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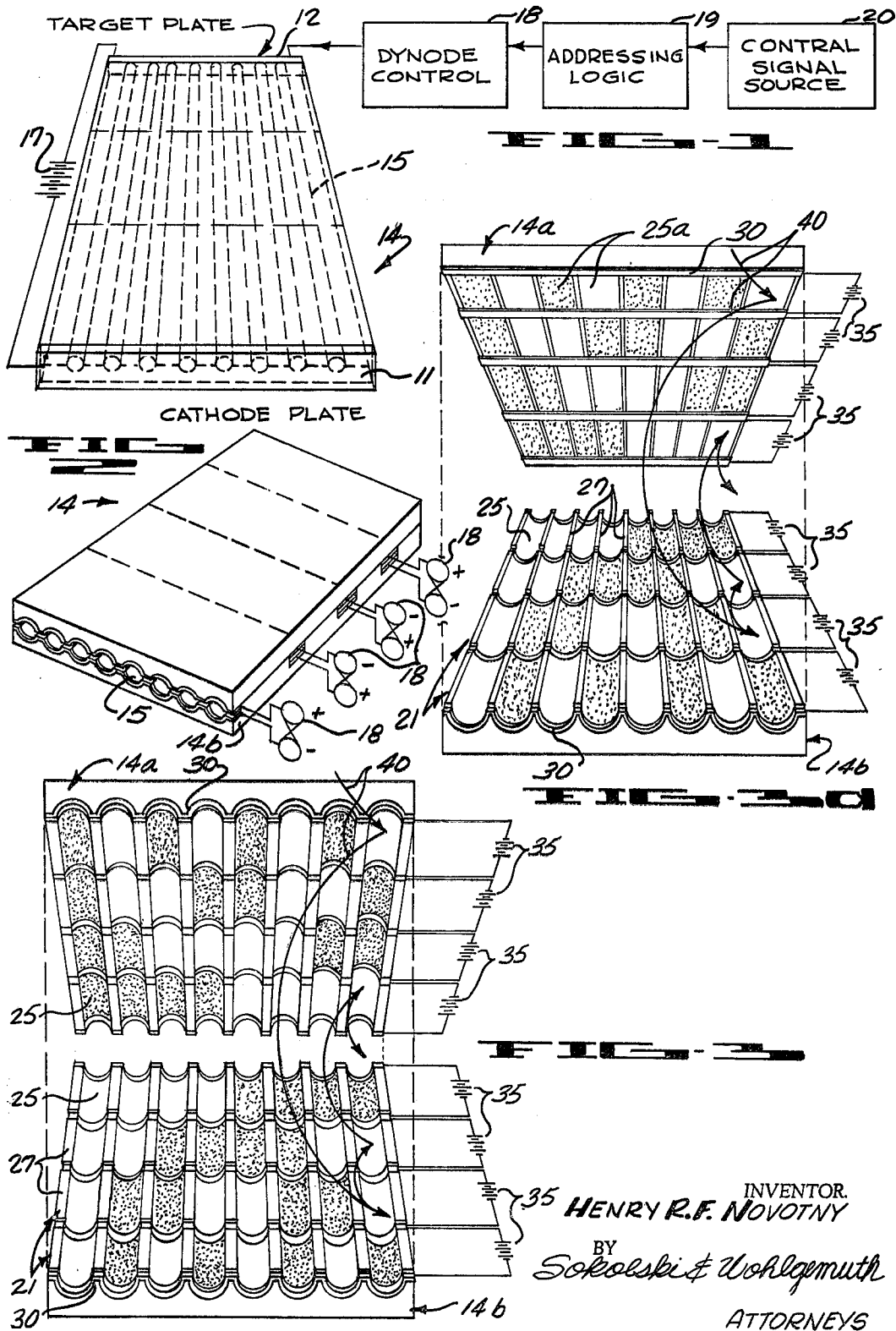
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ELECTRON BEAM SCANNER WITH TRANSVERSE DIGITAL CONTROL

Filed July 26, 1968

2 Sheets-Sheet 1



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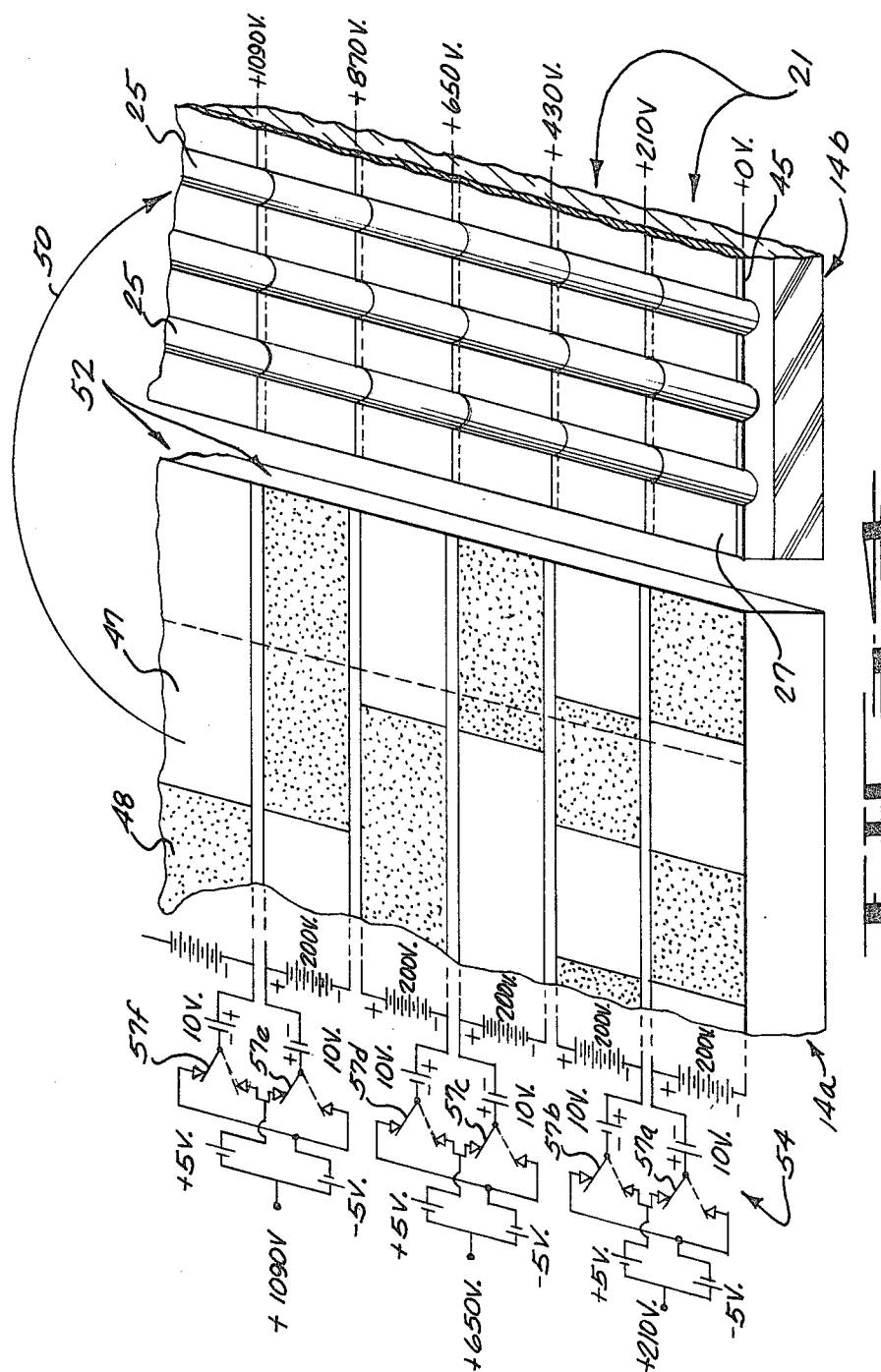
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ELECTRON BEAM SCANNER WITH TRANSVERSE DIGITAL CONTROL

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7 Claims

ABSTRACT OF THE DISCLOSURE

A parallel array of channels are linearly arranged between an electron emitting cathode and a target. The channels are formed at the interface of two separate plates which are joined together and electrically insulated from each other and each of which has a plurality of dynode sections formed by segmenting the channel array and arranged symmetrically between the cathode and the target. Potential differentials are imposed longitudinally across successive dynodes so as to provide electronic accelerating potentials to accelerate electrons from the cathode to the target. The individual channel segments in each dynode have on their inner surfaces electron emitting and electron absorbing coatings, these being arranged in a predetermined coded pattern. A flow of electrons is selectively caused to occur through any one of the channels at a time by selectively imposing transverse potential differences between oppositely positioned dynode portions of the two plates.

This invention relates to electron beam scanners, and more particularly to such device capable of linear scanning in response to a random digital addressing signal.

Electron beam scanning devices utilizing cathode ray tubes for video display and memory storage functions are extensively utilized in the prior art for various display functions and for storage uses such as might be required in a digital computer. In patent application Ser. No. 511,747, filed Dec. 6, 1965, now Patent No. 3,408,532 and assigned to Northrop Corporation, the assignee of this application, an electron beam scanning device is described which is capable of random addressing and which has compact proportions. This device utilizes a plurality of coded dynode members located between the electron emitting cathode and a target plate, these coded dynode members controlling the electron beam in response to a digital address signal. The device of this prior application while it offers distinct advantages requires a voltage differential between adjacent portions of each dynode which is relatively high, i.e., of the order of 200 volts. This voltage differential imposes a problem of voltage breakdown in the closely spaced structures utilized. To avoid problems in this regard requires special precautions in manufacture. Further, these potential result in relatively high electric field between the dynodes causing undesirable field emission which may lead to electrical breakdown.

The device of this invention provides an improvement over the beam scanning device of the aforementioned patent application, whereby a relatively small transverse potential is switched between oppositely positioned dynode sections to provide the desired electron beam scanning pattern. By using such transverse control, it is possible to achieve the desired dynode control without having relatively high potentials between adjacent dynode portions. The high accelerating potential between the cathode and the target to accelerate the electron beam is established by virtue of a voltage gradient therebetween with a switching action to control the beam being achieved

by virtue of relatively low transverse potential differentials established between opposing dynode sections in response to the addressing signal.

In summary, the device of the invention comprises a dynode structure in which a plurality of longitudinal electron beam channels are formed, such dynode structure extending between a cathode member and a target member between which the channels extend. The dynode structure is formed from a pair of plate members, fabricated of an electrically insulating material, at least one of which is grooved to form the channels, and which form separate electron control dynode sections. The individual channel segments which form the dynode sections are each coated with either an electron secondary emitting material or electron absorbing material in accordance with a predetermined code pattern. The dynode sections of one plate form half of the electron channel walls, while the oppositely positioned dynode sections of the other plate form the other half of such channel walls, these two halves being insulated from each other and having a voltage differential established therebetween by means of a switching control circuit. The dynode sections are formed from channel segments arranged in rows running transverse to the longitudinal extent of the channels. Accelerating potentials are established between the cathode and the target for accelerating the electron beam down the channel selected in accordance with the control address. A single channel is selected at a time by virtue of various combinations of transverse voltage potentials established between oppositely positioned dynode sections which cause the electron beam to be accelerated toward either one such section or the oppositely positioned section. The electron beam passes completely through only the channel in which it is accelerated only to secondary electron emitting channel surfaces and in which it is not caused to impinge against any electron absorbing channel surfaces.

The device of the invention will now be described in conjunction with the accompanying drawings, of which:

FIG. 1 is a functional schematic drawing illustrating a first embodiment of the device of the invention,

FIG. 2 is a perspective view illustrating the dynode structure of the first embodiment of the device of the invention,

FIG. 3 is a perspective view illustrating the plate sections utilized to form the channels of the first embodiment of the device of the invention,

FIG. 3a is a perspective view illustrating the plate sections of a second embodiment of the device of the invention, and,

FIG. 4 is a perspective view in conjunction with a schematic representation of a third embodiment of the device of the invention.

Referring now to FIG. 1, a schematic drawing illustrating a first embodiment of the device of the invention is shown. A dynode assembly 14, having a plurality of longitudinal channels 15 formed therein, has attached thereto at one end thereof a cathode plate 11 and at the opposite end thereof a target plate 12. Target plate 12, dynode assembly 14 and cathode plate 11 are joined together in an appropriate casing member (not shown) to provide a vacuum tight seal in the channels 15 between the cathode plate and the target plate. Cathode plate 11 may comprise a suitable electron emitting cathode, preferably of the cold cathode type, which may have a radioactive or photo-emissive surface and which is suitable for providing an adequate electron current. It is essential that a high vacuum be established in channels 15 and that adequate sealing be provided to maintain such vacuum.

Target plate 12 in the case of a display device or flying light spot scanner may be coated with a suitable phosphor. Electron accelerating potentials are established be-

tween cathode plate 11 and target plate 12 by means of a suitable multiple DC voltage supply 17 which, as shown in FIG. 3, may comprise a series of potential differentials connected and established between successive dynode members. FIG. 1 does not illustrate the individual dynode nor the details of the power or signal inputs thereto and is shown schematically merely to illustrate the general features of the device of the invention.

The passage of an electron beam through one of channels 15 at a time is effected in response to dynode control 18, which may comprise conventional flipflop circuitry, the dynode control operating in response to appropriate digital addressing logic 19. Addressing logic 19 operates in response to control signal source 20.

Referring now to FIGS. 2 and 3, the dynode assembly 14 of the first embodiment of the device of the invention is illustrated. Dynode assembly 14 is formed from a pair of dynode plate members 14a and 14b fabricated of an electrically insulating material such as glass which have a plurality of longitudinal grooves 25 formed therein and which are joined together to form a unitary assembly having longitudinal channels 15. Groove segments 25 form channel half sections, the opposing coated surfaces of which are electrically insulated from each other by means of uncoated insulating "lands" 27 which act as spacers between the interfacing halves of the dynodes. The channel segments forming the dynode sections in each row are electrically connected together at each end thereof by means of a metal strip 30, the dynode rows being separated from each other. A voltage differential is established between the opposite ends of each row of channel segments by means of a power source 35, to establish a voltage gradient between the side of the dynode assembly which is closer to the cathode plate, and the side of the dynode assembly which is closer to the target plate.

Surfaces of the dynode half sections are coated either with an electron secondary emissive material, i.e., a material that has secondary emission characteristics such as tin oxide or lead oxide, or are coated with an electron absorptive material such as gold or platinum black. The surfaces are coated to a point below the edges of the channel half sections so as to leave insulating "lands" 27 between opposite half sections. Such coating of the channel half sections is done in accordance with a predetermined pattern to follow a particular digital code such as, for example, GRAY code. For the purposes of illustration, in FIG. 3, the channel sections coated with electron absorptive material are stippled, while those coated with electron emissive material are shown unmarked. A flipflop switching circuit 18 (FIG. 2) is connected between the channel half sections in each row on one plate and the channel half sections in the opposite plate, to control the dynodes. As to be explained more fully in connection with FIG. 4, each flipflop, which may be appropriately switched by the addressing logic to either one condition or the other, is capable of supplying a voltage potential between the oppositely positioned rows of channel half sections in either one or the opposite polarity, the nonconductive flipflop stage providing a positive polarity with respect to that of the conductive stage. This voltage differential may be relatively low, for example of the order of 10 volts, to achieve the desired operation.

To illustrate how the channel selection is achieved by means of this switching circuitry, let us assume that flipflops 18 establish the transverse potentials indicated by the "+" and "-" signs shown in FIG. 2 adjacent to flipflops 18. Under such circumstances, the electron beam 40 as shown in FIG. 3 will initially be attracted to the top half-section which is coated with electron emissive material. The beam will then be successively attracted to the bottom half sections which are also electron emissive, and will finally be attracted to the top half section

which is electron emissive, thus providing complete passage of the beam through the channel.

An examination of the other channels will indicate that in each such channel, with the particular flipflop polarization indicated in FIG. 2, the beam will at some point in the channel be attracted to an electron absorptive area and thus will be aborted. Thus, for example, it can be seen that in the channel adjacent to the conducting channel just referred to, that the beam will be dissipated in the very first channel section, in the next channel the dissipation will occur in the second half section, etc. Thus by such transverse switching, any single channel can be activated at a time in a random fashion in response to the addressing logic signal.

Referring now to FIG. 3a, the plate sections of a second embodiment of the device of the invention are illustrated. This second embodiment is the same as the first except for the top plate section which is not grooved but rather has flat dynode segments 25a which are either coated with electron absorptive material (indicated by stippling) or electron emitting material (shown unmarked). The channels are thus in the form of half cylinders. Operation and the remainder of the structure is otherwise the same as for the first embodiment.

Referring now to FIG. 4, a second embodiment of the device of the invention is illustrated. The second embodiment differs from the first in that, rather than forming electron channels with two similar sets of grooves in the opposite plates, grooves are formed in only one of the plates, the other plate having a flat surface. The coded pattern of electron emitting and electron absorbing surfaces is provided entirely on the flat plate surface. Otherwise the structure of the second embodiment is the same as that described in connection with the first, and therefore will not be again described.

Plate member 14b, which may be of an electrically insulating material such as glass, has a plurality of longitudinal grooves 25 formed therein. Grooves 25 are coated with electron emissive material which has secondary emission characteristics, such as for example tin oxide or lead oxide. The coated portions of grooves 25 are separated from each other by insulating lands 27. Dynode plate 14b is separated into dynode sections 21, these dynode sections having successively higher potentials applied thereacross as we proceed down the electron channel as indicated in FIG. 4. The potentials are connected across the dynode section by means of conductive strips 45 which interconnect the coated groove portions and the power source.

Plate 14a has a flat surface which has a plurality of sections 47 coated with electron secondary emitting material and sections 48 coated with electron absorbing material, these coatings being arranged in a binary coded pattern. The two plates are joined together as indicated by arrow 50 in abutting relationship, the coated sections 47 and 48 being opposite the grooved portions 25 forming the electron channels. Dynode sections 52 formed by the coated portions 47 and 48 are separated from each other so that they are electrically insulated from each other. Also, the coated portions of grooves 25 are separated from coated portions 47 and 48 of the flat plate surface by insulating "lands" 27.

A potential differential is established between each of the dynode sections 52 of plate 14a and the opposed dynode sections 21 of plate 14b, by means of switching circuitry 54 which is schematically illustrated. The switches 47, which can be flipflops as described in connection with the first embodiment, are controlled to provide various combinations of differential voltages so as to cause the electron beam to pass through only one selected channel at a time, as already described in connection with the first embodiment. Thus, for example, with switch 57a in the position indicated in the figure, the bottommost shown dynode section of plate 14a will have a potential of between 5 and 205 volts imposed thereacross, this as compared with the potential of between 0 and 210 volts across

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the opposing grooved dynode section of plate 14b. The transverse potential under such conditions is such as to attract the beam to the flat surfaced plate 14a, the electrons drawn to such plate being either absorbed or causing secondary emission in accordance with the type of coating 48 or 47 presented, as the case may be. The voltage values given are illustrative only, in an actual device they will vary depending on the emissive and absorbing coatings used, the ratio of channel diameter to channel length, etc.

Thus it can be seen that the beam can be controlled by virtue of the various combinations of potentials established across the dynode sections in plate 14a by means of the control switches 57a-57f. The second embodiment thus operates in the same general fashion as the first, the only basic differences lying in the structural construction of the channels in placing all of the coated elements on a single plate having a flat surface and the technique used to establish the transverse potential. This has certain advantages in that it obviates the necessity for setting up a coding pattern in the curved surfaces, which is somewhat more difficult to achieve than in the case of a flat surface. The switches 57a-57f, of course, may comprise electronic flipflop circuitry as described in connection with the first embodiment.

I claim:

1. A line scanner device comprising:

- first and second plate members, at least one of said plate members having a plurality of longitudinal grooves formed therein,
- said plate members being joined together to form an integral structure with said grooves providing electron channels,
- a cathode member on one end of said electron beam channels,
- a target member on the other end of said electron channels, at least one of said plate members having preselected portions of its surfaces coated with electron emitting and electron absorbing material in a predetermined coded pattern, said coated surfaces forming the surfaces of said channels,
- said channels being divided into segments forming a plurality of dynode sections running transversely to the longitudinal extent of the channels,
- means for providing an electron accelerating potential

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between said cathode member and said target member, and

means for selectively applying a transverse potential between the opposed dynode sections of said two plate members, whereby an electron beam is selectively permitted to pass from said cathode member to said target member through only one of said channels at a time.

2. The scanner of claim 1 wherein only one of said plate members has said longitudinal grooves formed therein, the other of said plate members having a flat surface positioned in opposition to the grooves of said one of said plate members, said flat surface being coated with electron emitting and electron absorbing material in said predetermined coded pattern.

3. The line scanner of claim 1 wherein both of said plate members are grooved to form said channels and the grooved sections of both said plate members are coated with electron emitting and electron absorbing material in a predetermined coded fashion.

4. The scanner of claim 1 wherein said means for applying a transverse potential between opposed dynode sections comprises a flipflop circuit connected dynode each of the opposite rows of said dynode sections.

5. The scanner of claim 1 wherein said coded pattern is in a binary code.

6. The scanner of claim 1 wherein insulating lands are provided between said plate members to insulate opposed dynode sections from each other.

7. The scanner of claim 1 wherein said rows of dynode sections are separated from each other in insulated relationship.

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