

July 19, 1955

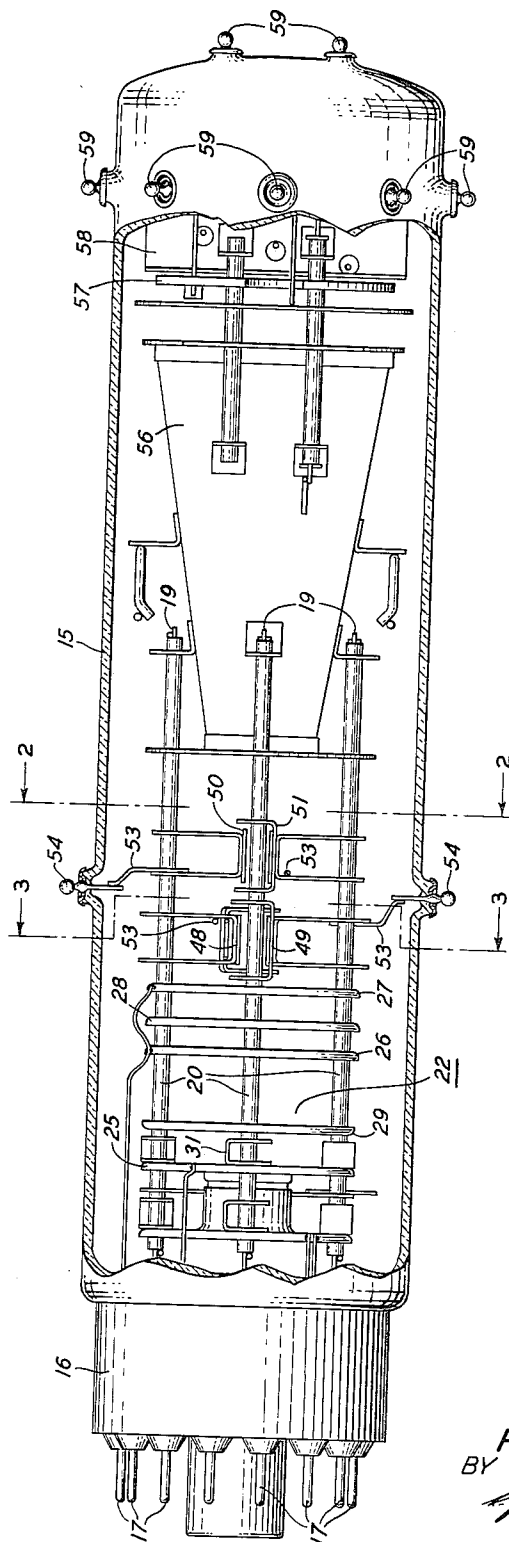
R. W. SEARS
ELECTRON DISCHARGE DEVICES

2,713,650

Filed Nov. 20, 1951

4 Sheets-Sheet 1

FIG. 1



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BY

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July 19, 1955

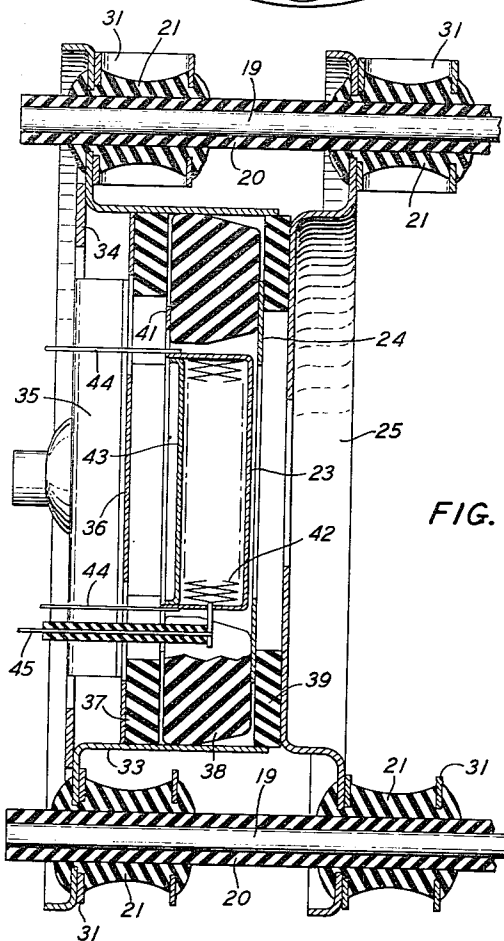
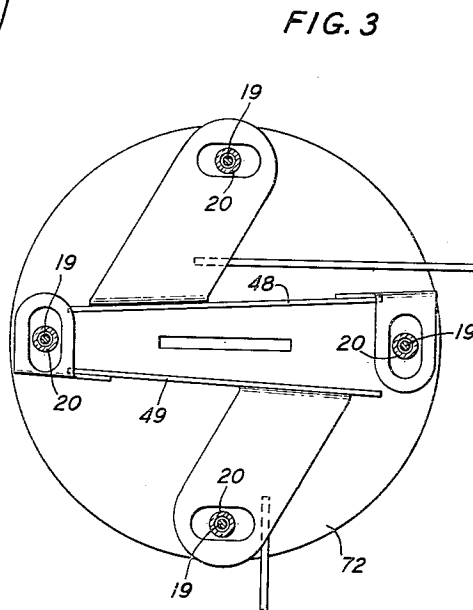
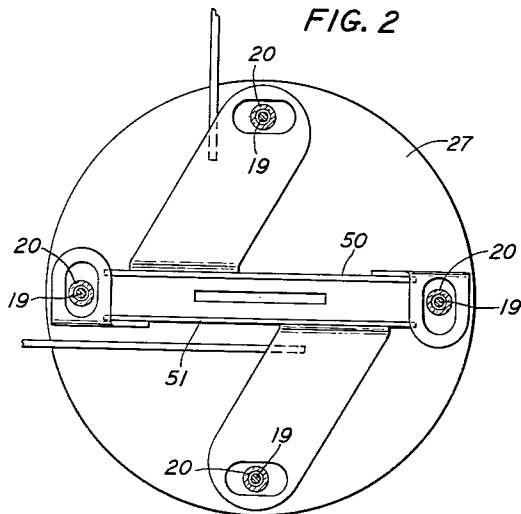
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2,713,650

ELECTRON DISCHARGE DEVICES

Filed Nov. 20, 1951

4 Sheets-Sheet 2



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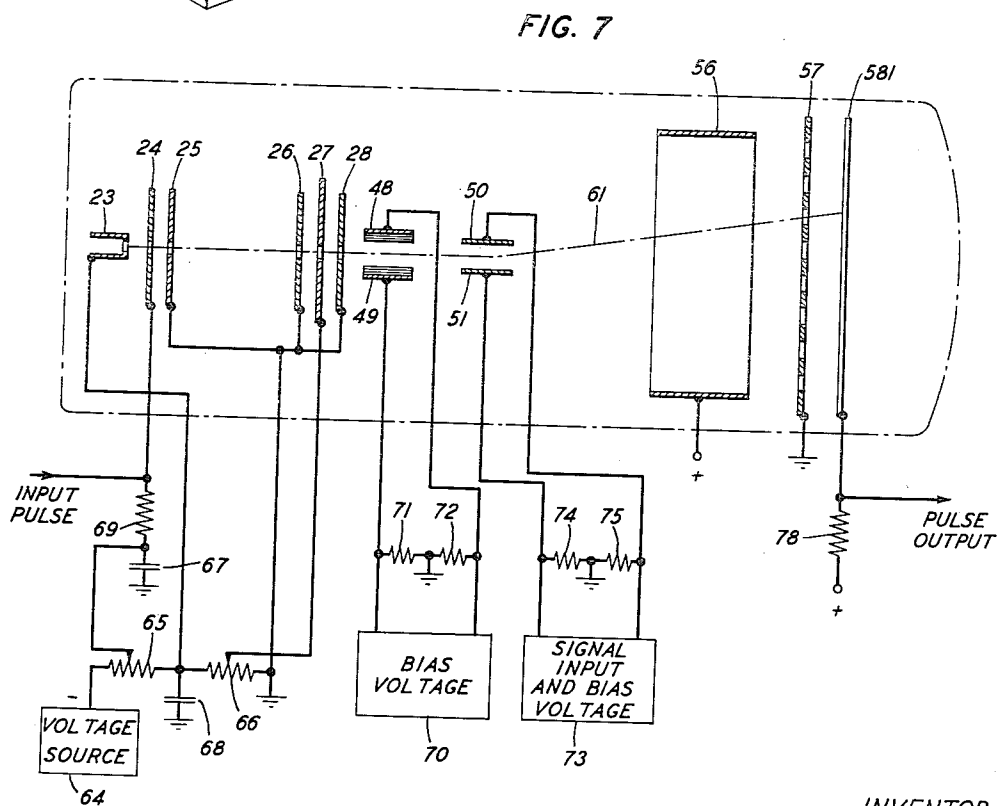
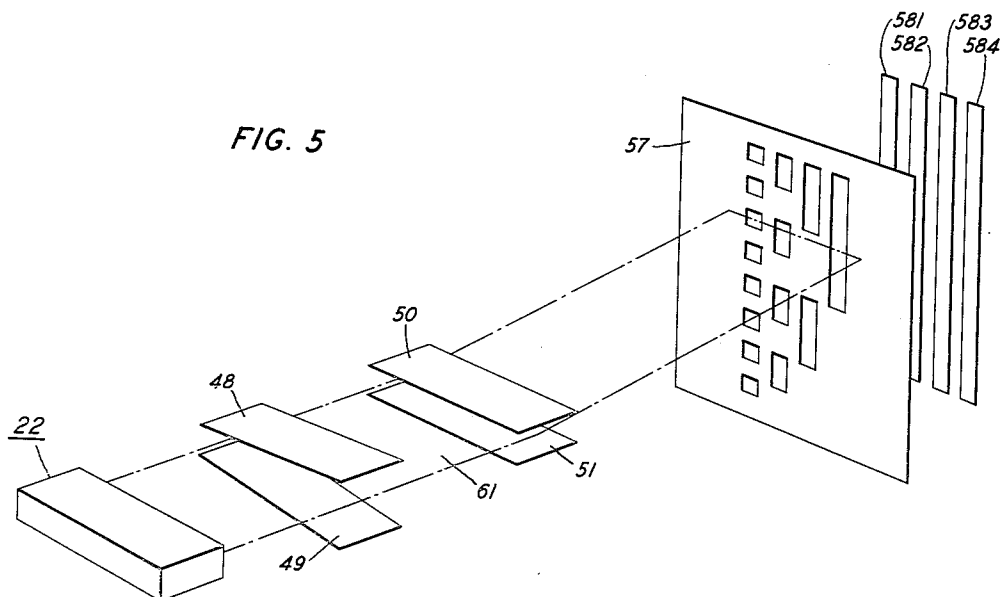
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ELECTRON DISCHARGE DEVICES

Filed Nov. 20, 1951

4 Sheets-Sheet 3



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ELECTRON DISCHARGE DEVICES

2,713,650

Filed Nov. 20, 1951

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FIG. 6A

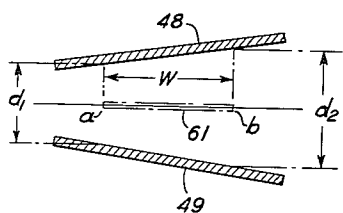


FIG. 6B

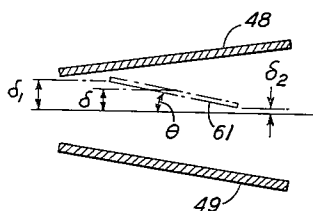


FIG. 6C

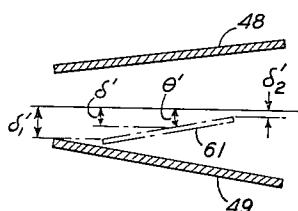


FIG. 9

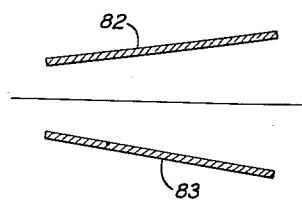


FIG. 10

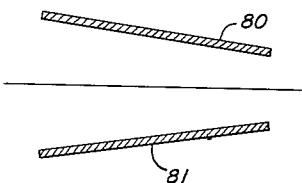
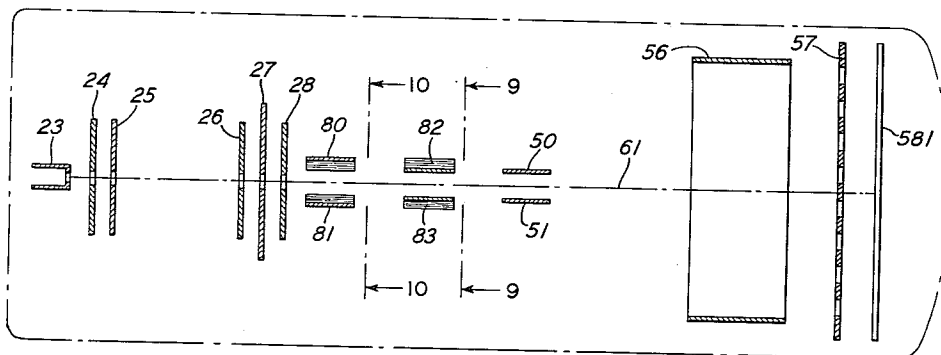


FIG. 8



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ELECTRON DISCHARGE DEVICES

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Application November 20, 1951, Serial No. 257,365

20 Claims. (Cl. 315—21)

This invention relates to electron discharge devices and more particularly to such devices employing electron beams.

Beam type electron discharge devices are of various types which may be employed in different systems and circuits. Such devices include beam deflection amplifiers, cathode-ray devices, coding devices, etc. While this invention is not limited to any particular type of electron beam devices, it will be described with particular reference to coding devices, which generally include an electron gun for generating the electron beam, deflection plates for imparting a signal to the electron beam, a target or targets upon which the beam impinges, and an apertured coding plate positioned adjacent and before the target or targets. Such coding devices may be employed, for instance, for pulse code modulation, the principles of which are described in, inter alia, an article "An experimental multichannel pulse code modulation system of toll quality" by L. A. Meacham and E. Peterson in the Bell System Technical Journal, vol. 27, at page 1. (January 1948.)

Certain coding devices for pulse code modulation are described in my article entitled "Electron Beam Deflection Tube for Pulse Code Modulation" at page 44 of that issue. The devices there described employ a point electron beam which is swept across the face of the apertured plate, thus requiring a certain increment of time for the sweeping operation. This time delay can be eliminated by employing in the coding device in place of the point electron beam a flat or ribbon electron beam the width of the apertured coding plate so that all the targets or collectors have electrons impinging on them at the same time rather than in succession. Such tubes are known as "flash" coders and are described in R. L. Carbrej Patent 2,516,752, issued July 25, 1950 and in W. M. Goodall's article "Television by pulse code modulation," volume 30 of the Bell System Technical Journal, page 1 (January 1951) and particularly at page 38.

In all of these devices, whether of the flash coding type or employing a swept beam, it is necessary that the electron beam be perfectly parallel to the coding rows in the aperture plate so that miscoding will not occur. In order to decrease the effect and the possibility of these errors various suggestions have been made. One of these suggestions is to use quantizing grids directly in front of the aperture plate, the quantizing grids feeding back to the deflector plates a signal when the beam departs from the line of the quantizing grid wire, as discussed in my above-mentioned article. However, quantizing in this manner is dependent on the motion of the point beam along the grid wire and therefore is not applicable to a flash coder.

Another suggestion that has been made is to rearrange the apertures in the coding plate so that a misalignment of the electron beam can cause an error of only one position in the code. This coding plate is known as a reflected binary coding mask and is disclosed in the above-mentioned Goodall article and in F. Gray Patent

2,632,058, issued March 17, 1953. This binary coding mask is effective in limiting the error introduced by a misalignment of the electron beam but does not prevent such a misalignment.

Priorly the deflection plates of the coding device and the aperture coding plate were mechanically aligned by jigs in an attempt to attain proper alignment of the electron beam. These two components of the electron beam discharge device are at opposite ends of the device and are physically considerably removed from each other as these devices are generally rather long. Considerable difficulty was therefore encountered in attempting to mechanically align the deflection plates and the apertured coding plate and the results were not entirely uniform or satisfactory.

It is one object of this invention to attain proper alignment of an electron beam with another element or elements in an electron discharge device.

It is another object of this invention to attain alignment of both point electron beams that are swept across a target and flat or ribbon beams that are flashed onto the target. More specifically, it is an object of this invention to align electron beams and the apertured coding plates in electron discharge coding devices.

It is a still further object of this invention to facilitate the assembling of electron beam discharge devices.

It is a still further object of this invention to improve electron beam discharge devices. More specifically, it is an object of this invention to improve flash coders employing ribbon electron beams.

Further it is an object of this invention to eliminate edge effects that might be introduced into ribbon beams in electron beam discharge devices.

These and other objects of this invention are achieved in accordance with this invention by the provision of a pair of deflection plates, the plates being located on either side of the undeflected electron beam and equidistant therefrom. The plates are slightly oblique to the plane of the electron beam and are oppositely inclined so that they are closer together at one end than at the other. A bias potential applied to these plates will both deflect a flat electron beam towards one of the plates and rotate it, the direction of deflection and rotation being dependent upon the inclination of the plates and the polarity of the applied potential. Thus, in accordance with this invention, a potential bias applied to inclined deflection plates provides an accurate electron alignment of the electron beam. This alignment of the beam is adaptable for various types of electron beam discharge devices and is not limited to any specific type.

In one specific illustrative embodiment comprising a flash coder, the inclined deflection plates are positioned between the electron gun and the plane parallel signal deflection plates and have a potential applied thereto to align the flat ribbon electron beam with the coding apertures in the apertured coding plate of the device. Specifically, in this embodiment the plane parallel signal deflection plates may have applied thereto a biasing potential to counteract and cancel the deflection of the electron beam introduced by the inclined deflection plates when rotating and aligning the beam.

In another specific illustrative embodiment, two pairs of inclined deflection plates are employed, the inclinations of the two pairs being opposite, and have applied thereto a potential of such polarity that the deflections of the electron beam by the two sets of plates cancel each other while the rotations of the electron beam add to each other.

It is therefore one feature of this invention that inclined deflection plates, closer together at one end than at the other, be positioned within an electron beam discharge device between the electron gun and the target or anode of the device. More specifically, it is a feature

of this invention that a potential be applied to these inclined deflection plates such that the electron beam is aligned with the target or with some other element within the device.

It is a further feature of this invention that such inclined plates in one illustrative embodiment be incorporated in a coding device and that a potential be applied thereto to align the plane of the electron beam with the planes of the coding apertures in the apertured coding plate of the device.

It is a still further feature of this invention that the aligning rotation be accomplished without deflection of the electron beam. Specifically, it is a feature of one embodiment of this invention that a potential be applied to the plane parallel deflection plates of an electron beam discharge device to cancel the deflection introduced by the inclined plates while having no effect upon the rotation of the plane of the electron beam. And specifically it is a feature of another specific illustrative embodiment of this invention that two pairs of inclined plates, being oppositely inclined, be positioned within an electron beam discharge device adjacent each other. In accordance with this feature of the invention, a potential may be applied to the two pairs of plates to cause rotation of the plane of the electron beam in the same direction by both sets of plates but deflection in opposite directions so that in effect no deflection of the electron beam occurs.

A complete understanding of this invention and of the various features thereof may be gained from consideration of the following detailed description and the accompanying drawing, in which:

Fig. 1 is a side view of an electron discharge device illustrative of one embodiment of this invention, a portion of the envelope being broken away;

Fig. 2 is a partial sectional view along the line 2—2 of Fig. 1;

Fig. 3 is a partial sectional view along the line 3—3 of Fig. 1;

Fig. 4 is an enlarged sectional view of the electron gun of the illustrative embodiment of Fig. 1;

Fig. 5 is a perspective schematic representation of the operation of the illustrative embodiment of Fig. 1;

Figs. 6A, 6B and 6C are sectional views of the alignment plates of the device of Fig. 1 showing the position of the electron beam for different applied potentials;

Fig. 7 is another schematic representation of the illustrative embodiment of Fig. 1, showing one illustrative combination of circuit elements employable therewith;

Fig. 8 is a schematic representation of another illustrative embodiment of this invention; and

Figs. 9 and 10 are plan views of the aligning electrodes of the device of Fig. 8 taken along the lines 9—9 and 10—10, respectively.

Referring now to Fig. 1, the specific illustrative embodiment of this invention shown comprises an envelope 15, as of glass, to which may be attached a base 16 having lead terminals 17 therein. The exhaust tubulation of the envelope 15 advantageously is positioned within the base 16 as is known in the art. Positioned within the envelope 15 and supported thereby are a plurality, such as four, support rods 19 having insulating cement coatings or sleeves 20 thereon. The electron gun means 22 is supported by the rods 19 and comprises a plurality of electrodes including a cathode 23, a beam intensity control electrode 24, best seen in Fig. 4, accelerating electrodes 25, 26 and 27, a beam focussing electrode 28, and a masking electrode 29. The disc-shaped electrodes 26, 27, 28 and 29 are each attached to the support rods 19 and insulated therefrom by the insulating coating 20 and cement 21, best seen in Fig. 4. Electrode 25, which is advantageously cup shaped, is also attached to the support rods 19 by the insulating coating 20 but clips 31 are employed for additional support.

The cathode 23, which is a hollow cup member advantageously having an electron emissive coating on the base thereof, and the beam intensity control electrode 24 are accurately positioned intimately adjacent each other in the sub-assembly shown in Fig. 4. Referring now to that figure, an outer cathode shell 33 is secured, as by clips 31 and the insulating cement or coating 20, to the support rods 19. A ring-shaped metallic member 34 having bent-up spring portions 35 is attached, as by welding, to the base of the shell 33. Positioned within the shell 33 and on the spring portions 35 are a heat baffle 36, a first insulator ring 37, a second insulator ring 38, the beam intensity control electrode 24, and a third insulator ring 39. Positioned adjacent the shell 33 is the accelerating electrode 25 against which the spring portions 35 bias the above-listed elements. The cathode 23 is situated within the central aperture of the second insulator ring 38 and has an integral flanged portion 41 extending between the first and second insulator rings 37 and 38. A heater element 42 is positioned within the cathode cup 23 and a backing member 43 secured thereto, as by welding. Cathode leads 44 and heater leads 45 extend through appropriate apertures and spacings in the cathode flanged portion 41. As the cathode is positioned between the first and second insulator rings 37 and 38 and the beam control electrode 24 between the second and third insulator rings 38 and 39, the height of the second insulator ring 38 determines the spacing between the cathode emissive surface and the beam intensity control electrode.

Referring again to Fig. 1, positioned adjacent the electron gun means 22 and also supported by the support rods 19 are two pair of deflection plates. The first pair, as better seen in Fig. 3, comprises two plates 48 and 49 located on opposite sides of the undeflected electron beam emitted by the electron gun 22 and inclined across the width of the beam by equal and opposite angles. These plates shall be hereinafter referred to as tilt plates and are explained further below. The second pair of plates, as best seen in Fig. 2, comprises a pair of plane parallel plates 50 and 51, hereinafter called the signal deflection plates, located symmetrically above and below the plane of the undeflected electron beam. Leads 53 connect each of the plates 48, 49, 50 and 51 to appropriate button terminals 54 in the envelope 15.

A hollow collector shield member 56, the purpose for which is discussed below, is supported by the rods 19 and extends adjacent the apertured coding plate 57 and the target or anode assembly 58 which may advantageously be of the type disclosed in Patent No. 2,668,927, issued February 9, 1954, to H. C. Jonas and R. W. Sears. Connections are made from the individual targets in the target assembly 58 to button leads 59 in the envelope.

The operation of the specific illustrative embodiment shown in Fig. 1 in accordance with this invention can be best understood with reference to Figs. 5, 6A, 6B, 6C and 7. Fig. 5 is a schematic perspective view, greatly simplified, of the device of Fig. 1 looking away from the gun or beam forming end of the device and towards the apertured coding plate. The flat ribbon electron beam 61, preferably of high concentration, is formed by the electron gun 22 whose electrodes may advantageously include those incorporated in the device of Fig. 1. However, it is to be understood that the electron gun may be of different construction. The tilt plates 48 and 49 and the signal deflection plates 50 and 51 are mounted opposite the electron gun 22. In Fig. 5, the apertured coding plate 57 is shown as laid out in accordance with the binary number system and with only four vertical columns for a four-digit code for simplicity though larger and more complicated codes are of course generally employed in such devices, such as that disclosed in the above-mentioned compending Jonas-Sears application. Similarly, for simplicity the target assembly is shown as comprising but four strips 581, 582, 583 and 584 mounted behind

and each aligned with a vertical column of apertures in the coding plate 57.

The flat electron beam 61 emitted by the electron gun 22 passes from the gun through the tilt plates 48 and 49 where the beam is subject to a steady deflection by a potential applied across the tilt plates 48 and 49. The steady deflection occurring as the beam passes between the tilt plates causes a rotation of the plane of the flat beam 61 in addition to the conventional deflection, as is explained further below in more detail with reference to Figs. 6A, 6B and 6C. The beam next passes through the signal deflection plates 50 and 51 where it may be given a deflection by potentials due to signals from a signal input voltage source. The beam then impinges on the apertured coding plate 57 and on the targets 581-584, in accordance with the particular code at that plane of the coding plate to which the beam has been deflected.

The action of the tilt plates 48 and 49 can be best understood with reference to Figs. 6A, 6B, and 6C which are cross section views of the tilt plates showing the position of the electron beam 61 for various potentials applied to the tilt plates. Fig. 6A shows the undeflected beam position assuming the undeflected beam position to be perfectly aligned with the central axis of the tilt plates. The electron beam 61 is of a width W and the right and left edges of the beam are designated b and a , respectively. The electrostatic field between two non-parallel plates resulting from the application of a potential difference is not uniform and is greatest where the plate spacing is smallest. When the tilt of the plates 48 and 49 is not too great, the electrostatic field mainly extends between them and is larger at a where the spacing between the plates is d_1 than at b , where the plate spacing is d_2 . To a first approximation the component of the field extending between the plates will be given by $\Delta V/d$ where ΔV is the applied potential difference between the plates. This field will deflect the beam by an amount δ given by

$$\delta = \frac{\Delta V SL}{2d V} \quad (1)$$

where V is the average velocity of the electron beam expressed in electron volts, S is the distance from the center of the plates to the position where deflection is determined, and L is the length of the plates as measured in the direction of the electron travel. Accordingly, the edge a of the beam 61 will be deflected by an amount δ_1 while the edge b will be deflected by an amount δ_2 , where

$$\delta_1 = \frac{\Delta V SL}{2V d_1} \quad (2)$$

and

$$\delta_2 = \frac{\Delta V SL}{2V d_2} \quad (3)$$

This will result in a deflection of the beam from the position shown in Fig. 6A to that shown in Fig. 6B. This is equivalent to an average deflection δ and a clockwise rotation through an angle θ as viewed from the target end of the device. This rotation is given by the approximate equation

$$\tan \theta = \frac{\Delta V SL}{2V W} \left(\frac{1}{d_1} - \frac{1}{d_2} \right) \quad (4)$$

Fig. 6C shows the beam deflected from its initial position by the application of a deflection voltage to the tilt plates 48 and 49 of opposite polarity to that shown in Fig. 6B. In this case the beam is deflected downward by an average deflection of δ' and rotated in a counter-clockwise direction by an angle θ' .

In using tilt plates 48 and 49 to align the electron beam 61 with the axis of the coding plate 57, the bias voltage applied to the plates 48 and 49 is adjusted until the beam has rotated through the requisite angle to attain perfect alignment. As the signal deflection plates 50

and 51 are plane parallel and therefore produce a deflection without rotation, the deflection of the beam 61 introduced by the tilt plates 48 and 49 can be balanced out by an approximate counter deflection by the signal deflection plates. This balancing of the deflection, however, will have no effect on the rotation of the beam 61 by the tilt plates 48 and 49. Thus the beam 61 can be aligned by adjusting the biasing voltages applied to the tilt plates 48 and 49 and the signal deflection plates 50 and 51 until the plane of the beam 61 is aligned with the axis of the coding plate 57 and deflected to the desired zero signal position.

Thus only a rough mechanical alignment need be made during the fabrication of the electron discharge device, such as a beam coding device, and then an absolute electronic alignment and zeroing may be attained by biasing the tilt and signal deflection plates.

One illustrative manner of operation of the device of Fig. 1, wherein are incorporated tilt plates to assure alignment of the electron beam in accordance with this invention, can be described with reference to Fig. 7 wherein the various elements of the device and circuit elements associated therewith are shown schematically. The accelerating, focussing, and beam intensity control electrodes are there shown as all obtaining their respective potentials from the negative voltage source 64 and associated potentiometers 65 and 66, the beam intensity control bias being obtained from potentiometer 65 and the focussing bias from potentiometer 66. Bypass condensers 67 and 68 prevent ripple from the negative voltage source 64 appearing on either the cathode 23 or the beam intensity control electrode 24. A resistor 69 in series with the beam intensity control electrode 24 enables the application of pulses or signals of suitable polarity to either blank or increase the intensity of the electron beam 61. The accelerating electrodes 25, 26 and 28 operate at a positive potential relative to the cathode and advantageously to the other electrodes. While they are shown electrically connected together and thus are at the same potential good beam focus may be obtained also if they are operated at different potentials provided that such potentials are all positive relative to the cathode 23.

The masking electrode 29 of Fig. 1, which is positioned in the field free space between the accelerating electrodes 25 and 26, has an aperture therein smaller than the width of the original electron beam emitted by the cathode 23 so that edge effects introduced into the beam by the beam intensity control electrode 24 and the accelerating electrode 25 may be eliminated. While the masking electrode 29 has been omitted from the simplified schematic of Fig. 7, as it has no function in the coding operation itself, it may advantageously be included in devices employing flat ribbon electron beams.

As pointed out above the flat beam 61 on passing through the tilt plates 48 and 49 is given a steady deflection and rotation by potentials from adjustable bias voltage source 70 in conjunction with resistors 71 and 72, which balance the potentials symmetrically with respect to reference ground. The slightly rotated beam then passes through signal deflection plates 50 and 51 where it may be given a deflection by potentials from the signal input and bias voltage source 73 and the resistors 74 and 75 which balance the deflection voltages.

The beam passes through the collector shield 56 which is shown in Fig. 1 as a flat hollow metallic member with trapezoidal sides, though a conducting coating on the inner wall of the envelope 15 could be employed. The beam then strikes the apertured coding plate 57. When the beam is deflected to impinge upon apertures in the coding plate, it passes through the apertures and strikes the collector strips, one of which 581 is shown in Fig. 7. Electron current to this collector strip causes a voltage to appear across output resistor 78. The collector strips are usually biased positively, as indicated, so that second-

dary electrons resulting from the bombardment of these strips are suppressed. However, an alternative method of obtaining the coded output signals is to make the collector strips highly secondary emissive, i. e., in excess of unity secondary emission ratio, and apply a negative bias thereto with respect to the apertured coding plate so that an even larger voltage of opposite polarity will appear across the output resistor 78. The collector shield 56 located in front of the apertured coding plate 56 is usually biased positive with respect to the coding plate 56 so that secondary electrons formed when the beam strikes the front face of the coding plate 56 are collected by it and thus prevented from finding their way to the collector strips and partially disturbing the coding process.

Regardless of the manner of obtaining the coded output signal, the beam must be aligned so that when it is flashed onto the coding plate 56 the beam will be parallel to the apertures and thus perpendicular to the vertical collector strips, thus allowing the electron beam to traverse only the apertures of the desired code while assuring that it will traverse each of them. The tilt plates 48 and 49 in accordance with this invention, deflect and rotate the plane of the beam with respect to the axis of the coding plate to provide an adjustable electronic alignment to compensate for any mechanical misalignment of the gun and target systems.

While the above description has been of a flash coder it is to be understood that this invention is equally applicable to the alignment of point electron beams which are swept across a target as well as to various other types of electron discharge devices, other than coders, wherein electron beams are employed.

In another specific illustrative embodiment of this invention, shown in Fig. 8, two sets of tilt plates are employed, elements identical in Fig. 8 with those in Fig. 7 being identified by the same numeral. In this embodiment, the flat ribbon electron beam 61 passes through a first set of tilt plates 80 and 81 and then through a second set of tilt plates 82 and 83. Fig. 10 shows the tilt of the plates 80 and 81 and Fig. 9 shows the opposite tilt of the plates 82 and 83. As was pointed out in connection with the prior embodiment, a deflection bias applied between the tilt plates will both deflect the beam and rotate it, a bias of one polarity deflecting the beam upward and rotating the plane of the beam in a clockwise manner and a bias of the opposite polarity deflecting the beam downward and rotating the plane of the beam in a counter-clockwise manner. Similarly, by virtue of the reverse inclination of tilt plates 82 and 83, with respect to tilt plates 80 and 81, a deflection voltage applied to tilt plates 82 and 83 will deflect the beam downward while rotating it clockwise or deflect the beam upward while rotating it counter-clockwise. Thus if the potentials applied to the tilt plates 80 and 81 and tilt plates 82 and 83 are so chosen that one tilts the beam upward and the other downward, the deflections will cancel each other while the rotations of the plane of the beam will add to each other. Specifically, a single biasing voltage may advantageously be employed with tilt plates 80 and 83 electrically connected together and tilt plates 81 and 82 electrically connected together, the biasing potential being applied between these sets of plates. While a single biasing voltage is employed different voltage sources could be utilized so long as the potentials applied to the two pairs of tilt plates are equal but of opposite polarity, i. e., the positive side of the voltage source is connected to one upper and the other lower tilt plate. Thus by employing two pairs of tilt plates a rotation of the plane of the electron beam may be obtained without a deflection of the beam at the axis of rotation. It is to be understood that this rotation without deflection occurs also with point electron beams that are swept across the apertured coding plate, the path of the electron beam during its sweep

being equivalent to the plane of the flat electron beam that is flashed onto all the collector strips at the same time.

It is to be understood that the above-described arrangements are merely illustrative of the application of the principles of this invention and that this invention is not limited in its application to electron beam coding tubes or to the specific illustrative embodiments disclosed. Numerous other arrangements may be devised by those skilled in the art without departing from the spirit and scope of the invention.

What is claimed is:

1. An electron discharge device comprising target means, means opposite thereto for projecting an electron beam thereagainst, means for deflecting the electron beam in a direction perpendicular to the direction of the electron beam, said deflection means comprising a first pair of deflection plates, means for aligning the electron beam with said target means, said aligning means comprising a pair of tilt deflection plates, said plates being positioned on opposite sides of the electron beam and being closer together at their one end at right angles to the direction of the electron beam than at their other end at right angles to the direction of the electron beam, and means for applying a biasing potential to said tilt plates whereby the electron beam is deflected towards one of said plates more at one end of said plates than the other, and means applying a biasing potential to said first pair of deflection plates returning the electron beam at the center line of said tilt plates to its undeflected position.
2. An electron discharge device comprising target means, means for projecting an electron beam against said target means, and means for aligning the electron beam, said aligning means comprising two pairs of tilt deflection plates located in succession along the electron beam, one each of said pairs of plates being located on opposite sides of the electron beam and each pair of plates being inclined towards each other so as to be closer together at their one end than at their other, the inclinations of the pairs of plates being opposite.
3. An electron discharge device in accordance with claim 2 comprising means for applying a biasing potential to one of said pairs of plates, and an equal biasing potential of opposite sign to the other of said pairs of plates.
4. An electron discharge device comprising target means, electron gun means opposite said target means for projecting a flat electron beam thereagainst, and means for aligning said flat electron beam with said target means comprising deflection means on opposite sides of the beam path for producing an electric field graduated in intensity from one edge of said flat electron beam to the other edge of said flat electron beam.
5. An electron discharge device comprising a target, means opposite thereto for projecting a flat electron beam thereagainst, and means for aligning the flat electron beam with said target means, said aligning means comprising a pair of deflection plates each having a surface adjacent said beam, the distance between said surfaces being shortest at one edge of the flat electron beam and gradually increased to the other edge of the flat electron beam.
6. An electron discharge device comprising target means, means opposite thereto for projecting a flat electron beam thereagainst, means for deflecting the flat electron beam in a direction perpendicular to the plane of the flat electron beam, means for aligning the flat electron beam with said target means, said aligning means comprising a pair of tilt deflection plates, each of said plates being at an angle to the plane of the flat electron beam and said plates being closer together at one edge of the flat electron beam than at the other and means applying a biasing potential to said tilt deflection plates whereby the flat electron beam is deflected towards one of said tilt plates and is rotated in a plane perpendicular to the plane of the flat electron beam.

7. An electron discharge device in accordance with claim 6 wherein said means for deflecting the flat electron beam in a direction perpendicular to the plane of the flat electron beam comprises a pair of plane parallel deflection plates and comprising means for cancelling out the deflection of the flat electron beam introduced by said tilt deflection plates without altering the rotation of the flat electron beams, said last-mentioned means comprising a biasing potential applied to said plane parallel deflection plates.

8. An electron discharge device comprising target means, means opposite thereto for projecting a flat electron beam thereagainst, and means for aligning the flat electron beam with said target means, said aligning means comprising two pairs of tilt deflection plates, one each of said pairs of plates being located on opposite sides of the flat electron beam, one pair of plates being inclined towards each other so as to be closer at one edge of the flat electron beam than at the other and the other pair of plates being inclined towards each other so as to be closer at said other edge of the flat electron beam than at said one edge.

9. An electron discharge device in accordance with claim 8 comprising means for applying a biasing potential to one pair of said tilt plates and means for applying an equal biasing potential of opposite polarity to the other pair of said tilt plates, whereby rotation of the flat electron beam is attained without deflection of the center of rotation of the beam.

10. An electron discharge device comprising target means, means opposite thereto for projecting a flat electron beam thereagainst, and means for aligning the flat electron beam with said target means, said aligning means comprising first deflection means on opposite sides of the beam path for producing a first electric field graduated in intensity from one edge of said flat electron beam to the other edge of said flat electron beam and second deflection means on opposite sides of the beam path for producing a second electric field graduated in intensity from said other edge of said flat electron beam to said one edge of said flat electron beam, said electric fields being equal and of opposite sign.

11. An electron discharge device comprising an apertured coding plate, electron gun means positioned opposite said coding plate for projecting an electron beam thereagainst, electron collector means positioned adjacent said coding plate to the other side thereof than said electron gun means, and two pairs of deflection plates positioned between said electron gun means and said coding plate, one of said pairs comprising a pair of plane parallel deflection plates and the other of said pairs comprising a pair of inclined tilt plates closer together at their one end than at their other, a line between said ends being perpendicular to the direction of the projected electron beam.

12. An electron discharge device comprising an apertured coding plate, electron gun means positioned opposite said coding plate for projecting a flat electron beam thereagainst, electron collector means positioned adjacent said coding plate to the other side thereof than said electron gun means, and a plurality of pairs of deflection plates positioned between said electron gun means and said coding plate, one of said pair comprising a pair of plane parallel deflection plates and another of said pairs comprising a pair of tilt deflection plates, each of said tilt deflection plates being inclined at an angle to the plane of the flat electron beam and said tilt plates being closer together at one edge of the flat electron beam than at the other.

13. An electron discharge device in accordance with claim 12 wherein said plurality of pairs of deflection plates also includes a second pair of tilt deflection plates, each of said second tilt deflection plates being inclined at an angle to the plane of the flat electron beam and

closer together at said other edge of the flat electron beam than at said one edge.

14. An electron discharge device in accordance with claim 12 wherein said electron gun means comprises a cathode, a beam intensity control electrode, a focussing electrode, a plurality of accelerating electrodes, and a masking electrode positioned in a field free space between two of said accelerating electrodes, said masking electrode having an aperture therein of smaller width than the flat electron beam emitted by said cathode whereby electron beam fringe effects are prevented.

15. An electron discharge device comprising an apertured coding plate, electron gun means positioned opposite said coding plate for projecting a flat electron beam thereagainst, electron collector means positioned adjacent said coding plate to the other side thereof than said electron gun means, a pair of deflection plates positioned between said electron gun means and said coding plate and on opposite sides of the beam path, and deflection means on opposite sides of the beam path for producing an electric field graduated in intensity from one edge of said flat electron beam to the other edge of said flat electron beam.

16. An electron discharge device comprising an envelope, a plurality of support rods within said envelope, electron gun means for projecting a flat electron beam supported by said support rods, said gun means comprising a cathode, a flat beam intensity control electrode having a slit therein, and disc-shaped accelerating and focussing electrodes each having a slit therein and supported by said support rods, a first pair of deflection plates supported by said support rods, each of said plates being at an angle to the plane of the flat electron beam and said plates being closer together at one edge of the flat electron beam than at the other, a second pair of deflection plates supported by said support rods, said plates being plane parallel, an apertured coding plate positioned opposite said electron gun means, a collector shield positioned between said deflection plates and said coding plate, and electron collector means positioned adjacent said apertured coding plate to the other side thereof than said electron gun means.

17. An electron discharge device in accordance with claim 16 comprising a third pair of deflection plates supported by said support rods, each of said third pair of plates being inclined at an angle to the plane of the flat electron beam and said third pair of plates being closer together at said other edge of the flat electron beam than at said one edge.

18. An electron discharge device in accordance with claim 17 comprising means for applying a potential bias to said first pair of deflection plates and means for applying an equal potential bias of opposite polarity to said third pair of deflection plates.

19. An electron discharge device in accordance with claim 16 wherein said electron gun means also comprises a masking electrode positioned in a field free space between two of said accelerating electrodes, said masking electrode having a slot therein of smaller width than the flat electron beam emitted by said cathode whereby electron beam fringe effects are prevented.

20. An electron discharge device in accordance with claim 16 wherein said cathode comprises an outer shell member, a spring member positioned across the base of said outer shell member, a first insulating ring member, a second insulating ring member, a cathode cup member having an emissive surface thereon and having a flanged portion integral therewith, said flanged portion extending between said first and second insulating ring members and supported thereby, and a third insulating ring member, said beam intensity control electrode being positioned between said second and third insulating ring members and supported thereby and one of said accelerating electrodes being positioned contiguous to said third insulating ring member whereby said spring member biases

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said insulating ring members, said cathode cup member
and said beam intensity control electrode towards said
one accelerating electrode and the distance between said
emissive surface on said cathode cup and said beam in-
tensity control electrode is determined by the height of 5
said second ring member.

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