Basic Electronics

By Ken Fischer

Class "A" Amplifiers

After reading the excellent article on Class "A" by Dave Funk in the last issue of *Vintage Guitar*, I just have to talk about Class "A" amplifiers once more.

Class "A" amps have the best tone going for those who put tone first. Yes, Class "AB" amps have more crunch, and because the best sounding Class "A" amps use EL-84 tubes, in groups of two or four tubes, their power is limited compared to the other types of output tubes in common use in high power "AB" amps. I've been making Class "A" EL-84 amps for almost twelve years. Since I keep exact records on every amp I build, including, "current owner", I looked back to see how many were ever resold. Turns out five Liverpools and no Rockets. That would say to me guitarists are very happy with their Class "A" EL-84 amplifiers. Besides Vox and "Wrecks", there are some more great sounding Class "A" EL-84 amps now being made by Dr. Z Amps, John McIntyre, and Tony Bruno. There's also a great new Class "A" 5881 amp made especially for blowing harp from Kendrick Amplifiers, and of course Dave Funk makes high power Class "A" amps for those who demand high power along with fine tone.

John McIntyre also makes Tube Coolers™ for those of you that have amps that run too hot. If you turn a Fender Twin or similar amp into a Class "A" amp, Tube Coolers™ will help you deal with the extra heat.

Now for the guy who said, "more Ampeg", but didn't leave his name on my machine ...try the Ampeg R12R Reverb-o-rocket with 6V6 output tubes. Ampeg didn't use 6V6 tubes very much at all, and the old R12R used both 6V6 tubes and 6SL7 and 6SN7 pre-amp tubes for a very unique voice. Do you play bass? Look for the very early Ampeg New York Bass Amps with stock British Mullard EL-37 (yes, that's 37) tubes. They're tall skinny Coke bottle shaped output tubes. Hey, I even rode a Yamaha Rotary Jet 80 to work at Ampeg for a year and a half, but I must have been on bad acid! I'd park it in front of B&D Harley on Route One and drive away their customers!

Back to electronic stuff. Before I got sent to the Tower of Rahway for my ulcers, I did get to test the improved Hot Cake Distortion/overdrive unit. The offending crackle is now gone at all volumes. The Hot Cake is my favorite modern distortion/overdrive unit and with Paul's 100% money back trial period you can't lose. Also, you can put two together for insane amounts of overdrive with no stability problems.

Tube Plate Voltage:

Some time back I was asked by *Guitar Player* magazine how tube plate voltage affects the sound of the output stage of a guitar amplifier. They also asked several other well known amp experts this question and printed our replies in an articles about the subject. As I always say, I respect these guys and their work, so the following is my opinion on the subject, and I can't help it if I'm right! Try this stuff for yourself and you can be the judge.

The voltage applied to your output tubes can affect many things. Voltage can affect power, headroom, tone, dynamics, feel, tightness or looseness, wet or dry, distortion, intermodulation and a host of other parameters. It can also greatly affect tube life. Different tube types and different brands among the same type will react to a particular voltage in different ways. Whether the tube is used in a Class "A" or Class "AB" circuit has a direct affect on plate voltage parameters.

O.K. let's take a typical Class "AB" amp such as a Fender Twin or Marshall 100 watt. The first Blackface Twin, model AA-763, ran about 460 volts on the plates. The dread CBS Fender Twin model AA-769 only had 405 volts on the plates. The 135 watt Silverface Twin had 500 plate volts. They all used four 6L6GC output tubes. We all know that the AA-763 and AB-763 Twins were the ones with tone. The AA-769 had many changes, but even converted to AA-763 specs, it lacks punch, dynamics, and headroom. 405 volts just doesn't cut it for the design of a Twin. The 135 watt Twin has mondo volume and headroom, but a colder, harsher sound. Too much voltage and the Twin becomes stiff and unyielding.

So is 460 volts the best voltage for 6L6GC tubes? Here's where it gets tricky. 460 volts works great in the Twin, but 405 volts doesn't. Now let's use the Fender Tweed Pro model 5E5-A as an example. This amp only uses 385 volts on its 6L6 tubes, yet it sounds great. What is going on? Well the answer is the circuit and transformers in the 5E5-A are designed in such a way that when all parameters are considered, 385 volts on the plates of the 6L6 tubes put them at their optimum operating point for this circuit.

Let's move on to a '67 Marshall Plexy 100 vs. a '69 Marshall 100 watt head. The Plexy runs about 460 to 480 volts on four EL-34 tubes. The '69 Marshall 100 runs about 505 to 520 volts on four EL-34 tubes. The Plexy has a warmer, smoother tone and the '69 has more volume, headroom, crunch, and a tighter bottom end. It's also a harsher sounding amp. I'm using my terms here, some may say harder sounding instead of harsher.

Also interesting to note, is that Siemen's brand EL-34's will run forever in the Plexy, but die the first time the '69 is cranked to ten. If you use Mullard or Brimar EL-34's like Marshall did, the tubes will live in both amps. The "one brand can take more voltage than another" problem is very much alive today. A Blackface Fender Deluxe Reverb runs its 6V6 tubes over the maximum design voltage. American brands such as RCA can take this with no problem. The 6V6 made in Russia won't hold up in the Fender Deluxe Reverb or a Trainwreck Express because the circuits push them too hard. They work well in lower power amps though. I'm told China now makes a 6V6 that will take anything thrown at it. I haven't listened to them yet so I can't report on their tone. Also, I'd like to get Dean, The String King, to try them in his Jim Kelley amps. Kelley amps push 6V6 tubes harder than any other 6V6 amp ever made and is a good test amp for 6V6 lifespan.

Amps that use EL-84 tubes normally run at lower plate voltages than other amps. This is because the EL-84 has the lowest design maximum plate voltage rating of any tube used in the output of current amp designs. I really love the tone of the Sovtek Standard grade EL-84. The only EL-84 with better tone is the very rare old German Telefunken EL-84 tube. Many companies run EL-84's at around 400 volts. That's too much voltage and destroys their tone in my book. I guess some companies value maximum power and tightness over maximum tone, but it is a matter of taste. Mike, of Dr. Z Amps, dropped the plate voltage of his prototype EL-84 amp from 400 volts to vintage Vox/Trainwreck levels. He then brought his amp down to the local music store and smoked every EL-84 amp on the floor.

Gerald at Kendrick Amps did some tricks with voltage to get his harp amp to rip it up. Point is, one should keep an open mind on this subject. While we're on the subject of tube voltage, the voltage on the plates of your preamp tubes also affects their performance. However, it does it in different ways. Higher preamp tube voltage, with all else being equal, translates to more gain. Also higher voltage usually gives you more headroom. Preamp designs being so variable makes it hard to give general rules about how they will react to voltage. For example, in most preamp designs more voltage equals less compression. But in some multi-stage master volume preamps, more voltage gives more compression.

Stability:

One characteristic an amplifier should possess is stability. This means the amp should be stable during operation in several ways. One way would be that all voltages remain within design limits during use. This would also apply to parameters such as currents, component values and such, staying within their limits. Also, factors such as frequency response and power output must stay within their design limits. Imagine playing through an amp that starts with 100 watts of power, but by the second set, after it gets hot, drops to only 50 watts. Or picture playing through an amp that, as the night wears on, gets darker or brighter sounding or playing through a bass amp who's bottom end fades during a gig. We've all played through an amp in need of repair with one or more of these problems, but there have been amps manufactured with this kind of stability flaw built-in at the factory. An example would be when the first transistor guitar amps hit the market, most suffered a problem called "Thermal runaway."

What would happen is, if the amp was played hard, the output transistors would heat up. As the output transistors got hotter the heat would allow them to draw more current. More current would make the transistors run hotter still. Of course hotter still means even more current would flow causing yet more heat. This cycle would go on until the transistors reached the heat level that would cause them to fail. The problem was lack of "thermal stability." Tube amps can also suffer thermal stability problems. Even today there are tube amps made with thermal stability problems. Some of these designs suffer with power and tone change problems. I know of more than one design that will run fine for months or even years and then suffer catastrophic failure.

These's another kind of stability problem that can affect an amp that's a bit harder to explain. It's a kind of unwanted electronic feedback. We all know if you place a mike in front of a speaker you'll get acoustic feedback. In a guitar amp if a signal from a later stage gets sent back to an earlier stage an electronic feedback may result. The frequency of this feedback may be in the range of human hearing, or above or below it. It can be caused by bad design or layout, stray capacitance or inductance, or a bad component.

Too much gain can affect stability, so can plugging in some effects pedals. Your amp may be fine until you pull the plug in an overdrive box which then will whistle and squeal even with your guitar turned down. A common variation of this electronic feedback is the dread, "parasitic oscillation." In the case of parasitic oscillation, the amp is fine until a note is played. The note increases the strength of the electronic fields inside the amplifier to the point where electronic feedback can occur. This type of instability can have many sonic results. One is the amp can break into oscillation and continue to produce its "squeal" even after you stop playing. Another affect of a parasitic can be the sound of an insect riding up on top of your note. A third common effect is the note is played with the amp up, but there's hardly any volume from your speakers. If you look at your output tubes they're glowing like mad but still almost no sound. What is happening in this case is the amp is oscillating at a frequency out of the range of human hearing. The amp is producing full power, you just can't hear it 'cause it's all going to the parasitic. The note you do hear is the bleed from the guitar signal which is much weaker than the oscillation frequency signal.

It takes a really good tech to track down an instability problem and is not a do-it-yourself job. Of course if the amp design was wrong from the start, modification, if possible with the design in question, is the only cure.

Next issue: The portable, kerosene tube, outdoor guitar amp...fact of fiction?

Ken builds his highly-regarded Trainwreck amplifiers in Colonia, New Jersey. VG