May 7, 1957 B. CUTLER ET AL 2,791,688

SWEEP GENERATOR USING NONLINEAR SWEEPS

Filed Feb. 9, 1953

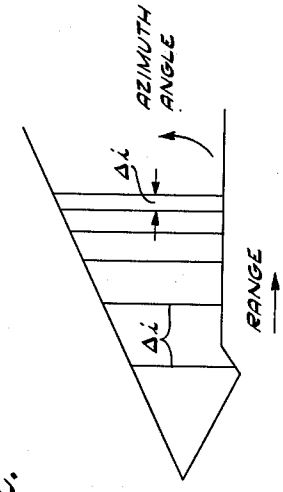
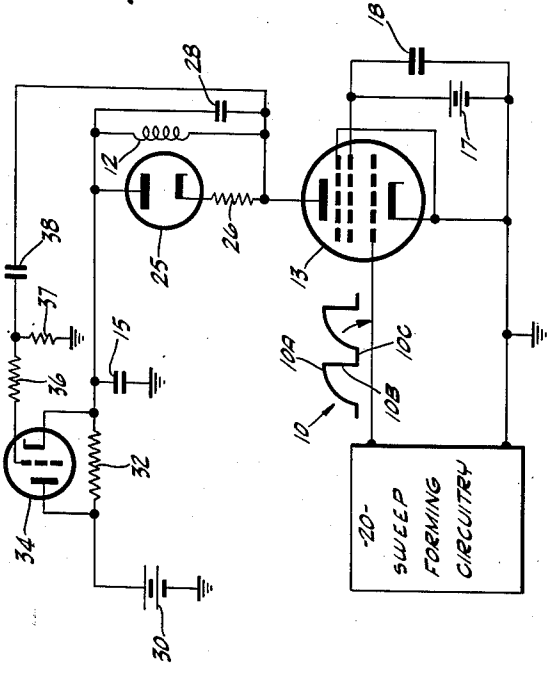



FIG. 1.

FIG. 2.



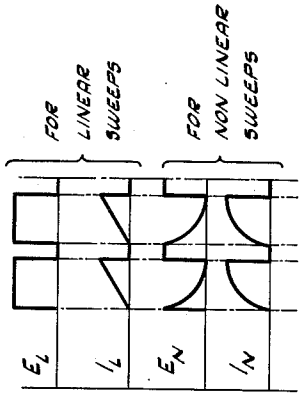




FIG. 3.

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United States Patent Office 2,791,688
Patented May 7, 1957



2,791,688

# SWEEP GENERATOR USING NONLINEAR SWEEPS

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Application February 9, 1953, Serial No. 335,786

9 Claims. (Cl. 250—27)

The present invention relates to improved circuitry for supplying energy to a load wherein the current flows at a decreasing rate as a function of time; and, more specifically, relates to improved circuitry for supplying current to a deflection coil of a cathode ray tube in the production of exponential or logarithmic sweeps of a cathode ray beam.

In general, the present invention involves apparatus for supplying energy to a deflection coil of a cathode ray tube in the production of logarithmic or exponential sweeps of the character shown in Figure 1 wherein such sweeps are produced by current flowing through the deflection coil, the current flowing at a decreasing rate, either exponential or logarithmic in character. For this purpose, the deflection coil is serially connected in a circuit which includes a grid controlled tube, the deflection coil, and a special power supply which embodies important features of the present invention. The power supply is such that it supplies a relatively high voltage at the start of a cathode beam sweep, the magnitude of such voltage, however, decreasing continuously with time so that, at the end of the cathode beam sweep, the voltage is a minimum. The power supply involves a condenser which is charged through a resistance during the generation of the sweep. At the end of the sweep, the voltage on the anode of the aforementioned tube, during the flyback time, increases, and this increase in anode voltage is transferred to effect a substantial short-circuiting of the aforementioned resistance, whereby the condenser may assume a substantially fully charged condition preparatory to the start of the next cathode beam sweep.

It is therefore an object of the present invention to provide improved circuitry for accomplishing the aforementioned functions, operation and result.

A specific object of the present invention is to provide an improved power supply useful in supplying a load which requires a current flowing at a decreasing rate.

Another object of the present invention is to provide improved circuitry allowing the use of a relatively small power amplifier tube which is controlled to produce the aforementioned current flowing at a decreasing rate.

Another object of the present invention is to provide an improved arrangement of this character in which the power dissipation in the power amplifier tube supplying the deflection coil is greatly minimized.

Another object of the present invention is to provide an improved arrangement of this character for minimizing space requirements and improving mechanical structure and reliability.

The features of the present invention which are believed to be novel are set forth with particularity in the appended claims. This invention itself, both as to its organization and manner of operation, together with further objects and advantages thereof, may be best understood by reference to the following description taken in connection with the accompanying drawings in which:

Figure 1 shows a presentation produced on the face of a cathode ray tube by supplying an increasing current



to a deflection coil of the cathode ray tube at a decreasing rate in accordance with certain features of the present invention;

Figure 2 is a schematic representation of apparatus useful in practicing the present invention; and such apparatus embodies features of the present invention; and

Figure 3 shows different voltage and current wave forms useful in producing a linear sweep as well as for producing a nonlinear sweep in accordance with features of the present invention.

Referring to the drawings, Figure 1 shows a presentation on a cathode ray tube produced by cathode beam sweeps, each starting from a central origin point **0**. The angular position of each sweep represents, for example, the azimuthal position of an antenna beam scanning through space, while the length of the sweeps represents range. A presentation of this character involving the use of nonlinear sweeps, as shown in Figure 1, is described and claimed in the copending patent application of Homer G. Tasker et al., Serial No. 175,168, now Patent No. 2,737,654. This presentation is formed by sweeps which travel outwardly from the point **0** with ever decreasing speeds. To accomplish this result, the current flowing through the deflection coil of the cathode ray tube increases at a decreasing rate.

Normally, in the production of linear sweeps, as indicated in Figure 3, a voltage wave $E_L$ is supplied to the deflection coil. This waveform is generally square or trapezoidal so that the current through the induction coil $I_L$ increases at a uniform rate represented by the straight inclined line. This follows from the following equation

$$E = L\frac{di}{dt}$$

Thus, in generating linear sweeps, when the voltage is of substantially constant magnitude, the current changes at a uniform rate.

Heretofore, in developing sweeps of the character illustrated in Figure 1, a power amplifier tube was serially connected with the deflection coil and a power supply producing a substantially uniform voltage. Such power amplifier tube was grid controlled and had control voltages of the character illustrated at **10** in Figure 2 applied to the control grid of the same. Such an arrangement required a relatively large power amplifier tube because of the relatively large amounts of power required to be dissipated by the same upon the following considerations. Using a constant voltage power supply of, for example, 700 volts, at the beginning of a cathode beam sweep,

$$L\frac{di}{dt}$$

is about 450 volts and during the latter portion of the sweep it is approximately 75 volts. This means that there is approximately 625 volts across the final power amplifier tube when it is drawing the maximum current, i. e., about 300 milliamperes. Thus, the power dissipation required for a power amplifier tube producing nonlinear sweeps and using a voltage source which is substantially constant in magnitude, is much larger than that required for equivalent linear cathode beam sweeps. Thus, one feature of the present invention pertains to automatic reduction of the magnitude of the supply voltage during the formation of the sweeps to such an extent that the voltage drop across the power amplifier tube remains substantially constant during the sweep interval, thereby greatly reducing the power required to be dissipated in the final amplifier tube and allowing a smaller tube than was heretofore required for the same purpose.

Thus, the apparatus as described in detail later serves to produce a current flow through the deflection coil of the character illustrated at $I_N$ in Figure 3, using an ap-

plied voltage to such deflection coil of the character illustrated at $E_N$ in Figure 3.

In Figure 2, the deflection coil **12** of the cathode ray tube is connected in the anode current path of the final power amplifier tube **13** which may be a tetrode or a beam power type tube. This series circuit comprising the coil **12** and tube **13** is supplied from a voltage source which, for all intents and purposes, as will be more evident from the following description, may be considered to be the voltage developed across the condenser **15** having its ungrounded terminal connected to one terminal of the coil **12**, the other terminal of coil **12** being connected to the anode of tube **13** and the cathode of tube **13** being grounded. A voltage source **17** is connected between the screen grid and cathode of tube **13**, such source **17** being bypassed by bypass condenser **18**.

The control grid of tube **13** is coupled to "sweep-forming circuitry" **20** which is of the character described in the aforementioned copending application Serial No. 175,168, for producing a voltage wave of the character illustrated at **10**. Such voltage waveform has a rising portion which rises at a decreasing rate, such portion having the reference numeral **10A**; and such waveform **10** has the vertical portion **10B** which represents that the magnitude of the voltage changes from its maximum value to its minimum value in a very short time interval. The small horizontal portion **10C** of the wave **10** represents a time interval during which the cathode beam may move from its maximum deflected position to its central original position 0 in Figure 1. This time represented by the horizontal portion **10C** represents the so-called "flyback time."

The diode rectifier tube **25** has its anode connected to the ungrounded terminal of condenser **15** and its cathode connected to one terminal of resistance **26**, the other terminal of resistance **26** being connected to the anode of tube **13**. It is observed that the serial circuit comprising tube **25** and resistance **26** is connected in shunt with the deflection coil **12** and serves to dampen oscillations which otherwise may result in a large magnitude voltage during the flyback time, i. e., during the time the magnetic flux originally produced by coil **12** collapses.

The voltage source **30** has its ungrounded terminal connected to the ungrounded terminal of condenser **15** through the resistance **32**. This resistance **32** is effectively shunted by tube **34** during the flyback time or period; but, during the sweep period, the condenser **15** is charged through such resistance **32**. For this purpose, the tube **34**, which is normally nonconducting, has its anode connected to one terminal of resistance **32** and its cathode connected to the other terminal of resistance **32**. The control grid of tube **34** is returned to ground through the serially connected resistances **36** and **37**, the junction point of which is connected through condenser **38** to the anode of tube **13**.

During the sweep cycle, i. e., during the time when the voltage **10** rises, as indicated at **10A**, the voltage on the anode of tube **13** is depressed to such an extent to cause the tube **34** to become nonconducting so that, at this particular time, the condenser **15** which is supplying energy to the coil **12** is simultaneously being charged through resistance **32**. At the end of the sweep, the voltage on the anode of tube **13** suddenly rises and this rise in voltage is transferred through the condenser **38** to the control grid of tube **34** to thereby render such tube **34** conducting, and in such case, resistance **32** is effectively short-circuited and the condenser **15** is charged through a circuit of relatively low resistance, whereby the voltage on condenser **15** may rise to its maximum value preparatory to the beginning of the next sweep. During such next sweep, tube **34** is rendered nonconducting and condenser **15** is being discharged at a controlled rate determined by the magnitude of resistance **32** in its relationship to the magnitude of the capacitance **15**, i. e., by the time constant of the circuit comprising resistance **32** and condenser **15**, substantially. This time constant is such that the change in voltage drop existing between the cathode and anode of tube **13** is much less than is otherwise the case when, for example, the positive terminal of voltage source **30** is connected directly to one terminal of the deflection coil **12**.



While the particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from this invention in its broader aspects and, therefore, the aim in the appended claims is to cover all such changes and modifications as fall within the true spirit and scope of this invention.

We claim:

1. In a system of the character described, an inductance load, an amplifying discharge device having a control grid, a cathode and an anode, a source of recurrent sawtooth type of waves coupled to said device for controlling the same, impedance means, a source of substantially continuous voltage connected in a serial circuit with said impedance means, load and the anode and cathode of said device, a condenser having one of its terminals connected to the junction point of said load and impedance means and charged by said source through said impedance means, and means controlled by the voltage developed on the anode of said device for effectively decreasing the magnitude of said impedance means in accordance with decreased current flow through said device, said impedance means having a finite impedance value at all times and providing a charging circuit for said condenser when and as said condenser is being discharged through said device.

2. In a system of the character described, a load, an amplifying discharge device having an anode and cathode, impedance means, a source of unidirectional voltage serially connected with said impedance means, load and the anode and cathode of said discharge device, said discharge device having a control element, a source of sawtooth type of waves coupled to said control element and controlling the current flow through said serial circuit, a condenser charged through said impedance means and serially connected with said device, and said load being coupled to said serial circuit and effective during the "flyback" time of each of said sawtooth waves for effectively decreasing the magnitude of said impedance means in accordance with decreased current flow through said device, said impedance means having a finite impedance value at all times and providing a charging circuit for said condenser when and as said condenser is being discharged through said device.

3. In a sweep amplifying system of the character described, a source of voltage, an impedance means, a condenser charged by said source through said impedance means, a load serially connected with said condenser and supplied with energy therefrom, and means recurrently decreasing the magnitude of said impedance means in accordance with decreased current flow through said load, said impedance means having a finite impedance value at all times and providing a charging circuit for said condenser when and as said condenser is being discharged through said load.

4. In a system of the character described, a source of voltage, an impedance means, a condenser serially connected between said voltage source and said impedance means, a discharge device having a control element, a cathode and an anode, a load serially connected with said condenser and the anode and cathode of said device in a serial circuit with said condenser supplying energy to said load and said device, means coupled to said control element and producing a cyclical variation of current in said serial circuit, and means coupled to said serial circuit and sensitive to said variations for effectively decreasing the magnitude of said impedance means in accordance with decreased current flow through said device, said impedance means having a finite impedance value at all times and

providing a charging circuit for said condenser when and as said condenser is being discharged through said device.

5. In a system of the character described, a source of continuous voltage, a resistance, an inductive load, a discharge device having an anode, a cathode and a control element, said source, resistance, load and device being connected in a first serial circuit, a condenser having one of its terminals connected to the junction point of said load and said resistance in a second serial circuit comprising said source, resistance and condenser, and in a third serial circuit comprising said condenser, load and device, a source of generally sawtooth waves coupled to said control element, each of said sawtooth waves having a slowly rising portion and a quickly decaying portion which occur during the so-called flyback time, a second discharge device connected in parallel with said resistance and having a control grid, and a second condenser having one terminal connected to the anode of the first-mentioned device and the other one of its terminals connected to said control grid for changing the resistance of said second device to thereby control the flow of charging current from the first-mentioned source to the first-mentioned condenser.

6. In a system of the character described, a first source of generally sawtooth waves, each of said waves having a slowly rising portion which is followed by a rapidly decaying portion, a second source of continuous voltage, a load, an amplifying device amplifying said sawtooth waves, resistance means, said second source, load, device and resistance means being connected in a serial circuit, a condenser coupled to said serial circuit and charged through said resistance means for supplying energy to said load, and means coupled to said serial circuit and sensitive to said rapidly decaying portion for decreasing the magnitude of said resistance means in accordance with decreased current flow through said device to thereby control the rate at which said condenser is charged, said impedance means having a finite impedance value at all times and providing a charging circuit for said condenser when and as said condenser is being discharged through said device.

7. In a system of the character described, a load supplied with sawtooth types of current waves, each of said waves having a slowly rising portion followed by a rapidly decaying portion, and said rising portion representing a current which flows at a decreasing rate comparable to an exponential logarithmic rate, a condenser coupled to



said load for supplying said current, a source of voltage for charging said condenser, impedance means connected between said source and condenser for controlling the charging of said condenser, and means coupled to said load and sensitive to said decaying portion for decreasing the magnitude of said impedance means in accordance with decreased current flow through said load, said impedance means having a finite impedance value at all times and providing a charging circuit for said condenser when and as said condenser discharges through said load.

8. In an amplifying system of the character described, a discharge device having a control element, a load connected with said device in a serial circuit supplied with sawtooth types of current waves, each of said waves having a slowly rising portion followed by a rapidly decaying portion, and said rising portion representing a current in said serial circuit which flows at a decreasing rate comparable to an exponential or logarithmic rate, means coupled to said control element for controlling said current at said rate, a condenser coupled to said serial circuit for supplying said current, a source of voltage for said condenser, impedance means connected between said source and said condenser for controlling the charging of said condenser, and means coupled to said load and sensitive to said decaying portion for decreasing the magnitude of said impedance means in accordance with decreased current flow through said device, said impedance means having a finite impedance value at all times and providing a charging circuit for said condenser when and as said condenser discharges through said device.

9. The system set forth in claim 3 in which said means for altering the magnitude of said impedance comprises an amplifying discharge device having a control grid, anode, and cathode with the anode and cathode serially connected with said condenser and said load, a source of recurrently appearing voltage applied to said control grid.

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