Jan. 11, 1927. 1,613,954

W. A. KNOOP

SWEEP CIRCUITS FOR CATHODE RAY OSCILLOGRAPHS

Filed June 20, 1923

Fig. 1

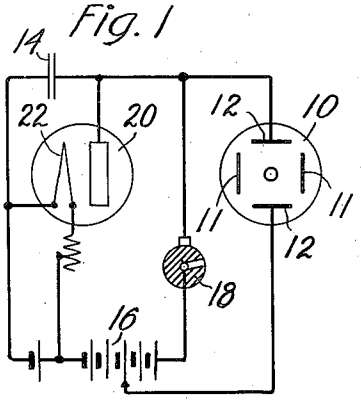


Fig. 2

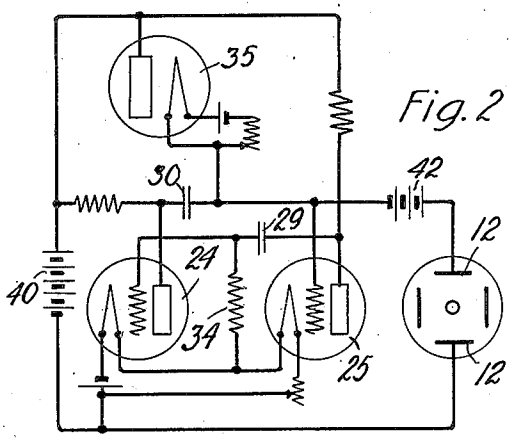


Fig. 4

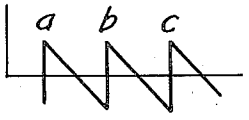


Fig. 3

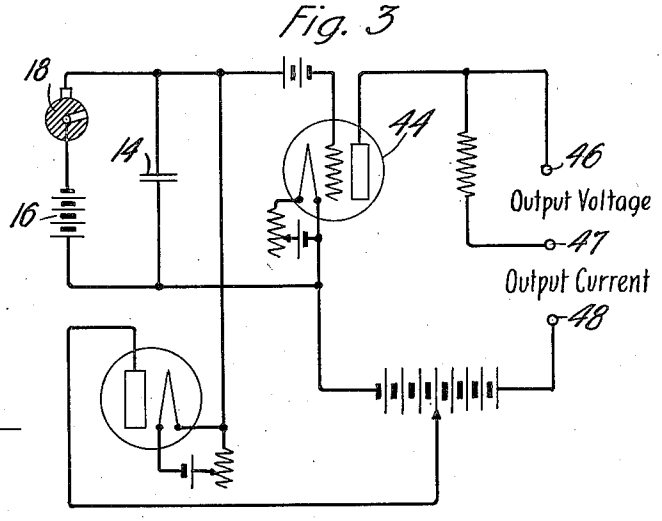


Fig. 5

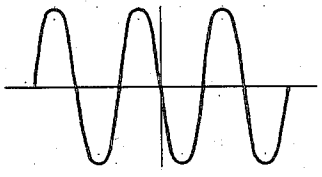
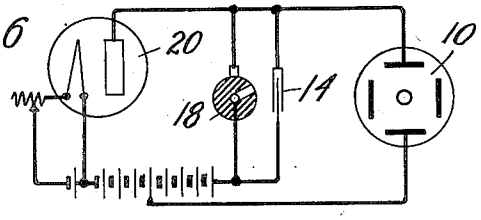


Fig. 6



Inventor:

William A. Knoop

by Jul C.R. Palmer Atty

Patented Jan. 11, 1927. 1,613,954

UNITED STATES PATENT OFFICE.

WILLIAM A. KNOOP, OF EAST NORTHPORT, NEW YORK, ASSIGNOR TO WESTERN ELECTRIC COMPANY, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

SWEEP CIRCUITS FOR CATHODE-RAY OSCILLOGRAPHS.

Application filed June 20, 1923. Serial No. 646,503.

This invention relates to auxiliary circuits for vacuum tube oscillographs and has for its object to provide a periodically varying source of voltage, the value of which during a portion of each period will vary uniformly with time.

The vacuum tube oscillograph or Braun tube, as is well-known, comprises two pairs of plates arranged at right angles to each other with means for applying potentials to the plates for deflecting a beam of electrons or cathode rays in accordance with electrical characteristics to be measured. The tube may also be provided with external magnetic coils for the same purpose. For certain uses of the Braun tube it is desirable to apply to one pair of plates a voltage which will swing the beam in one plane at a uniform speed. This requires a voltage which varies uniformly in one direction. Preferably the beam is thrown in the other direction substantially instantaneously so that it produces no effect on the fluorescent screen or photographic plate, during this portion of its movement.

In accordance with this invention the voltage varying uniformly with time is produced by discharging or charging a condenser through a constant current path. In one form of the invention a commutator connects the condenser to a source of voltage through a path containing no resistance so that the condenser is instantly charged. The commutator then disconnects the source and during this period the condenser discharges through a two-electrode thermionic vacuum tube working at voltage saturation, that is, with the filament temperature so low that all of the electrons emitted pass to the plate throughout the range of voltage applied to the tube. Since the current through the two-electrode tube is constant, the voltage across the condenser decreases at a constant rate. One pair of plates of the Braun tube is connected in a path in shunt to the condenser so that the voltage on the plates varies at the same rate as the voltage of the condenser.

The condenser may also be charged through a similar two-electrode tube and caused to discharge instantaneously. Other ways of charging the condenser may, of course, be used. For example, the varying charge on the grid condenser of certain types of vacuum tube oscillators may be employed.

The invention will be more fully understood from the following detailed description and claims taken in connection with the accompanying drawings in which Fig. 1 represents schematically a circuit embodying the invention; Fig. 2 is a similar view of a circuit in which a flat topped wave oscillator is employed; Fig. 3 shows the addition of a vacuum tube amplifier between the condenser and the Braun tube; Fig. 4 shows graphically the variations in potential produced by the condenser; Fig. 5 shows a pattern which may be produced by the Braun tube when using the invention, and Fig. 6 is a view showing a modification of Fig. 1.

Referring to the drawings by reference numerals, the Braun tube 10 has two pairs of plates 11 and 12, of which one pair, say the plates 11 may be connected to a source of current or voltage to be examined, and the other pair may be connected to a source of varying voltage such as that provided by this invention. The showing of the Braun tube is only schematic. The actual structure of a Braun tube which may be used is described in "Bell System Technical Journal," volume 1, No. 2, pages 142–151, November 1922.

As shown in Fig. 1, one of the plates 12 is connected to one electrode of a condenser 14 and the other plate 12 is connected to an intermediate point on a battery 16, the negative terminal of which is connected to the other electrode of condenser 14. A commutator 18, which may be rotated at any desired frequency, periodically connects the positive terminal of battery 16 to charge condenser 14. During the period when the contact of commutator 18 is open, condenser 14 discharges through a two-electrode thermionic tube 20. The cathode 22 of tube 20 is maintained at a sufficiently low temperature that the current through the tube, at least through the major portion of the period of discharge is constant. This means that the quantity of the charge on the condenser decreases at a constant rate and the voltage varies linearly with time. The lower plate 12 may be connected to battery 16 at such point that the polarity of the voltage between plates 12 reverses midway between

the times when the contact of commutator 18 is closed.

In Fig. 4 is shown the variation in voltage of the upper plate 12 with respect to the lower plate 12. The spot of light on the fluorescent screen produced by the cathode rays will travel from one side of the screen to the other periodically at a frequency corresponding to the intervals between the points *a*, *b*, *c*, etc. in Fig. 4. Suppose it is desired to examine the wave form of a 60 cycle voltage, the commutator 18 may be operated at a frequency of 20 cycles. If a voltage derived from the 60 cycle current be applied to the plates 11, the beam of cathode rays will produce on the screen the pattern shown in Fig. 5. Since this pattern is repeated twenty times a second it produces on the eye the effect of a permanent pattern.

Referring to Fig. 2, the vacuum tubes 24 and 25 are comprised in a flat topped wave oscillator circuit substantially like that described in an article by Abraham and Bloch in "Comptes Rendus", volume 168, pages 1105 to 1108. The tubes are so connected that the output of each tube is connected to the input of the other and blocking condensers 29 and 30 are provided for the respective grids in such a way that the tubes are alternately rendered inoperative or substantially inoperative by the high negative potential on the grid. The condensers discharge through high resistance paths 34 and 35. In the article above referred to each of these resistances is a non-inductive resistance connected between the corresponding grid and the cathode circuit. For the purposes of this invention the resistance 35 is in the form of a two-electrode vacuum tube working at current saturation as described above in connection with Fig. 1, and the anode terminal thereof is connected to the positive pole of the source of space current 40 instead of to the filament circuit. This is for the purpose of providing a positive potential for the anode of tube 35. The plates 12 of the Braun tube are connected to suitable points, such as those shown in the drawing, for obtaining a voltage proportional to the voltage across condenser 30. In the operation of the oscillation generator the condenser 30 becomes charged very quickly and discharges relatively slowly and at a constant rate through the tube 35. Battery 42 may be provided for adjusting the normal voltage across the plates 12.

In Fig. 3 the vacuum tube amplifier 44 has its input electrodes connected across the condenser 14. The potential across the condenser varies substantially as in Fig. 1 and the variations are amplified by tube 44 and may be utilized in the output circuit of the amplifier either in the form of voltage variations across terminals 46 and 47 or as current variations between terminals 47 and 48, it being understood, of course, that when terminals 46 and 47 are being used, terminals 47 and 48 are connected together. When it is desired to use the current variations, one of the magnetic coils of the Braun tube may be connected between terminals 47 and 48.

The circuit of Fig. 6 differs from that of Fig. 1 in that the condenser 14 is charged through the tube 20 working at voltage saturation, as in the circuit of Fig. 1, so that there is a constant current with a variation of plate voltage, and is caused to discharge instantaneously when the contact of commutator 18 is closed.

While the invention has been illustrated in a number of embodiments showing sweep circuits for Braun tubes, it is obvious that it may be used for other purposes where a voltage varying linearly with time is required.

The invention claimed is:

1. In combination, a condenser, a source of uni-directional current, means including said source for periodically producing charging and discharging currents for said condenser, and a constant current device through which one of said currents is required to flow, said source supplying substantially no electromotive force across said condenser during the flow of one of said currents.

2. In combination, a condenser, a source of uni-directional current, means for charging said condenser at a rapid rate from said source and for substantially preventing the flow of charging current during the discharge period, and a constant current device for discharging said condenser.

3. In combination, a condenser, a source of uni-directional current, means periodically connecting said source across said condenser, and a path in shunt to said condenser comprising a thermionic vacuum tube so connected as to discharge said condenser and having a source of electrons so limited as to maintain the discharge current constant.

4. In combination, a cathode ray oscillograph having a pair of electrodes, a condenser in a path across said electrodes, and means including a source of uni-directional current for varying an electric charge on said condenser at a constant rate.

5. In combination, a cathode ray oscillograph having a pair of electrodes, a condenser in a path across said electrodes, a source of uni-directional current, means including said source for varying periodically an electric charge on said condenser, and means for maintaining the rate of change of said charge constant during a portion of each period.

6. In combination, a cathode ray oscillograph and means for deflecting the beam of cathode rays at a constant angular velocity,

said means comprising a condenser, a source of uni-directional current, means including said source for charging said condenser very quickly and means for discharging said condenser at a constant rate.

7. In combination, a pair of electrodes, a source of uni-directional current having terminals and having an intermediate point connected to one of said electrodes, a condenser having one terminal connected to one terminal of said source and the other terminal connected to the other of said electrodes, means for periodically connecting said source across said condenser, and a constant current path in shunt to said condenser.

8. In combination, a pair of electrodes, a condenser in a path across said electrodes, a source of uni-directional current, means for periodically connecting said source across said condenser, and a constant current path in shunt to said condenser.

9. In combination, a pair of electrodes, a condenser in a path across said electrodes, a source of uni-directional current, means for periodically connecting said source across said condenser, and means for discharging said condenser at a constant rate when said source is disconnected therefrom.

10. In combination, a cathode ray oscillograph having a pair of electrodes, a condenser in a path across said electrodes, a source of uni-directional current, means including said source for varying periodically an electric charge on said condenser, and an electron discharge device in shunt to said condenser.

11. In combination, a cathode ray oscillograph having a pair of electrodes, a condenser in a path across said electrodes, a source of uni-directional current, means for periodically connecting said source across said condenser, and a path in shunt to said condenser comprising a thermionic vacuum tube so connected as to discharge said condenser and having a source of electrons so limited as to maintain the discharge current constant.

In witness whereof, I hereunto subscribe my name this 13 day of June A. D., 1923.

WILLIAM A. KNOOP.