A LOOK AT THE YAQIN MC-10L AND MC-10T

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Any comments or suggestions? You are welcome to e-mail the Author via lez at ntlworld.com

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Introduction

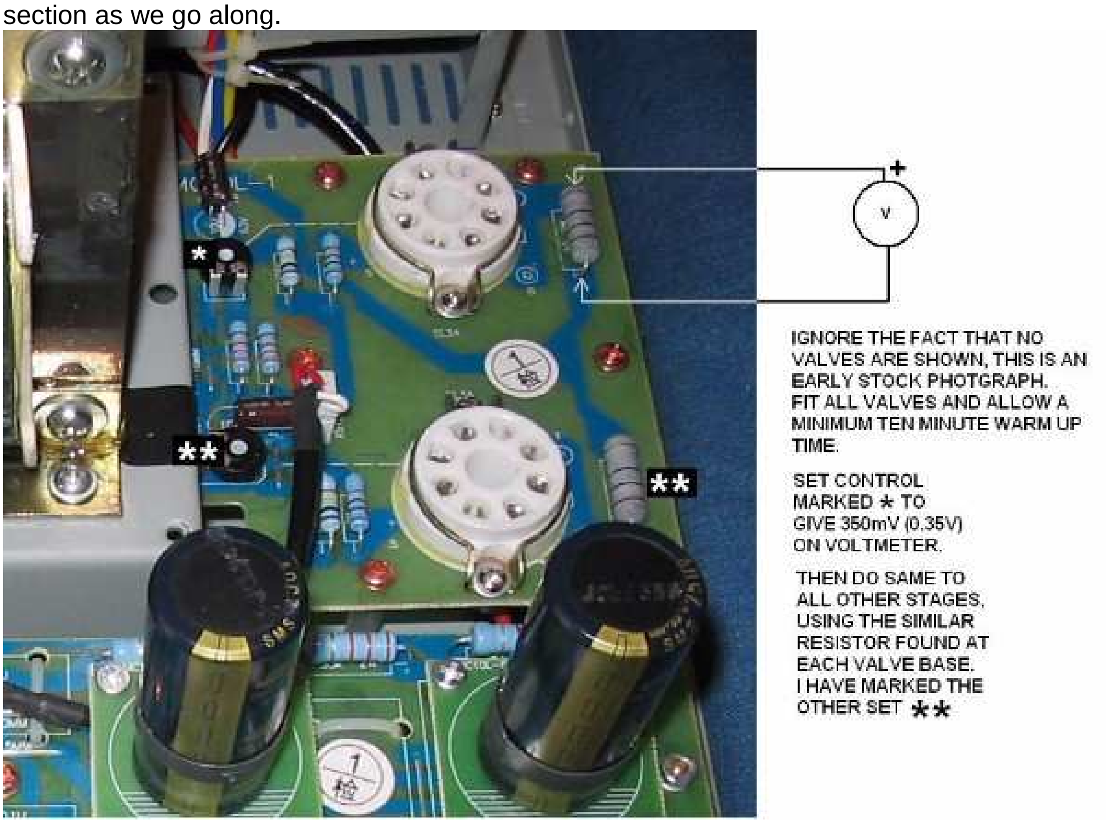
The front picture shows an early Yaqin MC-10L purchased by the author in 2007 and shows how well the amplifier was packed. The valves were all given identification numbers so that when installed in their designated places, they would produce the same bias conditions as when despatched from the factory. My first impressions were of a very bright sound, plenty of air and a much improved sound stage that instantly relegated my Yamaha Solid State Amplifier to the spare room. The level of Bass was a little disappointing yet somehow the overall sound seemed very natural. I do not use any pre-amp or EQ which probably would have helped here. Why did I buy a valve amplifier? Well my Brother Tom decided to build one and when I heard the sound from it I was quite amazed. Like me, he listens to Rock Music most of the time and his comment “Guitarists use valve amplifiers so surely you need one to reproduce their sound” was enough to make me start thinking about valve amplification.
Not wishing to digress too much from the Yaqin, sufficient to say that adding up the cost of power supply transformer, components, chassis and output transformers, the cost began to look very daunting.
My finished creation I know would not look very good in a domestic setting so it would probably have to be built into some kind of box and hidden out of sight.
Enter the Yaqin, advertised at a very reasonable price even with the very expensive carriage fee added on, I decided to take the plunge and very glad that I did.

Expecting the worst!

Yep, I was expecting the worst, an amplifier like this for such a low price, surely something is going to break so better get prepared.

Bias

My first task was to measure the voltages across the 10 Ohm cathode resistors to determine what value of bias was set up by the factory for the EL34 output valves and seemed to indicate 35mA i.e. 0.35V across each resistor.
Bias? Well I was carried away writing this little guide without thinking of those of you who have not been into valve amplification before. So I will attempt to give a little in-sight to each section as we go along.



On newer models you do not have to lift the top cover as access points are given for easy bias adjustment.

It really is not a black art setting the bias but what is it for? Well there is plenty of info on the internet but simply stated it is like you controlling the water from a tap. By adjusting the little controls, called potentiometers, you are setting the tap to deliver a certain flow of water. Turn it too far one way and you turn it off, not much good! Too much and you get a flood, which in the case of a valve will cause it to get very hot and fail, probably burning out something else in the process like the very expensive output transformer which feeds it. In our water analogy we would use a flow meter to set the correct rate of water from the tap. In our valve amplifier, the valve currents will produce voltages across each of the 10 Ohm resistors for us to measure with a Multimeter. In our case, the flow will be correct when the voltage is 0.35V or alternatively we can state it as 350 thousandths of a volt or milli-volts, abbreviated as 350mV.

Why do we need to have this flow?
We can use another analogy here, suppose you are holding one end of a rope which is coiled on the floor which you want to use to send a message to a partner holding the other end. Obviously, any movement you make to your end of the rope will not be felt at the other end so it will be impossible to send a message. OK, so we take out the coil and have the rope hanging loose between you and your partner. Your partner would only receive something of a message if you jerked the rope really hard with big swings of your arm, the message would be rather distorted and we don't want that. But if we arranged for the slack to be taken up and a slight steady pull applied (bias?), then your partner would be able to perceive the slightest of movement of the rope so any rope message will now be read without distortion. Too much steady pull (bias) will do nothing more than make both of you feel hot and tired, even when no message was being received, very wasteful. So there is your bias in a nutshell, just enough to keep everything in control and allow the valve to respond to its input signal with the least distortion.

If you are non-technical I hope the above helps you to understand in a simplistic way, what bias is and why it is important to set it up correctly. You should do this whenever you change the EL34 output valves located as shown in the photo, two on each side of the amplifier. Valves have a tendency to alter their characteristics slightly as they start to clock up running hours so it is a good idea to check the bias settings every now and again. The Yaqin employs what is called fixed bias and as each valve has its own control there is no need to waste money buying so called Matched Quads or Matched Pairs. Other amplifiers, particularly guitar amplifiers, use what is called Auto bias which is self made by each valve so it is more important to buy Matched Quads or Pairs for these amplifiers. This is so that they all self-bias to approximately the same level.
The best advice is to try and purchase four valves from the same manufacture that have been made at around the same time. Feel free to try all four from different manufacturers but it is not recommended to mix them as there may be very slight changes between brands and you do want the best sound? Yes?

* * * * * * *

Whilst the top cover was off, I took various voltage measurements to aid fault finding later should this ever be required. I have placed this information in the Fault Finding section so I can concentrate here on describing the rest of the amplifier.

Construction

Physically, the amplifier is built up on a metal base, the two main printed circuit boards being mounted onto the base using insulating pillars. The top cover has cut outs for the valves and on early versions like mine, cut outs for the four main smoothing capacitors. I suspect that these capacitors were hidden out of sight on later amplifiers for three main reasons.

First would be safety as these components have approximately 450 volts on them and though well insulated they do pose a possible safety hazard, though I think a fairly unlikely one.

Secondly, the style of capacitor i.e. its physical size, has been discontinued by manufacturers for a shorter but fatter size, probably dictated by other markets where their improved immunity to mechanical shock would be appreciated and their shorter height ideal for compact power supplies.

Thirdly, the sight of four bland capacitors poking out of the top panel does not exactly add to the aesthetic qualities of the amplifier.
The top cover also carries three large Green circular transformer covers that have made many to believe that the transformers are toroidal. Toroidal transformers are specially wound on large donut shaped cores and have special qualities like better efficiency, smaller size, lower weight and a lower exterior magnetic field so screening or special placement onto the chassis is not required. These things come however with one big disadvantage and that is cost.

The Yaqin does not use toroidal transformers, probably due to cost and instead the transformers are of the usual laminated metal frame type of construction. It is usual to mount the power transformer at 90 degrees to the output transformers to reduce magnetic coupling between them. Yaqin have mounted all transformers in the same direction to each over and the very substantial metal covers are given the job of providing the magnetic isolation. The transformers are wound on a single bobbin which I am told improves transformers regulation.

You will also note on the front cover photo that there is a small square MC-10L badge located between the two sets of capacitors. This badge has been attached to hide a hole but what was it originally for? The reason will become apparent when we look at the history of the amplifier and its earlier brother the MC10-K. I am indebted to Bob Drinkall on the Yaqin Tube Valve Amplifiers facebook Page for the following 10-K photographs.

First of the line?

The MC10-K sported a total of 11 valves, two of which were Magic Eye indicators. Notice that there is a small double Triode sitting where the plastic badge now resides.
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This is the MC10-K but in the 10 Tube format. The small double Triode has gone, its mounting hole hidden by the plastic badge. So we have finally arrived at the reason for it, to allow old chassis tops to be used with later models.
The Magic Eyes were next to go, substituted by double Triodes. This allowed the octal based Triodes to go, making room for an extra pair of smoothing capacitors. The fancy aluminium mounts were also added to the capacitors to hide the large holes left in the chassis top.

The front panel requires little comment, it carries a mains supply on/off switch, a volume control and a 4 position input selector switch. You may suffer from cross talk here, this being the ability to hear for example a Tuner input, faintly in the background when one of the other inputs is in use. One of the main reasons for this is the fact that the inputs are not taken to the switch on separate screened leads, this would make eight in all, four for the left and four for the right. Instead, all four inputs on each channel are lumped together into a single screened lead which may provide some degree of isolation between left and right but does nothing for the four individual inputs on each channel. Because I use a remote switch box and hence only one input to the Yaqin, I do not suffer from cross talk but for those of you who do, then it may be possible to reduce this to a satisfactory level by re-wiring with separate screened leads.

This is part of a Yaqin catalogue photo and shows the layout of the rear panel. The RCA input sockets require no comment except that which has already been described. Likewise the speaker output sockets which have generous entry holes to accept very heavy gauge speaker wires. My particular speakers are rated as being 6 Ohm impedance which was tricky for me as the Yaqin only provides either 4 or 8 Ohms. All enquiries on the internet gave the indication that the 4 Ohm output was best suited for 6 Ohm speakers but after many hours of listening I still cannot decide which is best. 8 Ohm output seems to provide a firmer bass but at the loss of top ‘air’ which seems to come back on the 4 Ohm output.

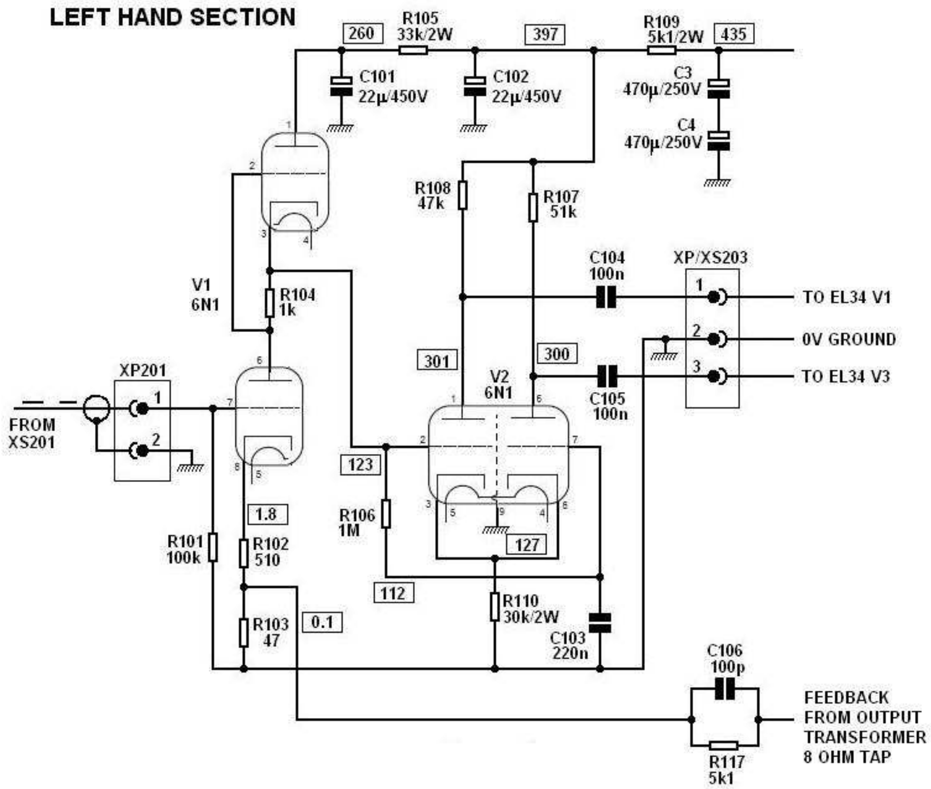
Earthing and Earth loops

The mains input connector is a standard IEC type with a small drawer that contains the mains fuse plus a spare. But I discovered something here; the earth pin was not connected to anything and left completely open circuit. I was not happy with this as I see this equipment as Class 1 which implies that a hazard could exist if there was a short circuit of any mains wiring to chassis. Also I originally had an audio feed from a cable TV box plugged into the DVD inputs and this caused the Yaqin chassis to attain an unpleasant voltage, presumably from the cable box supply filters.
When a PC soundcard was plugged into the Yaqin it caused the soundcard to ground this induced voltage and led to failure of the soundcard so something had to be done.

I fitted a good quality earth bond between the IEC earth pin and the base chassis plate. This does not cause any earth loops except when the PC is connected but the level of hum is so small that it is generally un-noticeable. It can easily be cured by fitting audio isolating transformers at the PC but I have not needed to do this. For those who do not know what an earth loop is, it is simply the fact that two pieces of equipment, for example the Yaqin and a PC may have a slight difference in potential on their chassis earths due to for example the existence of a mains input filter.. When you connect them together via the audio leads, a small current at mains frequency (50 or 60Hz) will pass between the chassis of the two units and this can be induced onto the signal lines and cause hum to be heard.

Front end

Here is the circuit of the re-drawn front end, which are the stages using the small 6N1 valves, between the source selector switch and the larger EL34 output valves. On the right channel V1 is V4 and V2 is V3. Also the valve pins used are reversed so for example, pins 6, 7 and 8 on the left channel become pins 1, 2 and 3 on the right channel, this applying to both valves.

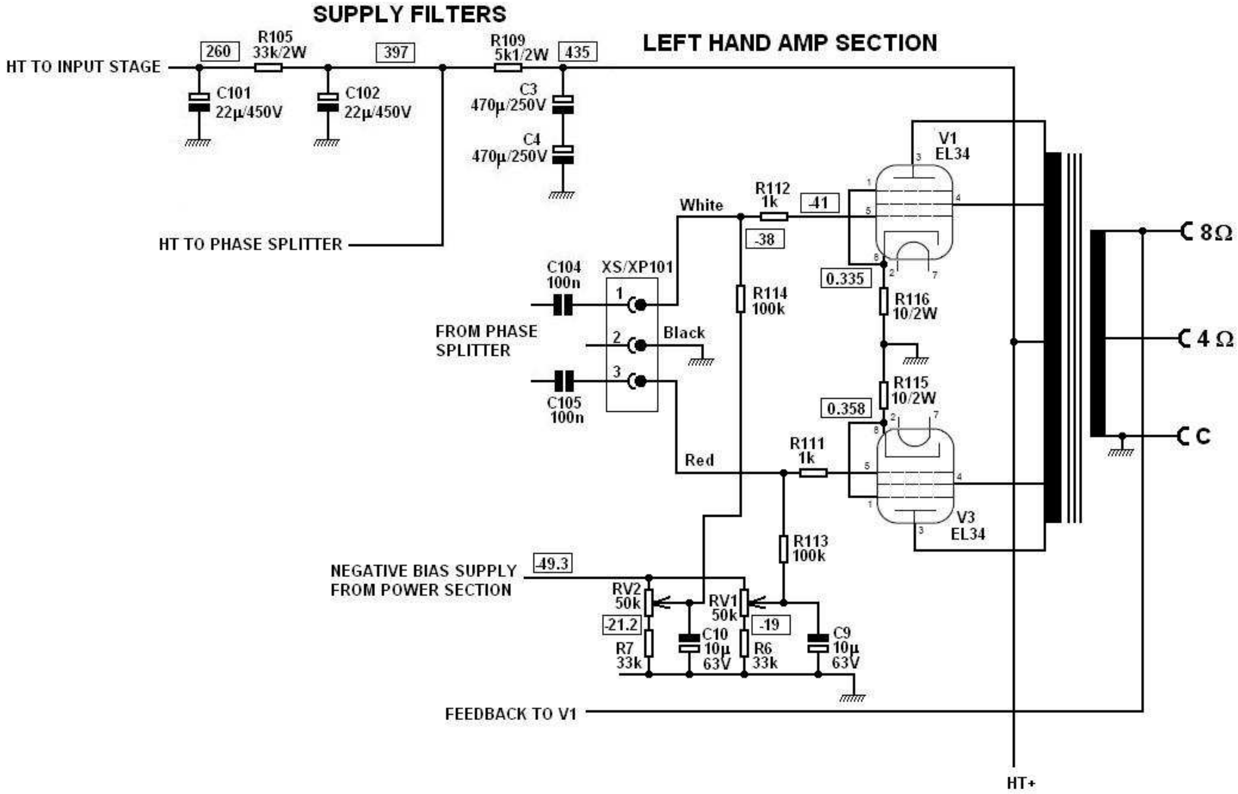


The first half of V1 consists of a voltage amplifier using its second half as a kind of infinite anode load (but by voltage values approximately 40k Ohms) with the overall current set by R104. This is approximately 3.5mA and biases the top halves grid at minus 3.5V with respect to its cathode. The circuit allows direct connection of the second valve V2, without any capacitor which could otherwise produce unwanted phase shifts. It also improves the low frequency stability when feedback is applied to R103 via C106 and R117.

Intermediate Stage

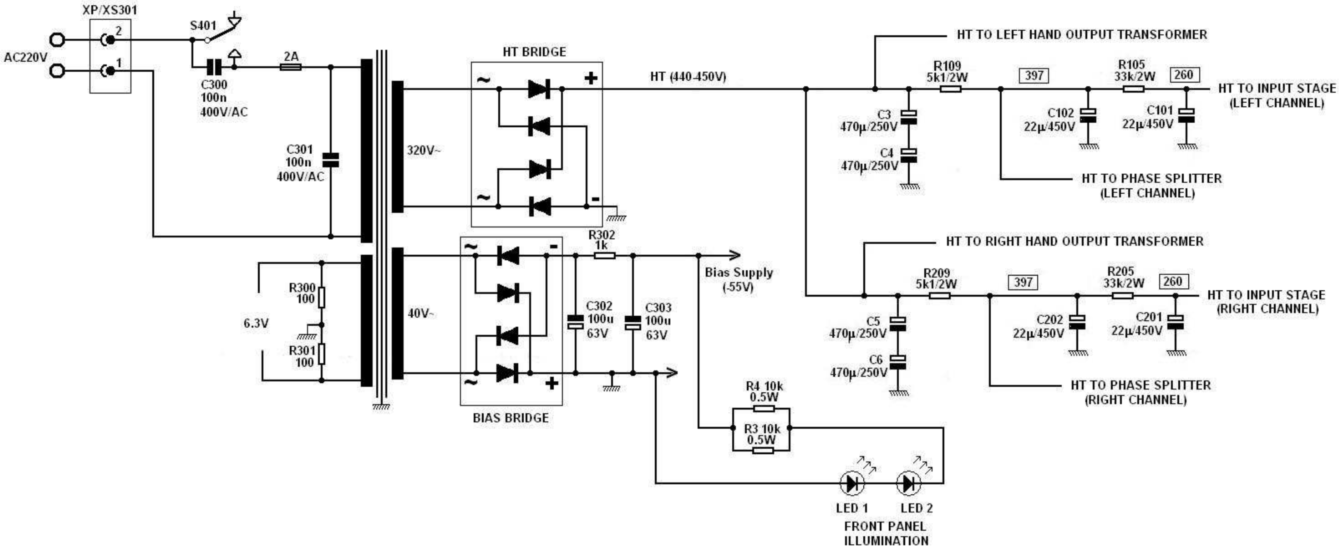
The intermediate stage consists of a cathode-coupled phase-splitter often called a Schmitt phase splitter and provides a push-pull drive voltage for the output stage. It is necessary in a cathode-coupled phase splitter for the anode load of the right hand section to be slightly higher than that of the first section if reasonable balance is to be obtained. Thus R107 is made 51kΩ and R108 47kΩ. At low frequencies, the presence of C103 and R106 in the grid circuit of the right hand triode produces both phase and amplitude unbalance. The frequency at which the lack of balance becomes significant depends on the time constant of these components and in the MC10L it is less than 5Hz. The cathode voltage on the upper section of the first 6N1 (V1 Pin 3) determines the operating conditions of the phase splitter. The task of the phase splitter is to take a single input signal and produce two versions of it, one of which is a mirror image of the other. When applied to the output valves, the two signals will make one valve turn off as the other turns on and vice versa.
That is what is meant by the term Push-Pull.

Output Stage



The output stage consists of two output pentodes, type EL34, in what is called a fixed bias circuit. This means that each valve has its bias independently controlled by its own adjustable control; here they are RV1 for V3 and RV2 for V1. Matching of the output valves is therefore unnecessary whereas other amplifiers employing the alternative self-bias have to be fitted with matched valves in the hope that each arrives at the similar bias points. The anode (Pin 3) supply voltages are taken from the reservoir capacitors C3 and C4 (which will be discussed later) via the output transformer. The screen grids (Pin 4) are fed from taps on the transformer and this arrangement is called Ultra Linear Mode or Distributed Load. Basically it makes the Pentodes appear almost like Triode valves, which are very linear and consequently the distortion is lower. Bias is supplied to the valves via R113 and R114 with the 1k resistors R111 and R112 included as a normal measure to prevent parasitic oscillations. The inclusion of the 10 Ohm resistors R115 and R116 allows measurement of the valve currents, using a standard voltmeter, without having to break into any of the circuits. The method for setting up the bias was discussed on pages 3 and 4. Audio signals are coupled to the output stage by capacitors C104 and C105. These two components are favourites of the ‘modification brigade’ who either up the values to something like 220 - 470nF and fit paper in oil types of capacitor in an attempt to tailor the sound to their preference. There is however a much more useful modification to be made here as will be discussed later.

Power Supply



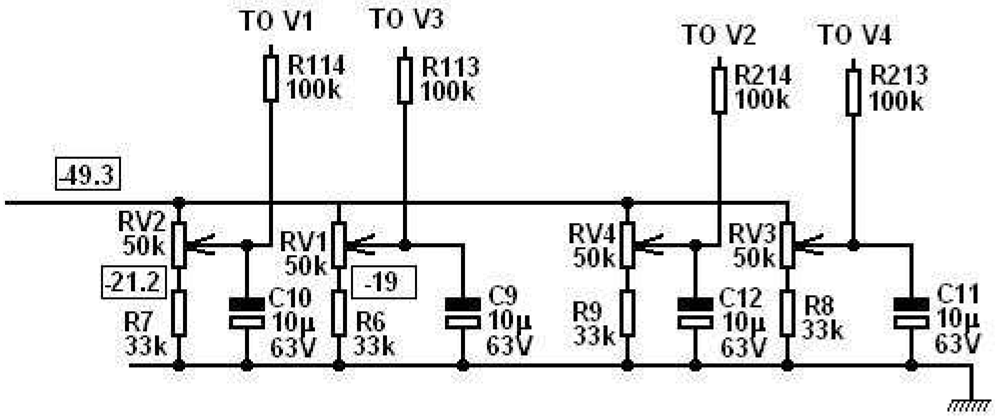
The power-supply stage shown in the circuit diagram above uses two bridge rectifiers to provide all of the direct current (DC) supplies. The first bridge fed with 320V AC produces the main HT rail of approximately 450V. The first set of smoothing electrolytic capacitors, sometimes referred to as Reservoir capacitors, require some explanation. These are C3, C4, C5 and C6 which are arranged as two sets of series connected capacitors. The reason for series connecting them is the fact that each capacitor is only rated at 250V and yet the supply rail is at 450V. By connecting the capacitors in series the working voltage is doubled to 500V but at the same time the effective value is halved, so we finish up with a 235uF 500V capacitor. By fitting an identical pair in parallel we once again achieve 470uF at the higher working voltage of 500V. There is a very important modification we need to do here, as will be discussed later and which Yaqin themselves have fitted on their latest amplifiers.
Because the output stage does not have a great deal of gain by itself, the level of smoothing provided so far is adequate but the other stages will require more smoothing. Additional smoothing is achieved using the resistors R109/R105/R209/R205 and the capacitors C102/C101/C202/C201 (22 µF) so that the expense of smoothing chokes is avoided. With the power supply under load, the voltage across C102 and C202 should be close to 400V whilst that across C101 and C201 will be 260V. The capacitors are rated for 450V which must not be exceeded, but could possibly happen if all valves are removed and power is applied to the amp. So when fault finding try to keep some valves in circuit or arrange for the amplifier to be powered with a lower mains supply so that the main HT does not go above 450V.

Bias Supply

The second bridge rectifier is fed with 40V AC from the mains transformer and with the pi smoothing circuit provided by the 1k resistor and two 100µF capacitors; it provides a negative voltage of around -55V for the bias circuits.
This voltage is conveniently used to illuminate the front panel Logo using two Blue light emitting diodes (LEDs), series wired with R13 and R14 doing the current limiting of around 10mA. The value for R13 and R14 is 10k but in later models this was reduced to 6k8 to obtain a brighter light.

The actual current drawn by all four bias control circuits is roughly 5mA.

The circuit is drawn on the next page.

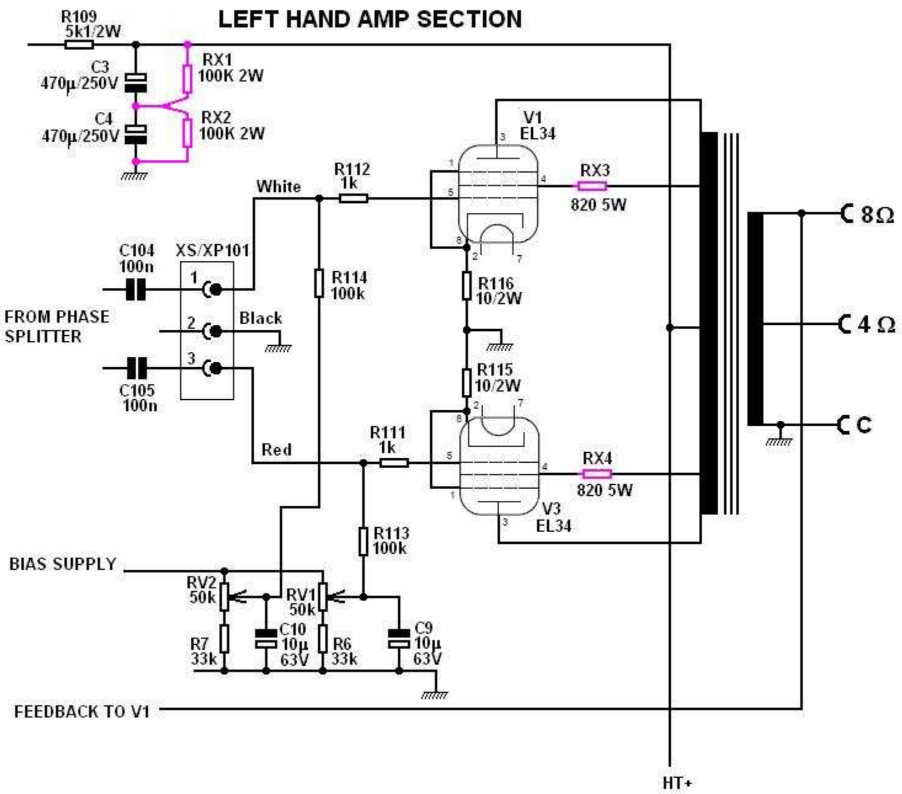


Pretty self explanatory, the -55V (-49.3V actual measurement) is fed to all four preset controls RV1 – RV4, each having a 33k resistor and a decoupling capacitor of 10µF. The grids of the output valves are fed with the bias, as required, via 100k Ohm resistors R113, R114, R213 and R214 as shown.

Modifications and changes made to later models.

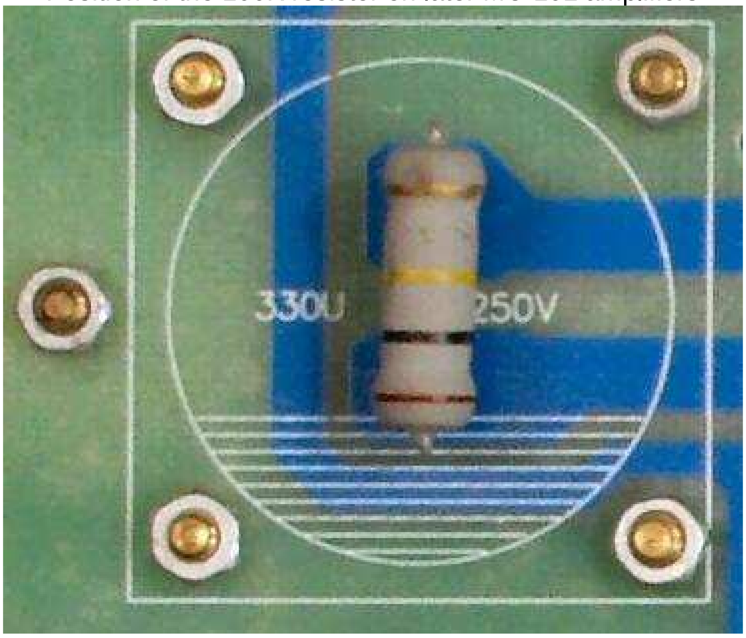
Here is a list of some changes you can make to the MC-10L, first however the most important ones and regarded as very necessary:-

Voltage Equalisation Resistors

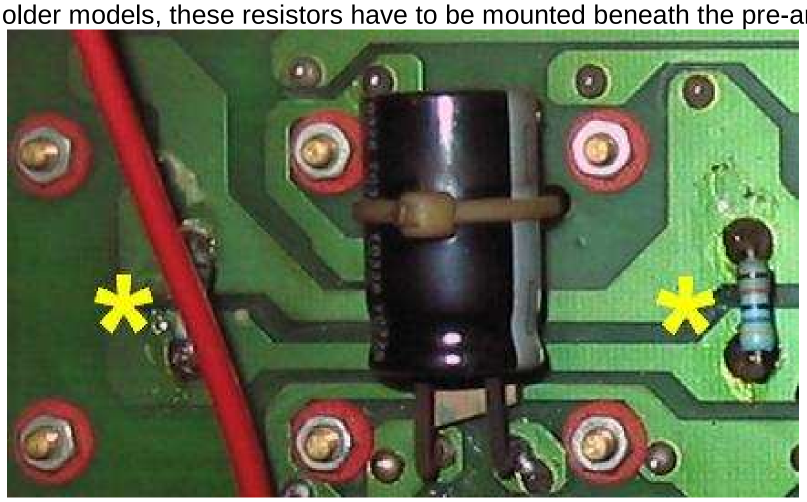


Leakage currents within the capacitors C3 and C4 could cause the voltage sharing to go astray with the result that one of the capacitors may have more than 250V across it. This can be prevented by fitting voltage equalising resistors shown as RX1 and RX2. This is a modification that Yaqin now fit on their latest models as shown in the photo on the next page.

Position of the 100K resistor on later MC-10L amplifiers



On older models, these resistors have to be mounted beneath the pre-amp board.



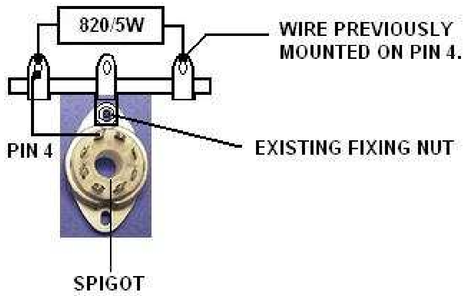
The left most resistor is partly hidden by the Red wire. By using a higher value of resistance I was able to use 1 Watt resistors that were to hand at the time. I would probably use the 100k 2 Watt resistors if I was fitting them now because there is an additional advantage.

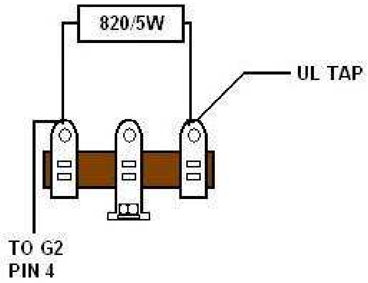
This is the fact that 100k resistors provide a reasonable discharge path when the amp is switched off so the capacitors do not hold any charge waiting for your fingers!

Screen Grid Stoppers/Current Limiters

In the diagram on Page 10, RX3 and RX4 as far as I can tell are not fitted to latest models and was a modification I decided to do after reading about failures in EL34 valves due to excess screen currents. The articles concerned recommended the fitting of limiting resistors but I have also read that they assist in the stability of amplifiers and help reduce the chance of parasitic oscillations. Lately, I have found some documentation on the internet that was produced by Philips (Mullard) that recommends the fitting of 470 Ohm to 1k Ohm resistors in series with the screens of EL34's. One particular high end amplifier that came my way had a very similar output stage to the MC-10L, using ultra linear screen taps on the output transformers, but including a 750 Ohm screen resistor on each EL34. I modified my MC-10L using the more easily obtainable 820 Ohm resistors.

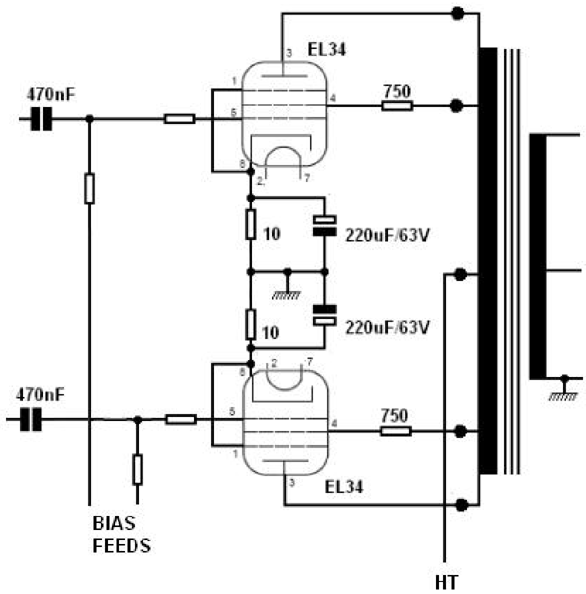
They are not so easy to install on the MC-10L and I mounted mine on four small tag strips. You can buy the tag strip in one length and just cut it to suit. I used the outer most screws of each valve holder as they were easier to get to and also meant the least disturbance of wiring. Hopefully these rather crude sketches will give you some idea of fitting.





Having mounted a tag strip at each valve position, simply remove the wire from pin 4 of each EL34 and connect it to one end of the resistor.
In one of the above sketches it is marked as UL TAP.
Then using a short piece of insulated wire, connect the other side of the resistor to Pin 4, i.e. the pin you removed the original wire from.

I am convinced that fitting these resistors has improved the bass response of my amplifier but I have no measurements to be able to back this theory. Here is the circuit of the high end amplifier on which the modifications were modelled.

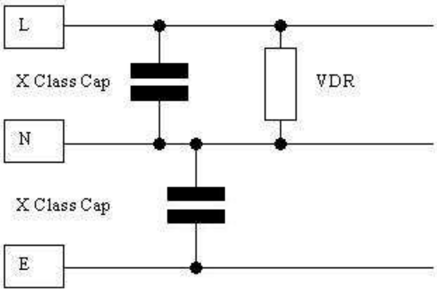


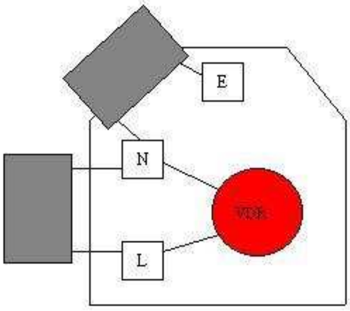
Cathode de-couplers

Notice in the high end amplifier circuit shown above that it also has 10 Ohm resistors in each of the EL34 cathode circuits, just like the MC-10L. However, the resistors have a 220uF 63V electrolytic across them. While I was fitting the screen resistors I added the capacitors at the same time, there is plenty of room for them on the underside of the circuit board. Unfortunately, I did this modification at the same time that I added the screen resistors so I cannot tell which of the two modifications resulted in the slight Bass improvement.

Mains Filter

This information was found on a website so I do not claim it as my idea in any way, I cannot recall the actual website but praise was given to Richard for his idea.
I do not know if there is any advantage to fitting this circuit, perhaps where mains interference is a big issue then may be. Anyway, I have included it in case anybody wants to fit it.





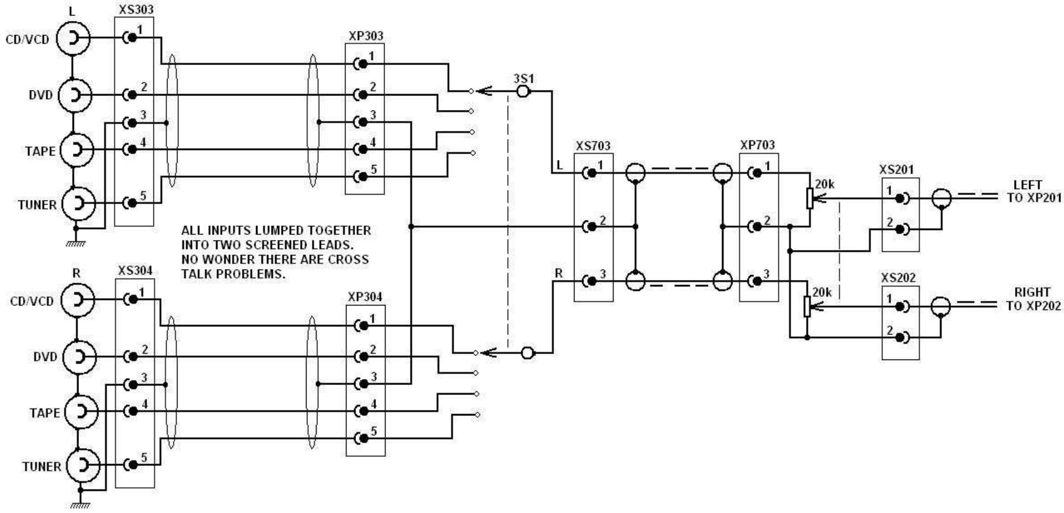
Rear of typical IEC inlet for illustration only.

The capacitors (shown as Grey blocks) are what is called 'X' class and only this type can be fitted here to comply with the latest safety requirements. The actual value can be 47nF to 68nF and of course rated for 250V AC if you live in the UK.
The VDR (shown as a Red disc) is a Voltage Dependent Resistor and is normally of a high resistance except until a high voltage spike appears on your mains supply whereupon it exhibits a low resistance. It therefore has to be selected in value for whatever your mains supply is.
For those in the UK, the capacitors are RS 210-487 (47nF) or 210-493 (68nF).
The VDR is Maplin HW13 or RS 238-621 for 230V mains and
RS 238-592 for 115 V mains.
In addition you will need some small bore insulating tubing to place over the legs of the components to prevent any short circuits.

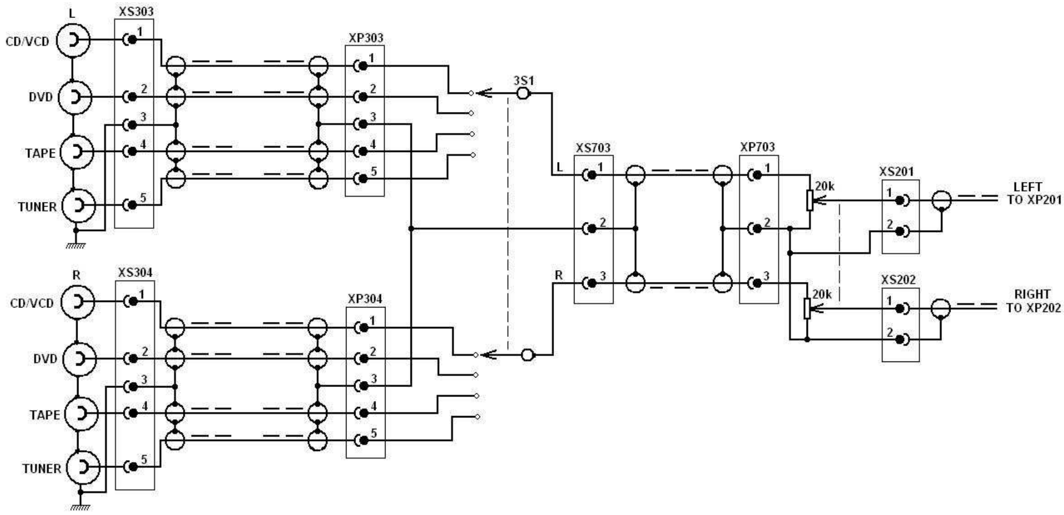
WARNING: As with all modification work on your MC-10L, always ensure it is unplugged from the mains supply before starting work.
Remember that it is you who is responsible for your own safety and if in any doubt seek professional advice before you start.

Cross Talk **(Slight hearing of what's on another source whilst switched to another)**

Another weakness in design no doubt brought about by cost saving especially in the wiring stages of construction. All four inputs of each channel are combined into one screened cable instead of being separate. This is bound to cause cross talk on such a high impedance circuit.



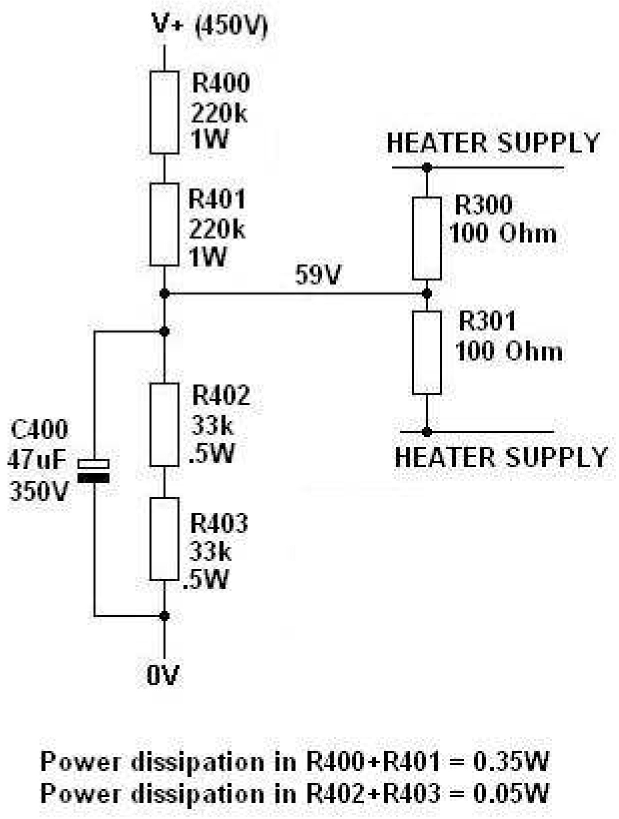
If you suffer from cross talk (and you probably do) then this may provide at the very least a reduction to acceptable levels.



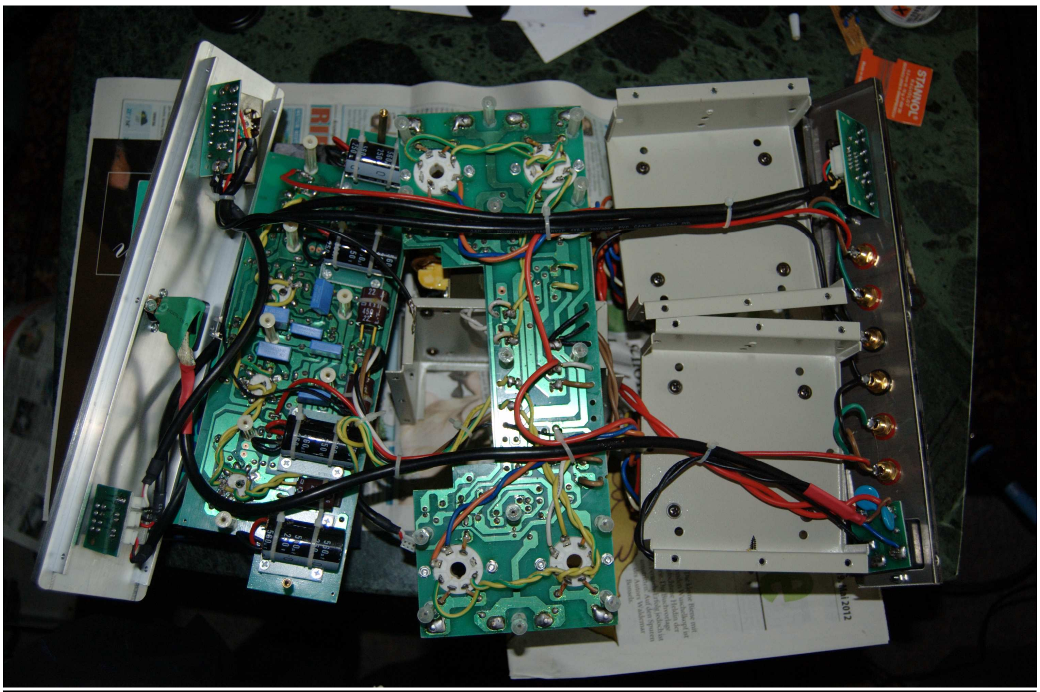
Floating the Heaters

Not too many problems seem to have beset the pre-amplifiers and phase splitters apart from defective 6N1's producing nasty crackling on the output or mains hum due to defective cathode/heater insulation. The cathode/heater insulation is really pushed hard in the MC-10L and looking at the specifications of the 6N1 makes one feel that the design is really asking a lot of these valves. It has been suggested that a potential divider should be constructed from the HT line such as to float the heater supply at a fixed voltage, say 60V. You would have to lift the fixed resistors presently fitted on the heater lines from earth (these are shown as 100 Ohm resistors R300 and R301 on the page 9 schematic) prior to doing the modification. The 60V float would effectively do the job of hum reduction and reduce the potential difference between cathode and heater of the 6N1's. I have not tried this modification myself as it does require quite a bit of work and besides, I have not had any 6N1 failures in the 5 years I have owned my MC-10L. However, Matthias Günther has sent me some information on how he implemented this modification. Many Thanks Matthias.

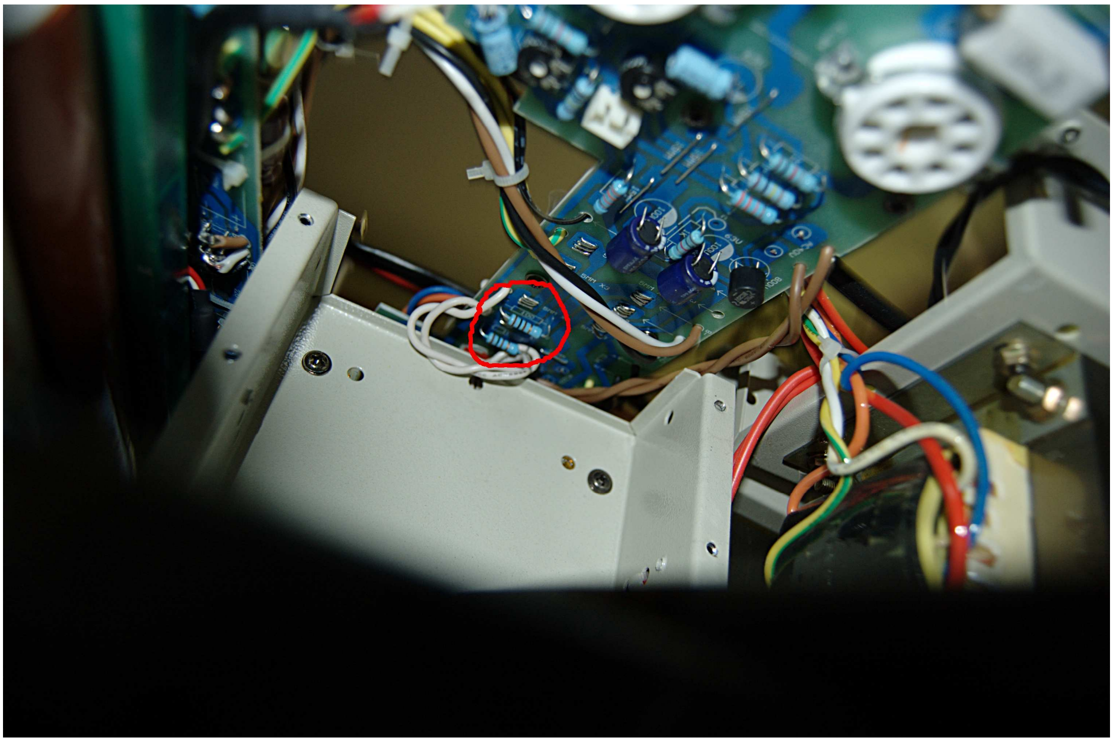
The Circuit



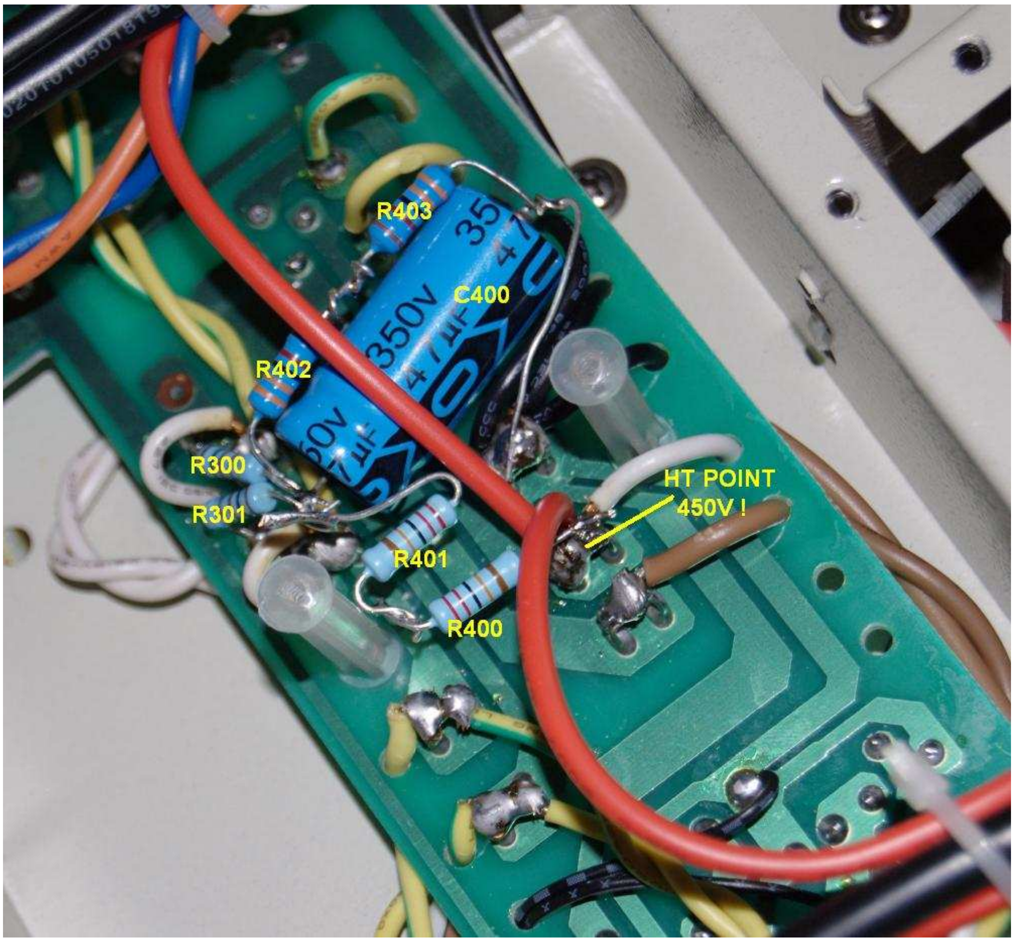
It does require complete removal of the base panel in order to access the power supply section of the rear board



Location of the 100 Ohm resistors R300 and R301



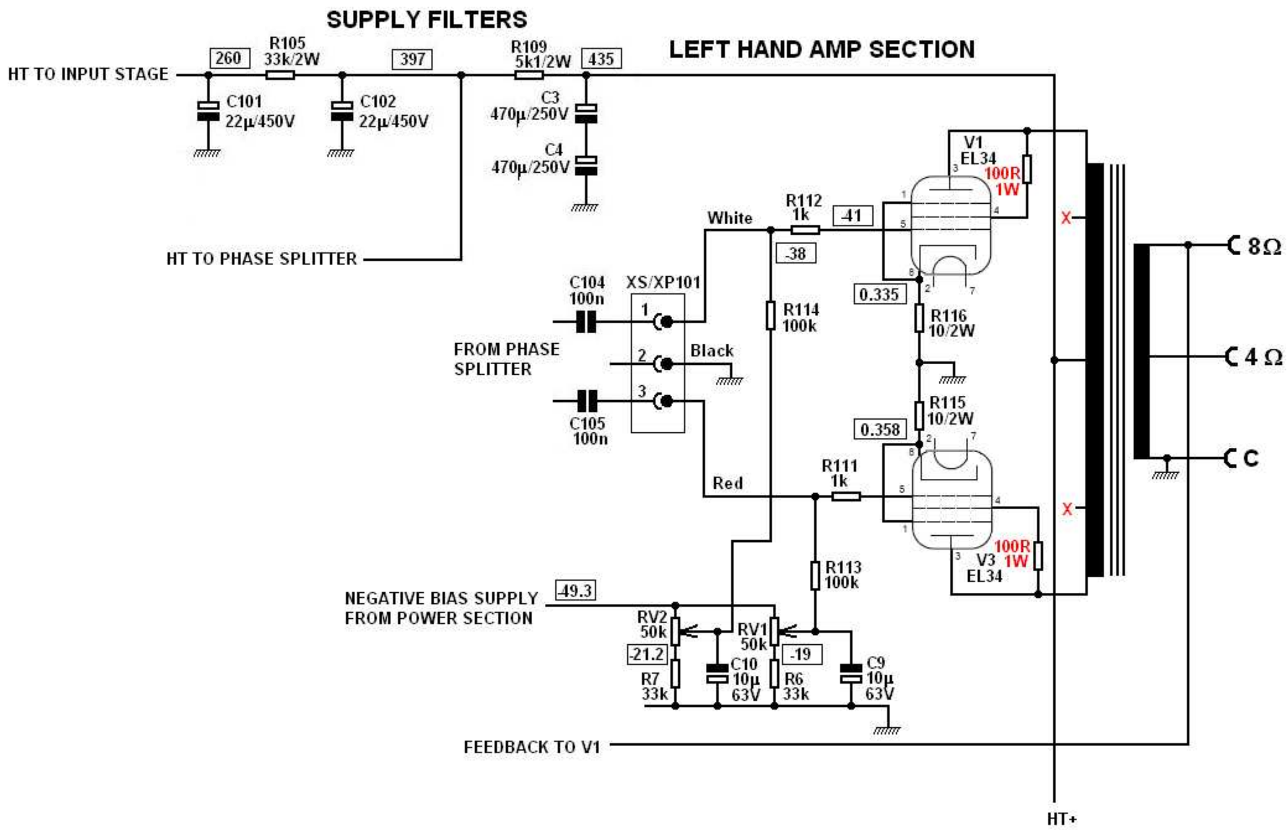
Fitting the Mod



Triode Mode

I have been often asked if it is possible to wire the MC-10L in Triode mode?

Well I don't think there is much more to do other than disconnect the ultra linear output transformer tapping from pin 4 of each EL34 and well insulate it as you don't want it accidentally shorting to chassis or for that matter anywhere else. The now vacant pin 4 is now connected to the anode of the EL34 (Pin 3) via something like a 100 Ohm 1W resistor. These are minimum values and could be higher, say up to 470 Ohms with a 2W rating for better reliability, especially under fault conditions.
The suppressor grid at pin 1 stays connected to the cathode at pin 8. For true triode emulation it would seem at first sight that tying it to the Anode would be the best thing to do. However the grid structure is not designed for that and it would be very unhappy! I have looked over other circuits where a Pentode has been wired as a Triode and the suppressor grid is always connected to the cathode.
I have not tried this mode myself, the main reason is the daunting task of taking the amp apart to revert to UL mode should I not like the Triode mode ☺.
Don't forget you will have a lot less power available in Triode mode so your speakers need to be reasonably efficient.



Mains input voltage

I want to start here with a problem that has been blamed for premature failures of other Yaqin amplifiers as well as the MC-10L. This is the worrying problem of mains supply voltage and the fact that a lot of amplifiers from China have been manufactured with 220V in mind instead of the 240V here in the UK. Perhaps I was lucky with my amplifier as all voltages around the amplifier seemed to be as expected with the HT supply being around 450V DC and the valve heaters being run at 6.3V AC. Running a 220V Yaqin on the UK supply of 240V will cause the heater supply to rise to around 6.8 to 7 volts but more importantly, the HT supply is likely to rise to close on 500V which is the maximum that the smoothing capacitors are rated to handle. If you have a high HT or measure the heater voltage as close to 7 volts AC then there is a good chance that your amplifier was meant for a 220V mains supply. It has been suggested on the Yaqin Face Book Forum that the mains transformer has its mains input voltage stencilled on its upper surface. You will have to remove the top, complete with attached round cans, to get a glimpse of this. It may save you the trouble of trying to ascertain its input rating by measurement. The main worry is that the mains transformer may be running a lot hotter than normal and may suffer insulation failures in the long term. 50 deg C is about the hottest you want the mains transformer to increase by and there is a simple way of getting a rough idea of your amplifiers mains transformer temperature increase. It involves a little maths but is really quite simple. You need to use your digital Multimeter to measure the resistance of your amplifier WHILE IT IS COLD.

Before you use your MC-10L for the evening, unplug the amplifier from the mains and apply the Multimeter across the pins of the mains plug, making sure of course that the mains switch on the amplifier is set to ON.

We will take my MC-10L as an example and it measured **5.8** Ohms.

We now use the formula –

Maximum allowed resistance rise = (measured resistance x 0.1965) + measured resistance.

Which in my case is (5.8 x 0.1965) + 5.8 that works out as 1.1397 + 5.8 = **6.9397** Ohms.

The **6.9397** Ohms is the maximum resistance you want to see when you repeat the measurement exercise when the amplifier is hot.

Now connect your amplifier back into the supply socket and run the amplifier for the evening so it is nice and hot.

Switch off the amplifier and measure the resistance as before, my MC-10L measured **6.7** Ohms, close but ok! Phew!

The increase in the resistance reading is due to the resistance of the copper wire in the transformer rising with temperature and now you have the two readings we can do some more easy calculation.

For example; we can find the % change in the transformer resistance which we don't want to be more that 20%.

Once again taking my MC-10L as an example, the formula here is –

Percentage rise = ((Hot resistance divided by Cold resistance) times 100) minus 100 or

((6.7/5.8) x 100) – 100 or

(1.155 x 100) – 100 or

115.5 – 100 = **15.5%**

Finally we can use this % figure to deduce the temperature rise (which we don't want to see above 50℃) with the formula –

Temperature Rise = Percentage rise divided by 0.393 or

15.5 / 0.393 = **39.44**℃.

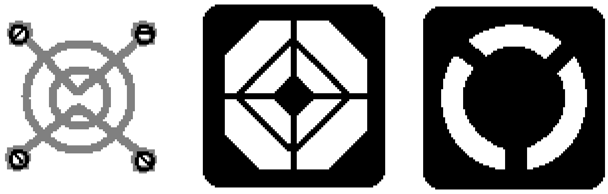
So if you suspect over heating of your MC-10L mains transformer then the above may either calm or shatter your nerves!

Please note that the formulas are not precision but given to me by a friend who suggested that they just gave a reasonable guide as to what is going on inside the transformer.

I found the metal can surrounding the mains transformer was getting very hot indeed and reckoned that a bit more ventilation would be in order. So I decided to add a ventilation grille to the round can that surrounds the mains transformer.

You can buy various grilles for miniature fans and after cutting a suitable hole I installed one at the upper rear of the can, invisible from the front. The wire type is the easiest to fit but be sure to use the shortest possible screws so they do not interfere with the transformer.

40mm FAN GRILLE



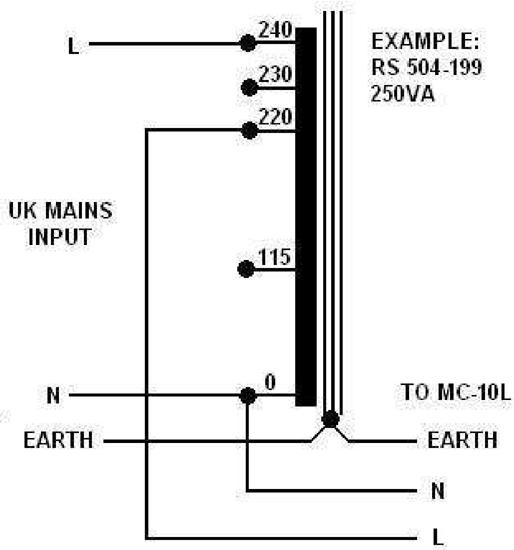
One can certainly feel the heat being ejected from the improved air flow around the transformer. I inserted this modification here as I think it is worthwhile even for a Yaqin fitted with a 240V transformer.

But what do you do if you are unfortunate enough to have a 220V version?

Auto Transformer

Certainly measure the heater voltage to confirm or allay your worst suspicions.

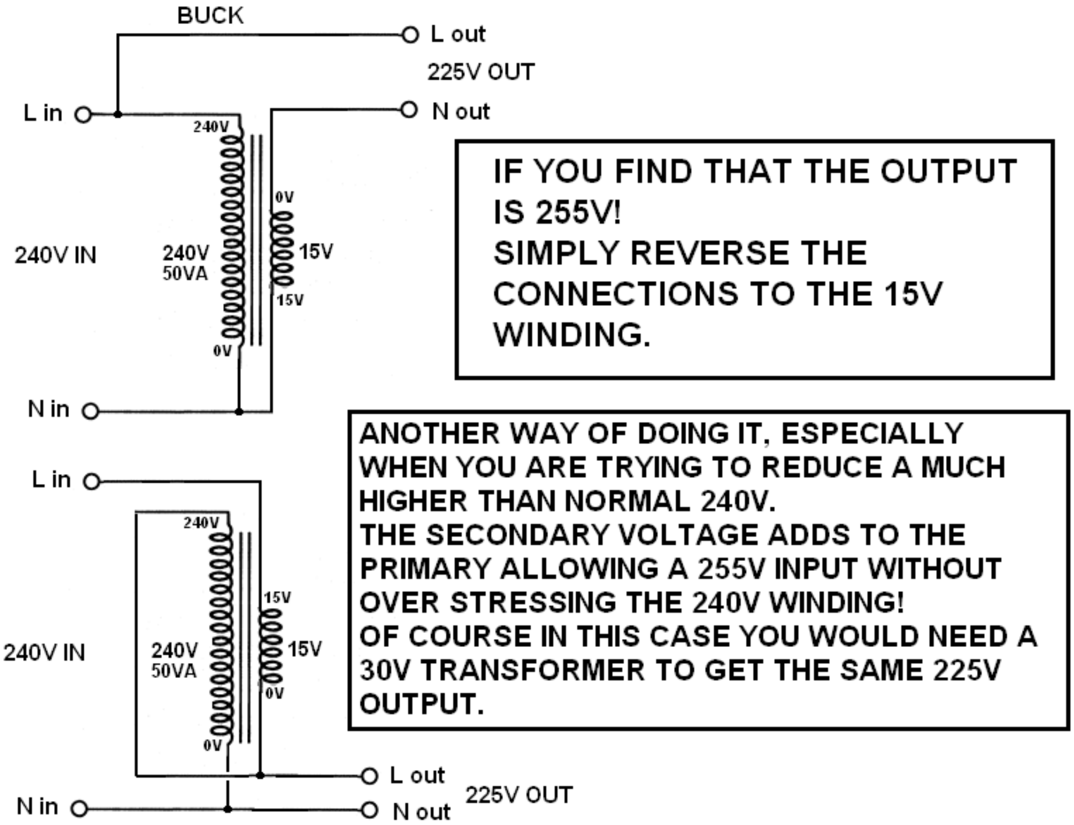
If it is a 220V model then my own preferred arrangement would be to buy what is called an AUTO Transformer. These devices consist of one winding with taps, mainly manufactured to provide a simple way of getting 115V from the UK's 240 system. A typical transformer would be the RS components 504-199.



You may be able to get away with a smaller transformer but for just a little extra outlay it is worth getting one with an adequate VA rating. As you can see from above, you may apply the mains supply to either the 240 or 230 Volt tap and still obtain 220V for the MC-10L.
Some people advocate the use of a simple 15V transformer wired in series with the mains input. I have not tried this myself but is plausible provided it has adequate ratings and it would have to be fitted into a well earthed enclosure. Because it was not designed to be used like this, I cannot recommend it as being fit for purpose and can only promote the auto transformer as being the correct way to go. I understand of course that owners in the USA or other countries using 120V supplies have had similar problems with some MC10-L's being over-run. I have also heard of power resistors being used to drop the odd 10 to 15V but remember that these will be getting quite hot so a suitable well ventilated and insulated enclosure must be used.

Buck and Boost Transformer

If it is not possible to obtain an auto transformer with appropriate inputs then the alternative method of using the low voltage windings of a mains transformer may be a solution. Anyway, if you want to use a 15V transformer here is how you wire it, make sure you make the 225V Buck version! The circuits are for UK 240V supplies but will work for 115V supplies with suitable alternative transformers. Confirm correct output with a Multimeter before connecting to your amplifier!



When things go wrong!

Arcs and Sparks!

Yes, this does seem to occur a lot in valve amplifiers and not just the MC-10L. The main culprit in the MC-10L seems to be in the output stages and somehow, it occurs more in the left hand channel than the right. This is indeed quite puzzling as there is no apparent reason why the left hand channel should be more prone to such failures. It is possible that the failures may be due to 'tube rolling', a term given to trialling various types of output valve to achieve improvement in sound. As such it is very easy to fit a valve that may have an unknown defect and when it fails the MC-10L gets the blame. It could however be R6 - see page 27.

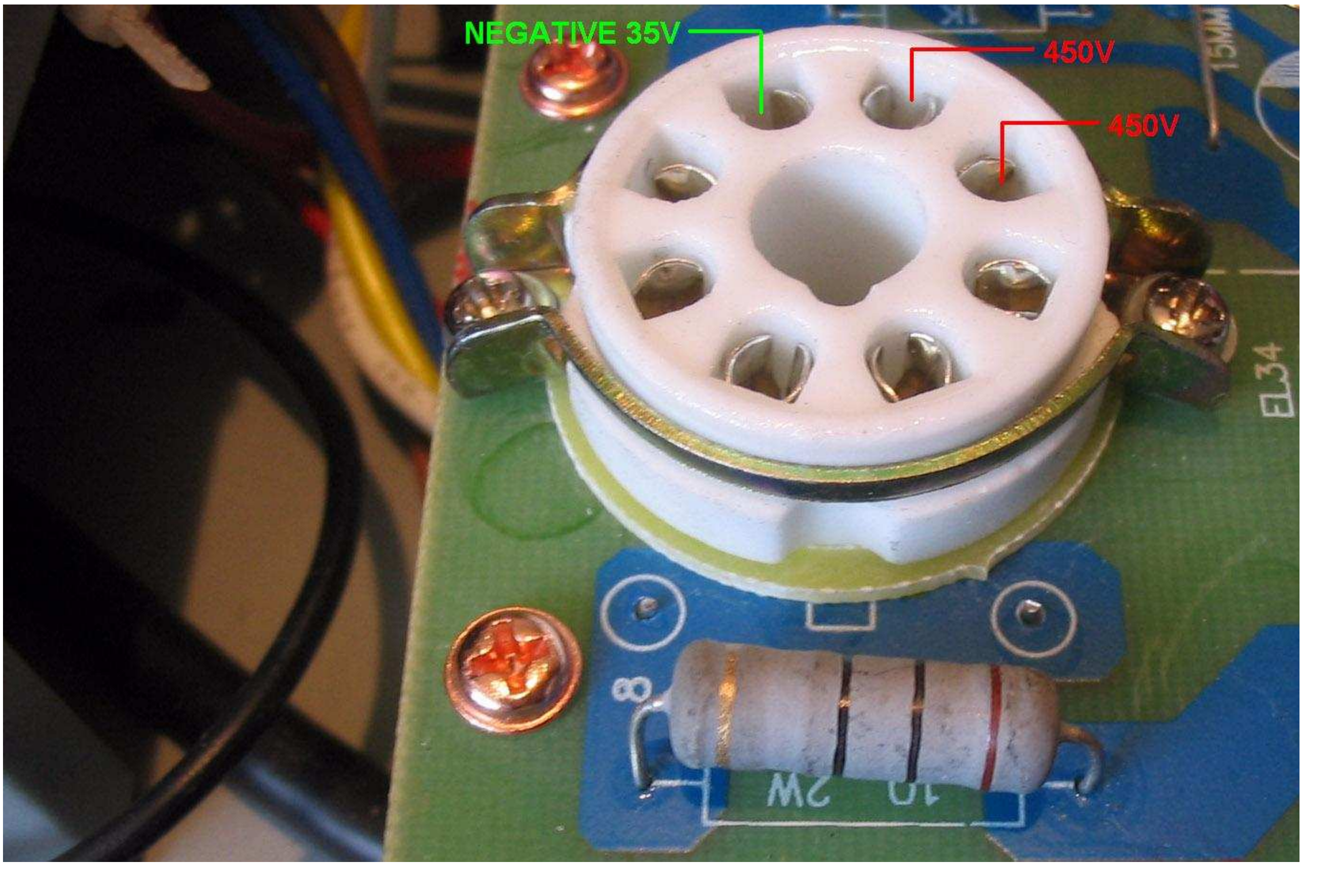
The above photo shows a poorly soldered connection between an EL34 base and the circuit board, cause was a very poorly tinned wire prior to soldering. There are a number of similar connections around each EL34 and are definitely worth a check, perhaps the loss of one of these could cause dramatic failure around this part of the amplifier.
Another possibility is the lack of screen resistors as previously mentioned. The worst case scenario here is failure of the actual grid structure causing it to short to the adjacent control grid. Because the screen grid is at a very high potential you definitely don't want it shorting to the control grid where its effect may also disturb the bias to the other valves. The increase in valve current produces a failure contest between the cathode resistor (the one you measure the bias at) and the output transformer. I know of some instances where owners have shorted out the cathode resistor in order to get a little more from the amp! The improvement (if any) would be extremely small and takes away the safety feature of the cathode resistor, which is a metal film resistor and acts like a fuse, hopefully blowing open circuit and saving the expensive output transformer. If you used the special bias setting up box previously described, you do not need accurate cathode resistors and you could replace them with 150mA quick blow fuses. I have not tried fitting fuses here, it is just another of my 'food for thought' ideas.

Let's get back to the scenario then where one channel has smoked and the cathode resistor has burnt out.

The first thing to do is remove both EL34's for that channel and treat them as suspect, totally guilty until otherwise proven innocent!

By all means keep the EL34's in the working channel as this will help keep the HT from rising too high due to light loading. Now on the faulty channel, check both empty valve holders and confirm that the following voltages can be obtained.

DO TAKE CARE AS THERE IS AT LEAST 450v ON SOME CONNECTIONS!



Loss of 450V on either of the above connections may indicate an open circuit output transformer, especially if the other channel is working correctly.

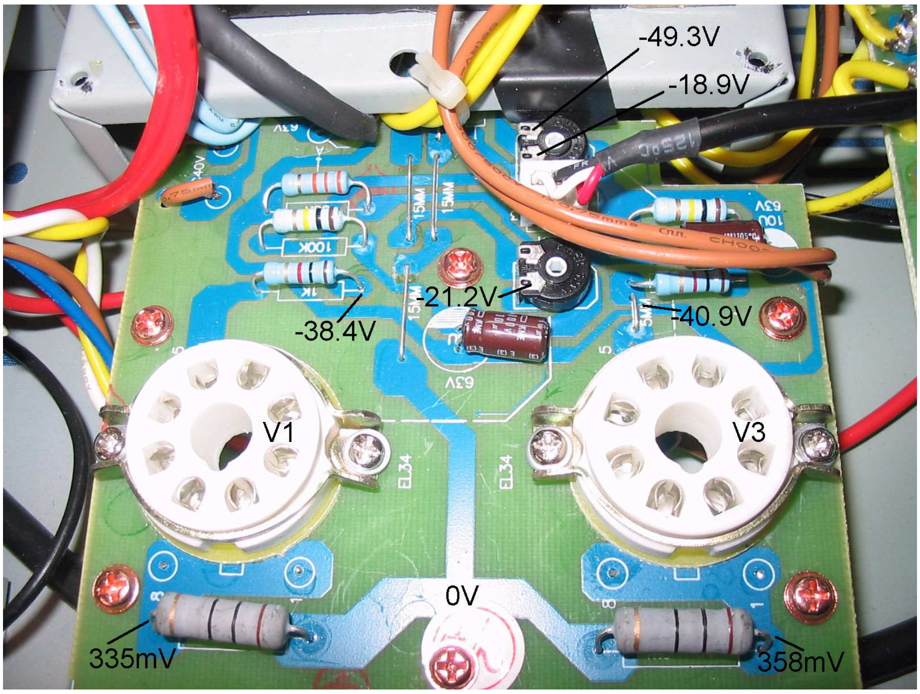
It would be most unlikely to find loss of the negative 35 bias voltage on both vacant valve holders unless serious damage had been done to the bias components. You should be able to see this voltage vary with adjustment of the bias control for the valve holder you are measuring. Check that the voltage change is smooth and there are no control settings that give intermittent readings as for example the control had a damaged internal track.
If you set the control for maximum negative voltage than you will be preparing the circuit to give minimum current through the valve when it is replaced and its final setting point can be set later.

Finally, with all power removed from the amplifier, check out the remaining pins of both valve holders which are pins 1 and 8, located either side of the spigot as shown in the photo on the following page. They should be connected together and then go to chassis earth via the cathode resistor. This should measure 10 Ohms though you may find it open circuit if there has been a large surge current through it. Only by taking off the top cover will you be able to see if it has become a charred relic.

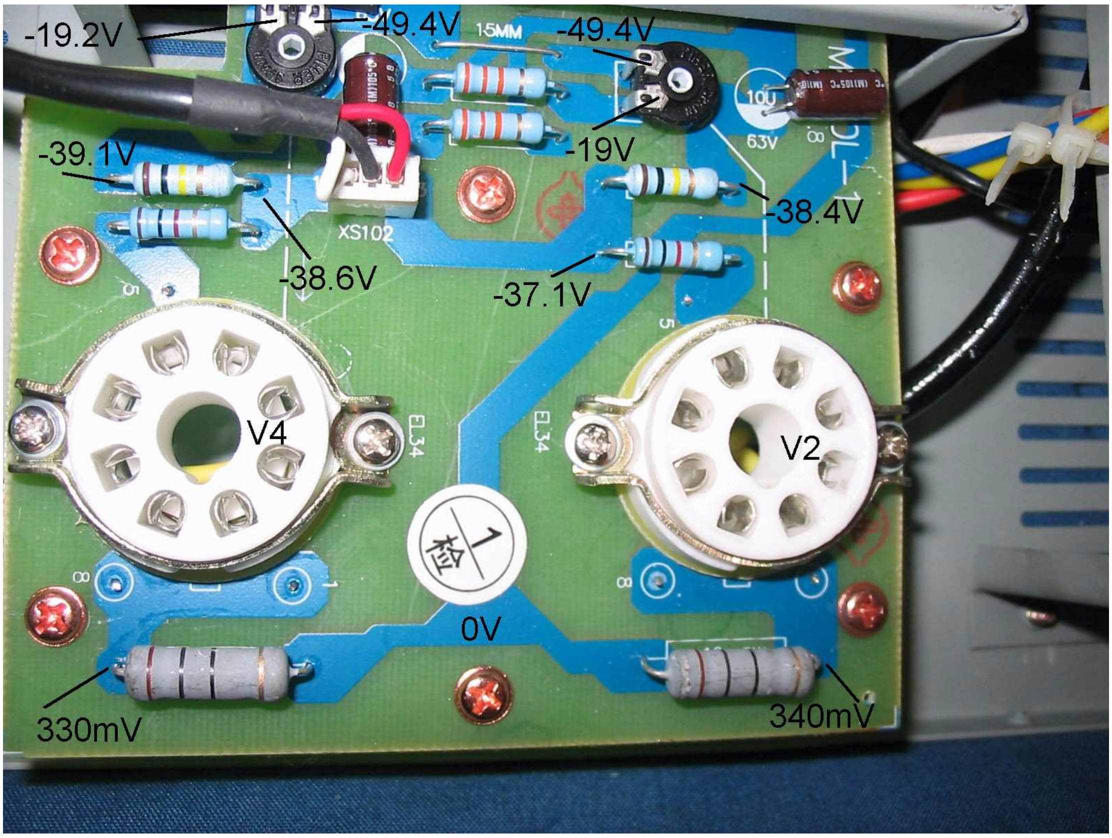
So let's assume all voltages are correct and you have, or have not, needed to replace the cathode resistor. It all points now to a defective valve that has caused the problem and these are best checked on a valve tester designed for the job. You could of course check for shorts inside the valve using a Multimeter but it is quite likely that the short circuit is intermittent and is not really a good test. For peace of mind, I would definitely recommend the replacing of both valves which hopefully will restore proper operation. But remember of course that for testing purposes you still have a good known pair in the working channel!

Listed are some typical voltages taken from a working MC-10L. Notice that there are no valves shown in the photographs as these were taken prior to fitting them, the voltages however are those obtained with valves fitted.

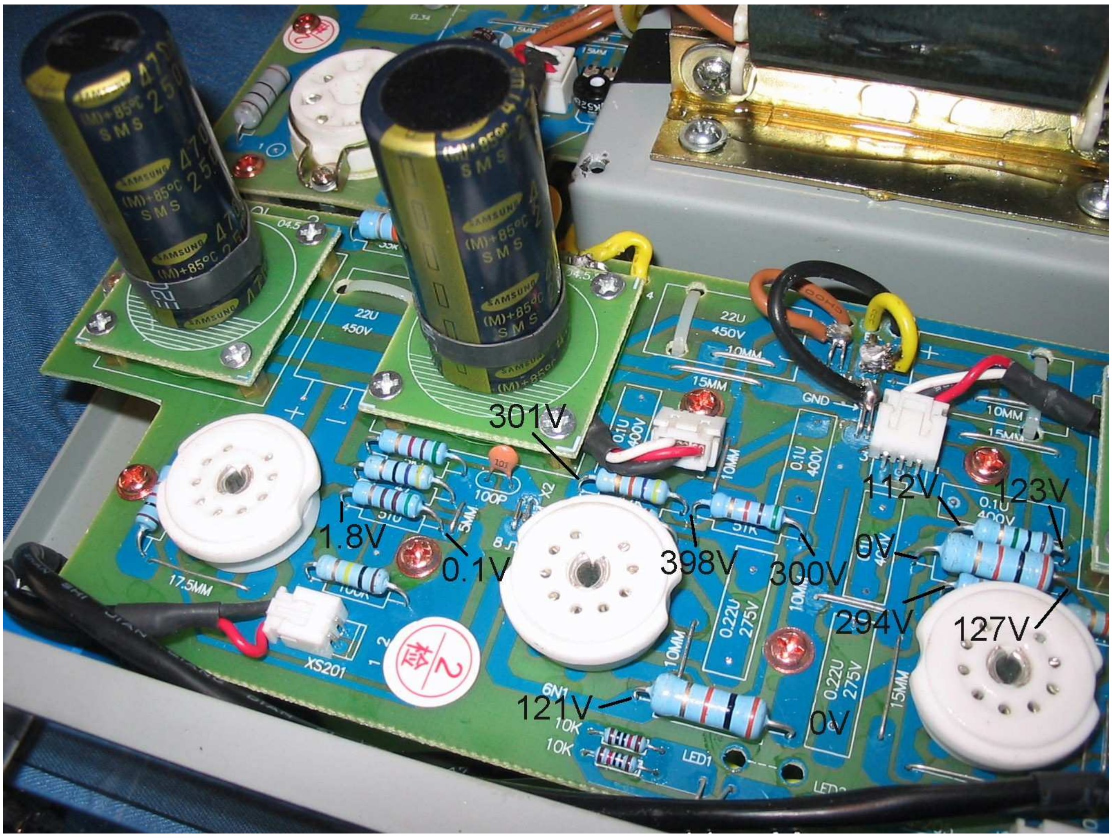
Left Channel Output Voltages



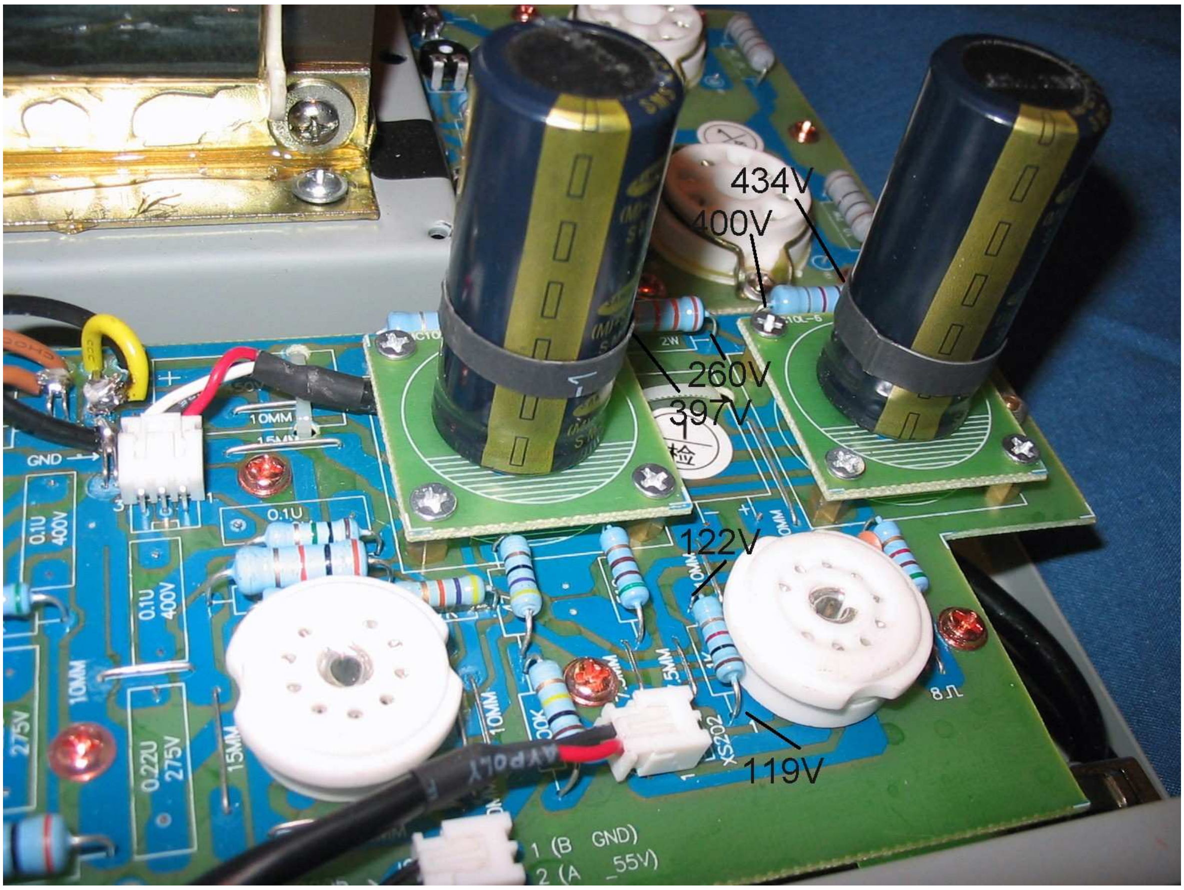
Right Channel Output Voltages

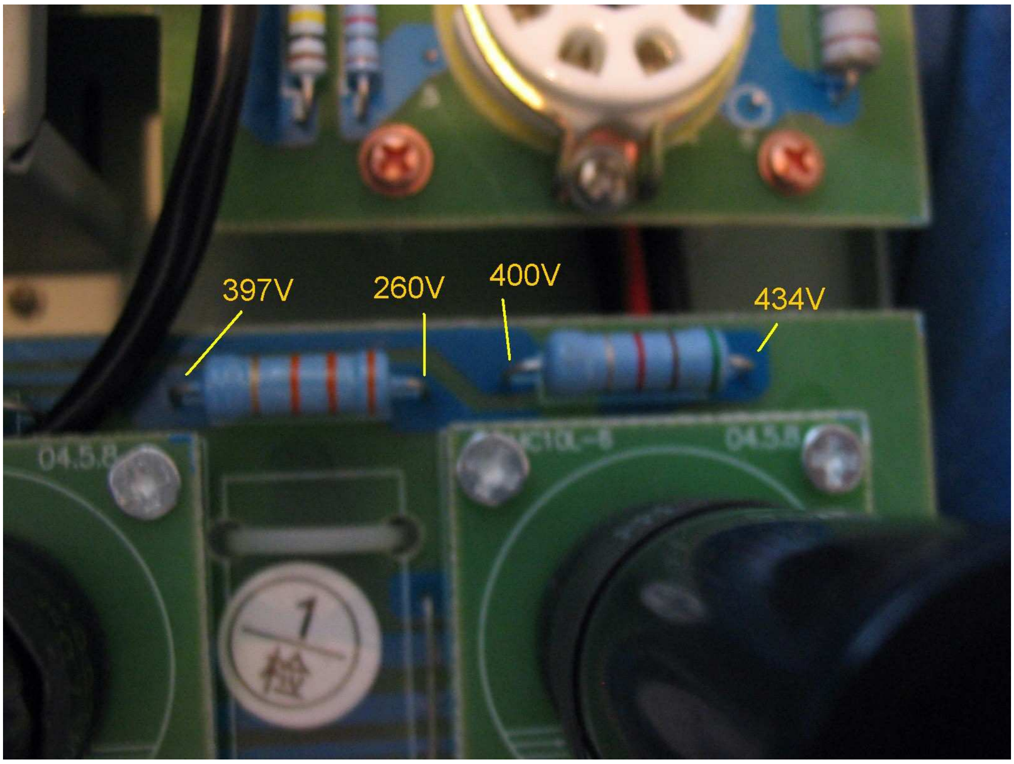


Pre-Amps and Phase Splitter Voltages

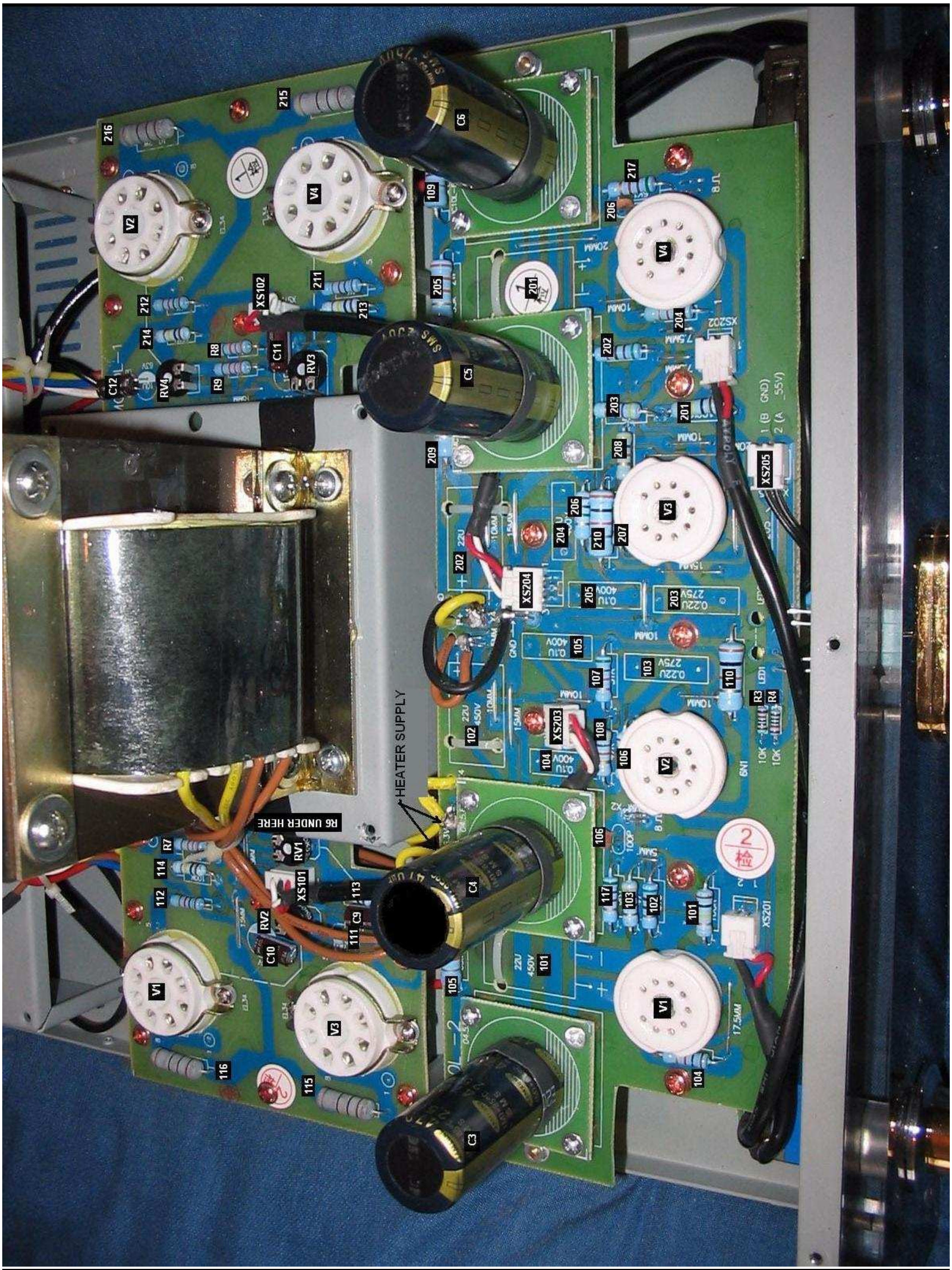


Pre-Amps and Phase Splitter Voltages





Component Identification



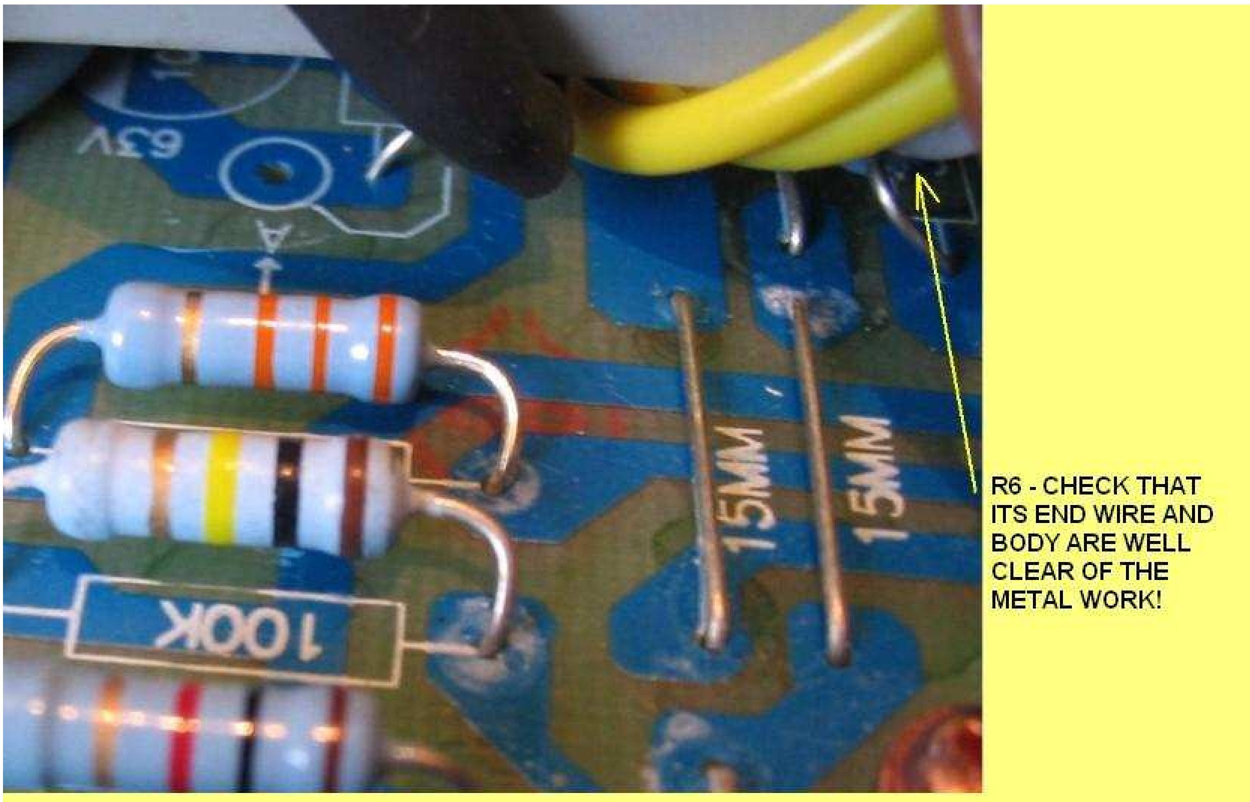
USE ZOOM 200% TO SEE MORE DETAIL

A New Build Quality Issue

From audiokarma.org member TonyMc.
I have been having an issue with my Yaqin since I bought it that I finally figured out last night. I noticed that the L channel would cut out once in a while. I thought it was a bad cable so I swapped it out and all was well until last night it did it again. So now being a bit more concerned I took the amp to the ol' work bench and opened it up. I looked at the RCA in-puts and all looked well. The R and L sockets are one unit on a black plastic block then soldered to a small circuit board and plugged into a couple of nice computer style cables, all very clean. The layout of the amp looks very nice so I could not figure out what the problem was. Then I saw what looked like a hair sitting in the chassis. Low and behold it was a piece of metal from the manufacturers putting the small machine screws in the aluminium side rails. I found a couple more and then a couple more so I grabbed a small light to shine under the RCA circuit board and what do you know... One of those little shards of aluminium was touching the little pin for the L RCA tuner jack that comes out of the bottom of the circuit board.
So far all is well since removing all loose shards.

R6 (And it being a suspect for LH Channel failure).

Yes, R6 is part of the bias circuitry and that associated with V3, the lower EL34 on the left hand channel. This resistor is not mounted in the visible area of the circuit board but rather mounted beneath the power transformer. You can just see one end of it in the following photo.



If R6 (33k) was shorted to chassis the grid bias voltage could be dropped from say -35V to -23V. Looking at the EL34 graphs, the EL34 anode current could rise from 35mA to over 200mA and places the anode dissipation well (and I mean well!) over the dissipation curve. It only takes a few moments to check and could save you a lot of bother later on.

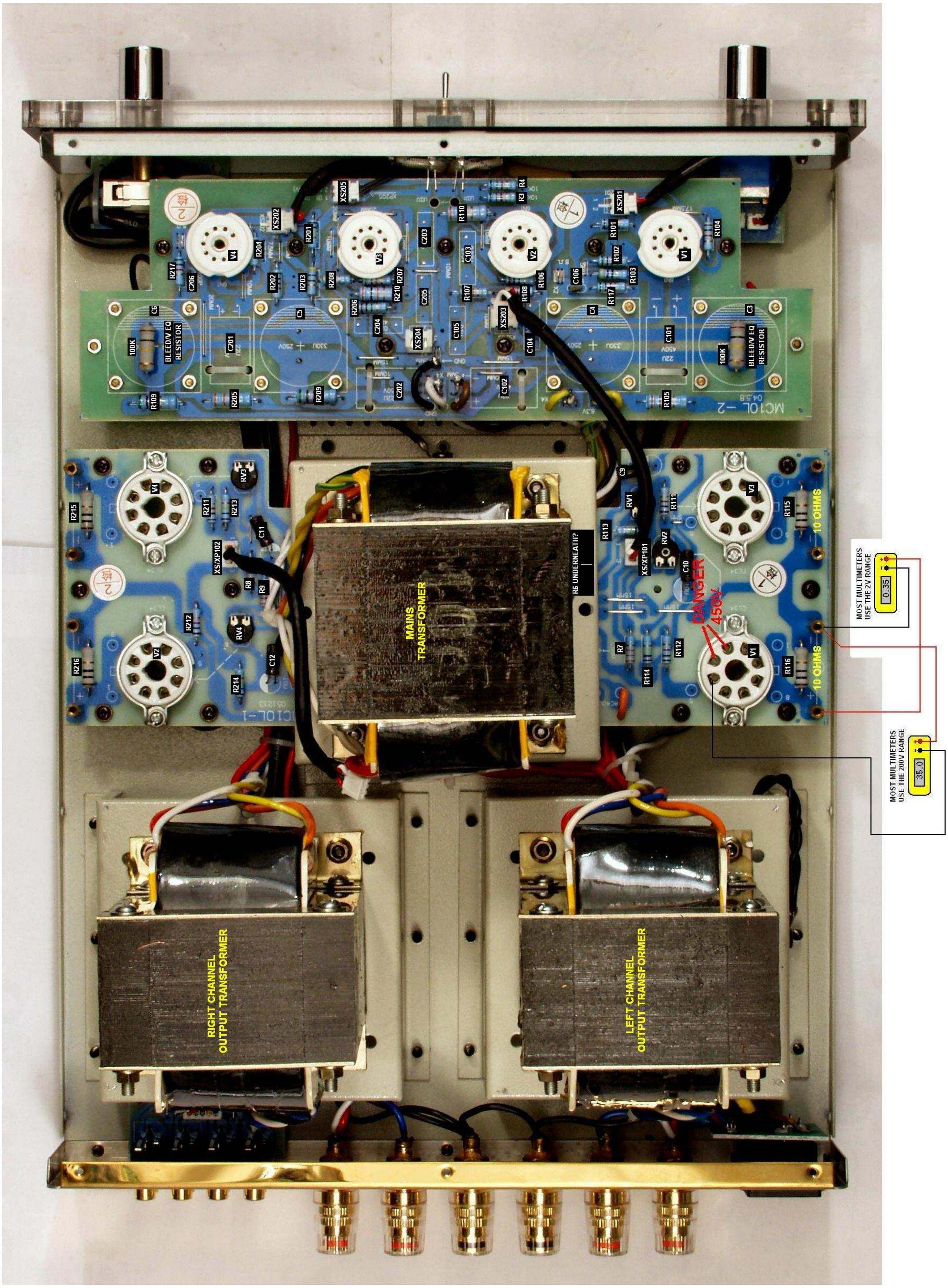
Quickie fault finding tests.

It sometimes helps to be able to isolate stages when trying to locate a fault. In most cases of course, a fault in the power stages usually shows itself by lots of smoke and some components trying to glow like the valves☺.
The following helped an owner locate a fault due to wire whiskers shorting out the left hand channel audio. Having no Left Channel output, he first tried plugging the right hand preamp/splitter output to the left hand channel by swapping over the feed cables associated with XS203 and XS204. The cable lengths allowed him to temporarily connect XS101 (Left hand output stage - IN) to XS204 (Right hand preamp/splitter output). Having now obtained audio on the Left Channel, proving that the Left output stage was OK, he then put all the former plugs and sockets back into their proper places. He then tried swapping XS205 (Right hand pre-amp input) into the board connector usually fed by XS201 (Left hand pre-amp input). He found that this rewarded him with audio and thus suggested the fault was indeed in the circuitry before XS201, whereupon he found shorting wire whiskers on the input selector switch. The same technique could be used if you suspect a fault in either of the channels preamp/splitter stages as well as the input circuitry.
I hope the above proves to be a useful tip for you.

Later MC-10L Models.

As mentioned earlier, there now seems to be a Mark II and Mark III version in addition to the new arrival MC-10T.
The Mark II did away with the four high voltage smoothing capacitors showing above the top panel, these being hidden below out of sight. The 100k voltage equaliser/bleeder resistors were added at the same time and there was some slight adjustment in layout of components on the left and right hand output circuits. To avoid the necessity of having to remove the top panel to reset valve biases, access was made to the measuring points and at the same time extra access points for adjusting the preset bias controls.
The Mark III appeared to be identical except that the mains toggle switch was replaced with a push button type and some amplifiers came with aluminium front panels instead of the Black plastic ones.

Later circuit board layout with component identification.



Front View of the later MK.III model with push button supply switch and silver front panel.

THE MC-10T

The following photo was taken from the Yaqin web site and advertised as the MC-10T.
It appears physically identical to the one shown above.

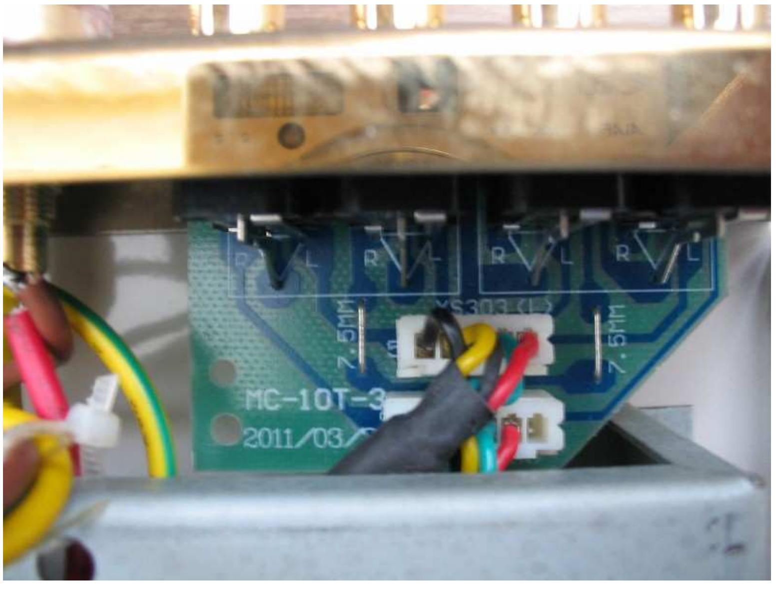
The MC-10T appears to be similar to a MC-10L Mark III except that the 6N1 valves have been replaced with 12AT7. What sonic improvements are to be gained from this change is uncertain, it would leave the input valves without an internal screen and I am not too certain about the difference between the Heater to Cathode maximum voltage ratings.

I had the chance to look into the MC-10T and took a few photographs, the one I had to review had a Black front panel like the original MC-10L. Basically it is also the same circuit as the MC-10L, even the output transformers are labelled 10L. The only component changes I could see were the LED feed resistors going from 10k to 6k8 even though the board is silk screened 10k. I guess Yaqin wanted a brighter Logo light but it has the advantage of Blue light leaking out to shine on the bases of the centre two 12AT7's, kind of cool!

The HT (B+) balance resistors across the smoothing capacitors are increased from 100k 2W to 150k 2W. If it wasn't for the heater wiring being different you could plug 12AT7's in place of the 6N1's on your MC-10L. As mentioned earlier, the 12AT7 does not have an internal screen like the 6N1, instead pin 9 is used to centre tap an otherwise 12V heater on pins 4 & 5. By connecting pins 4 & 5 together as one heater feed and using pin 9 as the other heater feed then you could do it. The amp gives a clean 45W per channel before the peaks start to round off, both + and - peaks rounding nicely at the same time and the output started to fall as we approached 100kHz! There is now a voltage selector on the rear panel for US/Europe power and a significant amount of extra Earthing has been incorporated.

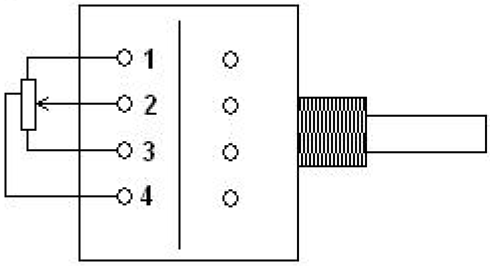
MAINS INPUT AND VOLTAGE SELECTION SWITCH

It was nice to see that metal structures carrying mains supply, like the mains transformer mount, has its own separate Earth connection. There are no screen grid resistors on the EL34's which I would have liked to see. Also the 4 channel inputs are still lumped together which may give crosstalk problems.



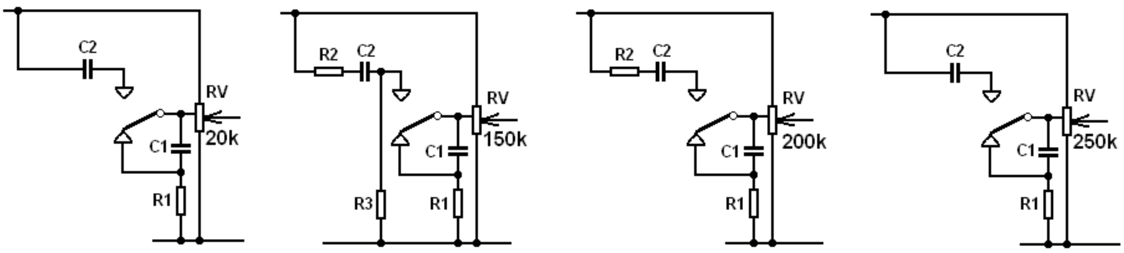
The only slight defect with this MC-10T is the ALPS? Pot. It is a 20k control but whilst the Left Channel measures 20.3k the Right Channel measures 21.5k. This is well within the specification for this potentiometer but the difference results in one channel being 2dB louder than the other! Wiring both channels from just one side of the control gives equal output so the problem appears to be with the control and not the amp. Normally these controls are much better matched but this control was different from the norm

The control fitted had 4 rather than 3 legs per side. I am going to have to check my MC10-L next time I open it for a service check. It is intriguing to find a control with an apparent Loudness Tap? Now this opens up some questions as I am sure I read somewhere that a resistor has to be inserted in normal use between leg 4 and leg 1 (Ground) else the control does not perform in true Logarithmic fashion? I will have to try to get confirmation on this but no doubt a reader can shed more light? Anyway, the presence of the Loudness Tap does perhaps allow the option of fitting a loudness switch, to boost Bass and Treble for low listening levels. I suppose if you left C2 out of circuit you would just get Bass boost.



Exactly what component values you would use all appear to be different even though the 3dB point seems to be very similar. The B&O and NAD are both 328Hz, the Sansui is 272Hz (similar to early Kenwood's), the Luxman is 161Hz and the Pioneer is 482Hz. Personally I would try for 195Hz as I have been told this is a nice point to aim for and C1 would be 68nF and R1 12k. If indeed the control has a Loudness Tap then some experimentation could be in order here, but where would one fit the switch!

None of this has been tried! More food for thought – I'm a devil – I know!



RV at 20k
B&O C1 = 4u7uF
R1 = 100R
C2 = 3n3
NAD C1 = 220n
R1 = 2k2
C2 = 1n8

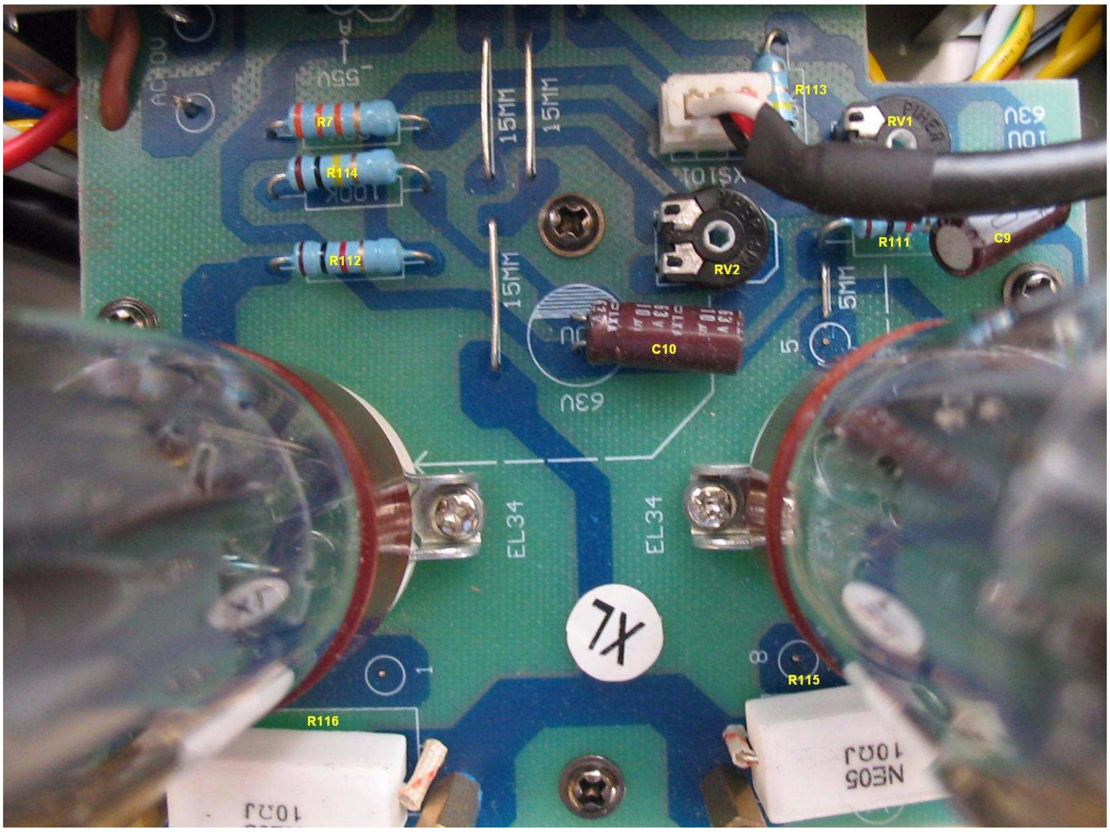
RV at 150k
SANSUI
C1 = 39n
R1 = 15k
C2 = 510p
R2 = 22k
R3 = 1M

RV at 200k
LUXMAN
C1 = 82n
R1 = 12k
C2 = 220p
R2 = 27k

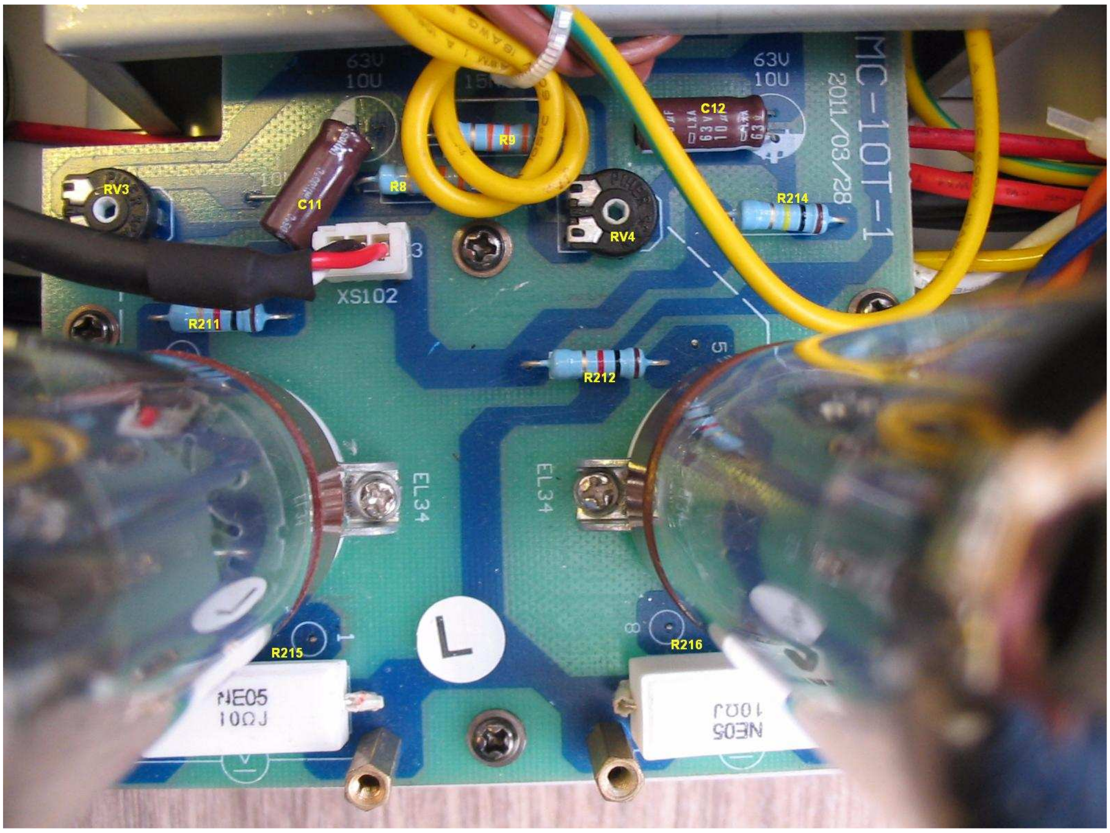
RV at 250k
PIONEER
C1 = 22n
R1 = 15k
C2 =180p

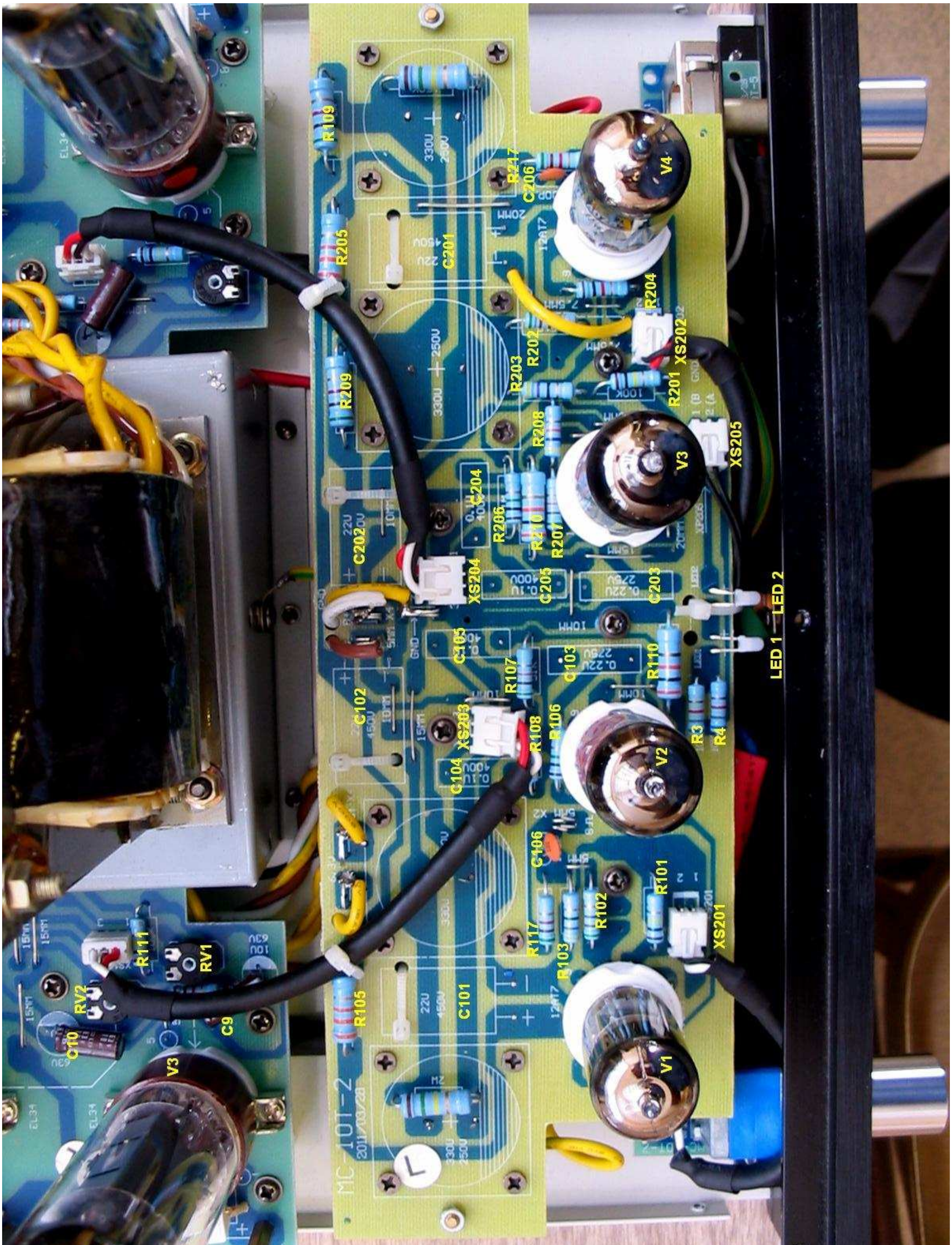
Because the circuitry of the MC10-T is virtually identical to the MC10-L, the same component identifiers can be used.

LEFT CHANNEL OUTPUT



RIGHT CHANNEL OUTPUT




R109
R205
R209
C202
XS204
C105
C102
XS203
C104
R105
C101
R217
C206
C201
R204
R202
XS202
R203
R201
R208
V4
V3
XS205
C204
R206
R210
R207
C205
C203
LED 2
LED 1
R107
C103
R110
R108
R106
R3
R4
V2
C106
R101
R102
R117
XS201
R103
V1
R111
RV1
RV2
C9
C10
V3

Turn a MC-10L into a MC-10T?

So the next burning question? Can you modify a 10L into a 10T?

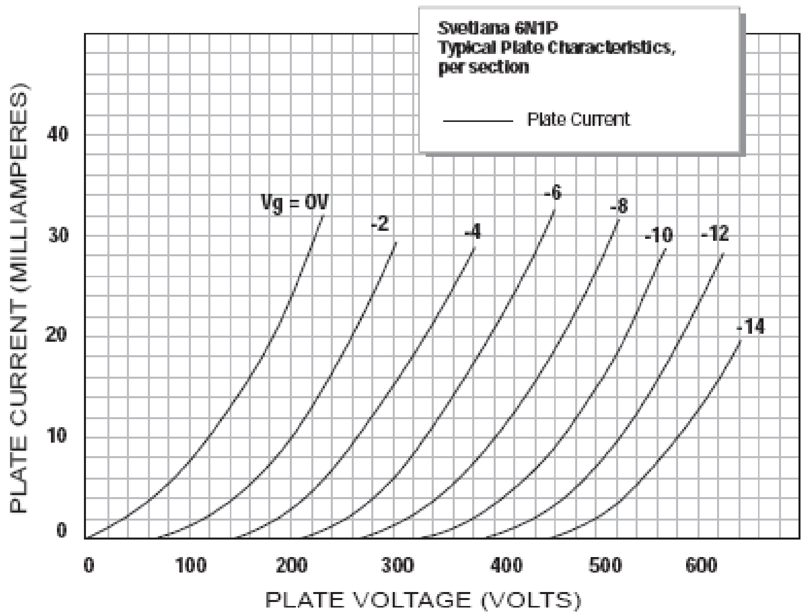
Well Matthias Günther had a try at this too! Well I think you would after removing the base plate for the heater lift mod wouldn't you?

After rewiring the heaters and fitting 12AT7's he remarked "The amp sounds very sweet with 12at7eh, new production, nothing special. Also very dynamic, 6n1 were cold, sterile and boring in comparison."

Basically, you have to lift the front circuit board and locate Pin 9 on each of the valve holders. This will be connected to the Earth Tracking and has to be well isolated. Next look to the valve holder Pins 4 and 5, these will be carrying thick heater wiring. You have to remove the wires from pin 5 and relocate them onto the now vacant pin 9. Next you need to apply a shorting link so that pins 4 and 5 are connected together. When you have done this you can insert the 12AT7 valves and you will have a MC10-T!

Basic Valve (Tube) Data.

Svetlana 6N1P
Dual Audio Triode



SVETLANA TECHNICAL DATA

6N1P
Dual Audio Triode

The Svetlana™ 6N1P is a miniature glass-envelope small-signal dual triode intended for use as a line-level amplifier or driver in high-quality audio amplifiers. Except for higher heater-current consumption, it is a direct plug-in replacement for the 6DJ8, ECC88 or 6922 in most high-level audio applications. Features include very low distortion—optimized for line stages; medium transconductance; internally shielded between sections, allowing their use at differing signal levels; higher plate-voltage and dissipation rating than 6DJ8 types; and larger cathode than 6DJ8 types, giving it longer life and more transient current capability.

Characteristics

Electrical

Cathode	Oxide-coated, unipotential	
Heater voltage (AC or DC)	6.3 volts AC or DC (±0.6 volts)	
Heater current	600 mA ± 35 mA	
Heater-cathode voltage	±100 volts peak	
Amplification factor (nominal)	33	
Transconductance (nominal)	7500	µS
Plate resistance (nominal)	4400	ohms
Interelectrode capacitances (typical), per section, with cathode grounded:		
Grid to cathode	3.2	pF
Anode to cathode	1.5	pF
Grid to anode	1.6	pF

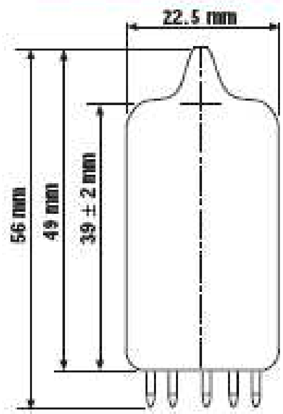
Mechanical

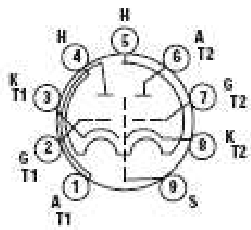
Base	standard 9-pin miniature, glass button
Basing diagram	JEDEC 9AJ
Socket	9-pin miniature
Operating position	Any
Nominal dimensions:	
Height of glass envelope	49 mm (1.93 in.)
Diameter of glass envelope	22.5 mm (.88 in.)
Overall height	56 mm (2.20 in.)
Net weight	15 g (.50 oz.)

Maximum ratings

Anode voltage, DC	250	V
Anode dissipation, per triode	2.2	W
Cathode current, continuous, per triode	20	mA
Maximum grid-circuit resistance	0.5	megohm

Svetlana Outline drawing





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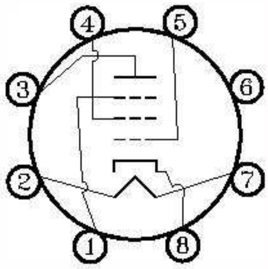
EL34 Output Valves

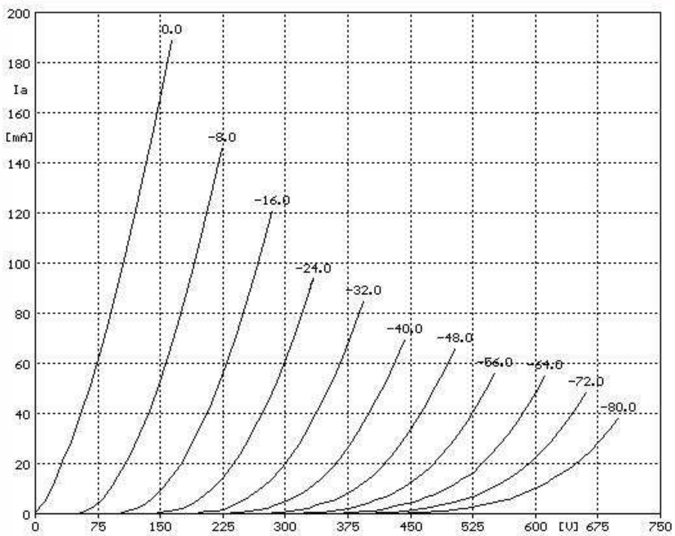
The EL34

Specification and max ratings(*)

Filament Voltage	6.3 V
Filament Current	1.5 A
Plate Voltage (*max*)	800 V
Plate Current (*max*)	140 mA
Plate Dissipation (*max*)	25 W
Screen Voltage (*max*)	425 V
Screen Current (*max*)	50 mA
Screen Dissipation (*max*)	8 W



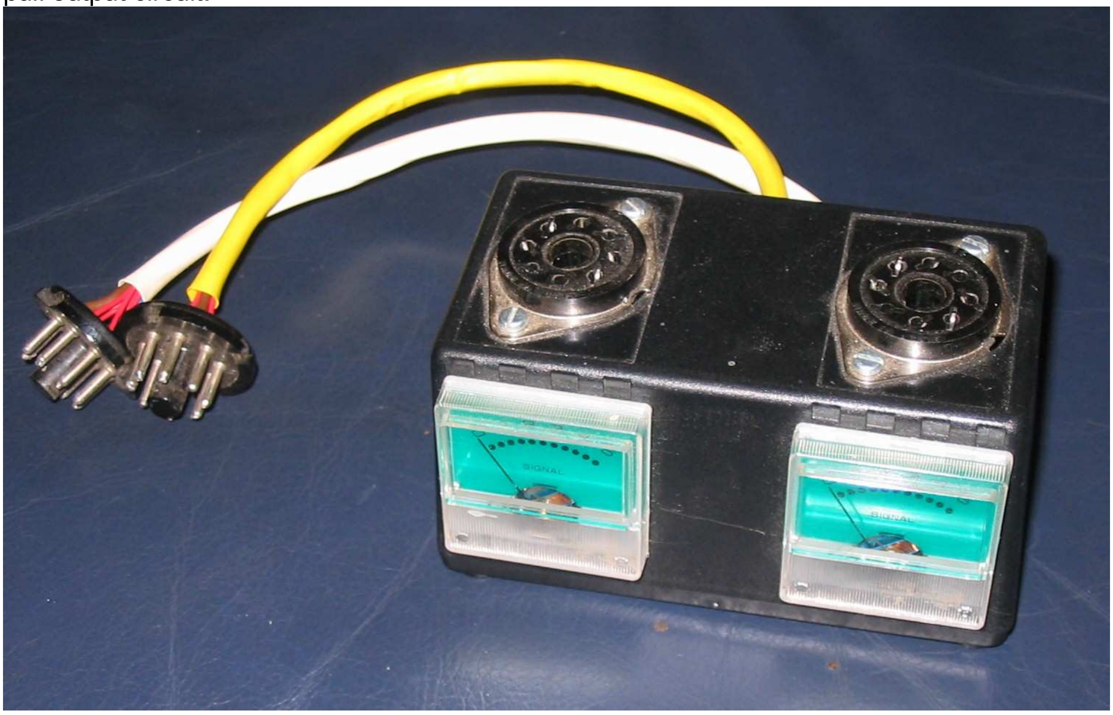
(*) These specifications are provided 'as-is', with no warranty of any kind. Use of these parameters shall be entirely at the user's own risk.



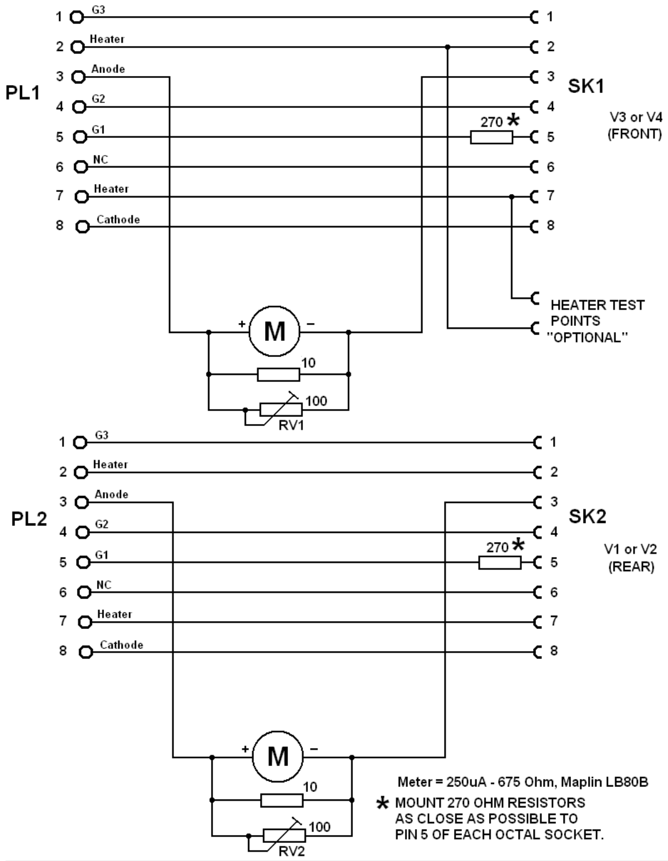
EL34 triode mode connection.

Bias setting box

More of an addition rather than a modification, I made a handy bias setting box which enables you to set up both EL34's on one channel at a time. I repeat the safety notice here about how I made some suitable plugs using the bases obtained from some defective valves. However, it would be more prudent, safety wise, to use the correct fully insulated moulded plugs if you can obtain them. The bias setting box is shown on the next page, it is easily calibrated using a simple DC power supply and allows you to see what is happening on both halves of the push-pull output circuit.



The meters are very cheap moving coil units, there accuracy is not important as each is set by a trimming resistor to be accurate at one setting, normally 35mA flowing to show 3.5 on the 0-5 scale.



Meter = 250uA - 675 Ohm, Maplin LB80B

* MOUNT 270 OHM RESISTORS AS CLOSE AS POSSIBLE TO PIN 5 OF EACH OCTAL SOCKET.

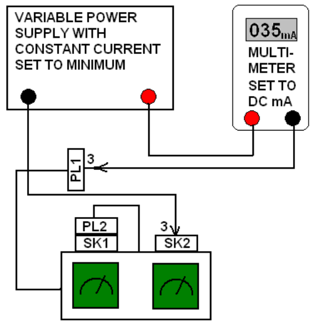
CALIBRATION

CONNECT PL2 INTO SOCKET SK1.

CONNECT A POWER SUPPLY WITH CONSTANT CURRENT CONTROL SET TO MINIMUM, TO PIN 3 OF PL1 VIA A MULTIMETER SET TO READ 200mA

CONNECT POWER SUPPLY 0V TO PIN 3 OF SK2, THUS PLACING BOTH METER CIRCUITS IN SERIES.

ADVANCE POWER SUPPLY SLOWLY, WHILST ADJUSTING RV1 & RV2 SO THAT AT 35mA SHOWN ON THE MULTIMETER, BOTH METERS M1 & M2 HAVE THEIR POINTERS CENTRED ON THE DATUM SPOT BETWEEN 3 & 4 ON THEIR SCALES.



IF YOU WISH TO SET YOUR VALVE CURRENTS HIGHER, SAY 40mA, THEN IT IS RECOMMENDED THAT THE METERS ARE CALIBRATED AT THIS FIGURE INSTEAD OF 35mA, PLACING THE METER POINTERS ON THE DATUM SPOT 4 ON BOTH METERS. THIS IS RECOMMENDED AS THESE CHEAP METERS ARE NOT PARTICULARLY ACCURATE OVER THEIR SCALE RANGES. FOR EXAMPLE, THE FOLLOWING FIGURES WERE OBTAINED AFTER CALIBRATING AT 35mA.

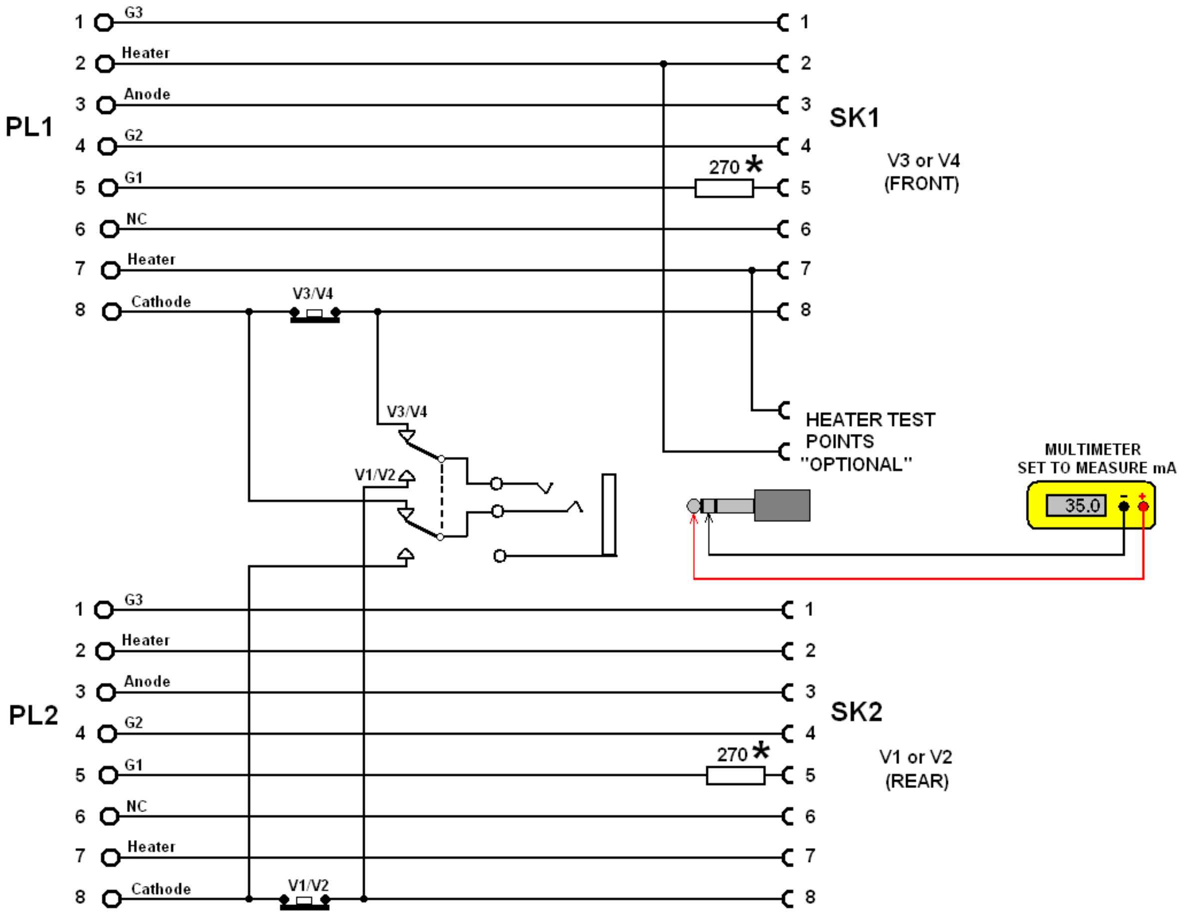
METER SCALE	ACTUAL CURRENT
0.5	5.6mA
1.0	10.7mA
1.5	16.2mA
2.0	20.7mA
2.5	24.8mA
3.0	29.5mA
3.5	35.1mA
4.0	44mA
4.5	54mA
5.0	66mA

I GUESS YOU GET WHAT YOU PAY FOR!

SAFETY NOTE: THE PHOTO SHOWS OCTAL PLUGS MADE UP FROM OLD FAULTY OCTAL VALVES THAT HAD ALL 8 PIN POSITIONS IN THEIR BASES. FOR HEALTH AND SAFETY REASONS, ONE SHOULD ENDEAVOUR TO USE THE TYPE OF OCTAL PLUG THAT ALLOW SCREW COVERS TO BE FITTED.
NEVER FIT OR REMOVE VALVES AND PLUGS WITH THE AMPLIFIER SWITCHED ON. ALWAYS ALLOW SUFFICIENT TIME FOR HIGH VOLTAGES TO DECAY BEFORE REMOVING EITHER PLUGS OR VALVES. FINALLY, MAKE SURE YOU FIT CORRECT VALVE INTO ITS SOCKET WHEN TRANSFERRING FROM MONITOR BOX TO AMP.

If you do not have a power supply that has constant current control then you can place a fixed resistor of 120 Ohms in the positive supply line of a variable 0 – 6V power supply. If when setting up the bias in the MC-10L you experience oscillation taking place, then increase the 270 Ohm Grid Stopper to 1k Ohm though I have tried numerous valves with 270 Ohms and not experienced any problems.

Here is a poor man's version using a standard external Multimeter and a stereo jack plug.
The switches maintain circuit continuity until depressed when the Multimeter takes over.



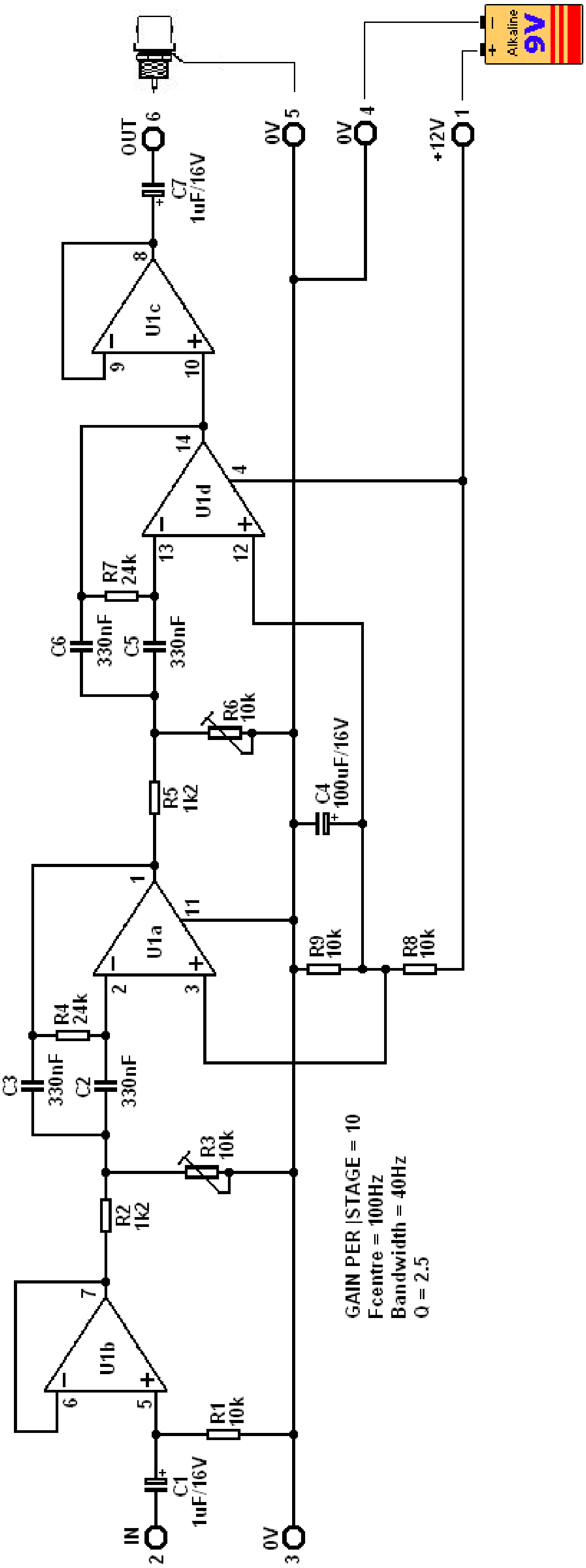
I suggest the toggle switch is mounted so it operates side to side with the toggle pointing to the correct push button switch.
This may avoid accidentally open circuiting one of the valves.
You must also make sure of course that the Multimeter is set to its mA range.

Being too Purist?

I decided I was going to get my amplifier output circuit's balanced spot on!
What am I saying? Well the idea is to get equal but opposite standing currents flowing in the output transformer so that the chances of core saturation are at a minimum and maybe, just maybe, the sound might show some improvement, not that it really needed it! Setting the bias voltages exactly the same does not work due to the fact that the windings of the output transformer will have differences.
Anyway, the way to do it is to have no input to the amp, Volume set to minimum and monitor, one at a time, each channel for 100Hz ripple (120Hz in USA or elsewhere on 60Hz supply).
The bias is set correctly for both valves after which a tiny shift in bias is applied to one valve, just slightly up or down, for minimum 100Hz (120Hz) output.
My first attempts did not work for the simple reason that I was getting too much high frequency noise pick up due to my location, not helped by having mobile phone masts right above my flat. So I constructed a cheap and cheerful 100Hz Filter. Originally I used 4k7 for R3 and R6 (1k5 for 60Hz supplies) but then fitted 10k Trimmers so that I could peak the filter, probably being too purist again!

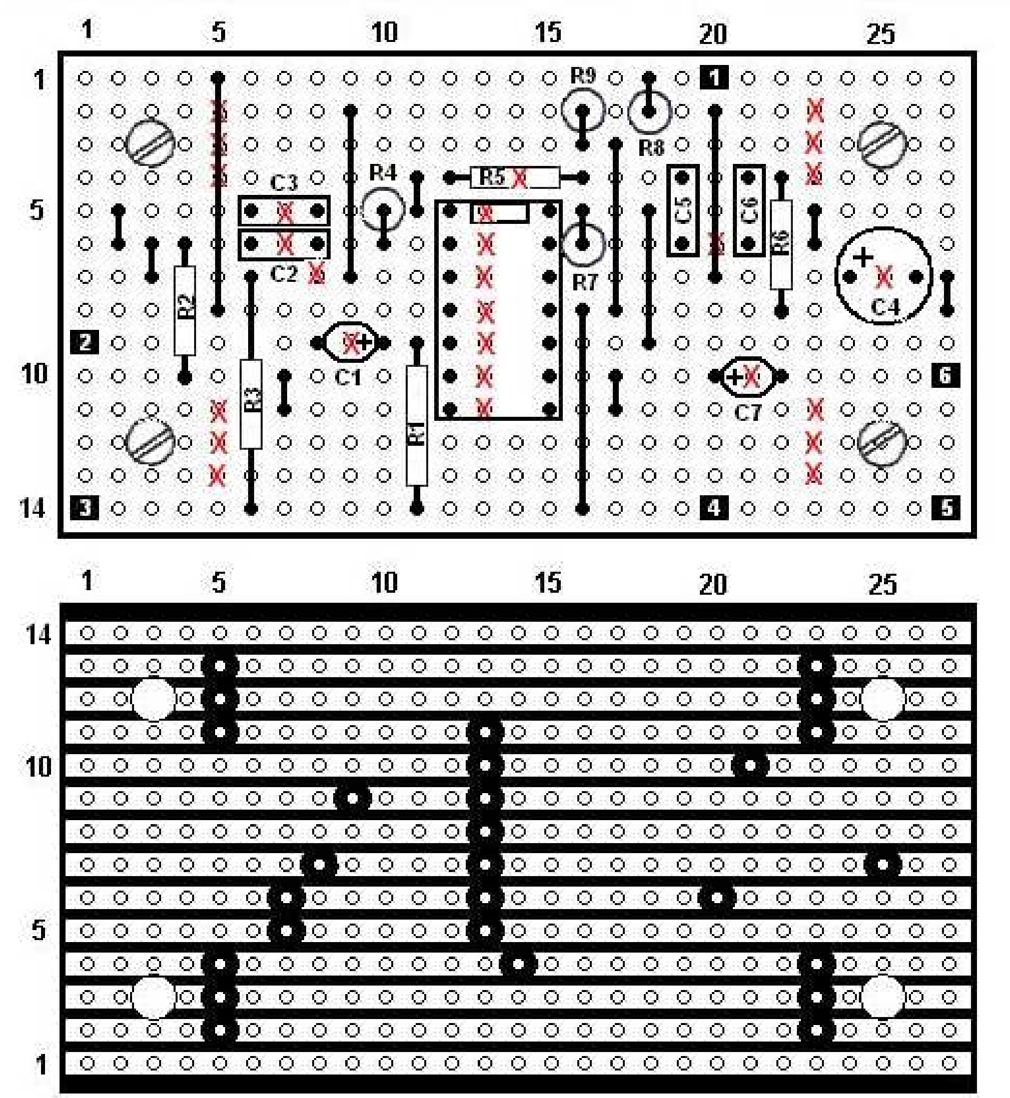
The other change I hope to look at later is checking and setting the two drive signals from the phase splitter to ensure they have equal and opposite levels.
The filter box should come in handy here as well, because for setting this up we inject 100 Hz (120Hz if you set the filter for this frequency) and adjust the phase splitter outputs for a MAXIMUM output.
Perhaps it may prove useful to add a double pole toggle switch to the filter. This would select either the mains frequency (50 or 60Hz) or the ripple frequency (100 or 120Hz). Thus we could use mains pick up to adjust the phase splitter outputs and avoid extra test equipment.

The Filter Circuit

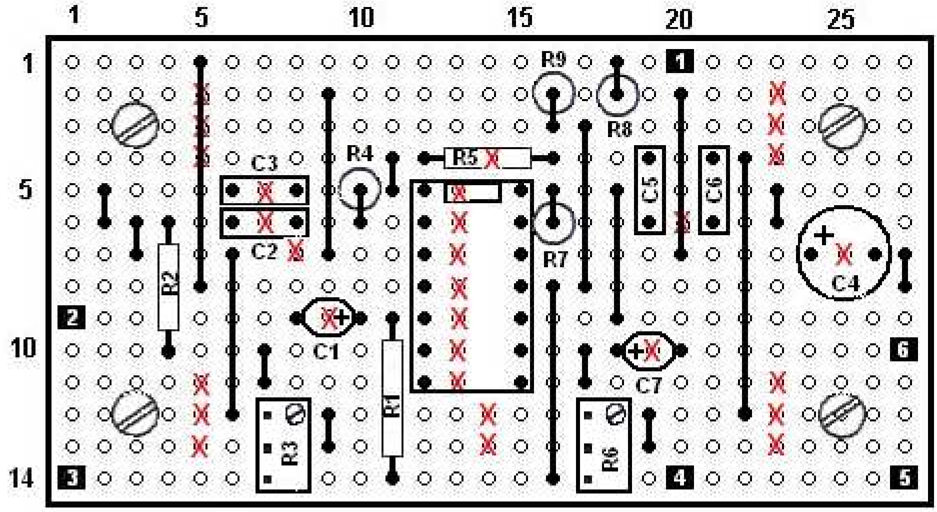


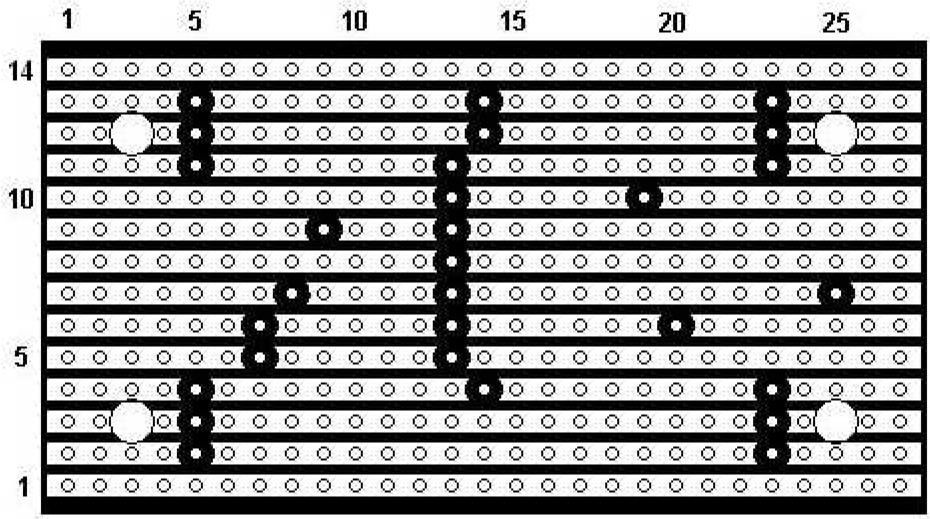
Thanks to the use of the LM324 Quad Op-Amp, the supply can be as low as 6V so a standard 9V 6LF22/6LR61/MN1604 battery works fine.
U1b acts as a buffer/voltage follower so that the applied input impedance does not upset the first band pass filter stage. Two identical stages are used formed around U1a and U1d with U1c acting as another buffer/voltage follower. R8 and R9 establish the half rail supply required for correct AC operation of the amplifiers, isolated on the output by C7.
Each stage has a gain of 10 and designed to give a bandwidth of 40Hz centred on my chosen centre frequency of 100Hz.
The Q of the circuit is approximately 2.5 for the 100Hz filter and 3 for the 120Hz one.
For the prototype 100Hz filter, the actual calculated value of R4 and R7 was 24k1 and that of R3 and R6 was 4k8. I used the nearest values of 24k and 4k7 respectively which resulted in a slight error but not considered too important. The actual filter peaked at 98Hz and its -3db points spanned 38Hz being positioned at 72Hz and 110Hz.

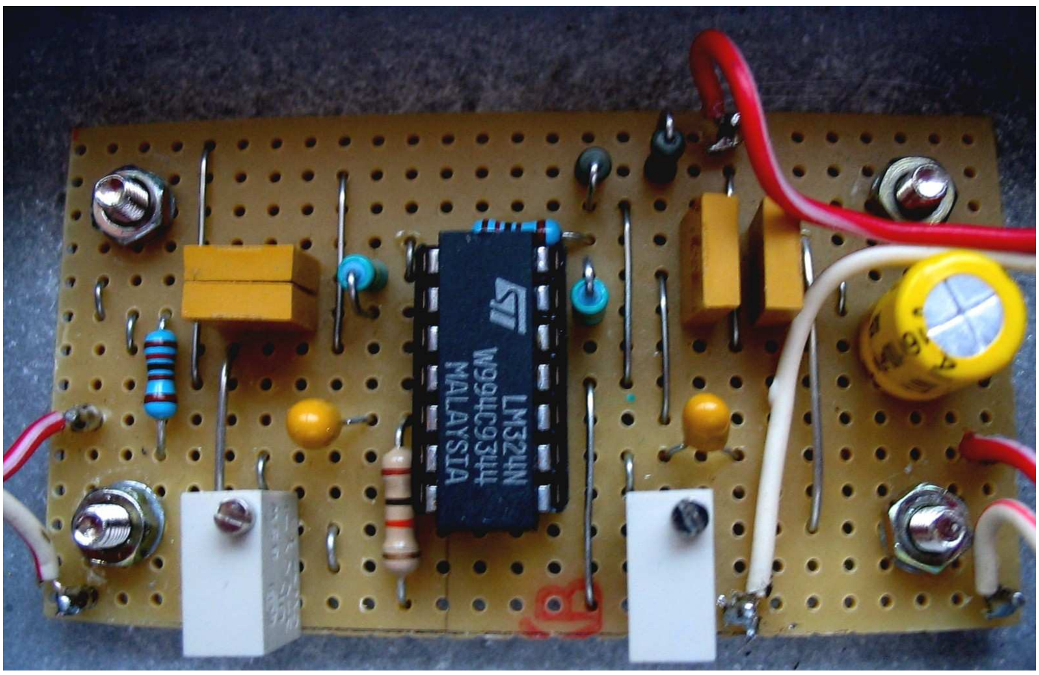
Board Layout



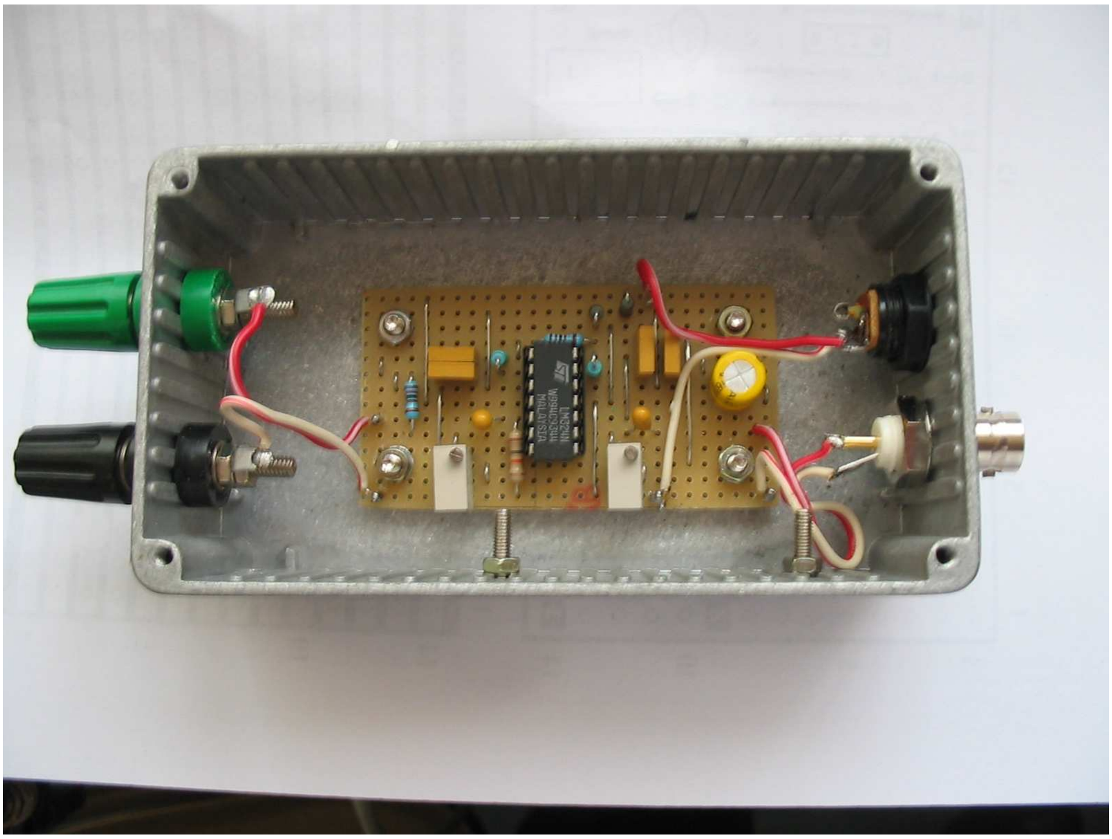
Here is the later board where I used adjustable resistors (10k) for R3 and R6.







I constructed the unit into a painted die cast box measuring 120mm x 60mm with a depth of 40mm.
Input from the speaker terminals is at pins 2 and 3 (0V); you should keep your speakers connected for the tests but this may make a problem. What happens is that the loudspeaker can act like a microphone and make measurements erratic. It is better to use a fixed dummy load resistor instead; the same value as your speakers e.g. 8 ohms, which can now be removed. The resistor does not have to be of a high wattage rating as the amplifier is not being driven for these tests. A scope or RMS Voltmeter is connected to a BNC socket wired to pins 6 and 5(0V). The RMS Voltmeter could be substituted by a sensitive AC voltmeter as no actual value measurement is taken. Only the amplitude needs to be observed and the meter should ideally have an analogue display so that trends in amplitude can be more readily observed.



Here is a repeat of the procedure:
Substitute fixed resistors for the loudspeakers e.g. 8 Ohms
Have no input to the amp (Volume control at minimum), monitor left hand channel for 100Hz ripple (120Hz in USA or elsewhere on 60Hz supply).
Set the bias correctly for both valves and then set the bias on one valve just slightly up or down for minimum 100Hz (120Hz) output.
Repeat procedure on the right hand channel.

Labels: For 100Hz Ripple

100Hz Filter/Amplifier
Connect Black Terminal to Amplifier Speaker Common. **Connect Green Terminal to Speaker Output.** **IMPORTANT! Keep Speaker Connected.** **Connect Oscilloscope or RMS Meter to BNC and apply DC power, Centre pin is Positive.** **Adjust bias for both valves then slightly adjust one of the bias controls for minimum 100Hz signal.** **Your amplifiers output stage is now correctly balanced.**

For 120Hz Ripple

120Hz Filter/Amplifier
Connect Black Terminal to Amplifier Speaker Common. **Connect Green Terminal to Speaker Output.** **IMPORTANT! Keep Speaker Connected.** **Connect Oscilloscope or RMS Meter to BNC and apply DC power, Centre pin is Positive.** **Adjust bias for both valves then slightly adjust one of the bias controls for minimum 120Hz signal.** **Your amplifiers output stage is now correctly balanced.**

For a pair of 4mm input terminal posts.

SPEAKER	**COMMON**

For the BNC output socket and a DC input Jack**.**

OUTPUT	**DC +9 to +12V**

To be continued: