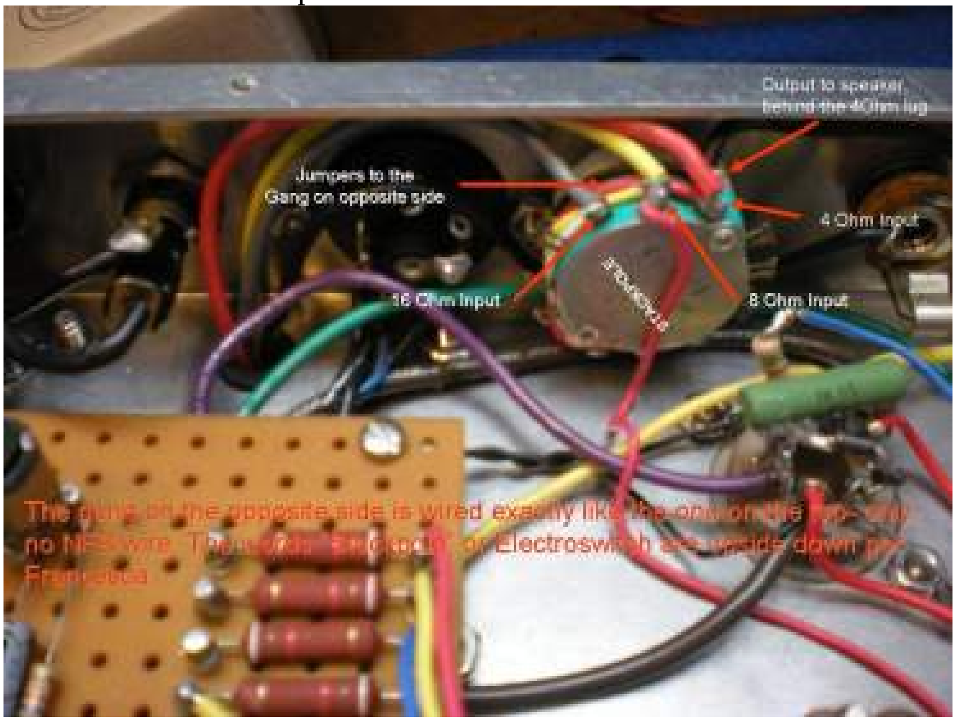
-Install power tube sockets. Power tubes are mounted with the alignment notch and pin1 towards the middle of the chassis. Note that both V4 and V5 have double lead ground lugs that are mounted on the screws nearest the preamp tubes. You don't need one on V5 if your PT has a heater Center tap and you are not installing the 100 Ohm resistors shown below.

-Install the remaining ground lugs by the fuse holder and in front of where the cap stack will be placed. You may wait on this until you set the cap stack to make sure you have it right. Again, use two double lead ground lugs on each one.

-Install fuse holder and speaker jacks in the rear of the chassis. Leave the impedance selector off for now.

-The impedance selector on Francesca was a Stackpole (now Electroswitch) and on Orphan Annie and the Undocumented Express, a Lorlin. Either way, they need to be wired with jumpers from each impedance position and the output wire to the adjacent *gang* (set of 4) lugs on the switch. Use the trimmed remnant of each 3 different impedance wires (grey, red, yellow) and the black common wire that goes to the output jack as your jumper cables. This was done to insure that the switch could handle the voltage. You will find that the lug sizes on the Stackpole / Electroswitch unit are too small to accommodate the heavy multiple wires. I used the tip of one side of a set or forceps to carefully enlarge the lug holes.

-The Negative Feedback wire from the Presence pot is attached to the 8 Ohm wire's lug on the switch- cut a long enough piece of red 20 AWG wire to run from the impedance switch to well past the Presence Pot on the other side of the chassis. Don't solder the main lugs on the top of the switch- you need to wait until you have the speaker jacks in place, and the leads that go to them sized. See the picture below:



-Install the pilot light, switches, and potentiometers in the front of the chassis.

-If you are using the authentic KF copper wire grounding buss and using stainless steel cased pots (PEC, Clarostat), you will need to use the (difficult to find) grounding lugs with long leads that are bent around the pot on the side- one per pot. If you are using non-stainless pots, you will solder the copper wire directly to the pots later. Leave the Pots loose at this point- you *may* have to take them off in the process of wiring them up later.

-***Fit the transformer wire holes with the proper sized rubber grommets***. This is optional, but high voltage wires rubbing against sharp aluminum is a safety hazard in my book. Feed the Transformer wire bundles through these holes (making sure to get the OT oriented correctly- the bundle with the grey / yellow / red / black wires go though the hole closest to the back of the chassis by the fuse holder) and set the transformer onto the chassis. Do them one at a time.

-Using #10 hardware, attach the transformers to the chassis with the screw head on the outside of the amp- except for the 2 inner screws on the OT nearest where the PS Cap stack will go, which are done the opposite way to give a flat surface for the caps. Note that both sides of the Tranny bolts have flat washers on them, unlike the other smaller chassis bolts.

-Fit all of the chassis mounted components- pots, switches, pilot light (be really careful if you are using the authentic plastic lights- they crack very easily), fuse holder, tube sockets, ground lugs, etc.

-The power cord can be attached later to make things less awkward.

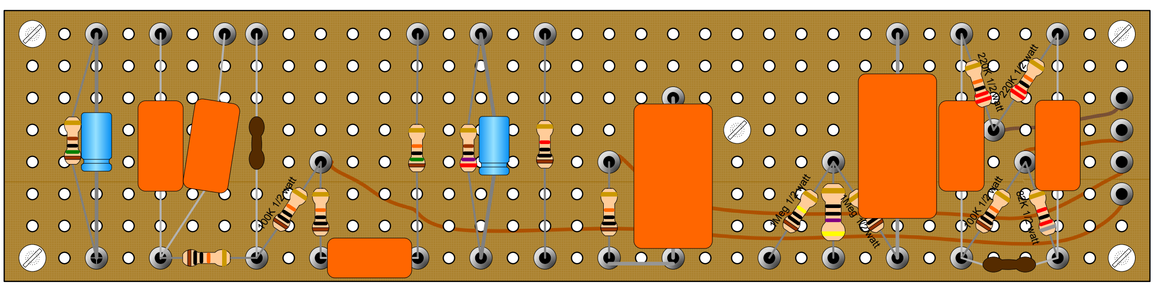
-Attach the board standoff onto the chassis with the #6 hardware; this will help align the tranny wires, etc. as you solder them to their respective components.

-Recheck your work. Make sure that all hardware is securely tightened and that all pots and switches operate smoothly. You don't want to be trying to re-tighten things once the wiring is in place.

Building the Preamp and PS boards:

-Using the layout diagram on page 18, mechanically attach the various components onto the Preamp board. Attach the bias and B+ wires that run under the boards (drawn in red crossing the board) to the appropriate lugs, soldering them into the hollow part of the bottom side of the lug. To prevent them from coming loose as you solder the top components, I strongly suggest that you run the wire up the inside of turret and have some of the wire bent over onto the outside of the turret. Take it from me, I had one come loose and had to almost tear my entire preamp board apart). The RC components can be mounted by placing the leads into the holes of the turret (looks pretty), but I wrap my leads around the turret barrel to ensure a really good mechanical bond before soldering. Again, YMMV.

You can cut the correct color and length of 20 AWG wire for each flying lead and attach them mechanically to the lugs as well at this point- *but I don't recommend it*. Part of getting really good lead dress and neat smooth wires like KF is doing it "in-situ"…. If the wires get all kinked up or bent, they are very difficult to smooth back out. This is a highly personal point- I just found it way easier to get a neat result this way. Using a heated wire stripper makes this really easy- no pulling on the wires with a hand stripper- which usually screws up that nice neat lead dress you just spent several minutes getting just right. Double check all components are in the correct spot and orientation (particularly caps). If you're striving for total "KF-ness", the resistors are also oriented a specific way. Only then solder the topside components on the lugs that don't require a wire lead going off the board. I was told that KF cleaned all component leads prior to soldering with Scotchbrite or perhaps 600 grit paper (no steel wool!), others use isopropyl alcohol.



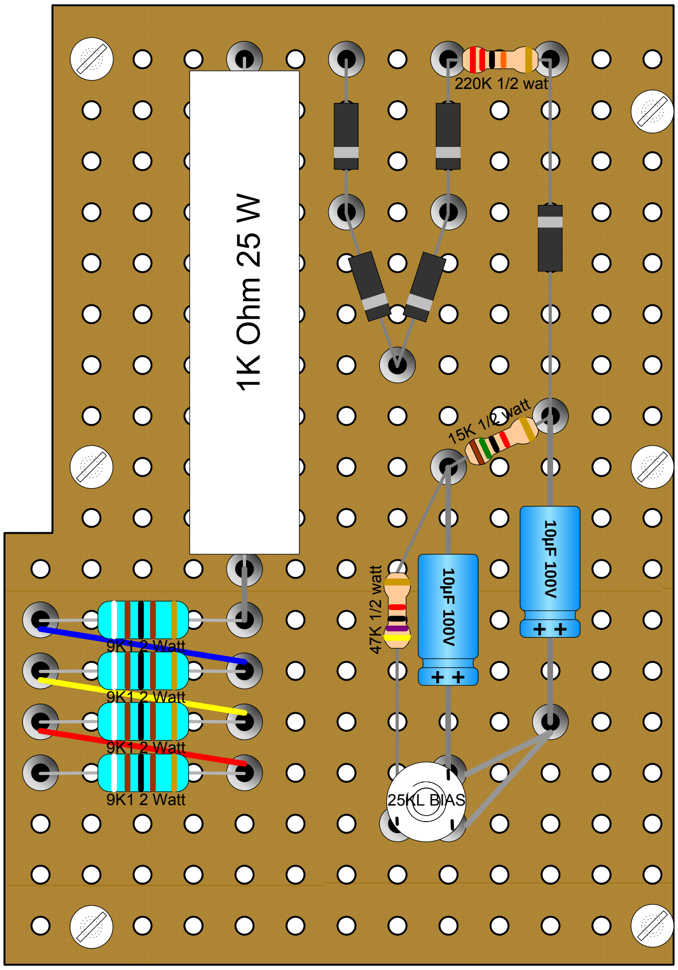
-Using the picture below, perform the same steps for the PS board. Make sure that the diodes and caps are oriented correctly for polarity. On later amps, KF put the bridging wires between the 9.1K dropping resistors below the board.

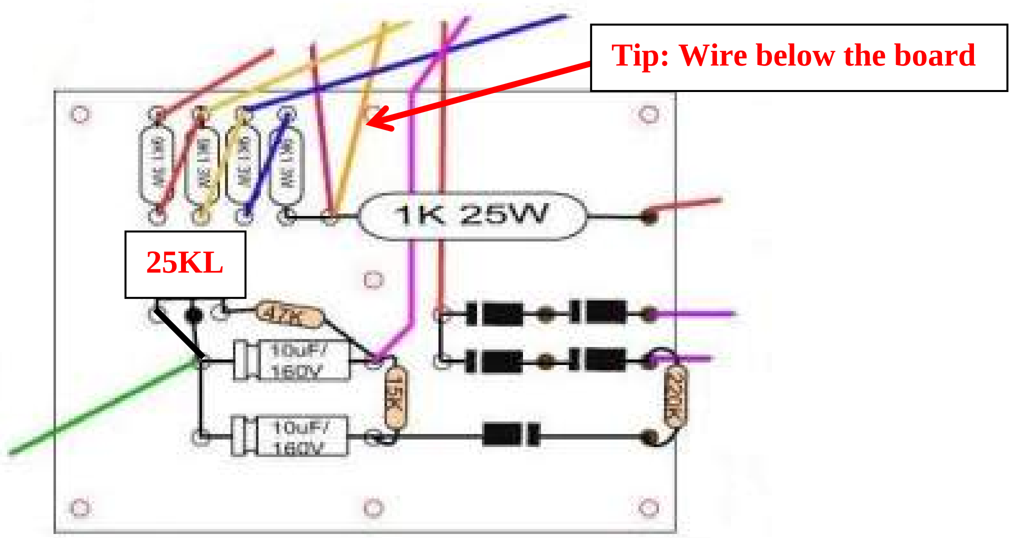
-The Bias pot is 22K in the Ceriatone kit, KF used a 25K. Note that on several layout drawings, the third leg of the Bias Pot is shown as unconnected- this is very wrong. It needs to be connected to ground to prevent damage to the tubes in the event of Bias pot failure.

-The 47K Bias Resistor is commonly substituted with a 56K value to allow for hotter bias settings, and it was Carbon Comp on Francesca.

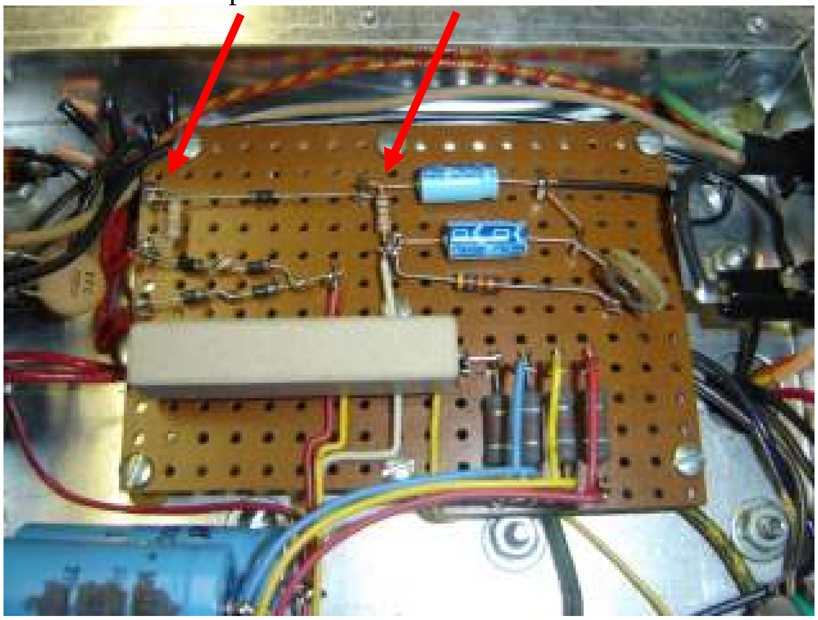
-Wait on the flying leads for the PS board- their lead dress in most cases is best done after it's installed. If you must attach them now, don't solder both ends of the jumper wires on the 9/1K resistors yet- solder only the lugs closest to the bias pot to hold them in place.

-See the notes below on the wire used for the B+ 1 and B+2 connections- because it seems (to me) that heavier wire is needed, the 25W resistor is difficult to install. If the wire noted below in yellow off the 25W is heavier gage than 20 AWG, it makes it impossible for the 25W to lay relatively flat on the board. An alternative method is to attach this wire (in yellow in the diagram) under the board, relieving that clearance problem. This is expanded upon in the 'Wiring the PS Board" section later. Look at the file pictures to better understand this.





-If you are trying for 100% accuracy, use the file pics to note the way KF mounted some components- some resistors have bent leads curving to lugs rather than soldering them in directly between lugs. See examples below.



-Wait until later to mount the boards; you will want the maneuvering room.

3. Wiring the chassis:

General notes:

-Begin by carefully reviewing the layout pictures of both Francesca and the Undocumented Express for details on exactly how and where KF laid his wires:

Amp Garage Trainwreck Picture Files

Lead dress in a Trainwreck is so important that it will make the difference between tonal nirvana and a howling mess….

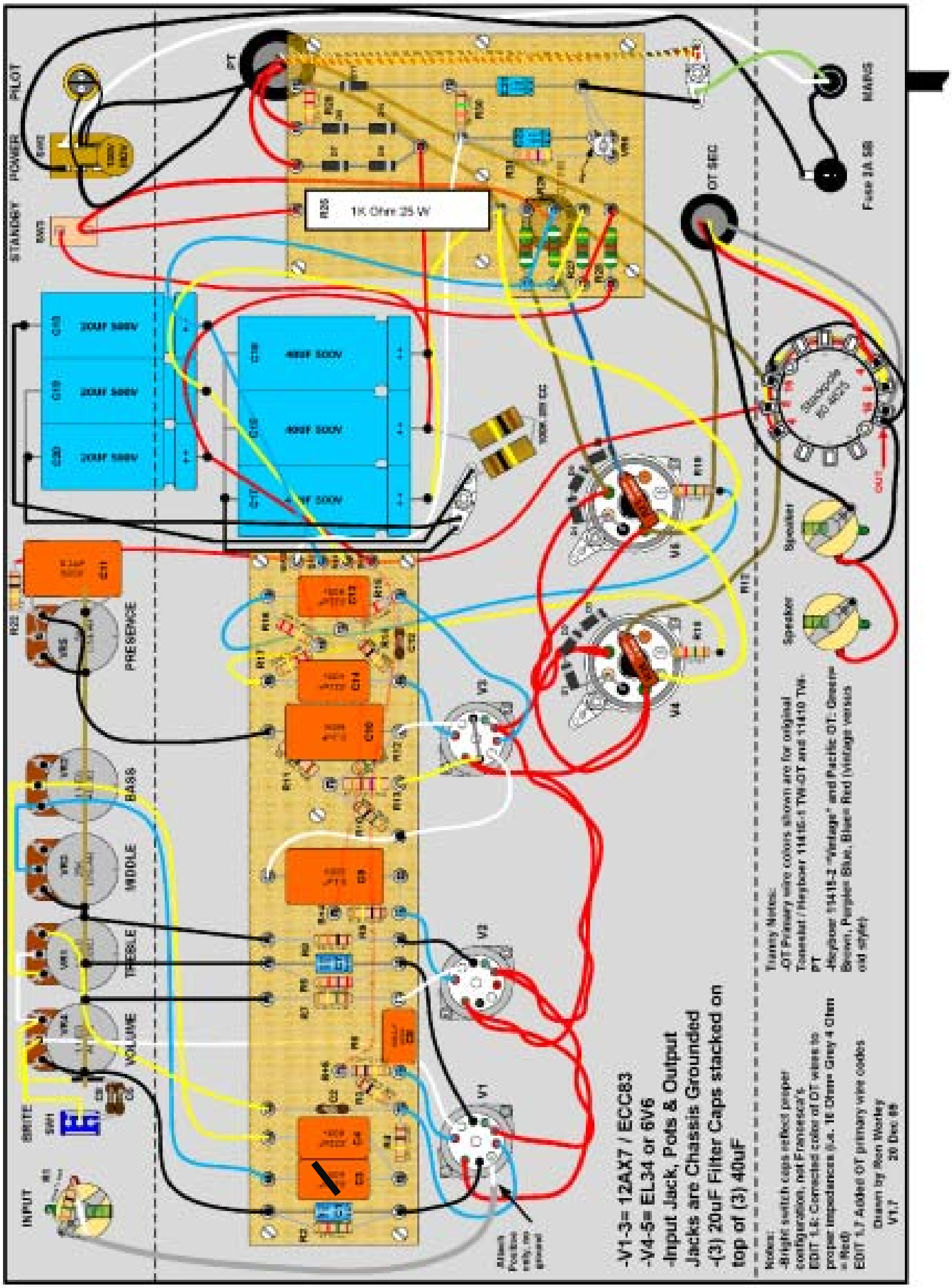
-In general if you are crossing a signal wire over a filament or power wire, it should be at 90 degrees to each other to minimize crosstalk and noise.

-Use 20 gauge solid core wires for all components excepting 18 gauge stranded for the tube / valve heaters. Francesca used 20 AWG stranded red "Colombia" wire, but 18 AWG seems better for the higher current heaters- your choice. Francesca also used 24 or 26 AWG black wire for the pilot light. Colors are not tonally important, only esthetically- again it depends on how detailed you are trying to be. KF was not 100% consistent with colors either; the Undocumented Express uses black and red heater wires versus all red on Francesca and other differences.

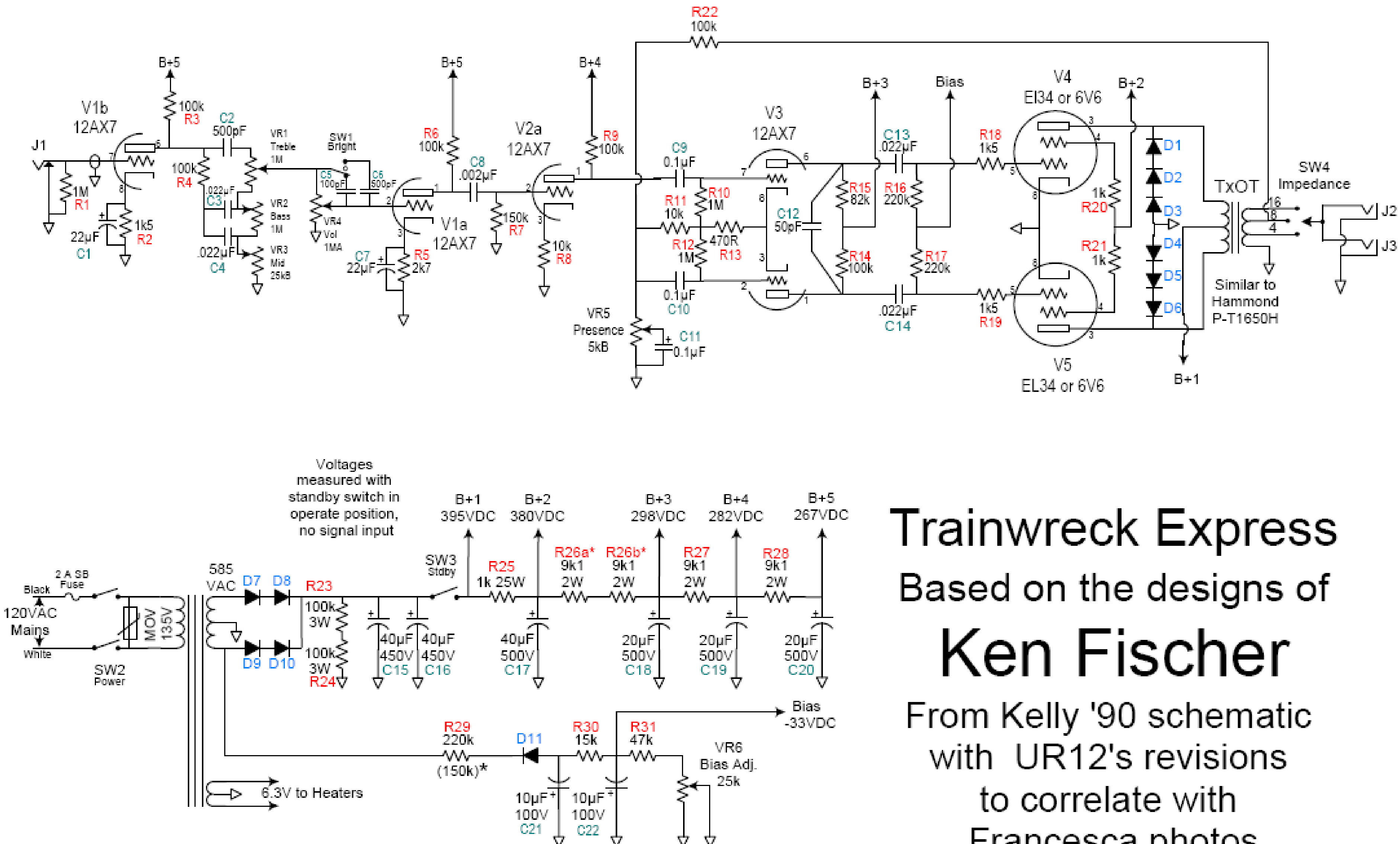
- The Undocumented Express also uses what appear to be Tranny clippings for the B+1 and B+2 leads going from the 25W Cement Resistor on the PS board to the Standby switch, V5 grid and first 40uf PS filter cap. There is probably a really good reason for this- these voltages are 380V+, and the 20 AWG 300V wire used by many is well past rating. I am told that the Undocumented Express is a not a forgery, and there's some logic to what was done there. I also used some of the 18 AWG red and black stranded tranny clippings for the speaker jack wiring.

-The undocumented Express chassis has very noticeable pencil lines forming a grid pattern of what looks like an inch square. This may have been done to get very exacting precision on the lead dress of that amp. This is a pretty good idea really; it might help eliminate some of the instability issues that many builders seem to run into- but that's up to you and your sense of accuracy.

-If you are going to use Teflon (PFTE) insulated wire, please be aware that the fumes of it burning are EXTREMELY hazardous- use proper ventilation and / or perhaps a respirator if you do use it.



-V1-3= 12AX7 / ECC83
-V4-5= EL34 or 6V6
-Input Jack, Pots & Output Jacks are Chassis Grounded
-(3) 20uF Filter Caps stacked on top of (3) 40uF
1K Ohm 25 W
INPUT
VOLUME
TREBLE
MIDDLE
BASS
PRESENCE
STANDBY
POWER
PILOT
MAINS
OT SEC
Speaker
Speaker



Trainwreck Express

Based on the designs of

Ken Fischer

From Kelly '90 schematic
with UR12's revisions
to correlate with
Francesca photos

D- all diodes 1N4007

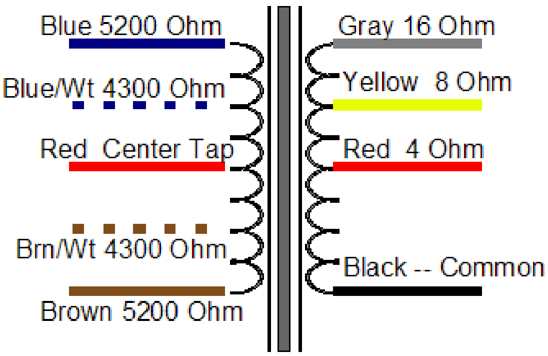
* May need to change values to achieve correct bias. See:
http://ampgarage.com/forum/viewtopic.php?t=1338&highlight=express+bias+resistor

* Show in many TW schematics as a single 18k2 4W resistor, but usually implemented this way

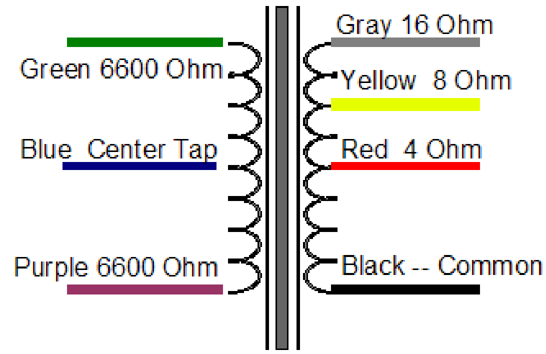
Wiring the Transformers and Power Circuits:

-Wire the transformers to the appropriate components using the diagram below. The PS board is not installed until after this step is completed.

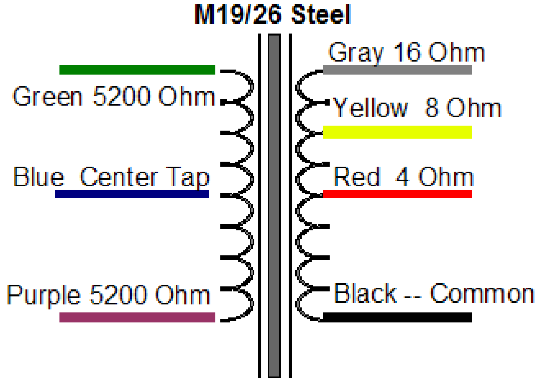
Dual Tap Liverpool/Experimenter's
5200/4300 Ohm Primary
4/8/16 ohm Secondary
M19/26 Steel



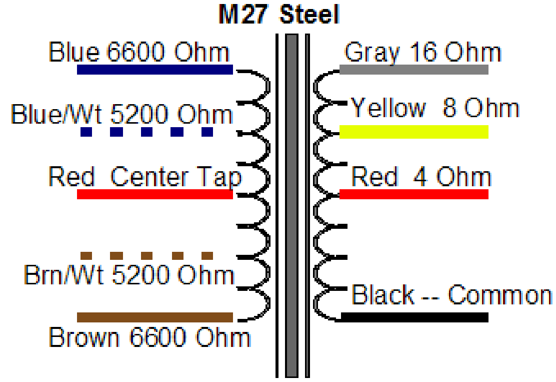
Vintage Spec Express
6600 Ohm Primary
4/8/16 ohm Secondary
M19/26 Steel



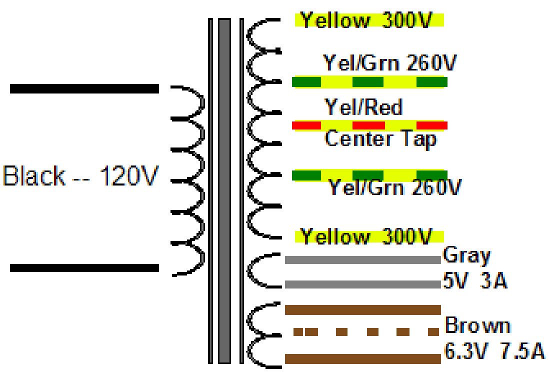
Vintage Spec Single Tap Liverpool
5200 Ohm Primary
4/8/16 ohm Secondary
M19/26 Steel



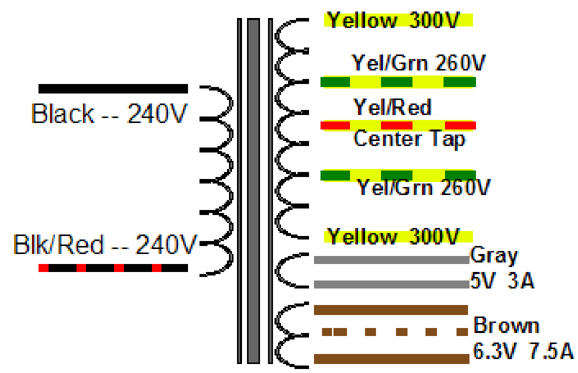
Standard (Old Style)
6600/5200 Ohm Primary
4/8/16 ohm Secondary
M27 Steel



North American Spec
Power Transformer 120V
(Rocket, Pool, Express)



Outside North America
Power Transformer 240V
(Rocket, Pool, Express)



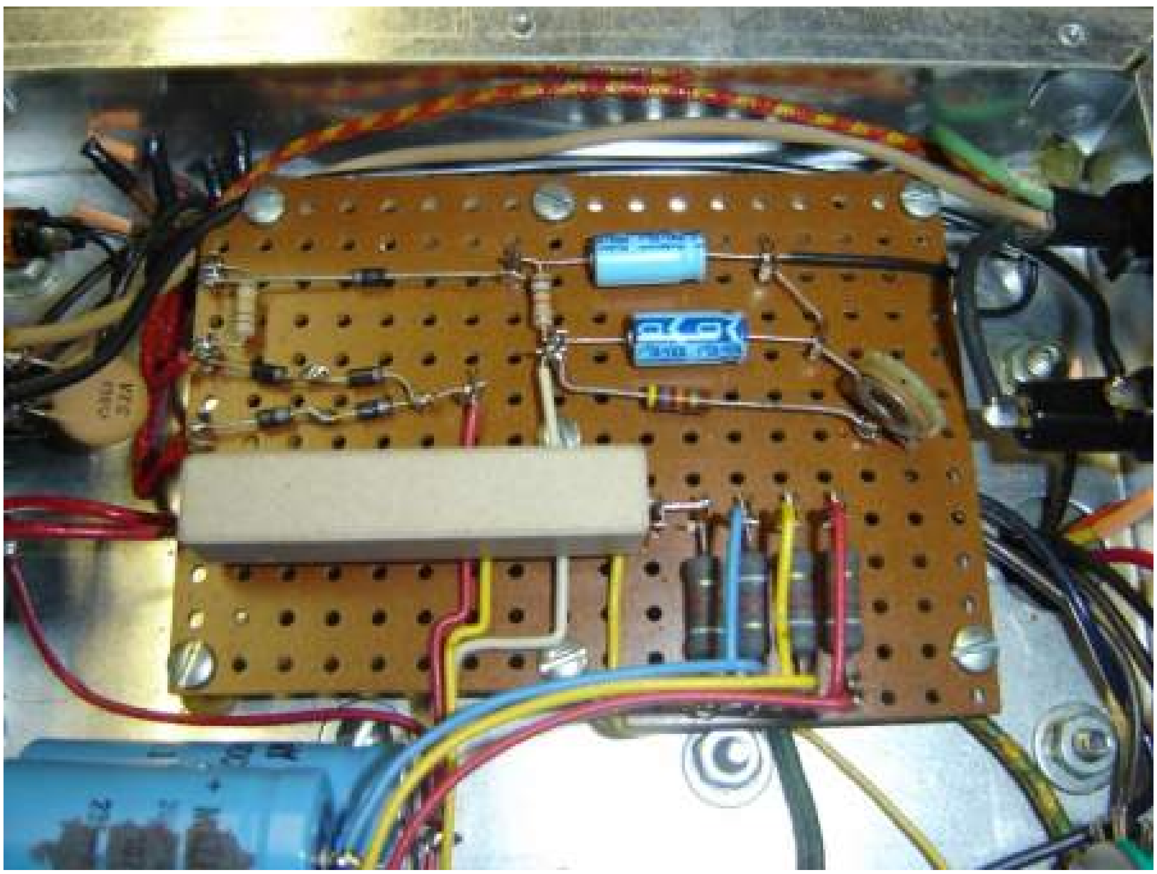
PT Wires

Yellow 300v secondary wires - to diode stack on PS board
Yellow/Green 260v secondary wires - not used
Yellow/Red 0v - to ground lug under power cord
Gray 5v - not used (clip short and heat shrink)
Brown 6.3v - heaters
Brown/White center tap - to ground lug under power cord

OT Wires (Hole under PS board)
Blue wire- to pin3 of V5 (Purple wire on new Toneslut "Vintage" OT)
Brown wire to pin 3 of V4 (Green wire on new Toneslut "Vintage" OT)
Red wire- Center-tap to standby switch (Blue wire on new Toneslut "Vintage" OT)
Blue / White, Brown / White- not used (clip short and heat shrink)

OT Wires (Hole by fuse holder)
Grey wire- to 16 ohm position on Impedance switch
Yellow wire- to 8 ohm position on Impedance switch
Red wire- to 4 ohm position on Impedance switch
Black wire- to ground lug on speaker jack

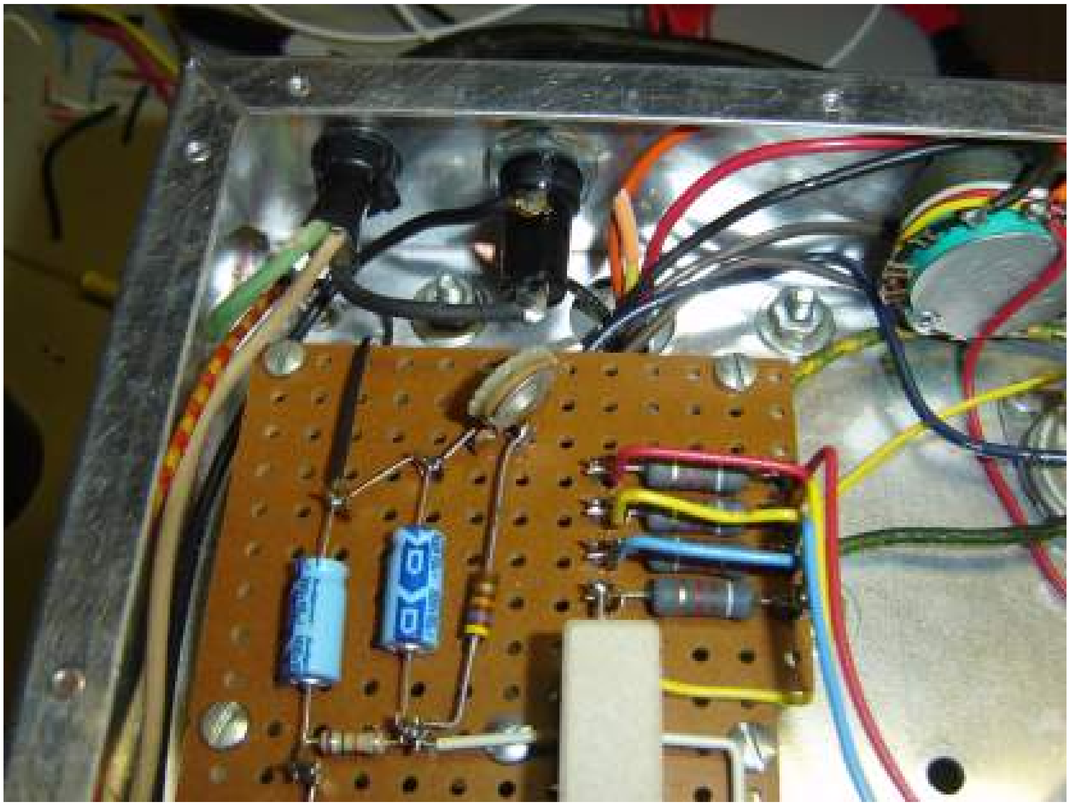
-Here's a picture of how Francesca is wired around the PS board for tranny wires. The OT has another wire bundle that comes through the chassis under the PS board that contains the Brown and Blue wires that go to the V4 / 5 power tube sockets and a center tap to the standby switch.



-There are several wires that are not used on the Toneslut OT- the 2 Yellow / Green 260 wires and the 2 Grey 5V wires (which you would use if you were using a tube rectifier- the Express uses solid state diodes for this function). Clip these wires short and use shrink tube (orange if you're anal!!) to electrically isolate them. See the picture above for details.

-The PT center tap wire on the Heyboer trannys from Toneslut should be grounded to the ground lug by the power cord's strain relief in the back of the chassis. Francesca's PT did not have a center tap, so an artificial tap was made by installing 100 ohm resistors off the V4 socket to the ground lug. It can be done either way… but it's highly recommended to use the Center tap wire if your PT has one.

-Install the power cord at this point. You will have to strip the outer casing back about ~8 inches to have enough white wire to go around the PS board standoffs up to the Power Switch (measure this carefully before you cut!). The black and green power wires will be cut off shorter as appropriate to be attached to the Fuse Holder and ground lug respectively. Save the black wire, you may need it later.



-Wire the power switch, standby switch, MOV (looks like a ceramic cap) and pilot light- extra black wire that connects the fuse holder to power switch is required- you might be able to use PT clipping- the wire from the power cord that you clipped off is too short. Note that the pilot light wires are twisted.

-Run the red OT center tap wire in the middle of the PS board standoffs up to the Standby switch- but don't solder it until after the PS board is installed.

Wiring the OT, Impedance Switch and Output Jacks:

-You've already wired up the Impedance switch with jumpers to the second (lower) gang of the switch. Install the Impedance Switch to the chassis tightly- noting that the 8 ohm lug is at top-dead-center. Install the two shorting speaker jacks to the chassis as shown in the picture below. The shorting part of the jacks are not used, it is presumed that KF used what he had on hand.

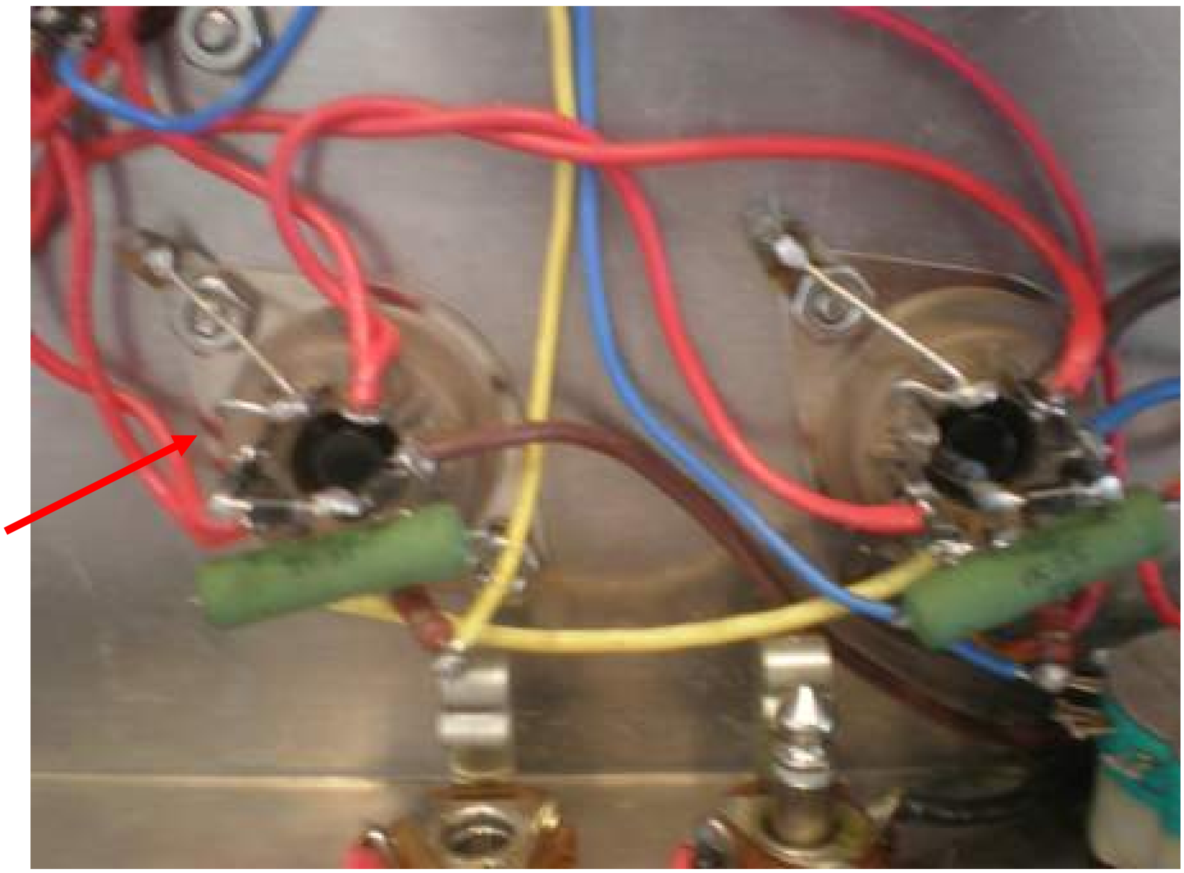
-As noted before, Use 18 AWG stranded wire from the tranny clippings (personal opinion for power handling considerations) to wire the speaker jacks to the impedance switch- note that the right most jack only has a red positive wire; the ground occurs via the chassis. Don't solder the wires on the Impedance switch yet. Solder the black negative OT wire to the ground lug of the first speaker jack.

-Using the picture below, wire the OT leads to the Impedance switch. Solder the lugs at this time. You should have 2 wires per lug (jumper and OT wires on the front 3 lugs and jumper and positive lead to the speaker jack on the back lug). You will also have the NFB wire on the 8 Ohm lug at top-dead-center- This may pose some difficulty getting 3 wires into the 8 ohm lug- I had to take a small screwdriver and enlarge the lug hole.

Wiring the Power Tube Sockets:

-Using the picture below for lead dress guidance, let's begin getting the main valve sockets squared away. Start by soldering a bare wire lead going from the ground lug on the interior mounting bolt / screw of each socket to pin 8 and is then bent over to pin 1. If your tube sockets don't have two lug holes per pin, don't solder it yet. If it does have dual holes, solder both pin 8 and 1 on the bottom hole. This is KF's design, but there's a catch:

If when you're all done building the amp and want to bias the amp using the 1 ohm resistor method you will have to undo all of this. Using this bias method, you must remove the wire bridging pin 1 and pin 8, and then ground pin 1. Rather than redo everything each time you need to bias, I suggest that you run the ground wire from the lug to pin 1, and install a small jumper between pins 1 and 8. This way, you will only have unsolder the jumper from pin 8, bend it out slightly and proceed with the biasing procedure. See below:



-If your PT does not have a proper center tap wire, then you can provide one by soldering 100 ohm resistors from pins 2 and 7 of V5 to the ground lug-see the picture above for details.

-Using (3) 1N4007 diodes for each socket, fabricate the fly-back protection assembly- a semi-circular loop that will "fly over" the middle of the socket, connecting the three diodes between pins 1 and 3. Be very careful not to overheat the diodes when soldering, and ground yourself to something large and metal to prevent any possible damage due to Electro-static discharge (ESD). Also be sure to orient the diodes correctly- the silver band on the black body of the diodes goes on the side of pin 3. If you have single hole lugs on your socket, solder both the ground wire and diode lead to pin 1. If you have dual hole pin lugs solder the ground wire to the bottom hole and the diode to the upper hole. Same goes for other side on pin 3- diode lead on the upper hole, or if it's a single hole, don't solder yet.

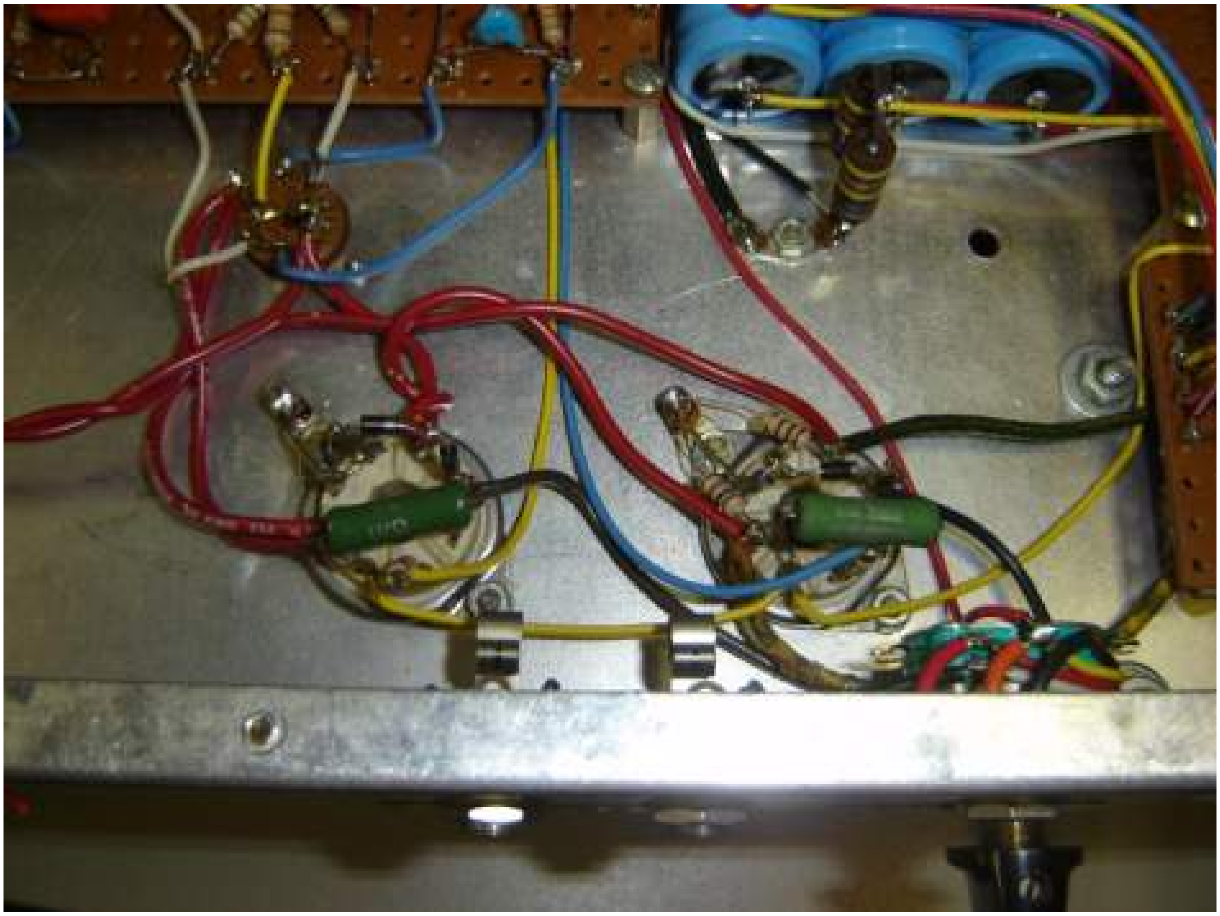
-Solder the OT primary wires to pin 3 of the sockets. Use the pictures below, and make sure that you attach the blue wire to V5 and the brown to V4 for the Heyboer trannys. If you are using some other tranny type, you will have to figure out what wire goes where on your own. If that's the case, consider not clipping these wires to proper length until after you've successfully fired the completed amp up. If all is well, simply unsolder them and clip to length based on proper lead dress. The reason to do this is that if you get it backward, the amp will oscillate and sound very bad.

-Solder the large 5 or 7W 1K screen resistor up over top of the socket to pins 4 and 6. Same drill- don't solder the lead on pin 6 yet if you've got single-hole lugs. Use the pictures to show you how to bend the leads under the body of the resistor to fit into the valve socket lugs.

-Run the yellow wire between pin 6 of each socket- same again on V5's pin 6- don't solder yet if you have single hole lugs.

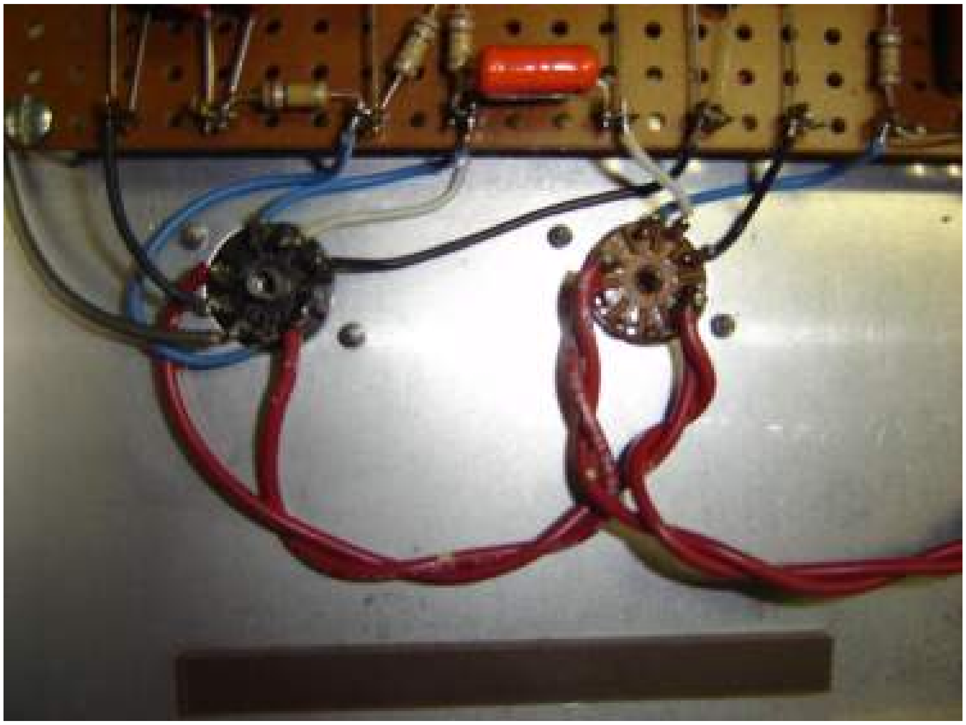
-Solder the 1.5K grid stopper resistors to pin 5 of each socket straight up. You will eventually solder a wire to the other end, but not now.

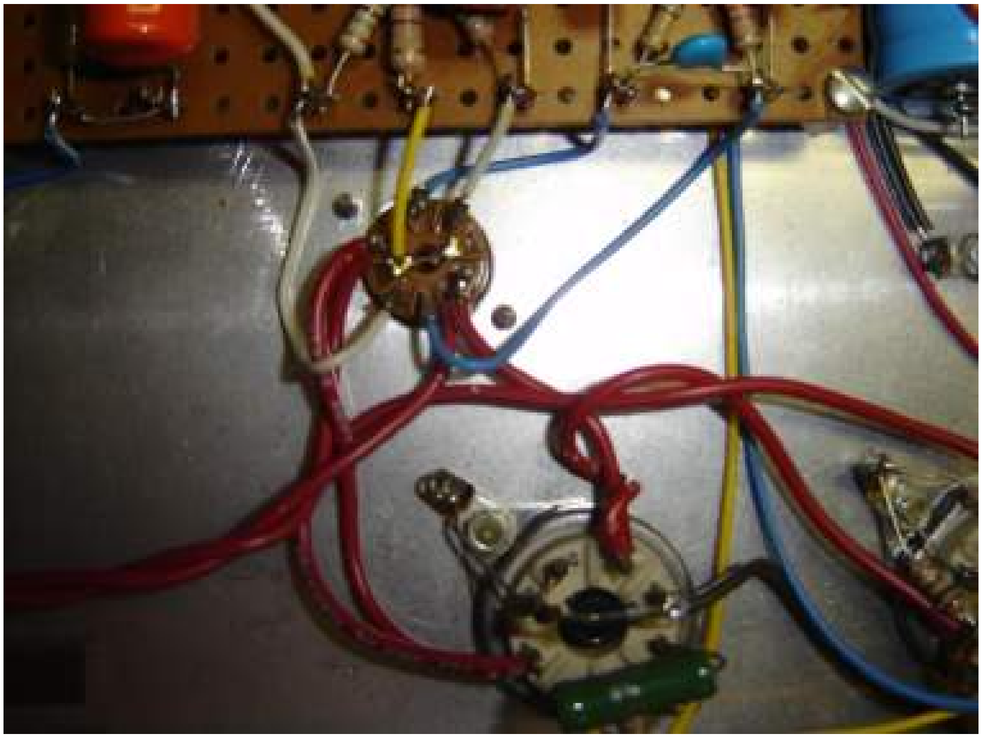
-Run the heater supply wires from the PT under where the PS board will go, taking care to place them between the proper standoffs for lead dress. If you've got the double hole socket lugs, solder them to the lower hole on pins 2 and 7. If not, just thread the wire through the hole temporarily.



Wiring the Heaters:

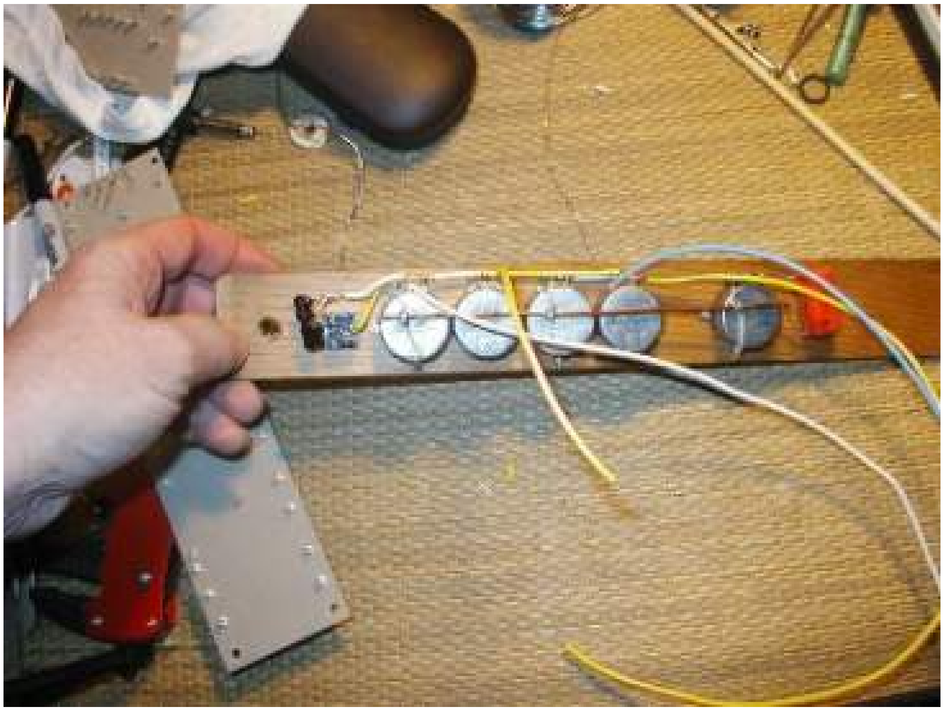
-Using the KF "Lazy Loop" lead dress method and the pictures below, wire the heater wires to the preamp tube sockets. The pictures below of Francesca below detail a potential wiring error- make sure that your filament wire loops go from pin 9 on V1 to pin 9 on V2 and V3, and then to pin 7 on V4 and V5. Likewise, go from pin 4 on the preamp sockets and pin 2 on V4 and V5. For whatever reason, KF wired several of the heaters out of phase; perhaps for some unknown good reason. Lead dress here is very important to minimize hum and noise in the amp.



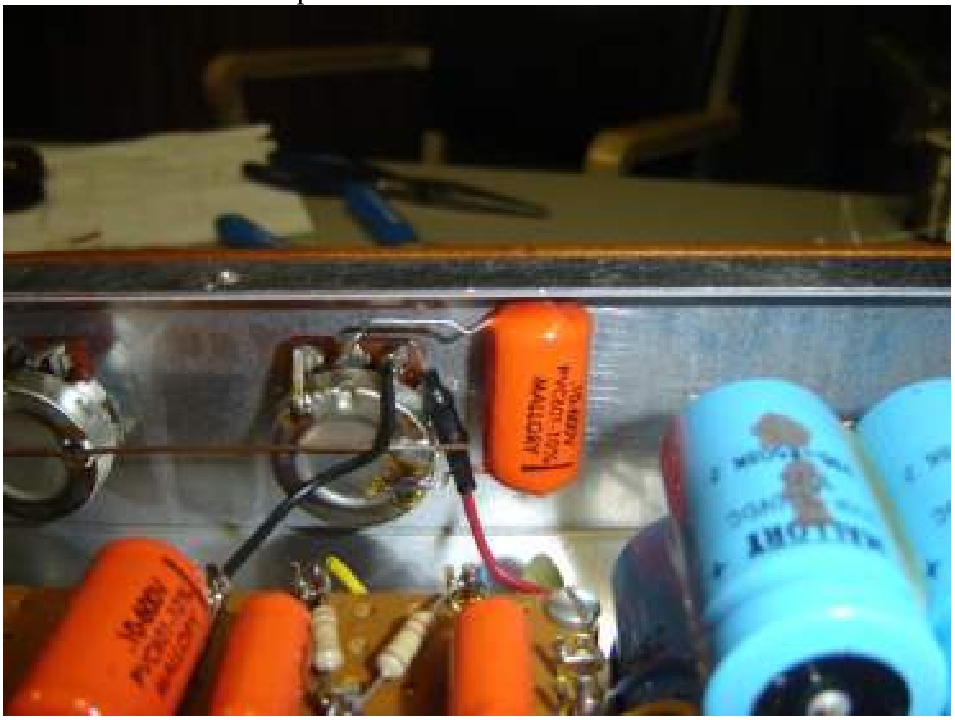


Building the copper wire grounding buss and wiring the Presence Pot:

-This is best done now before you have the Preamp board and cap stack installed to give you the greatest amount of maneuvering room. The Allyn Meyers chassis have significant "lip", as you can see in the pictures. One way to avoid the difficulty of wring under the lip is to make a "pot jig" from a piece of wood (like the faceplate). Gearhead on the forum came up with this idea, and it is a good option. If you are using the copper wire buss like I did, this will be stable enough to transfer from the jog to the chassis.



-Attach the .1uf cap to the presence pot per the picture below. The bottom side is grounded to the pot case or copper bus bar if you are using pots with stainless casings.

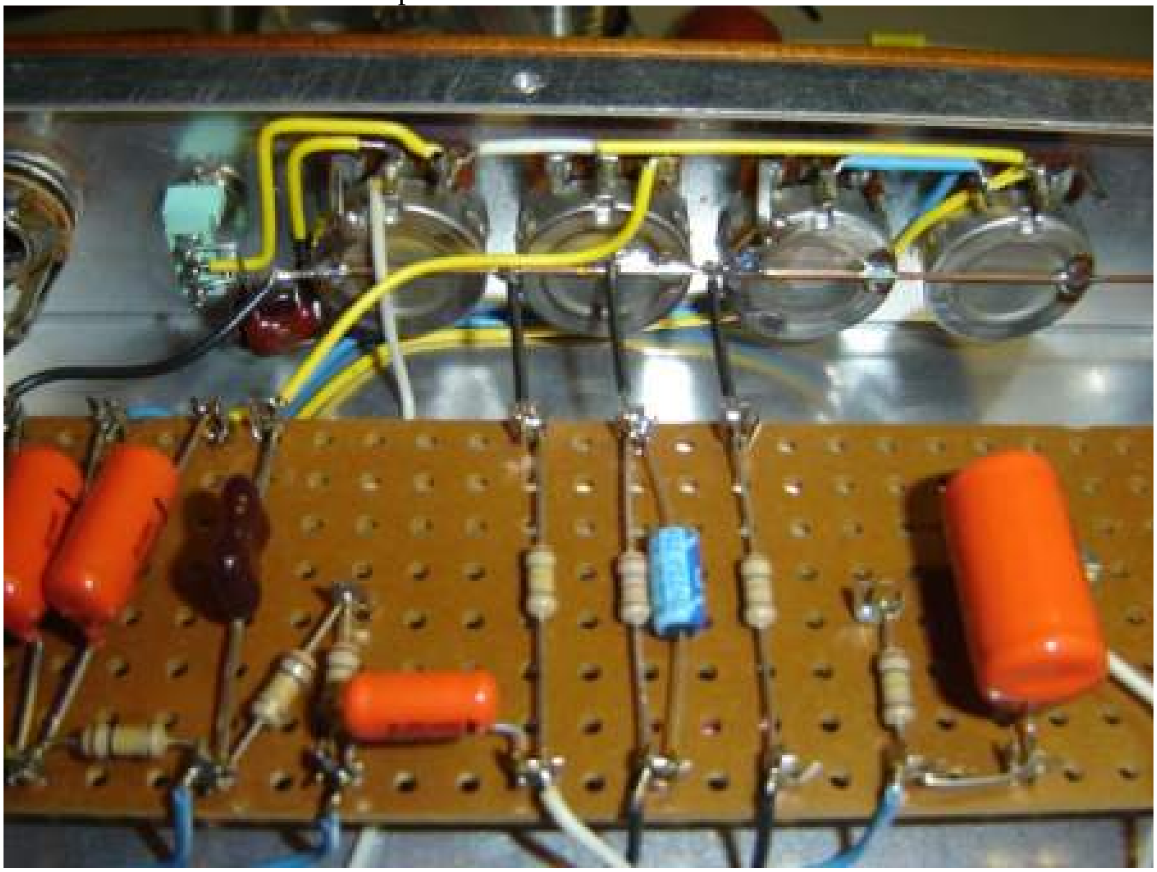


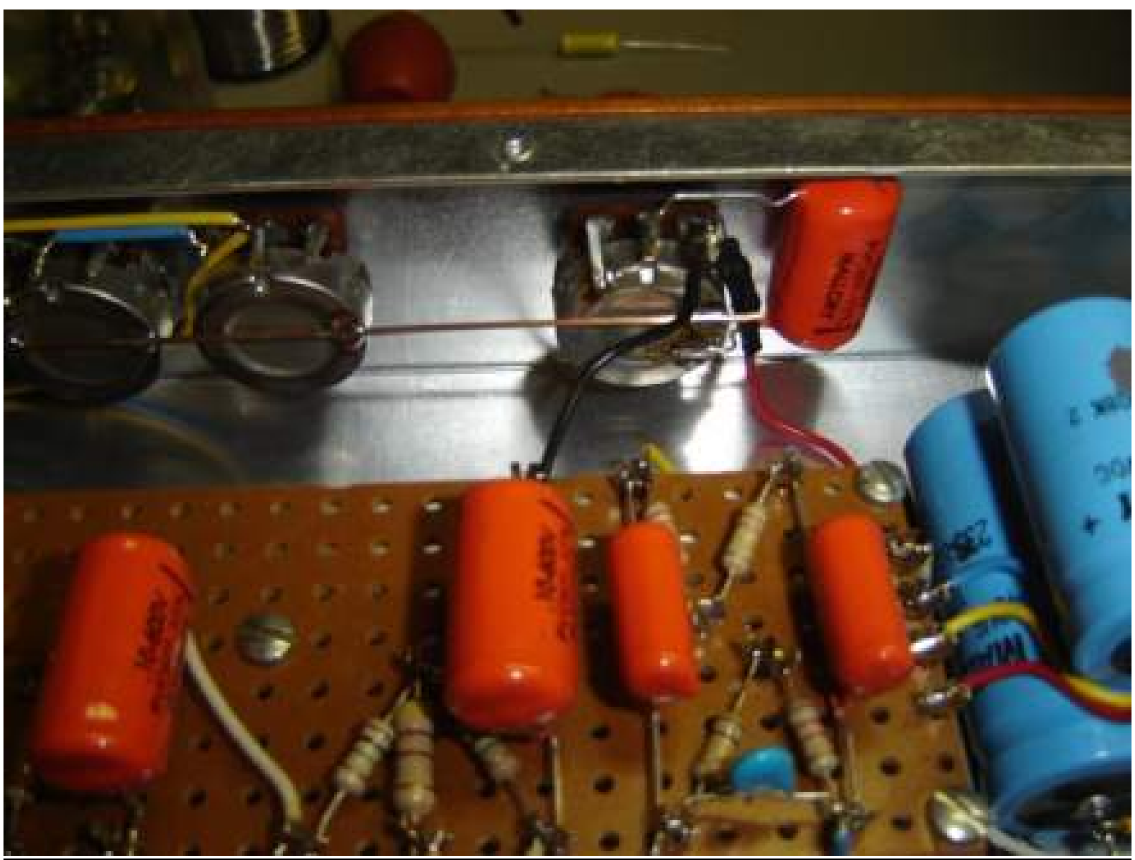
-Feed a ~3/4" piece of shrink tubing over the end of the red NFB wire, then fit the wire to get the proper length to the Presence pot (while maintaining proper lead dress). Using the picture above, in "Wiring the Copper Grounding Buss" for reference. Cut the NFB wire to the appropriate length to allow for a stripped lead to attach to the 100K resistor. Be sure to route the NFB wire outside the Preamp board standoffs before you cut the NFB wire. Solder the resistor to the NFB wire then the other end of the resistor to the presence pot. After it all cools, slip the shrink tubing up over the resistor and bare wires- then use a heat gun to shrink in place.

-If you are using stainless pots and have not attached the ground lugs yet, remove all pots and add the ground lug inside the star washer and the pot. Re-attach to the chassis and tighten.

-Using the #14 or #16 copper wire stripped out from normal Romex household power wire, feed the wire through the ground lugs and solder firmly against the pot casing. The ground right most pot lug of the Presence control (shown in the picture above) is grounded to the pot casing. If you are using stainless pots, you will have to run a very short black ground wire to the copper ground buss wire.

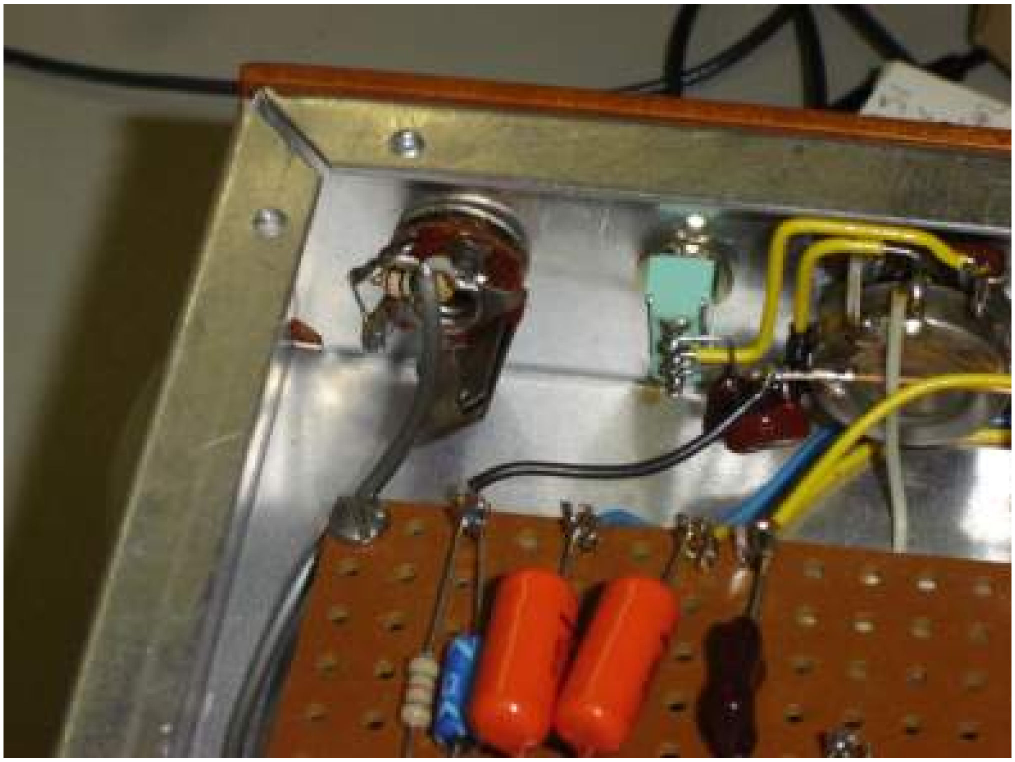
-If you are using non-stainless pots, scrape the desired attach points on the pot casing, and using some flux, solder strongly to each pot casing. Solder the bottom lead of the .1uf cap to the ground point on the back of the Presence Pot. Use the pictures below to help you.

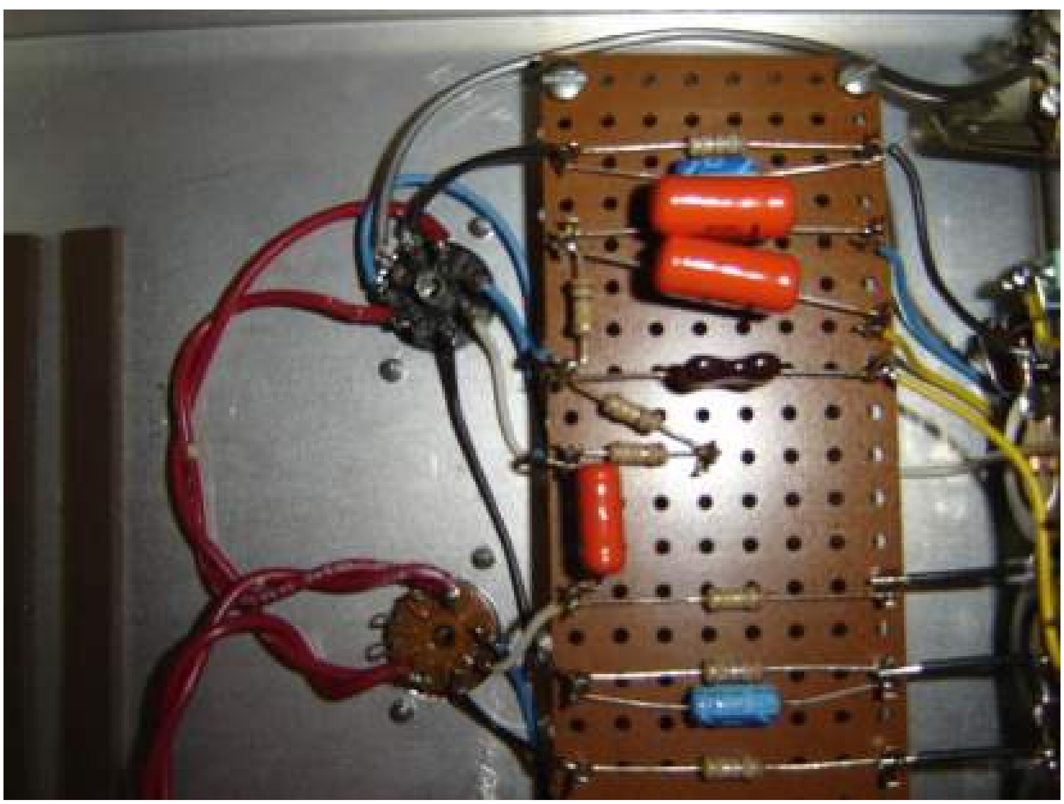




Wiring the Input Jack, Bright Switch and Remaining Pots:

-Wire the shorting input jack with the 1M resistor and shielded cable, making sure to trim the shielding wires back under the insulation on the V1 tube side. Use tinned shielding or stripped 20 AWG wire on the jack side to jumper between the shorting lug and the ground lug. Use the picture below for guidance. Make sure that you use proper lead dress, running the shielded cable outside the standoffs for the Preamp board.



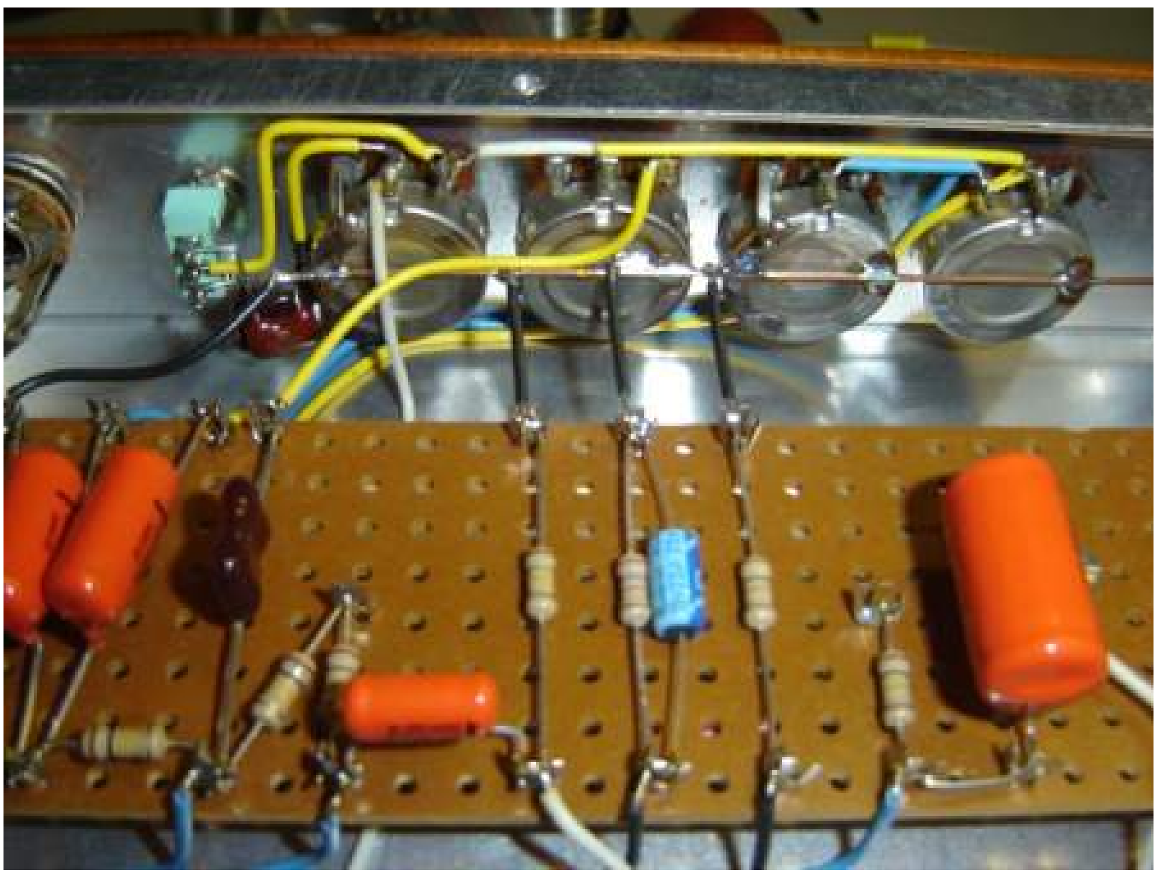


-Silicone the 100 and 500pf bright switch caps together. Put silicone sealant on the back of the bright switch to "glue" the caps to the back of the switch to stop parasitic oscillation- it is reported that KF did this to help with stability. Wire them to the switch as shown in the picture below, using shrink tubing on the leads that go to the volume pot. Make sure that the leads going to the switch from each respective cap do not tough each other. A bit of shrink tubing here would not be a bad idea, but KF didn't do it as far as I know.

-Make sure that you've tightened all of the pots securely to the chassis.

-Install the wires going between the pots at this point to give you maximum maneuvering room. Lead dress here is paramount- even minor variances are reported to cause stability and tonal differences.

- The ground right most pot lug on the Volume and Mid controls (shown in the picture below) is grounded to the pot casing. If you are using stainless pots, you will have to run a very short black ground wire to the copper ground buss wire.



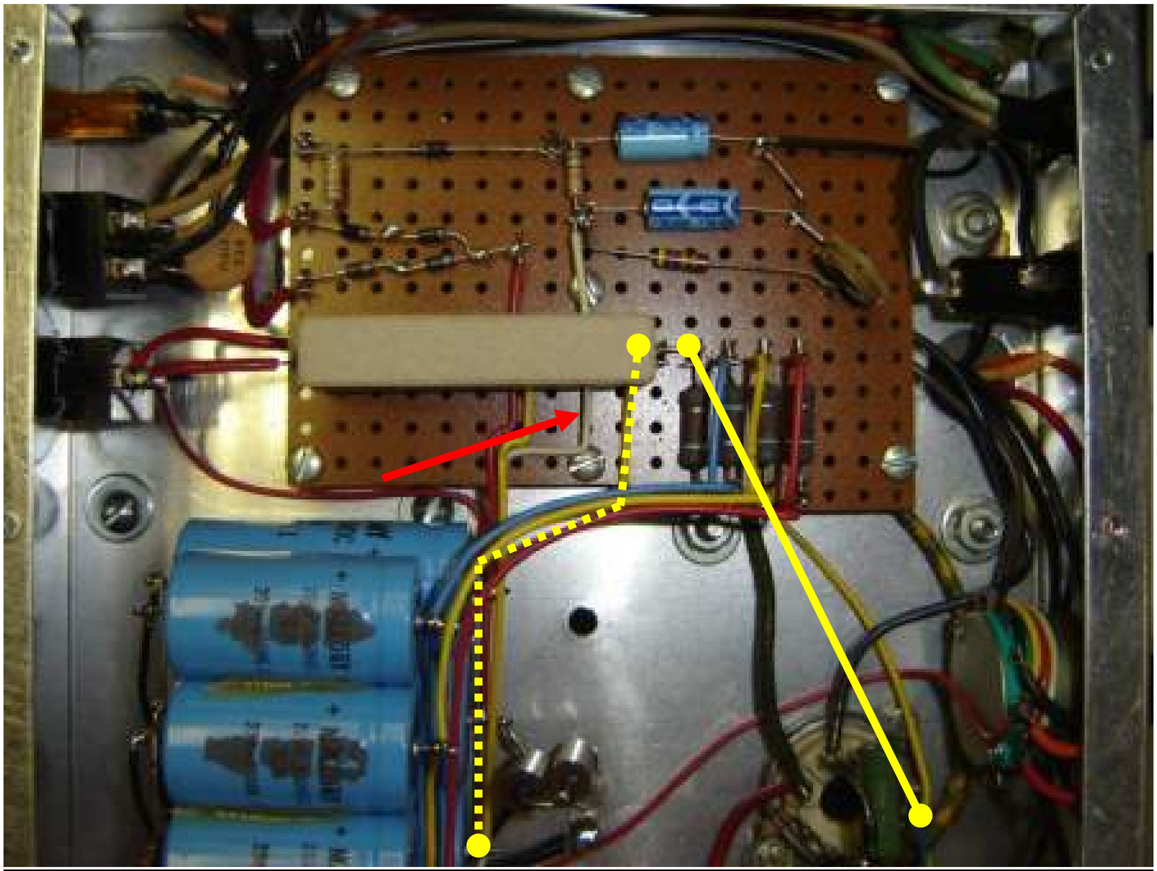
-The leads from the pots to the Preamp board will be installed later after the board is physically in place..

Installing and wiring the PS board:

-Use black 20 AWG for the lead from the ground lug to the 10uf bias caps.

- Use a clipping of red 18 AWG stranded wire left over from the PT for the lead from the Standby switch to cement power resistor- don't solder it yet.

-Carefully measure the length of the PT secondary wires that go to the lugs at the diodes on the PS board. Once you're sure, solder them to the lugs- you don't get a do-over on tranny wires….



-As I will explain in the section on wiring the cap stack, there is an issue on the gauge of the wires used between the PS board and the cap stack- KF appears to have used 20 AWG 300V wire. The B+1 and B+2 are almost 400V- well above the 20 AWG rating. I am suggesting that you use 18 AWG stranded wire- tranny clipping work great. If you buy into my thinking, then you will discover that the wire indicated above causes a real problem if it's 18 AWG lying over the white bias wire (red arrow). The Cement resistor will not lay flat or level on the board, making it difficult to connect on the end by the Standby Switch. My recommendation is to use the 18 AWG, and run this wire under the board and then to the 40uf cap as indicated above with a dotted yellow lines. Of course, don't run it in a straight line as drawn, curve it over to the cap stack and along the front of the 40ufs to the left most cap's lead.

-Using more 18 AWG stranded, run the B+ wire supplying the Power tubes to pin 6 on V5. Solder it to pin 6 and the wire going to pin 6 on V4 if you have single hole socket lugs.

-Now that the PS board is in place, trim and install the red OT Center Tap wire to the top lug of the Standby switch and solder it and the red B+ wire going to the Cement Resistor on the PS Board.

Building and Attaching the Filter Cap Stack:

1. Align the three 40uf caps as you wish to orient the wring on the casings. Use a small clamp or tape to hold them in position. Before "Gluing" them together with silicone, consider soldering their ground leads together. Look at the picture of Francesca; you can see that the left most lead (looking from the positive lead side) is wrapped around the center lead once then over to the right most lead for soldering. The center lead is then soldered around the wrapped lead. You can put a piece of tape on one side to hold them together and then apply some GE Silicone sealer or hot glue into the grooves between the caps. Let sit for about an hour, then GENTLY roll them over and apply silicone on the opposite side. Let cure for a couple hours. A black ground wire goes to the solder lug in front of the cap stack and is soldered to the right most 40uf cap lead- but wait until the whole stack is done to attach the wires.

2. At the same time “glue” the three 20uf caps together like the 40uf, making sure to orient the cap labels on the top like KF did. Then solder the ground leads of two left most 20uf caps together (looking from the positive lead side). The right most lead is just clipped off at about 3/8”. You can put a piece of tape on one side to hold them together and then glue in the same manner as the 40uf set. The ground lead wires to the 20uf caps are ultimately attached to the center and right most (independent) cap.

After both sets of 3 caps have dried, begin assembly of the completed stack by applying silicone to the tops of the 40ufs and the bottom of the 20ufs. Place the 20’s onto the 40’s and affix them with the centerline of the middle caps aligned. Consider squiring some more silicone into the gaps between the caps to get an extra secure stack. Use caution however, this stuff sticks like crazy and is hard to clean up. Use a couple clamps of pieces of tape to hold them in the correct position if you need to. See the picture below for the proper alignment:

Let cure for a couple hours. You should dry fit the finished stack first of course, before proceeding to the next step.

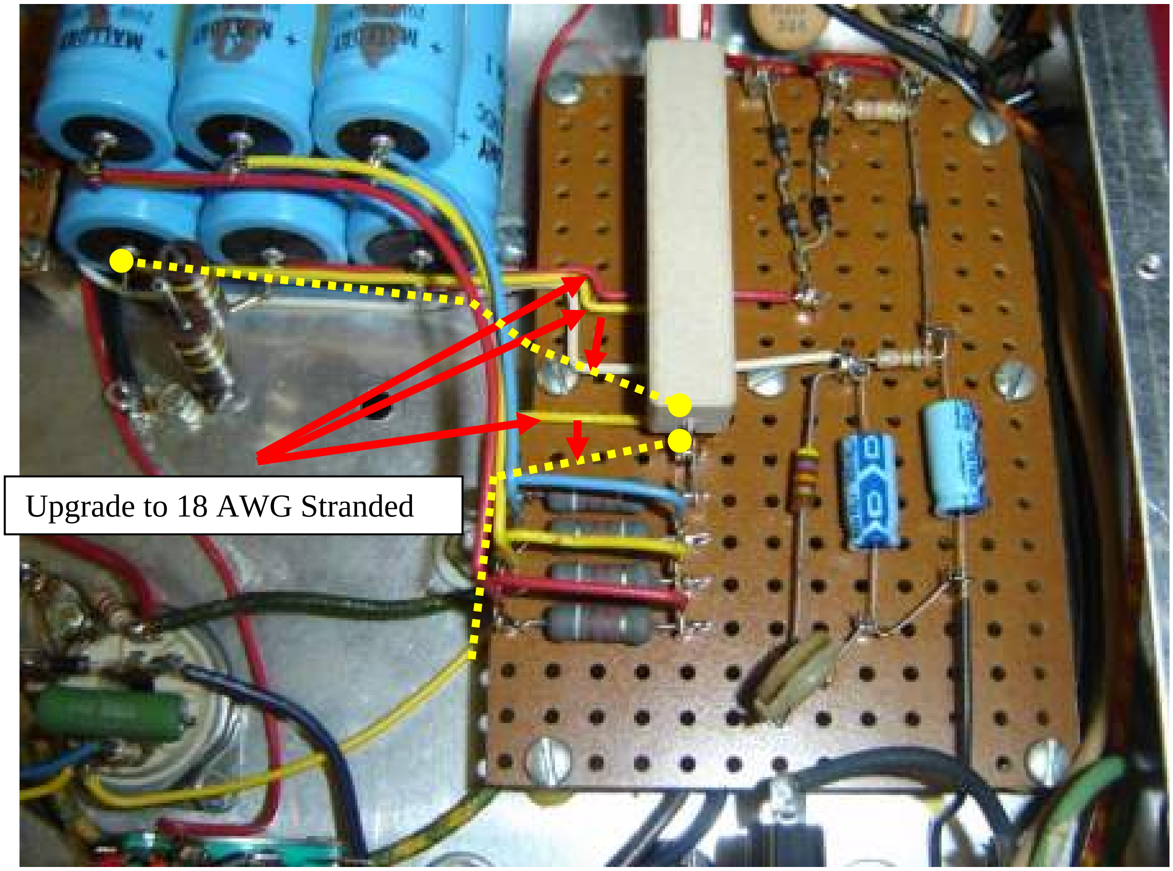
3. Wire up the back wire connections and leads to the back of the cap stack before mounting to the board- it's a bitch to try to wire them in place. The front leads can be done after the stack is in place. See the picture below to visualize the wiring and rear lead setup.

4. Take a hair dryer or heat gun if you have one- The glue will harden slower if you pre-heat the chassis, giving you time to work. Heat the chassis under where you will put the caps...not to hot! Put your hot glue on the chassis and to the two grooves between the three 40uf caps, invert the stack and set it into place. Jiggle them back and forth a little to get maximum coverage and minimum space between the caps and chassis (this will eliminate the caps sticking up too high in the chassis). Align the stack so that the head of the PT attachment bolt sits into the "notch" of the right most 40uf cap. Use the edge of the preamp board to align the back- make the left most 40uf cap sit parallel to the edge. You should have PLENTY of time before the glue hardens. This works great. I was told the vinegary smelling silicon contains acetic acid (hence the smell) and can corrode aluminum over time. I'm not sure but better to be safe. Let cure overnight. This holds the caps very securely and it looks OK unless you got sloppy with the silicone. It's possible to cut and scrape the excess off if you demand total neatness.

Wiring the Cap Stack:

-Mount the Preamp board onto the previously installed standoffs using #6 lock washers and machine screws.

-Wire the cap stack to the PS and Preamp boards using the pictures below (lots of personal opinion here):



-As I noted before, the wires identified above (running under Cement resistor) are 20 AWG on Francesca. If you use the technique of 18 AWG stranded for all B+1 and B+2 wires, the cement resistor will not lay flat on the PS board. The bent yellow wire also lays over the white bias lead- which causes the cement resistor to sit way off the surface on the side by the power switches. I suggested wiring the bent yellow lead under the board to the cement resistor's solder lug, and the lower yellow wire to the lug that the first 9.1K bleeder resistor connects to - not 100% KF, but much easier to work with (and electrically safer IMHO). If you make all three wires 18 AWG, you can run them all under the cement resistor- but it will be well off the board surface. Your call….

-Solder the red jumper wire between the leads of the middle and right most 40uf filter caps.

-Run the red wire from the diodes to the right most 40uf filter cap. This wire carries high B+, so consider up-rating it to 18 AWG stranded tranny clippings.

- Run the white wire from the bias circuit to the preamp board under the cement resistor. Note how the wire is laid across the front of the 40uf caps and wrapped around them then up to the Preamp board.

-Run the flying leads from the 9.1K dropping resistors to the 20uf filter caps. Pay careful attention to how nicely KF arced the wires so smoothly- there are no kinks whatsoever. Also note that they go vertically for ~ ½" before they start towards the cap stack. Don't solder them to the 20uf cap leads yet.

-Run the blue / yellow/ red B+ wires from the 20uf caps to the Preamp board- start with the blue first, then yellow, then red.

-Solder the ground wires from the back of the cap stack to the Ground lug as shown above, then the dual 2W 100K Bleeder resistor assembly between the ground lug and the center 40uf cap's front lead.

-Install and solder in the 9.1K dropping resistor flying leads now if you haven't already. Be careful, the proximity of these jumpers to the flying leads going to the cap stack makes it very easy to accidently burn their insulation.

Wiring the Preamp Board

-Wire the flying leads to the preamp tube sockets using the schematic and the picture below as guidance. Needless to say, lead dress is vital here….

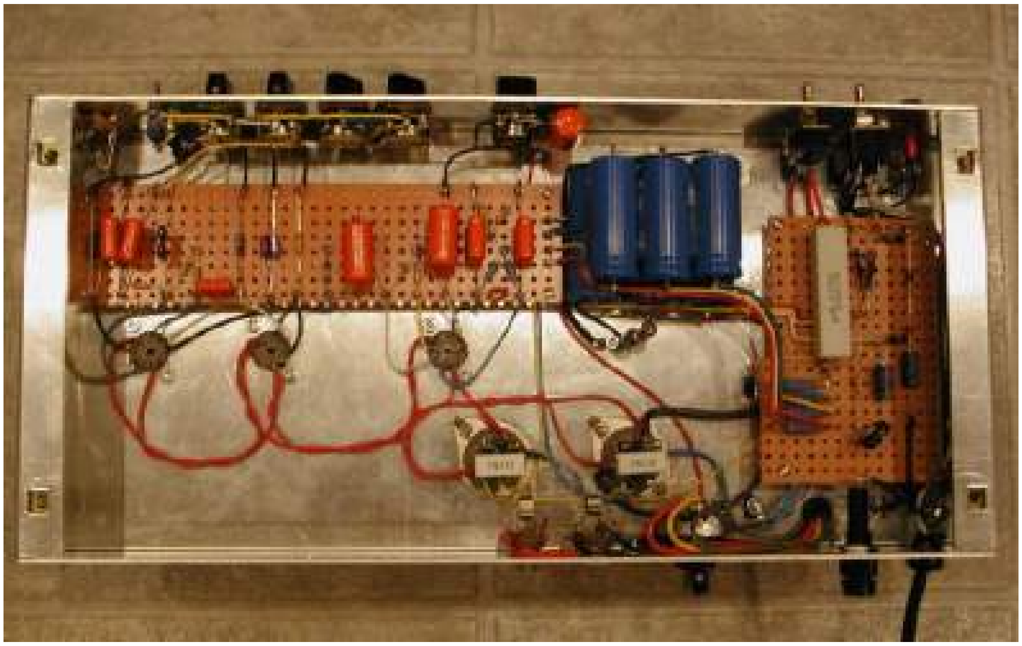
-Some builders use shielded cable from the center lug of the Volume pot to grid of V1a (pin 2) and a 33K or 68K grid stopper resistor directly on the grid of V1b (pin 7) to help with stability.

-All of the signal wires off the preamp board go straight down to the aluminum chassis to act as a shielding, and so that they don't run parallel to other wires. You'll even see a few wires that form loops over a filament wire.

-The ground wires from the Preamp board are short and direct to the grounding buss to isolate them from signal wires down on the chassis.

4. Final Construction Details:

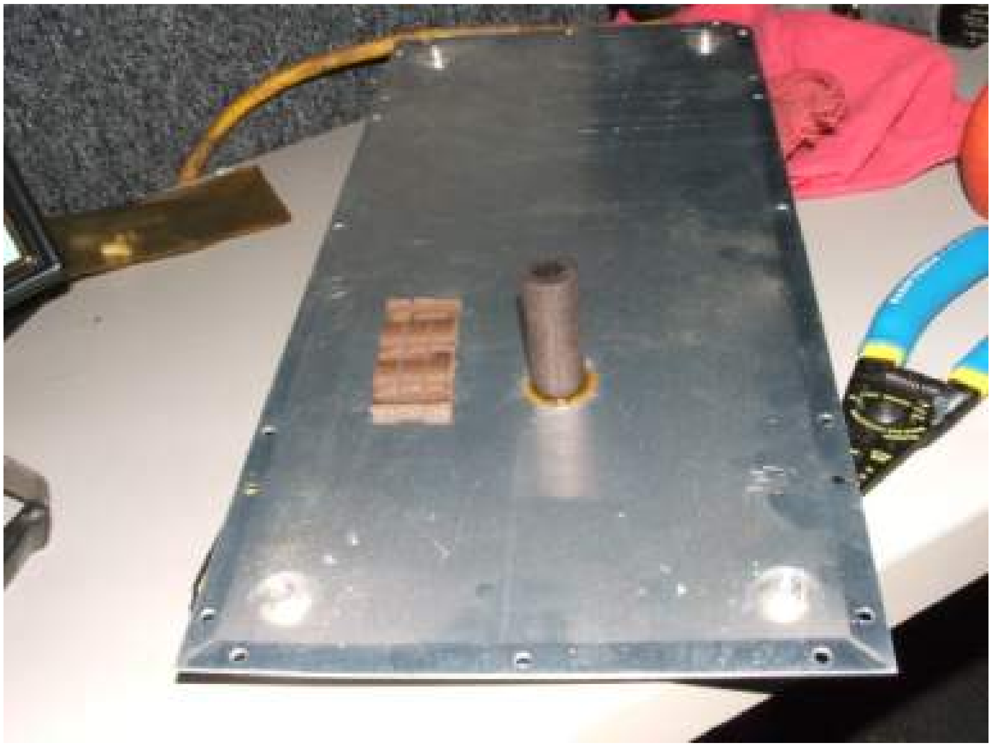
-You're almost done…. Certainly the hard part is over with. Here's what your creation should look like (picture courtesy Dana Hall (UR-12 on the forum)):



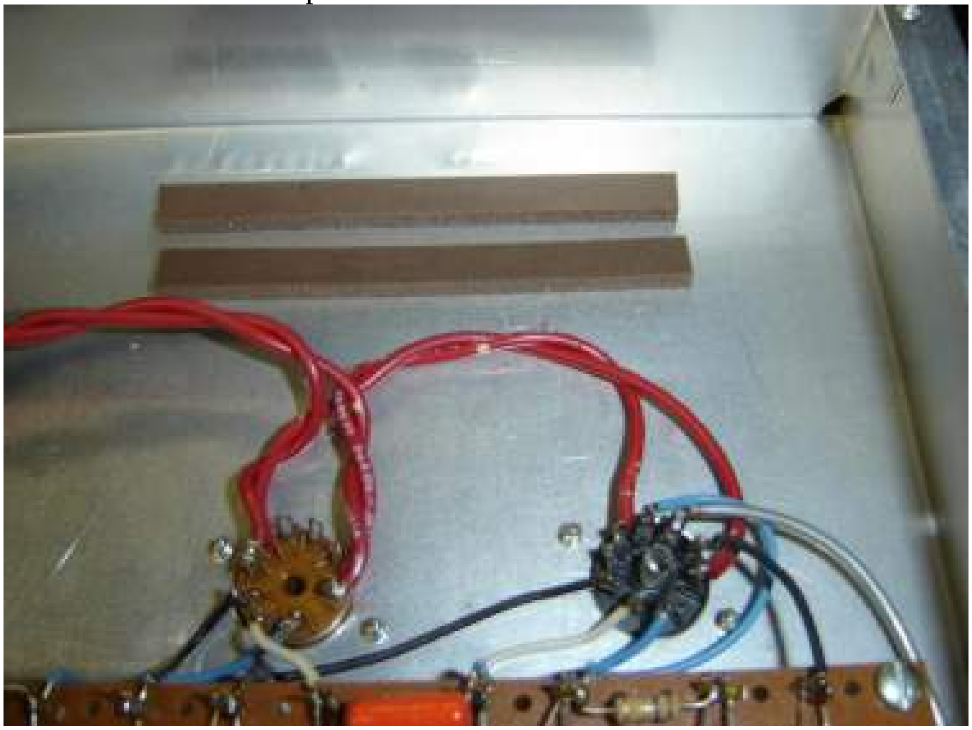
-There are still a good number of things left to do before you're going to take your masterpiece to a gig.

-If you're 100% KF on this, you will do several things differently which are not needed on the Ceriatone or Allyn Meyers chassis (see pictures below):

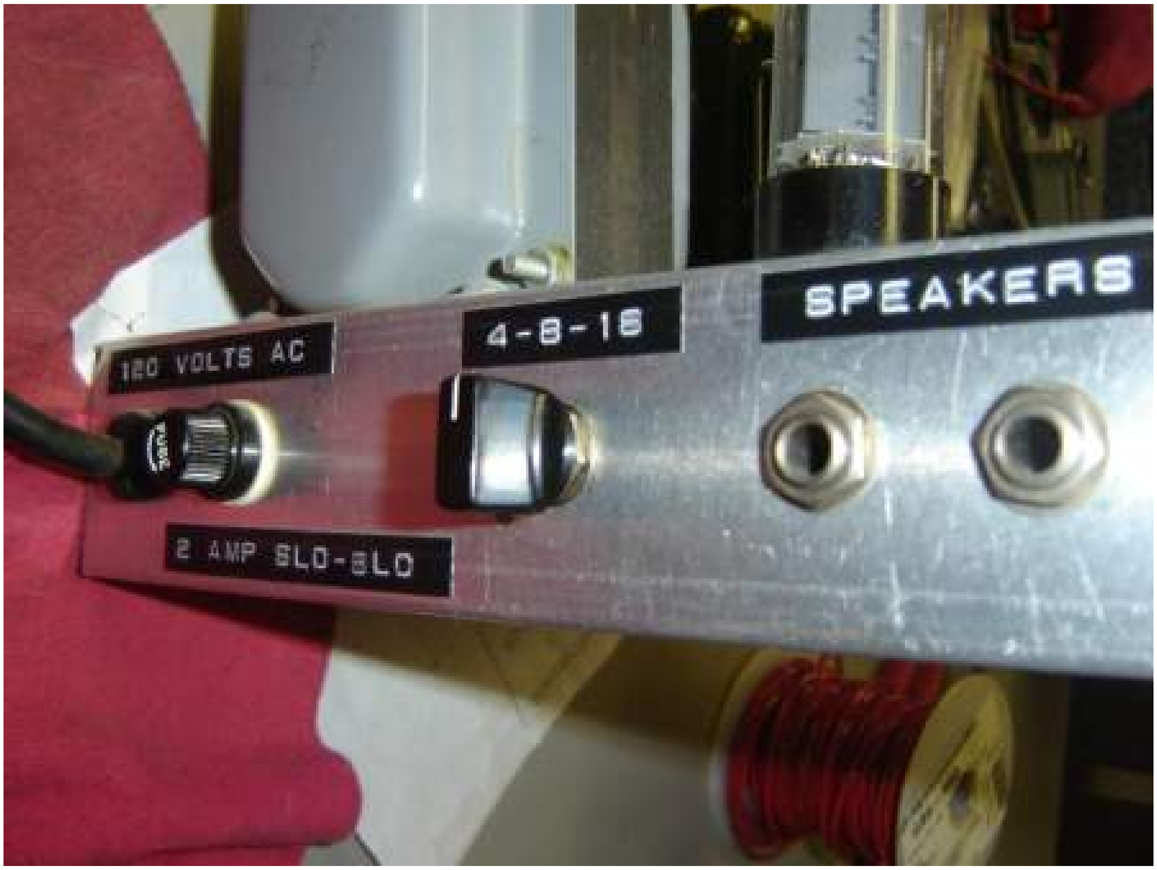
-You will add a dowel between the trannys for mechanical stability.
-You will attach a hollow dowel that is used with a 1 ½" #10 machine screw to support the bottom plate on the flimsy Bud chassis that KF used.
-You will install the 4 "Nutserts" into the bottom plate that allow the chassis to be attached to the cabinet.



-Attach weather stripping by preamp tube sockets and on the bottom plate where the caps will touch. A piece also goes along the bottom edge of the cabinet's front panel to plug the gap between the chassis and cabinet.



-Label the chassis back panel (and bottom plate support bolt if you are using the BUD chassis) with DYMO label tape per the pictures below (I used a newer technology Brother labeler and it looks great; it's up to you and your desire to be 100% authentic to KF's methods):




CAUTION
THIS UNIT MUST BE GROUNDED


REMOVE TO SERVICE

5. Setting up the amp

Tubing the amp:

This is one of the most important, yet highly subjective aspects of amp building. The Express seems to be one of the most sensitive amps regarding tube selection, particularly for the V1 Preamp tube. I've gathered some in puts from the forum and others for your review. What you end up doing is going to be down to your budget and ability to find appropriate tubes.

Mike Krotopkin (KCA NOS Tubes) - "(For inexpensive startup tubes) I'd go with Tung Sol Reissue 12AX7s ($15 each) and SED EL34s ($40 per pair). (For a final tube selection) The NOS Siemens are great EL34s and I have them in stock too".

Glen: For his clones: "Both amps had the same tubes, early 60s Sylvania 12AX7s and new GT EL34Ms #7 rating biased at about 45ma.The Youtube video clips are with old Telefunken (Mullard relabeled?) preamp tubes, and Groove tube EL34s".

Wreckboy: "That amp was loaded with Siemens EL34 (Groove Tubes grade 4 which was Ken's favorite for that particular brand of EL34s). Tungsgram ECC83 (V1), Yugoslavian ECC83 (V2) and another Tungsgram ECC83 (V3). Ken used mostly Tungsgram and Yugoslavian pre-amp tubes because he felt they were the best preamp tubes that were available at the time, although not necessarily his all-time favorites. That class of favorites included the golden era tubes inculding Mullard, Amperex, Valvo, Telefunken".

Allyn Meyers: "NOS Siemens are the power tubes for the Express. Make sure they are matched. Preamp tubes are NOS Tungsrams or Pre war EI's. That is the TW sound. You can make it darker or brighter by mixing up different NOS tubes but, Ken liked those and usually shipped the amps with those. They are transparent. It sounds like you have a speaker plugged into your guitar with no amp...only really f%^$ing loud"!

Don't put the tubes in yet, you need to test the amp without them first!

Pre-startup Steps:

-Before you apply power to your new creation, take the time to do some house cleaning. Use can of compressed air to really hit all the nooks and crannies in the amp. If you're using some used tube sockets (particularly for the power tubes), re-tension the connectors inside the socket- I have a specific tool that looks like a small ice pick for the job.

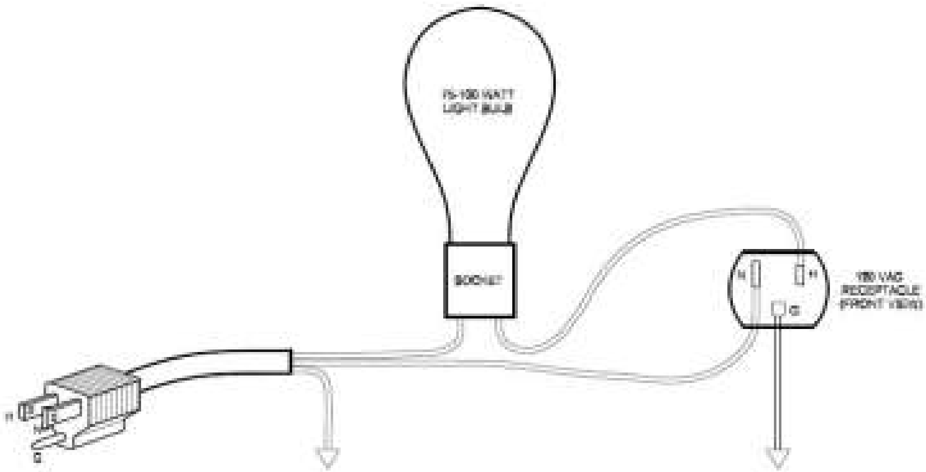
-Set all controls to minimum before starting, it will cause less "strain" on an unproven circuit.

-If you have one, put the amp into a cradle so that you can work on it while it's upside-down and safely power it up with tubes installed. Here's a picture of mine that I built (with a Princeton in it):

Simple Startup Procedure (courtesy of Brownote amps, modified for the Express):

VERY IMPORTANT WARNING!!! You're about to power up a potentially lethal device. That means, if you don't know what you're doing you could die! If you're unsure about anything in the power-up steps, find a friendly amp tech and pay for assistance. It could save your life.

NOTE: On first power-up, use a bulb limiter or Variac. It will keep you from destroying some very expensive parts if there is any problem with your amp. The drawing below shows a 75-100W lamp, but I typically use a 40W to start with. I built a self contained version in the second picture below:



Before turning on the power:

1. Recheck all mechanical and wire connections. Make sure all screws and nuts are tight. Carefully inspect all solder joints. Recheck all connections and compare to the layout and photos. Most amp problems are due to silly things that are overlooked during assembly.
2. Set the Bias trimmer to the middle point, install the 2 amp ***Slo-Blo*** fuse and hook up speakers or a load box. Make sure the impedance selector is set correctly.

Setting max negative bias voltage:

1. First, locate the bias trimmer (located on the PS Board). With your DMM set to the highest DC Voltage range, measure the bias voltage with the amp on ***BUT in standby, no B+****!!!* The best way to measure the bias voltage is place the positive or red lead onto the power tube grid (pin 5 for an EL34 or 6L6) and the negative or black lead onto a good chassis ground connection. I use leads with small "hooks" that prevent the lead from slipping off. Apply power to the amp using only the power switch, not the Standby. The bulb may glow for an instant, but should immediately settle down to no glow or at most a very dull light glow. If you get a bright glow, IMMEDIATELY THROW THE POWER SWITCH TO OFF. If all is well, turn the bias pot to read the MAX NEGATIVE voltage and record that value.
2. Here is an expanded excerpt from the Duncan site to say this in another way:

"Turn your amp on, but leave it on STANDBY. Set your DMM to the highest DCV scale, ground the black probe to the chassis, and take a reading from pin FIVE of any power tube socket. You should see a negative voltage in the -35 to -50 volt range if the amp has EL34s. Amps which use 6V6s will usually have bias supplies which produce voltages that are similar to EL34 amps...but not always. Note that you should **not** have any power tubes installed in your amp yet".

3. If you have any issues at this point, make sure to drain the caps before doing ANY troubleshooting. I use a 10W 1K cement resistor with lead attached to each end. Apply one end to Pin 1 of any preamp tube and a good ground. Wait for several minutes, and then use your DMM to test for any B+ voltage off the caps.

4. You can also use a Variac to slowly apply voltage to the amp. If you use this method, set up your DMM to measure DCV on the caps (I suggest using the clip on type leads) with the Variac set to Zero Volts. Throw the power switch on the amp to ON, then the Variac. Add Voltage slowly (maybe 10V every couple seconds) until you get to half power (~200V). Bring the Variac back down to zero, then throw the Standby switch to ON and bring it all back up to full wall voltage (120VAC). You can use your DMM to measure that exactly if you like.

Power-up with Bulb Limiter, No tubes installed

1. With NO tubes installed, plug the amp into your bulb limiter and turn on the Mains switch. The bulb should have no glow. If the bulb glows, recheck all wiring until you find the error.
2. Switch the amp from standby to ON. Your bulb limiter should flash at first and then return to a dull orange glow. (The flash is from the caps getting their initial charge.)
3. Using a digital multi-meter (DMM) on the ACV setting, check for heater voltage between Pin 4 and Pin 9 of V1. Checking at V1 will check heater connections for the entire harness. Note: The bulb limiter will affect your voltage readings so don't panic if you have less than 6.3VAC.
4. Switch your DMM to ACV to check the supply voltage from the wall at the ON switch and then the across PT secondaries where they attach to the PS board by the diodes. Switch to DCV and check for high voltage DC on the filter caps and B+1 through B+5. At this point, the B+ voltages on the caps will all be similar as there are no tubes installed, therefore no load or current flow.

5. Check for high voltage DC at all plate voltages on the preamp and power tubes (Pins 1&6 on V1-V3, pin 3 on V4-V5).
6. Check for negative DC voltage on the bias pot wiper.
7. If everything checks out, turn the amp off bleed down the caps using a power resistor. (Since there are no tubes installed, the caps take a little longer than usual to bleed down).

Power-up with Bulb Limiter, Tubes Installed

1. Make sure you've bled the caps down with the power resistor (yes, I'm being anally repetitive on this point; it's your life you're gambling with here). Install tubes and connect a speaker (or speaker load) to the speaker jack.
2. Connect the amp to your bulb limiter and turn on the Mains switch. The limiter should glow slightly as the heaters draw current. Dim the lights to check all tubes, making sure that the heaters are all glowing.
3. Switch the amp from standby to ON. The limiter will flash and should then return to a dull glow. Repeat all voltage checks. Remember that all voltages will be lower due to the bulb limiter- B+1 will be perhaps around 260V, with the other B+ voltages accordingly lower due to the dropping resistors.
4. If everything checks out, turn off the amp and disconnect the bulb limiter. You can now plug the amp into a normal AC outlet and do your final checks.

Trainwreck Express Voltage chart V1.1					**Amp Name / Serial #:**				
V1 - 12ax7	**V1a**					**V1b**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	anode (plate)	grid	cathode	heater	Jumper	anode (plate)	grid	cathode	heater
Expected	**210**		**1.9**	**6.3 VAC**	**h**	**182**		**1.5**	**6.3 VAC**
Actual									
V2 - 12ax7	**V2a**					**V2b**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	anode (plate)	grid	cathode	heater	Jumper	anode (plate)	grid	cathode	heater
Expected	**267**		**2.8**	**6.3 VAC**	**h**	**na**	**na**	**na**	**6.3 VAC**
Actual									
V3 - 12ax7 (PI)	**V3a**					**V3b**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
	anode (plate)	grid	cathode	heater	Jumper	anode (plate)	grid	cathode	heater
Expected	**190**	**28**	**42**	**6.3 VAC**	**h**	**193**	**27**	**42**	**6.3 VAC**
Actual									
V4 - EL34	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
		heater	anode (plate)	screen	Bias V	Screen R	heater	cathode	
Expected		**6.3 VAC**	**415**	**397**	**-33**		**6.3 VAC**		
Actual									
V5 - EL34	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	
		heater	anode (plate)	screen	Bias V	Screen R	heater	cathode	
Expected		**6.3 VAC**	**415**	**397**	**-33**	**na**	**6.3 VAC**		
Actual									
							ON	**Expected**	
						Mains:		**120.0V**	
						Secondaries:		**585V**	
PT Type:						**B+1:**		**420V**	
OT Type:						**B+2:**		**405V**	
						B+3:		**317V**	
						B+4:		**298V**	
Plate V:						**B+5:**		**283V**	
Plate Current (Ma):		**(Recommended 42-45Ma)**				**Bias Min V:**		**-35V**	
Dissapation (V*A):		**(Recommend 70% of max or 17.5 Watts)**				**Bias Max V:**		**-28V**	

Final Power-up

Note: Before powering up for the final test, adjust all controls as follows:
Volume – 7:00 (off)
Treble, Mid, Bas – 12:00
Presence – 12:00

1. Connect a speaker (or speaker load) to the speaker jack. Also, if you have fluorescent lights over your bench, you might want to turn them off an use some other light- they cause the amp to be really noisy when played.
2. Turn on the amp and wait a few minutes for the tubes to warm up.
3. Switch the amp from Standby to ON.
4. Using a DMM, Place the black negative lead onto a good chassis ground. With the red positive lead, check and adjust the bias current to 40-45mA (Pin 5 on either power tube). Be sure that you take a periodic peek at the tubes to make sure that it's not red-plating (glowing bright red). Turn the amp off immediately if it is.

5. Check plate and screen voltages at the power tubes. You should see about 415 VDC on the plates (Pin 3, V4 & V5) and 397 VDC on the screens (Pin 4, V4 & V5). You can use the chart above to record your findings.
6. Check plate voltages at the phase inverter (V3a (Pin 1) will be about 190 VDC, V3b (Pin 6) will be about 193 VDC. (This will vary depending on the tube and may range between 190 and 200 VDC on either plate.)
7. Check preamp plate voltages- V1b (Pin 6) will be about 182 VDC, V1a (Pin 1) will be about 210 VDC, and V2a (Pin 1) about 267 VDC.
8. Plug in your guitar and turn the Volume control to 12:00. Listen for any unusual noises before playing anything and then return volume to zero.
9. Gradually turn up the Volume while strumming the guitar. At 9:00 the volume should be reasonably loud. Stand away from the amp when playing, it will make horrendous amounts of noise if you're close with the guitar and there's no chassis cover to shield the amp from RF energy.
10. Check bright switch for correct operation

If all has gone according to plan, you should be grinning from ear to ear by now! Congrats!!! If you have any problems, get on the forum and get some help. Don't get frustrated. Most start-up problems are relatively simple mistakes.

Detailed Startup procedure (Courtesy of Paul Ruby):

The following is a simple checklist to follow for your first power up of a new amp. The goal here is to protect your valuable circuitry rather than have it go "poof" due to a simple wiring mistake. Unfortunately, we've all given into the temptation to "fire it up" as soon as the last solder joint is cold. That's a mistake. I lost a brand new Hammond 269EX. Talk about bursting your balloon of excitement!! This debug procedure actually starts prior to completing the final solder joints...

The starting point is to do some basic circuit checkout PRIOR to soldering the transformers into the rest of the circuit. If you've already soldered in your trannies, take a minute to desolder the secondaries from the rest of the amp. Iron is expensive and it's worth some effort to protect it.
Start with no tubes installed, MAINS UNPLUGGED, trannies NOT soldered in and get out your ohmmeter. Also remove the pilot lamp if you have one (this is not easy with the authentic sealed plastic pilot light). Use your ohmmeter to verify that the connection points for the PT secondaries are open circuits. With no tubes and no pilot lamp, the 6.3VAC (and 5VAC if you have a tube rectifier installed) secondaries should be open circuits, no continuity. If you used a tube recto, then the HV secondary of the PT should also read as an open circuit. With solid-state diodes, there is continuity to the filter caps. So, you will see an initial low resistance that increases with time as the filter caps charge. Actually, some meters use a pulsed current to measure resistance, so use the continuity setting on your meter for this. Also, check your speaker jack with and without a speaker plugged in to make sure it isn't shorted.

If all is well, solder in your tranny's low voltage secondaries. Don't yet solder in the HV secondary. You can also solder in your OT secondary.

With no tubes installed and switched to standby, install your pilot lamp and use a 250mA slo-blo mains fuse. Click on the power for 1 second just to see the pilot come on nice and bright. This is primarily checking the 6.3VAC supply line is not shorted and is properly connected to the lamp. If the lamp did not come on, check to see if the fuse blew. If not, try another lamp and do the 1-second power thing again. If the fuse blows, there is a short on the PT or mains. If the fuse survives, then it's likely that the 6.3VAC is not properly connected to the pilot lamp. Use your AC voltmeter to check for 6.3VAC (actually more like 7VAC with no tubes installed) at the lamp and all the tube sockets. If you have a recto tube powered by 5VAC, then also check that you have 5VAC at the recto tube socket now. This will be up around 6VAC without the recto tube installed as yet.

In the following steps, B+ is going to go high. If your amp circuit does not include a bleeder resistor, you should install one at least for the debug phase. Solder a 100K, 2W resistor across the first filter cap (from B+ to ground). You can use four 470K, 1/2W resistors in parallel if you don't have a 100K 2W resistor.

Assuming you now have a nice bright pilot light, hook your AC voltmeter to the tranny HV secondary (which is still not soldered into the circuit). Turn the power on just long enough to get a reading to verify it is correct. You should get a value 10 to 20% higher than the rated output voltage. If you get a value less than the rating, shut down the amp and check the fuse. If you get a proper value from the HV secondary, power down and solder the secondary to the recto tube or diodes. Install the recto tube (if you have one). Now replace the 250mA slo-blo mains fuse with a 2A slo-blo (or whatever your amp calls for). Hook your VOM to the HV secondary again. BE VERY CAREFUL at this point, your B+ will charge up for this power up.

Before powering up LOOK AT YOUR RECTO DIODES AND FILTER CAPS!!! You ABSOLUTELY MUST have the diode and cap polarities correct. This is critical yet is a very common error. If either the diodes or caps are wired in reverse, you WILL destroy the caps, diodes and PT!!

Did you check the recto diodes and caps? Now walk away, watch some TV, come back in 20 minutes and LOOK AT THEM AGAIN! :) Sorry, but this is important.

Power up the amp and watch the following things as quickly as possible and roughly in this order: pilot lamp comes on brightly; HV secondary goes to nearly the same value as it did with the lines unsoldered; recto tube filament lights up right away; Recto tube plates do NOT glow red (overheat). If any of these three does not happen, shut off the amp immediately and find the problem by looping back to the beginning of this checklist. If these check out, power down. B+ MUST be discharged to safely continue messing with the amp guts. Your bleeder resistor will take at least a minute to bring B+ down to safe levels. RW: Use a homemade bleeder made from a 5W or greater cement power resistor soldered to leads with alligator clips. Attach one lead to pin 1 of any preamp tube and the other to the chassis or a ground lug. Wait several minutes, then check for residual B+ off the caps with this bleeder removed.

Now hook your DC voltmeter to B+ and ground. Power up again and check the B+ voltage. With no tubes installed, all the filter caps will charge up to the same voltage. If you do not have a choke, the voltage should be very close to 40% higher than the raw AC. Assuming your measured, say, 600VAC across the full secondary in the above steps, then each half is delivering 300VAC. B+ will be ~40% above this, which is ~420VDC. If you have a choke, the DC voltage depends on the size of capacitance prior to the choke. With no cap prior to the choke, the first filter cap should char to about 90% of the AC volts. With the same 300VAC on each half, the first filter cap should have ~270VDC. If there is a cap prior to the first filter, then the DC volts out will depend on the load current. With no load (as there is now without tubes installed), even a small capacitance will allow B+ to charge up all the way to the same as the no-choke case. As an aside, you can use this pre-choke cap to adjust B+ under load to some point between the 90% and 140% of the VAC.

KEEP IN MIND that every time you power up from now on that B+ will be high. In all the following stuff, allowing B+ to bleed is implied at each power down.

If all is well, check that B+ is at the OT on all the primary taps. Without the power tubes installed, the OT primary should be at B+. If not, something is wrong at the OT. Power down immediately and check for shorts of the OT primary. This should not be the case, however. An OT short should have been caught by now by checking B+ levels in the previous steps. This is really just a final sanity check to really make sure the trannies aren't going to be killed by any mistakes. Leave the amp on for a few minutes and make sure neither tranny is getting warm. The OT should stay dead cold and the PT should get just a little warm supplying the pilot lamp and tube recto. If your amp is fixed bias, make sure the negative voltage is being generated and check that it gets to the power tube grids and is adjustable with the bias pot.

OK, finally ready to put some tubes in. Power down and install all the signal tubes. You also need to hook up a speaker or dummy load for the OT. I actually suggest you hook up speaker rather than a dummy load, but preferably an old or less valuable speaker to get started. Turn volume and gain pots all the way down and tone controls to center. If your amp is fixed bias, turn it all the way down to start (most negative grid voltage possible. Power up and, again, watch for the following signs: pilot lamp comes on brightly; all tube filaments light up right away; tube plates do NOT glow red (overheat) this time paying attention to power tubes. If your amp is fixed bias, check power tube current and bias appropriately. Do this soon after power up to make sure all is well. You should be able to hear a little hiss or hum from the speaker. Of course, hopefully this is low level requiring your ear up next to the speaker to tell. If hiss and hum is loud at this point, there are problems. If there is dead silence, something is likely wrong, too. But, let's hold off on the AC signal debug until later.

Now is time for DC bias assessment. *With one hand behind your back*, measure and write down the B+ levels at each filter cap. Also write down cathode and plate voltages at all stages and also the screen grid voltage at the power tubes (if applicable). Compare all the DC voltages to those expected. In general, the triode gain stages should have ~1V on the cathode, 0V on the grids and ~1/2 B+ on the plates. If the DC voltages are not in the ballpark (within 50% of the general rule just stated), take some time to check the circuitry of the offending stage. If you have a cathode follower in the signal path, the grid should be at the plate voltage of the previous stage and the cathode should be about a volt higher.

The moment of truth arrives! Plug in your guitar and turn up the gain and volume knobs slowly and see how it goes. With a lot of luck, you'll hear the guitar sounding great with no hum or squeal. However, such a case is the exception and even then is typically reserved for experienced amp builders. To err is human and problems at this point are to be expected. Don't get discouraged. Jump down to the debugging stuff below...

Debugging / Troubleshooting (Courtesy of Paul Ruby):

What causes hum and how do I reduce it?
How do I wire my filaments to avoid hum?

Hum can come from many places, all related to the same root cause. Our amps draw power from your local utility company as AC, alternating current. At 50 or 60hz, the AC from the utility is in the audio range and you'll hear it if it gets into the signal path of your amp. So how does it get into the signal path? Hum enters the signal path from the heater (filament) wiring, poorly filtered B+, improper ground wiring or ground loops, right out of the air as radio frequency interference coming into unshielded signal lines, via direct magnetic coupling from PT to OT, or from ancient amp wiring connecting tube filaments directly to the AC mains (no tranny). You'll need to tackle each of these in your amp to keep hum out of your ears.

Hum From Ground...

Hum from ground is usually a buzzy, raspy sound. The solution is to follow proper star grounding. The sound is similar to the RF source of noise getting into unshielded input lines or ground loops. Since it's a big task to convert an amp to star ground if it isn't already, you may want to clean up line shielding first. Also, be sure you don't have ground loops outside the amp, too.

Hum From Unshielded Input Lines...

Hum from unshielded lines is usually a buzzy, raspy sound. If your amp does not hum or buzz with the guitar cord unplugged (e.g. the input lines are hard grounded by the input jack), then the problem may be your guitar or guitar cord picking up the noise. Or, it may be your input lines running from the hacks to the tubes. You need to determine which it is first.

One quick way to see how bad your input wiring is to simply plug a short patch cord into your amp's input and see how much that hums. This simply releases the grounding of the input jack so you can hear what is getting into the line. Don't touch the tip of the dangling patch cord or your body becomes an antenna grabbing all noise from the air and sending right to your amp. The result is painfully loud buzz. If hum is as bad or worse than the hum with your guitar plugged in, the problem is probably your input wiring. If it is better than with the guitar, then the guitar is the likely source of the noise. Your guitar's pickups are very good at picking noise out of the air from other electrical equipment near by. Shut off stereos, PCs and especially PC monitors.

Still suspect the input wiring? The key thing is that the input stage is a very sensitive node for noise. This is especially true once past the 68K ohm grid stopper resistor in series with your input lines. As such, the 68K grid stopper really should be mounted right on the tube socket with ZERO lead length between the socket lug and the resistor. Your shielded wire then runs from the other side of the resistor to the input jack. The shield of the cable is only grounded at the jack end. Cut the shield off the tube end and use a hunk of heat shrink to make sure it doesn't short to anything near by.

Note, I use shielded input lines on ALL my amps and mount the 68K resistors on the tube socket as the first thing when getting rid of hum. I don't even bother to debug first. It's cheap, easy insurance against hum, noise or feedback (squeal). Just do it! Read more about hook up wire here. Hum From Filament wiring... Hum from filaments is characterized, typically, by low frequency 60hz (50hz outside America). It's not usually a "buzzy" sounding hum. On a scope, it will look reasonably like a sine way by the time it gets to the speakers.

If you have an ancient (er... vintage) amp that connected tube filaments directly to the AC mains, you very likely have a severe hum problem. As an aside, the tip off for this sort of thing is that the tubes have oddball numbers, like 50L6 or 35C5. The first number of the tube designation is the heater voltage. If your tubes are taking 50V or 35V, chances are they are wired in series and hooked right to AC mains. This is a real problem in old amps made as cheaply as possible so be warned when hunting around on eBay...

The only solution that I can ensure effective for old amps with heaters wired to AC mains is to convert the power distribution to modern standards. That gets rid of hum and, more importantly, brings the amp up to modern safety standards. This means adding a power transformer to the amp to isolate the mains, wiring the tube heaters in parallel and switching to standard tubes: 6L6, 5AR4, 12AX7, etc. Obviously, the choice to dive into a vintage amp like this is up to you. But, if your goal is a playable amp, this is the way to go. You want a collector's item? Stick it in a closet.

Hum from the heater (filament) is the easiest to take care of. No, you don't need DC filaments! The filament is powered directly by AC from the power transformer in your amp. The heater in the tube, of course, is hot and can source electrons, just like the cathode. If the heater is negative with respect to the cathode, electrons from the heater will be jumping from the heater to cathode. They way to stop this is to keep the heater from going substantially negative, or better yet make it positive, with respect to the cathode. This is easy to do!

Warning!! All amps have some form of DC referencing of the filament winding from the PT. If you're trying to get rid of hum in an old amp, you MUST find the existing DC reference connection and determine its type. If you decide to use an alternate referencing method, the existing reference MUST be disconnected or you risk toasting your PT!! Read ahead to learn the methods so that you know what to look for.

First, check to see if your filament winding has a center tap. If so, that's the lead we're going to play with to reference your filament voltage. If not, get two 100 ohm, 1W resistors, wire them in series connecting the two ends of this to each of the filament lines. The node at the junction of the two resistors (the end of the resistors NOT connected to either filament line) is now your "center tap." It's not really a center tap but serves the same purpose for the remaining discussion...

The easiest thing to do is ground the center tap (CT) of the filament winding. Each filament wire will still go negative with respect to the tube cathodes, but only about -9V at the negative peaks of the AC wave form. That's good enough in most amps to keep hum out of the signal path. Very high gain amps, however, will get some hum from this. Even though only a little is getting in, the high gain preamp amplifies the little hum to something audible. High gain amps need a positive DC reference for the filaments.

A better, but slightly more difficult, solution than grounding the CT is to connect it to some clean, positive DC voltage source. If the power stage in your amp is cathode biased with a nice big bypass cap on the cathode resistor, you're set! Just tie the CT to your power tube's cathode. There's somewhere between 9VDC and 35VDC at this node. It's just as free and easy as ground, so use it instead of ground if you have it.

If your amp is not cathode biased, then you need to find or make an alternate DC reference. Maybe your amp has 12VDC available for relay switching or something. If you have it, use it. The last resort is to make a DC reference voltage. In this case, add a resistor divider from your preamp B+ stage. Wire on end of a 470k 1/2W resistor to preamp B+. Wire the other end to an 82K 1/2W resistor. The other end of the 82K resistor goes to ground. The junction of the two resistors will have between 30 and 50VDC. Add a 100uf, 100V filter cap from ground to this node, negative side of the cap to ground. Now, connect your filament CT to your new source of ~40VDC. Done!

Hum From B+...

Hum from B+ ripple is characterized by 120Hz (or 100Hz outside America). The key difference from filament hum is that the frequency is doubled by full wave rectification of the AC mains. This is a dead give away using an O-Scope for debug.

The filter caps on B+ in your amp have the job of smoothing out the DC B+ voltage in your amp. The plate resistors of the triode gain stages are tied right to B+ and ALL ripple on B+ becomes part of the signal delivered from the stage. This is why B+ goes through stage of R (resistor) C (cap) filters from the PT down to the input gain stages. By the time B+ gets to the input stages it must be DEAD FLAT. Fortunately, if you're debugging an amp or building from a known schematic, chances are that the issue is a leaky or otherwise bad filer cap causing B+ ripple. Note that the problem may also be excessive current draw from B+ somewhere. The filter cap values are chosen for the proper load. Excessive load will cause more ripple. You'll certainly want to keep this in mind if debugging a B+ ripple problem.

It's hard to tell the difference between 60-cycle hum and 120-cycle hum without an analyzer, but it would sure narrow it down if you knew for sure. 60Hz will be related to the power transformer, the filament circuit or environmental hum finding its way into the amp (we are absolutely surrounded by 60-cycle hum). 120Hz will be related to ripple current in the power supply.
To narrow down the source, pull the phase inverter tube. If the hum stays, it's in the power amp. If it goes away, it's in the PI itself or in a preamp stage. Zero out the volume. If the hum goes away, it's between the input and the grid of V1b.

If it hums with nothing plugged in, and doesn't hum when plugged in, the jack is not "shorting" properly when unplugged. Did you use a shorting type jack and ground the shorting tang?

Allyn Meyers: "you will get Hiss...that is normal but, loud hum is not. Check the 10K tail resistor on your PI to Presence pot. Make sure you have it properly grounded there".

Other Forum info on Hum:

"Here's a good source:
http://www.aikenamps.com/InputRes.htm

Most of my recent builds have a 10k grid stopper on the first stage at the largest. My Hi-Octane went from a humming nightmare to a relatively quiet (for a high gain amp) amp when I dropped the grid stopper from 68k to 10k.

Grid stoppers are used for a couple of reasons. 1.) To kill any RF interference. 2.) To kill high-frequency parasitic oscillation. 3.) As part of the voicing of the amp.

For 1 & 2, a 10k is usually large enough on the first stage. Other ways to kill RF are wrapping the input grid lead through a ferrite bead a couple of times, or running a very small (10-50pf) cap from the input jack tip lug to ground".

"The problem with grid stoppers is that they're prone to pick up noise, and the larger they are, the more noise they pick up as you've seen. I would say drop to 10k and see if the amp is stable. If it is, you should have significantly less hum than you do now.

That first stage is very susceptible to hum. Before trying to reduce hum by changing that resistor (which is a band-aid type fix), I would try other means. First, where are the heater wires? Do you have them twisted and as far away from other signal wires as possible? Second, regarding the wires going to the grids, take a chop stick and play with them, move them around, see if you can find the quiet spot where they want to be. Are the grid wires as short as possible? Have you tried using shielded wires going to the grid(s)? Ground the shield only at the input end. Also, your ground layout is very important too- do you have any ground loops? Where did you ground things? I ground the cathodes for the first stage, the filter cap for the first stages, the gain pot and the input jack all in the same place - a spot on the buss wire on the back of the pots close to the gain pot.

The bottom line is, do everything else you can think of to reduce hum before trying to fix it with a grid stopper resistor. It is possible, (I do it it) to have no hum (dead quiet) without having to resort to compromising the value of the grid resistor or using DC heaters or any of the other so called tricks.

Your answer, I believe, lies in the layout. Heater wires, grid wires and grounding - that is the key (in my humble opinion)".

"Grid stops need to be located properly or they will introduce noise which will become more apparent as the number of gain stages goes up.... choice of layout, grounding, and construction method has the most effect on noise.... if you choose a fender style approach it will be prone to the typical issues caused by that layout choice and you may have to go lengths to de-bug it...

Grid stops are supposed to be as close to the grid as physically possible.... right on the grid terminal of the tube socket.... shrink wrap them to the end of a shielded cable and use the wire lead of the resistor to solder to the socket pin.....ground the shield at the other end ....at the input of the unit..... it's not a panacea but it will shield the grid line and put the grid stop in the right place so you can focus on the rest of the amps issues...."

Alan Phillips of Carol Ann Amps on alternate grounding schemes and hum reduction:

"This is the scheme I use on virtually everything. Most of my amps are higher gain models that would have issues with the grounding scheme used on TW's. Ken did it his way probably because he knew he could get away with it, and it's pretty simple, I assume.
I can absolutely guarantee that the scheme I use in most situations will be substantially less troublesome and is something to think about if you venture on to anything with more gain or complexity. Like I said it does work in TW style amps and it also means you don't need to solder to the back of pots.
There are many schemes, but this is the one I nearly always use on everything.

Starting at the power and going forward.

1. The incoming power supply earth (ground) should always have its own ground point as close to the mains input as possible.

2. The filament (heater) ground should also use its own ground point as close to the first power tube as practical.

3. The power supply center tap, all three 40uF cap grounds and two bleed resistors connect to the chassis bolt in front of the smoothing caps.

4. The ground for the bias circuit really doesn't cause issues because it has such a low current flow that it can be grounded wherever is convenient.

5. I always use speaker jacks that don't ground themselves to the chassis.
The largest currents in any amplifier are those flowing in the output transformer secondary. To avoid the flow of this current through the chassis connect the OT ground wire directly to the speaker jack ground.

6. Run a wire from the speaker jack ground and create (drill) a ground point in front of the presence pot. Connect the wire to this ground point along with the ground from the top right (looking from the front) 20uF smoothing cap and the ground tab from the presence pot (don't ground the pots body). The only current that flows in the wire from the speaker jack to this ground is associated with the feedback loop and this is small.

7. Join the two grounds from the last two 20uF caps and make a ground point in front of the 'Mid' pot. Connect the cap grounds to here. Run ground cables from the mid-point ground lug, third stage cathode ground (10K resistor on the board).

8. Create (drill) a ground point in front of the volume control. Run the ground from the volume pot lug, first two stages cathode grounds, 150K resistor.

9. Connect the input jack ground to a ground point as close as possible to the jack. Switchcraft

jacks actually ground themselves, but I use a separate cable in case the jack nut comes loose in the middle of a gig or something. This avoids crackles and pops.

Some may look at this and think it creates a ton of ground loops. Ground loops only occur with sufficient ground current flow. It doesn't because it uses the chassis as the main ground conductor (instead of a thin wire hanging off the pots) and by its layout, controls and keeps heavy current flow away from sensitive areas.

-Hum reduction: Lifting the center tap for the filament supply and running a 100 ohm hum balance pot (like those seen on the SF Fenders) works a treat on this design to help reduce noise. A good quality pot is important though, something like a higher power Clarostat model. Excellent quality part. Just don’t be tempted to use a standard Alpha pot though.

Apart from external lead dress problems, filament noise can be induced internally in preamp tubes as well. The hum balance pot really helps in this situation tame any 120Hz noise and even some 60Hz noise.

If you don't want to drill a hole before you find out that this doesn't work, just hot glue the pot to the chassis and test to see if it helps. If it does, then drill a hole for it.

AES (Antique Electronic Supply) sells the 2W 100 ohm pot used in Silverface Fenders for hum balance”.

Stability Problems:

Here are some notes from the Amp Garage Forum:

-Look very closely at the lead dress, particularly around the tone stack and the V2 grid wire.

-If you're basing your build on Glen's clips as your benchmark, then use the 6600ohm taps on the transformer (blue and brown with no stripes). Glen's Express, being an earlier one, has the 6600ohm output transformer whereas later, more aggressive amps, have the 5200ohm output transformer.

-Did you check the value of each resistor and pot before you placed them?

-When I first got my express going I was having some issues with a squeal at more than half volume. After much searching and rewiring I installed a shield on the first 2 preamp tubes and it went away.

1. Disconnect the NFB wire from the impedance switch. Do you have squeal now?

 2. If no, I would suspect that either of the following is the case:

 a. OT primaries are backwards...swap them around

 b. NFB wire is interacting with the power tube grids. Move the NFB wire away from the grid wires.

-You can play with the wiring going to and between the tone controls using a chopstick. You want the lead to the treble pot to be "floating", and bass and mid running parallel about two mils apart. Here is a post discussing manipulation of the leads to the tone controls:

http://ampgarage.com/forum/viewtopic.php?t=169&highlight=

More Forum Notes:

-Changing the grid wires from solid core to stranded PVC helped quiet things down too.

-Move the wire coming off the wiper of the volume pot out, away from the pot body at least 1/4" you will see some of the microphonics disappear. Also don't use solid core teflon (thin jacket) wire for that one. If you run it along the chassis under the board and have it too close to the pot body, it will act as a big microphone! I use PVC (sometimes stranded) with thick jacket as an insulator

-I don't know about caps and such being microphonic, but poor solder joints sure as heck are, I thought I had microphonic tube problems on my first amp for 2 weeks, and it was a poor rotating solder joint. I've been much more meticulous about soldering ever since, it's absolutely necessary. Even blackened tube pins can cause scratchy tone; I polish them until they shine now.

- I use shielded audio cable for all input jacks and the volume control signal wiring. That has led to an almost complete cessation of amp bugs.

-Noise reduction: balance pot on artificial center tap, bottom plate firmly attached to chassis. Express presence control, Francesca layout, shielded volume pot to v1b, 33k grid resistor on V1a.

-1.8k Rk (cathode) resistor on V1a/b. This depends on your K (cathode) voltage. I only had 1.02 on A and .89 B. This bumped both cathode voltages to about 1.33 with my 174 volt plates on V1. Cut the noise a bunch, I may pull the 33K resistor.

-**Allyn Meyers:** “You can also check to make sure the tail of the PI is grounded (very common with this build to forget). If there is a ground issue with the PI, you will see weird voltages and attenuated volumes”.

-**Glen:** “My original '89 Express had an oscillation problem when the controls were pushed up to far especially the treble and presence. The fix was simple but took a while to figure out. On my original the output transformer leads coming off each power tube and run over and under the power supply board to the OT were very sensitive. The wires ran under the edge of the power board right about even across from the lower end of the 1k power resistor right above the top of the 4 power resistors in a row. I had to place a tiny bit of foam rubber under the edge of the power supply board to keep those wires pressed down firmly against the chassis right as they ran under the edge of the power supply board. Once they were held down the problem went away, and the amp runs fine to this day even with it all dimed. The OT primary wires are a PREMIUM source of noise. Get them down on the deck and twisted if you can”.

Microphonics:

-If you want to save yourself a LOT of frustration by trying to find the "perfect" tube which is not microphonic, wire a 33k 1 watt resistor directly on to the grid (pin 7) of V1. It also kills any oscillations the amp may be having. The standard value for virtually every other amp on the planet is 68k but 33k seems to work just fine and does NOT suck the tone out of the amp ...

More info on grid resistors can be found here: http://www.aikenamps.com/

Go to TECH INFO then "Grid Resistors - Why Are They Used?"

The white wire (on Francesca) coming off the volume pot going to pin 2 of V1 from the Volume pot needs to either be bent as to not touch ANYTHING or (my preference) is replace it with RG-174U or RG-178 coax. Be sure to ONLY ground one end of the coax or you may introduce a ground loop.

This stuff is awesome in the fact it's solid shielded coax:
http://store.haveinc.com/Ebus30/Parts/Part.asp?Part=GEPVDM230BLA&Material_Code=CURRENT

Low frequency parasitic oscillation:

The cures involve proper lead dress and shielding. Did you:

1. Shield the jack-to grid wire?
2. Make the runs from the board to the Volume / tone pots and from board to tube sockets as short as possible?
3. If you have a bright cap, try rotating it 90 degrees in one direction or another.
4. Keep plate wires away from grid wires, if possible. If they need to cross, make the crossing 90 degrees, with grids as far away from plate wires.
5. Make sure OT output wires are as far away from grid wires as possible.
6. Check the lead dress for your NFB / presence wire.

I would try a grid resistor on V2a (second gain stage). You could try something large, like 100k and see if it solves the problem. If it does, you could go lower until you find the value that is just enough. Ken used 820 Ohms here on many amps

Although the pics of Francesca are pretty hot glue free, the pics of Ginger show liberal use of the glue gun. My first thought is that this was to hold things in place.

My first build was incredibly microphonic; I could tap on the wires around V1 with a chopstick and almost induce oscillations. In the process of getting some wires to stay where I wanted them to with a dab of glue here and there, it seemed to reduce the microphonics.

So this is complete speculation, but perhaps one of the ways Ken brought an amp under control was a few strategic drops of hot glue.

The deal is to tame the microphonics not completely eliminate them. You can do this with lead dress, glue, chassis deadening material such as rubber strip insulation, and purposely selected tubes

Biasing (Highly edited version off Duncan's Amp Pages):

HOW TO BIAS YOUR EXPRESS

PROPER HIGH-VOLTAGE SAFETY PROCEDURES AND PRECAUTIONS MUST BE PRACTICED AT ALL TIMES WHEN SERVICING VACUUM TUBE AMPLIFIERS!! IF YOU ARE NOT *COMPLETELY* FAMILIAR WITH THESE PRECAUTIONS, SEEK GUIDANCE FROM SOMEONE WHO IS!

Make sure that you have drained the charge off the filter caps before doing anything in the amp.

For this very obvious reason, I recommend the use of spring clip probes that have small hooks on the tips in situations where you don't need to probe more than one thing during a given procedure. I clip them in where I need them before I apply B+ voltage with the STANDBY switch to ON and remove them after I go back to Standby. This allows you to effectively use the "One hand behind the back" method of working- it can prevent a dangerous shock from having both hands in the chassis. Also, you will be shooting to bias your EL-34s at ~42-45mA, YMMV.

THE CATHODE RESISTOR METHOD

This is the method that is best for hobby techs and do-it-yourselfers. It is far and away the safer of the two methods, and can be successfully done with medium- and even low-quality test equipment. It is performed by reading the cathode current through each power tube. The cathode current is composed of the plate current *plus* the screen current. Plate current can be identical on two tubes (tubes are matched by plate current readings) while one tube is drawing more screen current; with this method, the readings will appear to indicate a mismatch when such is not actually the case. Since the cathode current will always be higher than the actual plate current, the readings obtained with this method will tend to make you set the tubes a little colder than your calculations will indicate that they are. This promotes slightly more conservative operation, which is beneficial to tube life. If you feel that the inaccuracy is significant, or if you'd just like to know how large it is for your particular amp, you can always read the voltage drop across each screen resistor, figure the screen current (I = E/R) and then subtract it from the cathode reading.

Note that these instructions assume that your amplifier is biased by applying a negative voltage to the control grids; cathode-biased amplifiers cannot be adjusted other than by changing the value of the cathode resistor(s) so this method does not apply to them. BE AWARE THAT THE ACCURACY OF THE RESULTS YOU OBTAIN WITH *ANY* BIASING METHOD WILL BE DIRECTLY AFFECTED BY THE QUALITY OF YOUR TEST EQUIPMENT, AND YOUR SKILL IN USING IT. If any part of the following instructions doesn't make sense to you, seek help from someone with more experience.

WHAT YOU WILL DO:

A) Replace the ground wire on each power tube socket with a 1-ohm resistor.

B) Read the voltage drop across this resistor (in millivolts (mV)) with your DMM.

C) Read the plate voltage.

D) Use the above readings to calculate the static dissipation wattage.

E) Adjust the bias to obtain the best tone, while keeping the tubes within specifications.

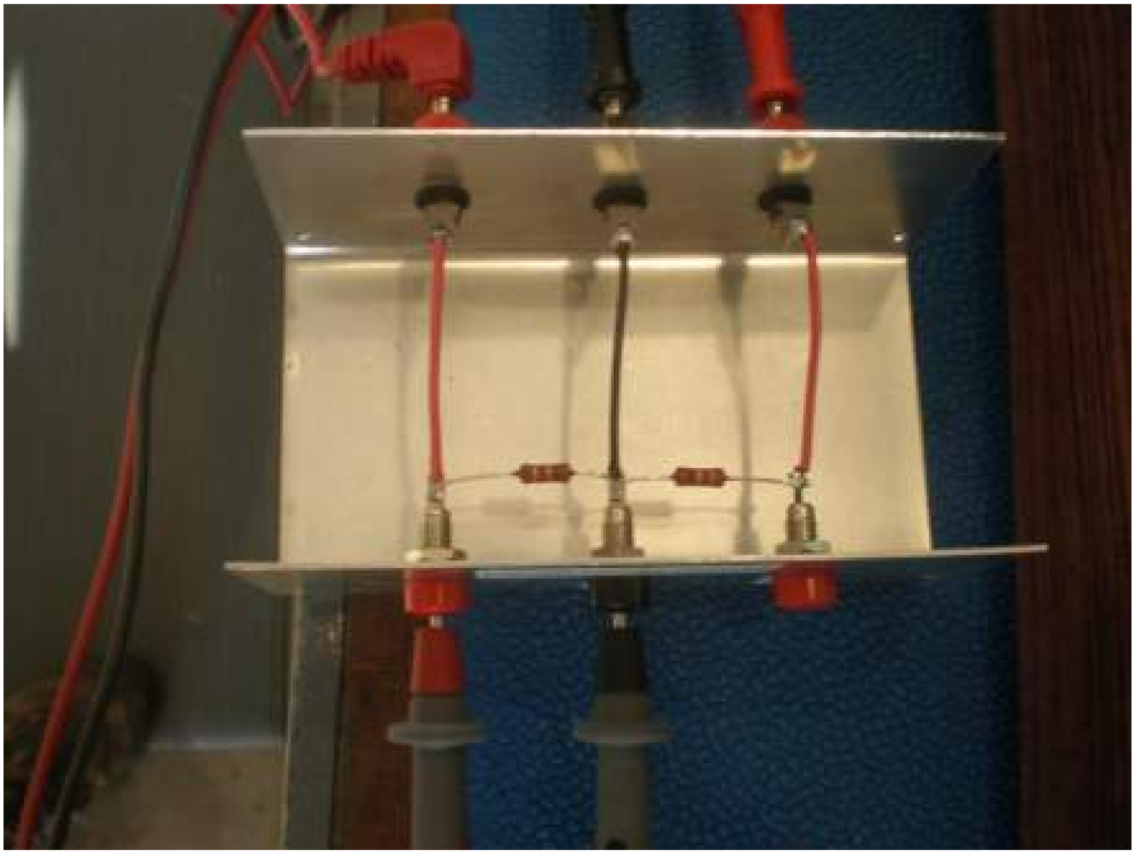
A SUGGESTION: You may want to practice taking these readings and making these adjustments with your old tubes still in the amp, or with a spare (used) set. That way, you won't fry your new tubes if you make a mistake.

On some sockets, the pins are numbered on the bottom (terminal) side; it is sometimes difficult to

tell which pins the numbers go with. The best way to tell which pin you are looking at is to count clockwise from the notch on the locator "keyhole" in the center of the socket, with the first terminal clockwise from the notch being pin ONE. This assumes that you are looking at the sockets from the BOTTOM, or UNDERSIDE.
Most guitar amplifiers use output tubes which have the same (or very similar) basing. ("Basing" refers to the order in which the internal elements of the tube are connected to the pins on the bottom of the tube.)

A WORD ABOUT TAKING READINGS: It is vital that your probe tips make *good* contact with the pins you're attempting to read. Tube-socket terminals often have a residual coating of non-conductive flux on them, and it is necessary to push the probe against the terminal hard enough to break through this coating. Most test probes supplied with today's meters are fairly blunt; if you can come up with a set of "insulation piercing" test probes, these will help solve this problem. Don't go overboard when pressing the probes against terminals, however...the probe tip may suddenly slip off the terminal and slide down against the chassis while the side of the metal prong is still touching the terminal. This will result in a dead short from that terminal to ground, and if you're reading plate or screen voltage the resulting spark (and loud popping noise) might make you jerk back reflexively, pulling the chassis off your workbench and into your lap, injuring you or breaking your tubes. BE CAREFUL! Also be aware that amp chassis surfaces are usually dirty or corroded, so the advice above goes double for touching a probe to the chassis (ground). You may even want to take a small flat file and scrape a nice shiny spot on the chassis in a convenient place, to aid you in making a good ground contact. RW: This why I recommend using the long (3-4") spring clip type probes with little "hooks" at the end and installing them before applying any power.

As you've already read several times, there's a lot of ways to hurt yourself with an uncovered, high-voltage amp. I try to avoid sticking my hands into a live amp as much as I can, so I've developed the handy little box below. With this box and some extra leads, you eliminate the need to solder in the 2W 1 ohm resistors onto the tube socket or to stick your hands into a live amp. It also makes checking each tube fast and easy- just move the DMM positive probe to the other input probe jack on the box. Obviously, the box is normally covered when in use.

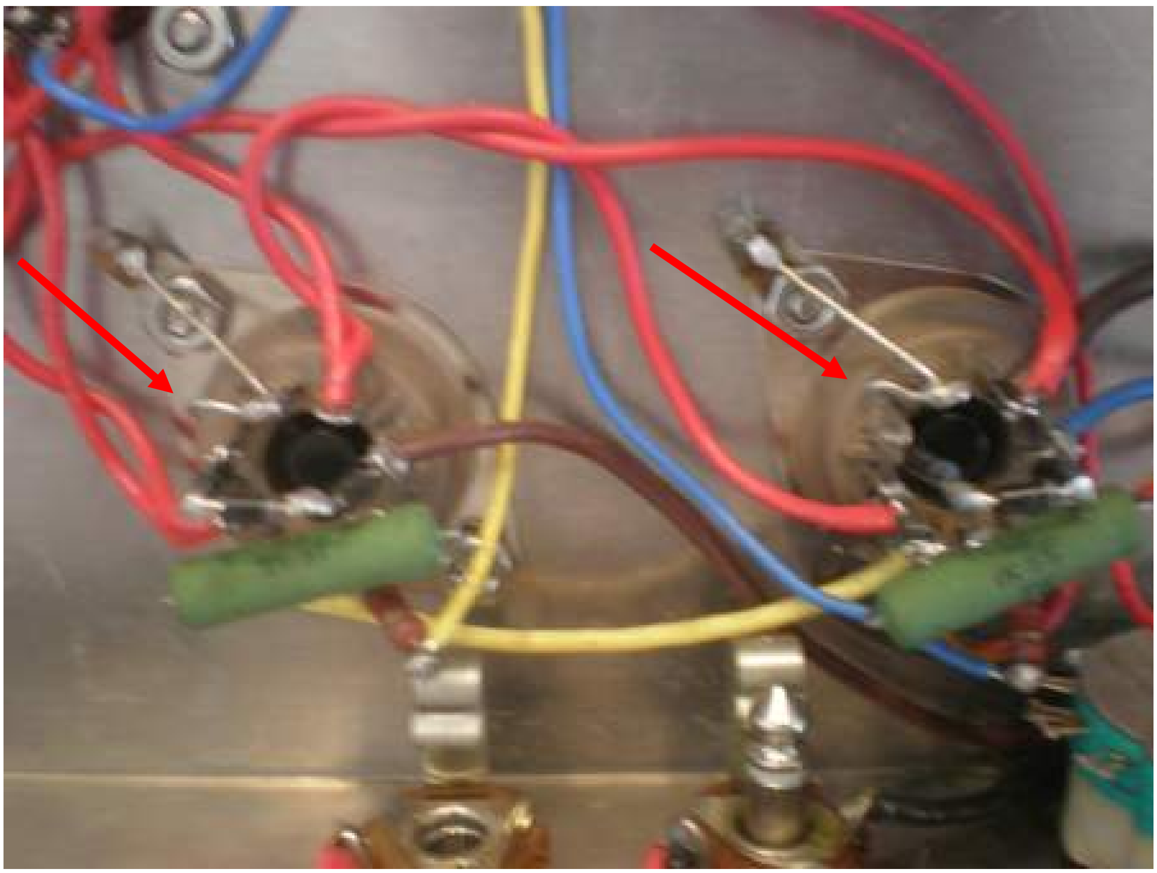


You'll need a 1-ohm resistor for each power tube in the amp. The EL-34 tubes have their cathodes on pin EIGHT, which will be grounded to the chassis. Pin ONE will be tied to pin EIGHT, and both will be grounded- you will need to untie them before proceeding with this method.

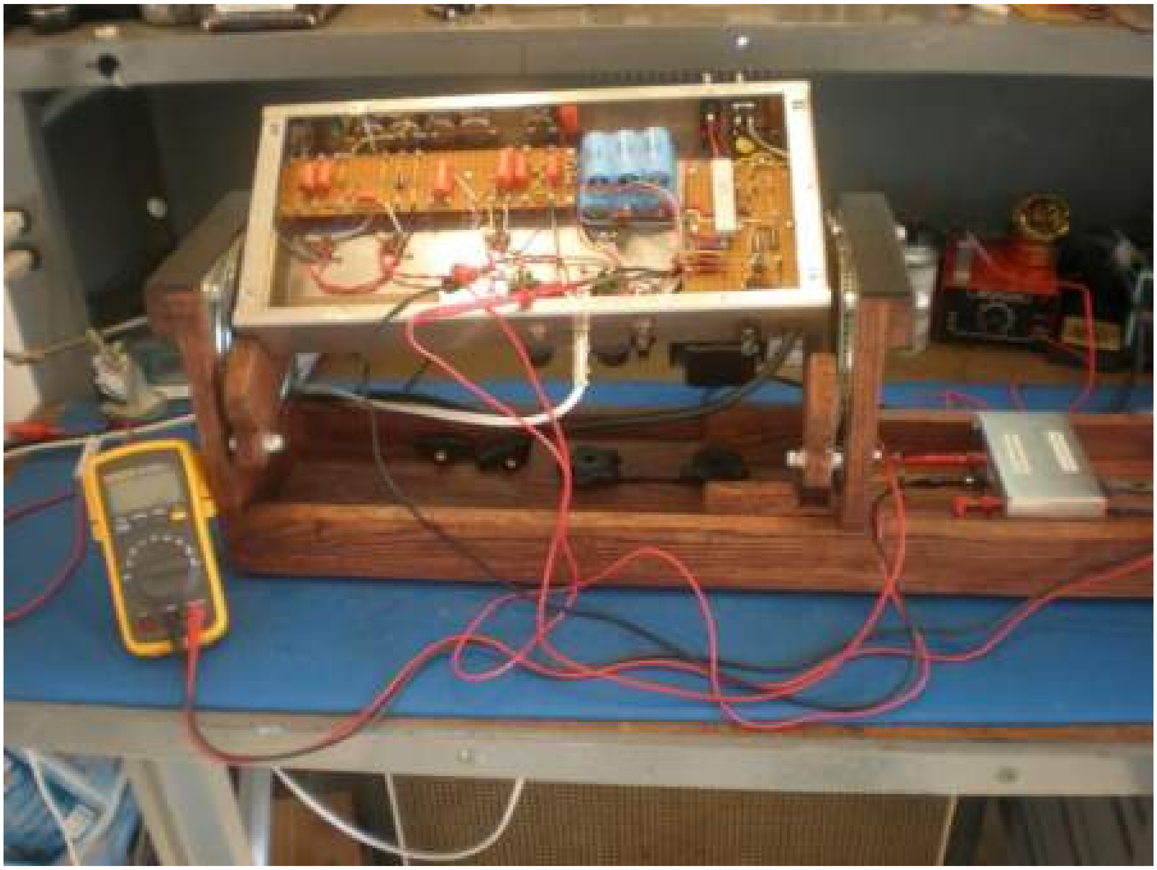
I prefer to use 2-watt resistors because they have thicker leads which will take more abuse, but half-watt will work just fine. The accuracy of your measurements will be directly related to the tolerance of these resistors; precision 1% (or better) types are suggested.

If you built the amp with the ground wire going from the lug to pin ONE and a small jumper between pins ONE and EIGHT, all you will have to do is unsolder the jumper from pin EIGHT (use a solder sucker to get it cleanly unsoldered) and bend it out of the way. Once you're done biasing, all you will have to do is re-solder the jumper to pin EIGHT.

If you built the amp like KF, then you will have to undo the entire grounding wire set up on pins EIGHT and ONE, ground only pin one and install the 1 ohm resistor across pin EIGHT and ground. After you're done, you have to redo the whole thing. That's why I came up with the mod for my amp…it's your call.



Here's how this bias box would be used with your DMM to bias the amp:



Turn your amp on, but leave it on STANDBY. Set your DMM to the highest DCV scale, ground the black probe to the chassis, and take a reading from pin FIVE of any power tube socket. You should see a negative voltage in the -35 to -50 volt range for EL34s. Note that you should *not* have any power tubes installed in your amp yet.

First, locate the bias trimmer pot on the PS board. Next, adjust the bias control until you have MAX NEGATIVE voltage on pin FIVE. (In other words, rotate the bias pot until you obtain the highest negative voltage that the bias supply is capable of delivering. Install your tubes and wait a few minutes for them to warm up (RW: I do NOT recommend leaving it in STANDBY- turn it off. You will have to flip the chassis over and it will have live electrical voltage- you could slip and have your fingers hit a live wire or component).

Turn the amp to ON and make sure your DMM is still set to the highest DCV scale; take a reading between the chassis (ground) and pin THREE on any power tube socket. Remember, the BLACK probe always goes on the CHASSIS. Write this plate voltage down; you'll need it later.

Now, set your DMM to the lowest DCV scale (usually 200 mV) and take a reading across the 1-ohm resistors (Pin 8 and ground) for each tube. (This reading can be interpreted directly in milliamperes (mA), because one mV across one ohm equals one mA because V=IR). It'll be pretty low, because you have the bias trimmer set to max negative voltage.

Adjust the bias pot until you get a reading across the 1-ohm resistor(s) somewhere in the 30-40 mV range. Note that the polarity of this reading is unimportant; only the numerical value means anything. (If you put the black probe on the side of the resistor that is grounded to the chassis, you will get a POSITIVE reading.)

MULTIPLY the plate voltage you read on pin THREE earlier by the reading you just obtained from the 1-ohm resistor. (Example: 450 Volts times 35 milliamps, or .035 Amperes.) This will give you the STATIC DISSIPATION WATTAGE at which the tube is operating. (It'll be wrong, but more on that later.) The above example gives a static dissipation of 15.75 WATTS, which is well within specs for an EL-34 (fairly cold, in fact). Max dissipation for the EL-34 is 25 watts, and a good suggest running level is 70% or 17.5 watts. To sum up what this calculation is, PLATE VOLTAGE times CATHODE CURRENT equals STATIC DISSIPATION (IDLING) WATTAGE. It is important not to exceed the tube manufacturer's specification for this parameter, because tube life will be shortened. At extreme settings, tube life will be measured in MINUTES...be advised. Also remember that you have 2 power tubes, and they are not exactly the same, even if you bought a matched set. You will need to use the higher bias voltage of the two as your max, or an average of the two, just make sure that you don't set dissipation wattage too high.

Although the plate voltage will change somewhat when you change bias voltage, determine roughly what bias voltage setting will be required to get to about 17.5 Watts static dissipation- in this case, 17.5W / 450 volts gives you a bias voltage setting of 38mA. Set that bias voltage, then take another reading from pin THREE (remember to set your meter on the HIGHEST DCV scale before you do!) and write it down. This new reading should be LOWER than the first reading you took, because the tubes are drawing more current now and the plate voltage will drop somewhat. Multiply this new reading by the value you measured across the 1-ohm resistor(s); this will give you the idling (static) wattage. You can continue this dance until you really get it tight, but this should be good enough to get you sounding good. The cooler you run the tubes, the longer they'll last. If you dig the way the amp sounds when the tubes are idling at only 12 watts, fine...don't worry about it.

Remember, *each time you adjust the bias control, you'll have to take a new reading from BOTH the 1-ohm resistor *and* the plate (pin THREE) and multiply them to see how hot the tubes are running.* You can play your guitar through the amp each time you adjust the bias, and see how you like it. You can even adjust the bias by ear, and then take readings as outlined above to see if the tubes are being operated within their ratings. If you find that you only like the tone when the tubes are operating near their limits, you may decide to trade some tube lifetime for the tone you seek. If you like the tone with the tubes running cold, you'll obtain significant extra tube life that way. It's YOUR call.

If you see a few milliamps difference between the readings on the 1-ohm resistors, don't sweat it; this could be due to poor matching, differences in screen current between the tubes, or differing leg impedances in the output tranny's primary. (All of those things are fairly common in guitar amps.) Having the currents balanced on the two legs of the tranny helps eliminate 120 Hz power-supply ripple from the output. Note that you can swap the tubes around to obtain the best current balance, since you can take individual readings on each socket. If you see a large difference between them (say, 8-12 milliamps) this means you need to find out why this difference exists. One thing you can do is SWAP the tubes into the opposite sockets and take new readings. If the bogus readings are consistent on the SOCKETS, then you'll need to look at the circuitry to find out the cause. If the readings MOVE with the TUBES, you can be fairly sure you have a poorly-matched pair.

Once you have everything adjusted to your taste and you're sure the tubes are being operated within specifications, leave the amp fully powered up for three or four hours. Eyeball the tubes every fifteen minutes or so, to make sure the plates aren't turning red. You are doing this to let the tubes "settle" into their new operating conditions; at the end of the settling period, take a final set of readings to make sure everything is still OK. If any readings have drifted significantly, readjust the bias accordingly. Note that the incoming line voltage directly affects all of the voltages in the amp; you may want to read the line voltage occasionally to see if this is happening. Line voltage will drop a bit around supper time (lots of juice being used for cooking) and also after sunset. If the line was 120VAC when you completed your biasing procedure and its 117VAC when you take your final readings after the settling period, expect to see a corresponding small drop in your measurements.

You may decide to purchase a "bias-probe" type device; this is a gizmo that consists of an "interruptor" socket/plug assembly that goes between the tube(s) and the amp's socket(s). This test adaptor will have a couple of test leads hanging out through a hole in the side, for connection to your meter(s). If you do get one of these, there is no need to install the 1-ohm resistors on the tube sockets as outlined above. You can use the readings obtained from the adaptor sockets in place of the readings normally taken across the one-ohm resistors.

BE AWARE THAT THERE ARE TWO TYPES OF THESE ADAPTORS COMMONLY AVAILABLE. One type *breaks* the cathode connection, and instructs you to connect the test leads to the CURRENT jacks on your meter. The other type contains a one-ohm resistor in series with the cathode pins, with the test leads connected to either side of the resistor; this type instructs you to connect the test leads to the VOLTAGE jacks on your meter. It has been my experience that some amps (especially old Marshalls) do not react well to having several feet of wire inserted in series with the power tube cathodes, and will oscillate like crazy. Therefore, if you decide to get a set of these test adaptors, get the ones which use an internal 1-ohm resistor.

REMEMBER...THERE ARE VOLTAGES PRESENT INSIDE EVEN THE SMALLEST TUBE AMPLIFIER WHICH WILL KILL YOUR ASS JUST AS DEAD AS A HAND GRENADE WILL!! If you're not familiar with high-voltage safety, seek guidance from someone who is. BTW, an oven mitt or a pot-holder (real men like me use welding gloves) will come in handy for handling hot power tubes if you need to switch sockets; you don't want to let the tubes cool off too much while you swap them before taking new readings.

THE OUTPUT TRANSFORMER SHUNT METHOD

This is the way many pro techs measure plate current. A *good* quality DMM is required for this measurement. (When it comes to good DMMs, you have three choices...Fluke, Fluke, and Fluke.) This section assumes that you know a bit more about your amp, and how to use your test gear. If any of it is unclear, DON'T TRY THIS.

NOTE... Marshall amps have output transformers which have a very low DC resistance in the primary winding. If your meter's internal current-measuring shunt resistor is a relatively high value (~ 10 ohms, for instance) it will induce significant error into a transformer shunt measurement. This is because when such a meter is connected in parallel with half of the output transformer's primary, a significant portion of the current is not flowing through the meter, and can't be read. For this reason, unless you're *sure* you have a meter with a low internal current-sensing resistor (~ 1 ohm) the shunt method is *not* recommended for use on Marshall (and other low DCR) output transformers.

WHAT YOU WILL DO

A) Read the current flowing through each leg of the output transformer's primary.

B) Read the plate voltage.

C) Use the above readings to calculate the static dissipation wattage.

D) Adjust the bias to obtain the best tone, while keeping the tubes within specifications.

For this particular reading, you'll need to change your test leads to the CURRENT input jacks, and select the 200 mA DC range. The two probes are applied to the center tap and either of the ends of the output transformer's primary. (On a Toneslut tranny, the center-tap is RED with a YELLOW stripe, and the two plate wires are BLUE and BROWN). On the Express, the easiest way is to put one probe on pin THREE of either socket, the other on the center-tap, which will be located on the STANDBY switch.

The current that would normally flow through half of the transformer's primary winding is "shunted" through the meter, and thus measured. A small amount still flows through the part of the winding you are shunting, but the transformer's resistance is much higher than your meter's internal resistance. (See "NOTE" above.) Nearly all of the current flows through the meter.

SAFETY ADVISORY

BE WARNED...for all practical purposes, a meter set to measure CURRENT is equivalent to a STRAIGHT WIRE. This means that as soon as you touch either probe to the high voltage circuitry, THE OTHER PROBE NOW CARRIES THE SAME VOLTAGE. If you drop the probe and it lands on your arm or leg, you could be electrocuted. If it lands on the chassis (or anything else that is at earth or circuit ground potential) a huge spark will be generated, along with a noise like a small firecracker. (Please don't ask how I know this) The probe tip will be partially melted, and at the very least, the meter's internal fuses will blow. At worst, the meter will be history. Shorting the HV to ground isn't especially good for the amp either, and may blow the amp's fuse or damage the circuitry. You can easily kill a rectifier tube this way. BE ESPECIALLY CAREFUL NOT TO LET A PROBE SLIP OFF A TERMINAL AND HIT THE CHASSIS WHILE YOU ARE TAKING A READING! BE *EXTRA* CAREFUL TO MAKE SURE YOUR FINGERS DON'T SLIDE DOWN THE PROBE AND COME INTO CONTACT WITH THE METAL TIP!! And make DOUBLE DAMN SURE you know which two points in the circuit you are supposed to touch the probes to, because if you accidentally touch the bias supply and the plate supply at the same time, you won't believe what happens. IF YOU'RE NOT *SURE* WHAT TO PROBE, *DON'T* PROBE IT!!

Once you've obtained the current readings from both sides of the output transformer's primary, you'll need to take a plate voltage reading so you can calculate the static dissipation wattage (as outlined above in the CATHODE RESISTOR method) and decide whether you need to increase or decrease the plate current.

REMEMBER TO REMOVE THE TEST LEADS FROM THE CURRENT MEASURING JACKS, AND TO SET THE METER TO THE HIGHEST DC VOLTAGE RANGE BEFORE YOU TRY TO READ THE PLATE VOLTAGE!! If you attempt to read the plate voltage with your meter still set up for a current reading, the results will be spectacular (as outlined above.) Since you may need to take several plate CURRENT and several plate VOLTAGE readings before you are finished setting the bias, you will need to be extremely vigilant about changing the meter settings (and the test leads) each time you take the different readings. Most pro techs use TWO METERS for this procedure, leaving one set up for current and one for voltage. (I use a handheld meter for the voltage reading, and a bench meter for the current.)

Once you have the necessary readings, the procedure is the same as for the CATHODE RESISTOR method: read, multiply, listen, adjust, read, multiply, listen, adjust, read, multiply, etc. Don't neglect the "settling" period, either. BE CAREFUL!!

Tweaking the amp:

Glen: “I'm tempted to tweak it just a tad to mellow it out just a bit, either adding some input resistance, a smaller bright cap, a resistor in series with the bright cap, or possibly a larger PI (faux cut control) cap. It doesn't need much to totally be there, and maybe 5 years from now it will need nothing. I played it tonight at my weekly club gig and I really feel that it has just a tiny bit more gain in the preamp than my original, which makes the volume knob sit lower for the same overall gain and in turn the bright cap has more effect when you click it in. It actually sounds best turned up a little farther than actually like gain wise, just to minimize the bright caps effect.
I actually like using the full bright 500pf position on my original Wreck. I think I'll first try raising the PI cap from 50pf (what's in my original) to 80 or 100pf. Result: after trying a bunch of different smoothing caps in the clones PI circuit it came down to a 250pf.

Try out little snubber caps over the plate resistor(s) on stage 2 and/or 3…try just one first. You can try a .001uf across the plate resistor on the second stage. Depending on the cap used, (disc or other) a 400v to 600v rating should be used. This will also allow you to use some 12AX7s that were just a little too microphonic in the amp before to work in the amp. I know snubbers are frowned, but depending on the amp, some need them. This will also roll off just a slight bit of the highs. Very, very subtle and will have a bit smoother or warmer sound; it may be a sound like the amp is broken in. Try the snubber before you try making any other changes. It’s also easily removed if you don't like it, or as the amp ages and sounds more mellow, you can remove it.

-Ken hand tuned his express amps by tweaking bits for each customer so a parts list is going to be a good starting point but you better get some extra values if you are going to tune it like he did.

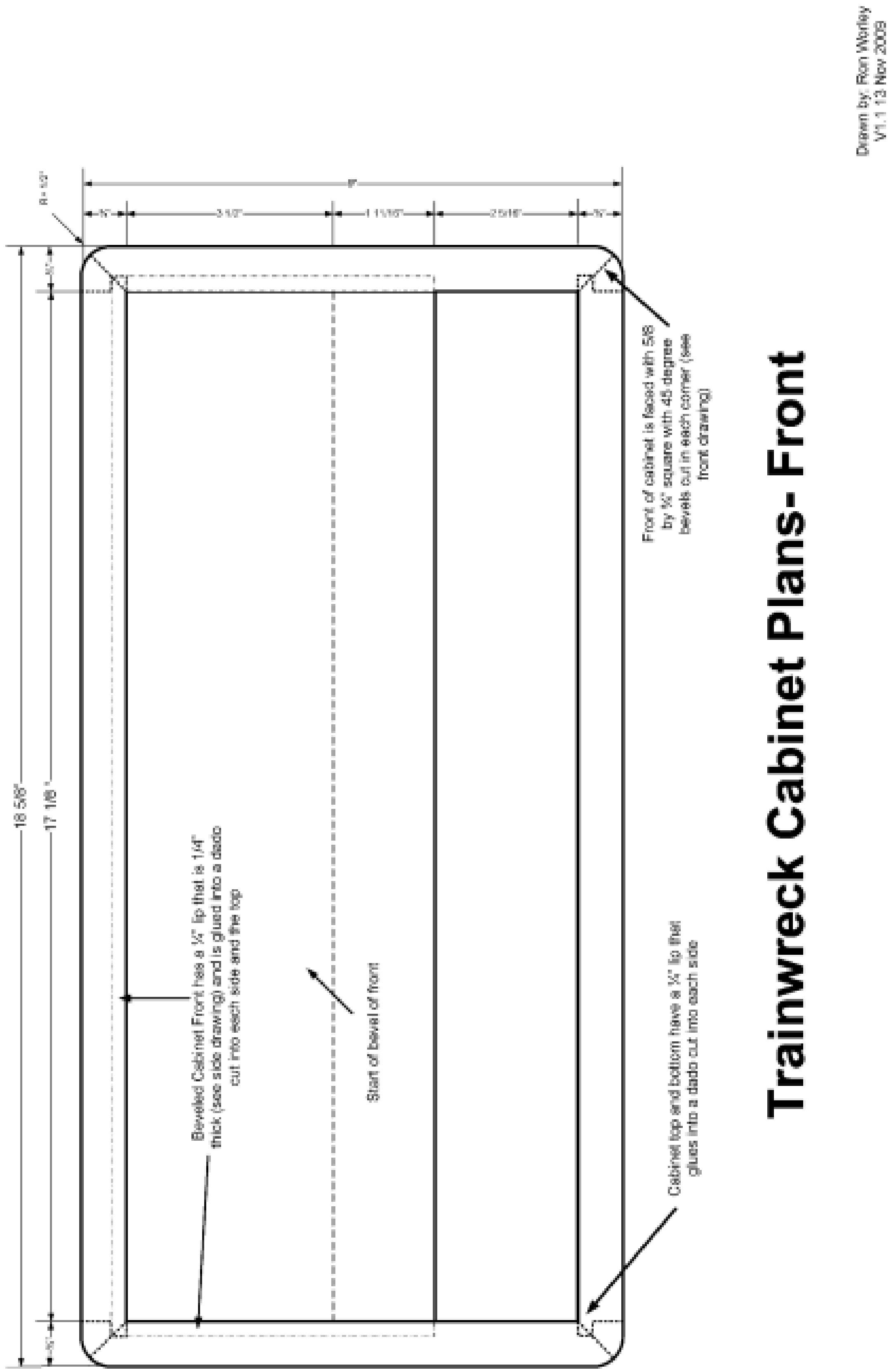
-The resistors on the cathodes can be adjusted and the 820 ohm resistor after the volume pot can be changed to values from between 820 ohm to 2.2k.
-There are some other things that can be changed like the .002 150k high pass network between stage 2 and 3.
-The phase inverter and power tubes are all the same in most real wrecks.
-The second stage cathode resistor changes from 2.7k to 1.5 for more gain in some wrecks"!

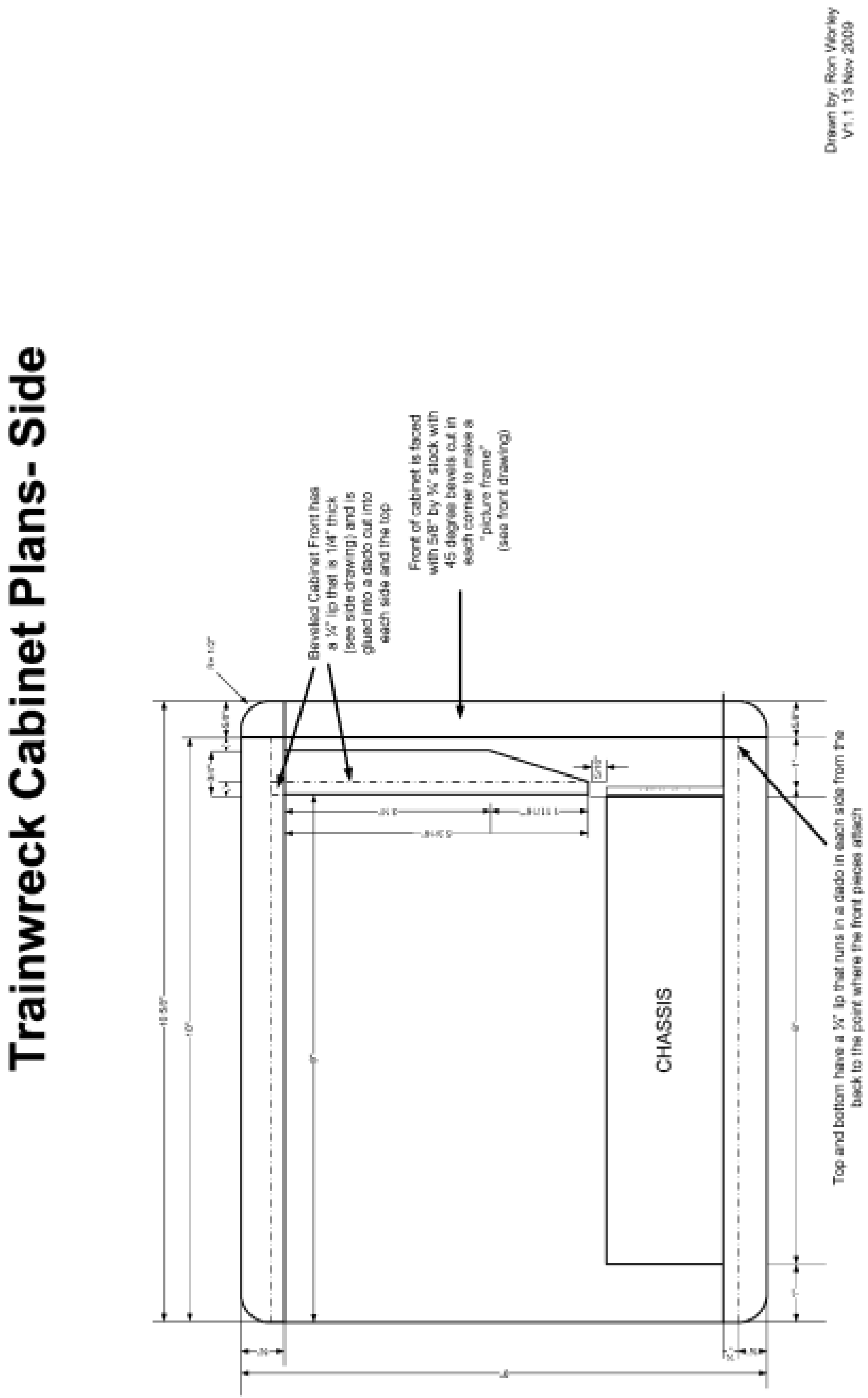
6. Building the Cabinet:

There are numerous sources for authentic reproduction cabinets. There is a cabinet layout drawing by M. Taylor in the files section on the forum- but it has some dimensional inaccuracies, so I did my own drawings. Larry Mann ("Distortions" on the forum, **distortions@comcast.net**) is a very popular source for exotic wood masterpieces. Be prepared to pay significantly here though- we're talking ~$400 a pop. Another great supplier is Jean at BNP Lasers for custom laser etched faceplates- You provide the art, and she does the rest.

The Authentic Ken Fischer Cabinet

Here are drawings that I did based upon the design and dimensions of a real Trainwreck cabinet. There are also examples of real Wrecks with simpler 45 degree miter joint construction, but this is what appears on most that I have seen pictures of:


Drawn by: Ron Worley
V1.1 13 Nov 2009
Trainwreck Cabinet Plans- Front
Front of cabinet is faced with 5/8 by ¾" square with 45 degree bevels cut in each corner (see front drawing)
Cabinet top and bottom have a ¼" lip that glues into a dado cut into each side
Beveled Cabinet Front has a ¼" lip that is 1/4" thick (see side drawing) and is glued into a dado cut into each side and the top
Start of bevel of front
18 5/8"
17 1/8"


Trainwreck Cabinet Plans- Side
Drawn by: Ron Worley
V1.1 13 Nov 2009
Beveled Cabinet Front has a ¼" lip that is 1/4" thick (see side drawing) and is glued into a dado cut into each side and the top
Front of cabinet is faced with 5/8" by ¾" stock with 45 degree bevels cut in each corner to make a "picture frame" (see front drawing)
Top and bottom have a ¾" lip that runs in a dado in each side from the back to the point where the front pieces attach
CHASSIS

The "Drawer-Cab"

Here's a low cost solution that was proposed on the forum- it's a tongue and groove drawer kit supplied by Woodcraft that is a very cost effective alternative to a custom cabinet, plus it can get abused on the road and you won't care: "Jem" from the Amp Garage forum came up with this solution.

Tim Hulsey: "The drawer kits are made from plantation-grown cherry. I took the TW cab plans from the files and took off 1/8" from all the outside dimensions (5/8" stock instead of 3/4") yielding a 9-3/4H x 8-7/8D x 18-3/8/W drawer. Lay the drawer on its side, and *voila*, you have a TW cab with half-blind dovetail joints. You have to supply the cabinet front (the easy part).
.
Money: Merchandise Net: $47.60; Shipping Amount: $9.25; Total Amount: $56.85"

http://www.woodcraft.com/family.aspx?familyid=1991&productid=140719

More forum Notes: "I dry-fitted it, and I needed to shave a 128th off my 17-1/8" long faceplate to get a PERFECT fit for a 17x8x2 chassis. I'll radius the edges, but you wouldn't HAVE to. Now, this won't be a furniture grade cab like Distortion's, but it is an economical cab alternative".

"Actually, it's got just enough clearance to get the chassis in the cab. If you make your faceplate without the extra 1/8" length, you would have plenty of room for tolex or for weather stripping like Ken used. A 5/8-3/4" thick front will add a great deal of bracing, and you could add square battens in the upper corners.

"If you decide to order... the dimensions must be in decimal form, so from Dr. Hulsey's dimensions: 9-3/4H x 8-7/8D x 18-3/8W drawer equals 9.75Hx 8.875D x 18.375W"

Building the cabinet

The cabinet comes ready to put together- its precision CNC machined joints mated perfectly. Use your favorite wood glue (I like titebond) to put it together. I also used a rubber mallet to "coax" the joints together- they are tight. Make sure you have the drawer bottom grooves all aligned at the back of the cabinet.

If you'd like to saw off the 1/4" groove for the drawer bottom, it's 3/4" from the outside edge of the drawer to the inside of the groove. So add that to your dimensions (depth or width depending...).

If you want to keep the drawer bottom groove, you can use some 1/4" guitar perfling makes the groove decorative- try Stewart MacDonald (www.stewmac.com). The perfling is only 1/8" thick, so you need to buy some ¼" stock (Home Depot, Lowes), and sand it down to allow the perfling to lay flush. The actual drawer groove is about 9/32" deep, so you need to sand down the stock to about 5/32". Use a table mounted belt sander to get the desired thickness across the whole piece of stock. Error on the high side- the perfling is designed to be sanded down (the design goes all the way through the piece), and you can get it perfectly flush with your orbital hand sander. I installed the perfling on the bottom and sides only- I used plain stock for the upper groove since you can't see it (and it looks good too). You could use just stock the whole way around and it will look fine too. Here's my drawer-cab with the perfling installed below.

I routed a 1/4" radius on the outer edges and corners using a round over bit. Don't do the inner edges until you are done measuring for the chassis bolt holes installing the front panel- you want a straight edge to work with.

Once you have the basic cabinet together, you will have to do some pretty precise measurements, drilling and nailing for the chassis bolt holes and mounting the cabinet front. To exactly align the chassis bolt holes I made a template out of Plexiglas (see below). Unless you have a very precise way to cut the Plexiglas, you will likely have slight irregularities in the degree of "squareness" you achieve on the cut edges.

You will have one perfect edge (see the arrow in the picture below)- the one that is the uncut one from the factory. Use this corner and known-good right angle for your alignment to the chassis. I use painter's tape to affix the Plexiglas as precisely as I could, visually sighted and then marked the exact center of each of the chassis bolt capture nuts. Once you're happy with your precision level, take the template off the chassis and drill holes in each market point. I measured the exact diameter of my spring punch, and drilled these holes to that size. Then when I transferred the template to the cabinet, I could very precisely punch the exact center of the hole with no wiggle. I also suggest that you mark the orientation of the template (front with an arrow), and remember to do it on the same side of the template- you be drilling from the cabinet bottom, so the orientation is the same.

The back edge of the chassis is exactly 5/8" from the back edge of the cabinet- using a carpenter's square and a metal ruler I carefully marked a line along the outer bottom edge at 5/8" across the whole width of the chassis. I also marked the inner edges of the cabinet sides on bottom of the cabinet as well with the square. Use your one good 90 degree corner to precisely align the template to the cabinet and tape with painter's tape. (I used ¾" from the back edge to allow the perfling to be seen- on an authentic cab, 5/8" is right).

Use your spring punch to mark the holes, remove the template, and drill the four ¼" bolt holes. Easy, eh? The good news is that the Chassis capture nuts have enough play to allow for a little bit of drilling error.

I would then fit the chassis to the cabinet to make sure your alignment is good for the holes. The chassis capture nuts have a certain amount of "wiggle room", so you have some room for error. If you are too far off, you will have to either dowel and redrill the hole or drill a bigger hole if you're not too far off.

Next, you have to make the front panel. I used a 1"x6" (actually ¾" thick) piece of oak from Lowes (or whatever you like). First I ripped it on the table saw to 5 1/4" wide to allow the right gap for the brown weather stripping). The plans below use 5 5/8", which is not right by my reasoning- there is no allowance for the weather stripping. Then I set up the rip fence to table saw to ½ ", and set the blade angle at ~9 degrees away from the fence. I ran the board through the blade on the end edge, thereby giving me the proper bevel. By doing the whole board, I now have enough for 4 cabinets. Push the wood though slowly- the oak is hard, and if you push to fast you will likely burn the wood (does not sand out that easily). Cut the board to proper width (measure your cabinet exactly) and you're ready to install it.

Next, you will mount the front panel to the cabinet. The drawing below does not give a dimension for how deeply the front panel is recessed from the front edge. I estimate that on a correct cabinet it would be a ¾"" recess, but on my cabinet I used 5/8"" after dry fitting with my chassis to allow the perfling to be seen on the back edge. In order to get the front panel exactly aligned, I made some 5/8” blocks on my table saw, and laid the cabinet on its front edge on a very flat surface. The blocks were placed on the table inside the front top edges of the cabinet, and then the front panel was laid on top of them- giving you perfectly square alignment with the front edge of the cabinet. See the picture below to understand what I’m trying to say… Make sure that you have checked the clearance of your OT from the front edge of the chassis- this depth is important in making sure that you mount the front panel correctly. If you don’t, your chassis may not fit in all the way and your chassis bolt holes and faceplate alignment will be off. If anything err to the front edge of the cabinet to make sure you have clearance. (Edit- after a second cabinet build, I have refined the dimensions- I used 5/8” to make it flush with the faceplate).

On my first cabinet, I used a pneumatic nail gun to attach the front panel by shooting 4 nails into each side of the cabinet. It worked very well, but left a large hole that require a lot of putty to fill and did not stain all that well. You might want to consider using screws and doweling over the heads or other better cabinet maker methods. This was a prototype first cabinet for general use, not the fine piece of furniture that guys like Larry Mann make, so it’s no big deal this time…. You could also use corner support blocks and glue them on the inside of the cabinet to hold the front panel. I chose for a more solid (but uglier) attachment method. On the second cabinet, I got a tad smarter and used recessed stainless screws and dowelled holes- it looks a LOT better:

Now you can rout all the inner edges of the front and back edges with your round-off bit.

After you've finished all the mechanical work, sand the cabinet down with progressively finer sand paper, apply a few coats of polyurethane (sand with 220 grit or finer between coats), and you're done constructing your cabinet.

It's probably redundant, but your cabinet and dimensional situation in building it will all vary. You need to dry measure your work carefully to insure that you don't encounter real problems. As such, the dimensions on the cabinet plans below may not be accurate for your build. Larry Mann indicated to me that several of the dimensions are wrong. I determined that the front panel needs to be 5 ¼" tall to allow for the brown weather stripping, and that the panel should be recessed 3/4" from the front edge for an authentic Wreck cabinet. It was also pointed out to me by Gary Hultgren (gahult) that Matt's material list is wrong- you need more that 6 ft of boards to allow for the mitered edges- use about 6 ½ feet and you'll be good to go.

7. Mounting the Chassis in the Cabinet and Final Details

-When you're all done troubleshooting and tweaking the amp, you're ready to put it into the cabinet. Attach the bottom plate using the #8 3/8" sheet metal screws and the optional support bolt if you're using the real-deal Bud chassis. Attach the front faceplate carefully to the chassis- the knurled nuts on the power / standby switches are a bitch to get tight without marring the wood. KF unsoldered the pilot lamp and then resoldered after attaching the faceplate- I cheated and just made the hole in the faceplate large enough for the lamp to fit through. Your call…

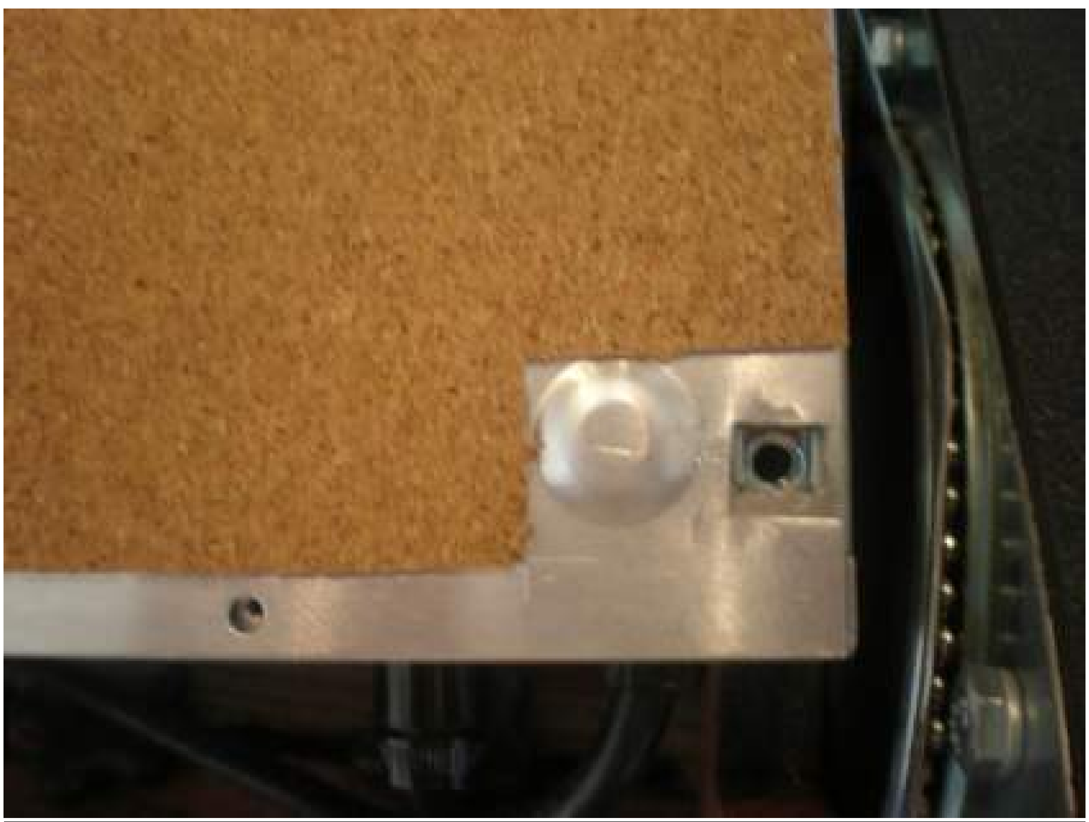
-Attach the weather stripping foam to the top of the faceplate (as seen on a real wreck). I also put it on the bottom, but it made it a real bastard to install the faceplate below the front panel without dorking the foam up..

-At this point you can attach the rubber cabinet feet (if you have not already). They are simply screwed into the cabinet with #8 ¾" Flathead stainless wood screws, just outboard of the chassis bolts towards the front and back respectively (see the picture below).

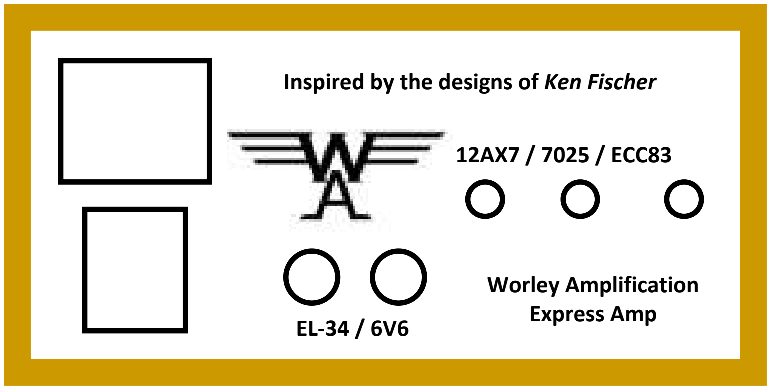
-You either bought or made your cabinet; either way it should assemble the same way.

-Mechanical stability seems to affect electronic stability on the Express; KF did a lot of things to help with making the amp stable. It has been noted somewhere that an application of thin adhesive backed cork on the bottom plate between the chassis and the cabinet helps with transmission of mechanical vibration (like when the head is on top of the speaker cab….).

-For any of the chassis types, the cabinet is secured via the use of (4) 1 ½" ¼ -40 machine screws that thread through the cabinet into the chassis (into the chassis lip-mounted nuts on the Ceriatone / Allyn Meyers chassis and into the "Nutserts" on the KF official Bud chassis bottom plate). It was suggested on the forum that they threaded through the cabinet feet, but that is not the case- see the picture below of a real Wreck:



Attach a tube chart to the inner wall nearest V1, and the build is done. Here's my version that I did in Powerpoint (it's very close to the original except my logo, etc):



Speakers

Glen: "I had 4 new alnico blues that I tried in my favorite '68 4x12. Not a good match in my opinion, except maybe for clean country. The Express is bright enough and the blues make it even more so... Later I tried just two in a 2x12, but still couldn't ever get happy with them. My favorite speakers no doubt with the Trainwreck Express or Liverpool are old Celestion pulsonic cone G-12M 25 Watt or the Scumback reproduction Green-back 25 watt speaker are pretty decent. I have 4 of the Scumbacks in a 4x12 and one high power version of their 25 in a 1x12. Nice speakers. A little brighter than an original, but seem to be mellowing out the more I play them. G-12Hs work for some folks, but for the most part they can get a little bright too with the Express and are more efficient which the amp doesn't need any more volume. The 25s help to tame the volume a bit too".

Hubie: Kenny used the following speakers:

Express - Pre rola 30's for a Les Paul, pre-Rola 25's for a Strat or Tele (003 cone)

Liverpool - Pre Pre rola 30's for a Les Paul, pre-Rola 25's for a Strat or Tele (003 cone)

Rocket- Two 2x12 Alnico Blues (one open and one closed)

Songwriter 30- Two 2x12 blues (one open and one closed)

He said the old speakers can't be replicated. If you take an old speaker and hit the bracket it chimes a musical note.

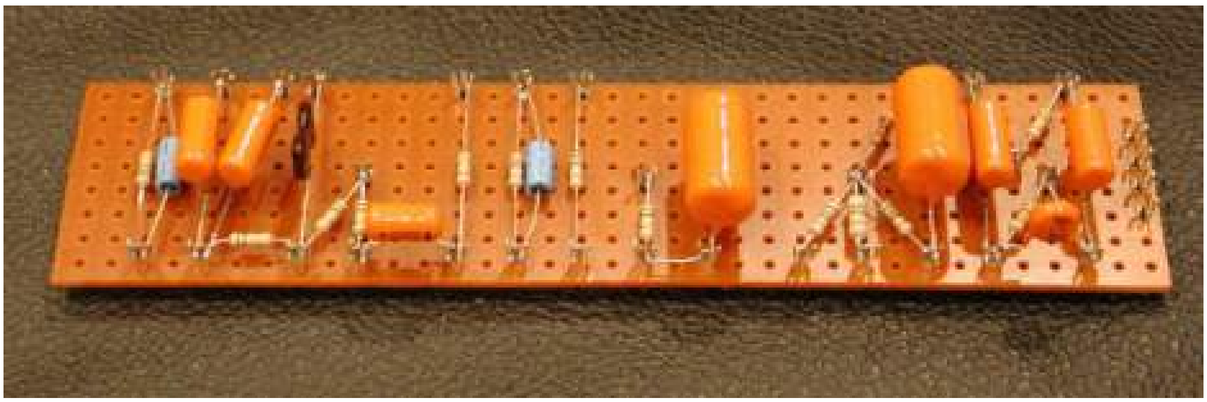
Try that with a new one and it doesn't work

Appendix A: The Ken Fischer Tribute Amp

The Ken 06 Express is constructed using the most accurate period-correct parts that are available in 2007. Over 70 people have had input or have contributed in finding and providing original parts. Some parts are just unobtainable, but only a few substitutions have been used. These substitute parts have been selected to insure that they are the same or better quality as the original part. The part specifications that were used were taken carefully from in an Express that Ken built in 1985, named *Francesca*. Everything was reproduced painstakingly, down to the nut and screw head orientation!

Ken used two boards in his Express amps — A Preamp board and a Power Supply board.

The Preamp Board



The Preamp Board was constructed using the same material Ken used in all of his amps, an XXX grade phenolic perfboard with a hole spacing of .265 inches and hole diameter of .093 or 3/32". It measures 8 holes wide (2 ¼"), 35 holes long (10 ¼") and is 1/16" thick. This board is difficult to find today but we were able to source the original board material. Push-in terminals or "Flea Clips" were used to mount the components in Ken's amp, and we were fortunate enough to be able to use original Flea Clips to construct this amp.

Ken used PVC Series Mallory caps: these are a polyester cap, the PVC series are also getting scarce, but we were lucky enough to source this type for this amp. Other original parts that were used include all carbon film resistors, and correct silver mica caps. All components were carefully oriented exactly the same as the original model. For example, while it makes no difference in the voicing of the amp, all gold bands on resistors are oriented towards the tube socket side of the board just like Ken did it. The PVC caps are also oriented with the black line pointing to the front of the amp, as was done in Francesca.

Substitutions

The 47 pf cap in the Phase Inverter is not from the same manufacturer that Ken used, but is accurate in construction and specification. We also had to substitute Nichicon 22uf electrolytic caps for the 22uf Rubycon brand that Ken used. It seems this value of Rubycon axial caps has gone the way of the dinosaur and no longer exists.

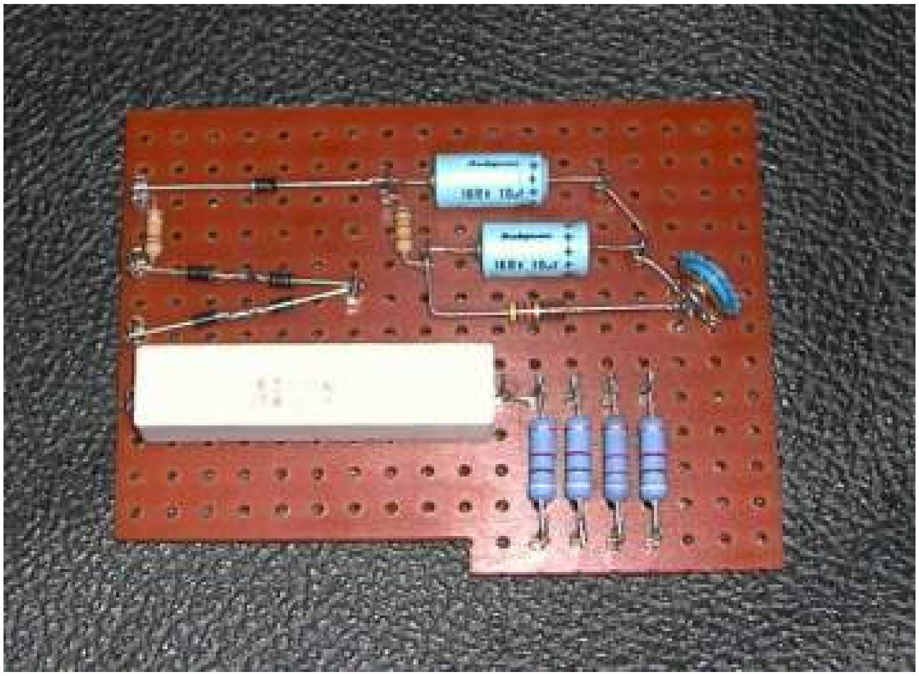
Component Measurements

Component measurements of board from left to right, with the board oriented with the power connections to the right:

Part	Actual Value Measured

1.5k Carbon Film Resistor	1.47k
22µf Electrolytic Cap	23.3µf
.02µf PVC Cap	.021µf
.02µf PVC Cap	.020µf
100k Carbon Film Resistor	98.1k
500pf Silver Mica Cap	525pf
100k Carbon Film Resistor	98.9k
100k Carbon Film Resistor	99.1k
.002µf PVC Cap	.002µf
150k Carbon Film Resistor	148.1k
2.7k Carbon Film Resistor	2.64k
22uf Electrolytic Cap	24.8µf
10k Carbon Film Resistor	9.85k
100k Carbon Film Resistor	98.1k
.1µF PVC Cap	.100µf
1M Carbon Film Resistor	975k
470 Carbon Film Resistor	465 ohm
10k Carbon Film Resistor	9.87k
1M Carbon Film Resistor	981k
.1µf PVC Cap	.100µf
.02µf PVC Cap	.021µf
100k Carbon Film Resistor	99.5k
82k Carbon Film Resistor	82.0k
220k Carbon Film Resistor	221k
220k Carbon Film Resistor	219k
PVC .02µf Cap	.021µf
47pf Silver Mica Cap	51pf

Power Supply Board



The Power Supply board uses the same perfboard and flea clip construction as the preamp. It contains the high voltage and bias supplies. The board is the central part of the power supply and contains parts with the exact specifications that Ken used. We were again fortunate to have people donate hard-to-find NOS period parts for the PS board including a “thumb wheel” 25k trimmer pot and two original Rubycon 10µf capacitors. The caps haven’t been made in years and are also considered "extinct." All component orientations of resistors and, of course, diodes and caps were strictly followed to match Ken’s board exactly. A carbon composition 47k resistor and 220k and 15k carbon film resistors were used, along with 1k 25W “cement” and 9.1k 3W metal oxide power resistors. All diodes are 1N4007.

Substitutions

10µf 160v Rubycon electrolytic caps were used in place of 10µf 100v Rubycon caps.

Component Measurements

Component measurements of board from left to right, with the board oriented with the power connections to the right:

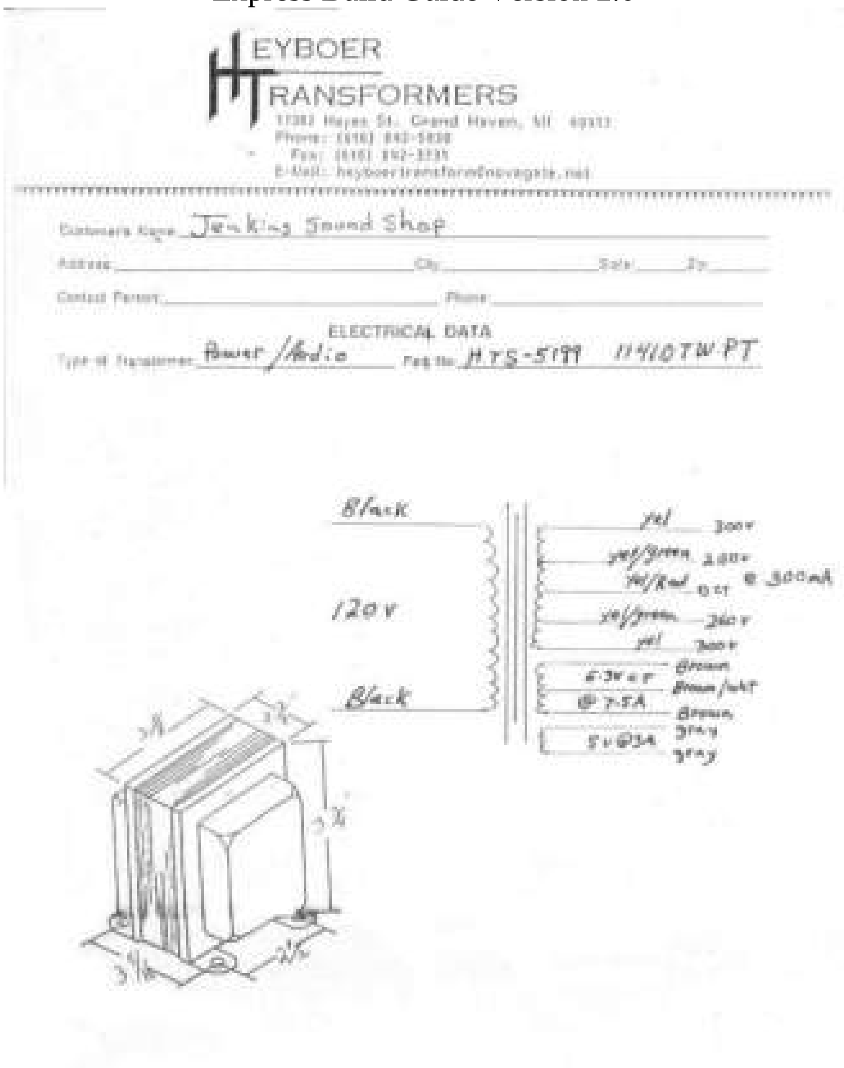
Part	Actual Value Measured
1k 25w PWR Resistor	981 ohms
9.1k 3w PWR Resistor	9.03k
9.1k 3w PWR Resistor	9.03k
9.1k 3w PWR Resistor	8.98k
9.1k 3w PWR Resistor	9.04k
15k Carbon Film Resistor	14.86k
47k Carbon Comp Resistor	50.1k
220k Carbon Film Resistor	219k

25k Trim Pot	23.9k
10µf 160v Electrolytic Cap	11.98µf
10uf 160v Electrolytic Cap	11.04µf
1N4007 Diode (fwd bias voltage)	.579v
1N4007 Diode (fwd bias voltage)	.581v
1N4007 Diode (fwd bias voltage)	.586v
1N4007 Diode (fwd bias voltage)	.580v
1N4007 Diode (fwd bias voltage)	.578v

Power Supply

The power supply board is only part of the whole power supply. There are external parts that connect up to the power supply board to complete the whole power supply circuit. These external parts include the power transformer, the Mallory TV-series electrolytic filter caps, power and stand by switches, neon power light, fuse holder, MOV, 100k bleeder resistors and power cord with strain relief. The parts mentioned above, with the exception of the power transformer, were all the exact parts that Ken used.

The power transformer was manufactured by Heyboer in 2003. (see figure A below). It supplies 300VAC for the high voltage and is rated at 300mA. It also supplies the 6V heater voltages and has a 120 AC volt primary.[1] The power transformer for this amp has powder coated end bells that are a different style than the ones on the output transformer. This is another small detail that was done to match the original Express.

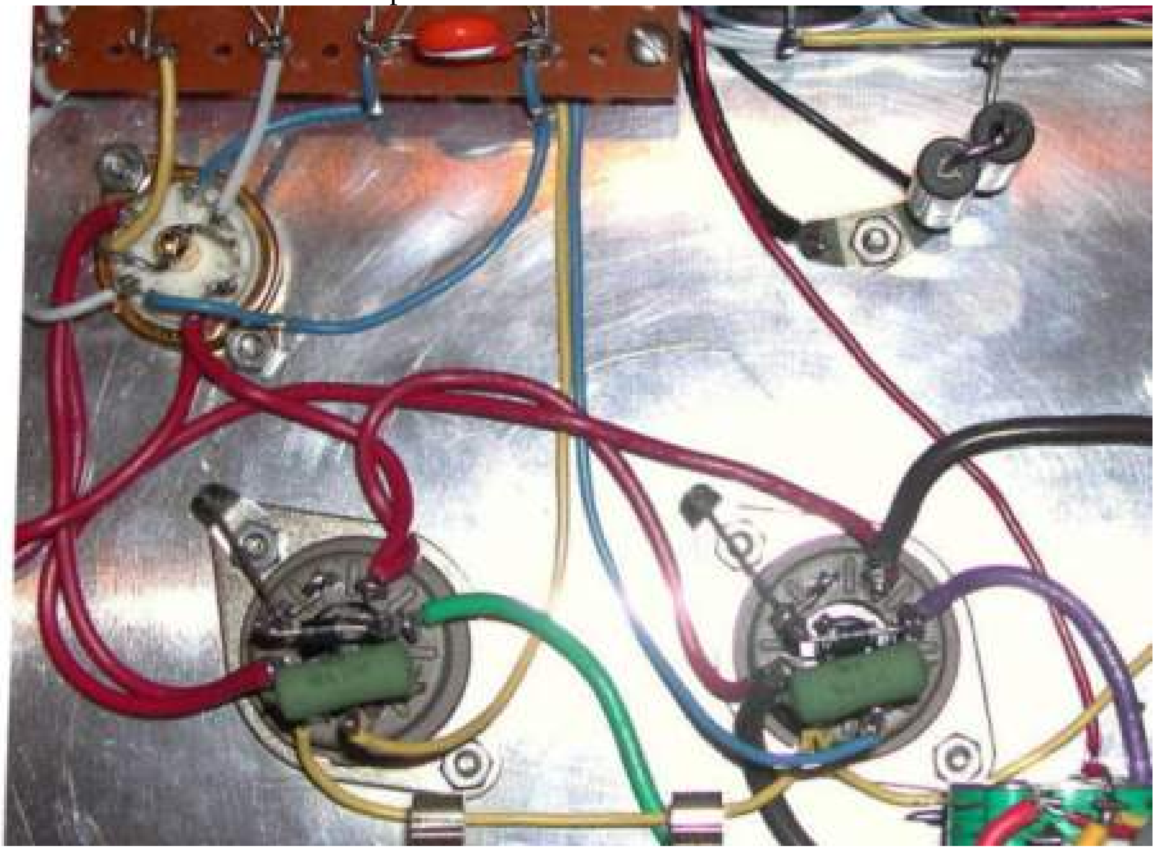


[1]Over the years the AC voltage coming out of the wall outlets in the US has gradually increased from 110v to 115 to 117 to 120v and higher. New old stock power transformers are generally wound for 110 or 115 volts. If you use one of those today on 120VAC it raises all of the secondary voltages. This can be a problem if, e.g., the 6V heaters were run at 7.5V, as it would shorten the life of the tubes.

Other parts that make up the power supply are the power and standby switches, 130v varistor, fuse holder, line cord, original Mallory TC series filter caps, 100k bleeder resistors and original yellow Mode Electronics 120v neon power indicator.

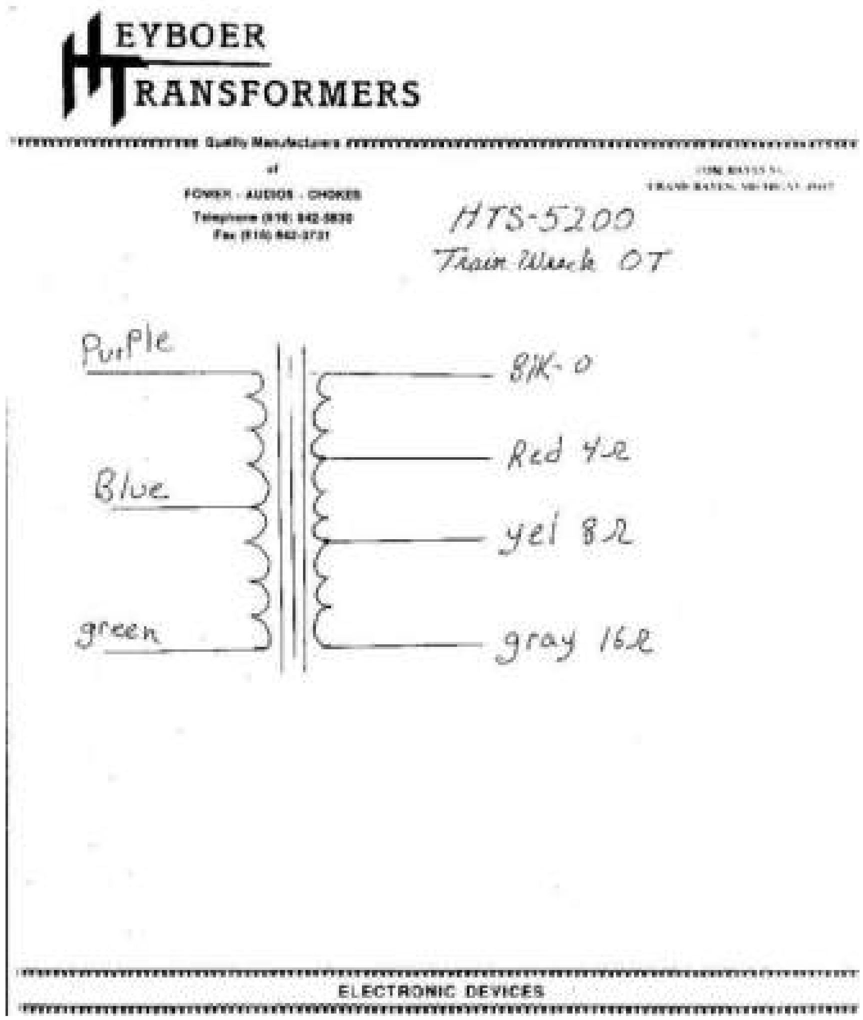
Power Amp

The power amp consists of three sections, the power tubes, the phase inverter and the output transformer. The amp runs in a class AB1 mode, push-pull configuration. The power tubes used are NOS EL34s made in Germany by Siemens. All of the tubes donated for this amp were hand picked by Ken himself to be used in a friend's Express. These tubes were made in the old RFT plant in Neumann East Germany. Components for the power tubes are mounted on the tube socket. These include 1k 5w screen resistors, fly-back protection diodes and a 1.5k grid resistor.



The phase inverter (at upper left in the picture above) is a 12AX7 long tail phase inverter, not unlike those used in Fender and Marshall amplifiers. It is sometimes referred to as the “driver tube” because it supplies two output signals 180 degrees out of phase to drive the two power tubes.

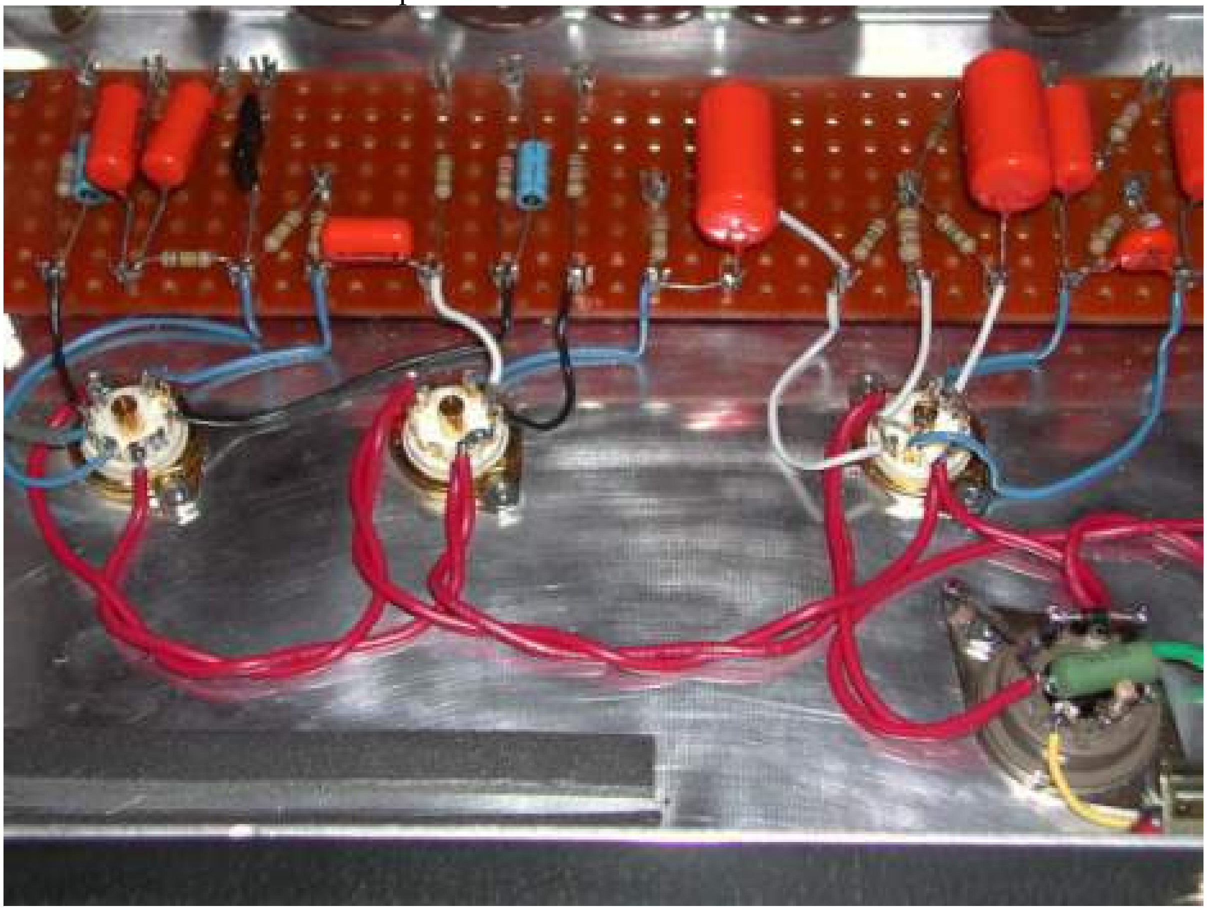
Several different output transformers from different companies were used in many of the Express amps. It has been documented that Ken used ‘off the shelf’ Stancor A-3801 units and had contacted Heyboer for some transformers at one time. The A-3081 had 6.6k primary impedance and was classified as a “Hi Fidelity” transformer because of its extended frequency range. There is some dispute as to what Ken intended to use the Heyboer for -- some believe that Ken had ordered these for a stereo amp he was building. The Heyboer transformer ordered by Ken had a 5.2k primary impedance. The Transformer we selected was a Heyboer wound to the same specifications as the one Ken ordered.



The output transformer's secondaries are connected to a Stackpole impedance selector switch to connect the speaker to the appropriate secondary winding. This allows the amp to be used for 4, 8 or 16 ohm speaker configurations. Stackpole has been out of business since the early 80s, being bought out by Electroswitch. Ken used a part number 73-1037 switch. We were fortunate enough to find an original Stackpole switch for this amp. The switch is a dual 6 position switch. It's wired to provide 3 poles and both sections were wired in parallel to increase the power handling capability of the switch.

Preamp

The preamp consist of three stages using two 12AX7 tubes. This amp has a hand selected set of NOS Tungsram tubes, made in Hungary, that again were personally selected by Ken, to be used in a friend's Express. (Note that Telefunkens were also a favorite brand of Ken's. These tubes were made in the same RFT plant in Germany as the EL34 power tubes.) The first stage amplifies the guitar input and is fed into the tone stack. From the tone stack, the signal goes into a recovery stage and then to the gain stage.



PVC-coated solid-core 20 AWG wire was used in the original Expresses and the same wire is used in this amp. The color code, wire length and proper wire specifications correspond exactly to the layout found in Francesca. Shielded wire was used from the input jack to the input of the first preamp stage. This is the only shielded wire in the amp.