Part 1- What Is Crossover Distortion?

We will discuss the Class AB, push-pull amplifier, since that is what most all tube guitar amps are. We know that the output of the amp is essentially an ac voltage, or sine wave. If you don't know what I mean by sine wave check out the graphic below.

One complete sine wave is called a "cycle". A cycle starts at zero, swings positive a certain amount, then back to zero, and then negative the same amount, and back to zero. This cycle is what makes a sound wave that we hear. Musical tones are listed as "cycles per second (Hz). IE, 60 cycles per second…etc. The more cycles per second, the higher the frequency.

Anyway, the output tubes are in pairs, with each tube handling slightly more than half the cycle. The "zero" point in the cycle is called the crossover point. This is the point that one tube "takes over" for the other tube to produce it's part of the cycle.
In a class B amp, one tube would shut completely off when the other tube takes over. In class AB, neither tube cuts entirely off, but they do get close to that point. As the signal gets near the "cutoff" point, it gets rather non-linear, meaning the sine wave form is out of shape somewhat.
This non-linearity is what we call crossover distortion, because it occurs at the zero or "crossover" point.

Now, that sounds like something really bad huh? Well, don't let all the hype fool ya. If you have a Peavey 5150 or similar amp, crossover distortion is actually your friend! In fact, that is one of the great secrets of the Resonance control on the 5150 and 5150 II.

This brings me to the only "Plain English" explanation I have, as it relates to guitar amps:
Crossover distortion is an over hyped term, used mostly by those who have some design, product, or service that they want to sell you. They will make it sound like the world is ending if your amp has this "flaw". Unless you are an audiophile or a Jazz guitar player, it is nothing much to worry about until it gets REALLY severe.

Part 2- Bias

Continuing our discussion of crossover distortion in Class AB amplifiers, we will now touch a little bit on a much discussed and mostly misunderstood subject. Bias, and how it relates to crossover distortion.

Before we go any further, we need to touch on basic tube theory. What exactly does a tube do anyway? Without being too technical about it, tubes are basically just little amplifiers. A tube has a "filament" (also called the cathode) which is heated until it releases electrons through a "grid". The electrons are then absorbed by the "plate" (also called the anode). The whole point of this process is to make a small signal into a larger signal.

In other words, a tube is a little amplifier.

When we refer to biasing an amplifier, that generally means we are setting the idle current for the power tubes. The idle current is just that. It is the current present when there is no signal passing through the tube. It is adjusted by changing the bias voltage, which is a negative voltage applied to the grid of the tube. As this negative voltage is adjusted, the current at the filament will increase or decrease. Ohms Law states that Voltage = Current x Resistance. If voltage increases, then current must increase as well. As the bias voltage becomes more negative, the current becomes smaller, and the tube is said to be biased "colder". As the bias voltage becomes less negative, the current goes up, and the tube is said to be biased "hotter".

So how does this all relate to crossover distortion? Remember we are talking about a class AB amplifier, so we are dealing with two tubes working as a pair. Refer to Part 1 of the discussion.
If the bias voltage is too far negative, the idle current gets small enough that the tubes get near their “cutoff” at the crossover point. This as we discussed before, causes the crossover distortion to get worse. To rectify this problem the voltage is adjusted less negative, so that the tubes do not get so near their cutoff at the crossover point. This decreases the crossover distortion, but there are limitations and tradeoffs to be consider here.

This is by no means a comprehensive discussion of this subject, but I hope it helps shed a little light on just what bias is, and why it is important.

Part 3 (coming soon) will cover some of the limitations and tradeoffs concerning different bias settings, as I mentioned above. Included also will be a discussion of other factors affecting crossover distortion. We will also cover the Resonance control on the 5150 and other Peavey amplifiers.