TRANS*NOVA G

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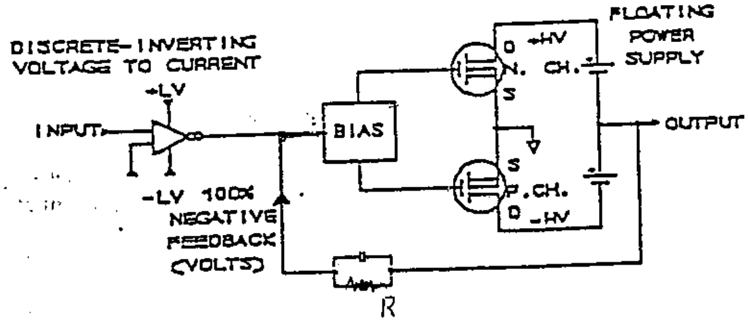
Amplifiers employing the Trans*nova principle have been in production since 1982. The original motivation for the circuitry, described in U.S. Patent 4,467,288, Strickland, 1985, was to develop a new power amplifier topology which would take full advantage of the high performance of the power mosfet--today the device standard for power handling. In this design, the resulting simplicity, speed, stability and accuracy created an amplifier with sonic credentials setting the standard for most of the last two decades--longer than the Compact Disc has been with us! In order to explain the new design, we must take a brief look back at the Tran*nova principle.

FIG. 1



Trans*nova employs a novel cooperation between voltage feedback, fed through the feedback resistor, and signal current from the driver stage. The result is unexpected and very desirable--an output stage with *100% negative (voltage) feedback, with no loss of voltage gain.* Most of the output voltage signal trying to return through the feedback resistor is canceled by the subtractive voltage drop in the resistor caused by the drive current. Such a circuit point is called a *node.*

After this partial cancellation, the *nodal* signal is the sum of the drive voltage needed by the mosfet gates and 100% of the *error* voltage present at the drains of the mosfets. The surprising 100% error feedback occurs because there is no path to attenuate it--the current-mode driver being "wide open" to any voltage changes sent back into it. The enduring acceptance of the Trans*nova design tells us that it is a valuable alternative to the more common topologies. It would be "unsound" to abandon Trans*nova in the pursuit of efficiency.

High efficiency amplifiers based on class AB topologies typically have arrangements to select higher rail voltages for larger signals. In the common arrangement called class H, the higher voltages are entered in "digital" fashion, using transistors and diodes as *switches.* In the less common arrangement called class G, a second set of devices is activated so as to bring into play higher rail voltages in a smooth, analog manner. Other factors being equal, H and G classes are equally efficient, with H increasing the dissipation on the AB devices and G spreading out its dissipation into the AB and G devices.

In selecting the topology for the C-Series amplifiers we wanted to provide the sonic and short-path advantages associated with Trans*nova, and yet avoid the extra complexity, size and cost of multi-rail designs. Could this be done? We intuitively felt that Trans*nova's floating bi-polarity power supply would be the answer--if there were an answer. As seen in Figure 1, if the amplifier is outputting +45 V at a certain instant, the + terminal of the (+/- 50 VDC) bi-polarity supply is at +95 V at that instant. If we could properly "move" the output terminal from its Trans*nova center-tap connection toward this +95 volt potential, the amplifier could theoretically replicate H or G designs without the need for multi-voltage rail supplies.

The circuits based on this method are not literally class H or G, in the terms explained above. To reinforce this distinction, **classes h** and **g** will be used in discussing the new circuitry. Also the term **class ab** will remind us that the linear stage is no longer literally class AB.

We first ran **class h** versions of circuitry of this type employing four mosfets operating as fast switches. This was the easiest test of the principle, but it injected high frequency transients into the audio which were clearly going to be very difficult to remove. We next arranged to use *controlled-slew-rate* rail-voltage transitions, reducing the transient problem, but creating a much more complex system and a whole new set of difficulties for the center-tap system circuitry. The general connection for these topologies is shown in *Figure 2.*

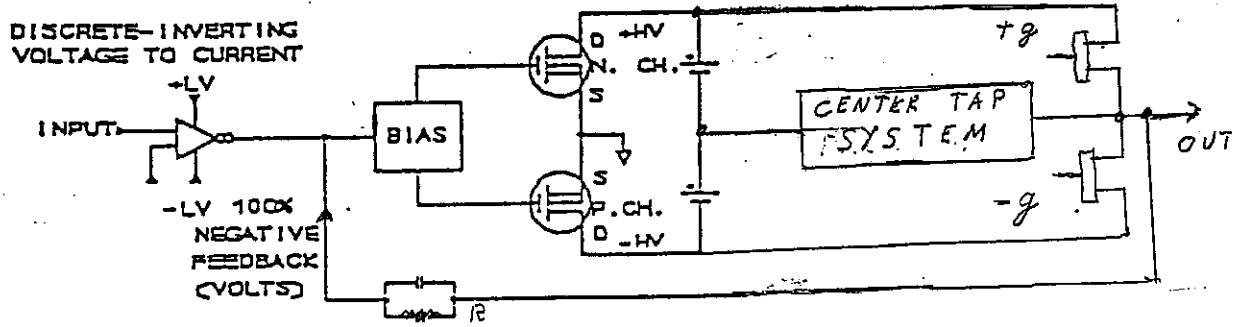


FIGURE 2

We decided to concentrate on **class g** assemblies, wherein we could smoothly bring additional output devices into play, taking advantage of their added dissipation capability--and surprisingly, also resulting in a simpler system.

Because the selectable-impedance, constant-power operation chosen for the amplifier demands varying the power supply +/- voltages by a 2:1 ratio, the transition to the **class g** region would best be driven by sensing the drain voltages of the Trans*nova **class ab** output stage. This technique senses the onset of clipping while it is still a few volts away, and precludes it from happening at this time.

This sensed voltage is used to drive a *current balance servo* (*cbs*) comprising the appropriate **g**-devices and associated driver circuitry. The **ab** drains are held at this (pre-clip) voltage *plateau* while the *cbs* circuitry quickly adjusts the conductance of the the g devices to the proper conditions to hold this plateau voltage. We may think of the *cbs* operation as if it were a cascode configuration, well known for unity current gain and *nodal* input impedance. Thus the voltage-to-current gain (transconductance) does not change between **ab** and **g** modes--very important for closed-loop stability.

The center-tap circuitry is obviously an important element of this operation. It goes through several states on each quarter wave. Each **g**-device set also goes through several states per quarter wave. The exact details of these interactive circuits will be explained later in the manual for the amplifier, after patent pending status is achieved.