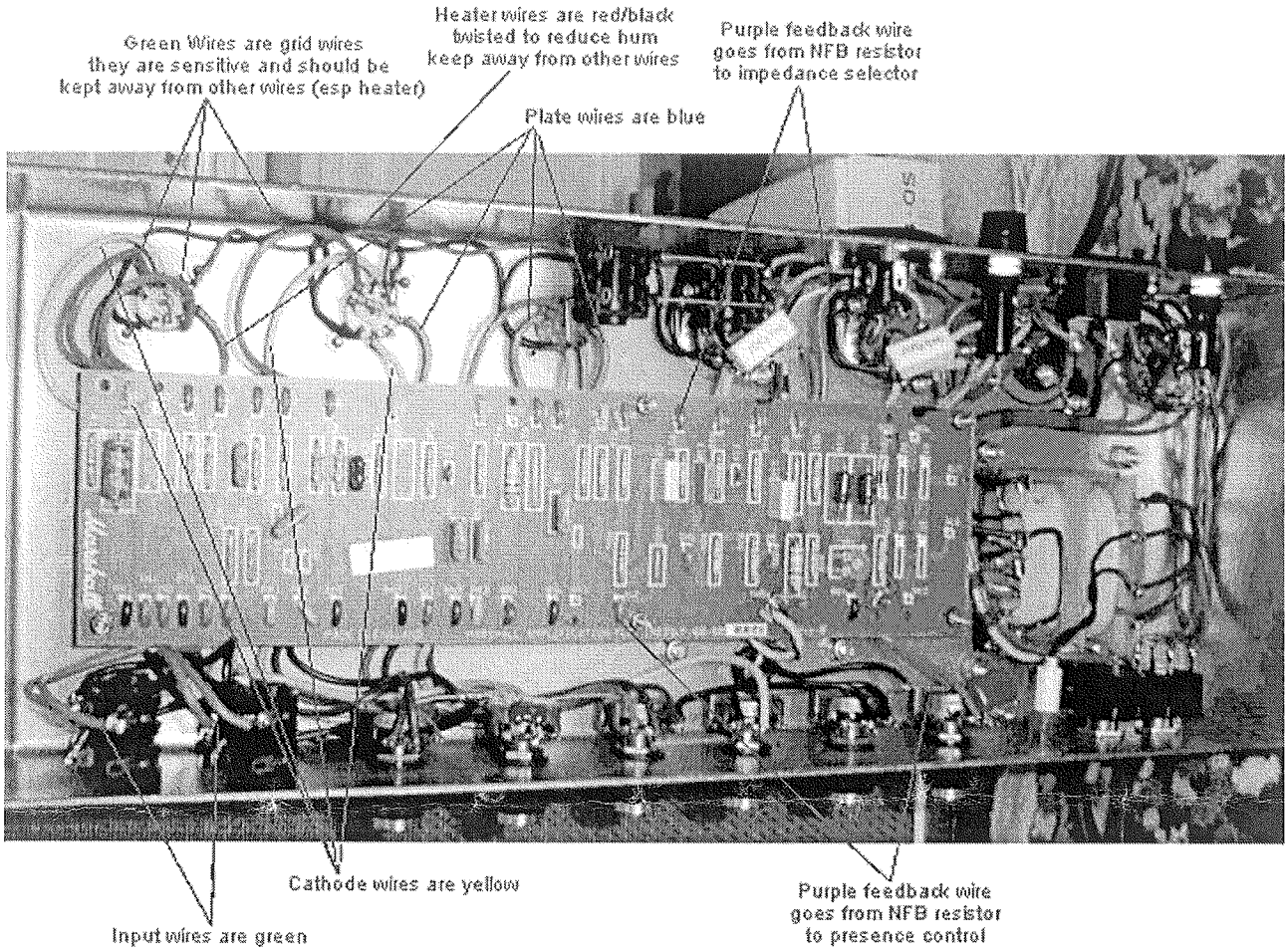
1995 JTM45 Reissue Wiring
Standard Marshall Color Scheme



1st Stage Rk/Ck

This is the first Stage cathode resistor and cathode bypass capacitor (k for cathode). The first stage is defined by tube V1. The two triodes in V1 (V1A and V1B) are used for the 1st stage of the Normal and Treble channels respectively.

This is a big part of the difference in tone between the early amps like the JTM45 and the later lead amps such as the model 1987. The early amps and later bass amps used the shared cathode circuit: a single resistor and bypass cap shared by both sections of the first pre-amp tube. The plexi lead amps and later amps used two seperate resistor/capacitor combinations to give the two channels more divergent tonalities.

In the shared cathode arrangement, current from both channel stages is flowing through the one Rk, so it is theoretically biasing each channel as if it has a single Rk of twice the value (connect these in parallel and you have the shared resistor value). So 820 ohms shared is like 1640 ohm Rk on ChI or ChII separately, when the cathodes became split, CHII got more gain in the first stage from the deal than before, even with the same nominal value of 820 ohms.

1st Stage Normal Channel

The cathode resistors are there to bias the preamp tubes. Going from 820 to 1K or 2.7k will decrease the gain and give a cleaner sound. Going much smaller than 600 or so ohms definately moves this stage into the non-

linear region and gives asymmetrical clipping. The cathode resistor works in conjuntion with the plate resistor to bias the tube. If you change either of these too much in one direction or the other, you'll get asymmetrical clipping as one side of the waveform clips before the other (more THD - not neccessarily gain). This is not necessarily a bad thing. Now, add a capacitor, and you get even more gain. A small capacitor like Marshall's .68uF boosts upper mids and highs. The perceived effect of this cap is also increased with larger Rk values. A 25uF cap will boost all frequencies in the guitar range. The 330 or 350uF in Marshalls is overkill, boosting all frequencies down to a few hertz. The 1st stage normal channel cathode cap on the 820k resistor is 320uf on the 50 and 250 on the 100 watt. This value is so large already, that this doesn't make any appreciable difference.

Another thing to consider is that gain/voicing changes to the early stages of the amp will be propaged to (and multiplied by) the later stages. It's better to add gain throughout the amp and not all in one stage. This is the technique used in higher gain amps (4 and 5 gain stages).

1st Stage Lead/Treble Channel

A small capacitor like Marshall's .68uF boosts highs and mids. A 25uF cap will boost all frequencies in the guitar range.

Coupling Cap Between 1st and 2nd Stages

Using a 0.022uF (22n) coupling cap instead of the 0.0022uF (2n2) is a popular mod for more beef in Marshall Lead and SuperLead amps on the treble channel. The 0.022uF coupling cap forms 1st order high-pass filter with a cutoff frequency of 72hz. The 0.0022uF coupling cap forms a 1st order high-pass filter with a cutoff frequency of 720 hz (drops 6dB/octave below this freq).

The switch from 22n to 2n2 coupling cap at Ch I, .1uF to .02 coupling at the PI, V1 cathode caps, and other changes make the post '68 Lead amps thinner and brighter at any volume.

Mixer Bypass Cap

This capacitor in parallel with the mixer resistor for the bright channel forms a "short circuit" at high frequencies and lets the highs come through the mixer with less dB loss. The original Fender Bassman circuit used no bypass cap here. Changing the value of this cap, or removing it altogether can give a wide range of tonal options. The 470/500pF bypass cap gives an approximate corner frequency of 720 Hz for the 1st order low pass filter created.

Mixer Resistors

These two 470K resistors form a resistive mixer in which Channel's I and II are joined. There is also some loss of gain in the mixer, and in fact the original Bassman 5F6-A circuit used 270K resistors in this position. For a slight gain boost, you can use values lower than 470K here. To maintain a consistant tonality, if you change this resistor value you will need to "scale" the bypass cap (i.e. have the cut-off frequency for the low-pass filter remain the same).

Marshall changed from 270k to 470k resistors in mid '66 (even though 270k's did creap in after that date occassionally). The presence of 470k mixer resistors will date the amp to be post mid '66 (you can't really draw conclusive dating info from the presence of the 270k's). The exception is that 4 channel PA heads normally came with 470k mixer resistors.

2nd Stage Rk

This is a "classic" plexi mod that sounds nice and thick. In most plexi amps and metalfaces up thru around '72 there is a .68uF capacitor bypassing (parallel) this resistor. The MK II amps (post '73) didn't have this cap. This boosts the gain of the stage and gives a mid-high boost which can thicken up leads nicely. You can install this capacitor with a switch to bring it in and out of the circuit.

My '72 50 watter (above) didn't have this cap either. My '72 50w has a 100k NFB resistor attached to the 4 ohm

tap (lots of power amp gain), that configuration does work well (sounds mushy) with the .68uF cap, so that's probably why the cap is not there.

Slope Resistor

The slope resistor is part of the tone network. It controls how the tone controls work. Also, the 33k slope resistor on these amps has a 500pf cap and the bass and plexis use 56k and 250pf. The 33k value (as opposed to 56k) has more gain in bass & mids. 33k also moves the resonant frequencies for the bass and mid tone controls slightly higher. You can even go to 16k for more bass and mid gain (and the overall frequency response flattens some).

Tone Caps

These three capacitors, the two bigger ones and the one square one (beneath the Slope Resistor) determine how the Bass, Treble & Mid controls work. One difference between a Super Lead Plexi and a bass head are the values of these three capacitors (and the Slope Resistor which works with them.)

Duncan Monro's Tone Stack Calculator FMV Tonestack

Output Coupling Caps

Are another component which gets modified or replaced a lot. The Lead amps used a 0.02uF here, where the Bass amps and JTM45 used a 0.1uF. The 0.1uF allows more bass to flow thru. These caps are located between the phase inverter and the power tube grids.

The switch from 0.022uf(22n) to 0.0022uF(2n2) coupling cap at Ch I, .1uF to 0.022uF coupling at the PI, V1 cathode caps, and other changes make the post '68 Lead amps thinner and brighter at any volume.

Bright Cap on Lead (Ch I) Volume

This capacitor acts to make the lead channel very bright at lower volume levels. As you turn up the control the effect lessens. By about halfway up the tone does thicken up a lot. You can remove this cap or change out it's value to lessen the effect. Also this cap is responsable for the volume jump when you first open the volume knob.

The .005uF bright cap on the Ch I volume pot replaced the 100pF bright cap in late '67 (before the other major changes in '68).

Bias Trimpot

This is where you adjust the bias current for the output tubes.

Biasing FAQ

Negative Feedback Circuit

Negative feedback is an out of phase signal fed back into to the amp to cancel out certain frequencies, designed to bring the amp out front more in the mix. The negative feedback circuit consists of the presence control potentiometer, feedback resistor and where the feedback resistor is connected. The negative feedback affects not only gain and frequency response but also dampening, a lot of tonal variation can be achieved, simply by changing out the value of this resistor or by changing which output transformer tap it is connected to. The output signal is fed back into the amp before the phase inverter and the presence knob controls the amount of negative feedback.

The negative feedback circuit was changed over the years by Marshall, from a large amount of negative

feedback, to less and less, over the years. Also the changes were not constant, but actually varied wildly at times.

The entire JTM series used 27K and 16 ohms. Pre '67 the 27k and 16 ohm combination was pretty universal, but there are several rare occurances of a small valued bypass cap across the 27k resistor (this would increase the bass, but have less overall gain). I believe this was changed to the 47k and 8 ohm setup for Lead amps only, circa late '67, even though there was still lots of variation from the factory. The NFB lead was normally connected to the 8-ohm tap in SL amps, to the speaker jacks in Bass and PA. In late '68-'70 some of the SuperLeads had the NFB connected to the far side of the impedance selector or directly to the speaker jacks (which made the NFB variable). The 100k resistor seems to begin appearing around '70, again Lead amps only. The Bass, PA, etc., retained the original NFB setup (even though there are exceptions).

Typically this depends on if you have a 50 watter or 100 watter. 50 Watters have a 47K on the 8-ohm tap and 100 watters have the 100K on the 4-ohm tap. They are *supposed* to sound the same but if you A/B them you'll hear a sonic difference. Be aware that there is lots of variation in Marshalls as they came from the factory, every now and then you'll see a 47K on the 16ohm tap (which is a lot of feedback) or a 100K on the 8ohm tap but those were pretty far and few between. Marshall used to experiment a lot in the 60's.

Using 100K will increase the gain and mids. Finally, The lower resistor value gives a bit more smoother sound, while the higher value gives more of a harder edge at the expense of smoothness. Larger value means less nfb, therefore more gain.

On some older Marshalls (like my '69) the negative feedback (purple) wire was connected to the speaker jacks, so the feedback varies depending on which speaker impedance is selected. The more negative feedback means less gain in the power section; less nfb means more gain. The 16 ohm tap is gonna have more voltage coming off of it than 8, and 8 will have more than 4, so you can control the overall gain of the amp by choosing which tap you use. Use 16 for the least gain, 4 for the most. Remember, this is only power amp gain, not preamp. Also, the Presence control will make more of a difference when there is more voltage to work with. So, if nfb is on the 16 ohm tap, Presence will seem to do more than if nfb is on 8 or 4.

A little known fact (and all the George Lynch follows may like this since he preferred the '73 hand wired heads) is that the common .1uF cap on the Presence pot was a .68uF cap resulting in a very cool "cut" to the upper mids that was not as harsh as the .1uF.

With the 100k feedback resistor, the 0.68uF cap bypassing V2a may be too much. With a 47k feedback resistor, it's just right though. My '72 has the 100k feedback resistor and no .68uF cap on v2a.

Bias Splitter Resistors

The bias splitter resistors, although we call them that for obvious reasons, they're really not just to adjust magnitude of the fixed bias voltage as I've sometimes heard; they also serve as grid resistors for the power section, required for the particular operating characteristics and appropriate functioning of the output tubes. The bias splitter resistors, along with the rest of the bias supply, controls the DC bias voltage of the (input) grid with respect to the plate voltage. Lower values of splitter resistors give more grind to the sound (browner).

Also the 70's Marshalls saw different bias splitter values. 82K, 100K, 150K and the common 220K. The smaller values will load down the preamp and roll off the top end. The 82K/100K was usually used when 6550's came stock in the amp. A lot of people had the 6550's switched over to EL34's and most techs didn't change the bias splitters which resulted in a little more preamp crunch and a "browner" sound to the top end. The 220K's are the classic value for use with EL34's.

It is also a popular place to install a master volume circuit. This type of MV is called a PPIV (post phase inverter) MV. In the PPIV MV, the phase inverter tube is included in the pre-amp distortion. Actually the phase inverter sound, when driven hard, really thickens up the amp sound and is a large part of what people normally refer to as power tube distortion (without the power tubes). In other words, the PPIV MV sounds like a cranked amp at lower volumes (unlike the pre-PI MV used on the 2203/2204 series).

Differences between PTP and PCB (MK II) amps

The important thing to remember (and this is where a lot of the myth about hand wiring stemmed from) is that half way through 1973 Marshall was still hand wiring the 1987-1959 models (aka plexi's) and about half way through that year they switched over to PC boards. When they switched over to PC boards *that's* when they stopped using the .68uF across V2A's cathode. The result was a lack of gain but Marshall claimed the design was not altered so people began to believe that hand wiring was the key to better tone, especially since the hand wired 73's sounded better (and also had more gain due to that cap). This is not a definative difference, because occassionally during the early 70's amp would appear without this cap. Probably because they ran out of stock. Marshall also switched from EL34 to 6550 tubes in the US.

Although the "MKII" circuit changes including smaller bias feed Rs from ca. beginning of '74 are often attributed to switch to 6550s in export models, I've come to believe that they at least predated that, maybe even undertaken for some other reasons. The 10/73 50W I mentioned above has the 82Ks splitters, .68 Presence cap, and some other revised circuit details, but I'm convinced it came with EL34s stock, it won't even bias most 6550s. It doesn't say MKII anywhere. I corresponded w/one guy who has a Lead from this time frame with all the MKII schematic circuit changes, but he bought it new in '74 in Australia, where Marshall never switched to 6550s at all.

Presence Control Change in MK II

This control changes from the single 5K-lin taper pot with a .1uF cap in '74 to a 22k pot and .68uF cap in parallel with a 4.7k resistor (same time as the start of the 6550/MK II change). This change was made to stop the control from making a "scratchy" noise, since in the original circuit there is some DC across the control. Some folks say there's a tonal difference and prefer the earlier circuit. It is very easy and cheap to try it out.

Bias Trimpot

The PCB amp has a bias pot standard.

Rk/Ck Lead Channel & Channel II

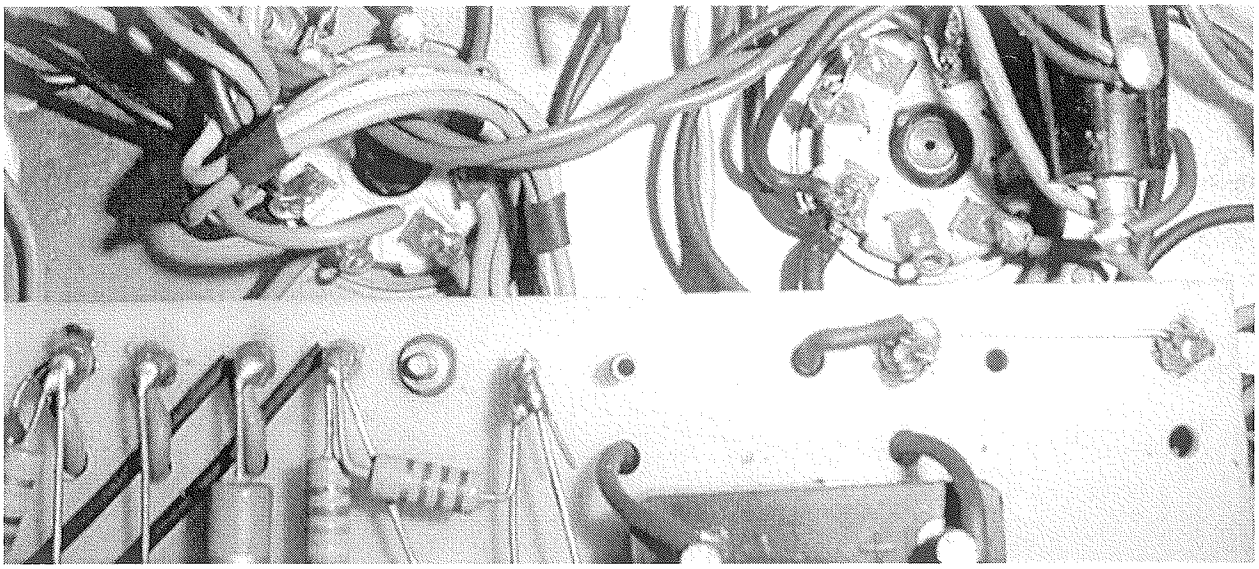
Here we see that the Rk/Ck combination has been seperated into two circuits with different values in the model 1987. Channel II keeps the values from the older amps (and 1986 amps) while Channel I gets a 2.7k paralleled with a .68uF. This leads to a brighter & "gainier" tone for the lead channel.

Screen Grid Resistors

Most of the older Marshalls did not have grid resistors. Back then they used Mullard EL34's that could handle up on 800V on the plates. Screen grid resistors are typically the 1K5W resistors that are mounted across pins 4 and 6 on the output sockets. Pin 6 is not used in the EL34 tube, so it makes a convenient mounting point for the grid resistors. The screen grid resistors limit the current that can flow thru the grid. They also have a safety function of burning out when the output tube shorts, instead of the transformer. So, if they look burnt, its best to replace them.

The 100 watters always had there resistors. But the 50 watters are a different story. They were not on my '72 50w PTP English model. But they are on my '76 50w US PCB model. They were also missing on a friends '76 Lead and Bass combo. I think that they started using these on the 50 watters for the most part starting around '73. If anyone knows more precisely, please email.

Notice that this '72 50w amp did not originally have grid resistors. It does now.



Purpose of Screen Grid Resistors

When screen grids are less positive than the plate (normal case), screen dissipation is usually minimized: electron flow is diverted toward the plate. So no dissipation problem unless the screens are misaligned (see below).

But in a classic pentode output stage, screen grid voltages are fairly constant. When control grid voltages go upward and the tube turns on, the plate voltages swing more negative than the screen grid. This leaves the screen grid as the most positive element in the tube. Screen current (and therefore dissipation) goes up, and is usually limited by the screen resistors. (Note that this is a dynamic (AC) condition, so screen resistors must be unbypassed to remain effective).

At lower volume levels, even the transient currents thru the screens are not a huge problem, but this depends on tube quality of course. Problems arise at higher volumes, as you would expect.

But the REAL problem occurs when that nasty Marshall impedance selector plug falls out, or if speaker load is much higher than it is supposed to be. Pentodes have a relatively high internal resistance, so the plate has to struggle a bit to pull down when connected to a 3K to 5K primary. BUT the 3K (or whatever) primary spec is counting on the specified output load! With speakers disconnected, the primary imp. (reflected back from the secondary) goes very high. Result: no more struggle for the plate to pull very low. Screens are then absorbing lots of current...and with no screen resistors they will easily burn.

Control Grid Resistors

Control grid resistors (also called Swamp Resistors) are used to get rid of unwanted oscillations (optional). These resistors also showed up on 100 watters since '68 or '69. I'm not as sure when. I haven't seen these on any 50 watters yet. If anyone knows, then e-mail me.

Resonance Control

This mod was first posted by Mark Cameron. It works on on Fenders and Marshalls with great results. It adds an extra knob (output jack holes work well for this). Basically, it is the opposite of a presence control, allowing you to tighten up the bottom. I will try to talk you thru the wiring. Looking at the back of a 1meg pot, left to right, numbering pins one two and three. Disconnect your purple feedback wire from the impedance selector and solder to pin three. Solder a new wire from the feedback resistor (where the purple feedback wire used to be connected) to pins one and two. Solder a .0047 cap from pin three to pins one and two.

Special thanks to:
Brian at http://www.marstran.8k.com/ for the schematic.
Wizard of Ozz at Marshall Amp Forum
Plexi Palace Marshall Forum
Rich from Les Paul Forum Amplifiers
Les Paul Forum Amplifiers
Trace at Voodoo Amps
Obsolete Electronics Marshall Tech
Bruce Clement's Chassis Pics
Ted Breaux
Mark Garvin
Psychodave
Mark Cameron
Jeff West

Return to Marshall Info Page
Return to Clay's Gear Page
Return to Last Words

Send e-mail to Clay: clay@redpt.com