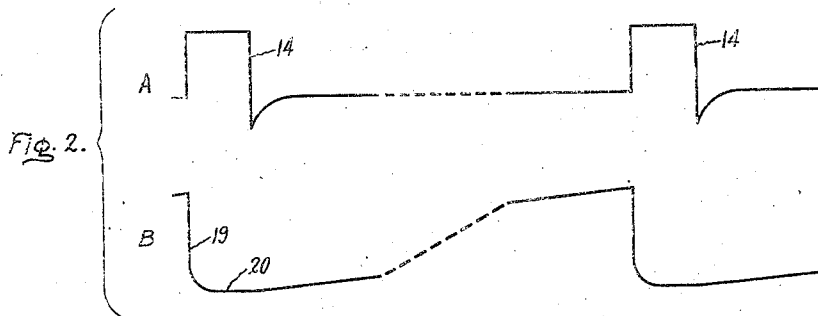
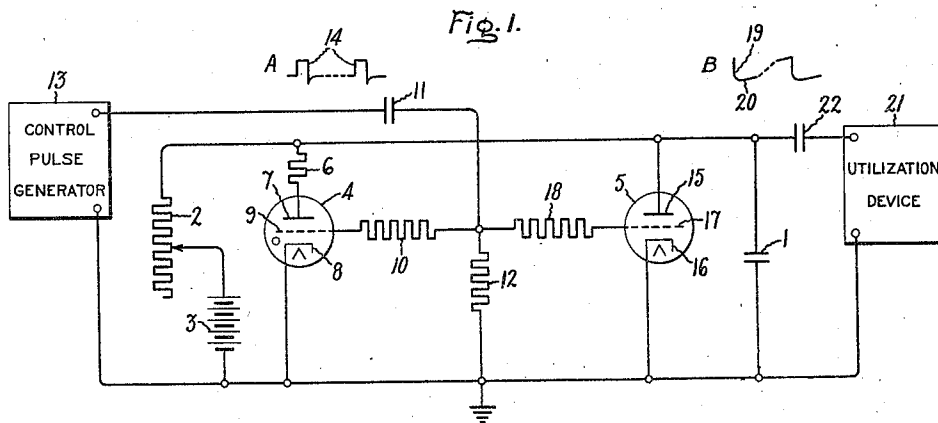


Feb. 24, 1948.

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SAWTOOTH WAVE GENERATOR

2,436,663

Filed Nov. 15, 1944



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UNITED STATES PATENT OFFICE

2,436,663

SAW-TOOTH WAVE GENERATOR

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Application November 15, 1944, Serial No. 563,465

4 Claims. (Cl. 250-27)

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My invention relates to generators for producing voltage variations of sawtooth form which may be employed for deflecting the electronic beam in cathode ray signal portraying devices. This application is a continuation-in-part of my copending application Serial No. 482,403, filed April 9, 1943, for Pulse systems and assigned to the same assignee as the present invention.

Cathode ray electron discharge devices having fluorescent screens on which signals are portrayed by the impingement thereon of a cathode ray beam are commonly employed for obtaining visual indications of high frequency signals. In signal translating systems such as radio locating apparatus of the echo type, the location of a distant object may be determined by the position of an abrupt vertical deflection in a normally horizontal trace, the distance between the beginning of the trace and the vertical deflection being a measure of the distance to the distant object. In order that the signal accurately may be portrayed without blurring, it is essential that the horizontal trace always begin at the same point on the screen, thereby insuring that vertical pulses will occur at the same point in registry, thereby avoiding lateral shifting of the vertical deflection and consequent blurring of the visual indication on the fluorescent screen. In order that the horizontal trace may begin at the same point on each occurrence thereof, it is necessary that the starting voltage of the scanning wave which controls the cathode-ray beam trace be the same throughout the operation of the sawtooth wave generator. Accordingly it is an object of my invention to provide an improved sawtooth wave generator in which each sawtooth rise begins at the same voltage regardless of the variations in the time between the sawtooth waves.

The novel features which I believe to be characteristic of my invention are set forth with particularity in the appended claims. My invention itself, however, both as to its organization and method of operation, together with further objects and advantages thereof, may best be understood by reference to the following description taken in connection with the accompanying drawing in which Fig. 1 represents diagrammatically a sawtooth wave generator embodying my invention, and Fig. 2 represents certain characteristics pertaining to the operation of the generator of Fig. 1.

The generator shown in Fig. 1 is of the type in which a capacitor is periodically charged and discharged to provide the desired wave form, the capacitor being charged from a suitable source

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through a resistance so that its charge increases substantially linearly and being discharged rapidly at predetermined intervals. The intervals between the time of discharge and the subsequent starting of the charging cycle may vary. However, an arrangement is provided for insuring that the starting of the charging cycle will always begin at the same voltage regardless of changes in the interval between discharge and the start of the next charge.

Referring now to the drawing, the generator shown in Fig. 1 comprises a capacitor 1 connected in series with a variable high resistance 2 across a suitable source of direct current indicated as a battery 3. In order to charge and discharge the capacitor 1 and thereby produce a sawtooth wave, two electron discharge devices 4 and 5 are connected in parallel with each other and with the capacitor 1, a current limiting resistance 6 being connected in series with the device 4 which is of the gaseous discharge type. The device 4 includes an anode 7, a cathode 8, and a control electrode 9. In order to render the device 4 alternately conducting and nonconducting and thereby effect the desired charging cycle of the capacitor 1, the control electrode 9 is connected through a limiting resistor 10 and by means of a coupling capacitor 11 and resistor 12 to a suitable apparatus 13 for generating a control voltage wave. The control voltage wave comprises positive pulses of square wave form. When these positive pulses are impressed on the control electrode 9, the device 4 is rendered conducting and the capacitor 1 is discharged rapidly therethrough. The square positive pulses as indicated at 14 on the curve A in both Figs. 1 and 2 may be of relatively short duration, whereas the interval between pulses is long. For example, a wave may comprise positive pulses 14 of the order of 12 microseconds duration occurring at intervals of 1200 microseconds. During the operation of the generator, the device 4 discharges the capacitor 1 very rapidly during the first portion of each of the positive pulses 14. However, as the voltage across the device 4 falls during the discharge of the capacitor, it reaches a value such that ionization ceases and the device becomes nonconducting. It is therefore necessary to provide some arrangement for preventing the starting of the charging cycle of the capacitor when the device 4 becomes nonconducting. It is in order to insure the complete discharge of the capacitor 1 to a fixed minimum voltage that the electron discharge device 5 is provided. This device is highly evacuated and includes an anode 15, a cathode 16, and a control

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electrode 17. The control electrode 17 is connected through a limiting resistor 18 across the coupling resistance 12 so that it is excited simultaneously with the control electrode 9 by operation of the generator 13. Since the device 5 is in parallel with the device 4, it provides a second discharge path for the capacitor 1 and prevents any rise of voltage should the device 4 become nonconducting due to the fall of voltage below that necessary to maintain ionization of the gas. Since the pulses 14 are of square wave form, the voltage on the control electrode 17 remains constant and the impedance of the device 5 also remains at a low fixed value for the duration of each pulse 14. Since the voltage of the source 3 is maintained constant, the capacitor 1 is discharged to the same voltage during each pulse 14 when the adjustable resistance 2 is set so that the current flowing through it remains constant during the latter portions of the pulses 14. As indicated in the lower curve B of Fig. 2, which represents the change with time of the voltage across the capacitor 1, the voltage falls suddenly at the beginning of each of the pulses 14 as indicated at 19 and quickly reaches a constant value 20 which prevails throughout the remainder of the pulse 14. It is thus possible for the durations of the pulses 14 to vary within a wide range without changing the minimum voltage to which the capacitor 1 is discharged. The charging rate of the capacitor 1 is substantially a linear relation, the resistance 2 being high. At the end of the linear rise the positive pulse 14 renders both devices 4 and 5 conducting to discharge the capacitor 1 to its minimum voltage determined by the impedance of the device 5, and at the end of the square pulse 14 both devices are rendered nonconducting and the capacitor begins to charge.

The sawtooth wave B generated in the apparatus shown in Fig. 1 may be employed to energize the deflecting elements of a cathode ray device (not shown) which may be incorporated in a utilization device indicated at 21, the device 21 being coupled to the generating apparatus through the capacitor 22.

From the foregoing it is readily apparent that I have provided a simple circuit arrangement for producing a sawtooth wave the linear rising portion of which will always start at the same minimum voltage regardless of wide variations in the duration of the intervals between successive sawtooth portions of the wave.

While I have described and illustrated a specific embodiment of my invention, other modifications will occur to those skilled in the art. I do not therefore desire my invention to be limited to the particular arrangement illustrated and described and I intend by the appended claims to cover all modifications within the spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. A generator for producing voltage variations of sawtooth form comprising a source of direct current, a capacitor, resistance means for connecting said capacitor across said source, two electron discharge devices connected in parallel with each other and with said capacitor, each of said devices having an anode and a cathode and a control electrode, means for impressing on said control electrodes a periodic voltage wave having square pulses in the positive direction, one of said devices being rendered highly conducting during the first portion of each of said square pulses and the other of said devices having a pre-

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determined resistance during said square pulses whereby said capacitor is charged in the interval between said pulses and is rapidly discharged during each of said pulses to a fixed value of voltage dependent upon the resistance of said other device.

2. A generator for producing voltage variations of sawtooth form comprising a source of direct current, a capacitor, resistance means for connecting said capacitor across said source, two electron discharge devices connected in parallel with each other and with said capacitor, each of said devices having an anode and a cathode and a control electrode, means for impressing on said control electrodes a periodic voltage wave having square pulses in the positive direction, one of said devices being charged with a gas whereby said device is rendered highly conducting and effects a rapid discharge of said condenser during the first portion of each of said square pulses, the other of said devices having a predetermined resistance for the duration of each of said square pulses whereby said capacitor is discharged to the same predetermined voltage during each of said square pulses and each charging of said capacitor in the intervals between said pulses begins at the same voltage.

3. A generator for producing voltage variations of sawtooth form comprising a source of direct current, a capacitor and a resistance connected in series with said source, two electron discharge devices connected in parallel with each other and with said capacitor, each of said devices having an anode and a cathode and a control electrode, means for impressing on said control electrodes a periodic voltage wave having square pulses in the positive direction, said means including limiting resistors in series with the control electrodes of said devices, one of said devices being rendered highly conducting during the first portion of each of said square pulses and the other of said devices having a predetermined resistance during said square pulses whereby said capacitor is charged in the interval between said pulses and is rapidly discharged during each of said pulses to a fixed value of voltage dependent upon the resistance of said other device.

4. A generator for producing voltage variations of sawtooth form comprising a direct current source, a capacitor and a resistance connected in series across said source, two electron discharge devices each having a cathode and an anode and a control electrode, said devices being connected in parallel with each other and with said capacitor, said anodes being connected to the positive terminal of said source and said cathodes to the negative terminal thereof, means for impressing simultaneously on both of said control electrodes square pulses of predetermined duration equal to the desired interval between sawtooth waves whereby said devices are rendered conducting to discharge said capacitor, said capacitor being charged in the intervals between said pulses to produce a sawtooth wave, one of said devices being of the gaseous discharge type for facilitating the rapid discharge of said capacitor during the first portion of each of said square pulses and the other of said devices maintaining a predetermined minimum voltage across said capacitor for the remainder of the duration of each of said square pulses whereby the sawtooth wave beginning at the end of each square pulse starts at the same minimum voltage.

DONALD E. NORGAARD.