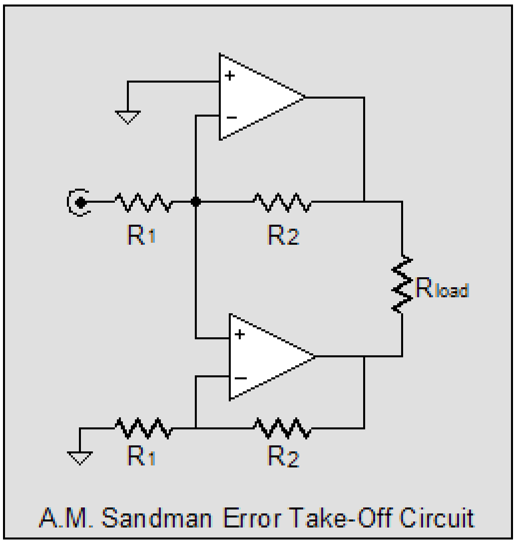
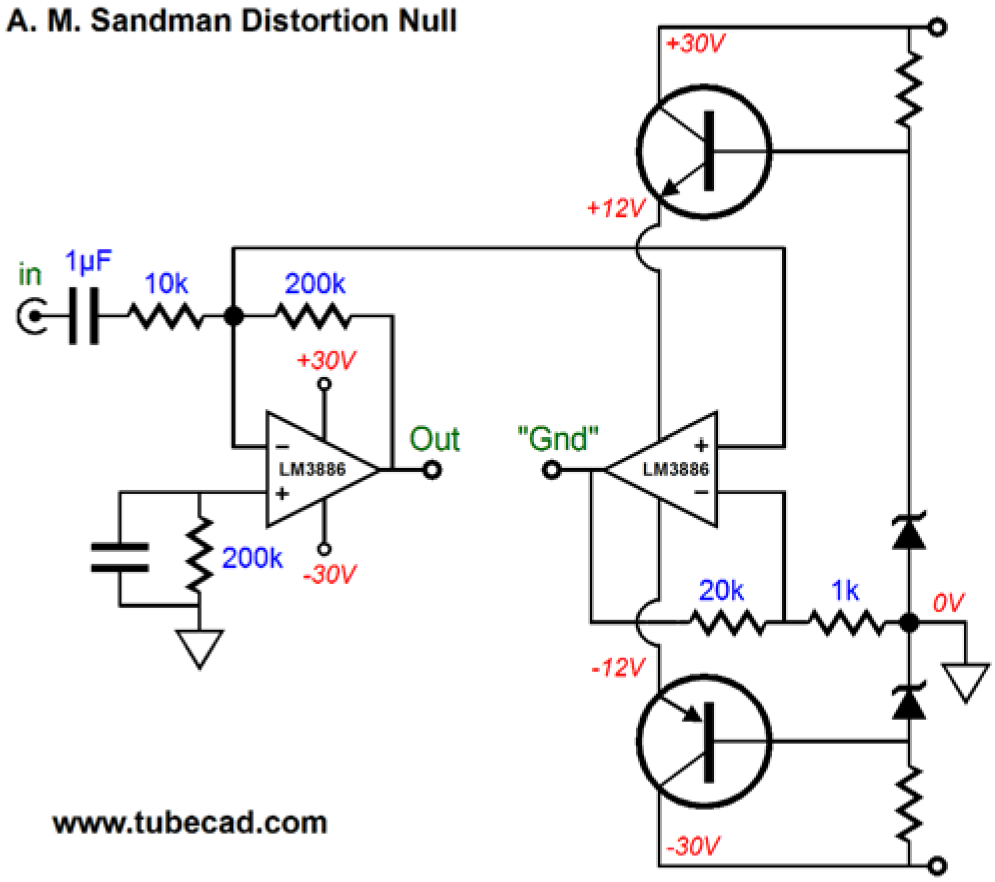
http://tubecad.com/2014/04/blog0286.htm

LM3886 Distortion Null Topology

More Thoughts on the Sandman Distortion Null Topology
My last post continued the Sandman error-take-off circuit thread. I pointed out how the error-take-off amplifier, the "virtual-ground" amplifier, the amplifier on the bottom of the following schematic, must get hotter than the main power amplifier, the top amplifier, as the error-take-off amplifier's output devices must see the full power-supply rail voltages at the full current swing into the speaker, while the main power amplifier's output devices are unburdened by the voltage swing into the speaker, which necessarily subtracts from the rail voltages.



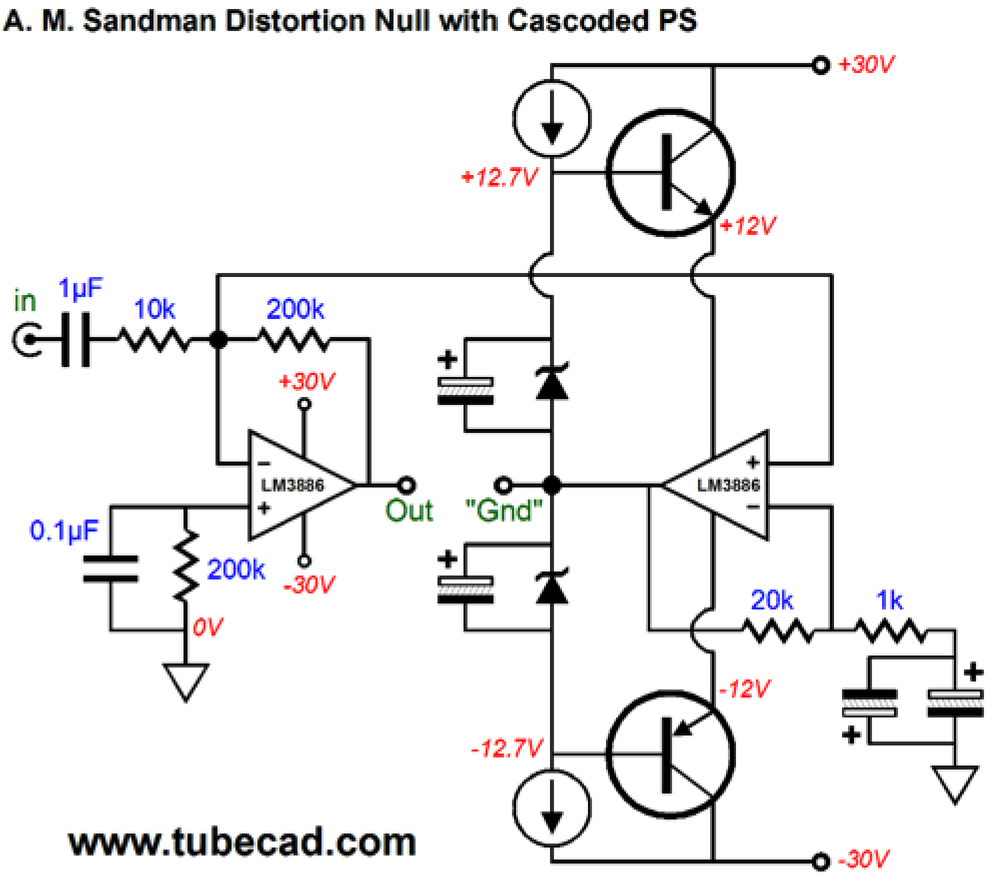
The workaround that I presented was to use two power transistors to reduce the rail voltage that the error-take-off amplifier saw.



This solution would limit the heat the error-take-off amplifier would produce, but it also limited the potential power output that the two amplifiers could deliver into the speaker. Remember that the error-take-off amplifier's output voltage hovers around 0V as long as the main power amplifier does not clip.

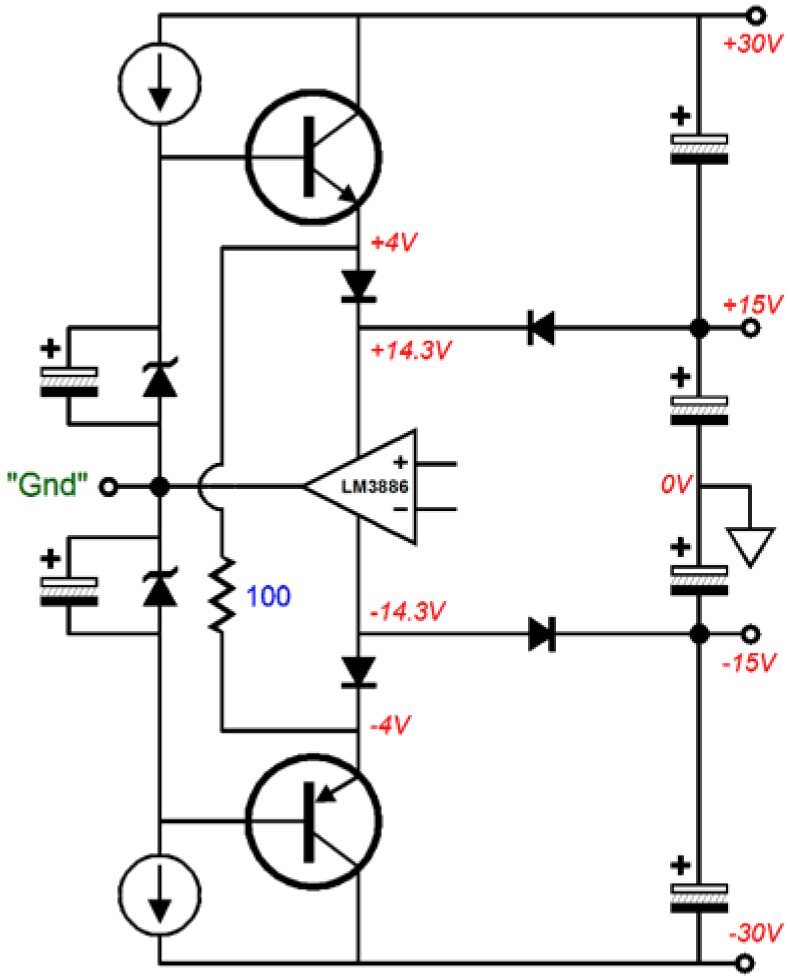
(The error-take-off amplifier's output will consist of the same amount of distortion that the main amplifier produces, which should be very small in amplitude, less than 1% of the main amplifier's output voltage swing.) But if the main amplifier clips, a form of distortion, the error-take-off amplifier's output will swing away from 0V in the opposite polarity to fill in the missing voltage. Potentially, the main amplifier's nominal power output could be quadrupled, if the error-take-off amplifier's output were allowed to swing equally large voltages as the main amplifier. The above solution will not allow that, as the +/-12V power-supply rails limit the error-take-off amplifier's potential output voltage swing to about +/-8Vpk.

My new workaround is to cascode the error-take-off amplifier, so that we can both limit its heat dissipation and still allow it to swing big voltages. In the schematic below, we see the two extra power transistors no longer referenced to ground, but to the error-take-off amplifier's output. As long as the error-take-off amplifier's output voltage hovers around 0V, the two extra power transistors will also hover around their fixed output voltages. But as the error-take-off amplifier's output swings away from 0V, so too will the two extra power transistors. In other words, the error-take-off amplifier will always see a fixed 24V differential between its positive and negative power-supply pins, although its output voltage will swing up and down 24Vpk.



No doubt, some are scratching their heads over the two electrolytic capacitors that terminate the 1k feedback resistor on the error-take-off amplifier. Why two capacitors? Why are they placed in opposition? The assumption is that very little DC voltage will be present at the end of the 1k resistor, so a large-valued electrolytic capacitor can be used. In general, this scheme works fairly well. The problem is that, compared to film capacitors, the electrolytic capacitor produces far more distortion. One workaround is to use high-quality non-polarized electrolytic capacitors, such as those made by Panasonic, as they present far lower distortion. The other workaround is to use two normal electrolytic capacitors in parallel opposition, which tends to cancel the distortion produced by each. (I have been told that for this trick to work best, the two electrolytic capacitors should be tightly matched in value.)

One important fact that must be stressed is that the universe has not been cheated. The same amount of heat will be developed within the chassis. The error-take-off amplifier has handed off some of its heat dissipation to the two power transistors, not eliminated it altogether. There are no free lunches in electronics. Not that we cannot subtract some of the excess heat by going to a class-G setup, wherein two power-supply rail voltages are used. Such an arrangement, however, gets complex and would require special power transformers.



At idle, the heat dissipation has certainly been lessened with the class-G topology. But note how the error-take-off (LM3886) amplifier now sees +/-14.3V power-supply rail voltages at idle and how more than 28.6V voltage differential across the LM3886 is now possible. For example, the negative-power-supply pin never sees less than -14.3V, just as the positive-power-supply pin never sees less than +14.3V, but both pins can see up to 28V, so maximum power-supply differential voltage would be equal to 28V + 14.3V, or 42.3V. In other words, in this class-G arrangement, the error-take-off amplifier could get hotter than it would in the cascoded version.

I must also mention that while quadrupling the nominal output power is enticing, we should not forget that once we go over that nominal wattage, the 8-ohm load appears more like a 4-ohm load to each amplifier; thus, only 8-ohm speakers should be attached to this Sandman error-take-off amplifier. (If we get twice the voltage swing, we must expect twice the current flow. So, instead of 3A peak, 6A peak.)

(By the way, I once received an e-mail from a reader that stated that he "mourned the demise of the once interesting articles" by me, and he was particularly saddened by those I had recently written on GainClone designs, which I seemed not to understand fully. A second later, I had shot off a reply that proclaimed that I stood chastened and I awaited links to schematics and articles written by the reader that would enlighten me as to what was truly possible—not that I could ever hope to achieve equally dizzying heights of imagination or electronic prowess, as my goal would be no more than to be humbly inspired. Well, I made the huge and shameless mistake of shooting the messenger. I failed to note the quotation marks that encompassed the entire statement and that all the text constituted a hyperlink to the original writer's missive on some forum. Well, I wonder if the above schematic would assuage some of that heartfelt mourning. Of course, it is not as transgressive, as truly unprecedented, as, say, specifying some special brand of coupling capacitors or resistors; alas, such transcendent insights elude the coarse tissue of my brain. Never forget that the architect, no matter how gifted and accomplished, is nothing compared to the interior designer who specifies lavender-colored drapes, as the latter deed requires true talent, if not genius. The architect need only know such trivial architectonic tidbits, such as structural, mechanical, electrical, materials, anti-earthquake, heating, ventilation, air conditioning, plumbing, rain gutter systems techniques and practice and a good deal of math and legal codes and many more equally easy things, whereas specifying lavender-colored drapes, rather than the fatally-wrong puce- or mauve-colored drapes, requires so much more dedication and mental wherewithal... it is no wonder that so few can perform the task ;)