

# ***Dynaco MKIII Modification Manual***

***Designed by:***

***Alan Kimmel***

***Ron Welborne***

**Welborne Labs**

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## DYNACO MKIII MOD

The Dynaco MKIII was a carefully crafted amplifier designed to match circuits of that era with a new line of "Super Fidelity Output Transformers" designed by David Hafler. The MKIII is therefore a very good candidate for modifications. Whether you are just performing a parts upgrade or are trying a complete mod package like ours described below, your efforts should result in an excellent sounding pair of monoblock amplifiers.

To call our MKIII Mod a "Mod" is a misnomer at best! The Welborne Labs MKIII Mod, designed by Alan Kimmel, is a complete overhaul of the Dynaco MKIII amplifier. The only original hardware that remains untouched, are the transformers and the chassis---everything else goes. In its place is a completely new driver circuit, a compliment of output tubes and a mosfet-driven voltage regulator. The driver circuit is a slightly modified version of our ST-70 Mu-Stage design and is positioned where the original driver board was mounted on the MKIII chassis. The chosen output tubes are the 6550's. The 6550's provide one of two possible compliments to the Mu-Stage, the other being a push-pull parallel set of EL-34s. There's not enough room on a MKIII chassis for four EL-34s and therefore that option is out. Our MKIII Mod has focused considerable attention on the output stage---by selecting output tubes that operate well with both the driver circuit and the output transformers a unique design is the result with performance that far exceeds that of the original Dynaco MKIII amplifier.

The size of the MKIII chassis does not provide adequate room for the amount of power supply capacitance needed to allow this amp to easily drive a complex load, therefore we have converted the supply to solid-state rectification and designed a voltage regulation stage for the B+. A mosfet is used as the pass element resulting in a very *stiff* supply. A softstart feature is built into the regulation stage to reduce turn-on surges as a result of adding the diode rectification. The diode rectifier is a bridge circuit that plugs into the existing MKIII tube rectifier socket without any other modifications required. The existing 'can' filter capacitor may be used, if it is still in good condition, or it can be disconnected from the circuit and not used.

Since this is a complete overhaul of the MKIII, our kit supplies all new tube sockets, wiring, terminal strips, resistors capacitors, etc. As was said above, the only items that remain unchanged are the chassis, transformer, filter capacitor, and the input and output jacks. Of course these items are also subject to possible improvements, but we have left them for your scrutiny. The MKIII Mod is a complete package featuring MIT MultiCap and WIMA polypropylene capacitors, Caddock film and Roederstein metal film resistors, and the RAM LABS vacuum tubes. The MKIII Mod includes all components individually packaged and marked along with complete assembly instructions.

Please note: the MKIII mod is not recommended for novices or first time kit builders.

### **MKIII DESIGN FEATURES**

The MKIII mod features: a "main" printed circuit board consisting of the 5751/6U8A tubes and peripheral driver circuitry; a second voltage regulator circuit board; and the bias rectifier, filter caps, a zener diode regulator circuit and the bias adjustment potentiometers which are hardwired. The existing output circuitry is retained.

The existing power supply filter capacitor is retained but you may opt to not use it simply by disconnecting it from the circuit. In place of the original capacitor and inductor is a mosfet driven voltage regulator and B+ capacitance.

A high-pass and low-pass filter network is designed into the front-end of the driver circuit. These filters provide stability and offer much more reliable operation over the life of the amplifier. The high-pass circuit provides a low frequency roll-off at approximately 10Hz.

A switch is included to provide a mute function which allows you to connect and disconnect interconnect cables without turning off the amplifier.

A significant amount of point-to-point wiring still remains within the MKIII chassis and therefore it is recommended that this kit only be attempted by individuals possessing a thorough understanding of tube circuits and having a moderate level of kit building experience.

The following instructions are for installing the complete Welborne Labs MKIII modification kit in an existing chassis. If you have purchased only the circuit boards and are tailoring this mod to your own specifications or are building an MKIII from scratch, use these instructions as a guide or as needed. These instructions are far from being 'in-depth' and it is recommended that you have in your possession a copy of the original Dyna MKIII schematic or are very familiar with its layout and circuitry.

### **TOOLS REQUIRED FOR DISASSEMBLY AND ASSEMBLY**

The following items will be required, or are recommended, to successfully assemble this kit:

Soldering Iron  
Solder  
Solder Wick or Solder-Removing Device  
Drill  
Pliers  
Wire Strippers  
Hex Driver  
Screw Drivers  
Volt/Ohm Meter  
Schematic of Original Dyna Circuit May be Helpful

## DISASSEMBLY INSTRUCTIONS

We recommend that you follow this disassembly sequence. As you disassemble the amplifier, place all of the old components and hardware in a container and keep them until you have completed this modification.

- 1) Remove tubes.
- 2) Remove bottom cover.
- 3) Retain existing filter capacitor. For the present time, be careful to leave existing hookup wire intact and all leads left as long as possible.
- 4) Remove original driver circuit board.
- 5) Remove feedback leads from 16 ohm tap of output terminals.
- 6) Remove AC filament leads to driver board. Leave filament leads to the output tubes intact unless you are planning to replace them with new wire (recommended).
- 7) Remove rectifier tube socket. Leave lead lengths intact as much as possible. We are just replacing this socket with a new one and will be rewiring the new socket like the original.
- 8) Remove all output tube bias circuitry (pots, capacitors, rectifier diode, resistors, etc.). Disconnect the transformer from the bias rectifier but leave the original transformer lead (red/black) that attaches to the bias rectifier diode intact and as long as possible.
- 9) Disconnect all input wiring (signal and ground) to the RCA input jacks. Replace jacks if desired (recommended).
- 10) Remove coupling capacitors between the driver circuit and output stages. Remove resistor network from the output stages (these will be replaced with better quality components).
- 11) Output terminals should be replaced or at least thoroughly cleaned.

This completes the disassembly phase of the MKIII mod. If you plan on replacing any of the remaining original wire (recommended because it is old) or replacing the output transformers, tube sockets, etc., now is the time to do it.

While all circuitry is removed, now is also a good time to clean the chassis, inside and outside, and perform any cosmetic surgery that you may have planned, ie. polishing or re-chroming, painting, lettering, etc.

## **ASSEMBLY INSTRUCTIONS**

We recommend that you follow this assembly sequence. Refer to figures 1 through 9 as you follow the assembly instructions.

### **CIRCUIT BOARD POSITIONING AND DRILLING**

- 1) Turn the chassis upside down and position the unstuffed circuit boards inside the chassis (foil side of circuit board facing down) as shown in figure 1. Holes for main board should exist, however check for proper fit. Measure and mark the position of the regulator circuit board's four mounting holes on the chassis using a pen or marker. It is required at this time to drill new mounting holes in the chassis for this board. After drilling holes, place the circuit board to the side for later use. Also drill a 3/16 inch hole for the bias jack.

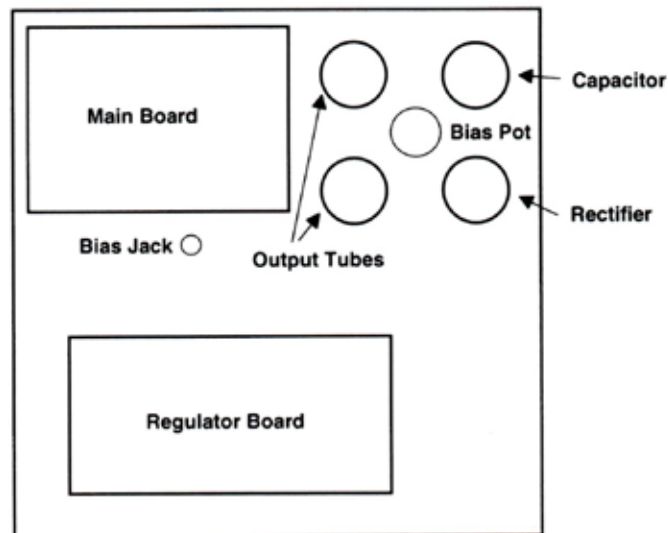


Figure 1. Bottom View of Chassis

## ASSEMBLY INSTRUCTIONS

### Filament Wiring and Bias Circuit

- 1) Install new tube sockets and re-connect the leads to the 8-pin rectifier tube socket.
- 2) Install filament leads (white 18ga. Teflon-coated wire) to the output tube sockets. Be sure to twist the filament leads tightly as this will help to reduce stray electrical noise. Route the filament leads as close to the chassis as possible and away from input signal conductors. Refer to figure 2.
- 3) The bias circuitry is hardwired using one or two terminal strips and is best located by the regulator board. Connect all bias circuit grounds to one point on a solder lug of the terminal strip. The bias circuit input connects to the power transformer's red/black lead wire. Be sure to check all polarities of the diodes and electrolytic capacitors. The output of the bias circuit is taken from the wiper (middle terminal) of the bias pot and connects to the resistor network of the output tubes. See figures 3 and 4.

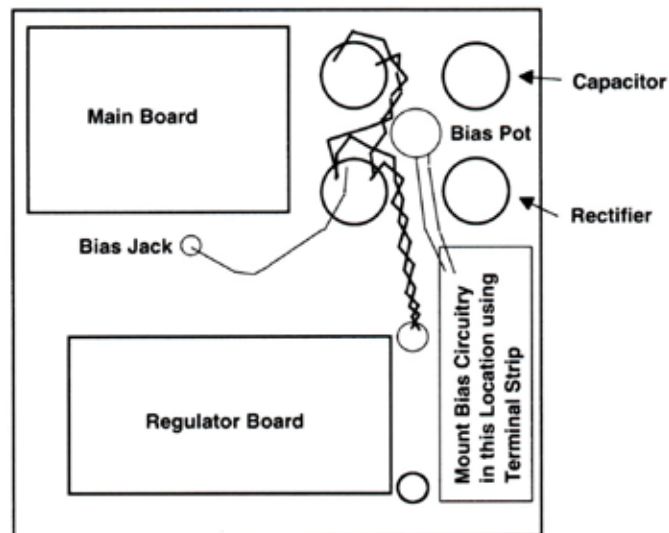


Figure 2. Bottom View of Chassis, Filament Wiring and Bias Circuit



## ASSEMBLY INSTRUCTIONS

### BIAS CIRCUIT INSTALLATION (cont'd)

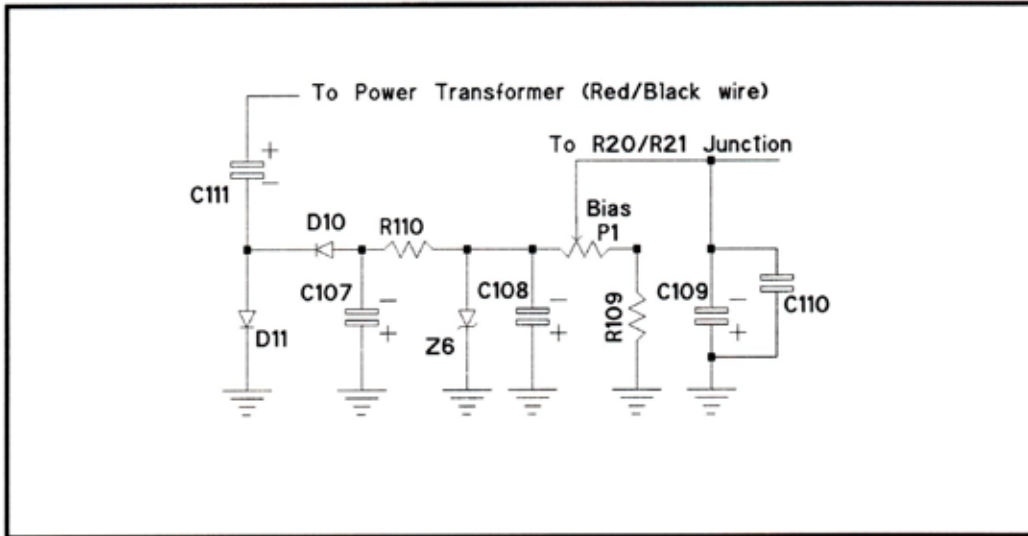


Figure 3. Bias Circuit

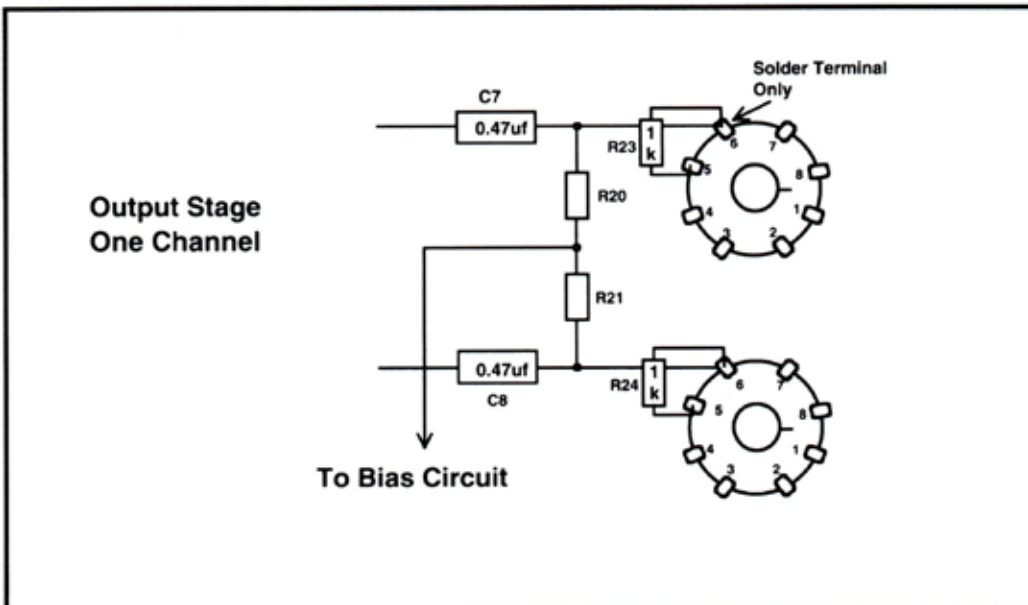


Figure 4. Bias Network

## ASSEMBLY INSTRUCTIONS

### OUTPUT STAGE ASSEMBLY

Continue assembly by reconnecting the output sockets to the output transformer and bias network. See figure 5. The transformer B+ lead (red) will be connected just prior to installing the voltage regulator card. The feedback lead will be connected to the main board after it is installed in the chassis.

Connect a wire from R26 (11.0 ohms) to the bias jack and run one wire from the junction of R20 and R21 to the middle lug of the bias potentiometer.

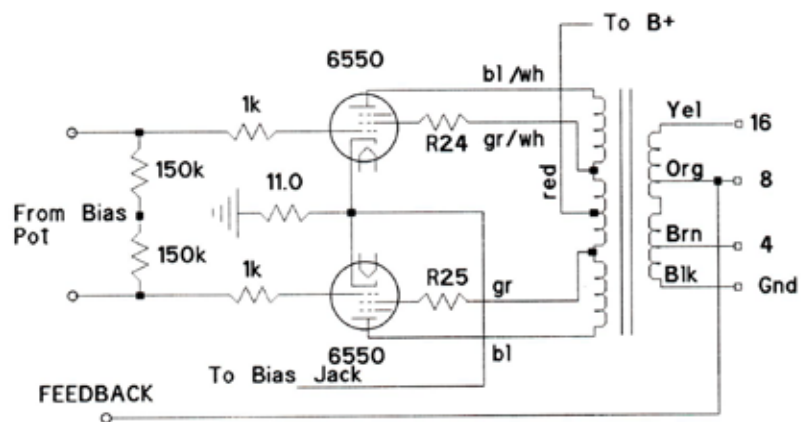


Figure 5. Output Circuitry and Bias Network

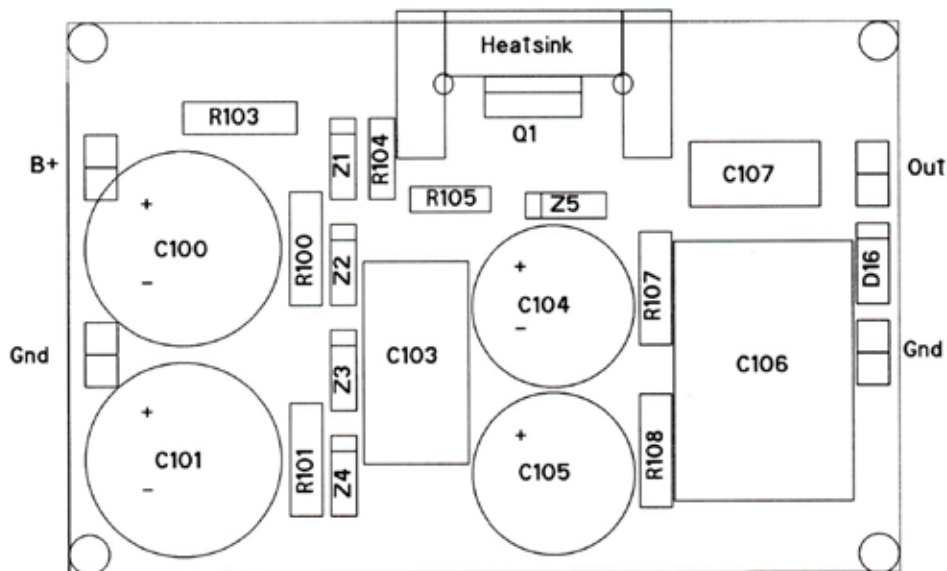


## ASSEMBLY INSTRUCTIONS

### VOLTAGE REGULATOR BOARD ASSEMBLY AND INSTALLATION

- 1) Begin by stuffing the regulator board with its components. Refer to the stuffing guide of figure 6. It is usually easier to stuff the small low profile components first (ie. resistors and diodes) and then the larger high profile capacitors. Be sure to note polarity of the electrolytic capacitors and zener diodes.
- 2) Once the circuit board is stuffed with all of its components, the wiring can be installed. All leads originating from the circuit board need to be inserted and soldered now as it will be difficult to add wires once the circuit board is mounted in the chassis and you have begun to connect them to other points in the circuit. 18 gauge teflon coated hookup wire has been included.
- 3) Be sure to install the small heatsink to the regulator mosfet.
- 4) The board should now be ready to install in the chassis. Make sure the mosfet and its heatsink do not come in contact with the chassis. Attach the regulator board using the standoffs and screws. Next connect one 500V B+ lead to the output transformer. The second B+ lead will attach to the main circuit board after it is installed.

This completes the regulator circuit board assembly phase.

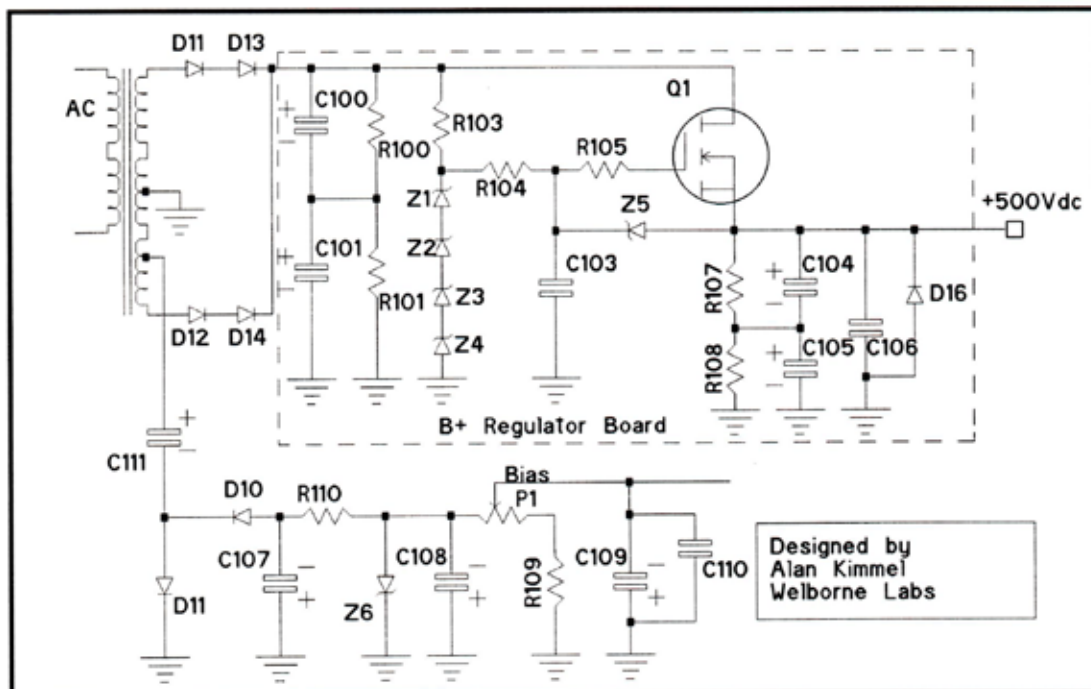


PS-3 STUFFING GUIDE

Figure 6. MKIII Voltage Regulator Stuffing Guide

## B+ REGULATOR BOARD PARTS LIST FOR ONE CHANNEL ONLY

Resistors		
R100,R101, R107,R108	220kohm	2W metal oxide
R103	8.2kohm	2W metal oxide
R104	10Mohm	Roederstein 1/2W 1% metal film
R105	332ohm	Roederstein 1/2W 1% metal film
Capacitors		
C100,C101	100uf/450V	Panasonic electrolytic capacitor
C103	1.0uf/630V	Solen polypropylene capacitor
C104,C105	47uf/450V	Panasonic electrolytic capacitor
C106	1.0uf/600V	Solen polypropylene capacitor
Semiconductors		
Q1	2SK1511	MOSFET 1000V 5A
Z1,Z2	1N5378B	100V 5W zener diode
Z3, Z4	1N5383B	150V 5W zener diode
Z5	1N4742A	12V 1W zener diode
D16	1N4007	1000V 1A diode
Miscellaneous		Printed Circuit Board
PCB		



b0W

B+ Regulator Circuit

## ASSEMBLY INSTRUCTIONS

### MAIN CIRCUIT BOARD ASSEMBLY AND INSTALLATION

- 1) Begin by stuffing the main circuit board with its components. Refer to the stuffing guide of figure 8. It is usually easier to stuff the small low profile components first (ie. resistors and diodes) and then the larger high profile capacitors. There are six (6) feed-thru wires located on the circuit board and these are designated numerically. Wonder wire has been included to be used as the feed-thru wires. Insert a feed-thru into each hole and solder to the pads on both sides of the circuit board. Any component leads that pass thru copper on the component side of the circuit board should be soldered to the pads on both sides of the board.
- 2) Once the circuit board is stuffed with all of its components mount it on the chassis and secure with screws and nuts. Filament wires can now be attached and these should be taken from the output tube sockets. Next attach the B+ line from the voltage regulator card.
- 3) Now connect the feedback lines from the power transformer. Then you can connect the input line from the rca jack. Attach the rca's ground wire to one of the ground pads on the main board. Bring one wire from the voltage regulator ground pad to one of the main board's ground pads. If you are using the mute switch be sure to attach it to the designated pads on the circuit board. Next attach capacitors C7 and C8 to the outputs of the main board. Their outputs solder to pin 6 of each output tube.

This completes the assembly and installation phase of the MKIII mod. Now is a good time to go back and double-check and triple-check all of your wiring.

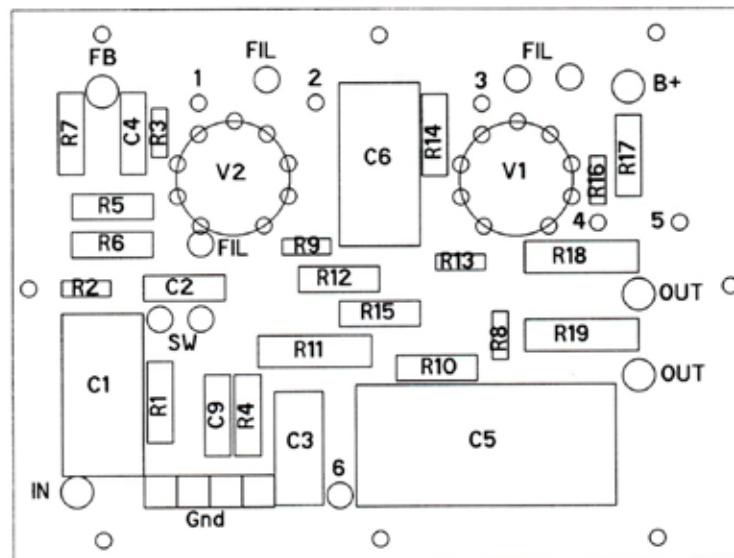
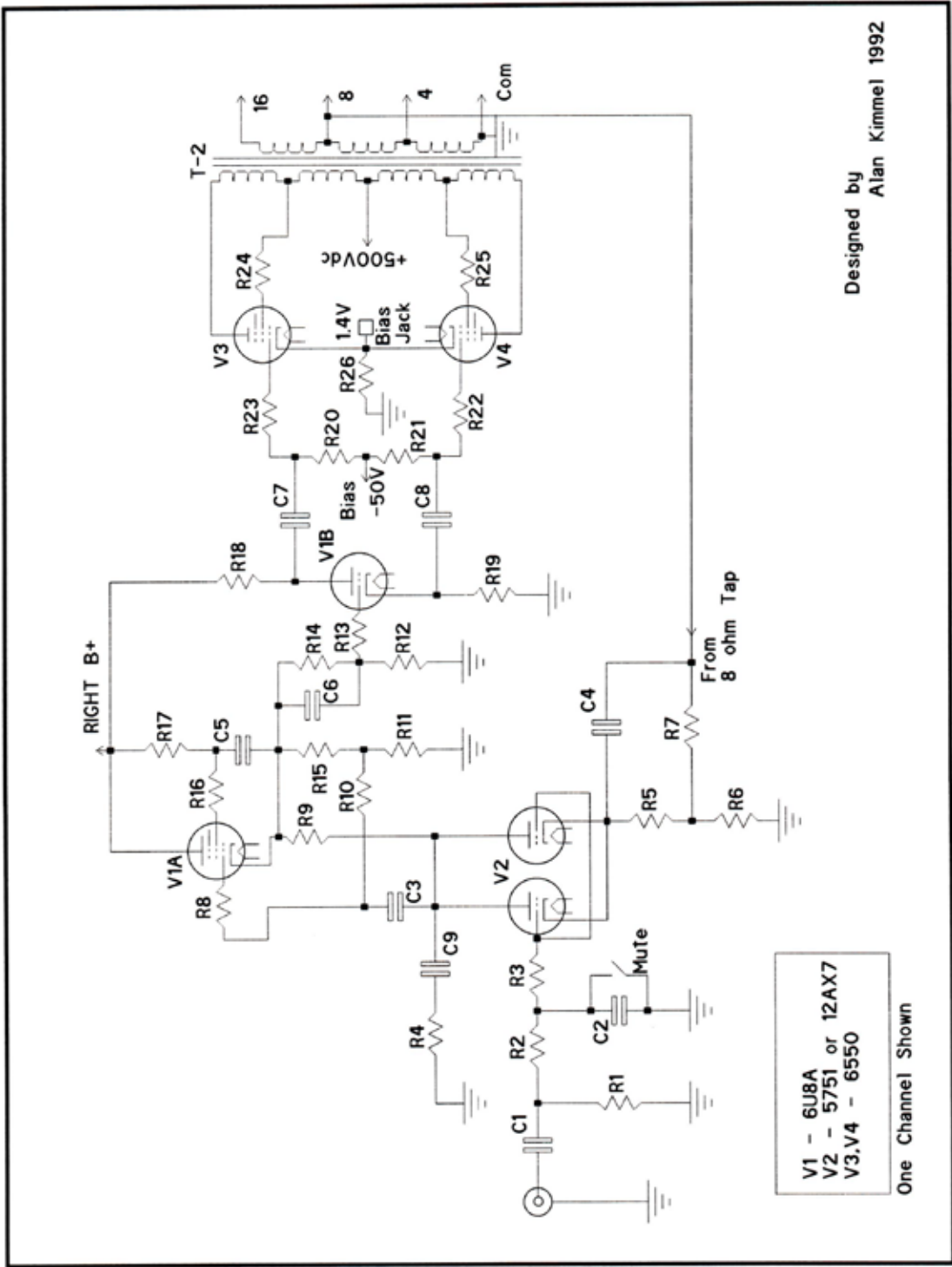


Figure 8. MKIII Driver Board Stuffing Guide



**Dynaco MKIII Mod Parts List For one channel only**

## Resistors

R1	150kohm	Roederstein 1/2W 1% metal film
R2	10kohm	Caddock 3/4W 1% film
R3,R8,R13,R16	150ohm	Caddock 3/4W 1% film
R4	221kohm	Roederstein 1/2W 1% metal film
R5	560ohm	Roederstein 1/2W 1% metal film
R6	100ohm	Roederstein 1/2W 1% metal film
R7	3.6kohm	Roederstein 1/2W 1% metal film
R9	15kohm	Caddock 3/4W 1% film
R10,R14	2.2Mohm	Roederstein 1/2W 1% metal film
R11	150kohm	2W metal oxide
R12	3.0Mohm	Roederstein 1/2W 1% metal film
R15,R22,R23	1.0kohm	Caddock 3/4W 1% film
R17	330kohm	Roederstein 1/2W 1% metal film
R18,R19	47kohm	2W metal oxide
R20,R21	150kohm	Roederstein 1/2W 1% metal film
R24,R25	270ohms	2W metal oxide
R26	11.0ohms	2W metal oxide

## Capacitors

C1	0.1uf/600V	MIT MultiCap polypropylene capacitor
C2	68pf/630V	Siemens polypropylene capacitor
C3	0.1uf/630V	Solen polypropylene capacitor
C4	47pf/630V	Siemens polypropylene capacitor
C5	0.47uf/630V	WIMA polypropylene capacitor
C6	0.1uf/600V	MIT MultiCap polypropylene capacitor
C7,C8	0.47uf/600V	MIT MultiCap polypropylene capacitor
C9	47pf/630V	Siemens polypropylene capacitor

## Vacuum Tubes

V1	6U8A	Ram Labs driver tube (tested)
V2	5751	Ram Labs driver tube (low noise)
V3,V4	6550	RAM or GE output tubes (matched pair)

## Miscellaneous

PWB		Printed circuit board
TS1,TS2		Driver tube sockets
TS3,TS4		Octal tube sockets
Hookup Wire		Kimber Kable hookup wire
Hardware		Terminal strips, bias jack

**Power and Bias Supply Parts List For one channel**

D11,D12,D13,D14		Solid state rectifier (Plug-in replacement for 5AR4)
D10,D11	1N4007	1000V 1A diode
C107,C111	80uf/250V	Panasonic electrolytic capacitor
C108,C109	100uf/100V	Panasonic electrolytic capacitor
C110	.1uf/400V	MIT MultiCap polypropylene capacitor
R109	10kohm	Roederstein 1/2W 1% metal film
R110	15kohm	2W metal oxide
P1	10kohm	Potentiometer
Z6	1N4761A	75V 1W zener diode
Miscellaneous		Terminal strips, hookup wire, octal socket

The Welborne Labs MKIII Mod designs, schematics and printed circuit board layouts are the property of Welborne Labs and Alan Kimmel. They have been included in this catalog for your personal use. Licensing is available and required for individuals and OEMs wishing to market assembled units with these designs.



## **POWER-UP AND TEST INSTRUCTIONS**

### **Power-up Sequence**

- 1) It is recommended that you connect the amplifier to a dummy load or old set of speakers during the power-up procedure. Use the mute switch to short the amplifier's inputs. Amplifier must have tubes installed to power-up and test operation.
- 2) If you own or have access to a variable ac transformer, use it to slowly increase the ac voltage during power-up. Monitor the B+ as you increase the ac voltage. At full ac you should measure approximately 500 Vdc  $\pm$  10V. If you do not have access to variable transformer, use a voltmeter to measure the B+ voltage as you power-up the amplifier. If the B+ does not show signs of increasing, immediately turn off the power.
- 3) If the B+ comes up OK, and you are connected to a set of speakers, you can flip the mute switch and listen for excessive noise, oscillations or hum.
- 4) Adjust bias to approximately 1.4 volts. (1.35 to 1.45 is fine). Bias is measured from the bias jack with respect to ground.
- 5) If all measurements checkout OK, you can apply a signal to the input.

### **Troubleshooting**

- |                                       |   |
|---------------------------------------|---|
| <b>Problem:</b> Low or no B+          | Check the polarity of all electrolytic capacitors.  |
| <b>Problem:</b> No Sound              | Check to make sure the mute switch is off or properly connected. Are the tubes glowing? Are your speakers properly connected?   |
| <b>Problem:</b> Excessive Hum         | Possible ground loop in circuit or chassis may not be grounded. Check all ground wiring. Check filament voltages and wiring. Check all tubes.   |
| <b>Problem:</b> Outputs will not Bias | Check all connections in bias network surrounding the output tubes. Check to see if voltage is reaching and leaving the bias circuitry on the bias circuit board. There should be approximately -75 volts dc on the anode side of the rectifier diode. Try swapping output tubes. Check the output tubes on a tester if possible, if they are not closely matched, you may have trouble biasing them. |

If you have difficulty troubleshooting your equipment, give us a call. We will be glad to help you get your equipment running. Please keep in mind that it is very difficult to troubleshoot equipment over the telephone and it can also be very expensive. A letter might be more appropriate, but in either case it will help if you have taken the time to write down as many symptoms as possible and also take and record some voltage measurements at key nodes in the circuit.

If all else fails, you can send your amplifier to us, however this should be your last resort. We have built an tested this amplifier and it works and therefore we have to assume that if your amplifier does not work, it is probably something you did wrong during assembly. We charge a flat rate of \$25 per hour for repairs and you will be charged unless it is found to be an error in our design or assembly instructions that caused your amplifier to not function.

## FINAL NOTES

No doubt many of you will look at this mod and see many more improvements that can be made. We will now suggest a few improvements ourselves and also identify some pitfalls to watch out for if you do make some additional mods once our circuit is in place.

Regulation of the filament voltage will probably offer only marginal improvement, if any. Filament regulation is better suited for preamps. However, if you feel this regulation is necessary, we would recommend it only for the driver stages.

Some of you may be considering adding even more filter capacitance to the power supply. You must be careful when you proceed down this path as too much capacitance will begin to overload the power transformer resulting in a distorted ac waveform. If you want to use more capacitance, I recommend replacing the original power transformer with one having double the current capacity.

We recommend matched output tubes, they will be easier to keep balanced as the tubes age.

We suggest replacing the RCA jacks with new ones. We also recommend replacing the output terminals with either new ones or binding posts. Most original output terminals will be very oxidized and difficult to adequately clean.

The original MKII output transformers were in most cases not very good. Many companies now offer a set of aftermarket transformers that are superior to the old design. These are highly recommended if you are wanting to squeeze every last bit of detail from this amplifier.

If you have purchased our MKIII mod kit, we hope you enjoy your new amplifier and we welcome your comments and would also like to hear of your results from any additional improvements you have made to our circuit. For those of you contemplating this purchase, we think you will be pleased with our mod. We feel it is the most musical MKIII we have ever heard and we have listened to just about all of them in our 15 years in this hobby.