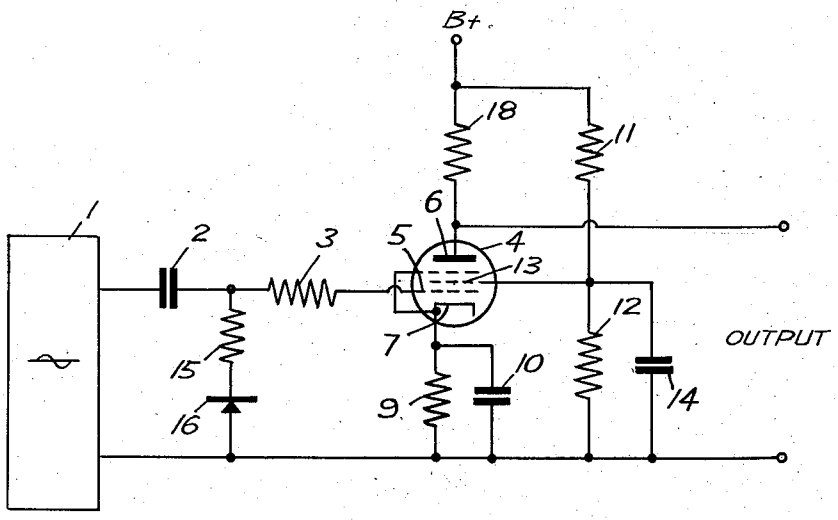
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AMPLITUDE LIMITING CIRCUITS

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AMPLITUDE LIMITING CIRCUITS

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In general this invention relates to improvements in limiting circuits utilizing electron discharge tubes. Although circuits have been developed to provide symmetrical amplitude limiting, difficulty is encountered when very large output voltage of fixed amplitudes is required. In addition, the symmetry of output voltage has sometimes suffered when new tubes are used to replace old ones of the same type. Some circuits offer effective limiting, but, due to the differences in effective grid-cathode impedance levels among tubes, readjustment of resistor values in the circuit is necessary to maintain symmetry. This invention provides a limiter capable of producing large output amplitudes and uses a circuit configuration that is not sensitive to differences in grid conductance or cut-off voltage among tubes.

The accompanying figure is a drawing of a schematic circuit diagram that represents one embodiment of this invention. In this figure, an input voltage generator 1 supplies a voltage having alternate positive and negative values. This voltage is applied through a coupling capacitor 2 and a series grid resistor 3 to the control grid 5 of an electron tube 4. Anode 6 of tube 4 is supplied with anode voltage from a B+ supply through a load resistor 8. Resistor 9 is connected from cathode 7 to ground to provide self-biasing for tube 4. A cathode by-pass capacitor 10 is used in parallel with the cathode resistor 9. Resistors 11 and 12 are used to supply the screen grid 13 to tube 4 with a voltage, the value of which is intermediate to the plate and cathode voltages. A screen by-pass capacitor 14 is used in parallel with resistor 12. A grid return resistor 15 is connected to the junction of capacitor 2 and resistor 3. The bottom end of the grid resistor 15 is connected to ground through a silicon junction diode 16, the cathode of which is connected to the grid return resistor 15 and the anode of which is connected to ground.

During the positive half-cycle of the input when the input amplitude exceeds the bias level, the grid 5 becomes positive with respect to the cathode 7 and the grid 5 draws current. This grid current provides a voltage drop across resistor 3 in such a direction to oppose the input voltage and, thus, prevents grid 5 from going further positive. The plate current, then, is limited to a value corresponding to approximately zero grid-to-cathode voltage.

During the negative half cycle of the input, when the input amplitude is sufficiently negative, the flow of plate current is stopped and tube 4 becomes nonconducting. The cathode self-bias is set so that the point at which grid current is drawn and the point at which plate current is cut off are each equidistant above and below the A.-C. zero axis of the input voltage.

If the diode 16 were removed from the circuit and resistor 15 were directly connected to grid 5, the capacitor 2 would become charged since the total current flowing in one direction during positive half cycles would exceed the grid current flowing in the opposite direction, even if the resistor 15 were made low with respect to the input

resistance of tube 4. Thus, an additional bias would be provided that would distort the desired limiting symmetry. If diode 16 is introduced to the circuit between resistor 15 and ground, resistor 15 can be selected so that, during the negative half cycle, the current flowing through the capacitor 2 is equal and opposite to the current flowing during the positive half cycle. Thus, the average current through the capacitor is zero and no charge is allowed to accumulate. If the circuit branch containing resistor 15 and diode 16 is connected directly to the grid and if a new tube of the same type but having a different impedance level is substituted for tube 4, the value of resistor 15 has to be readjusted before equal currents can flow during positive and negative half cycles under the new impedance conditions. In addition, the amount of grid swing would depend on the point at which the grid becomes conducting during the positive half cycle and the point at which the grid becomes clamped due to the conduction of the diode during the negative half cycle.

However, in this invention the grid return branch containing resistor 15 and diode 16 is connected not directly to grid 5 but from the junction point of capacitor 2 and resistor 3 to ground as shown in the figure. Resistors 3 and 15 are so selected that their resistances are equal. With a configuration of equal resistances, the quiescent voltage at the mid-point of resistors 3 and 15 is maintained at one-half the cathode bias level. Once the values of the resistors are fixed, the dividing action of the equal resistors maintains the operating point at the proper level even if a new impedance level is introduced. A change in resistors is not necessary to compensate for a change in impedance level due to the substitution of another tube of the same type.

Placement of the circuit branch containing resistor 15 and diode 16 at the junction of capacitor 2 and resistor 3 also allows a full grid swing from the point at which the grid becomes conducting to the point at which electron tube 4 is cut off. Because the limiting action is dependent on a full swing of the grid from cut-off to grid conduction and not on the clamping action of the diode, a larger output amplitude can be realized.

Although the figure describes one embodiment of the invention, those skilled in the art will be able to recognize other embodiments that differ in some elements not essential to this invention. For example, rectifier devices other than a silicon diode and various types of multi-electrode tubes other than a pentode are available for substitution in the circuit.

What is claimed is:

1. A voltage amplitude limiter comprising an electron tube including at least a cathode, an anode and a control grid, means for connecting a voltage to said anode, biasing means connected between said cathode and a reference point, means for generating an input voltage having alternate positive and negative values, intermediate means for connecting said input voltage to said control grid, said intermediate means comprising a capacitor and a first impedance in series, circuit means connecting said intermediate means from the junction point of said capacitor and said first impedance to said reference point, said circuit means including a second impedance and a rectifier in series, said first impedance being substantially equal to said second impedance whereby a symmetrically limited output signal is provided at said anode.

2. A voltage amplitude limiter comprising an electron tube including at least a cathode, an anode and a control grid, means for connecting a voltage to said anode, biasing means connected between said cathode and a reference point, means for generating an input voltage having alternate positive and negative values, intermediate means

for connecting said input voltage to said control grid, said intermediate means comprising a capacitor and a first resistive-impedance in series, circuit means connecting said intermediate means from the junction point of said capacitor and said first resistive-impedance to said reference point, said circuit means including a second resistive-impedance and a rectifier in series, said first resistive-impedance being substantially equal to said second impedance whereby a symmetrically limited output signal is provided at said anode.

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