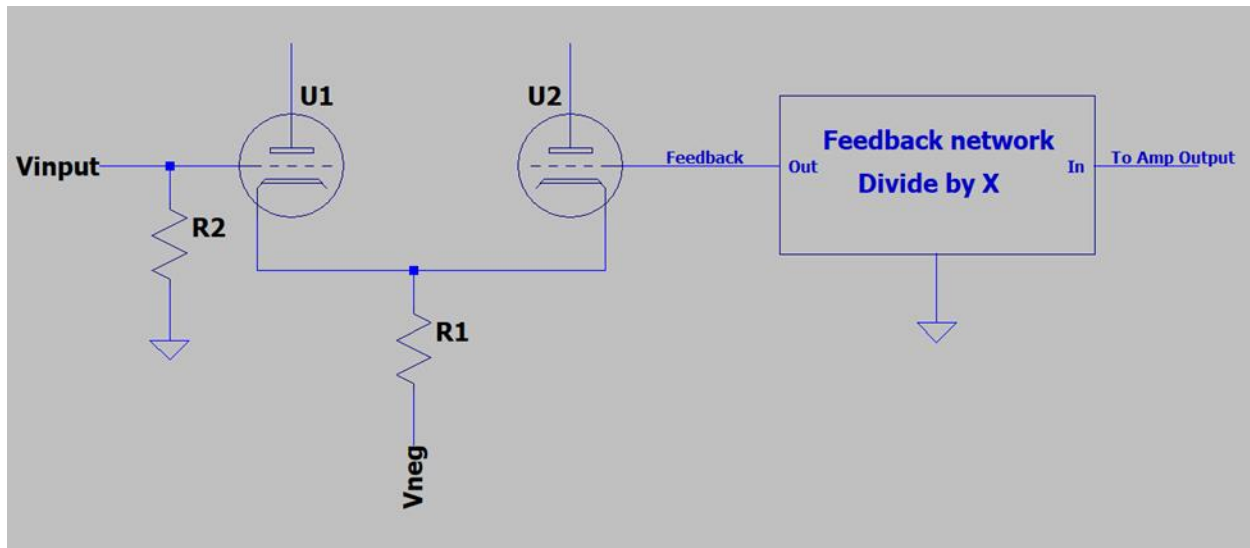


I may have come up with something new. On the other hand, there is nothing new under the sun. If this is old hat, just be kind when deflating my bubble!

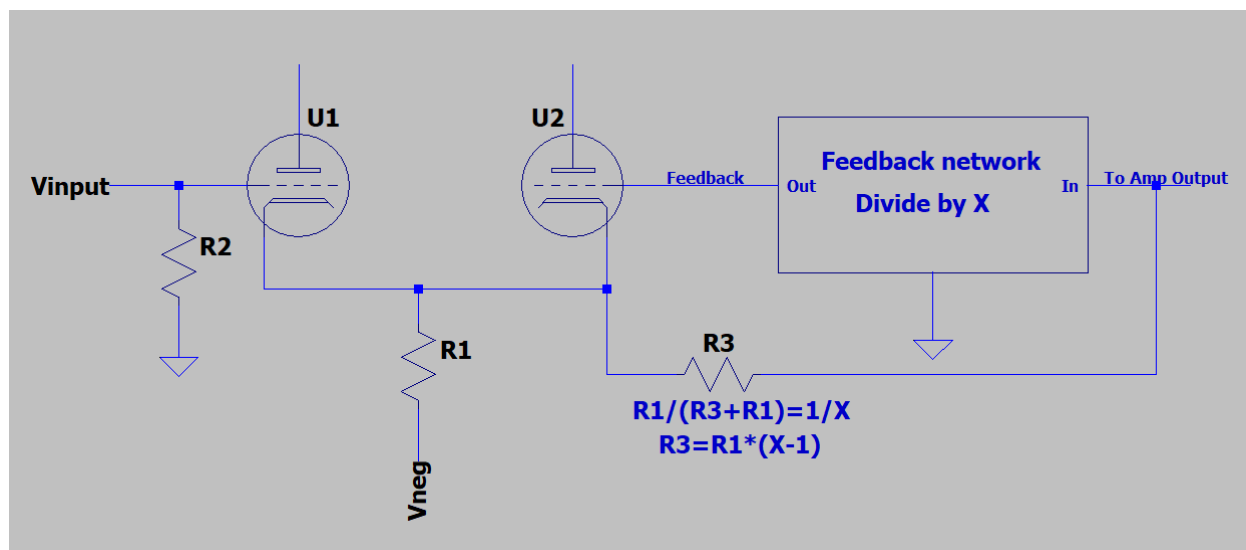
This pertains to a long tail pair as part of the VAS of a tube PP power amp. I could just use a SS current source, but what fun would that be. I also could use a tube current source, but as I hope to show here, there is a simpler way while remaining tube throughout. So, I start with a resistor and a negative supply voltage that is usually available in a fixed bias output stage, what could be simpler, and then a problem presents itself, 2nd harmonic distortion. This can be explained with the help of the diagram below.



As the feedback follows the input signal, a common mode signal is generated at the tube cathodes that modulates the bias current provided by R1. This current variation causes the Gm of the input pair to also vary. As the signal swings positive and the current increases, the Gm increases, and likewise Gm decreases as the signal decreases. This signal correlated variation can produce a significant amount of 2nd harmonic distortion that feedback cannot correct because it is introduced into the input of the VAS stage.

This is likely well known and provides motivation for using high output impedance current sources for the long tail pair for such an application. This adds SS components, or at least another tube element to the design which I would like to avoid (just because I think I can). Those are great solutions and I am not trashing them, but rather, I am attempting to add another tool to the bag.

What if one could add and subtract just the right amount of current from the common cathodes to fully compensate for the variation in current in R1? I have shown with simulations that in fact you can with just 1 more resistor. How cool is that! See diagram below.



There is still the issue of noise on Vneg, but it is not signal correlated and with good conventional PS filtering can be made quite small. Even with worst case tolerancing using 1% resistors for the feedback network and R1 and R3 the reduction in 2nd harmonic is dramatic. I have also discovered that with slight adjustment of R3 from the calculated value other sources of 2nd harmonic can be tweaked out.

The math for the R3 value is an approximation and neglects small influences due to the fact that the tubes are not perfect cathode followers in the common mode sense, and that the overall open loop gain of the amplifier is finite.

Even if this is old hat, I posted it as a reminder of a useful technique.