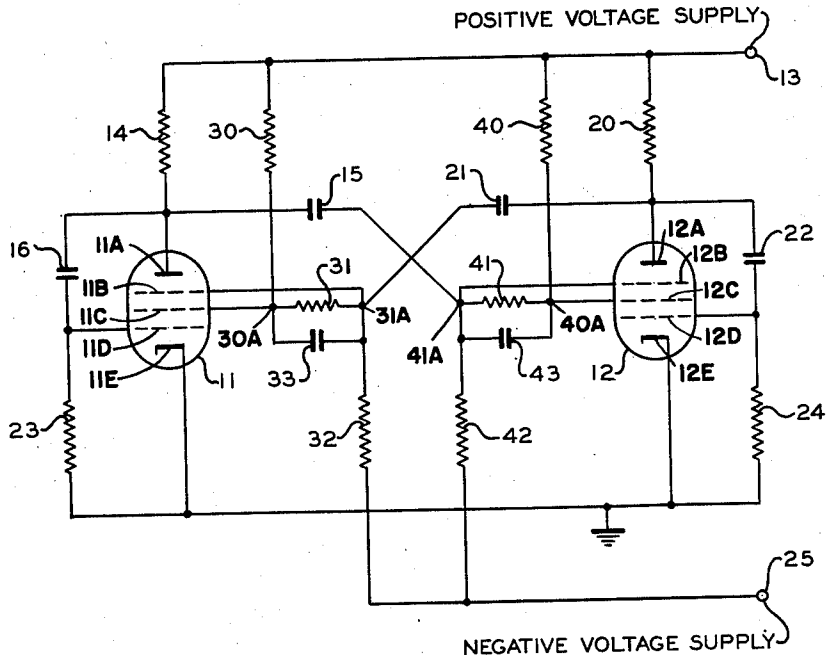
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MULTIVIBRATOR

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INVENTOR
GEORGE H. NIBBE
BY
ATTORNEY

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MULTIVIBRATOR

George H. Nibbe, Chicago, Ill., assignor, by mesne assignments, to the United States of America as represented by the Secretary of the Navy

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This invention relates to multivibrators and more particularly to multivibrators having amplified time constants.

In the conventional free running multivibrator, the length of the conducting period for each tube is mainly dependent upon the resistance and capacitance in the control grid circuit of the other tube. The conducting periods of the tubes determine the ferquency of the rectangular voltage wave output and also the ratio between the positive portion of the wave and the negative portion. In order to obtain long periods of conduction for either tube or a low frequency of operation in this type of multivibrator, it becomes necessary to use large capacitors and resistors in the grid circuit of either or both of the tubes.

In the present invention a multivibrator is proposed in which the plate conduction period for either or both of the tubes may be either an exceedingly long time, or a fairly long period with small circuit elements for designs where space is at a premium. Another feature of the present invention is that the plate voltage of the conducting tube has a linear rate of change and thus the circuit may be used to supply either a sawtooth or a square wave voltage wave form.

A primary object of the present invention is to generally improve multivibrators.

Another object of this invention is to provide a multivibrator capable of producing extremely low frequency square wave voltages.

A further object is to provide a multivibrator capable of producing square wave voltage gates having very long time durations.

A still further object is to provide a multivibrator capable of producing linear sawtooth voltage outputs.

These and other objects of the invention will be apparent from the following description when taken with the accompanying drawing which is a schematic diagram of one embodiment thereof.

Referring to the drawing, pentode electron tubes **11** and **12** are multivibrator tubes having their plate circuits alternately conducting and non-conducing. The anode **11A** of pentode **11** is connected to the positive voltage supply at terminal **13** through plate load resistor **14**, to the suppressor grid **12B** of pentode **12** through condenser **15**, and to its own control grid **11D** through condenser **16**. The anode **12A** of pentode **12** is similarly connected to the positive supply at terminal **13** through plate load resistor **20**, to the suppressor grid **11B** of pentode **11** through condenser **21**, and to its own control grid **12D** through condenser **22**. The cathodes **11E** and **12E** of pentodes **11** and **12** are connected together and in this embodiment to ground. The control grid **11D** of pentode **11** is returned to the common cathode connection through resistor **23**, and the control grid **12D** of pentode **12** is connected to the common cathode connection through resistor **24**. A voltage divider consisting of resistors **30**, **31**, and **32** is connected between the positive voltage supply at terminal **13** and the negative voltage supply at terminal **25**. The screen grid **11C** of pentode **11** is connected to the junction **30A** of resistors **30** and **31** and the suppressor grid **11B** of pentode **11** is connected to the junction **31A** of resistors **31** and **32**. Condenser **33** is connected in parallel with resistor **31**. Similarly resistors **40**, **41**, and **42** form a voltage divider between terminal **13** and terminal **25** with the screen grid **12C** of pentode **12** connected to the junction **40A** of resistors **40** and **41**, the suppressor grid **12B** of pentode **12** connected to the junction **41A** of resistor **41** and **42**, and condenser **43** connected in parallel with resistor **41**.

In the operation of this embodiment of the invention the plates **11A** and **12A** of pentodes **11** and **12** are alternately conducting and non-conducting. Assuming that the plate **12A** of pentode **12** has just completed the non-conducting portion of its cycle, condenser **22** is charged to the potential of the positive voltage supply at terminal **13**. When the plate **12A** of pentode **12** becomes conducting due to a positive voltage pulse on its suppressor grid **12B**, the plate **11A** of pentode **11** becomes non-conducting. This switching process is rapid due to regenerative action as explained later herein. When the plate **12A** of pentode **12** becomes conducting, the plate **12A** voltage drops causing the control grid **12D** of pentode **12** to drop due to coupling by condenser **22**. The drop in plate **12A** and control grid **12D** voltages in pentode **12** continues until the values of control grid **12D** and plate **12A** voltages satisfy the conditions for one point on the load line plotted on the tube characteristics for pentode **12** with load resistor **20** and the operating voltages present on the other tube elements. Condenser **22** starts discharging which raises the control grid **12D** voltage and allows the plate **12A** voltage of pentode **12** to drop which coupled back to the control grid **12D** of pentode **12** tends to keep the control grid **12D** voltage from rising. This feed back of voltage, commonly referred to as "Miller-feedback," causes the time constant of discharge for condenser **22** to be substantially equal to the product of resistor **24**, condenser **22** and the gain of pentode **12**. As this time constant is very large, the rise of voltage at the control grid **12D** of pentode **12** and the fall of voltage at the plate **12A** are very linear. The plate **12A** voltage of pentode **12** drops until it approaches the voltage of the screen grid **12C** of pentode **12**. In this operating condition the control grid **12D** voltage further increases the screen grid **12C** voltage drops due to an increased screen current. A portion of this drop in screen grid **12C** voltage of pentode **12** is coupled to the suppressor grid **12B** of pentode **12** by the voltage divider consisting of resistors **40**, **41**, and **42**. The lowering of suppressor grid **12B** voltage causes a decrease in plate **12A** conduction and a further increase in screen **12C** conduction. This cumulative reaction results in the plate **12A** conduction being rapidly cut off with a resulting rise in plate **12A** voltage. This rise of plate **12A** voltage of pentode **12** is coupled through condenser **21** as a positive voltage pulse to the suppressor grid **11B** of pentode **11** causing plate **11A** conduction to be initiated in pentode **11**. Pentode **11** then goes through an operation identical to that described above while the plate **12A** of pentode **12** remains non-conducting. At the end of the plate **11A** conduction period of pentode **11**, plate **12A** conduction is resumed in pentode **12** and the cycle is repeated.

In the operation of this multivibrator, the plate conduction periods for pentodes **11** and **12** may be equal or unequal depending upon the time constants of the respective pentodes. The circuit could be readily synchronized with an external source by applying a synchronizing voltage to either the screen grid or the plate of either pentode depending upon the time relations desired and the polarity of the synchronizing signal. It will be apparent to those skilled in the art that a square wave voltage output may be obtained from the screen grid or suppressor grid of either pentode and a sawtooth voltage waveform may be obtained from the plate of either pentode. A trigger voltage could likewise be obtained from the screen grid of either pentode for synchronizing other circuits.

The invention described in the foregoing specification need not be limited to the details shown, which are considered to be illustrative of one form the invention may take. The scope of the invention is defined by the appended claims.

What is claimed is:

1. An amplified time constant multivibrator comprising, first and second electron tubes each having at least a cathode, an anode, a control grid, a screen grid, and a suppressor grid, a first condenser connected between the anode and control grid of said first electron tube, a sec-

ond condenser similarly connected to said second electron tube, a first resistance connected between the cathode and control grid of said first electron tube, a second resistance similarly connected to said second electron tube, a positive voltage source, said first and second condensers adapted to be charged from said positive voltage source, and to be discharged through said first and second resistors with amplified time constants, and a resistance-capacitance coupling from the anode of each of said electron tubes to the suppressor grid and screen grid of the other of said electron tubes, said resistance-capacitance coupling circuits used to initiate plate conduction in one of said electron tubes when plate conduction in the other of said electron tubes ceases, the plate conduction time for each of said electron tubes being dependent upon said amplified time constants.

2. An amplified time constant multivibrator producing sawtooth and square wave voltages of long duration comprising, first and second electron tubes having at least a cathode, an anode, a control grid, a screen grid, and a suppressor grid, a first condenser connected between the anode and control grid of said first electron tube, a second condenser similarly connected to said second electron tube, a first resistance connected between the cathode and control grid of said first electron tube, a second resistance similarly connected to said second electron tube, a positive voltage source, said first and second condensers adapted to be charged from said positive voltage source, and to be discharged, with amplified time constants through said first and second resistors and said first and second electron tubes, a negative voltage source, a first resistance-capacitance voltage divider between said positive voltage supply and said negative voltage supply, the suppressor grid and screen grid operating potential of said first electron tube being obtained from said first resistance-capacitance voltage divider, a second resistance-capacitance voltage divider similarly connected to said second electron tube, and third and fourth condensers connected between the anode of each of said first and second electron tubes and the suppressor grid of the other, the coupling of said third and fourth condensers initiating plate conduction in one of said electron tubes when plate conduction ceases in the other, the length of period of plate conduction in each of said first and second electron tubes depending upon the amplified time constant in the control grid circuit of the electron tube having plate conduction.

3. A multivibrator comprising, first and second electron tubes, each of said electron tubes having at least an anode, a control grid, a suppressor grid and a cathode, means coupled to said tubes for alternately initiating anode conduction in said tubes, said means including, a coupling between the anode of said first tube and the suppressor grid of said second tube for initiating anode conduction in said second tube at the cessation of anode conduction in said first tube, a coupling between the anode of said second tube and the suppressor grid of said first tube for initiating anode conduction in said first tube at the cessation of anode conduction in said second tube, a first capacitor coupled between the anode and the control grid of said first tube, a first resistor coupled between the control grid and the cathode of said first tube, a second capacitor coupled between the anode and the control grid of said second tube, a second resistor coupled between the control grid and the cathode of said second tube, said first capacitor charging during the anode conduction of said second tube and discharging through said first resistor and said first tube during the anode conduction of said first tube, said second capacitor charging during the anode conduction of said first tube and discharging through said second resistor and said second tube during the anode conduction of said second tube.

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