Sept. 2, 1958 W. R. AIKEN 2,850,670

ELECTRONIC DEVICE

Filed Dec. 2, 1955 3 Sheets-Sheet 1

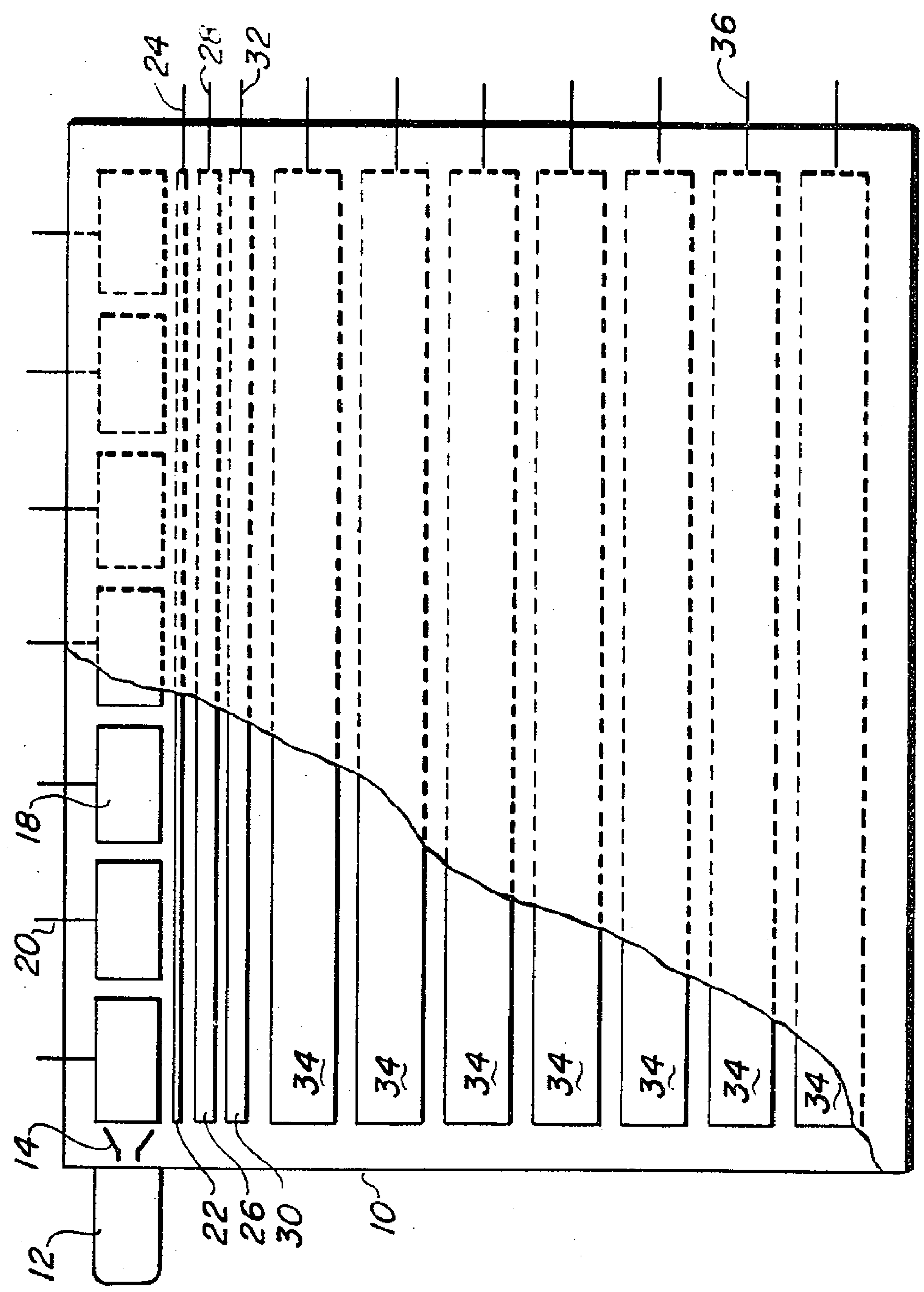

Fig. 1.

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Filed Dec. 2, 1955 | 3 Sheets-Sheet 2

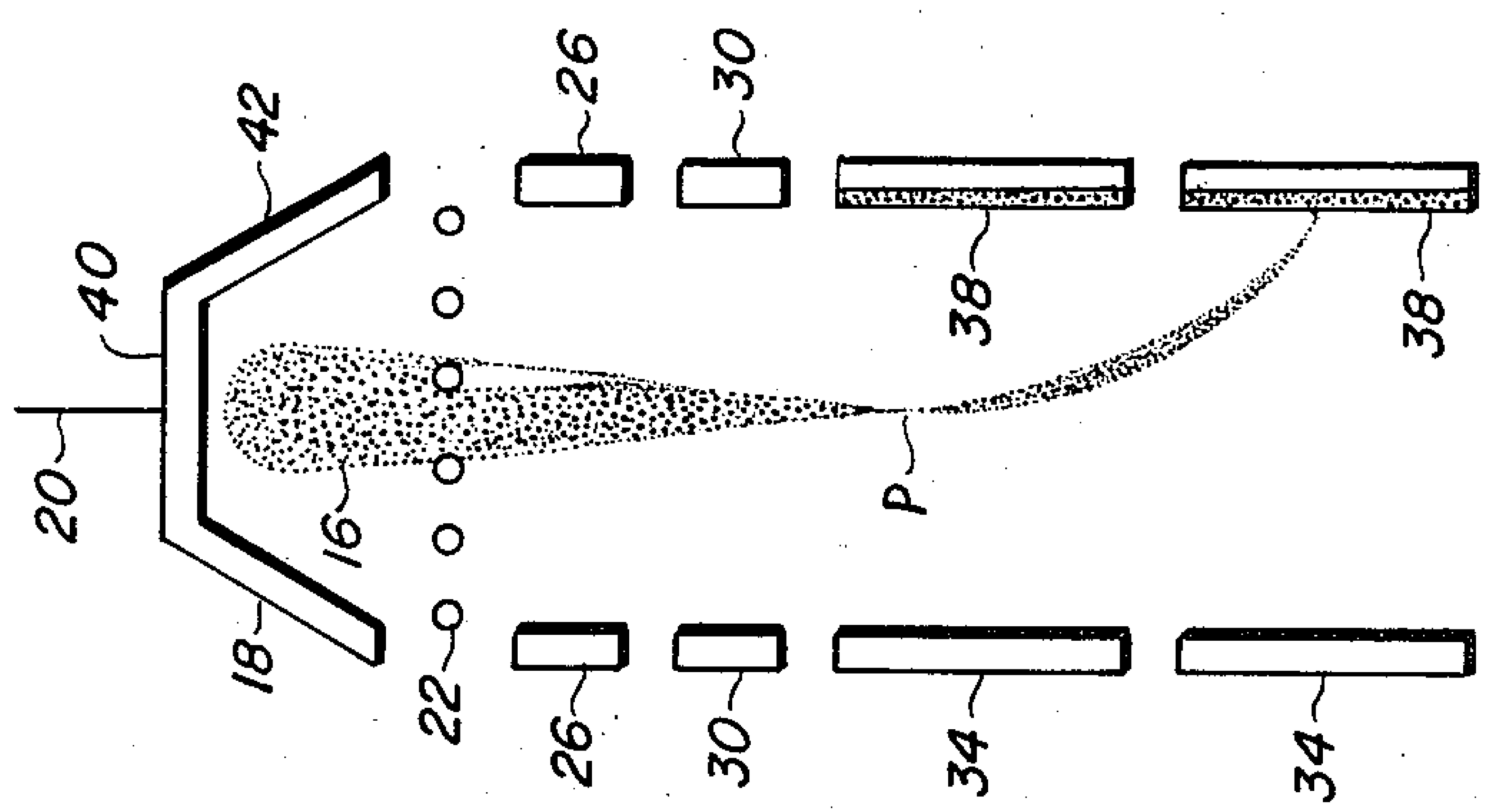

Fig. 3

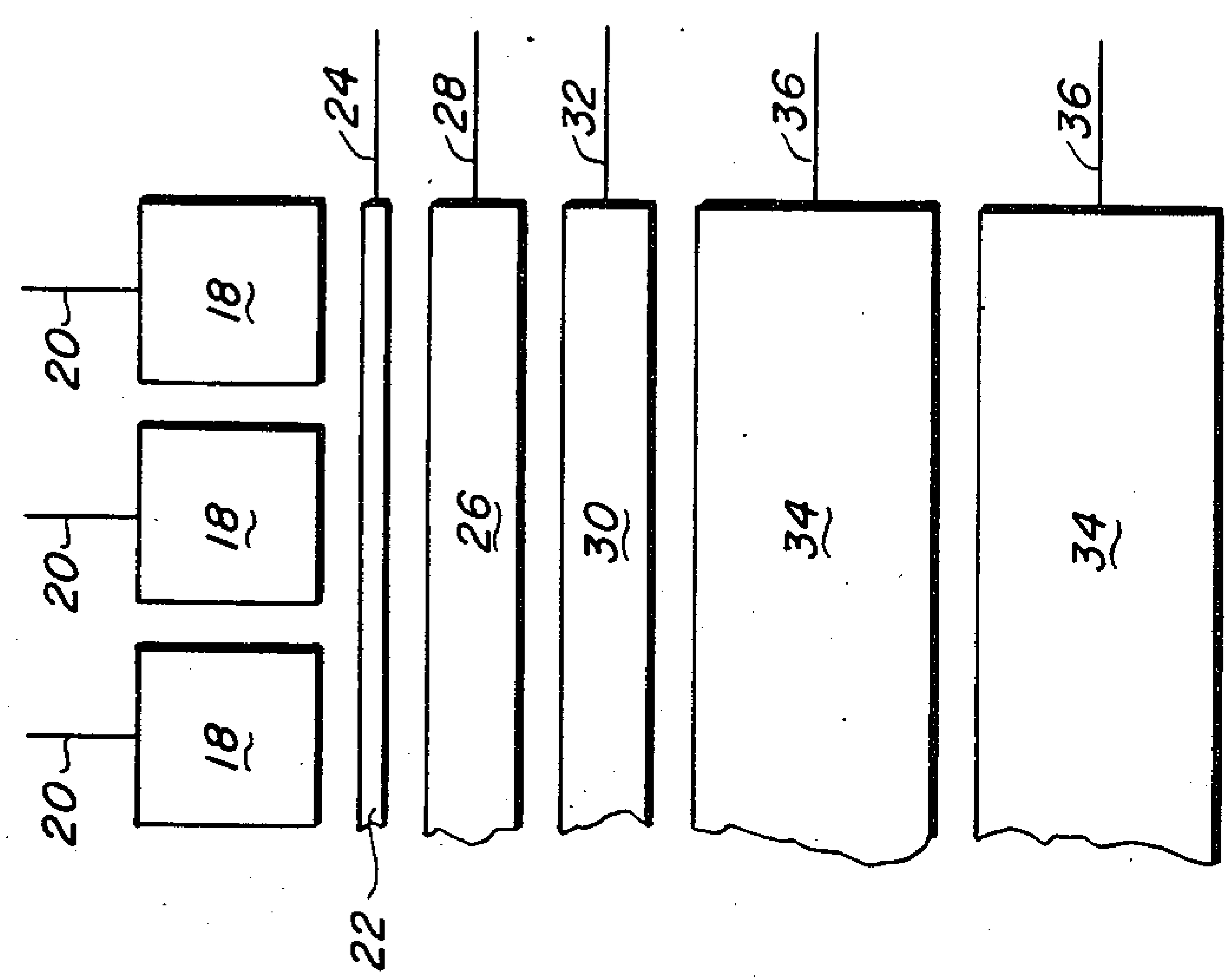

Fig. 2

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Filed Dec. 2, 1955 3 Sheets-Sheet 3

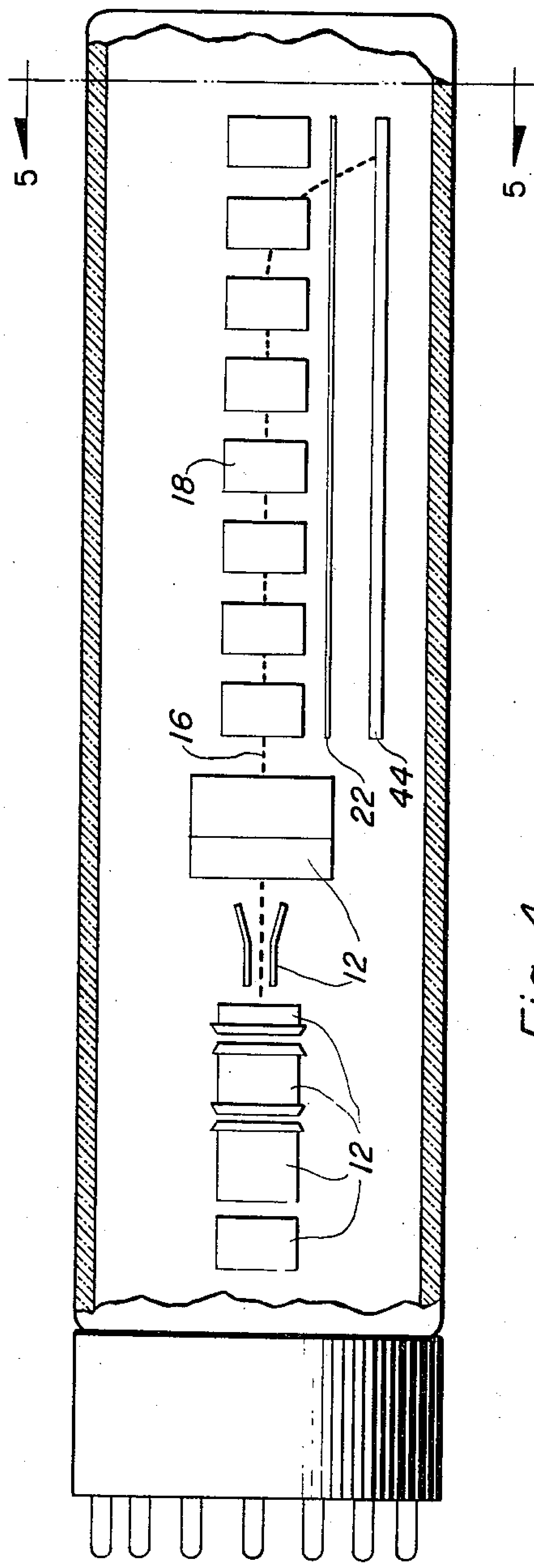

Fig. 4.

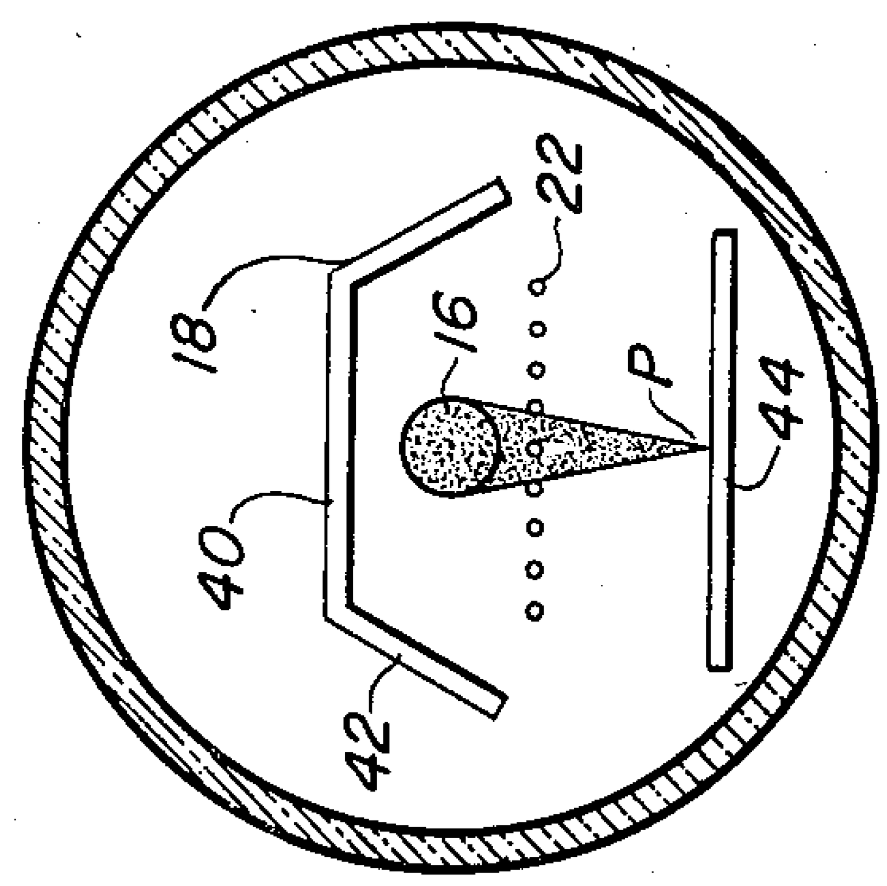

Fig. 5.

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2,850,670

Patented Sept. 2, 1958

2,850,670

ELECTRONIC DEVICE

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Application December 2, 1955, Serial No. 550,561

6 Claims. (Cl. 315—25)

The present invention relates to an electron beam deflection system and more particularly to an electrode structure for use in connection with a cathode ray tube of the flat or shallow type.

The instant invention has particular application in cathode ray tubes of the Aiken type. The Aiken type cathode ray tube is characterized by its relatively flat or shallow depth dimension which may be two or three inches as compared with the nearly twenty inch depth of the conventional elongate cathode ray tube. A complete description of the Aiken type cathode ray tube may be had by referring to copending application Serial No. 355,965, which was filed May 19, 1953 now abandoned and Serial No. 396,120, which was filed December 3, 1953 and issued as Patent No. 2,795,731, June 11, 1957.

In one embodiment, an Aiken type cathode ray tube is comprised of three sections; a primary section, including an electron gun, a linear array of horizontal deflection electrodes, and a slotted electrode having slot disposed therein co-extensively with the array; a transition section, including an arrangement of accelerating and focussing electrodes; and a high voltage section, including an electron sensitive target and an associated array of vertical deflection electrodes.

In operation, the electron gun is caused to deliver a beam of electrons along the first path through the channel formed by the linear array of horizontal deflection electrodes. Beam deflection is effected by suitably lowering the voltage on one or more of the horizontal deflection electrodes with respect to the cathode potential of the electron gun. The beam thereupon is deflected to a second path through the slotted electrode and focusing and accelerating electrodes of the transition section into the high voltage section. The beam may then be caused to impinge upon the target of the high voltage section by suitably lowering the voltage on one or more of the vertical deflection electrodes with respect to the voltage of the target. When the electrons impinge upon the target, the fluorescent material thereof becomes excited and emits a visual signal in the form of light which may be viewed from a point outside the tube.

The instant invention is an improvement in the electrode structure which may be employed in the primary section of an Aiken type tube. It has been found that it is possible to increase the inherently fine electron beam focusing characteristics of the primary section through the utilization of the electrode structure hereinafter described. In the prior Aiken type cathode-ray tubes the plurality or linear array of horizontal deflection electrodes formed a channel having a base and perpendicular side walls through which the electron beam was initially caused to travel. When the beam was deflected by the energized deflection electrode of this array, it was caused to bend and travel toward and through a slot formed in a slotted electrode. In this arrangement, the deflected beam was caused to focus at a point in the region defined by the slot. Beam focus was necessary at this point in order that no energy was sapped from the electron beam by electron impingement upon the edges of the slotted electrode. It will be obvious that this point of focus, which may be referred to as a "cross-over" point, should advantageously occur at a point close to or adjacent the target in order to obtain the maximum resolution and definition in the image display. In its broader concept, the instant invention achieves improved results by forming each of the horizontal deflection electrodes with side walls which are flared and which may be used in combination with either a plurality of parallelly arranged grid wires or with a slotted electrode such as used in the prior art embodiments. Through the utilization of the combination with grid wires, the grid wires are placed near the deflection electrodes and since the beam in that area is broad and not yet finally focused, only a small portion of the electron beam which is deflected by the horizontal deflection electrodes will impinge upon any one of the grid wires so that the majority of the energy of the beam will pass between the grid wires and, accordingly, the loss of energy will be slight. The position of the cross over point of the electron beam can be caused to vary in the plane adjacent the target such that the cross over point may be effected closer to the bottom, the center, or the top of such plane. It will be appreciated that different tube arrangements will require different points of cross over. One manner in which the position of the cross over point may be varied is by altering the angle of the sides of the deflection electrodes. Also, supplemental focusing accelerating electrodes may be employed to cooperate with the grid wire assembly to accelerate the beam to effect a change in the position of the cross over point.

A complete understanding of the invention may be had by reading the following description in connection with the accompanying drawings, in which:

Figure 1 is a front view of an Aiken type cathode-ray tube partially broken away to clearly illustrate the colocations of the electrode structure of the instant invention;

Figure 2 is an enlarged front view of the electrode arrangement of the instant invention;

Figure 3 is an end view of the electrode arrangement shown in Figure 2;

Figure 4 is a front view of a cathode ray tube of the facsimile type employing the electrode structure of the instant invention, and

Figure 5 is a sectional view of the device illustrated in Figure 4 taken along line 5—5 of Figure 4.

There is illustrated in Figure 1 an Aiken type cathode-ray tube having an evacuated envelope **10**. An electron gun **12** capable of emitting an electron beam **16** is disposed within a receiving aperture in the upper right hand corner of the envelope **10** and may be of the conventional type having electrostatic plates **14**. Any suitable electron beam forming arrangement may be employed in the practice of this invention, and a detailed description thereof is not given here, but may be found in literature such as for example, in an article entitled "Improved Electron Gun for Cathode Ray Tubes" by L. E. Swedlund in "Electronics" for March 1946. It will be obvious to those skilled in the art that electromagnetic deflection means may likewise be employed.

A linear array of horizontal deflection electrodes **18**, shown in detail in Figures 2 and 3, is disposed within the envelope **10** along the top marginal edge thereof. The electrodes **18** are slightly spaced from one another and the entire array extends away from the electron gun **12**. Each of the electrodes is provided with an electrical conductor **20** which is adapted to pass through the envelope **10** to an electrical generator outside the tube. Any electrical generator capable of producing selective signal energization of the electrodes **18** may be herein employed; however, specific reference is made to co-pending application Serial No. 514,653, which was filed June 10, 1955. It has been found that a device of the type therein described will function satisfactorily to apply the desired energization to the horizontal deflection plates **18**.

A plurality of grid wires **22** is disposed in spaced relation from and in coextensive relation with the array of horizontal deflection plates **18**. These grid wires **22** are disposed in parallel relation with respect to one another and are suitably coupled together at their terminal portions, and are provided with an electrical conductor **24** which is adapted to extend through the envelope **10** to a regulated power supply, not shown, situated outside the tube. Directly beneath the primary section of the tube, there is disposed the transition section of the tube which comprises, as shown in the illustrated embodiment, two accelerating and focusing electrodes **26** and **30** provided with associated electrical conductors **28** and **32**, respectively, which are adapted to pass through the side wall of the envelope **10** to a regulated power supply, not shown. Each electrode of the individual pairs of accelerating and focusing electrodes **26** and **30** is spaced apart a degree sufficient to permit electron beam passage therethrough.

The high voltage region of the tube, comprising a set of vertical deflection electrodes **34** and a target **38**, is disposed in spaced relation beneath the transition section. The vertical deflection electrodes **34** are affied to the inner side wall of the envelope **10** in any one of the manners well-known in the art. These electrodes **34** may be transparent and formed of an electrically conducting glass suitably affixed to the inner wall of the envelope **10** or alternatively, these electrodes may also consist of electrically conducting material which is capable of being painted on the inner surface of the tube. This material may also be transparent. Each deflection electrode **34** is provided with an electrical conductor **36** which is adapted to pass through the wall of the envelope **10** to an electrical generator of the type capable of applying or impressing selective signal energization to the electrodes **34**. An electrical generator which has been found to be satisfactory in this connection is shown and described in co-pending application Serial No. 514,653, which was filed June 10, 1955.

A target **38** is provided on the inner wall of the envelope **10** opposite the wall on which the vertical deflection electrodes **34** are affixed. The target is comprised of an electron sensitive material of the type which upon electron bombardment will emit a visual signal in the form of light.

It will be noted from an examination of Figures 2 and 3 that the horizontal deflection electrodes **18** are formed with a base portion **40** and outwardly extending side portions **42**. The electrostatic field established by these electrodes causes the electron beam **16** to converge at a cross-over point P which point is located on the side opposite the grid wire **22** assembly from that of the deflection electrodes **18**.

In operation, the electron gun **12**, upon suitable energization from an incoming signal, causes the electron beam **16** to be delivered along a path which is in substantial parallel alignment with the lonigtudinal axis of the linear array of horizontal deflection electrodes **18**. Initially, all the horizontal deflection electrodes **18** are maintained at a potential negative with respect to the cathode potential of the electron gun **12**. As the electron beam **16** enters the electrostatic field established by the horizontal deflection electrodes **18** most adjacent the source of electrons, a repelling force of said field causes the beam to be deflected downwardly in a direction away from the first electrode of the horizonal deflection electrode array. The field established within the horizontal deflection electrodes **18** deflects the electrons through the open side of the electrodes **18** toward and through the arrangement of grid wires **22**.

In the initial condition in which the horizontal deflection electrodes **18** are maintained at a negative potential with respect to the beam **16**, it has been found that satisfactory results were obtained by applying a potential of 800 volts negative with respect to the cathode potential of the electron gun **12**. The grid wire assembly comprised of the grid wires **22** is maintained at 800 volts potential positive with respect to the cathode potential of the electron gun **12**.

In achieving a line scan, signals are applied to the horizontal deflection electrodes **18** in succession from an electric generator and are preferably applied to adjacent electrodes in an overlapping manner. That is, a signal is applied to the deflection electrode **18** closest to the source of electrons which thereupon drives the electrode in a positive direction approaching the value of the potential on the grid wire assembly. However, prior to the instant the potential value on the first electrode reaches a value substantially equal to the potential of the grid wire assembly, a positive going signal is applied to the next adjacent electrode **18**. Manifestly, when the potential on the first electrode reaches the approximate potential value on the grid wire assembly, a field-free zone is established within the region defined by the grid wire assembly and the horizontal deflection electrode **18**, and the electron beam **16** is free to travel to the next adjacent horizontal deflection electrode **18**. This procedure is repeated along the entire array of electrodes **18** in such a manner that the charge on at least two electrodes **18** is always changing at the same time.

It will be readily understood that the employment of a wire grid arrangement comprised of the grid wires **22**, while being effective to maintain the desired and aforementioned field-free region, provides a minimum amount of surface area upon which the electrons may impinge. In addition, since said grid is not in the focal plane, the beam is wide and as it is later focused, no shadows cast by said grid wires are continued into the focused beam. Accordingly, this arrangement will not cause a loss of beam energy by trapping or otherwise stopping the flow of the electrons of the beam **16** passing therethrough.

Further, it is to be understood that the order in which the horizontal deflection electrodes **18** are charged or discharged may be reversed. In such case, initially all of the horizontal deflection electrodes **18** of the linear array are maintained positive with respect to the cathode potential of the electron gun **12**. The potential value in such case is equal to the potential value impressed on the grid wire assembly comprised of the grid wires **22**, thereby establishing a field-free zone along the entire longitudinal dimension of the array of horizontal deflection electrodes **18**. The field-free zone permits the electrons which comprise the electron beam **16** to travel the entire length thereof without being confronted by any spurious electric fields. In operation, the horizontal deflection electrode **18** most distant from the electron gun **12** is commenced to be driven toward its maximum value. Next, a negative going signal is applied to the adjacent electrode **18** just prior to the instant the first driven electrode **18** reach its full negative value. This procedure repeats successively along the entire array of horizontal deflection electrodes **18**.

In either arrangement, after the electron beam **16** has been deflected by the horizontal deflection electrodes **18**, the beam **16** is caused to pass through the grid wire assembly comprised of the grid wires **22** and accelerated thereby toward the high voltage section of the tube. After passing through the grid wire assembly, the beam **16** is next caused to pass between the two pairs of focusing electrode structures, the first of which is comprised of the accelerating focusing electrodes **26** and may be maintained at 2 kv. potential positive with respect to the cathode potential of the electron gun **12**. The second focusing electrode assembly comprised of the pair of electrodes 30 is maintained within the range of from 0 to 8 kv. potential positive with respect to the cathode potential of the electron gun 12. These electrodes establish electrostatic fields which tend to further focus the electron beam and cause it to be further accelerated into the high voltage or display section of the tube.

The electron beam 16, after being deflected, accelerated, and focused in the primary and transition sections of the tube, is caused to travel along a path which is parallel and in close proximity to the deflection electrodes 34. The vertical deflection system is operated much in the same manner in which the horizontal deflection system is operated. Signals applied to the vertical deflection electrodes 34 are also preferably applied in an overlapping manner so that the potential on at least two adjacent electrodes 34 is changing at the same time. Initially, these vertical deflection electrodes 34 and the fluorescent target 38 are maintained at substantially 13 kv. potential positive with respect to the cathode potential of the electron gun 12. By virtue of the fact that each of the elements of the high voltage section is maintained at an equal potential value, a field-free region is established therewithin permitting the electron beam 16 to have unobstructed travel within the field-free region until a suitable lesser potential is applied to one of the vertical deflection plates 34.

As one of the vertical deflection electrodes 34 is driven negative with respect to the target potential, the so driven electrode 34 exerts a deflecting force on the beam 16 causing it to be deflected toward and impinge upon a fluorescent target 38. The electron impingement upon the fluorescent material of the target 38 causes the material to become excited and thereby give off a massness of intensity which is directly proportional to the intensity of the impinging electron beam 16. It will be readily apparent, that the light emitted from the fluorescent coating of the target 38 may be viewed through the optically transparent deflection electrodes 34 and also may be viewed from a position toward the opposite side of the target 38.

It is apparent from the foregoing discussion that the position of impingement of the electron beam 16 on the target 38 at any given instant will be consistent with the particular ones of the horizontal and vertical deflection electrodes 18 and 34, respectively, which are energized at such instant, and the value of the energizing signal applied thereto. Further, it will be apparent to those skilled in the art that in the use of the novel electrode arrangement herein set forth with a conventional television receiver, the horizontal deflection electrodes 18 will be cyclically energized at a time rate which is consistent with the provision of the line scan of the television picture, and the vertical deflection electrodes 34 will be energized at a time rate which is consistent with the provision of a frame scan of a television picture. The energization of the vertical-horizontal deflection electrodes may be effected by a suitable electronic generator means which are synchronized in their operation by the incoming sync signal received from the television transmitting station. As pointed out herein before an electronic generator suitable for operation in conjunction with the instant apparatus is described in detail in copending application S. N. 514,653 which was filed June 10, 1955. It might be well to point out here that the instant invention may be employed in many of the cathode ray tube applications too numerous to specifically set forth herein; however, one example is in connection with a cathode-ray tube used in facsimile tube applications.

As mentioned above, the instant apparatus may advantageously be employed in connection with cathode ray tubes employed in facsimile systems. A facsimile type cathode ray tube is illustrated in Figures 4 and 5, wherein it will be noted that the horizontal deflection electrodes 18, having a top portion 40 and flared outside portions 42, is employed in conjunction with a grid wire assembly consisting of the grid wires 22. An elongate fluorescent target 44 is disposed beneath the grid wire assembly. In this embodiment, the electron beam 16 delivered by the electron gun 12 is caused to travel through the channel formed by the linear array of deflection electrodes 18 until one or more of these deflection electrodes is energized in such a manner as to establish an electric field which will act to repel and thereby deflect the beam 16 toward and into impingement with the target 44. Such electron bombardment will cause the fluorescent material of the target 44 to luminesce and give off a visual signal in the form of light. It will be noted that the focus point or cross-over point P of the electron beam 16 resides closely adjacent the fluorescent target 44, thereby making it possible to achieve a very fine line or small dot of light appear on the fluorescent target 44.

With the arrangement as illustrated in Figures 4 and 5 the instant electrode arrangement may be advantageously and satisfactorily employed as a flying spot scanner, wherein it is necessary for the cathode ray tube to have a flat screen, a very small spot of light, and ample spot brightness. The application of cathode ray tube scanning to facsimile systems may be accomplished in several different ways. As in television, both horizontal and vertical scanning is necessary. At the sending or transmitting end a successful method employed is flying spot scanning, the moving spot on the phosphor screen being projected optically onto the subject copy and the reflected light caught in a photo tube, which then provides the facsimile signal. The rapid horizontal scanning is provided by a deflection of the beam in the cathode ray tube, the vertical scanning, either by movement of the tube or by vertical motion of the subject copy.

At the receiving end, the transient image on the cathode ray tube screen must be photographed to get a permanent record. Also, as at the transmitting end, there are two modes of operation which are possible. In one case horizontal scanning is by cathode ray tube while vertical scanning is obtained by moving the film. Another case, both horizontal and vertical scanning by cathode ray tube so that a television-like raster is employed. In view of the above, it may be readily discernible that the instant apparatus may be employed in connection with facsimile systems among many other applications of the instant invention.

It will be readily discernible from the foregoing description that although the device has been described in connection with an Aiken type cathode ray tube and a cathode ray tube of the facsimile type, there are numerous other environments in which the device may be employed.

What is claimed is:

1. In an electron discharge device, and an electron beam source means for delivering a beam of electrons along a path, a set of deflection electrodes disposed along the beam path, each electrode having a planar surface with angularly depending side walls for applying deflecting forces at successive intervals along the beam path, and a plurality of parallelly disposed grid wires spaced from and in co-extensive relation with said set of deflection electrodes for maintaining a substantially field-free region for the portion of the beam path within the zone defined by said set of deflection electrodes and said grid wires.

2. In an electron space discharge device, means for delivering an electron beam along a given path, deflection electrode means disposed along the beam path, a plurality of grid wire members disposed in spaced coextensive relation with the deflection means for establishing a field-free region therebetween through which said electron beam is directed, and means for applying energizing potentials to said deflection electrodes to bend said beam from said region at successive intervals along its length

and through said grid means into a successive zone in the discharge device.

3. In an electron space discharge device, means for delivering an electron beam along a given path, deflection electrode means disposed along the beam path each electrode having a planar upper portion with depending angular side portions, a plurality of grid wire members disposed in spaced coextensive relation with the deflection means for establishing a field-free region therebetween through which said electron beam is directed, means for applying energizing potentials to said deflection electrodes to bend said beam from said region at successive intervals along its length and through said grid means into a successive zone in the discharge device, and focusing means disposed between said grid wire members and said successive zone for determining with the angle portions of said deflection electrode means the point of beam cross-over in said successive zone.

4. In an electrostatic deflecting and focusing system for use in controlling a segment of the path of an electron beam in a space discharge device, means for establishing a field-free region along the beam path including deflection electrode means disposed along the beam path, a plurality of grid wire members disposed along the beam path in spaced coextensive relation with the deflection means to establish a field-free region therebetween for the electron beam, and means for applying energizing potentials to said deflection electrodes to effect bending thereby of said beam from its path through said grid means and into a successive zone in the discharge device.

5. In an electrostatic deflecting and focusing system for use in controlling a segment of the path of an electron beam in a space discharge device, means for establishing a field-free region along the beam path including a plurality of deflection electrode members disposed along the beam path to apply deflecting forces to the beam at successive intervals along its path, said members having an upper planar portion with angularly depending side portions, and a plurality of grid wire members disposed in spaced coextensive relation with the deflection means to establish a field-free region therebetween for the beam path.

6. In an electron space discharge device, target means, means for directing an electron beam along a path in non-registering relation with said target means, deflection electrode means disposed along at least an initial portion of the beam path for applying bending forces to successive intervals of the beam to bend same to successive paths in a zone adjacent said target means, secondary deflection means for selectively bending the beam from said successive paths into registration with said target, and grid wire members for establishing a field-free reigon along said initial portion of said beam disposed in spaced coextensive relation with the deflection means and in the successive paths of the beam.

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