Oct. 6, 1942. P. T. FARNSWORTH 2,297,949

DEFLECTING SYSTEM

Filed May 22, 1941 2 Sheets-Sheet 1

FIG. 1

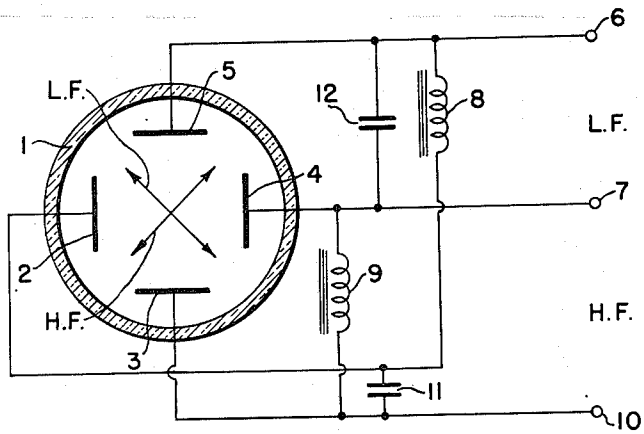
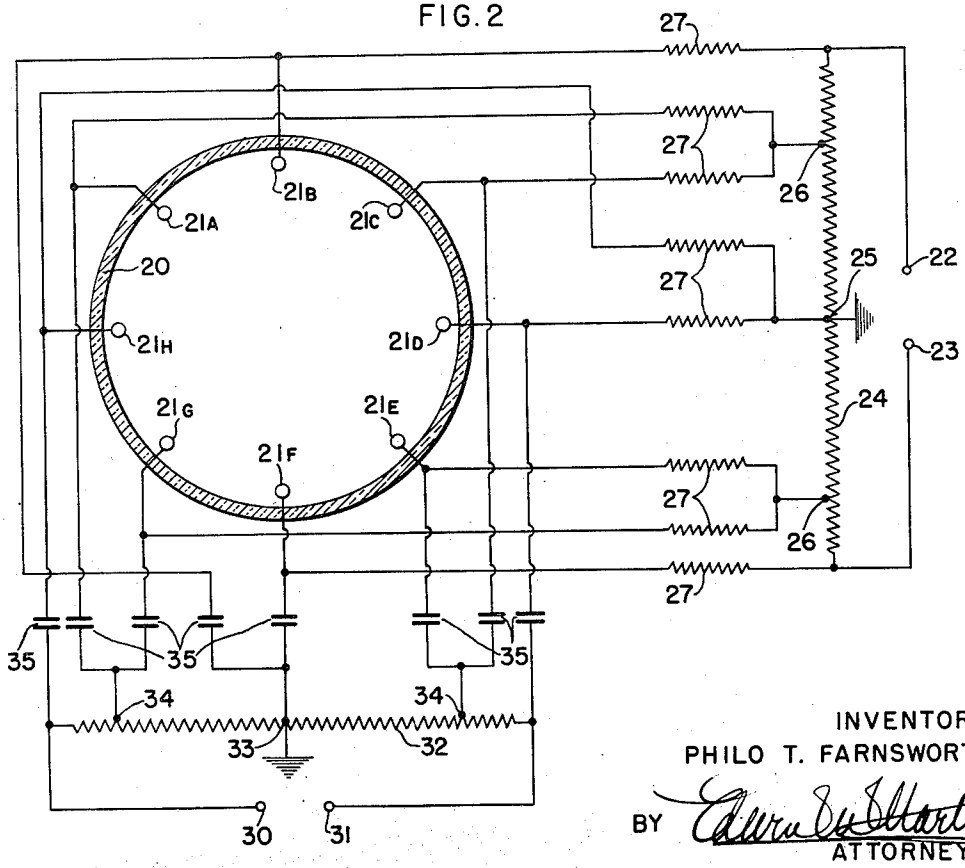


FIG. 2



INVENTOR
PHILO T. FARNSWORTH

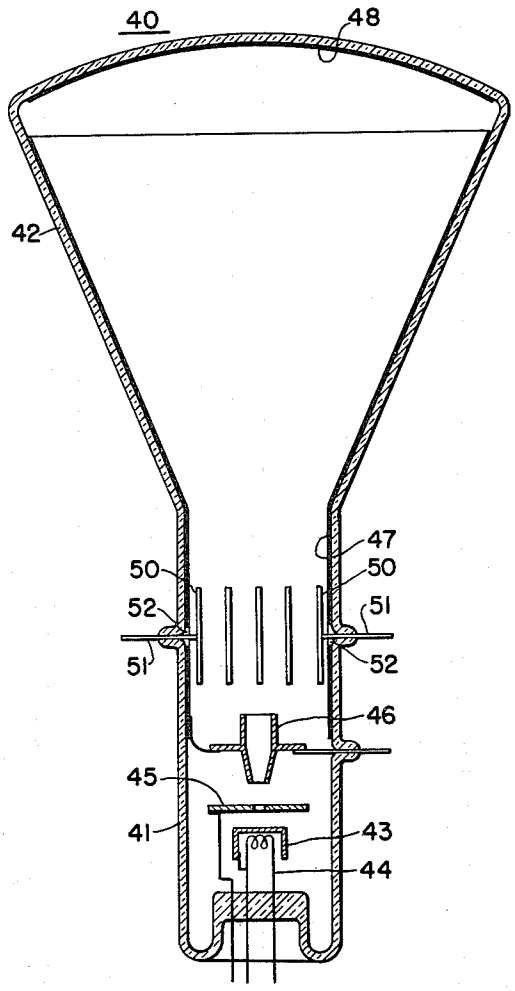
BY Edwin S. Hartman
ATTORNEY

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FIG. 3



INVENTOR
PHILO T. FARNSWORTH
BY
ATTORNEY

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DEFLECTING SYSTEM

Philo T. Farnsworth, Fryeburg, Maine, assignor to Farnsworth Television and Radio Corporation, a corporation of Delaware

Application May 22, 1941, Serial No. 394,659

8 Claims. (Cl. 250—27)

This invention relates to a system for deflecting a beam of electrons and particularly relates to deflection by means of electrostatic fields.

In conventional electrostatic deflecting systems, such as, for example, are employed in television systems, a pair of metallic plates is disposed in a plane, one plate on each side of the path of the electron beam to be deflected. An alternating voltage of a desired wave shape is applied between the deflecting plates to effect deflection of the electron beam. For deflecting the beam in a second direction, a similar pair of plates is provided in a second plane displaced from that of the first pair of plates along the path of the electron beam.

In many cases it is desirable to effect deflection of the electron beam in a single plane only, for which purpose it is necessary to dispose the deflecting plates in the same plane. With conventional systems, however, serious distortion of the electrostatic field in the space enclosed by the deflecting plates is produced thereby, and the deflection of the beam is no longer a linear function of the deflecting voltage.

An object of the present invention, therefore, is to provide a new and improved system for deflecting a beam of electrons in which the beam deflection is a linear function of the deflecting voltages.

In accordance with the present invention there is provided a beam deflecting system comprising a plurality of deflecting electrodes, preferably all disposed in the same plane, connected to two pairs of input terminals by circuit means for controlling the flow of current through the circuit. This connection is made in such a manner that all of the electrodes effect deflection of the beam in one direction in response to a signal applied to one pair of the input terminals and effect deflection in another direction in response to a signal applied to the other pair of input terminals.

For a better understanding of the invention, together with other and further objects thereof, reference is had to the following description, taken in connection with the accompanying drawings, and its scope will be pointed out in the appended claims.

In the accompanying drawings, Fig. 1 shows schematically a deflecting system embodying the present invention, while Fig. 2 shows a modification thereof, and Fig. 3 shows a cathode ray tube including a deflecting system in accordance with the present invention.

Referring now more particularly to Fig. 1 of the drawings, there is shown schematically in cross-section an electron discharge tube comprising an evacuated envelope 1 and including a plurality of deflecting plates 2, 3, 4 and 5 arranged in the same plane substantially as shown. The path of the undeflected electron beam is perpendicular to this plane and the electron source and target are not shown for the sake of simplicity.

For the purpose of deflecting the electron beam in one direction, as indicated by the arrow LF of Fig. 1, at a relatively low rate of speed, there is provided a pair of input terminals 6, 7 adapted to receive a low-frequency deflecting voltage wave. A path for the low-frequency wave between the terminal 6 and the deflecting plate 5 is provided by the direct conductive connection therebetween and a path from the terminal 6 to the deflecting plate 2 is provided by way of a choke 8 of low impedance at the deflecting wave frequency. Similarly a path between the terminal 7 and the deflecting plate 4 is provided by the direct conductive connection therebetween and a path from the terminal 7 to the deflecting plate 3 is provided by way of a choke 9 of low impedance at the deflecting wave frequency.

For the purpose of deflecting the electron beam in a second direction normal to that just referred to, as indicated by the arrow HF, there is provided an input terminal 10 which, together with input terminal 7, is adapted to be connected to a source of deflecting voltage of relatively high frequency. A path for the high frequency wave applied to the terminal 7 is provided by the direct connection of this terminal with the deflecting plate 4 and its connection with the deflecting plate 5 by way of a condenser 12 having a low impedance at the high frequency. Similarly the high-frequency input terminal 10 is directly connected to the deflecting plate 3 and to the deflecting plate 2 by way of a condenser 11 having a low impedance at the high frequency. Consequently, the terminals 6 and 7 are effectively connected with plates 2, 5 and 3, 4, respectively, for the low-frequency wave, while the terminals 7 and 10 are effectively connected with the deflecting plates 2, 3 and 4, 5, respectively, for the high-frequency wave.

In operation, a deflecting voltage wave of low frequency is applied between the input terminals 6 and 7. Since the chokes 8 and 9 exhibit a low impedance at this deflecting frequency, the deflecting voltage is applied between the plates 2, 5 and 3, 4 which substantially act as a single pair of plates. A high-frequency deflecting voltage wave is applied between the terminals 7 and 10 and due to the low impedance of the condensers

11 and 12 at the high frequency of the deflecting voltage, the latter is applied between the deflecting plates 2, 3 and 4, 5. These plates, therefore, act as a single pair of deflecting plates effecting deflection in the direction perpendicular to the deflection effected by the combination of the plates for the low-frequency deflecting voltage. A combined electrical field is developed between the deflecting plates 2, 3, 4 and 5 suitable for deflecting an electron beam in two directions normal to each other and at different rates of speed.

Referring now to Fig. 2 of the drawings, there is shown schematically in cross-section an electron discharge tube 20 including a plurality of rod-shaped metallic electrodes 21A—21H positioned parallel to the axis of the tube envelope. The direction of the undeflected electron beam is perpendicular to the drawings and the source of electrons and the target are not shown for the sake of simplicity. For the purpose of vertically deflecting the electron beam by applying a deflecting voltage wave of relatively low frequency to the deflecting electrodes 21A—21H, there is provided a pair of input terminals 22, 23 adapted to be connected to a source of low-frequency deflecting voltage and connected to the ends of a voltage divider 24 having a grounded center tap 25. Oppositely disposed deflecting electrodes 21A and 21C are connected to the same tap 26 of the voltage divider 24 by way of resistors 27, as shown, so that the same deflecting voltages are applied to these electrodes. Similarly, electrodes 21H and 21D are connected to a common tap on voltage divider 24, as are electrodes 21G and 21E, the potential applied to electrodes 21A and 21C being equal and opposite to that applied to electrodes 21G and 21E. Electrodes 21B and 21F are so connected by way of individual resistors 27 that equal and opposite potentials are applied thereto.

The taps 26 on the voltage divider 24, to which electrodes 21A, 21C and 21G, 21E are connected by way of resistors 27, are so adjusted that the proper voltages are applied to these electrodes to produce a homogeneous electrical field.

For the purpose of deflecting the electron beam in the vertical direction at a relatively high rate of speed, there is provided a pair of input terminals 30, 31 adapted to be connected to a source of high-frequency deflecting voltage and connected to the ends of a voltage divider 32 having a grounded center tap 33. Oppositely disposed deflecting electrodes 21A and 21G are connected to the same tap on the voltage divider 32 by way of condensers 35 so that the same high frequency deflecting voltages are applied to these electrodes. Similarly, electrodes 21B and 21F are connected to a common tap on the voltage divider 24 as are electrodes 21C and 21E, the potential applied to electrodes 21A and 21G being equal and opposite to that applied to electrodes 21C and 21E. Electrodes 21H and 21D are so connected by way of individual condensers 35 that equal and opposite potentials are applied thereto.

The taps 34 on the voltage divider 32, to which electrodes 21A, 21G and 21C, 21E are connected by way of condensers 35, are so adjusted that the proper voltages are applied to these electrodes to produce a homogeneous electrical field.

Condensers 35 serve to interconnect certain of the deflecting electrodes for the high-frequency deflecting voltage while resistors 27 serve to interconnect others of the deflecting electrodes for the low-frequency deflecting voltage. Since two deflecting electrodes which are interconnected for one deflecting voltage may not be interconnected for the other, the condensers 35 preferably have a low impedance at the fundamental of the high-frequency deflecting voltage wave and a high impedance for the fundamental of the low-frequency deflecting voltage wave and harmonic thereof, preferably including the tenth harmonic.

In a preferred embodiment, each of the condensers 35 is given a value of 50 micromicrofarads, which represents an impedance of 240,000 ohms for the fundamental of a high-frequency deflecting voltage wave of 13.2 kilocycles and an impedance of 5.3 megohms for the tenth harmonic of a low-frequency deflecting voltage wave having a fundamental of 60 cycles. The resistors 27 are preferably each given a value of 2 megohms which is still sufficiently great as compared with the impedance of the condensers 35 at the fundamental of the high-frequency deflecting voltage wave and sufficiently small as compared with the impedance represented by the condensers 35 at the tenth harmonic to the low-frequency deflecting voltage wave.

In operation, a low-frequency deflecting voltage wave is applied between the input terminals 22, 23 while a high-frequency deflecting voltage wave is applied between the terminals 30, 31. The high-frequency deflecting voltage is applied to a combination of the deflecting rods 21A—21H so as to produce a homogenous horizontal deflecting field therebetween. Likewise, a low-frequency deflecting voltage wave is applied to the input terminals 22, 23 by way of the voltage divider 24 and resistors 27 to another combination of the deflecting rods 21A—21H to produce a homogenous vertical deflecting field. Consequently, a combined homogenous field is developed which is suitable for linear deflection of the electron beam in two directions at different rates of speed in either direction.

Fig. 3 shows a conventional cathode ray tube provided with a new deflecting system in accordance with the present invention. The figure shows an evacuated envelope 40 comprising a neck portion 41 and a bulb portion 42. The neck portion includes an electron gun of conventional design comprising a unipotential cathode 43, a heater filament 44, a control electrode 45 and an anode 46. Electrically connected to the anode is a wall coating 47 extending throughout a portion of the neck portion 41 and a portion of the bulb 42 of the envelope 40. At the bottom of the bulb portion 42 there is deposited an electron target 48, such as a fluorescent screen or the like. In the neck portion 41 of the envelope 40, adjacent to the anode 46, there are disposed about the axis normally traversed by the undeflected electron beam a plurality of elongated parallel conductive rods 50 extending in the direction of the path of the electron beam in the same longitudinal positions. For the purpose of applying deflecting potentials to the rods 50, there are provided a plurality of conductive supporting rods 51 extending to the exterior of the envelope 40 of which only two are shown for the sake of simplicity. Openings 52 are provided in the wall coating 47 in order to insulate the conductive supporting rods 51 therefrom.

In operation, the electron gun 43, 44, 45 and 46 develops an electron beam directed against the target 48 normally traveling along the tube axis. If deflecting voltages of proper magnitude are applied to the conductive rods 50 from sources

not shown, the electron beam can be deflected in two directions across the target 48, if the tube is connected in circuit as shown in Fig. 2 and described in connection therewith.

While there has been described what is at present considered the preferred embodiment of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention, and it is, therefore, aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What is claimed is:

1. A system for deflecting a beam of electrons comprising a plurality of deflecting electrodes, an input providing two pairs of input terminals, circuit means connecting said input terminals with said electrodes, and means for so controlling the flow of current through said circuit means as to effect deflection of said beam by all of said electrodes in one direction in response to a signal applied to one pair of said input terminals and deflection of said beam by all of said electrodes in another direction in response to a signal applied to the other pair of said input terminals.

2. A system for deflecting a beam of electrons comprising a plurality of deflecting electrodes, an input providing two pairs of input terminals for a deflecting signal of relatively high frequency and for a deflecting signal of relatively low frequency, circuit means connecting said input terminals with said electrodes, and means for so controlling the flow of current through said circuit means as to effect deflection of said beam by all of said electrodes in one direction in response to said high frequency signal applied to one pair of said input terminals and deflection of said beam by all of said electrodes in another direction in response to said low frequency signal applied to the other pair of said input terminals.

3. A system for deflecting a beam of electrons comprising a plurality of deflecting electrodes disposed in a common plane, an input providing two pairs of input terminals, circuit means connecting said input terminals with said electrodes, and means for so controlling the flow of current through said circuit means as to effect deflection of said beam by all of said electrodes in one direction in response to a signal applied to one pair of said input terminals and deflection of said beam by all of said electrodes in another direction in response to a signal applied to the other pair of said input terminals.

4. A system for deflecting a beam of electrons comprising a plurality of deflecting electrodes, an input providing two pairs of input terminals, circuit means connecting said input terminals with said electrodes, and impedance means for so controlling the flow of current through said circuit means as to effect deflection of said beam by all of said electrodes in one direction in response to a signal applied to one pair of said input terminals and deflection of said beam by all of said electrodes in another direction in response to a signal applied to the other pair of said input terminals.

5. A system for deflecting a beam of electrons comprising a plurality of deflecting electrodes, an input providing two pairs of input terminals for a deflecting signal of relatively high frequency and for a deflecting signal of relatively low frequency, circuit means connecting said input terminals with said electrodes, and impedance means for said high and said low frequencies for so controlling the flow of current through said circuit means as to effect deflection of said beam by all of said electrodes in one direction in response to said high-frequency signal applied to one pair of said input terminals and deflection of said beam by all of said electrodes in another direction in response to said low frequency signal applied to the other pair of said input terminals.

6. A system for deflecting a beam of electrons comprising four pairs of deflecting electrodes, an input providing two pairs of input terminals, circuit means connecting said input terminals with said electrodes, and means for so controlling the flow of current through said circuit means as to effect deflection of said beam by all of said electrodes in one direction in response to a signal applied to one pair of said input terminals and deflection of said beam by all of said electrodes in another direction in response to a signal applied to the other pair of said input terminals.

7. A system for deflecting a beam of electrons comprising a plurality of deflecting rod-electrodes, an input providing two pairs of input terminals, circuit means connecting said input terminals with said rod-electrodes, and means for so controlling the flow of current through said circuit means as to effect deflection of said beam by all of said rod-electrodes in one direction in response to a signal applied to one pair of said input terminals and deflection of said beam by all of said rod-electrodes in another direction in response to a signal applied to the other pair of said input terminals.

8. A system for deflecting a beam of electrons comprising a plurality of pairs of deflecting rod-electrodes, an input providing two pairs of input terminals, circuit means connecting said input terminals with said rod-electrodes, and means for so controlling the flow of current through said circuit means as to effect deflection of said beam by all of said rod-electrodes in one direction in response to a signal applied to one pair of said input terminals and deflection of said beam by all of said rod-electrodes in another direction in response to a signal applied to the other pair of said input terminals.

PHILO T. FARNSWORTH.