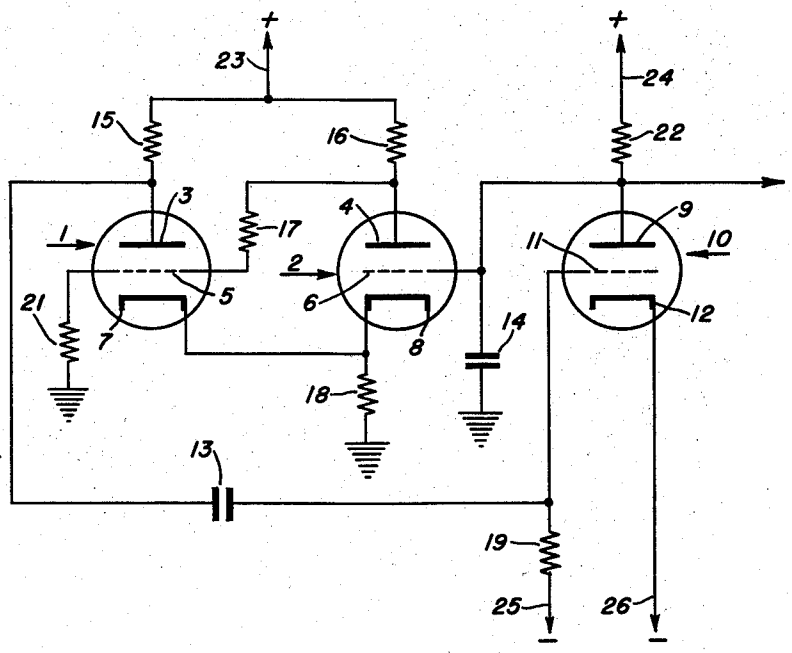
April 28, 1959 F. W. SIPPACH, JR., ET AL 2,884,525

SAWTOOTH WAVE GENERATOR

Filed March 5, 1956



FREDERICH W. SIPPACH JR.
and KURT STRAHLBERG
INVENTORS

BY
Rudolph J. Lunick
ATTORNEY

United States Patent Office 2,884,525
Patented Apr. 28, 1959

2,884,525

SAWTOOTH WAVE GENERATOR

Frederich W. Sippach, Jr., Millburn, N.J., and Kurt Strahlberg, Astoria, N.Y., assignors, by mesne assignments, to Daystrom, Incorporated, Murray Hill, N.J., a corporation of New Jersey

Application March 5, 1956, Serial No. 569,533

3 Claims. (Cl. 250—36)

This invention relates to a sawtooth wave generator and more particularly to such a generator wherein the trailing edge of the wave, that is the drop back portion of the wave form from the end of one linear time rise to the start of the next, is of very short time duration.

Sawtooth wave generators are commonly used in oscilloscope circuits to cause the electron beam to move at a uniform rate over the face of the cathode ray tube. The output of the sawtooth wave generator is connected to the deflection plates of the cathode ray tube and the uniformly increasing voltage wave form causes a trace of uniform rate to appear on the tube. The ideal sawtooth wave oscillator or generator would provide a wave form such that the retrace time for the electron beam was of zero duration. This is not possible with a conventional sawtooth wave generator. By the use of the improved sawtooth wave generator of this invention, however, retrace time may be improved over 10,000 percent over the retrace time of conventional sawtooth wave generators.

An object of this invention is the provision of a sawtooth wave generator of the kind in which th trailing edge of each sawtooth wave is of shorter time duration than provided by known generators of comparable simplicity and otherwise comparable performance.

An object of this invention is the provision of a sawtooth wave generator comprising a sawtooth wave multivibrator which includes a capacitor which is charged by a voltage source through a resistor, said multivibrator having an output which is coupled to the input grid of an output discharge tube, said discharge tube providing a low resistance path through which the said capacitor may be discharged.

An object of this invention is the provision of a sawtooth wave generator including an asymmetrical multivibrator having a first and second valve, each of said valves having an anode, cathode and at least a control grid therebetween, the cathodes being connected to a point or fixed potential through a common impedance, the anodes being connected to a point of fixed potential through separate impedances, the anode of the second valve being connected to the grid of the first valve through an impedance, the grid of the second valve being connected to a capacitor and resistor, said capacitor and resistor being connected in series across a source of constant potential whereby the capacitor may charge through the said resistor; an output discharge valve, having an anode, cathode and at least a control grid therebetween, the anode of the first valve being coupled to the grid of the output discharge valve through a coupling capacitor, the anode of the output discharge valve being connected to the grid of the second valve, the cathode of the output discharge valve being connected to a point of negative fixed potential, said output discharge valve providing a low impedance path whereby the said capacitor may discharge.

These and other objects and advantages of the invention will become apparent from the following description when taken with the accompanying drawing. It will be understood, however, that the drawing is for purposes of illustration and is not to be construed as defining the scope or limits of the invention, reference being had for the latter purpose to the appended claims.

The single drawing is a schematic circuit diagram of our improved sawtooth wave generator.

Referring to the drawing, an asymmetrical multivibrator circuit, which includes triode tubes **1** and **2**, is shown having an output discharge circuit which includes an output discharge tube **10**. The multivibrator circuit is of a conventional design and includes a common cathode resistor **18** which is connected to the cathodes **7** and **8** of the tubes **1** and **2**, respectively, and thence to ground potential. The anodes **3** and **4** are connected to a positive voltage source through the resistors **15** and **16**, respectively, by means of a lead **23**. The anode **4** of the tube **2** is connected through the resistors **17** and **21**, which resistors form a voltage divider, to ground potential. The point between the resistors **17** and **21** is connected to the grid **5** of the tube **1**. The grid **6** of the tube **2** is connected between the capacitor **14** and the resistor **22**. The capacitor **14** and the resistor **22** are connected between a positive voltage source, by means of a lead **24**, and ground potential.

The output discharge tube **10** and associated circuitry provides means whereby the time duration of the trailing edge of the generated sawtooth wave form is reduced to an extent not heretofore obtained by conventional sawtooth wave generators. The cathode **12** of the tube **10** is connected to a source of negative supply through a lead **26**, while the anode **9** is connected through the resistor **22** to a source of positive voltage through a lead **24**. A resistor **19** is connected between the grid **11** and another source of negative supply through a lead **25**. The input signal for the tube **10** is obtained through a capacitor **13** from the anode **3** of the tube **1** and is applied to the grid **11**. The output of the tube **10**, which is the desired sawtooth wave form, is taken from the anode **9**. The output from the anode **9** is also connected to the grid **6** of the tube **2** and the capacitor **14**.

A brief description of the operation of the novel sawtooth wave generator will make apparent the reason the sawteeth wave forms which are obtained from this circuit have an improved shape wherein the trailing edges of the sawteeth are of very short time duration. Consider first the multivibrator circuit alone which includes the tubes **1** and **2**, without the output discharge circuit, which includes the discharge tube **10**. Assume that the tube **1** is conducting and the tube **2** is cut off. This stable condition obtains so long as the grid **6** is sufficiently negative, and the grid **5** is sufficiently positive, each with respect to the common connections to the cathodes **7** and **8** of the two tubes. The capacitor **14** will charge up through the resistor **22** toward the positive potential which is connected to the resistor through the lead **24**, and as it does the voltage on the grid **6** becomes more and more positive. It is this charging up of the capacitor **14** through the resistor **22** which produces the leading or nearly linearly increasing edge of the sawtooth wave form. When the grid to cathode potential of the tube **2** becomes such that the tube **2** starts to conduct, the plate potential of the tube **2** drops. This drop in potential is coupled to the grid **5** of the tube **1** and cuts the tube off so that it ceases conducting. With tube **1** in the nonconducting state, relatively less current flows through the common cathode resistor **18** thereby making the grid **6** of the tube **2** highly positive with respect to the cathode **8**. The grid **6** becomes so positive with respect to the cathode **8** that the tube **2** draws grid current. The grid current which flows discharges the capacitor **14** and the trailing edge of the sawtooth wave form is thereby formed.

It will be noted that the discharge current passes through the resistor 18, therefore, the time it takes for the capacitor 14 to discharge depends upon the charge on the capacitor and the size of the resistor 18. The discharge time determines the time duration of the trailing edge of the sawtooth wave form. The amount of grid current which can be drawn through the cathode resistor 18, therefore, limits the abruptness of the trailing edge.

The output discharge tube 10 is included in the circuit of the sawtooth wave generator to maintain the trailing edge of the sawtooth wave of a minimum time duration or maximum abruptness. The tube 10 provides an extremely low resistance path through which the capacitor 14 may discharge. The cathode 12 of the tube 10 is directly connected to a negative voltage source, such as the other pole of the positive voltage source, through a lead 26 which helps provide sufficient anode to cathode potential for heavy conduction of the tube 10 during the discharge period of the capacitor 14. The grid of the tube 10 is connected through a resistor 19 to a negative potential by means of a lead 25 which negative potential is sufficient to keep the tube 10 cut off during the charging period of the capacitor 14. The capacitor charge portion of the cycle, which produces the leading edge of the sawtooth wave form, remains the same, then, as described above in the description of the circuit operation without the output discharge tube 10. Discharging of the capacitor 14, however, takes place mainly through the tube 10. At the instant that the tube 1 is driven toward cut off a large positive pulse is generated at the plate 3. This pulse is coupled through the capacitor 13 to the grid 11 of the tube 10 driving the tube into heavy conduction, at which time the capacitor 14 discharges rapidly. The minimum time duration of the trailing edge of the sawtooth wave is limited essentially only by the conduction capabilities of the tube 10. In this manner a sawtooth wave form having a trailing edge of extremely short time duration is produced. As the capacitor 14 discharges, the grid to cathode voltage of the tube 2 becomes more negative and causes the tube 2 to conduct less. The anode 4 of the tube 2, therefore, becomes more positive because less current flows through the anode resistor 16. The positive voltage is coupled to the grid 5 of the tube 1 through the resistor 17 and the tube 1 begins to conduct again. The tube 2 is driven toward cut-off by the current which flows through the common cathode resistor 18, which current causes the cathodes 7 and 8 to become positive. As the tube 1 conducts a negative-going pulse appears at the anode 3 thereof, which negative-going pulse is coupled to the grid 11 of the tube 10 through the capacitor 13. This negative-going pulse cuts off the output discharge tube 10 and the circuit returns to the point where the tube 1 is conducting and the tubes 2 and 10 are cut off. The sawtooth cycle then repeats itself.

Having now described our invention in detail in accordance with the requirements of the patent statutes what we desire to protect by Letters Patent of the United States is set forth in the following claims.

We claim:

1. A sawooth wave generator comprising an asymmetrically connected sawtooth wave multivibrator having a first and second valve, each of said valves having an anode, cathode and at least a control grid therebetween, the

cathodes being connected to a point of fixed potential through a common impedance, the anodes being connected to a source of fixed potential through separate impedances, the anode of the second valve being connected to the grid of the first valve through an impedance, the grid of the second valve being connected to a capacitor and a resistor, said capacitor and resistor being connected in series across a source of constant potential, whereby the capacitor charges through the said resistor; an output discharge valve having an anode, cathode and at least a grid therebetween, the anode of the first valve being connected to the grid of the output discharge valve through a coupling capacitor, the anode of the output discharge valve being connected to the connection between the capacitor and the resistor and to the grid of the second valve, the cathode of the output discharge valve being directly connected to a point of negative fixed potential, said output discharge valve thereby providing a low impedance path along which the said capacitor discharges.

2. A sawtooth wave generator comprising a sawtooth wave multivibrator having first and second valves, each of said valves having an anode, a cathode and at least a control grid therebetween, the cathodes being connected to a source of potential, the anodes being connected to a source of potential more positive than that of said first-mentioned source, the anode of the second valve being connected to the grid of the first valve, a capacitor connected in series with a resistor for charging it in series through said resistor, the end of said resistor remote from said capacitor being connected to a positive source of potential for charging said capacitor, an output valve having an anode, a cathode and a grid, the grid of the second valve being connected to a point on the lead between the capacitor and the resistor, the anode of the first valve being connected to the grid of the output valve through a coupling capacitor, the anode of said output valve being connected to a point on the lead between the capacitor and the resistor, and the cathode of said output valve being directly connected to a voltage source more negative than that of said first-mentioned voltage source, whereby when the generator operates said capacitor charges through the said resistor and discharges through the said output valve.

3. A generator as recited in claim 2, wherein the cathodes of the first and second valves are connected to said source of potential through a common impedance, the anodes are connected to their source of potential through separate impedances, wherein the connection between the anode of the second valve and the grid of the first valve is through an impedance, and wherein there is a connection from the grid of the output valve through a resistor to a voltage source more negative than that from which the capacitor charges.

References Cited in the file of this patent

UNITED STATES PATENTS

2,565,896	Webb	Aug. 28, 1951
2,767,378	Hass	Oct. 16, 1956

FOREIGN PATENTS

66,092	Netherlands	July 15, 1950
582,095	Great Britain	Nov. 5, 1946