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amplification

Why We Prefer Valves

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October 2013

Some audiophiles and almost all electric guitarists prefer thermionic valve (vacuum tube) amplifiers to solid state amplifiers. This article briefly discusses a few technical factors that might help to explain this.

Grid current

When the input voltage at the grid of a common cathode gain stage is sufficiently positive to overcome the bias voltage, the grid starts to draw appreciable current. This phenomenon has no natural equivalent in solid state circuits, although it can be simulated of course.

Grid current has significant effects: temporary bias shift associated with coupling capacitors (ultimately leading to blocking distortion), temporary bias shift associated with cathode bypass capacitors, and heavy loading of the previous stage (which can be very significant in a DC-coupled cathode follower). The bias shifting effects give an amplifier a dynamically varying response under overload conditions (sometimes referred to as 'swirl').

Overload characteristics

Valves generally have a smooth transition into overload, or in other words the degree of non-linearity of the response increases progressively as the clipping limits are approached. This results in relatively greater energy in the lower frequency harmonics and less energy in the higher frequency harmonics.

Output transformers

Solid state amplifiers do not require output transformers. This is a 'good thing' from a hi-fi point of view, but for a guitar signal the 'lo-fi' effects of an output transformer can be beneficial: very low frequencies are cut due to magnetising inductance, very high frequencies are cut due to leakage inductance, and further distortion is introduced due to magnetic saturation.

Reduced loudspeaker damping

A valve amplifier provides relatively little damping to the loudspeaker. The loudspeaker is then free to add its own dynamics to the signal. The builders of acoustic instruments such as violins and Spanish guitars go to great lengths to avoid

excessive mechanical damping – for an electric guitar the loudspeaker cone is the equivalent of the sound board in an acoustic instrument.

Power supply sag

Valve amplifiers generally have 'old fashioned' power supply circuits with relatively poor voltage regulation (i.e. the supply voltage drops quite a few percent when the current demanded reaches its maximum). This gives a compression effect to the signal which is relished by many guitarists.

Little or no global negative feedback

Global negative feedback improves linearity (up to the point of clipping) and increases loudspeaker damping. This makes it popular in hi-fi designs. For guitar amplifiers either no global negative feedback, or else a relatively small amount, is used. This means that the low damping, natural non-linearity in the 'clean' operating range, and smooth transition into clipping are all retained.

Valve amplifiers are louder than solid state (?)

A watt is still a watt, whether it comes from a transistor or a valve, but there are a couple of factors which help to explain the subjective impression that valve amplifiers are louder.

Many musical signals (especially from a guitar) have a high amplitude initial transient which quickly dies way to a steadier signal. If an amplifier produces very harsh clipping (typical for many solid state designs) the user will tend to play at a lower volume level to prevent this happening. For valve amplifiers with smoother overdrive characteristics, the user will be happy to operate at higher volumes with less objectionable distortion of the initial transient.

Solid-state guitar combo amplifiers are often built to a tight budget and the loudspeaker is one of the most expensive components. Sometimes a cheaper, lower-efficiency speaker is specified. It is relatively cheap to increase the output power of a solid-state output stage (as no output transformer is needed), which also gives the added marketing value of a higher wattage rating. Valve amplifiers will often be combined with more expensive higher-efficiency loudspeakers.

Valve amplifiers are the real thing

Great ingenuity has gone into emulating the characteristics of valves in solid state amplifiers, and more recently by using advanced digital processing techniques. While these technologies can get very close to 'a sound' they often fall short of the 'feel' of a real valve amplifier. A guitarist has complete control over the signal – pick-up selection, guitar volume and tone controls, type of pick (or finger style), how hard to pick, where to pick the string, use of fingers to produce 'pinched harmonics', angle of

attack of the pick, string bending and vibrato, double stop bends, pull-off and hammer-on touch, etc. etc. While a digital simulation can be set up to be ideal for a particular type of signal, it is difficult to give an accurate response under all the variations of playing style that are possible.

A computer simulation of driving a car is not the same as really driving a car. In the same way, playing through a simulation of a valve amplifier is not the same as playing through a valve amplifier. Valve amplifiers are the real thing.