

April 24, 1956

R. F. CASEY
SWEEP CIRCUIT

2,743,357

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2 Sheets-Sheet 1

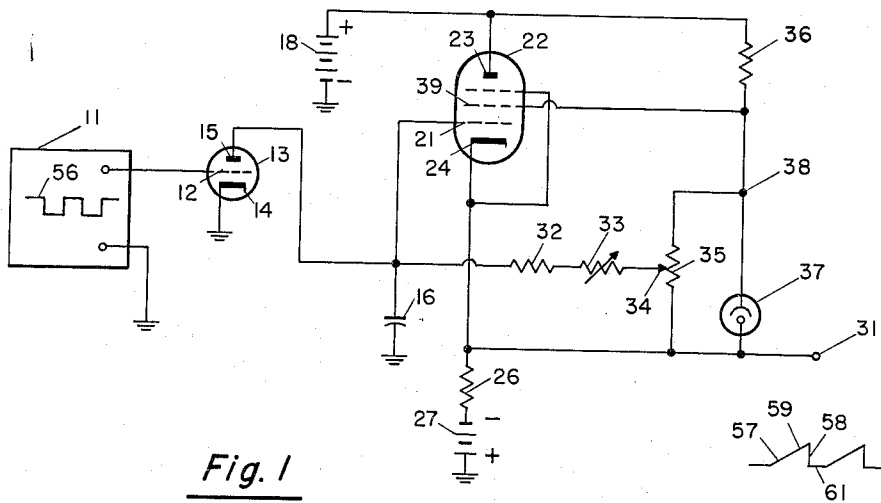


Fig. 1

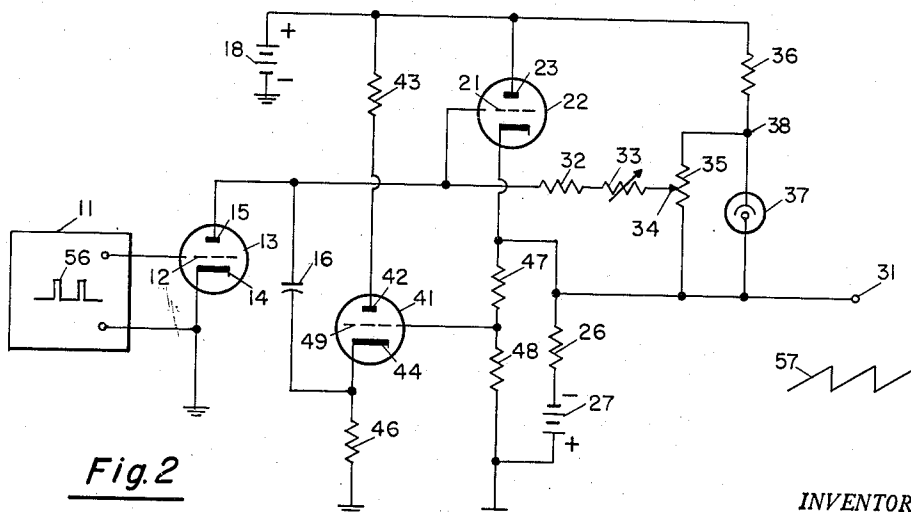


Fig. 2

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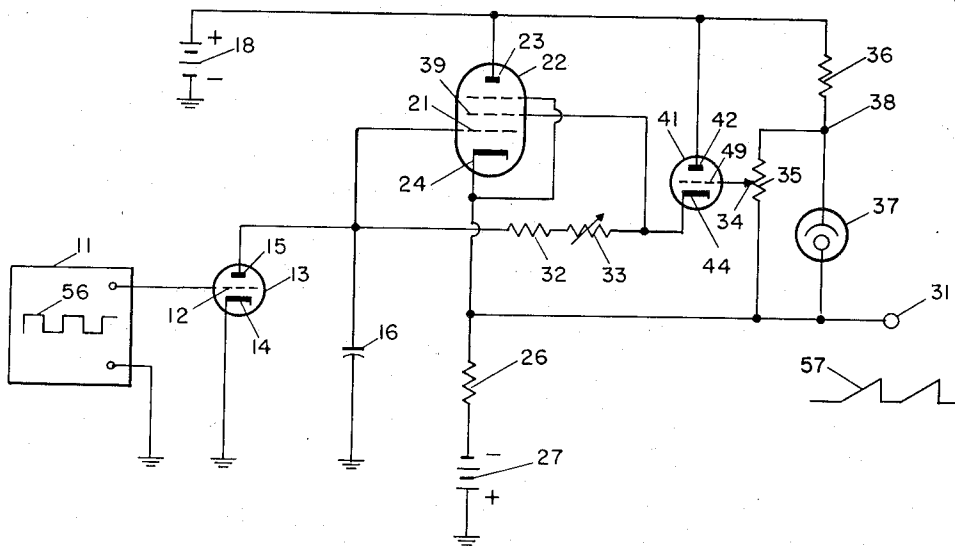


Fig. 3

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SWEEP CIRCUIT

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7-Claims. (Cl. 250-27)

This invention relates to signal forming electrical circuits and particularly to circuits for producing sawtooth voltage waves. Such waves are useful, for example, in causing an electron beam to scan a phosphor screen in a cathode ray tube.

An object of the invention is to provide a circuit for producing sawtooth waves having improved linearity.

Another object is to provide such a circuit which has a wide range of adjustable sweep speed rates.

A further object is to obtain a relatively large time duration sweep by charging a relatively small value of capacitance.

Other objects will in part be obvious and in part appear hereinafter.

The invention accordingly is embodied in a sweep circuit which includes a condenser for generating sawtooth voltage waves, the condenser being connected to a charging circuit and through a coupling circuit to output terminals, the coupling circuit providing non-linear signals opposed to non-linearity of the signals generated by the charging condenser so that the output obtained from the circuit is a corrected linear sweep signal, the invention being embodied in the combination of elements and arrangements of parts hereinafter set forth in detail.

In the drawing,

Figure 1 is a schematic diagram of a preferred embodiment of the invention; and

Figures 2 and 3 are schematic diagrams of circuits incorporating modifications of the circuit of Figure 1.

In Figure 1, a source 11 of keying signals is connected to a control electrode 12 of a discharge tube 13 having a cathode 14 which is grounded and an anode 15 connected to a sawtooth wave forming condenser 16. The condenser 16 is connected to a control electrode 21 of an output tube 22 having an anode 23 connected to a source 18 of voltage and a cathode 24 connected through an output load resistance 26 to a source 27 of negative voltage. An output terminal 31 is connected to the cathode 24 of the output tube 22. The condenser 16 is connected through a fixed resistance 32 and variable resistance 33 to an adjustable tap 34 on a potentiometer 35 which is connected between the output terminal 31 and a resistance 36 which in turn is connected to the voltage source 18. A constant voltage device 37 is connected between the output terminal 31 and the junction 38 between the potentiometer 35 and the fixed resistance 36. A screen grid 39 in the output tube 22 is connected to the junction 38.

In Figure 2 the circuit elements which correspond to the elements of Figure 1, are given the same reference numerals as in Figure 1. Figure 2 includes a feedback tube 41 having an anode 42 connected through a resistance 43 to the voltage source 18, and a cathode 44 connected to the remaining end of the condenser 16 and through a resistance 46 to ground. Series-connected resistances 47 and 48 are connected between the output terminal 31 and ground, and the junction therebetween is connected to control electrode 49 of the feedback tube

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41. These resistances 47, 48, may, if desired, be a potentiometer.

In Figure 3, the circuit elements which correspond to the elements shown in Figures 1 and 2 are given the same reference numerals as they have in Figures 1 and 2. Figure 3 includes a feedback tube 41 having its control electrode 49 connected to the tap 34, an anode 42 connected to the voltage source 18, and a cathode 44 connected to an end of the variable resistance 33. In this embodiment, the variable resistance 33 is not directly connected to the tap 34 as it is in the embodiments of Figures 1 and 2. The screen grid 39 of the output tube 22 is connected to the cathode 44 of the feedback tube 41.

The circuit of Figure 1 operates as follows: The synchronizing source 11 applies a synchronizing or gating signal 56 to the control electrode 12 of the discharge tube 13. The synchronizing signal 56 is preferably in the form of a square wave or rectangular pulse. Normally, the discharge tube 13 is conducting and thus maintains the sawtooth wave forming condenser 16 in a substantially discharged condition. When the voltage of the control electrode 12 is made relatively negative by the synchronizing signal, the discharge tube 13 ceases to be conductive and the sawtooth wave forming condenser 16 begins to charge from the voltage source 18 through the resistances 32, 33, 35 and 36. While the condenser 16 is thus charging, a positively increasing voltage is applied by it to the control electrode 21 of the output tube 22. This output tube, being connected in a cathode-follower circuit provides at its cathode 24 and at the output terminal 31, a positively increasing voltage 57.

The positively increasing voltage 57 is applied through the constant voltage device 37 to the junction 38, thereby improving linearity as will be described hereinafter. The constant voltage device 37 may be a gas-filled regulator tube as is shown schematically in the drawing, or may be an equivalent device such as thyrite.

When the negatively increasing voltage applied to the control electrode 12 of the discharge tube 13 by the synchronizing signal source 11 is interrupted, the discharge tube 13 becomes conductive, and the sawtooth wave forming condenser 16 is rapidly discharged, thus forming a steeply shaped negatively increasing voltage 58 in the output voltage wave. In the output voltage wave, the sawtooth portion 57 may be utilized to control the sweep or deflection of an electron beam in a cathode ray tube; the steep portion 58 provides the return sweep.

The constant voltage device 37 functions to provide improved linearity of the output signal, as follows: Normally, the sawtooth wave forming condenser 16 does not charge in a linear manner; it tends to charge relatively rapidly at first and then more slowly as it becomes more fully charged. The rising portion 57 of the output signal would thus tend to flatten out near its apex 59. This undesirable effect is minimized because of the novel circuit connection whereby the output voltage is coupled through the constant voltage device 37 to the junction 38. The positively increasing output voltage is thus fed back to the condenser 16. In effect, the charging voltage for the condenser 16 becomes increased in accordance with the positive polarity rise in the output voltage, due to the feedback. This increased charging voltage tends to cause the condenser 16 to charge faster than it normally would, the increase in charging rate becoming continuously greater during the progress of the charging. This increased charging rate counteracts the normal tendency of the charging rate to decrease. Thus, improved linearity is achieved.

The constant voltage device 37, having a fixed voltage drop thereacross, allows the various circuit elements to

have the desired values of voltage, and at the same time is capable of feeding back the entire magnitude of output voltage to the junction 38. This linearity correcting feedback occurs at all sweep speeds, including very slow speeds.

The negative voltage source 27 functions to provide a greater magnitude of output voltage to regulator tube 37 than would otherwise occur. The rate of charging of the condenser 16 and hence the steepness of the positively increasing portion 57 of the output signal, depends upon the adjustment of the variable resistances 33 and 35, and also on the magnitude of the voltage source 18 and of the capacitance 16. Adjustment of the tap 34 provides a degree of control over the amount of feedback through the constant voltage device 37, in addition to controlling the sweep speed. An advantage of adjusting the charging rate by means of the potentiometer 35, is that this potentiometer can have a considerably lower value of resistance than the variable resistance 33, and hence is more stable and more easily calibrated in terms of sweep speed. The fixed resistance 36 is preferably small enough in value so that the constant voltage device 37, if a gas filled tube, is conductive at all times, and does not tend to extinguish during the most positive excursion of the output voltage when the variable resistance 33 is set at its minimum value.

When the synchronizing signal 56 is as shown in Figure 1 of a substantially square wave shape, the output signal will have non-sweep portions 61 between each sweep and return portions 57 and 58. The non-sweep portions 61 may be substantially eliminated if desired, by providing a synchronizing signal 56 having relatively narrow positive portions as is shown in Figure 2.

It will be seen from the above that the circuit of Figure 1 provides an output sawtooth wave voltage which is substantially linear. However, there is a very small percentage of the wave form which is non-linear, the wave deviating slightly from complete linearity immediately to the left of the apex 59 of the waveform of Figure 1. In order to eliminate this minute non-linear portion of the waveform the circuits of Figures 2 or 3 may be utilized.

The circuit of Figure 2 operates in substantially the same manner as the circuit of Figure 1, but improved linearity is provided by the feedback tube 41 which is connected as a cathode follower and functions as a well-known "starved" amplifier. A portion of the output signal, obtained from the junction between the cathode load resistances 47 and 48 of tube 22, is applied to the control electrode 49 of the feedback tube 41. A corresponding sawtooth shaped voltage wave with the teeth spaced and occurring during the non-linear portions of the output thus is produced at the cathode resistance 46; this feedback voltage is applied to the lower side of the sawtooth wave forming condenser 16. Therefore, as the output signal becomes increasingly positive in polarity, a corresponding positive polarity voltage is applied to the lower side of the condenser 16, thereby tending to increase the voltage on the condenser 16 at an increasingly faster rate as it becomes increasingly charged. This feedback voltage to the lower side of the condenser 16, combined with the feedback voltage to the higher side thereof through the constant voltage device 37, provides better linearity of the positively increasing portion 57 of the output signal. The resistance 46 forms a part of the resistance through which the condenser 16 is charged from the voltage source 18.

The circuit of Figure 3 operates in substantially the same manner as does the circuit of Figure 2, except that the feedback tube 41 is in the feedback loop going to the higher side of the condenser 16, along with the constant voltage device 37. The positively increasing feedback voltage applied through the constant voltage device to the junction 38, is applied through the potentiometer 35 to the control electrode 49 of the feedback tube 41. The corresponding feedback voltage which is developed at the cathode 44 of the feedback tube 41 is applied through

the fixed resistance 32 and the variable resistance 33 to the condenser 16. The condenser 16 is charged from the voltage source 18, through the feedback tube 41 between its anode 42 and cathode 44. The tube 41 forms a part of the charging resistance for the condenser 16, the output electrode 44 thereof being effectively connected to a tap on the total charging resistance.

The feedback voltage is applied to the screen grid 39 of the output tube 22, in the embodiments of Figures 1 and 3. This positively increasing feedback voltage at the screen grid 39 causes the output tube to draw increasingly greater current during the time in which the output wave is changing in a positive direction, thereby reducing the tendency for the output voltage wave form to flatten out when it becomes more positive in polarity.

This connection has been found to improve the linearity of the output sawtooth signal. The output linearity can be further improved by operating the feedback tube 41 on a curved part of its operating characteristic so that the feedback voltage produced at its cathode 44 is non-linear in a manner opposite to the non-linearity of the output voltage. The novel circuits herein described are capable of providing overcorrection so that, if desired, the output voltage may be made non-linear in a manner complementary to its uncorrected non-linearity.

While a preferred embodiment of the invention and modifications thereof have been described, still other modifications will be apparent to those skilled in the art. The scope of the invention is defined in the following claims.

What is claimed is:

1. An electrical circuit comprising a condenser, a voltage source, a charging circuit comprising resistance connected between said voltage source and said condenser, a coupling circuit connected to said condenser and having an output terminal, and a constant voltage device electrically connected between said output terminal and a point on said resistance of said charging circuit.

2. An electrical circuit comprising a condenser, a voltage source, a charging resistance connected between said voltage source and said condenser, a cathode follower circuit having a control electrode connected to said condenser and having an output terminal, and a constant voltage device electrically connected between said output terminal and a point on said resistance.

3. The circuit in accordance with claim 2, in which a potentiometer having an adjustable tap is connected in parallel with said constant voltage device, and said tap is connected through a part of said charging resistance to said condenser, the part of said potentiometer between said tap and an end thereof forming another part of said charging resistance.

4. An electrical circuit comprising a condenser, a voltage source, a charging circuit connected between said voltage source and said condenser, a coupling circuit connected to one side of said condenser and having an output terminal, a constant voltage device connected between said output terminal and said charging circuit, and a cathode follower feedback circuit having an input electrode connected to receive signals from said output terminal and having an output electrode connected to said charging circuit.

5. The circuit in accordance with claim 4, in which said cathode follower feedback circuit includes an electronic tube having an anode and a cathode connected in series within and forming a part of said charging circuit.

6. The circuit in accordance with claim 4, in which said cathode follower feedback circuit includes an electronic tube having a cathode connected to one side of said condenser other than the side thereof to which said coupling circuit is connected.

7. An electrical circuit comprising a condenser, a source of voltage, a resistance connected between one side of

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said condenser and said source of voltage, an output coupling tube having an input electrode connected to said side of said condenser and having an output electrode, and a feedback tube having an input electrode connected to receive signals from said output electrode and an output electrode connected to the remaining side of said condenser.

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