AmpDiVa White Paper

Boosted Floating Grid Driver

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May 5th, 2017

An improved Floating Grid Driver can be designed in order to obtain a simpler circuit that does not require a custom transformer and can also increase the output current to the grid.

The AmpDiVa technology employs positive and negative grid pulses (as to the cathode) to push a vacuum tube in an high current conduction state or in an off state, allowing the tube to be used as a power switching device in a bridge or half-bridge topology.

The positive and negative grid polarization pulses can be provided by a Floating Grid Driver that is a buffer circuit with an optocoupled digital input and an asymmetrical bipolar output capable to source enough current to drive the grid current during the positive polarization.

A block diagram of a such circuit is depicted in fig.1.

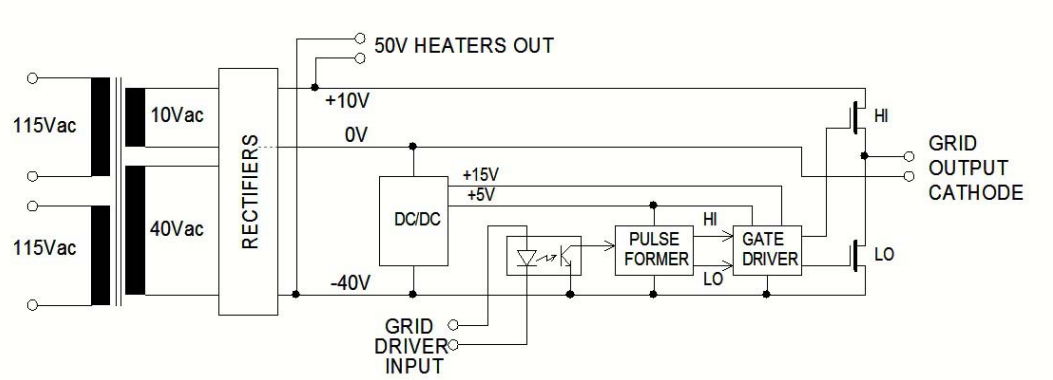

fig.1 - Floating Grid Driver block diagram

A similar circuit has several drawbacks:

1) it requires a custom power supply transformer with two asymmetrical secondary coils (even if this transformer can be used also to power the tube heaters) to provide the split power supply (ie. +10Vdc and -40Vdc) for the MOS output stage
2) it needs a pulse former in order to avoid cross conduction of the MOS output stage
3) an EMI filter is placed at the output to avoid high frequency ringing on the edges of the output pulses
4) the pulse former and the gates driver have to be supplied by a DC/DC converter
5) about 40 electronic components are connected in this kind of circuit

Furthermore, when the grid is positive polarized as regards the cathode, it acts as a direct polarized vacuum diode and the current drawn by the grid during the positive polarization pulse circulates in a loop closed by the power supply of the FGD, so this current is not used on the bridge load lowering the overall efficiency, as in fig. 2.

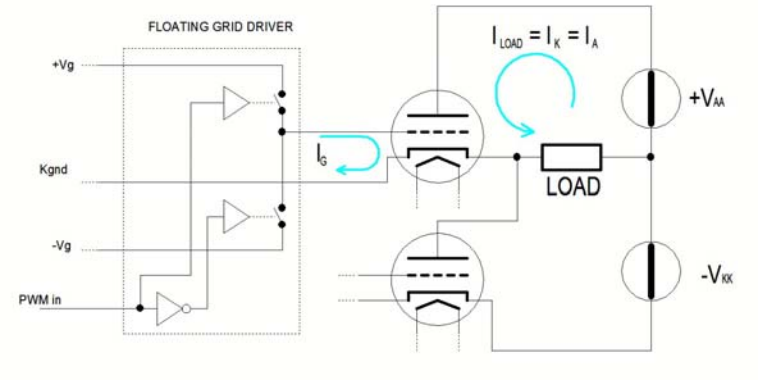

fig.2 - Wasted grid current loop

A different approach is presented in this paper: it is based on a direct connection of the grid to the anode during the positive phase of the PWM pulse and leaving the grid floating during the negative phase of the PWM pulse.

The grid have to be connected directly (or through a resistor) to the anode during the positive phase of the PWM pulse.
This improves a lot the cathode current even using low anode-cathode voltages and the cathode current is in this case the sum of the anode current added by the grid current (fig. 3).

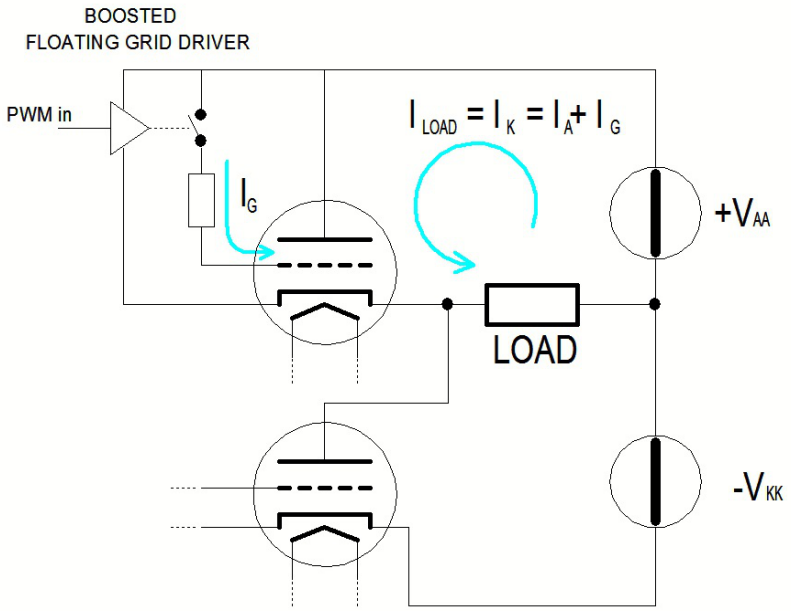

fig.3 - Boosted Floating Grid Driver concept diagram

The grid current can be limited by a resistor to avoid stress beyond the absolute maximum ratings defined by the tube specs.
The resistor value should be choose to have the minimum grid current that guarantees the maximum anode current for a certain anode voltage, that means the grid current should have the value to put the anode in a saturation region (fig. 4).

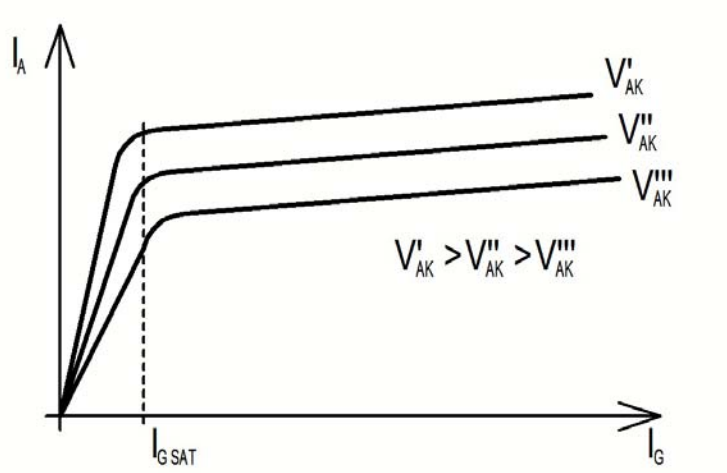

fig.4 - Anode current vs. grid current at increasing Vak

Instead of apply to the grid a negative pulse to put the tube in the off state, it is possible to leave the grid floating as it becames negative due to the charge collected by the electrons flowing through its mesh; this causes a pinch-off of the anode current dropping it pratically to zero.

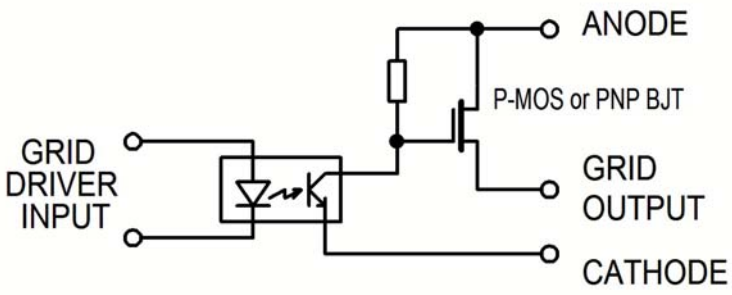

fig.5 - Boosted FGD simplest circuit

A very simple “Boosted Floating Grid Driver” circuit (fig. 5) with this behaviour can be designed using few components and it requires a single power supply that can be the same rail of the bridge arm at which it is connected.
No custom transformer is anymore needed and only simple off the shelf transformers can be used to glow the heaters.

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