D. The R X C constant of the combination of R11 and C6 must remain as high or higher than as designed. In other words, if R11 is decreased to 250K, for example, C6 must be increased to 2.0 uF.
R5 should not be made more than 470K, otherwise signal grid current on the upper half of the cascode can adversely affect the current (thus the plate voltage) of the upper half.
This limits the minimum value of C6, for practical purposes, to 1.0 uF. Higher values of C6 may be used. Electrolytics may be used for C6, but due to the naturally higher leakage of electrolytics, we do not suggest using a R11 value of over 100K with this type of capacitor. This means any electrolytic used as C6 would have to be 4.7 uF or higher. We would suggest paralleling electrolytics used for C6 with a film capacitor of .047 or larger at 200V or higher rating.

7. Other resistors on the board. The other resistors generally speaking should not or need not be changed.

8.Coupling capacitors (C2,C1) The values of these capacitors may be varied considerably, taking into account that too small a value will cause a low frequency rolloff, and too large a value, particularly in conjunction with high values of negative feedback,may induce low frequency oscillation ("motorboating").or pass subsonic signals and cause acoustic feedback from the speakers.
Electrolytic capacitors should not be used for C2 or C1, otherwise about any material is acceptable.

9.Other Capacitors on the board (C7, C4, C5). These are intended for high frequency phase-compensation and prevention of ultrasonic oscillation, the basic values are set by the output transformer characteristics. These can be tweaked *if* you have the proper equipment (basically, a dummy load, square wave generator and an oscilloscope).Trying to tweak by ear alone is not a good idea as if the amplifier oscillates at ultrasonic frequencies, or if there's transformer ringing , this can often only be seen on a scope.

10. Changing other tubes (12AU7). Generally different brands of 12AU7 tubes may be interchanged at will, and also interchanged with other tubes of identical pinout,identical filament voltage and similar voltage gain - usually 12BH7 (rarely, E80CC).

11.Swapping cascode voltage gain tube (V1). As noted above, generally 12BH7 and 6085/E80CC will drop in and work with no further change. Generally you will get better results with 12AU7 than 12BH7 or E80CC. Using tubes with higher mu & Gm, such as 12AT7, 12AX7 and 12AV7/5965 and others with 9A pinout will require will generally require reducing the values of R4 and R3 to get the plate voltage of the upper half of the cascode within limits as noted above. Value of R4 & R3 may have to be increased to accomodate very "hot" 12BH7's, if the plate voltage is too low.

12. Phase splitter tube (V2) Tubes with higher voltage gain (12AT7, etc.) will generally not split phase as evenly as the lower gain ones. The current draw required and the excessive output impedance of the 12AX7, 12AY7/6072 and 5751 tubes prohibits their use in this application. 12AU7, 12BH7, 6085/E80CC & E

6.General Troubleshooting Procedures.

1.Low B+ (HT) voltage from rectifier diodes or tube cathode. (Turn amplifier off before performing tests.) This indicates either a restriction in the power supply (open or high resistance windings in transformer or choke, bad rectifier tube, low capacity of power supply capacitors) or excessive current draw (caused by leaky filter capacitors, or shorts in tubes or output transformers) pulling down the voltage.

A. Test or substitute rectifier tube or check continuity of diodes. Replace if necessary.

B. Check continuity between the rectifier plate leads (pins 4 and 6) and between these leads and ground. If open at any point, check for broken connections in the leads. If high resistance found on one side of the winding, check for cold solder joints, inside the transformer as well if necessary. If high resistance condition exists after repairs, probable defective power transformer.

C. Discharge all filter capacitors, by shorting terminals to ground, then test with ohmmeter, observing polarity. Meter should first indicate close to dead short then rise slowly to a high value. If one or more sections will not rise or is much lower than the others indicates defective capacitor. Unfortunately some capacitors will pass a low voltage ohmmeter test but leak enough to cause trouble at high voltages. Use of a high voltage capacitor tester would be preferable, or a milliammeter in series with a high voltage power supply. Any current over a few ma after charging up would be suspect.Filter capacitors becoming excessively warm or hot during operation indicates a leaky condition also.

D. Pull output tubes, and disconnect the leads running from the filter capacitors to the output transformers. Check with ohmmeter resistance between transformer leads and ground (chassis). Resistance should be very high. If not indicates possible defective transformer. If suspected, try reconnecting the good transformer, installing the output tubes on that side, then operating the amplifier. If condition does not recur, but recurs when other transformer is hooked up (try without output tubes, so a short tube will not give you a false indication), then that transformer is the culprit.

2.Output tubes draw excessive current (biaset too high).

Swap the offending pair of tubes with the tubes from the other amp.

If the problem follows the tubes to the other side indicates probable bad tube.

If the problem remains on the side where it was originally, possible bad tube socket or bad connection in grid bias circuit (often open bias control) on that side.

Check voltages in bias circuit. If they appear normal (usually will create negative voltage of 50-60 volts at eyelets #2A and 2B), then check for excessive voltage drop (use a high impedance voltmeter to check this such as a VTVM) across R9 and R10.

If a drop of more than a few volts is found on only one,indicates severe tube unbalance or possible defective tubes.

If found on all tubes indicatesthat amplifier must be modified for lower DC grid circuit resistance (see chapter 4, "Changing Output Tube Configuration") to accommodate the tubes you have chosen. If no excessive voltage drops found across these resistors, and other bias circuit voltages appear normal, indicates type or brand of tube used requires modification to bias circuit to be used in this amplifier. See Chapter 4, "Changing Output Tube Configuration" for details.

4.One tube glows red or orange. Swap the offender with another tube (keep track of which one you swapped!) If condition follows tube, this indicates a probable defective tube or possibly bad solder joint inside the tube pins (which may be fixed by heating the pins with soldering iron). If condition appears in the same socket with a different tube indicates either a bad or wrong connection to that socket or a bad socket.

5.Biaset won't go high enough.Generally either means output tubes are worn out, or the 18K resistor from the bias controls to ground is either defective, not connected or out of tolerance (value too high). This could be caused by a bad or internally cracked/damaged bias control.

Occasionally even new tubes do not draw sufficient current, in this case, either replace the 10K bias controls with a higher value, or reduce the value of the 18K resistor going to ground from the bias controls (try a 10K or similar).

6.Transformer hot or vibrating excessively. Indicates either a component in the amplifier is drawing excessive current due to leakage (see section 1 above for how to track that type of problem down), tube are biased to draw an excessive amount of current, or transformer has internal short. Note that some Dynaco transformers as shipped from the factory vibrated excessively and physically isolating the transformer with rubber grommets or other methods may be necessary to solve the problem. All power transformers will dissipate some heat during operation, even with no load, however getting too hot to touch without burning skin indicates a problem.
If the first two possibilities are ruled out then turn the amplifier off and unplug, disconnect the ground (chassis) lead, remove the rectifier tube (5AR4) or disconnect from rectifier diodes, and pull all other tubes.
Check the resistance between the ground lead of the transformer and each of the leads going to the 5AR4 socket. The resistance on each side of the ground wire will not exactly the same but similar (say within 30%).
Check the resistance between the yellow wires connected to the 5AR4 and chassis or transformer case. The resistance should be very high (usually 1 meg or more). Check between the leads going to the 5AR4 and the different filament wires (pins 2 and 8 of the 5AR4 itself, also pins 2 or 7 of the 6CA7/ EL34's). Again the resistance should be very high. If any of these do not check out, a defective transformer is indicated, however other possible leakage paths should be checked, including where insulation where wires run close to the chassis, where wires enter the transformer, and under transformer bottom cover.
7.Capacitors bubbling, crackling, venting or smoking. Indicates that the capacitor was exposed to an overvoltage (or in the case of an electrolytic capacitor, reverse voltage), or is simply defective. Replace the capacitor, however before doing so, check to make sure the capacitor is of sufficient voltage rating, that the cause of any possible overvoltage condition (wrong size of voltage dropping resistor installed, etc.) is corrected, that the voltages in the circuit where the capacitor is installed are correct, and make sure the capacitor, if it is an electrolytic, is installed with the proper polarity- note that in the bias circuit where there are negative voltages present the capacitors are connected with the positive side to ground (chassis), for example.
8. Resistors overheating or smoking. Indicates either a resistor of the wrong wattage rating was chosen or that some element in the circuit (usually a defective tube or capacitor) is short and drawing a high amount of current through the resistor.
To determine resistor wattage rating, use Ohm's Law thusly:
Divide the voltage drop across the resistor by the resistance. This will give you the current in amperes drawn through the resistor. Then multiply the current in amperes by the voltage drop to get the wattage dissipation. Then double the wattage to find the minimum necessary rating. For example if voltage drop is 200 volts, size of resistor is 330,000, current is .0006 amps. Take .0006 times 200 equals .12 watts dissipation. The minimum rating for the resistor would be .24 watt, ergo a quarter-watt (1/4 watt) resistor would do.
Note that for resistors that effectively do not have a DC current drawn across them, principally grid resistors and phase or frequency compensation networks, the wattage rating can effectively be ignored, and the smallest convenient rating used. While AC currents exist in this amplifier, except for the resistors included in the feedback loop (R11 and the 680 ohm resistor across the output), these currents are negligible and may be safely ignored for wattage dissipation calculations. If the resistor is indeed of the proper wattage, then the other defective elements that are making the resistor overheat must be located and replaced prior to reinstalling a new resistor. In the case of a plate or screen resistor, test the tube for shorts or substitute with a known good tube and see if the problem recurs. In the case of possible defective capacitors, follow the procedures in the previous section for testing them.
9. Crackling, hissing, or noises through one or both amplifiers. First eliminate tubes as the source of the problem by substituting tubes one by one, and turning on the amplifier to see if the problem recurs.
If, after substituting all tubes the problem continues, a little detective work will be necessary. First, pull the tubes from the PC board, then turn on the amplifier again. If the sound disappears, then the problem is probably on the board or power supplied to the board. If not, and the sound appears in both channels, the problem is probably in the power supply (power transformer, choke, filter capacitor (s), or resistors attached to the filter capacitor (s). If not and the noise only appears in one channel, the source is most likely in the output stage, often the tube sockets, occasionally the biaset resistor or negative bias supply circuit, more rarely the output transformer. Bad bias control pots are often the source of output stage noise, try moving the controls slightly back and forth to see if the noise changes or goes away. Try wiggling carefully (without burning yourself or breaking the tube!) the output tubes on the affected channel, this will often indicate tube socket that are dirty, corroded, or have lost contact tension and must be replaced.

Most of the noise problems you may encounter derive from the following sources (from most to least common)
1.Loose, dirty, or corroded sockets, pins or connectors, in this case specifically tube sockets or input jacks or plugs. Tighten and clean or replace to correct.
2.Outside electromagnetic interference. Too much can be said about possible sources and solutions to go into heavy detail here (fortunately much has been written elsewhere on the subject), however the general idea is to either shield the signal from picking up the interference, eliminate the source of the noise, or shield the source to prevent it from emanating the offending interference.
3.Tubes. Substitute possible suspect tubes starting from the input. Replace defective tubes.
4.Bad solder joints. Reheat suspect connections to reflow solder. If solder does not seem to stick to a wire, connector, or lead, desolder the suspect unit, clean thoroughly, and resolder.
5.Broken or loose wires or leads. Inspect wires carefully and reconnect any potential offenders.
6.Capacitors (particularly electrolytic ones) with intermittent shorts or leaks. This is common if some of the old original capacitors are still present and not replaced. Also often caused by installing the bias supply electrolytic capacitors backwards. Note in the bias supply (where negative voltage is present) capacitors are installed with positive end at ground (chassis) potential.
7.Cracked or overheated resistors. Often found in power supply (by the main filter capacitor(s). More common if the original carbon resistors are still installed.
8.Intermittent arcing inside power or output transformer. Best indication of this is that other possible causes have been eliminated, and the noise eminates from speakers even though all tubes have been removed. Note that in the case of internal arcing noises will often be heard from the transformer itself.
10.Excessive audio hum. This is usually caused by one of the following:
1.Negative feedback wire from the 16 ohm output to pad 7 is not hooked up.
2. Ground loops, multiple ground paths, and bad ground connections. The audio system should be connected to earth ground only at one point (normally the preamp) and ground connection must be good. Having a component installed with poor transformer isolation (leaky insulation) will induce hum as well as having components with unpolarized (one prong is slightly wider than the other) line plugs.Try turning over unpolarized plugs first.
3.Tubes with cathode-heater shorts or leakage. Hum is bleeding from the AC filament to the cathode. Test or substitute possible offending tube (s) and replace if necessary.
4.Any audio connections (RCA plugs, tube grid pins, etc.) open or not making good contact.
5.Transformer vibration (thus inducing grid vibration in the tubes). This can be considerably exaggerated by tube microphony. If substituting tubes is to no avail, see section 5 above for more details.
11. Voltages on board are way off or amplifier distorts excessively. Check all of following:
A.The tubes you installed are are 12AU7 or 12BH7 tubes, or equivalents (ECC82, 6189, 5814, 5963, ECC99)
B. If voltages are only off on one amp of a pair, swap the 12AU7 on that side with the one on the other side. If the wrong voltages follow to the other side, that 12AU7 is bad. Replace it.
C.If voltages are off on both amps of a pair, check resistor values. If the PC board tube plate voltages are too high, then this can be either R8, R9, R11 or R10 being too high of a value, or R12 being too low of a value. Also check R15 and the resistor connected to the can capacitor.
If the PC board tube plate voltages are too low, then this can be either R8,R9 or R10 being too low of a value,or R12 being too high of a value.
D.Check output transformer and 6550/KT88 tube socket connections. Having any of the output transformer primary (connected to the output tubes) wires connected wrong (occasionally, these mistakes were made when the amplifier was built, so should *not* assume that they're connected correctly), or secondary wires either attached wrong, shorted to the chassis (except for the black wires), or shorted speaker wires/voice coil (don't assume a speaker is good until you've checked it on another amplifier), can do this.

12.Amplifier oscillates (tone comes from speakers with no input). Check wiring from PC board pads 1 and 3 to their respective 6550/KT88/EL34 sockets.
Pad 1 should be connected to 6550/KT88/EL34 sockets that have striped (green/white & blue/white) wires connected to them (from the output transformer)
Pad 2 should be connected to 6550/KT88/EL34 sockets that have solid (blue & green) wires connected to them (from the output transformer) See schematic for details.
Make sure only the GREEN wire from the output transformer is connected (via a wire from the 6550/KT88/EL34 socket) to pad 4.
If the amplifier is wired triode connected, make sure you do NOT connect pin 3 of either of the 6550/KT88/EL34's, or the green/white screen wire to pad 4 on the PC board, only the GREEN wire from the output transformer should be connected to pad 4.
Make sure the common/ 0 ohm lead on the output transfotrmer is connected to chassis/ground, and the board ground connection (pad 11) is hooked to ground, check this with an ohmmeter.
13.No sound in one amplifier: First eliminate tubes as the source of the problem by swapping tubes between the sides (6550/KT88/EL34's in pairs), and turning on the amplifier to see if the problem follows the tube (s) between the channels.
Next, check all connections: swap speaker & input connectors (avoid doing this while amplifier is powered up), between the two sides, see if the problem changes to opposite side (in which case you've got a problem with a cable, speaker or preamp).
Look at wires connecting between the board & tubes, make sure no leads going to the output terminals are disconnected or touching the chassis (except the 0/common lead on each side).
Check all voltages on the board where the diagram indicates, voltages way off indicate a resistor is open/wrong value.
Check voltages on pins 3 & 4 of all 6550/KT88/EL34 sockets (where leads from output transformers connect). They should have between 475 to 525 volts depending on recitifier tubes used, biaset being set correctly, and your line voltage, and power transformer tolerances, but ALL of those pins should have similar voltages. Missing voltage on one indicates an broken wire or open in transformer.

Adjusting AC Balance (RX1 on PC board)

The control on the PC board has been preset to work properly with tubes that measure within standard production tolerances. It is not necessary to adjust this to make the amplifier work correctly.If you don't have the required equipment to adjust this, or don't understand the instructions, leave it alone.

If desired, with the proper equipment it is possible to adjust this to get an exact balance in the drive voltage between the two output tubes.

This can be done via a number of methods, to wit:

1. Using an audio oscillator or function generator (set to sine waves),a dummy load resistor and a high impedance AC voltmeter. Note that a standard VOM like a Simpson 260 or Avometer will not work, and input impedances vary between meters. Read the manufacturer's documentation, the AC impedance must be 1 megohm or more. Hook the dummy load to the output connectors on the proper load impedance, hook up the oscillator or function generator to the input (one lead goes to the chassis, other goes to the chassis ground). Turn on the amplifier, make sure the bias is set correctly. Run a small voltage (say 100 mv, exact voltage isn't important but you have to check both sides with exactly the same voltage, so don't change it once you have it set) from the oscillator or function generator (you can check this voltage with your AC voltmeter)into the amp.. Use the AC voltmeter to check the AC signal voltage between pad 1 and pad 2B on the PC board. Note this voltage. Now, check the AC signal voltage between pad 2A and pad 3. Adjust RV1 so the AC signal voltage is the same across pad 2A and 3, as it was across pads 2B and 1.

2. Using a distortion analyzer. We're going to assume you know how to use one if you have one. Basically, hook a dummy load resistor to the output, hook the input & output to the DA, run a signal similar to usual input (about 100 mv is fine), adjust RV1 for minimum distortion.

Separate Bias Control Modification.

See diagram under "Alternate Power Supply arrangements".

To do this:

1. Remove 2A to 2B jumper on PC board if installed.
2. Install 2 25K linear controls. This requires drilling two holes in top or back of chassis.
3. Run wires from the 1K resistor after the bias diode to the right terminal (looking at the installed controls from the bottom) of each 25K control.
4. Run wires from the center terminal of one control to pad 2A, from the center terminal of the other to pad 2B.
5. Connect a wire between the left terminals (looking at the installed controls from the bottom) of the controls,then connect an 18K, 2 watt resistor between one of the lugs and the nearest convienient chassis ground location.
6. Disconnect the wire between pins 8 of the output tubes.
7. Remove the 11.2 ohm or 12 ohm Biaset resistor between pin 8 of one ot the tubes and ground.
8. On each of the output tubes, connect a 10 ohm, 1% resistor between pin 8 and one of the ground lugs on the tube socket bracket.
9. Now, only one of the tubes will have a wire between pin 8 and the Biaset terminal on the back chassis panel socket. Run a wire from pin 8 of the **other** tube to an unused terminal on the back chassis panel socket. On the outside of the chassis, using a Sharpie, Magic Marker or any other convienient method, mark this terminal as "Biaset #2, .50 volts", and the original Biaset terminal as "Biaset #1, .50 volts"
10. Follow the wire from the PC trace connected to the tube you just connected the wire to, back to the bias control it's connected to. On the outside of the chassis, mark this control as "Biaset Control #2". Mark the other as "Biaset Control #1"
11. Turn both controls approximately 3/4 of the way to the left (counterclockwise).
12. Hook your negative meter probe to any convienient chassis point.
13. Turn the amp on and allow the amp to warm up sufficiently (1-2 minutes).
14. Put your positive meter probe in the "Biaset #1" terminal. Adjust control #1 until reading at that point is .50 volts (500 mv).
15. Put your positive meter probe in the "Biaset #2" terminal. Adjust control #2 until reading at that point is .50 volts (500 mv).
16. Go back and do step 14 again to recheck the Biaset #1 voltage, which will have changed a bit since you've changed the load on the power supply in Step 15, unless you were real lucky and it was dead on without any adjustment.
17. Go back and do step 15 again to recheck the Biaset #2 voltage.
18. Repeat steps 14 & 15 if necessary until both Biaset voltages are .50 volts (1/2 volt or 500 mv)

Special Notes On Mark 2 Amplifiers

The Mark 2 Amplifier is an earlier version of the the more common Mark 3 amplifier. The two types are essentially identical, with the following notable exceptions:

1. Mk2 uses 6CA7/EL34 output tubes, Mk3 6550/KT88
2. Mk2 uses a 5U4-GB rectifier, Mk3 a 5AR4/GZ34.
3. Mk2 has a 50 ohm resistor where Mk3 uses the C354 choke.
4. Mk2 has a 12 ohm Biaset resistor, the Mk3 a 11.2 ohm Biaset resistor.
5. Mk2 uses a 25 pF capacitor where Mk3 uses a 12 pF capacitor.
6. Mk2 uses a single 100 uF 50V bias filter cap, the Mk3, two 50 uF 70V bias capacitors.
7. Mk2 has a 5K bias control pot + 10 K resistor to ground, the Mk3 a 10K pot + 18K resistor to ground.
8. Mk2 has 500V filter capacitors, Mk3 525V.
9. Some Mk2 amps came with the A-430 output transformer, which is the same as the A-431 used on all known Mk3's, except it does not have a 4 ohm tap.

Converting a Mk2 to Mk3 is very simple, make all changes above except for #3, #4 and #9 (adding a C-354 choke and changing the biaset resistor can be done, but is not necessary).

We strongly recommend the following changes.
These will allow the Mk2 to be used as either a Mk2 or Mk3 amplifier simply by swapping tubes and resetting the output tube bias.

1. Install 525V capacitor (we sell a 3 section, 525V unit) for the first 3 sections. See the appendix "Alternative Power Supply Strategies" for details on installing.
2. Change the bias pot to 25K.
3. Disconnect the 100 uF 50V capacitor. Install 47 or 50 uF , 100V capacitors between both ends of the 1000 ohm resistor (the one between the bias diode and the bias control) and ground (chassis). **NOTE: The positive end of the capacitors are connected to ground!**

Once the above changes are made, you may install the upgrade board and follow normal instructions as given in the manual for Mk3 amplifiers.

Special Notes On Biasing The Mark 2 Amplifier

The original Dynaco recommended biaset voltage (1.56V at the BIASET point on the back panel socket) with typical line voltages encountered today will result in the EL34 tubes running hotter than they are rated for. Even at lower voltages, the plate dissipation is right on the limit for EL34 tubes. You'll get extended life by running the tubes a bit cooler, even Dynaco themselves agreed this is a good idea, as the ST-70 models ran the tubes at lower bias than the Mk2's.

To resolve this problem, you can either:

1. Use the "fat bulb" style 6CA7/EL34 tubes. Unfortunately these are no longer in production and getting a bit hard to find.

2. If standard type EL34's are used, set the BIASET voltage (see other parts of the manual for instructions on setting this) to 1.2 volts instead of 1.56 volts. If this is done, it is very likely that even with the original 5U4-GB rectifier, the B+ voltage in the amplifier will exceed the 500V rating of the original aluminum can capacitor. So if you go with this option, **upgrading the first three sections of this capacitor to 525 volts is required.** Simply making the Mk3/Mk2 changes as noted in the section above will make it easy to bias EL34's properly without any further concern, assuming the 5U4-GB rectifier tube is used.

Using 5AR4 rectifiers with standard EL34 tubes. This will almost certainly result in the the B+ voltage being too high for even 525V capacitors if the tubes are biased as we recommend. See "What To Do If Your B+ Voltage is Too High" in the manual, and "Alternative Power Supply Strategies" following for assistance with this problem.

Using the "fat bulb" style 6CA7/EL34, you can set the BIASET voltage to the normal 1.56V, which usually will load down the power supply enough to bring the idle B+ voltage below 525V even with 5AR4/GZ34 rectifier tubes. Either way, **recheck the B+ voltage AND readjust the BIASET voltage after changing** the tubes.

Special Note: There are TWO versions of the Mark 2 amplifier. One uses a PC board of identical size to the Mark 3, and our board will "drop in". The other version is slightly larger, and to use our board, you must fabricate extension brackets to mount our board to the slightly larger hole.

If Your Amplifier Main B+ (HT) Voltage Is Too High:

The tolerances on the original Dynaco power transformers were a bit broad, and often, US line voltages are higher nowadays than they were when the amplifiers were made. This could also be a problem on European export models where authorities might be trying to standarize to 230V, as opposed to the 220V standard. (You'll also certainly get this effect if you have a export model wired for 220V Continental voltage and try to operate it on 240V British mains voltage!)

The net result is that often, even with the correct tubes and standard biasing, the voltage from the rectifier tube may be higher than the rating of the original filter capacitors..we consider 510V about as high as one should operate 525V rated capacitors.

Mark 2 owners should also read "Special Notes On Mark 2 Amplifiers"

There are several ways to approach this problem:

A. The simplest way is to use a rectifier tube which will drop more voltage. In the case of the Mark 3, the most common and easiest to find replacement is a 5U4-G or 5U4-GB. CV378/GZ37 tubes will drop the voltage as well, but will not fit under the cage. We do not recommend running the amplifiers without the cage.

5V4, GZ32, and 5R4-GY/YA/YB tubes may be employed as well, **in all cases, recheck the B+ voltage AND readjust the BIASET voltage after changing the rectifier tube.**

B. Use a resistor between pin 8 of the rectifier tube and the first section of the filter capacitor. Try a 100 ohm, 5 watt resistor to begin with, then **recheck the B+ voltage AND readjust the BIASET voltage.** Adjust the value of the resistor if necessary to change the voltage as needed, a larger value (more ohms) to decrease it, smaller (fewer ohms) to increase it. Be sure to **recheck the B+ voltage AND readjust the BIASET voltage** after changing the value of this resistor.

C. Use a zener diode between the rectifier tube and the filter capacitor. We haven't tried this, but it should work. The zener diode is going to have to be of a fairly high wattage (10W or more) as when the capacitor charges up, it's going to see a fairly high peak current. The zener voltage is going to vary depending on how much voltage one desires to drop. The zener diode has the advantage of having a constant voltage drop, as opposed to a resistor, whose drop will vary with the current drawn. **The cathode must be on the rectifier tube end for this to work. Check specs to see which end is the cathode.** Be sure to **recheck the B+ voltage AND readjust the BIASET voltage** after doing this. **Using a 100 to 120 ohm NTC (Negative Temperature Coefficient) resistor in series with the zener diode will reduce the wattage requirement of the diode and reduce power supply voltage surge on turnon.**

D. Install a zener diode of sufficient voltage and wattage between the chassis and the ground return of the power transformer (normally, the red/yellow wire.Again, we haven't tried this option in practice, but it should work **The zener cathode must be on the end connected to the chassis for this to work. Check specs to see which end is the cathode.** Be sure to **recheck the B+ voltage AND readjust the BIASET voltage** after doing this.

E. Use a lower value of input capacitor (the one directly connected to the rectifier tube). Try values between .47 and 5 uF.

F. Increase the voltage rating of the power supply capacitor(s).

See appendix Alternate Power Supply Strategies for details.

Alternative Power Supply Strategies

First, let's note that in the case of 5AR4/GZ34 rectifier tubes, one should not attach a capacitor larger than 60 uF directly to a the cathode (pin 8). There are can capacitors made that have sections as large as 80 uF, if you choose to use those, use the 80 uf as the second section, after the choke.

Please refer to the Alternate Power Supply diagrams.

Fig 1. Our Mark 3 power supply kit. This works assuming the power supply voltage is not excessive. It's very easy to install as it does not require any additional terminal lugs/strips.
We reduce the value of the resistors in the power supply, which will still allow adequate decoupling because the value of the capacitors is increased by 100% on 3 of the sections. This puts more voltage to the board, which allows it to swing more voltage before clipping, giving more headroom and lower distortion at normal levels.
The first three sections are in the 40-40-40 uF 525V Aero-M can capacitor, the last section is an axial lead, 47 uF 500V capacitor.
Install the 40-40-40 can cap same as if you were going to replace the original can. Desolder the wires & leads, break or straighten the locking tabs around the rim and the old capacitor will drop out. One lug goes to the wire from the 5AR4, the second goes to the wires from the choke and output transformer. A 4700 ohm 2 watt resistor goes between the second and third lug. A wire goes from the third lug to pad 5 on the circuit board. Between pad 5 and 6, install the 22K, 2 watt resistor.
Between pad 6 and the nearest convienient ground lug (ie. connected to chassis) usually one of the ground lugs on the bracket of one of the output tube sockets, install the 47 uF 500V capacitor. **Remember, the negative lead (the end the arrow points to) goes to the chassis end!**
See the photograph of the Mk3 undercarriage to see how the 47 uF cap is installed.

Fig 2. The Very Low Input Capacitor Strategy. If the B+ voltage is excessive for use with the 525V can capacitor, it's possible to lower the voltage by using a very low value of input capacitor connected to the 5AR4, between .47 to 5 uF
This can be very convienient as low values (such as .47 up to 2.0 uF) can be had as 600V rated film capacitors,which can be connected directly between pin 8 of the rectifier tube socket and the chassis. This leaves the other 3 sections of the 40-40-40 uF can capacitor free for the last 3 sections, thus it won't be necessary to hang the separate 47 uF 500V cap in for the last section.
After replacing the 40-40-40 uF 525V cap as noted in the previous section, don't hook up the wire from the 5AR4,to the cap, instead, remove the wire, and hook the small value capacitor between pin 8 of the 5AR4 and one of the ground lugs (connected to the chassis) of the can capacitor. (I suggest starting with 1.0 uF 600V) Also, one of the choke leads should be connected to pin 8 of the 5AR4. Hook the other lead of the choke and the output xfmr wire to one of the can lugs, then the 4700 ohm resistor to the next section. From that section, run a wire to Pad 5 on the PC board, and the 22K 2 watt to the third section. Run a wire from the third section to pad 6 on the PC board.
Film capacitors,by the way, do not have polarity as electrolytics do, you can install them in either direction.
Turn the amp on and after the output tubes are warmed up, reset the bias then check then check the voltage on pin 8 of the 5AR4 tube.
If the voltage is too low, then increase the value of the capacitor hooked to the 5AR4 until it reaches the desired level. Remember to reset the bias after each change.

Fig 3. The Double-Up Strategy. This is a bit more work as it means installing terminal strips and wiring 300-350V axial lead capacitors in series underneath the chassis.
For the second and third sections, you can use the same 40-40-40 uF 525V capacitor as shown above, you'll have one section spatre which you can hook to the section that goes to pin 5 on the PC board. You can use the 50-50 uF LCR clamp mount capacitor we sell (saves you $20) instead, you'll have to drill holes for the mounting bracket.

Fig 4. The 600V Cap Strategy. This means installing 2 20 uF 600V capacitors on terminal strips under the chassis. The last two sections can be wired as on Fig. 3.