Subject: Re: Popular myths about tube amps
Posted by Wayne Parham on Fri, 24 Jul 2026 16:16:12 GMT
View Forum Message <> Reply to Message

I'm an electrical engineer and I grew up in the 1960s and 1970s. Those were years when tubes were in decline, and by the 1980s they were probably at their lowest acceptance point.

There are several disadvantages to tubes, and so I understand why they were being left behind in that era. They are large, vulnerable and relatively power hungry. They are not only vulnerable to physical damage but also to microphonics from vibration. Combine that with our rapid movement in the digital realm and tubes were getting left in the dust.

My mindset tracked with those thoughts too. I considered tubes an interesting piece of history, something like the horse and buggy. I enjoyed the nostalgia of a tube radio but didn't think they had a place in the future. When I heard guitarists say things like "tubes sound better," I discounted their opinions because they also said things like "tube watts are louder than transistor watts," which I knew was nonsense.

A few facts started presenting themselves in the late 1980s and 1990s that slowly changed my opinion.

The first one was a realization that tubes are inherently resilient to lightning strikes and electrostatic discharge. In the 1980s, one of the things I did was to design large lightning protection systems for computers and computerized controllers. I used primary and secondary protection - Intentionally placing lightning rods to attract strikes to a known location as primary protection and incorporating surge-clamping diodes and other solid state protection devices as secondary protection on the power lines and the even more vulnerable computer interface lines. The strikes would induce a current in the control and/or signal lines, and the SCD and/or MOV devices would clamp those.

I couldn't help but to ponder that a tube transmitter had a huge antenna just luring lighting towards itself, but it had a natural resilience to strikes. The tubes might be vulnerable in some ways, but this is one way they were much less vulnerable to solid state.

The second thing I realized was that I had been mixing amplifier topology with single-element performance all my life. What I mean by that is since transistors are so small, much more complex circuits can be built in the same space. Naturally transistors are better for computers for that reason alone. And even in the analog space, you can make a much more complex solid-state circuit in the same size chassis. So you can employ numerous gain stages and feedback mechanisms in a solid-state amplifier, and those can be employed to reduce distortion. So much of the performance gains of a solid state amplifier were actually from topology - You could design-in more gain stages and distortion-reducing negative feedback in a relatively small solid state amplifier.

But those extra gain stages and feedback loops have their own disadvantages too. As the amplifier nears limits, the feedback loops become ineffective. When the amplifier enters clipping because of the power supply limits, feedback can no longer work and distortion rapidly increases from nearly zero to nearly 100%. An amplifier that isn't so dependent upon that mechanism may have a little more distortion through its normal operating range, but it doesn't rapidly rise as it nears clipping. That "graceful clipping" is why those guitar players thought tube watts were "louder." They weren't as nasty sounding when you pushed 'em hard.

And multiple stages introduce noise. So having a very simple amplifier brings a benefit of the potential of super-low noise at quiescence. Provided the power supply can be made pure, a simple class-A amplifier with few stages can be ultra-quiet.

Another little factoid - When distortion is even and particularly when it is mostly the lowest harmonics, the distortion is much less objectionable than higher orders. So 4% purely second harmonic is much less ugly sounding than 1% THD, if the harmonics are mostly odd and high, like 5th, 7th and 9th. Ironically, a solid-state amplifier that depends upon negative feedback for distortion reduction tends to have very low THD, but when it distorts, it's a mixture of all harmonics, low and high.

I was surprised to learn that when I compared two output devices - one a common tube and another a common transistor - the tube was actually much more linear than the transistor. The transistor circuit actually depends upon negative feedback to actively clean up the signal it has produced. A comparable tube is much more linear.

As an example, compare the 300B tube to a 2N3055 transistor. Both are commonly used as output devices in audio amplifiers.

The 300B is a directly heated triode, celebrated precisely because its internal structure is inherently linear. Its transfer characteristic follows a smooth 3/2 power law. When plotted on a graph, its plate curves are remarkably straight, parallel, and evenly spaced. This means that as the music signal swings up and down, the tube scales the signal with minimal warping.

The 2N3055 transistor, by contrast, is an inherently non-linear device governed by an aggressive exponential law. At the bottom of the audio wave, it suffers from a sharp conduction turn-on curve. Even when biased deeply into pure Class A to keep the transistor permanently "on," its current gain still warps significantly depending on the temperature and the amount of current running through it.

When comparing both devices as open-loop single ended amplifiers without negative feedback, they share a common trait: they do not cancel out distortion and generate a dominant 2nd harmonic. However, the type and amount of distortion differ vastly.

The 300B creates predominantly low-order 2nd harmonic distortion, with a rapid, steep drop-off to the 3rd, and virtually undetectable higher harmonics (4th, 5th, 6th). At moderate volumes, the open-loop Total Harmonic Distortion (THD) sits around 1% to 3%.

The 2N3055 - or any other standard bipolar transistor for that matter - has an open-loop transfer curve that bends much more sharply than a tube. This sharp bend creates significantly higher overall distortion. More importantly, it creates a long trail of higher-order odd harmonics (5th, 7th, 9th).

So the truth is that tubes are actually vastly superior to transistors when it comes to linearity.

That one simple truth was kind of a shock to me. I hadn't bothered to look at that in my youth, even a decade or so into my career. I was mostly focused on computers and digital electronics, and in those realms solid-state is almost a requirement. And solid-state output devices can handle a ton of current, so they're great for driving motors and other high-current loads. Solid-state can be used to make excellent amplifiers too. So I simply overlooked the truth of the matter which is that solid-state amps require topologies that employ negative feedback to mitigate the high levels of harmonic distortion they create.

Food for thought.