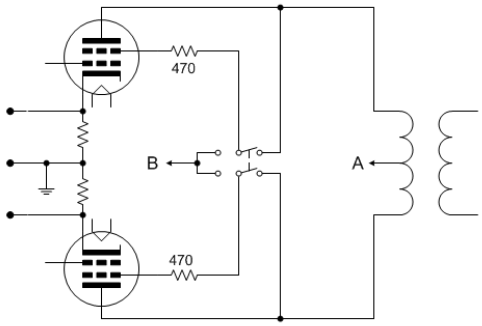
TRIODE / PENTODE THEORY

Was wondering if someone could explain the theory of using a pentode tube in triode mode. How is the screen connected, and to what? Also, how about a good schematic that shows a triode output section.

Joe



>>> Was wondering if someone could explain the theory of using a pentode tube in triode mode.

The not-so-quick nutshell explanation is this:

Pentodes and beam power tubes have a plate current which is fairly independent of the plate voltage. As long as the screen voltage is at a fixed value, then the control grid, G1, is very effective at controlling the plate current. Much more so that the plate voltage.

Triode curves look different. Plate current varies with G1 voltage, but also with plate voltage. G1 voltage is more effective than the plate voltage at controlling the plate current, and the mu of the tube is the ratio which explains how much more effective.

The pentode and beam power tubes retain their usual characteristics when the screen, G2, is maintained at a constant voltage relative to the cathode. We usually do this by connecting the screen to a node in the power supply of an amp.

>>> How is the screen connected, and to what? [for triode mode]

The screen gets connected to the plate.

In a pentode/beam power tube, G2 is also more effective at controlling plate current than the plate voltage. If you lock G2 to a fixed voltage, plate current stays pretty uniform for a big change in plate voltage.

But if you connect G2 to the plate, then when the tube passes signal, then plate voltage bounces up and down, and the screen goes right with it. With the screen voltage changing relative to the cathode, that independence of plate current to plate voltage goes away. The tube starts acting like a triode.

There is a suppressor grid or beam-forming plates in the envelope that wouldn't be there in a triode, but the tube is acting like a triode and exhibits basically the same characteristics.

It is usually considered a good idea to add a resistance of 100 ohms or more between the screen and plate to help ensure the screen doesn't exceed its dissipation rating. What I'd usually recommend is taking whatever screen resistor you usually use (470 ohms is typical in Fender amps, 1k in Marshalls), and connect that between the screen and plate.

You could have a switch to select pentode or triode mode. If the screen resistor went to the center lug of a SPDT switch, then you could connect a wire to the usually screen node of the power supply to one side, and a wire to the plate on the other side. Flipping the switch connects the screen (through the screen resistor) to either the fixed power supply node (for pentode operation) or to the plate (for triode operation).

HotBluePlates

How much resistance does it take between the plate suppressor grid is it before it's pentode. Looking at schematics the only difference i see between triode and pentode mode is resistance between the 2.

Nomad

>>> How much resistance does it take between the plate suppressor grid is it before it's pentode.

Not suppressor grid, screen grid. The suppressor, G3, can be connected to ground, to the cathode, to an external negative voltage, possibly even left floating and the tube will still work regardless.

>>> Looking at schematics the only difference i see between triode and pentode mode is resistance between the 2.

We don't care about "resistance" between the plate and the screen. On first glance, you might think that is the defining factor, because it is, after all, what you can see in the schematic.

What we care about is the screen voltage, and what happens to it during tube operation.

If the screen is fed a voltage that is roughly fixed relative to the cathode, then you have pentode mode. Since the cathode in an output tube is either tied to ground (fixed bias) or to the top of a cathode resistor with a hopefully steady voltage across it (cathode bias), then if the screen voltage is constant, the voltage of the screen relative to the cathode is constant.

If the screen is tied to the plate, and the voltage on the screen follows the voltage on the plate, which moves up and down during a signal, then you have triode mode. There could be 0 ohms of resistance between them, or a thousand ohms or more... As long as the screen voltage is fed from the plate, and follows its voltage, you have triode mode.

There is an in-between mode... ultralinear. A push-pull output transformer has the supply voltage fed into the center-tap, and the plates are fed from the ends. There are taps added to the primary in between the center-taps and ends, and the screens are attached to these taps. Now the screens are in between having a fixed voltage applied and one that changes in lock-step with the plate voltage. For this and other reasons, ultralinear has characteristics between those of pentode operation and triode operation.

HotBluePlates

Not sure I understand your question. The suppressor grid is usually at the cathode potential. It's there only to shield the plate from the screen and block electrons from bouncing off the plate back to the screen grid when the plate voltage swings below the screen voltage (secondary emission). This prevents the tetrode "kink". Beam power tetrodes have beam focusing elements that serve the same function as the supressor grid in a pentode. I may be wrong, but I think the pentode was developed as an alternative to the beam power tetrode to avoid patent infringements on RCA's monopoly.

Panhead

>>> I may be wrong, but I think the pentode was developed as an alternative to the beam power tetrode to avoid patent infringements on RCA's monopoly.

At this point, it doesn't matter, but it goes the other way around. RCA developed the beam power tube to avoid infringing on the pentode patent, because it had already been developed. The beam power tube incidentally had a feature that would have been useful in the pentode, had it been built into the earlier design.

HotBluePlates

>>> Looking at schematics the only difference i see between triode and pentode mode is resistance between the 2.

The plate voltage wobbles up and down to drive the load. In typical tube power stages, the plate is connected to the Output Transformer.

Something in the tube must attract electrons toward the plate.

In a Triode, the plate voltage also attracts the electrons. The wobble affects the attraction.

In a Pentode, the Screen (G2) is held at a steady high voltage and attracts the electrons. Most of them miss and hit the plate, even when the plate is wobbled to a low voltage.

If the naked tube is a Pentode (or Beam Power, same thing), look where the Screen is connected. Ignore any "small" resistor along the way. If it connects to the same end of the Output transformer, then it is working Triode. If it connects to a steady power supply point (which may be another end on the Output Transformer), then it is working Pentode. (If it connects halfway along the OT, it is Ultralinear, which is an in-between case.)

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Right. Pentode is simple, but was patented. Sarnoff either got patents cheap, or he threw money into evading them (ask Philo). Beam Power does the same thing as Pentode, better, without infringing the Power Pentode patent. G2 in "Beam" does the same as G2 in "Pentode", but tetrodes were not well patented. RCA's G2 worked better because RCA bought the Aligned Grid patent cheap from Brimar(?) who could not produce it commercially. To fake G3 without a physical grid, RCA used beam density and critical

distance effects to force a low potential zone out past G2. This has the added benefit of giving more/less "G3 action" for more/less current, soothing kinks and sharpening the knee. Then RCA wrote some brilliant puff-papers showing improvements on triodes and power-amp optimization and NFB, without mentioning the "P" word, only the "6L6" word.

PRR

From one other tread:

I'm reading up on tube amps and am curious about something regarding amps that switch between pentode and triode mode with output tubes to reduce power , a very usefule thing that I always use with my seymour duncan convertable which is way more amp than I generaly need.As I understand it, the pentode tube came into being in order to control oscillation in the tube, so how does cutting two grids out decrease power, and why doesn't it introduce the problems that the pentode was designed to prevent?

Otis

Ok, I think I've got it. The added sceen grid makes it much more effeicient, the suppresor grid stops unwanted bounce back, so I presume that in the switching they simply disconnect the sceen grid, leaving the suppresor grid be, thereby cutting gain?

Otis

>>> the pentode tube came into being in order to control oscillation

In RADIO-frequency circuits, triode plate-to-grid feedback (and tuned circuits) make oscillation.

In LARGE-signal circuits, triode plate-to-grid feedback makes the tube more linear but also reduces plate swing.

G2 blocks triode plate-to-grid feedback. (G3 keeps G2 effective down to very low plate voltage.)

Historically the first effect was found first.

In audio we are only interested in the second effect.

PRR