Part 3- Negative Feedback

We will begin by continuing our discussion from Part 2.

I touched on bias, and how there are tradeoffs to consider when choosing just where it should be set. In a nutshell, the tradeoff we are dealing with, is between standby current and power dissipation in the output devices, against distortion, weak output, and overall bad sound.

Class AB amplifiers must be biased within a certain range in order for the tubes to function correctly. If the bias voltage is set too far negative, a number of things can happen. The tubes will get very near their cutoff point at crossover, and the crossover distortion can be severe enough to adversely affect the sound. The output itself will be weak, since less voltage also means less current flow.

If the voltage is set too far positive, the tube will dissipate more current than it should. Output goes up, but this will also shorten tube life and can cause premature failure of the tube.

Negative Feedback

One method of reducing the amount of undesirable crossover distortion, without having to bias the amp so "hot" that we destroy tubes, is by the use of negative feedback. Negative feedback is used by most Class AB amplifiers, and refers to the "feeding back" of a small amount of the output signal back into the input in order to flatten out the crossover distortion "notch" somewhat. Done properly, this lets us bias the amplifier at a cooler voltage and still get a decent clean response (if desired).

The use of negative feedback also contributes some other improvements to the overall sound of the amplifier. Not only is the distortion reduced, the nominal output impedance of the amplifier is reduced as well. This will improve the amp's damping factor and tighten up the low end. It will also flatten out the frequency response of the amplifier somewhat.

I have discussed damping factor here before, so to sum it up without being too redundant:

An amplifier has to control the in/out motion of the speaker. The better the amp controls this motion, the "tighter" the sound will be. With less control over the excursion of the speaker, the sound gets "looser".

If we manipulate the damping factor, we can also manipulate the low-end response of the amplifier. Since a lower damping factor results in a "looser" response, you hear more apparent low end due to the speaker "flopping around" a little more. This can be especially useful at lower volumes, because we all know how the lows drop out when you turn the volume way down. If we reduce the damping factor as we turn down the volume, we can still get some decent lows.

The resonance control on a 5150 is actually adjusting the negative feedback applied to the signal, and thus will affect the damping factor. Turning up the resonance reduces the negative feedback, causing the crossover "notch" to become more pronounced. This also lowers the damping factor. The net result, more crunch and more lows at a low volume!

Anyone who has played a 5150 has probably noticed this. At low volume you can really crank that resonance control and get a decent bottom end. When you turn up the amp with the resonance way up though, the sound tends to get "boomy" and the speakers flap too much. That low damping factor sounds good at low volume, but as the output goes up it gets out of control and the speakers can't really handle the

extra lows.

You can get a better sound at high volume by turning down the lows a little on the eq, until you hear the attack tighten up a little. This actually just changes the low-end rolloff at first, and only seriously reduces low-end when cut to below 5 or so. Then turn down the resonance as much as you can stand, maybe to 3 or 4. You may even feel a little more low-end by turning the resonance down to a controllable level. That is how EVH does it, and that is why IMO that you don't necessarily want to re-bias a 5150 much hotter than we set it.

If you try to completely eliminate the crossover distortion (which you can't really do anyway), you might change the effectiveness of your resonance control. Sure, the clean tone gets a little warmer, but who buys a 5150 for the clean tone? Dialing the crossover notch in and out (and the damping factor up and down) is part of how the resonance control gets a decent low-end response at any volume level. You also get that seriously huge bass response at high volumes that the 5150s are famous for, if you know how to tweak it.
I haven't evaluated why, and James B says he hasn't either, but the low end seems to go up a little with hotter bias settings. If you go too far with it the Resonance may get out of hand, so keep that in mind when setting up your sound if you have modified the bias setting.

I have talked to players who decided that they just had to have the bias set hotter on their 5150. Afterward, they felt that they didn't really gain much, and that actually the amp seemed to have "lost" something. Maybe the frequency response kind of "flattened" out or the low end got flabby. That is fine if you want the 5150 to sound like every other (high-gain) amp out there. Not fine though, if you want that growl and crunch that put the 5150 on the map. That is what sets this amp apart from the pack.

If you have or are thinking of getting a 5150, my advice is to take some time with the amp before you decide to do any modifications to it. James Brown and Ed Van Halen spent a lot of time designing these amplifiers. There are good reasons for everything they did, and one person's "design flaw", is another person's "thinking out of the box".
If you spend a little time with it, learn the way the amp responds and how to manipulate the controls, you might find that you don't really need to do anything to it at all. You might save yourself some money, and have a more reliable amplifier in the long run. Not to mention, the advantage of NOT sounding exactly the same as every other Joe-Bob on the block.

I have said it before, and I will repeat it again.

Do you want a "better" sound out of your 5150? Make sure you have a decent set of output tubes in there with not too many hours on them, and that are matched reasonably well. Get some good crunchy preamp tubes and swap them around till they sound good, with no feedback problems. You also need the right speaker system (very important!). You need the right guitar, the right pickups, the right strings, and have it properly set up and adjusted for your style. You also have to play with good technique, and…hold your mouth just right.

Miss any element of that, and you are going to compromise your sound and possibly be unhappy with it. If all of the above fails or doesn't quite get you there, then maybe and I mean MAYBE consider some kind of mod to your amp. Just don't expect that to fix some other shortcoming in your way of doing things.