The Blue Guitar

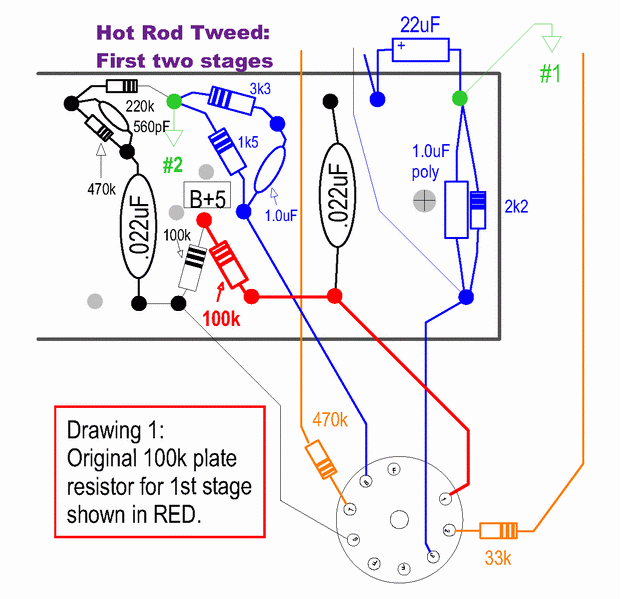
Blue Paper #010629

Split Load Plate Resistors

Introduction

"Split loads" have been around since the early days of vaccuum tube radios but have been not been used much in modern guitar amps. In working with amp designs we often encounter situations where we have too much gain and must dump some of the signal to ground through a resistor (or some other method of attentuating a signal). In many cases, these resistors will interact with the coupling capacitors or other capacitances within the circuit to create an RC network which will filter the sound so the reduction of the signal level may be accompanied by a reduction in the high frequencies as well. Using split load resistors on the plate of a preamp tube is one way to reduce the level of the audio signal without having a drastic effect on the tone of the signal.

So what is a split load plate resistor? Looking at a typical preamp stage we might find a 100k plate resistor, with the coupling cap (or tone stack) also connected to the plate. To reduce the signal level roughly by a factor of two, we can replace the 100k plate resistor with a pair of 51k resistors in series, with the coupling cap connected to the junction between the two resistors. While we normally think of the B+ from the power supply as being a source of positive DC voltage (up to 500vdc or even higher), it is also essentially an AC ground point as far as the AC audio signal is concerned. With the pair of 51k split load resistors instead of a single 100k plate resistor, much more of the audio signal is shunted to ground before the coupling cap or tone stack. For the sake of argument, you could get a similar reduction in signal level by using replacing the typical 100k plate resistor with a single 51k plate resistor; however, that would have a drastic effect on the bias of the preamp stage. By replacing the 100k plate resistor with a split load pair adding up to roughly 100k the bias of the tube stage would stay essentially the same. It so happens that there are many pairs of standard value resistors that add up to 100k (+/– 3%): 10k/91k, 18k/82k, 33k/68k, 47k/56k, etc. This allows us precise control over the signal level without having to alter the bias of the tube stages.

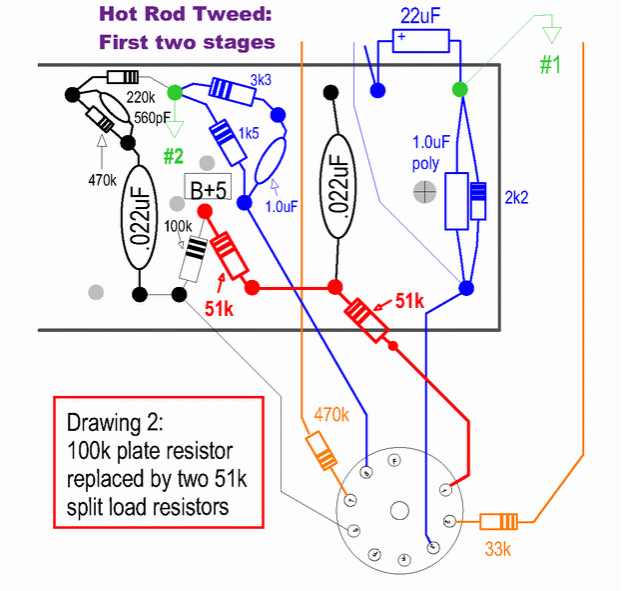


Drawing 1:
Original 100k plate resistor for 1st stage shown in RED.

So why should the RC effect of a split load plate resistor be any different from a voltage divider added in AFTER the coupling capacitor? My intuitive "take" on this is that the voltages and currents at the plate of the tube are a mix of DC and AC, so the tonal effects of a split load at the plate are more transparent. Once the audio signal passes through the coupling cap it is strictly AC so that any resistors added in after that cap are subject to the RC effects.

An interesting experiment would be to analyze an existing preamp design and add in split loads on ALL of the stages; by doing this you could fine-tune the gain structure of the signal as it passes through the

preamp. For prototypes, you could replace a 100k plate resistor with a 100k linear pot, with the wiper connected to the coupling cap (or tone stack) and the outer terminals connected to the plate and to the B+. (Most pots are not designed to be subjected to raw DC like this, so this is only a temporary measure to determine which pair of fixed resistors to use on each stage.)



Drawing 2:
100k plate resistor
replaced by two 51k
split load resistors

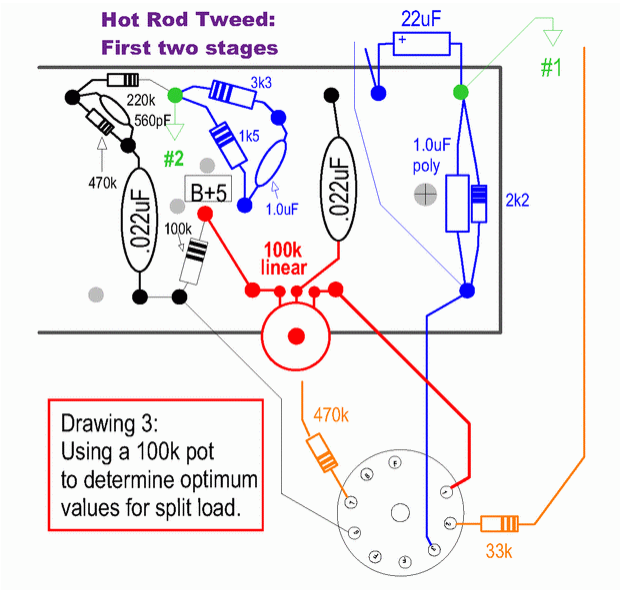
Details

I had heard about split loads a few years ago, but figured it would be too much of a hassle to implement them in my existing amps. Once I overcame my initial reluctance I found that they are much easier to use than I thought. With an eyelet board if you have already decided what values to use for the pair, you wire up one of them on the board exactly where the original plate resistor was located and then add the other one to the lead that goes to the tube socket [see Drawing 2]. When adding resistors to flying leads connected to tube sockets, if the signal is going into the tube, I will place the resistor right at the tube socket; if it is an output signal is coming from the tube I will place the resistor at the other end of the lead. This practice seems to improve the signal-to-noise ratio a bit.

To determine which values to use for your split load pair can be more complicated. You can wire in the 100k linear pot so that the two outer terminals are connected exactly as the two leads from the 100k plate resistor were connected. You then need to move the lead from the coupling cap to the wiper of the 100k linear pot [see Drawing 3 below].

Final notes

"Split loads" can solve many problems in a tube amp design by reducing the audio signal level without drastically affecting the tone. You can set the bias for any preamp stage as you like, and then set the output level from that stage independently. If you find that a particular tube stage is distorting too much, you could first try a split load on the plate of the preceeding stage and then observe the results. In some cases you might want to use the split load even earlier in the circuit.



Drawing 3:
Using a 100k pot
to determine optimum
values for split load.

A common request is to increase the headroom of a blackface Fender amp so that it doesn't start breaking up so soon; adding a split load to the initial preamp stage would allow you to reduce the signal level going into the tone stack. Using a 10k resistor on the plate and a 91k resistor going to B+ would reduce the signal level roughly 10%; to reduce it further you might try an 18k resistor on the plate and an 82k resistor going to the B+. This is just one example; split loads can be used throughout your amp

design to fine-tune the gain structure.

Although not suggested by the title of this article, split loads can also be used on the cathode of a cathode follower; that is a good way to reduce the signal level going into a 5F6A or Marshall-style tone stack. You could also try split loads on both the plate and cathode of a cathodyne phase invertor to reduce the signal level going to the output tubes; replacing each 56k resistors with a pair of 27k resistors as shown in **this drawing** should reduce the signal level by a factor of two.

Many thanks to both of the experts over at AMPAGE who introduced us to "split loads".

Good luck!

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Schematics which use split load plate resistors:

Blues Express Plus (Revision A9k)

http://www.blueguitar.org/bluexp12.pdf

More… (to be added later)

http://www.blueguitar.org/split_ld.zip