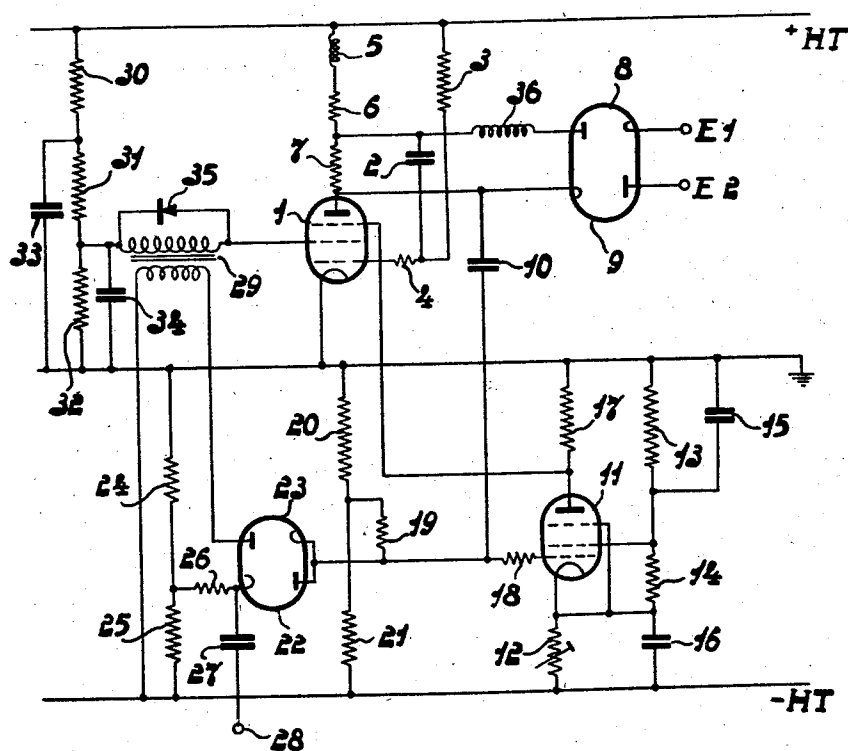


Nov. 4, 1958

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SAWTOOTH VOLTAGE GENERATOR

2,859,341

Filed Aug. 24, 1954



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2,859,341

SAWTOOTH VOLTAGE GENERATOR

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Application August 24, 1954, Serial No. 451,734

Claims priority, application Great Britain August 25, 1953

3 Claims. (Cl. 250—27)

This invention relates to a circuit for producing a sawtooth voltage during a time interval dependent upon a direct control voltage.

The sawtooth voltage producing circuit of the present invention comprises an integrating circuit including a pentode and comprising an integrating network whose integrating capacitor constitutes a feedback capacitor included between the control-grid circuit and the anode circuit of said pentode and of which the electrode connected to the anode circuit is coupled by way of a top catch diode to a source of direct control-voltage.

The sawtooth voltage producing circuit further comprises a grid-controlled switching tube which is normally current-conveying and whose anode is coupled to the suppressor grid of the said pentode so as to cut-off the latter.

A coupling capacitor is included between an output electrode of the pentode and an input electrode of the switching tube for restoring the switching tube and the pentode to their initial positions after the switching tube has been cut-off and the pentode has been rendered conducting.

Such circuits have the disadvantage that inaccuracies occur during the time interval dependent upon the direct control-voltage, more particularly at low values thereof.

According to the invention, in a circuit of the sawtooth voltage generating type, the said disadvantage is mitigated as far as possible and assistance is provided in restoring the switching tube to its initial state, by including a coil in the connecting lead between the integrating capacitor and the source of direct control-voltage and in series with the top catch diode.

In fact, the use of the step in accordance with the invention insures that, when the anode voltage of the said pentode increases, the catching action of the diode is temporarily removed. The voltage applied to the output electrode of the switching tube, even at low values of the direct control voltage, thus reaches a value sufficiently high to restore the switching tube rapidly to the current-conducting state.

In order that the invention may be readily carried into effect, it will now be described with reference to the accompanying drawing showing, by way of example, one embodiment thereof.

The circuit of the present invention shown in the figure, comprises an integrating network including an integrating capacitor 2 and a series resistor 3. The integrating capacitor 2 constitutes a feedback capacitor included between the control-grid circuit and the anode circuit of a pentode 1; the electrode of the capacitor 2, which is coupled by way of a grid stopper 4 to the control grid is connected by way of series resistor 3 to the positive terminal of a source of anode supply. The anode circuit of pentode 1 includes the series-combination of a linearizing coil 5, connected to the anode voltage lead, and two resistors 6 and 7. The resistor 6 is large relative to the resistor 7 connected to the anode, for example about ten times larger. The electrode of the integrating capacitor 2 coupled through the resistor 7 to the anode of the

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pentode 1, is coupled by way of a top catch diode 8 to a source E_1 of direct control voltage.

The anode of pentode 1 is connected to a bottom catch diode 9, whose anode for this purpose is connected to a constant voltage source E_2 . The anode of pentode 1 is, in addition, connected by way of a coupling capacitor 10 to the control grid of a switching tube 11 the tube 11 preferably being a pentode.

The cathode of switching tube 11 is negatively biased with respect to the grounded terminal of the source of anode supply by the voltage developed across a variable cathode resistor 12 and resistors 13 and 14 by the cathode current together with the screen-grid potentiometer current. The capacitors 15 and 16 are de-coupling capacitors. The anode of the switching tube is connected to ground through an anode resistor 17 and also is directly connected to the suppressor grid of the pentode 1.

The control grid of switching tube 11 is connected via a grid stopper 18 and the coupling capacitor 10 to the anode of the pentode tube 1 and via a resistor 19 to a potentiometer which is constituted by resistors 20 and 21 connected by way of the source of anode supply for switching tube 11. The control grid of switching tube 11 is also connected, via the resistor 18, to the anode of a diode 22 and to the cathode of a diode 23.

The cathode of diode 22 is positively biased with respect to its anode via resistors 24, 25 and 26 and is also connected via a capacitor 27 to a terminal 28 for negative triggering pulses.

The anode of diode 23 is negatively biased and connected to the secondary winding of a feedback transformer 29. The primary winding of the transformer 29 is included in the screen-grid circuit of pentode 1 and is connected to a potential divider comprising resistors 30, 31 and 32 and de-coupling capacitors 33, 34. Said primary winding is shunted by a rectifying cell 35 for suppressing negative output pulses of said feedback transformer.

The circuit shown in the figure operates as follows:

The switching tube 11 is initially conducting and the voltage drop developed across the anode resistor 17 and applied to the suppressor grid of pentode 1 cuts-off the said pentode. The anode voltage of pentode 1 then corresponds to the direct control voltage E_1 due to the top clamp circuit comprising diode 8. The control grid of pentode 1 exhibits only a low positive potential due to the grid current flowing via resistor 3 and grid stopper 4. The screen-grid voltage of the pentode 1 is comparatively high.

If a negative triggering pulse is supplied at the terminal 28, via the diode 22 to the switching tube 11, the tube 11 is cut-off. Consequently, the cut-off voltage at the suppressor grid of pentode 1 is removed and said pentode starts to conduct. The resultant voltage drop across anode resistor 7 is applied by way of coupling capacitor 10 to the control-grid of switching tube 11, thus assisting in maintaining the tube cut-off.

Immediately following the release of the suppressor grid of pentode 1, the anode voltage of said pentode begins to fall linearly with time until it reaches the voltage E_2 whereupon the bottom catch diode 9 begins to conduct and prevents any further decrease of the anode voltage.

In this connection it is noted that a bottom catch diode is not required to insure a minimum anode potential, since the tube 1 naturally exhibits a minimum anode potential determined by its adjustment.

When the anode voltage of pentode 1 stops decreasing, the screen-grid current, which rapidly decreases at the initiation of the conduction of pentode 1, starts to increase due to the control-grid voltage which continues to rise at constant anode potential by discharge of integrating capacitor 2. This increase in screen-grid current is

utilized in the embodiment under consideration for initiating the action of restoring switching tube 11 to its initial state.

The increasing screen-grid current of tube 1 brings about a positive pulse at the secondary winding of feedback transformer 29, which pulse is fed via diode 23 to the control grid of switching tube 11, thereby rendering tube 11 conducting.

This results in a decrease in the suppressor grid voltage of pentode 1, so that the anode voltage of said pentode increases and this increase is transferred by way of coupling capacitor 10 to the control grid of switching tube 11, causing the voltage drop across the anode resistor 17 to increase further. The action is then repetitive, as described. The described cumulative action causes tube 11 to be rapidly released and pentode 1 to be rapidly cut-off.

The anode voltage of pentode 1 rises until the top catch diode 8 becomes conducting and the circuit is then back in the initial state.

A pulse of a duration determined by the circuit and adjustable by means of the voltage source E_1 is normally taken from the anode of switching tube 11.

Normally, the minimum anode voltage E_2 of pentode 1 has a constant value whereas the direct control voltage E_1 is normally variable. The voltage E_1 determines the level at which the discharge of the integrating capacitor 2 starts and hence the time interval between start and reset.

When this time interval is small, the voltage E_1 differs only slightly from the voltage E_2 , so that during the reset action the maximum anode voltage provided via the diode 8 is reached so rapidly that the described cumulative action is not capable of resetting the tube 11 completely.

In these circumstances the switching tube 11 may be restored to full conduction in part by the considerably slower discharge of coupling capacitor 10 together with stray capacities. This results in unwanted inaccuracies in regard to the time interval of the sawtooth voltage produced.

According to the invention, in order to overcome the said disadvantage as far as possible, a coil 36 is included in the connecting lead between the integrating capacitor 2 and the direct control voltage source E_1 said coil being connected in series with the top catch diode 8.

Due to the use of the coil 36, when the circuit is restored to its initial state at the instant that the top catch diode 8 starts to conduct, the anode voltage may temporarily exceed the direct control voltage E_1 . It is thus insured that the cumulative action continues sufficiently long to bring about complete release of the tube 11.

The coil 36 must be so proportioned that the pentode 1 has an anode potential corresponding to the direct control voltage E_1 in a very short time after the reset action, that is, prior to the occurrence of the next triggering pulse.

It is to be understood that the invention is not limited to the details disclosed but includes all such variations and modifications as fall within the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. A circuit for producing a sawtooth voltage com-

prising a first electron discharge device having an anode, a cathode, a control grid and a suppressor grid, a source of operating voltage, a load impedance connected between said anode and said source, a source of direct control voltage, means for applying said control voltage to the anode of said first electron discharge device comprising a diode and an impedance means connected in series between said control voltage source and said anode, integrating means connected in the control grid-anode circuit of said first electron discharge device, a second electron discharge device having an anode, a cathode and a control grid, input circuit means connected to the control grid of said second electron discharge device, means for connecting the suppressor grid of said first electron discharge device to the anode of said second electron discharge device, means for connecting the anode of said first electron discharge device to the control grid of said second electron discharge device and means for deriving an output voltage from the anode circuit of said second electron discharge device.

2. A circuit as claimed in claim 1, wherein said impedance means comprises an inductance element.

3. A circuit for producing a sawtooth voltage during a time interval dependent upon a direct control voltage, comprising a first electron discharge device having an anode, a cathode, a control grid and a suppressor grid, a source of operating voltage, a load impedance connected between said anode and said source, a source of direct control voltage, means for applying said control voltage to the anode of said first electron discharge device comprising an inductance element connected in series with a unidirectionally conducting element between said anode and said control voltage source, an integrating capacitor connected in the control grid-anode circuit of said first electron discharge device, a second electron discharge device having an anode, a cathode and a control grid, means for applying a trigger pulse to the control grid of said second electron discharge device, means for biasing said second electron discharge device in normally conducting condition, means for connecting the suppressor grid of said first electron discharge device to the anode of said second electron discharge device for biasing said first electron discharge device in normally non-conducting condition, means comprising a coupling capacitor for connecting the anode of said first electron discharge device to the control grid of said second electron discharge device for restoring said first and second electron discharge devices to their initial conditions after said second electron discharge device is biased to non-conducting condition and said first electron discharge device is biased to conducting condition, and means for deriving an output voltage from the anode circuit of said second electron discharge device.

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