

- [54] **DISPLAY PANEL WITH RASTER SCANNING MEANS**
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Related U.S. Application Data

- [63] Continuation of Ser. No. 223,039, March 2, 1972, abandoned, which is a continuation of Ser. No. 38,408, Aug. 18, 1970.
[52] U.S. Cl. **315/169 R, 313/109.5**
[51] Int. Cl. **H01j 17/04**
[58] Field of Search..... **315/169; 313/109.5**

- [56] **References Cited**
UNITED STATES PATENTS
2,933,648 4/1960 Bentley 315/169

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- [57] **ABSTRACT**
A display panel includes a plurality of gas-filled glow cells including means for scanning the cells in raster fashion with unique starting means for initiating the scanning operation and with means at the end of the scanning operation for energizing the starting means.
13 Claims, 6 Drawing Figures

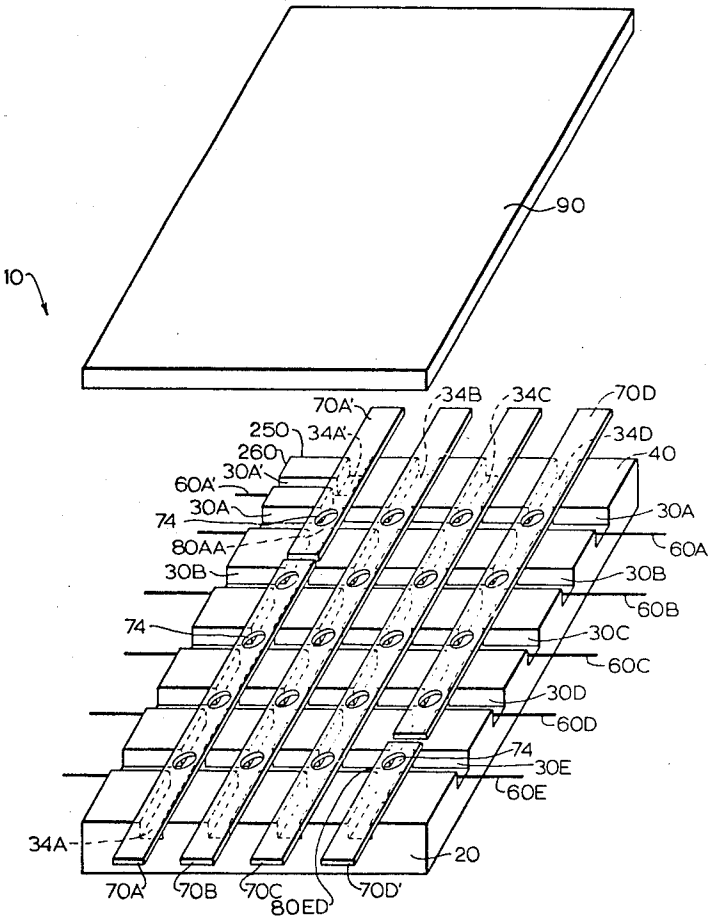
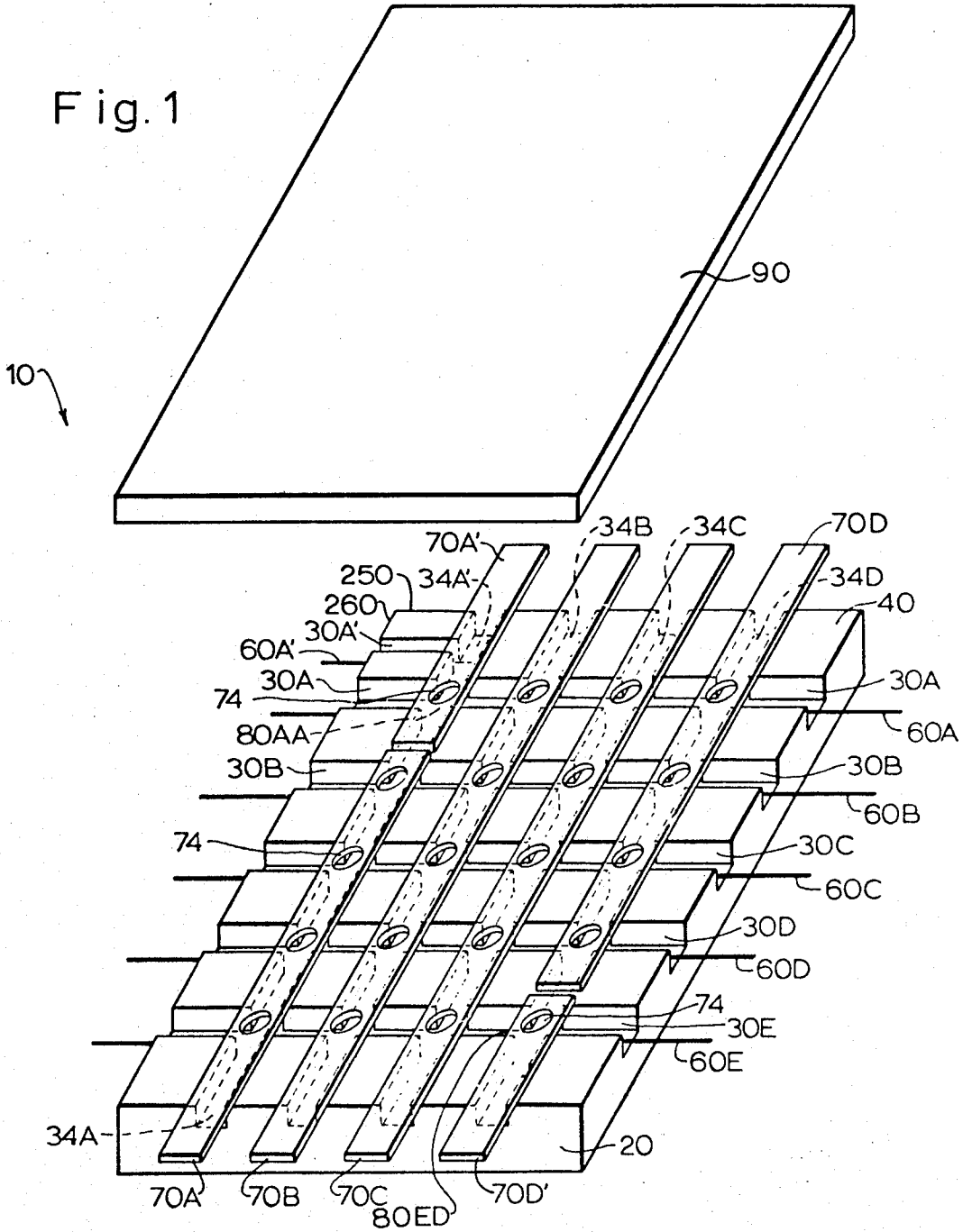


Fig. 1



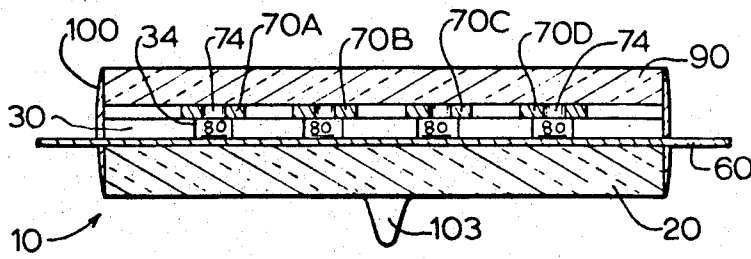
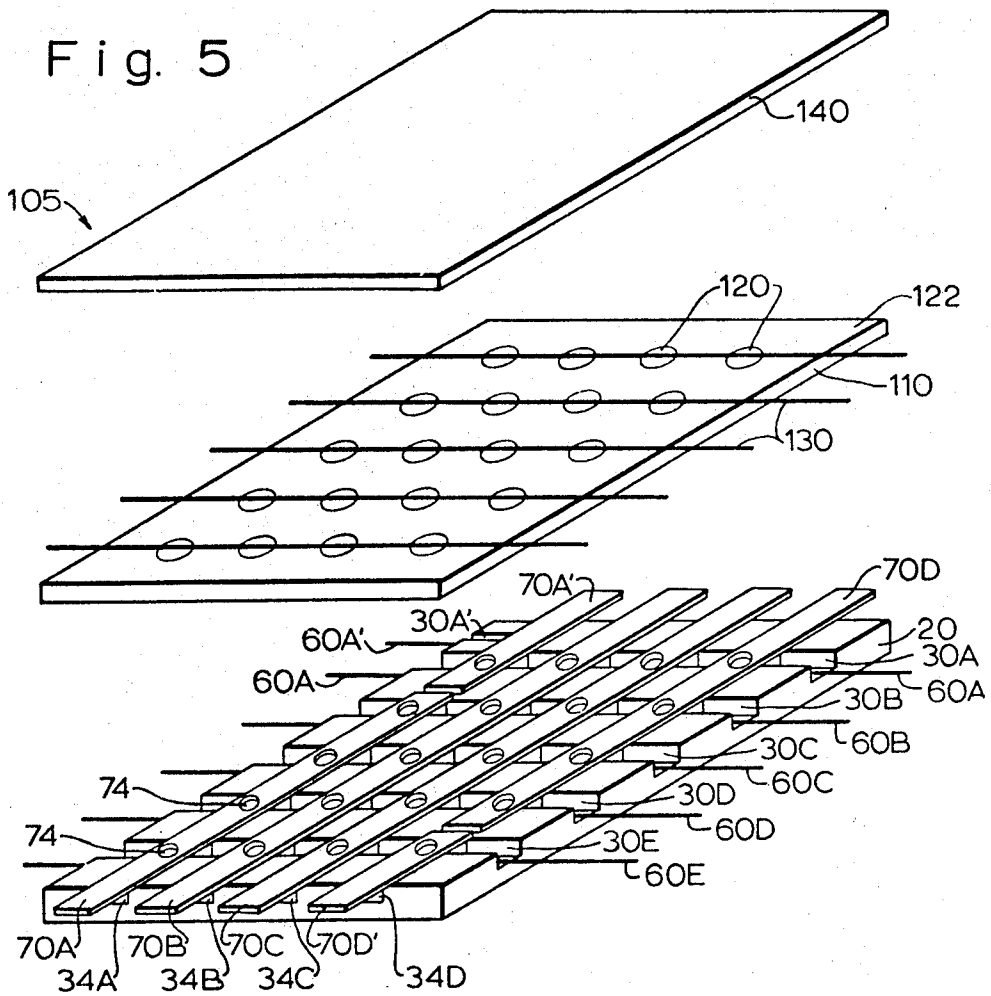


Fig. 2



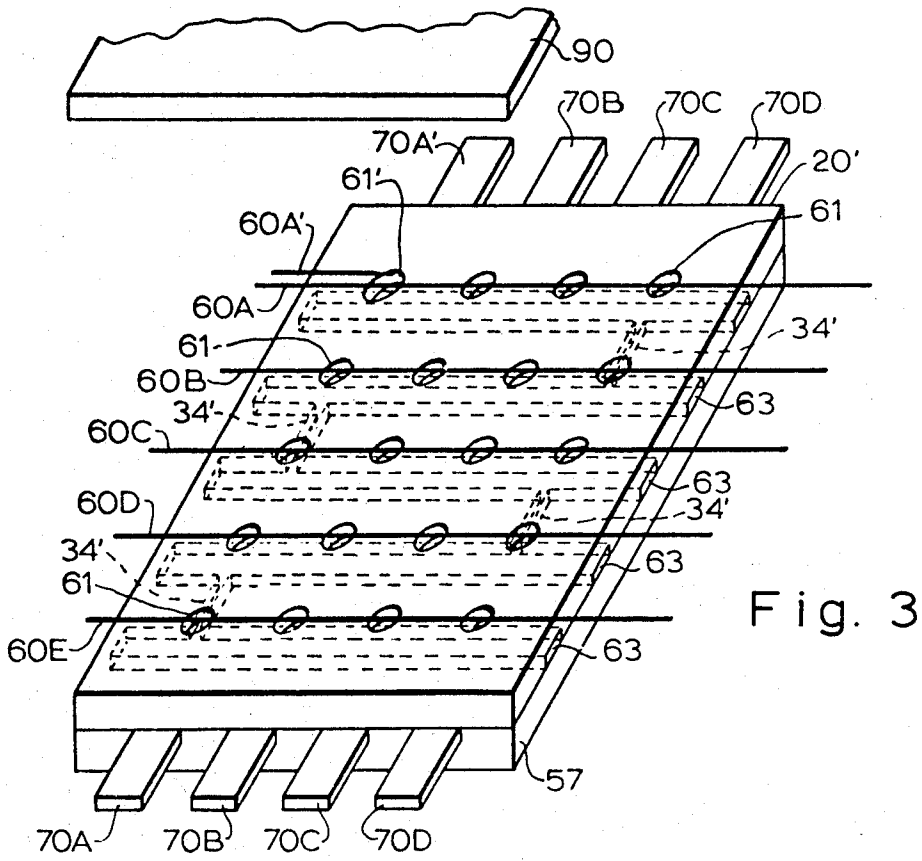


Fig. 3

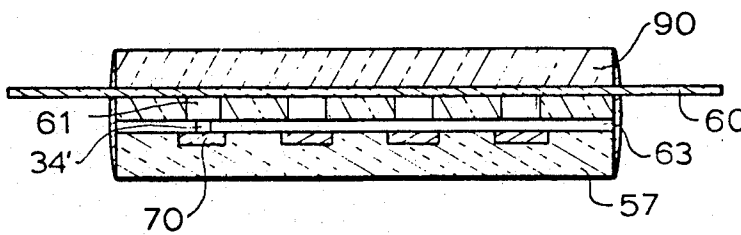
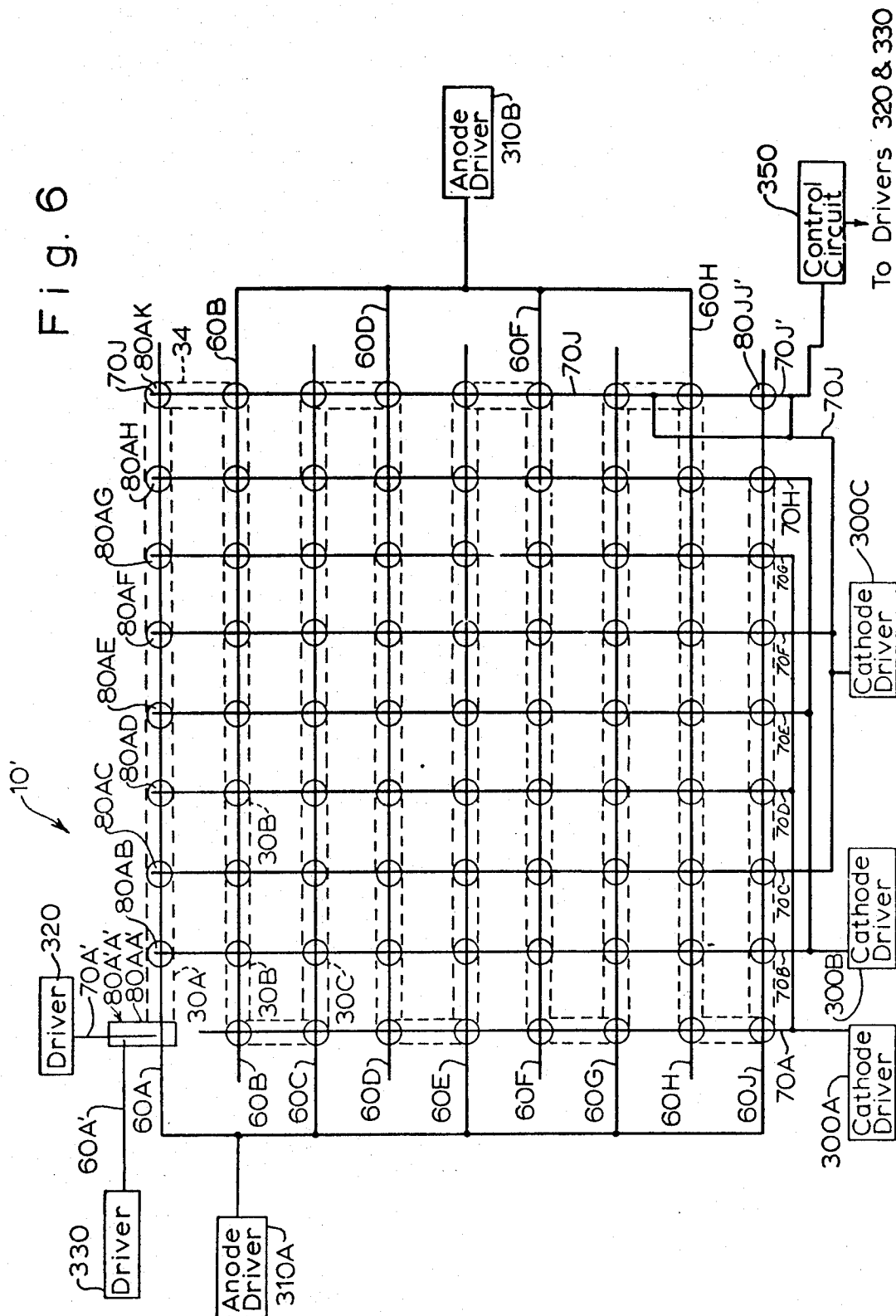


Fig. 4

Fig. 6



DISPLAY PANEL WITH RASTER SCANNING MEANS

This is a continuation of application Ser. No. 223,039, filed Feb. 2, 1972, now abandoned, as a continuation of Ser. No. 38,408, filed Aug. 18, 1970.

BACKGROUND OF THE INVENTION

Display panels comprising a plurality of gas-filled display cells are found in the art. However, these panels are generally not commercially feasible devices. The present invention relates to display panels in which the display cells can be scanned in raster fashion with unique scan-starting means being provided. The prior art provides no teaching of such a panel.

SUMMARY OF THE INVENTION

Briefly, a display panel embodying the invention comprises a plurality of display cells and electrode means for scanning through the cells in series and for initiating the scanning operation.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a prospective exploded view of a display panel embodying the invention;

FIG. 2 is a sectional view of the panel of FIG. 1 assembled;

FIG. 3 is a prospective exploded view of a modification of the panel of FIG. 1;

FIG. 4 is a sectional view of the panel of FIG. 3 assembled;

FIG. 5 is a prospective exploded view of another modification of the invention, and;

FIG. 6 is a schematic representation of a display panel embodying the invention and a circuit in which it may be operated.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The display panels described herein are thin, flat, sheet-like members which may have substantially any desired size and shape from, for example, postage stamp size to wall size, and they may include substantially any number of display cells. The panels may also include any suitable ionizable gas such as neon, argon, xenon, etc., singly or in combination, with a vapor of a metal such as mercury usually included in the gas to minimize cathode sputtering. The gas used is preferably a Penning mixture in which the gases of the mixture have related energy levels such that the metastable atoms of one gas produce ions of the other gas. Neon and xenon comprise a particularly effective Penning mixture. The gas pressure is preferably between 100 to 250 Torr, and, more particularly, about 175 Torr.

In the following description of the invention, different numbers of cells may be shown in the various figures for illustrating different aspects of the invention. For example, where panel structures are shown as in FIG. 1 it is convenient to show a relatively small number of cells. Where a panel is shown schematically in a circuit as in FIG. 6, a larger number of cells can be shown conveniently.

Referring to FIG. 1, a display panel 10 embodying the invention includes a first insulating bottom plate 20 of glass, ceramic, or the like having a plurality of parallel slots or channels 30 (A,B,C, etc.) formed in the top surface 40 thereof. The slots 30 may have any suitable

cross-section, and, for purposes of description, they are considered to be oriented horizontally. A second group of vertical slots 34 are also formed in the top surface 40 and these interconnect horizontal slots 30. Not all of the slots 34 are required for one mode of panel operation to be described below. Plate 20 also includes an auxiliary slot 30A' in the upper left-hand corner as seen in FIG. 1, which extends from the left edge 260 of plate 20 into the first vertical slot 34A.

Electrodes 60 (A, B, C, etc.), preferably wires used as scanning anodes in one mode of operation, are seated in slots 30. An auxiliary anode wire anode 60A' is disposed in slot 30A', and it extends into the first vertical slot 34A and into the portion 34A' thereof which lies between horizontal slot 30A and the upper edge 250 of plate 20. Electrode 60 and 60A' may be secured in place by means of a suitable cement (not shown), if desired.

Electrodes 70 (A, B, C, etc.) used as scanning cathodes are seated on or in the top surface 40 of plate 20. The cathode electrodes 70 are preferably flat strips, and each has a series of holes or apertures 74. The cathodes are oriented vertically, parallel to each other, overlaying vertical slots 34, and they are oriented at an angle, preferably 90°, to the anode electrodes 60, so that each cathode electrode 70 crosses each anode electrode 60 and each crossing defines a scanning cell 80 (FIG. 2). A cathode aperture 74 is located at each crossing and each cell 80. Each such electrode crossing is also at a crossing of a slot 30 and a slot 34. Each cathode 70 thus lies along a column of cells 80, and each anode 60 lies along a row of cells 80. In addition, each column of cathode apertures lies along a column of cells 80, and each row of cathode apertures, defined by adjacent cathodes, lies along a row of cells 80. Thus, each scanning cell 80 is made up of a portion of an anode 60, the associated portion of cathode 70 above it, and the volume of gas in slot 30 between these electrode portions.

The scanning cells 80 are identified by the anode and cathode which cross them. Thus, the auxiliary cell associated with electrodes 60A' and 70A' is cell 80A'A', and the associated first scanning cell in the first row having electrodes 60A and 70A' is cell 80AA', the second in the same row is 80AB, the third is 80AC, etc. The last cell in the last row is 80ED'.

According to the invention, the first cathode strip 70A is split in the region which lies between slot 30A and slot 30B to provide a first short portion 70A' and an elongated portion 70A. The first portion 70A' overlies vertical slot portion 34A' and extends from between slots 30A and 30B to and beyond upper edge of the plate 20 and through the panel seal to be described. Cathode portion 70A' has a cathode aperture 74 overlying slot 30A at cell 80AA. Cathode portion 70A extends from a position spaced from but close to portion 70A' between slots 30A and 30B to the lower edge of the plate 20 and through the panel seal area. It is to be noted that, with this arrangement, cathode 70A' is in operative relation with anode 60A' and anode 60A to, in effect, couple together auxiliary cell 80A'A' and the first scanning cell 80AA' in the first scanning row. In actuality, cell 80A'A' and cell 80AA' are one large cell.

The last cathode strip 70A at the right-hand edge of plate 20 is also split to include a first long portion 70D which extends from the upper edge of plate 20' to be-

tween slots 30D and 30E and a short portion 70D' which extends from between slots 30D and 30E across slot 30D to the lower edge of the plate 20. Cathode portion 70D' includes an aperture 74 overlaying slot 30E and cell 80ED. Cathode 70D and 70D' are close to but spaced and insulated from each other.

In one form of the invention, the panel 10 is completed by a cover viewing plate 90 of glass or the like. In the completed panel 10, the plates 20, 90 and the various electrodes are hermetically secured together by a seal 100 formed along their adjacent edges by any suitable means such as a fused glass frit, for example, Pyrocera or the like. The gas used in panel 10 is introduced in any suitable manner, for example, by means of a bell jar or by means of a tubulation 103 (shown only in FIG. 2), secured to bottom plate 20.

In a modified panel 10' which represents an alternative construction of the panel 10 described above, the electrodes 60 and 70 are reversed in position, with the anode wires 60 being on the top surface of an insulating plate 20' and with the cathodes 70 being adjacent to the bottom surface, between the bottom surface and a bottom cover plate 57. The plate 20' has a plurality of holes or cells 61 which comprise the scanning cells, with the first cell 61' being enlarged to accommodate auxiliary anode 60A' and cathode 70A', as described above. The cathodes are considered to be oriented vertically, each aligned with a column of scanning cells 61, and the bottom surface of plate 20' is provided with horizontal slots 63 which are aligned with rows of cells and which provide gas communication paths between the cathode electrodes. Vertical gas communication paths 34', similar to slots 34 in panel 10, are provided in the bottom surface of plate 20', but these are shown only at selected locations for a purpose to be described. Panel 10' also includes top plate 90.

The primary differences between panels 10 and 10' is that in panel 10 cell glow is viewed through a cathode hole and is thus somewhat obstructed and in panel 10' a viewer can see almost all of the cell itself with the small diameter anode wire providing substantially no obstructive effect. Of course, in panel 10 the cathode holes can be made as large as desired, however the need to provide cathode holes represents an economic deterrent to this construction. In panel 10', cathode holes are not required. For all practical purposes, either panel is satisfactory for most applications, however the arrangement shown in panel 10 is preferred in a panel 105 to be described below. For this reason the following description of the operation of the invention is directed specifically to panel 10.

In the description of the operation of the invention set forth below, reference is made to "scanning" or "glow transfer" from cell to cell. The exact mechanism by which this operation occurs is not known for certain; however, it may involve actual transfer of a mass of glowing ionized gas, or the diffusion of excited particles including metastable states which facilitate a new firing of an OFF cell, or both mechanisms may be involved.

In operation of the panel 10 and to execute a raster scanning operation, operating potentials (generally positive) are applied to the auxiliary anode 60A' and to cathode 70A' (generally negative) of cell 80A'A', with all other anodes and cathodes held at suitable non-operating potentials. The cell fires and the gas glows primarily in the vicinity of the electrodes 60A' and

70A' in slot 34A'. In effect, this glow performs a keep-alive function and provides excited particles to facilitate the start of the actual scanning cycle. To start the scanning cycle, operating potential is switched from anode 60A' to the first scanning anode 60A, with the previously applied potential still applied to the cathode 70A'. Glow now switches to the area where electrodes 60A and 70A' cross, at cell 80AA', and this glow is visible through hole 74 in cathode portion 70A'. Now, the scanning cells 80 are scanned, that is turned on, one at a time in raster-type fashion, beginning with the first cell 80AA at the upper left-hand corner of the plate 20, and the scanning operation proceeds from cell to cell along the top row to the right-hand end, from which it proceeds directly vertically to the next adjacent row and to the last cell therein, from which it proceeds to the left along the second row to the first cell at the end of the second row, and then downwardly to the first cell in the third row, and from there to the end of the third row, and so forth, to the last cell in the plate 20.

More specifically, after operating potential is switched from anode 60A' to 60A and glow switches from cell 80A'A' to the vicinity of anode 60A and cathode 70A' of cell 80AA', next, operating potential is switched from cathode 70A', and it is applied to the second cathode 70B. Now, the second cell in the first row, cell 80AB, turns on, and cell 80AA turns off. This switching of the cathode operating potential from one cathode to the next is carried out until the glow reaches the last cell 80AD in the first row. This transfer of glow along the first row of cells is facilitated by the common horizontal slot 30, in which these cells are located and in which excited particles can diffuse from an ON cell to the adjacent cell to be fired. With the last cathode 70D still carrying its operating potential, positive operating potential is applied to the second anode 60B associated with the second row of scanning cells, and, at the same time, operating potential is removed from anode 60A. This causes the glow to transfer from the last cell in the first row to the adjacent last cell in the second row. This operation is facilitated by the presence of a vertical slot 34 between these last cells in the first and second rows.

Now, with the operating potential again applied to each of the cathodes in turn, but in the reverse order beginning at the right-hand end and proceeding to the left-hand end of the panel, the glow is transferred by means of slot 30 toward the left along the second row of cells 80. When the glow reaches the last or left-most cell in the second row, operating potential is switched from anode 60B to anode 60C, and the glow transfer through the associated slot 34 to the first cell 80CA in the third row of cells. The scanning operation is now again carried out to the right along the third row. In this way, the scanning operation is carried out cell by cell and row by row through all of the cells 80. As the scanning operation takes place, the glow generated as each cell is turned on is visible through top plate 90.

When the glow reaches cell 80ED', with operating potentials applied to anode 60E and cathode 70D', current flow through this cell can be used to automatically apply operating potentials to electrodes 60A', and 70A' to fire cell 80A'A' and to prepare the panel for another scanning operation.

It is to be noted that the application of switching potentials to the cathodes and the interconnection of the cathodes to effect economies can be carried out in the

manner described and claimed in copending application Ser. No. 850,984, filed Aug. 18, 1969.

It is clear that the above-described operation can be carried out in the same way in panel 10'. The plate 20 and its electrodes may also be incorporated in a display panel of the type described in application Ser. No. 850,984. This type of panel 105, shown in FIG. 5, includes, seated on plate 20, a second insulating plate 110, of glass, ceramic, or the like having a plurality of apertures or cells 120 arrayed in rows and columns. The cathode electrodes 70 are disposed between plate 110 and the top surface of plate 20, with each aperture or cell 120 aligned with a cathode aperture 74 and with a cell 80 beneath it. Cells 120 comprise display cells in panel 105. Electrodes 70 may be seated in slots (not shown) in the bottom surface of plate 110, if desired, as described in copending application Ser. No. 6,839 filed on Jan. 29, 1970.

It is to be noted that the cells 80 are in a layer, and cells 120 are in a layer above the layer of cells 80, and the rows and columns of cells 120 are aligned with the rows and columns of scanning cells 80, with each cell 120 positioned above a cell 80.

An array of wire electrodes 130, used as display anodes, are seated on or in the top surface 122 of plate 110, with each generally aligned with and overlaying a row of holes 120 therein. The electrodes 130 need not be centered over the holes; they need only communicate with the gas in the holes. Thus positioned, electrodes 130 are parallel to and are aligned, each with one wire electrode 60 in plate 20.

A transparent cover on viewing plate 140 of a dielectric material such as glass completes the panel and is seated on center plate 110. The wire electrodes 130 might be seated in slots in the bottom surface of top plate 190, if desired.

The various insulating plates 20, 110, and 140 and the various electrodes of panel 105 are secured together hermetically along the edges of the panel by a seal 150 made of a glass frit or the like. The various electrodes, of course, are also secured in this seal area and project beyond the seal so that circuit connections can be made thereto.

It can be seen that a vertical flow path is provided from each bottom scanning cell 80 in plate 20 to each upper display cell 120 in plate 110 through the holes 74 in electrodes 70. Holes 74 should be small, e.g., 1 to 3 mils in diameter, to prevent spurious glow transfer from a scanning cell to a display cell. Holes of this size permit diffusion of excited particles which facilitate the desired glow transfer.

In operation of panel 105, as the scanning of cells 80 is carried out from cell to cell, as described above, if a generally positive potential, for example of the order of 150 volts, is applied to the proper display anode 130 as a particular cell 80 glows, glow is transferred upwardly into cells 120 in insulating plate 110 from each cell 80 as it is turned on. As the entire array of cells 80 is scanned, selected corresponding display cells 120 can be fired in this way, by means of positive potentials applied to anodes 130. These positive potentials or signals may be information or data signals from a computer or other such system. If the scanning and display operations are carried out at a sufficiently high rate, a stationary character or message can be displayed in the cells 120 and viewed through plate 140.

Another type of panel and mode of operation in which memory can be achieved, according to the principles of the present invention, is described and claimed in a concurrently filed application of Glaser and Kupsky entitled Display Panel Having Memory.

As noted above, an economical arrangement for performing a scanning operation is described and claimed in copending application Ser. No. 850,984 of Ogle and Holz. This mode of operation is described herein relatively briefly with reference to FIG. 6 which is a schematic representation of plate 20, anodes 60, and cathodes 70, with a larger number of cells 80 shown in FIG. 6 than in FIG. 1. FIG. 6 also includes portions of a circuit for scanning cells 80 in accordance with the teaching in the above-mentioned application. In the circuit of FIG. 6, the cathode electrodes 70 are connected in three groups as shown, although more than three groups could be formed. The groups of cathodes are connected to separate driver or switching circuits 300A, 300B, 300C. The scanning anode electrodes 60 are connected in two groups, with the odd-numbered anodes being in one group, and the even numbered anodes being in the other group. Separate anode driver or switching circuits 310A and 310B are connected to the two groups of anodes. These anode and cathode driver circuits operate either to apply operating potentials or non-operating potentials to the various electrodes.

According to the invention and referring to auxiliary cell 80A'A', the cathode 70A' thereof is connected to its own driver or switching circuit 320, and the anode 60A' is connected to its own anode driver or switching circuit 330. In addition, the last cathodes, in this case numbered 70J and 70J', although separate, are connected to the same cathode switching circuit 300C.

In performing a scanning operation, as described above, drivers 320 and 330 are switched on to fire cell 80A'A'. Then anode driver 310A is switched on, and anode driver 330 is switched off to fire cell 80AA' which, as described, is an extension of cell 80A'A'. Next, the scanning operation is carried out from cell to cell in the first row by maintaining operating potential on anode 60A and, as described in Ser. No. 850,984, by operating cathode drivers 30A, B, and C successively to switch operating potential from cathode 70A to cathode 70B, then from cathode 70B to cathode 70C, with each OFF cathode being raised to generally positive non-operating potential. This switching operation causes the glow to switch from cell 80AA' to cell 80AB, to cell 80AC, etc., until it reaches the last cell 80AJ in the first row. This glow transfer operation is facilitated by the gas communication path provided by slot 30A, as described in detail in the above-identified application Ser. No. 850,984.

As described with respect to panel 10, when the last cell in the first row is reached, the anode switching circuits 310A and 310B are reversed so that generally positive potential is applied to the anode 60B connected to switching circuit 310B and it is removed from the first anode 60A connected to switching circuit 310A. With operating potential still applied to cathode 70J associated with the last cell 80AJ, the glow now transfers through slot 34 from the last cell 80AJ in the first row to the last cell 80BJ in the second row. The glow is now transferred leftward from cell to cell along the second row of cells by switching the cathodes in the reverse order. In this way, by properly switching anode and cathode potentials, glow is transferred from cell to

cell and from row to row until it reaches the last cell in the last row, cell 80JJ'. At this point, both cathode 70J and the cathode portion 70J' are energized by cathode drive 300C, but only cathode portion 70J' draws current and, acting through proper associated control circuitry 350, it causes the electrodes 60A' and 70A' associated with cell 80A'A' to be energized so that the cell 80A'A' is turned on and the panel is ready for another scanning cycle.

As noted above, as the cells 80 are scanned, information signals applied to the associated display cells, if they are provided in the panel, cause these cells to glow and to provide a visual display of the input information.

It is to be noted that each of the panels described may be sealed inside an envelope so that, with respect to the panel itself, only a mechanical coupling of the various plates and electrodes would be required, and the seal around the edges of the panel could be omitted.

It is to be understood that the copending applications mentioned above are incorporated herein by reference. These and other applications which are useful in operating and making display panels are also incorporated herein by reference, such applications including the following:

Application Ser. No. 764,983, filed Oct. 2, 1968, which describes and claims a method and apparatus for introducing mercury into a display panel.

Application Ser. No. 850,841, filed Aug. 18, 1969 but abandoned in favor of application Ser. No. 8,773, filed Feb. 5, 1970, which describes and claims an arrangement for enhancing light output from a display panel.

What is claimed is:

1. A display panel comprising

an insulating plate including a plurality of anode electrodes and a plurality of cathode electrodes oriented with the anodes crossing the cathodes, with first gas-filled glow cells defined by each crossing of a pair of anode and cathode electrodes, gas communication channels formed in said plate and interconnecting all of said glow cells in a series which defines a raster, and

an auxiliary cell for facilitating the start of a scanning operation and associated with the first cell in the scanning series,

said auxiliary cell and said first cell in the scanning series comprising a single enlarged cell.

2. The panel defined in claim 1 wherein said single enlarged cell made up of said auxiliary cell and said first cell in the scanning series has associated with it one of said anode electrodes and one of said cathode electrodes for operation thereof to start a scanning cycle, and an auxiliary anode associated with said single enlarged cell for operation with said one of said cathode electrodes to fire said single cell just before the beginning of a scanning cycle.

3. A display panel including

a gas-filled envelope consisting of a first insulating base plate and a second insulating cover plate, means forming a plurality of gas-filled cells in said envelope, said cells being arrayed in rows and columns,

an anode electrode and a glow cathode electrode associated with each cell and a gas communication path in said base plate connecting all of said cells in a series beginning with a first cell and ending

with a last cell, said series forming a raster pattern,

said rows of cells including a first row, intermediate rows and a last row, and said gas communication path extending from the first cell in the first row along said first row to the last cell therein and from said last cell in said first row to the adjacent last cell in the second row of cells and from there to the first cell in the second row and thence to the adjacent first cell in the third row of cells, etc., until it reaches the last cell in the last row of cells, and

an auxiliary cell for facilitating the start of a scanning operation and associated with the first cell in the first row of said scanning series,

said auxiliary cell and said first cell being connected by a gas communication channel and comprising a single enlarged cell.

4. The panel defined in claim 3 wherein said single enlarged cell comprises said auxiliary cell and said first cell, said single enlarged cell having one of said anodes and one of said cathodes in operative relation therewith and an auxiliary anode for operation with said one of said cathodes.

5. A display panel including

a first base plate having a top surface and a bottom surface and a top viewing plate sealed thereto in gas-tight engagement, said top plate having a top surface and a bottom surface,

means defining a plurality of gas-filled cells arrayed in rows and columns,

a gas communication path connecting all of said cells in a scanning series which defines a raster beginning with the first cell in the first row and terminating with the last cell in the last row,

a first electrode aligned with each column of cells,

a second electrode aligned with each row of cells, the first of said first electrodes being aligned with the first column of cells including said first cell in said first row which comprises the first cell in said scanning series, said first of said first electrodes including a first portion which is associated with said cell and a second portion associated with all of the other cells in said first column,

the last of said first electrodes being aligned with the last column of cells including the last cell in said scanning series, said last of said first electrodes including a first portion aligned with the last cell in said last column and a second portion aligned with the remainder of the cells in said last column of cells.

6. The panel defined in claim 5 wherein said first cell in said scanning series includes an auxiliary portion adapted to operate before a scanning cycle begins and which is adapted to insure the proper starting of said scanning series at said first cell.

7. The panel defined in claim 5 wherein said first cell in said scanning series includes an auxiliary portion adapted to operate before a scanning cycle begins and which is adapted to insure the proper starting of said scanning series at said first cell and including auxiliary electrode means associated with said auxiliary portion of said first cell.

8. The panel defined in claim 5 wherein said first cell in said scanning series includes an auxiliary portion adapted to operate before a scanning cycle begins and which is adapted to insure the proper starting of said scanning series at said first cell and including an auxi-

ary electrode in operative relation with said auxiliary portion of said first cell and said first portion of said first of said first electrodes.

9. The panel defined in claim 1 and including a second gas-filled glow cell associated with each of said first cells and in gas communication therewith, said second cells including electrode means for transferring glow from a selected first cell to the associated second cell.

10. The panel defined in claim 5 and including a second gas-filled glow cell associated with each of said first cells and in gas communication therewith, said second cells including electrode means for transferring glow from a selected first cell to the associated second cell.

11. A display panel including

a first base plate having a top surface and a bottom surface and a top viewing plate sealed thereto in gas-tight engagement, said top plate having a top surface and a bottom surface,

means defining a plurality of gas-filled cells arrayed in rows and columns, there being a first column of cells, a last column of cells and intermediate columns of cells and there also being a first row of cells, a last row of cells and intermediate rows of cells,

a gas communication path in said base plate connecting all of said cells in a scanning series which defines a raster beginning with the first cell in the first row and terminating with the last cell in the last row,

said first cell in said first row of cells including an auxiliary portion which comprises a starter cell for said first cell,

a cathode electrode aligned with each column of cells, the first cathode electrode aligned with the first column of cells including a first portion in operative relation with said first cell and said auxiliary portion and a second portion in operative relation with all of the other cells in said first column,

the last cathode electrode aligned with the last column of cells including a first portion in operative relation with only the last cell in the scanning series and a second portion aligned with all of the other cells in the last column,

an anode electrode aligned with each row of cells,

and

an auxiliary anode electrode associated with said first portion of said first cathode electrode and said auxiliary portion of said first cell.

12. The panel defined in claim 11 and including an auxiliary gas-filled glow cell associated with each of said first cells and in gas communication therewith, said second cells including electrode means for transferring glow from a selected first cell to the associated second cell.

13. A display panel comprising

a gas-filled envelope including at least an insulating base plate and a cover plate and, associated therewith, a plurality of anode electrodes and a plurality of cathode electrodes oriented so that the anodes lie at an angle with respect to the cathodes and each anode crosses each cathode, with gas-filled glow cells defined by each such crossing and the volume of gas between the crossed electrodes, there being a plurality of rows and columns of said cells formed by said electrodes, there being a first row, a last row and intermediate rows,

gas communication channels formed in said plate and interconnecting each row of cells to the row of cells adjacent to it with the last cell in the first row coupled to the last cell in the adjacent second row and the first cell in the adjacent second row coupled to the first cell in the third row, such end-to-end coupling of said rows of cells being made throughout said panel whereby all of the cells of the panel are coupled together in a continuous series beginning with the first cell in the first row and ending with the last cell in the last row whereby, when suitable electrical potentials are applied to said anode and cathode electrodes, glow can be transferred from one cell to the next in each row successively throughout said panel, and

an auxiliary cell disposed close to said first cell in said first row and coupled thereto by a gas communication channel, whereby said auxiliary cell and said first cell comprise a single enlarged cell. said auxiliary cell having an anode electrode associated with it in operative relation with the cathode electrode associated with said first cell.

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