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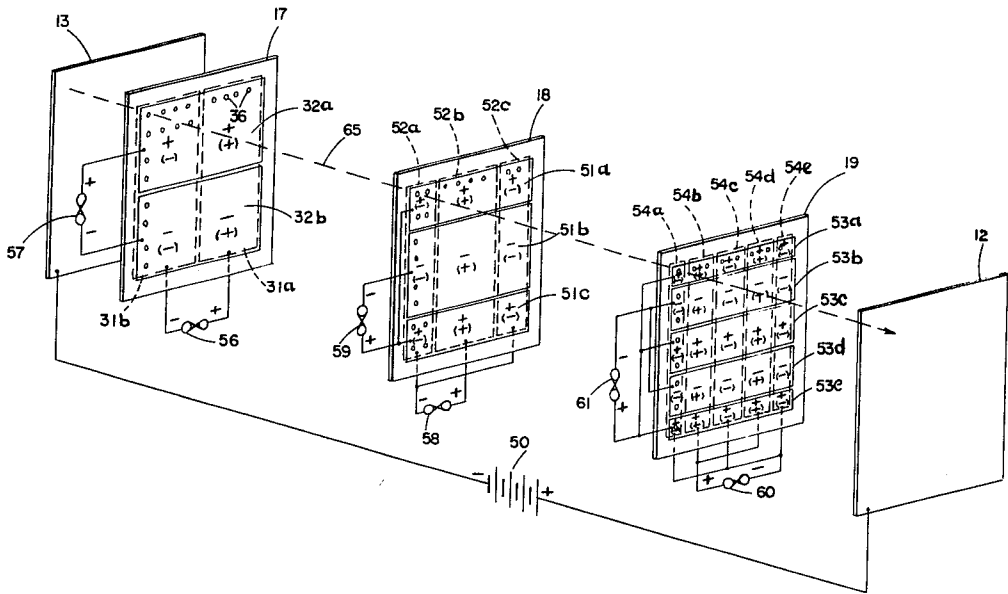
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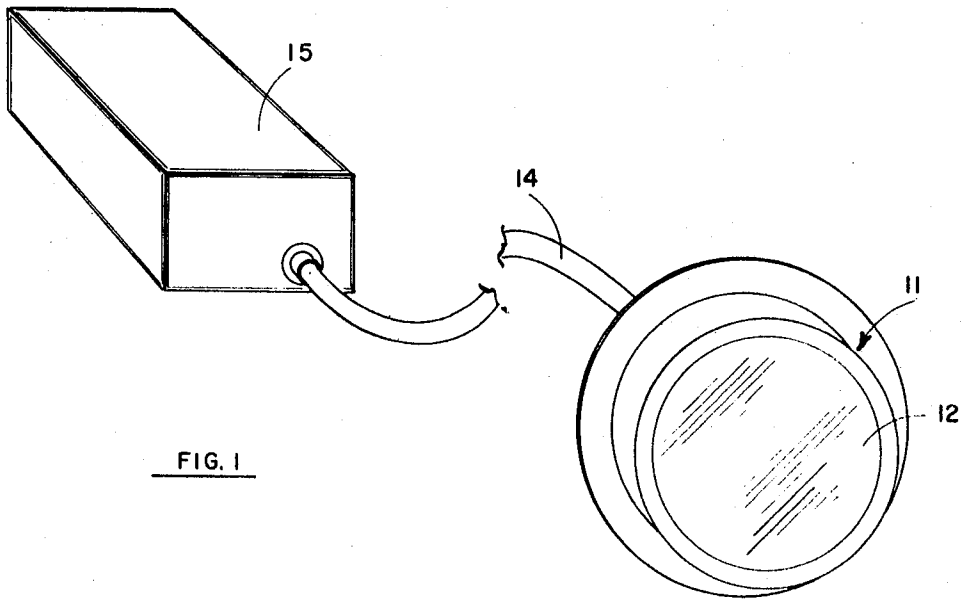
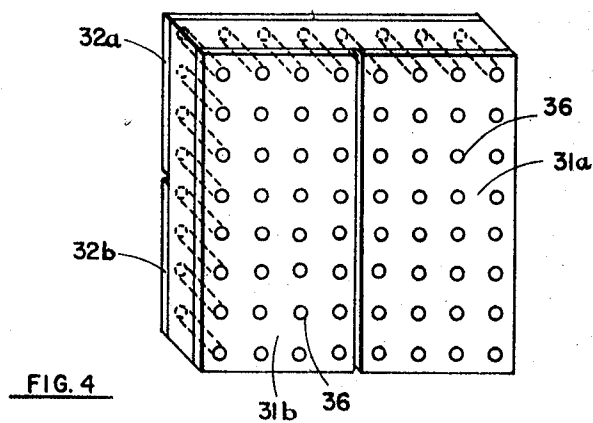
[54] ELECTRON BEAM SCANNER HAVING PLURAL
CODED DYNODE ELECTRODES
6 Claims, 6 Drawing Figs.

[52] U.S. Cl..... 315/12,
313/67, 313/105
[51] Int. Cl..... H01j 29/41
[50] Field of Search..... 313/67,
105; 315/12

[56] References Cited
UNITED STATES PATENTS
3,408,532 10/1968 Hultberg et al. 315/12

ABSTRACT: An electron beam scanner includes a flat electron emitting cathode and a flat target plate, between which are sandwiched a plurality of dynode members for controlling an electron beam between these two members. This electron beam is controlled by means of a digital addressing signal fed to the dynode members in accordance with information to be displayed. Each flat dynode member has a first set of electrodes arranged on one broad surface thereof in accordance with a first predetermined coded finger pattern and a second set of electrodes arranged on the opposite broad surface thereof in accordance with a second predetermined finger pattern. The oppositely located electrode portions on each dynode are polarized in response to digital control signals to address the electron beam to a single portion of the target plate at a time.





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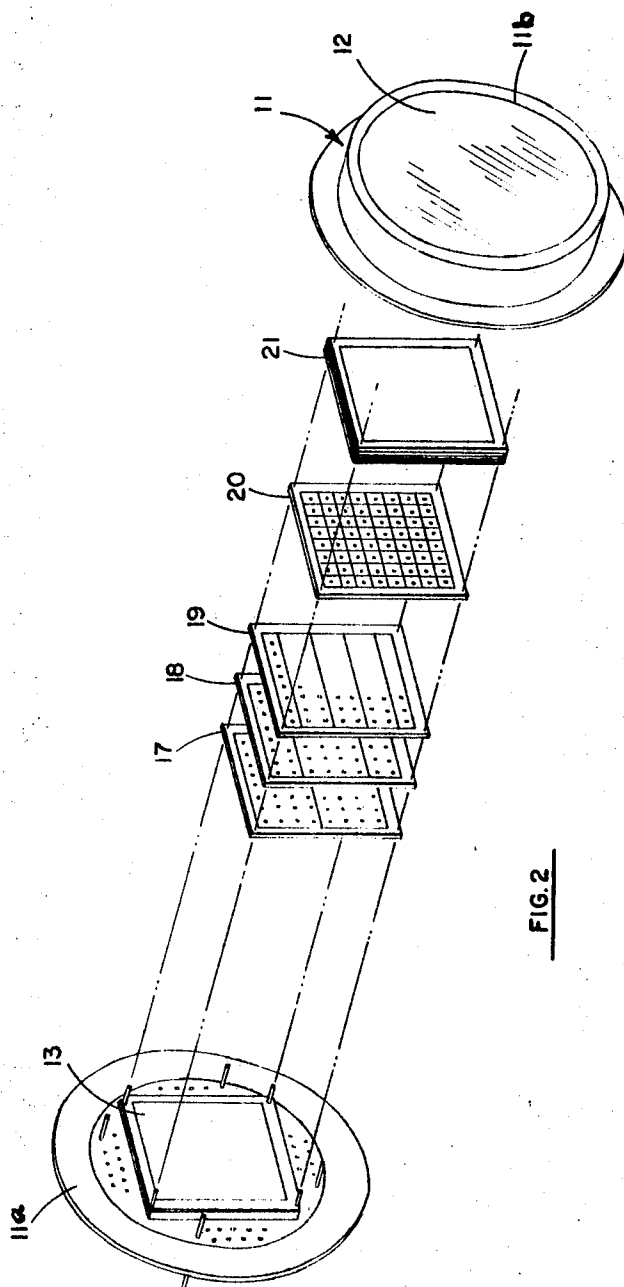


FIG. 2

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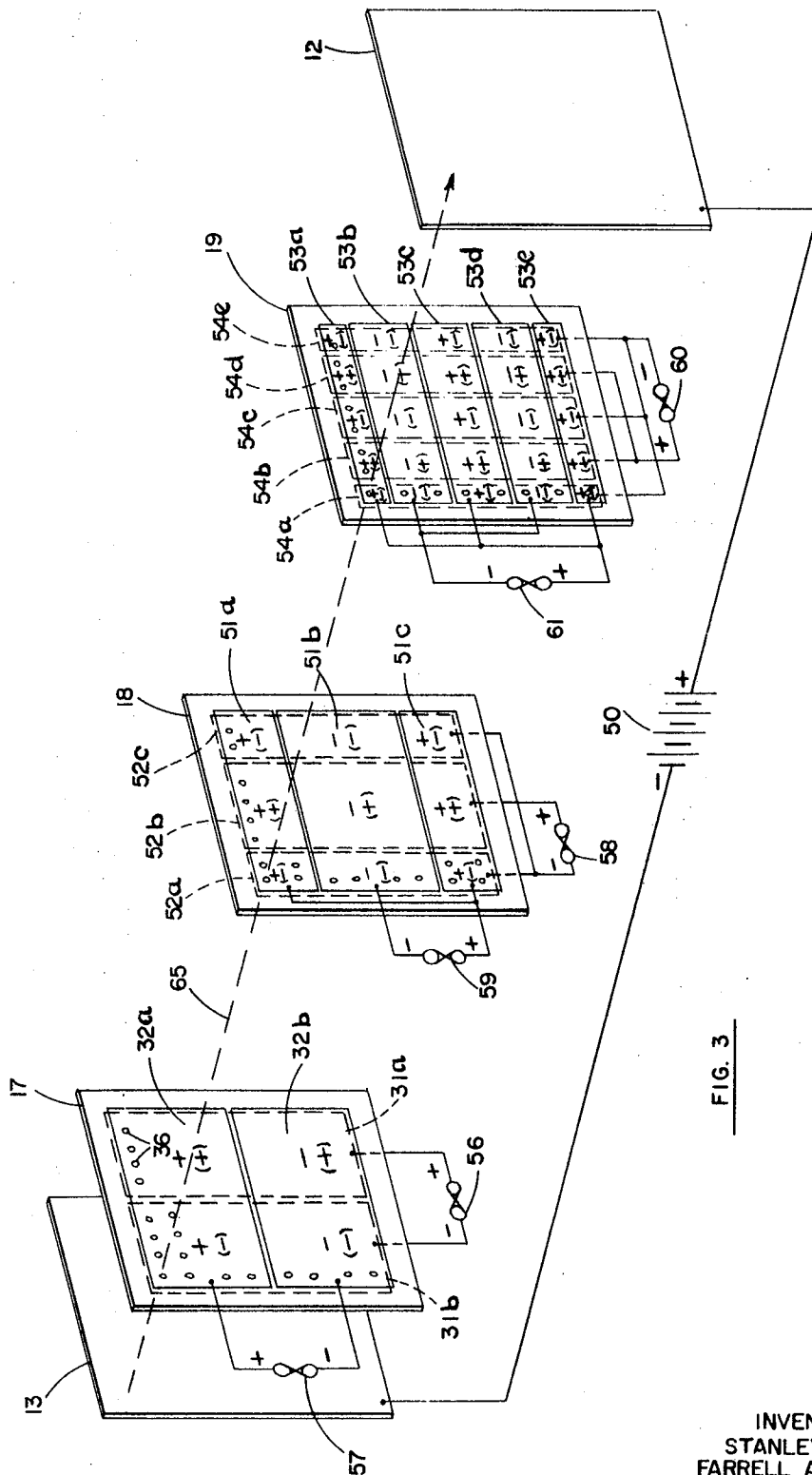


FIG. 3

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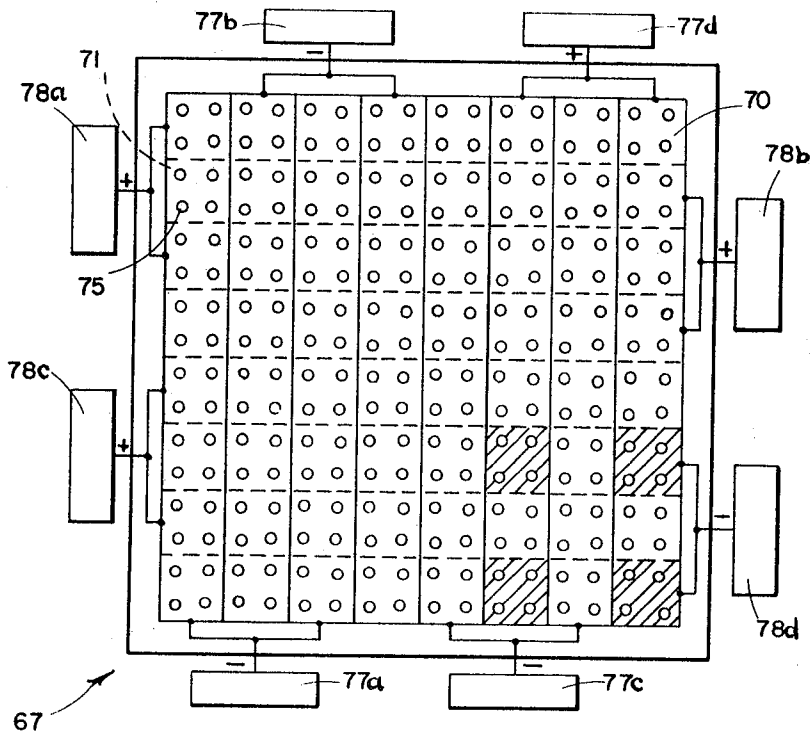


FIG. 5A

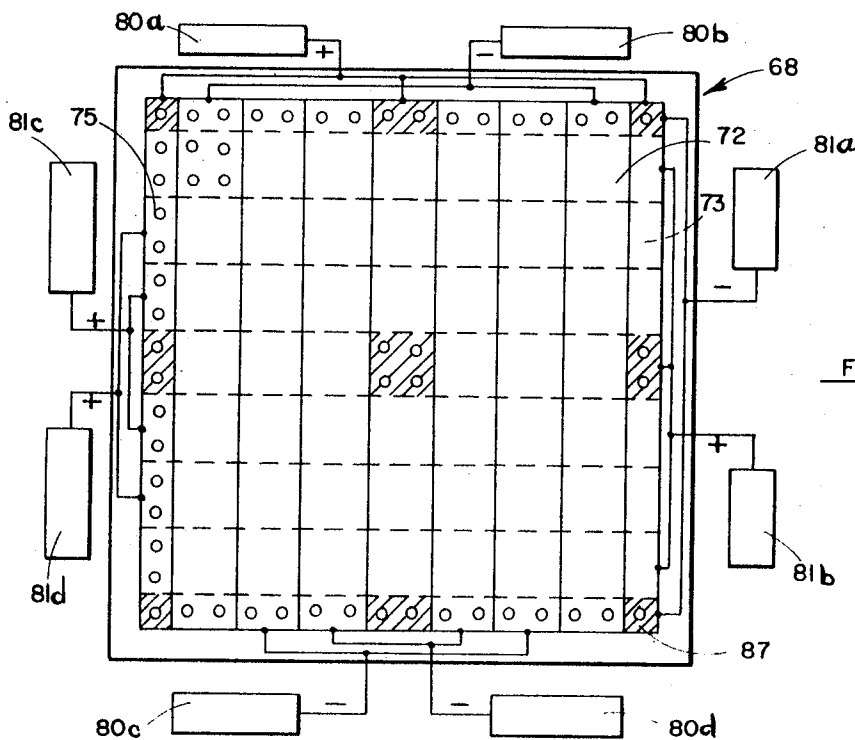


FIG. 5B

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ELECTRON BEAM SCANNER HAVING PLURAL CODED DYNODE ELECTRODES

This invention relates to electron beam scanners and more particularly to such scanners operating in response to digital control signals.

In U.S. Pat. No. 3,408,532 entitled "Electron Beam Scanning Device," and issued Oct. 29, 1968 to Northrop Corporation the assignee of the instant application, an electron beam scanner is described having flat thin proportions which operates in response to digital control signals. This device utilizes a plurality of dynode members for controlling an electron beam between a cathode and a target plate, these dynode members having electrically conductive coded finger portions for implementing the beam control. In this prior patent, identical coded dynode finger portions are placed on the opposite sides of each dynode and these identical opposite finger patterns given either a forward or reverse bias to effect the required control of the electron beam.

The device of this invention comprises an improvement on the dynode arrangement of the aforementioned patent, wherein different coded finger portions are placed on each of the opposite sides of each dynode, thereby both effecting the bias across the dynodes and at the same time combining the control functions performed by two dynodes in a single dynode. The device of this invention thus has the advantage of reducing the number of dynode elements necessary for any given degree of definition. It also further reduces the total biasing voltage necessary in view of the combination of biasing with the coding control functions, thus alleviating voltage breakdown problems in the unit. Further, the amount of power needed by the dynodes is reduced in view of the lesser number of dynodes required for any given degree of definition. Another significant advantage obtained is the lessening of the problems in the alignment of the dynodes, also in view of the smaller number of dynodes utilized.

It is therefore the principal object of this invention to provide an improved dynode design for an electron beam scanner in which the number of dynodes needed for a particular resolution is greatly reduced.

Other objects of this invention will become apparent as the description proceeds in connection with the accompanying drawings, of which:

FIG. 1 is a perspective view illustrating one embodiment of the device of the invention,

FIG. 2 is an exploded view illustrating the scanner unit of the embodiment of FIG. 1,

FIG. 3 is a schematic view illustrating the operation of a preferred embodiment of the device of the invention,

FIG. 4 is a perspective view illustrating the construction of one of the dynodes of the preferred embodiment of the device of the invention, and

FIGS. 5a and 5b are schematic illustrations of a second embodiment of the device of the invention.

Referring now to FIG. 1, an embodiment of the device of the invention as connected to its associated electronic drive circuits is perspective illustrated. A scanning display unit is housed within casing 11 which has a display screen 12 on its front face. The display unit is interconnected with the electronic circuitry for addressing the beam and the supply voltages for accelerating the beam from the cathode to the target by means of cable 14. The electronic circuitry and power supply are contained within housing 15.

Referring now additionally to FIG. 2, an exploded view of the scanner and display unit is shown. Mounted within airtight casing 11, as indicated in FIG. 2, is a cathode plate 13 which is attached to the base portion 11a of the housing and a phosphorescent screen 12 mounted on face bezel 11b of the housing. Cathode 13 may be of the radioactive type or may be thermally excited. An accelerating potential is supplied by a power supply (not shown) contained within housing 15, this accelerating potential being applied between phosphorescent screen 12 and cathode 13. Sandwiched between phosphorescent screen 12 and cathode 13 are control dynodes 17-19 which operate to control the electron beam, as to be ex-

plained more fully in connection with FIG. 3. Interposed between dynodes 17-19 and screen 12 are filter dynode 20 for filtering out "ghost" images which may appear due to inadequate rejection in the scanning control dynodes, and multiplier plates 21 which operate to multiply the electrons in the electron beam. The individual dynodes and other elements may be constructed and assembled as described in the aforementioned U.S. Pat. No. 3,408,532, so as to channel the electron beam between the cathode and the phosphorescent target plate. Filter dynode 20 may be designed as described in copending application Ser. No. 655,606, filed July 24, 1967. The instant invention is not concerned with these various structures and is rather involved with the structure of the control dynodes 17, 18 and 19 as now to be described in connection with FIGS. 3 and 4.

Referring now to FIG. 4, a typical one of the control dynodes which may be utilized in a preferred embodiment of the device of the invention is illustrated. Deposited on one surface of substrate plate member 30 are a pair of electrodes 31a and 31b arranged in a vertical finger pattern, while deposited on the opposite surface of substrate plate member 30 are a pair of electrodes 32a and 32b arranged in a horizontal finger pattern. Electrodes 31a, 31b, 32a and 32b are of a conductive material which may be vacuum deposited on the substrate 30, which may be of glass. A plurality of apertures 36 extend through the substrate and the electrodes to form electron beam channels, which, as to be explained in connection with FIG. 3, define the individual scan matrix elements of the device. The dynode may be constructed as described in connection with FIG. 5 of the aforementioned U.S. Pat. No. 3,408,532.

Referring now to FIG. 3, the operation of the preferred embodiment of the device of the invention is illustrated. In this illustrative example, a device having 8x8 definition is shown. It should be apparent, however, that higher orders of definition can be obtained by the use of additional dynodes and additional apertures 36 to accommodate the added channels needed. A voltage for accelerating an electron beam between cathode plate 13 and target plate 12 is provided by means of voltage source 50 which is connected therebetween. Dynode 17, as already described in connection with FIG. 4, has a pair of electrodes 32a and 32b on the front surface thereof, and a pair of electrodes 31a and 31b on the opposite surface thereof, these electrode pairs being arranged in a similar finger pattern but in orthogonal relationship to each other.

Similarly, dynode 18 has electrodes 51a-51c arranged in a particular finger pattern on one of its broad surfaces, and electrodes 52a-52c in a similar but orthogonally related finger pattern on the opposite surface thereof. The same holds true for dynode 19, which has electrodes 53a-53e on one surface and orthogonally oriented electrodes 54a-54e on the opposite surface in a similar finger pattern.

The electrodes of dynodes 17, 18 and 19 receive polarizing voltages from flip-flops 56-61 respectively. These polarizing voltages, as now to be explained, operate to enable or prevent the passage of an electron beam from cathode 13 through to target 15, the flip-flops being controlled by an appropriate addressing circuit to permit the beam to strike one elemental portion of target plate 15 at a time in accordance with the address. As can be seen, flip-flop 57 is connected between electrodes 32a, 32b, while flip-flop 56 is connected between electrodes 31a and 31b; flip-flop 59 is connected between electrodes 51b and electrodes 51a and 51c, while flip-flop 58 is connected between electrode 52b and electrodes 52a and 52c; and flip-flop 61 is connected between electrodes 53b and 53d, and electrodes 53a, 53c and 53e, while flip-flop 60 is connected between electrodes 54b and 54c and electrodes 54a, 54c and 54e. Flip-flop circuitry such as described in connection with FIG. 6 of the aforementioned U.S. Pat. No. 3,408,532, may be utilized to drive the flip-flops in accordance with appropriate addressing logic.

Let us assume for the purposes of illustrating the operation of the device of the invention that the flip-flops are being

driven so as to provide voltages to their associated electrodes in the relative polarities indicated in FIG. 3. Under such conditions, only the areas of the various dynodes indicated by "(±)" will provide a forward bias to the flow of electrons between cathode 13 and target plate 12, all of the other portions of the dynodes either having zero potential thereacross, or a potential repelling the electron flow. With this particular flip-flop excitation, only a single channel will be "open" between the cathode and the target, such as to permit an electron beam therethrough, this particular beam being indicated by the numeral "65." It thus can be seen that by properly addressing the flip-flops, the beam can be made to pass through any one of the 64 channels such addressing being possible either on a random or regular basis. It is further to be noted that the 64 channel matrix is possible with only three control dynodes, as compared with the six dynodes needed to achieve the same degree of definition in the aforementioned patent. It is further to be noted that the electrode finger pattern, as illustrated in FIG. 3, has a Gray code configuration but that the coding could also be implemented by means of a straight binary code, if so desired.

While the dynodes have been shown in the illustrative embodiment arranged in a particular order whereby there are an increasing number of electrodes on the dynodes as we go from the cathode to the target and with similar but orthogonally oriented electrode patterns on opposite sides of each dynode, this particular arrangement is not mandatory and the dynodes and electrodes can be arranged in any desired order. It is, of course, essential however that the dynodes and electrodes be aligned so that correspondingly apertures are in alignment to form the channels properly.

Referring now to FIGS. 5a and 5b, another embodiment of the device of the invention is schematically illustrated, this embodiment utilizing a pair of dynodes, each of said dynodes having electrodes arranged in strips on each of the broad surfaces thereof, the electrodes on one surface being oriented in orthogonal relationship to those on the opposite surface. Thus, dynode 67 has a plurality of vertically oriented electrodes 70 on one side thereof, and a plurality of horizontally oriented electrodes 71 on the opposite surface thereof. Similarly, dynode 68 has vertically oriented electrodes 72 and horizontally oriented electrodes 73 on its opposite surfaces. The electrodes, as for the previous embodiment, are conductive layers deposited on an insulating substrate, the electrodes being insulated from each other by providing a small spacing therebetween. As for the previous embodiment, the dynodes have apertures 75 formed therethrough which define the electron beam channels, a 16×16 matrix being shown for the example of FIGS. 5a and 5b. The two dynodes shown in FIGS. 5a and 5b would be aligned to define the various channels and used in lieu of the dynodes described in connection with the first embodiment in a device such as that illustrated in FIG. 2. It is to be noted, however, that in this instance a 16×16 matrix definition can be obtained with only two dynodes as compared with the four which would be needed to achieve the same definition with the embodiment described in connection with FIG. 3.

Referring to FIG. 5a, it can be seen that first and third vertical electrodes 70 are connected to logical switching circuit 77a, second and fourth vertical electrodes are connected to logical switching circuit 77b, fifth and seventh vertical electrodes are connected to logical switching circuit 77c, while sixth and eighth vertical electrodes are connected to logical switching circuit 77d. The first and third, second and fourth, fifth and seventh, and sixth and eighth of horizontal electrodes 71 are connected to logical switching circuits 78a, 78b, 78c, and 78d respectively.

Referring now to FIG. 5b, it can be seen that electrodes 72 and 73 are staggered halfway between electrodes 70 and 71 respectively of dynode 67. Further, half-size electrodes are provided along the edges of the dynode matrix in dynode 68. In dynode 68 of the vertically oriented electrodes 72 the first, fifth and ninth are connected to logical switching circuit 80a, 75

the second, and eighth are connected to logical switching circuit 80b, the third and seventh are connected to logical switching circuit 80c, while the fourth and sixth are connected to logical switching circuit 80d. Of the horizontally oriented electrodes 73, the first and ninth, the second, fifth and eighth, the fourth and sixth, and the third and seventh are connected to logical switching circuits 81a-81d respectively. The logical switching circuits may comprise latching circuits which can be triggered by a logical addressing control so that they generate signals of one of two different potentials for application to their associated electrodes.

To illustrate the operation of the device of the invention, the output of each of the logical switching circuits has in FIGS. 5a and 5b been arbitrarily designated to have a particular polarity, a "+" indicating the circuit's more positive output and a "-" indicating the lower polarity output of the circuit. For the particular potentials indicated, only the stippled areas of the two dynodes will experience a forward bias (assuming that the side of the dynodes facing upward on the sheet is the one facing the target). With the logical switching circuits in this condition, the channel for only a single matrix element, i.e., that designated "87," in FIG. 5b, is activated so as to permit the passage of an electron beam therethrough to the target. The logical switching circuits thus can be controlled to activate any one of the electron beam channels at a time in response to the logical addressing control circuit.

The embodiment of FIGS. 5a and 5b has the obvious advantage of requiring a lesser number of dynodes for a given degree of definition.

The device of this invention thus provides means for obtaining a given degree of definition in an electron beam scanner with a lesser number of control dynodes than heretofore required, this end result being achieved by combining the control functions formerly accomplished in several dynodes within a single dynode unit.

We claim:

1. In an electron beam scanner having an electron source, a target plate and means for accelerating the flow of electrons between said electron source and said target plate, the improvement comprising a plurality of dynode plates positioned between said cathode and said target plate for controlling the flow of electrons therebetween, said dynode plates each including:

- a first plurality of parallel electrodes arranged in a finger pattern on one side thereof,
- a second plurality of parallel electrodes arranged in a finger pattern on the side opposite said one side thereof,
- each of said dynode plates having a plurality of apertures formed therein for channeling the flow of electrons between said cathode and said target plate, the apertures of said plates being aligned to form channels and
- means for selectively applying voltage potentials between the electrodes on said one side and the other side so as to permit an electron beam to pass through only one of the channels at a time.

2. The scanner of claim 1 wherein the finger patterns of said first and second electrodes are similar but positioned in a mutually orthogonal relationship.

3. The scanner of claim 2 wherein each of said first and second electrodes are in the form of strips arranged in side by side relationship.

4. In a scanner having an electron source, a target plate, means for accelerating the flow of electrons between said source of said plate, and a plurality of dynode for controlling said flow of electrons, each of said dynodes comprising a substrate plate of insulating material, a plurality of electrodes deposited on one of the broad surfaces of said substrate plate, said electrodes being arranged in a finger pattern, a plurality of electrodes deposited on the broad surface of said substrate plate opposite to said one surface thereof, said dynodes having apertures formed therein defining electron beam channels, and

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means for selectively applying voltage potentials between the electrodes on opposite sides of each of said dynodes so as to permit an electron beam to pass through one of said channels at a time.

5. The scanner of claim 4 wherein the electrodes on any one of said broad surfaces are in the form of parallel strips.

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6. The scanner of claim 5 wherein the finger pattern of the electrodes on said one broad surface is similar to the finger pattern of the electrodes on the opposite surface thereof but positioned in orthogonal relationship thereto.

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