

July 7, 1953

P. H. DE BEURS

2,644,909

CIRCUIT-ARRANGEMENT COMPRISING A CATHODE-RAY TUBE

Filed Feb. 13, 1951

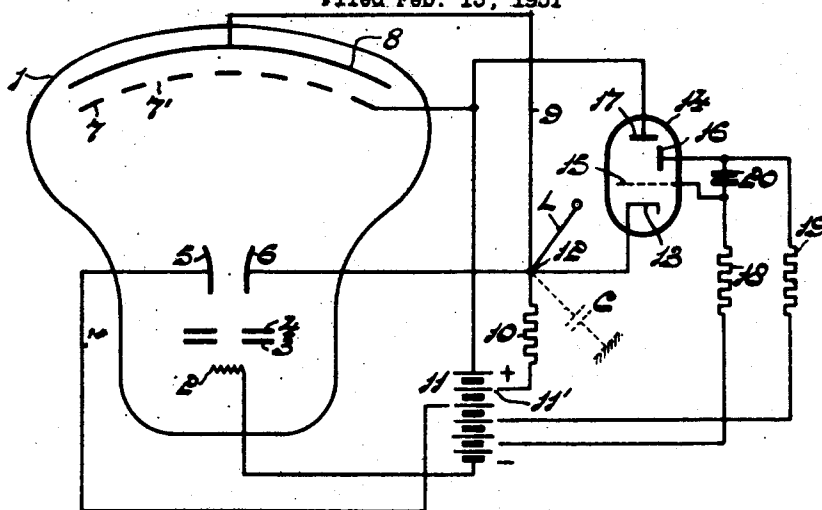
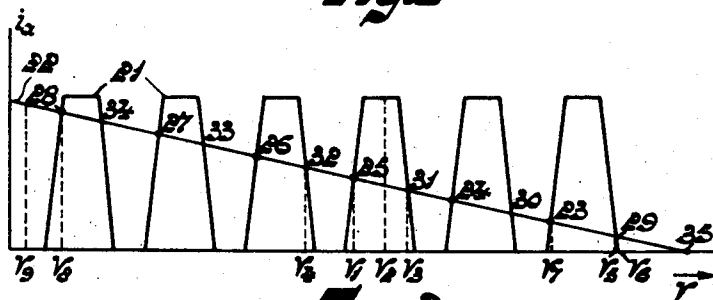


Fig. 1



UNITED STATES PATENT OFFICE

2,644,909

CIRCUIT-ARRANGEMENT COMPRISING A
CATHODE-RAY TUBE

Pieter Hendrik De Beurs, Eindhoven, Netherlands, assignor to Hartford National Bank and Trust Company, Hartford, Conn., as trustee

Application February 13, 1951, Serial No. 210,643
In the Netherlands March 6, 1950

4 Claims. (Cl. 315—21)

1

This invention relates to a circuit utilizing a cathode-ray tube whose electron beam may be deflected through a number of different stable positions in accordance with the demands of an external applied deflection voltage.

A circuit of this type is particularly applicable for counting purposes, as the electron beam may be deflected through successive positions as successive pulses are applied to the deflection system. Each time the beam has been deflected through all its different positions, it is necessary to return the beam to its initial position. The process of returning the beam from its final to its initial position is termed fly back, and the time interval in which fly back takes place is termed fly back time. It is possible to initiate a pulse each time fly back occurs, each pulse representing a number, which in turn represents the number of stable beam positions used in the particular application desired. Thus a counting process using fly back periods can be used, the speed of this process being limited by the fly back time.

In one known circuit of this kind, the cathode-ray tube comprises a plurality of collecting electrodes, arranged side by side in the direction of deflection and connected to taps on a potentiometer, and another tap of said potentiometer is connected to a deflection electrode of this tube. These taps are so chosen that when a beam strikes one of these electrodes, a deflection voltage is developed as such value as to direct the beam onto the electrode concerned. The beam is shifted from one position to another by supplying a pulse to the deflection system.

In another known circuit of this kind, the beam current of a cathode-ray tube is divided among a first collecting electrode and one or more additional collecting electrodes. The first collecting electrode is connected directly to a deflection electrode, and is also connected through a resistor to a voltage source. In an equilibrium position the beam current is so divided that a deflection voltage is developed corresponding to a fixed beam position. Any small deviation in beam position will change the deflection voltage in such fashion as to return the beam to its equilibrium position. The beam is shifted from one position to another by supplying a pulse to the deflection system.

The fly back process is controlled by a gas filled tube whose discharge path is through the deflection electrode of the cathode-ray tube. The voltage of this electrode is proportional to the beam position. When the beam is moved to its final position, this voltage will exceed a predetermined value, discharging the gas-filled tube. Consequently, the voltage of the deflection electrode is suddenly varied, so that the beam is displaced to its initial position, at which time the gas-filled tube stops discharging. Since the discharging

2

process just outlined takes about 100 microseconds, the fly back time is limited to this value.

This invention reduces the fly back time by substituting an electron discharge tube for the gas-filled tube, the potential on the deflection electrode being supplied from the cathode of said electron discharge tube. Means are provided for temporarily increasing the potential at a control electrode of the electron discharge tube when this tube conducts. This temporary increase in potential initiates the fly back process.

In order that the invention may be more clearly understood and readily carried into effect, it will now be described more fully by reference to the accompanying drawing.

Figs. 1 and 3 show examples of the circuit-arrangement according to the invention in which the beam is stabilized by means of current distribution.

Fig. 2 shows a diagram serving to explain the operation of the circuit-arrangement.

The cathode-ray tube 1 shown in Fig. 1 comprises a cathode 2, means 3, 4 for producing a cathode-ray beam which are known per se and which are shown here only diagrammatically, a set of deflection plates 5, 6 and collecting electrodes 7, 8. Means 3, 4 are coupled to suitably chosenappings on a supply battery 11. The electrode 7 is arranged in front of the electrode 8 and comprises a number of apertures such that the beam on being deflected, strikes alternately an element of the electrode 7 and, through an aperture of this electrode, an element of the electrode 8. The current i_a flowing to the electrode 8 then varies as a function of the deflection voltage V at the deflection electrode 6 in the manner indicated by curve 21 in Fig. 2. When the beam passes through an aperture of the electrode 7, the whole of the beam current flows to the electrode 8. If, however, the beam is intercepted by the electrode 7, the current flowing to the electrode 8 is zero. The electrode 8 is connected through a conductor 9 to the deflection electrode 6, this electrode furthermore being coupled by way of a resistance 10 to a tapping 11' on a battery 11. The negative terminal of the battery is connected to the cathode 2 of the cathode-ray tube. The collecting electrode 7 is connected to the positive terminal of the battery. The deflection electrode 5 is connected to a tapping on the battery.

The relationship between the current traversing the resistance 10 and the voltage of the electrode 6 (point 12) is indicated by a straight resistance line 22 in Fig. 2. If the resistance 10 is not traversed by current, the voltage is equal to the voltage of the tapping 11'. When the current increases, the voltage at point 12 decreases. In a position of equilibrium the current traversing the conductor 9 is equal to the current flowing through the resistance 10, which implies that the

3

positions of equilibrium of the beam must correspond to intersections of the curves 21 and 22 in Fig. 2. The intersections 23, 24, 25, 26, 27, 28 correspond to stable positions of the beam, whereas the intersections 29, 30, 31, 32, 33, 34 provide unstable positions of equilibrium.

More specifically, assume that, at a given moment, the voltage at point 12 is equal to V_2 . The current flowing through conductor 9 then exceeds the current traversing the resistance 10. Due to the difference in current, the existing change on the stray capacitance measured between point 12 and ground or the existing change on a capacitor indicated by C in Fig. 1 coupled to point 12 is decreased. Consequently, the voltage at point 12 will decrease to a value V_2 and the beam will move towards the stable position of the beam corresponding to the intersection 25. A similar reasoning applies if the voltage at point 12 is somewhat lower than the voltage V_1 corresponding to the intersection 25. The beam will thus move automatically to the stable position 25, if the voltage at point 12 lies within the interval between the voltages V_3 and V_4 corresponding to unstable positions of equilibrium 31 and 32. This interval thus constitutes the "attraction sphere" of the stable position 25.

Similarly, the voltages exceeding the voltage V_5 corresponding to the unstable position 29 belong to the attraction sphere of the natural initial position 35. Consequently, if the voltage at point 12 is higher than V_5 , the beam moves to the right until position 35 is reached. It should be noted that, if due to battery voltage variation or other cause the resistance line 22 were to be shifted to the left with respect to curve 21, and if a voltage were applied to point 12 which is higher than the voltage V_7 , in such manner that the intersection 35 of the straight resistance line 22 and the axis of voltage would lie at V_5 , a voltage lower than V_5 , the beam would move to position 23.

The beam may be moved from one stable position to another by supplying a pulse through a conductor L to point 12 in such manner that the voltage at point 12 is suddenly varied into a value which lies within the attraction sphere of the stable position desired.

It is assumed that the beam first occupies the initial position 35. A first negative current pulse supplied to point 12 then moves the beam to position 23, the second pulse moves the beam from position 23 to position 24, and so forth until after six pulses position 28 is reached. The beam is then adjusted to the left-hand edge of the extreme left-hand aperture 7' of the collecting electrode 7.

The seventh pulse moves the beam back to its initial position 35 in a manner which will be described hereinafter. The deflection electrode 6 is connected to the cathode 13 of a vacuum tube 14. The tube 14 furthermore comprises a control electrode 15, a secondary-emission collecting electrode 16, and an anode 17. The latter is connected to the positive terminal of the battery 11. The secondary-emission electrode 16 is connected by way of a condenser 20 to the control electrode 13 and by way of a resistance 19 to a tapping on the battery 11 such that when the tube is non-conducting, the potential of the electrode 16 is materially lower than that of the anode 17. The control electrode 15 is connected by way of a resistance 18 to a tapping on the battery, the voltage V_5 of which is somewhat lower than the volt-

4

age V_5 , which corresponds to the extreme left-hand stable position (28) of the beam.

As previously mentioned, the sixth counting pulse moves the beam to the extreme left-hand stable position. The potential (V_9) of the control electrode 15 is then so much lower than the potential (V_8) of the cathode 13 that the tube 14 is just non-conductive.

The subsequent seventh pulse at the first instance again reduces the potential at point 12, the beam being driven further to the left. The voltage difference between the electrode 16 and the cathode 13 now drops to a point where tube 14 begins to conduct.

The electrode 16 is struck by an electron current originating from the cathode. Since the electrode 16 is of the secondary-emission type and the potential of this electrode is lower than that of the anode 17, the current of secondary electrons emanating from the electrode 16 is greater than the incident current of primary electrons, so that a positive current flows by way of resistance 19 from the electrode to the battery.

Consequently, the potential of electrode 16 increases. The variation in voltage of electrode 16 is transferred by way of condenser 20 to the control electrode 15. The tube 14 conducts more current and the potential of electrode 16 undergoes a further increase which, as before, is transferred by way of condenser 20 to the electrode 15.

Owing to this interaction, the potential of the control electrode 16 increases to a value which is approximately equal to that of the battery voltage, the capacity C being rapidly charged in the positive sense by way of the tube 14.

After a short period of time, the voltage at point 12 has exceeded the voltage V_5 and thus has come within the attraction sphere of the initial position 35.

Since the control electrode 15 is not galvanically connected to the electrode 16, the potential of this electrode subsequently decreases due to the presence of a resistance 18. The current of primary electrons flowing to the electrode 16 decreases, so that the potential of this electrode undergoes a decrease which is transferred by way of condenser 20 to the electrode 15, tube 14 being cut-off within a short time.

The beam now moves to the initial position 35. Fig. 3 shows a variant of the circuit-arrangement in Fig. 1, in which identical elements are provided with the same reference numerals.

The deflection electrode 6 of the cathode-ray tube is connected to a cathode 41 of a discharge tube 40, which in this case may be of the ordinary triode type.

An anode 43 of this tube is supplied by way of a resistance 44 and connected by way of a condenser 45 to a control electrode 49 of a second discharge tube 47.

An anode 48 of this tube is connected by way of a resistance 51 to a tapping on the battery 11, a condenser 52 being included between the anode 48 and the control electrode 42 of tube 40. The cathode 50 of tube 47 is connected to the negative terminal of the battery 11. The control electrode 49 of tube 47 is connected by way of a leak resistance 53 to the cathode, so that tube 47 is, normally, conducting.

The control electrode 42 of tube 40 is furthermore connected by way of a leak resistance 46 to a tapping of the battery 11 such that, if the potential of the deflection electrode 6 has a value which corresponds to that of an arbitrary stable

position of the beam in the cathode-ray tube 1, the discharge tube 40 is cut-off.

If a shifting pulse supplied through conductor L to point 12 now decreases the potential of point 12 still below the voltage V_2 which corresponds to the extreme left-hand stable position (28 in Fig. 2) of the beam, tube 40 becomes conducting and a current flows through the anode supply resistance 44.

The voltage of the anode 43 thus decreases and, due to the capacitive coupling 45, the voltage of the control electrode 49 also decreases. This results in an increase in potential of the anode 48 of tube 47, which increase is transferred by way of a condenser 52 to the control electrode 42 of tube 40.

Tube 40 thus becomes conducting to a greater extent so that, due to the backcoupling by way of tube 47, the potential of the control electrode 42 is increased further, so that tube 40 suddenly becomes completely conducting and a strong current pulse ensues across the cathode lead of tube 40, which pulse rapidly charges the capacity C in the positive sense, so that the beam is driven to the right and the voltage at point 12 comes within the attraction sphere of the initial position 35.

After the current traversing tube 40 has attained its maximum value, the condensers 45 and 52 discharge by way of leak resistances 53 and 46, the potential of electrode 42 decreasing and the potential of electrode 49 increasing. This action is enhanced by the backcoupling so that tube 40 is suddenly cut-off again.

The circuit-arrangement may be varied within the scope of the invention in various ways. Thus, for example, it is possible for only one of the control electrodes 42 and 49 to be capacitively coupled to the anode of the other tube, while the other coupling is galvanic. As a further alternative, inductive coupling may be substituted for capacitive coupling.

By varying the resistance 51 the maximum variation in potential of the anode 48 and hence of the control electrode 42 may be limited, so that it is possible to make the beam fly back from the extreme left-hand position to any one of the intermediate stable positions instead of to the position 35.

What I claim is:

1. In a circuit arrangement including a cathode-ray tube provided with means to generate an electron beam, a deflection electrode to deflect said beam in a given direction and a collecting electrode system disposed in the path of said beam, means coupling said collecting electrode system to said deflection electrode to cause said beam to occupy one of a plurality of inherently stable positions and means to shift the beam from one stable position to a next position; apparatus for controlling the fly back of the beam comprising an electron discharge device having a cathode, a control electrode and an anode, means coupling said device to said deflection electrode to render said device conductive when a potential on the deflection electrode exceeds a predetermined threshold value, the cathode of said device being connected to the deflection electrode, and means responsive to conduction in said device to effect a momentary increase in potential on said control electrode.

2. In a circuit arrangement including a cathode-ray tube provided with means to generate an electron beam, a deflection electrode to deflect said beam in a given direction and a collecting

electrode system disposed in the path of said beam, means coupling said collecting electrode system to said deflection electrode to cause said beam to occupy one of a plurality of inherently stable positions and means to shift the beam from one stable position to a next position; apparatus for controlling the fly back of the beam comprising an electron discharge device having a cathode, a grid, a secondary emission electrode and an anode, means coupling said device to said deflection electrode to render same conductive when a potential on said deflection electrode exceeds a predetermined threshold value, said cathode being connected to said deflection electrode, means capacitively coupling said grid to said secondary emission electrode, a resistance, means to apply a positive voltage through said resistance to said secondary emission electrode, and means to apply a relatively high positive voltage to said anode.

3. A circuit arrangement, as set forth in claim 1, further including a second electrode discharge device having a cathode, a grid and an anode, the anode of the first device being coupled to the grid of the second device, the anode of the second device being coupled to the grid of the first device, at least one of these couplings being capacitive.

4. In a circuit arrangement including a cathode-ray tube provided with a beam source, a deflection electrode to deflect said beam in a given direction and a collecting electrode system disposed in the path of said beam and constituted by a first electrode having spaced apertures therein and a rear electrode, means including a connection from said rear electrode to said deflection electrode for coupling said collecting electrode system to said deflection electrode to cause said beam to occupy one of a plurality of inherently stable positions, a voltage source having a first resistance, means connecting the negative terminal of said voltage source to said beam source and the positive terminal to said front electrode and means connecting a first positive tap on said source through said first resistance to said rear electrode; apparatus for controlling the fly back of said beam comprising an electron discharge device having a cathode, a grid, a secondary emission electrode and an anode, a capacitor connecting said secondary emission electrode to said grid, means connecting said cathode to said deflection electrode and said anode to said front electrode, a second resistance connecting said secondary emission electrode to a second positive tap in said voltage source, and a third resistance connecting said grid to a third positive tap in said source, said third tap having a lower value than said second tap, said second tap having a lower value than said first tap.

PIETER HENDRIK DE BEURS.

References Cited in the file of this patent UNITED STATES PATENTS

Number	Name	Date
2,287,296	Dallos	June 23, 1942
2,350,069	Schrader et al.	May 30, 1944
2,361,766	Hadekel	Oct. 31, 1944
2,436,677	Snyder, Jr.	Feb. 24, 1948
2,457,911	Munster	Jan. 4, 1949
2,463,535	Hecht	Mar. 8, 1949
2,498,081	Joel, Jr. et al.	Feb. 21, 1950
2,522,291	Marrison	Sept. 12, 1950
2,523,162	Sunstein	Sept. 19, 1950
2,532,738	Six et al.	Dec. 5, 1950
2,564,908	Kunchinsky	Aug. 21, 1951