United States Patent

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[54] **DISPLAY PANEL CONSTRUCTION**
7 Claims, 8 Drawing Figs.

[52] **U.S. Cl.** ..... **313/220,** 313/109.5, 313/210, 315/169 R
[51] **Int. Cl.** **H01j 61/30**
[50] **Field of Search** ..... 313/109.5, 210, 220; 315/169 R, 169 TV

[56] **References Cited**
UNITED STATES PATENTS

2,925,530 2/1960 Engelbart ..... 315/169 X

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ABSTRACT: A gaseous display panel includes a top plate, a bottom plate, a center plate, and a plurality of arrays of electrodes associated therewith. The bottom plate, and the top plate if desired, are provided with slots, the center plate is provided with an array of holes, and the electrodes are arrayed to provide two layers of gas-filled glow cells. The various parts are constructed to provide optimum uniformity and thereby to achieve optimum operation with maximum economies and ease in construction.

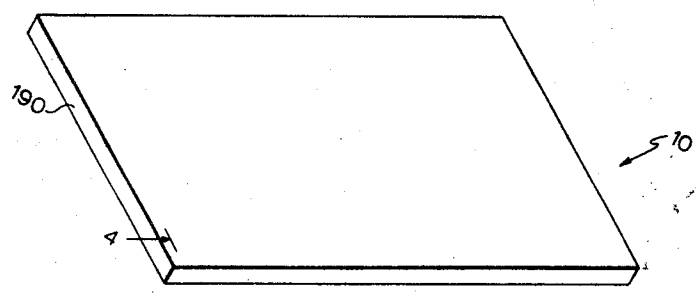
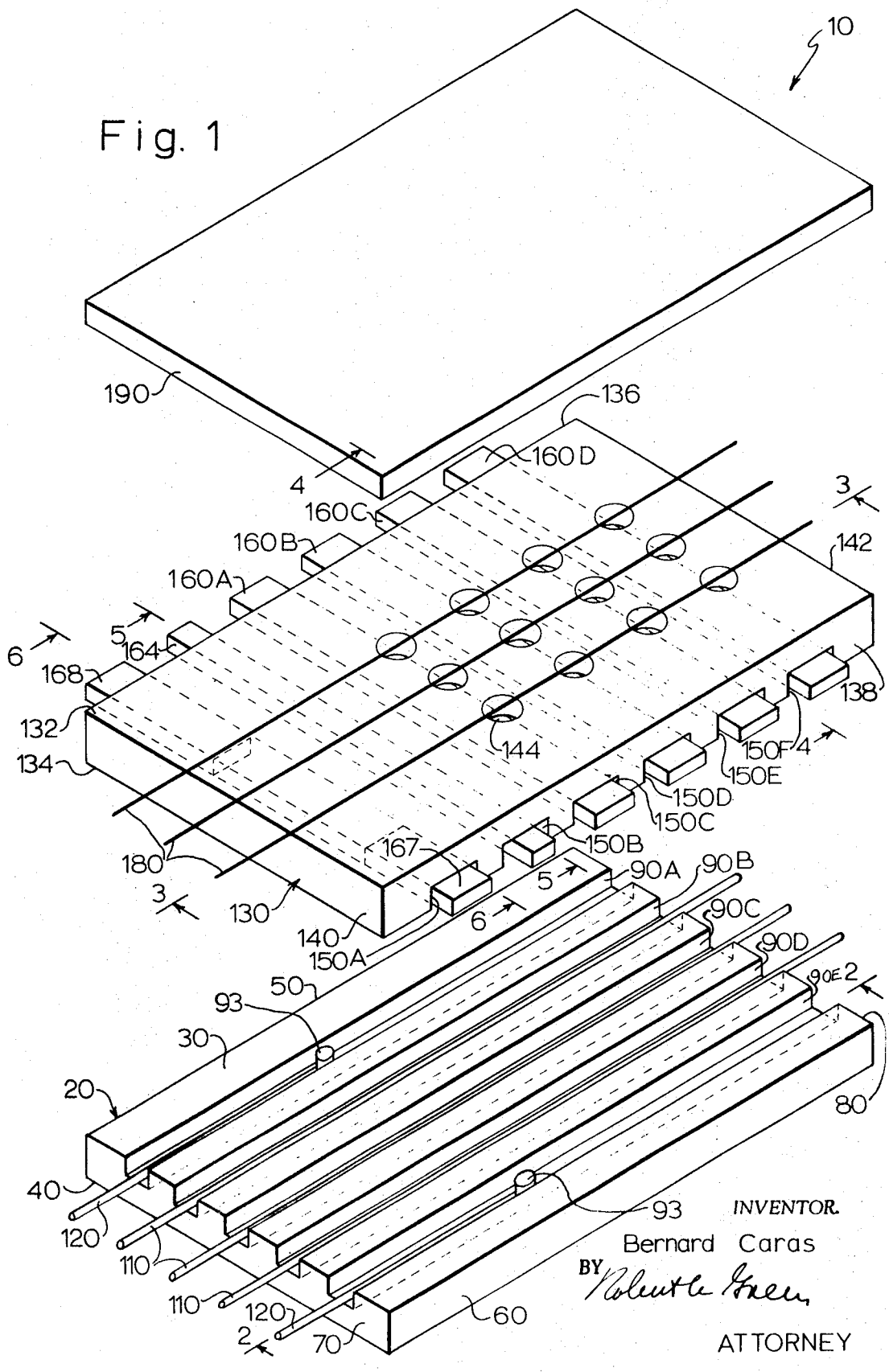


Fig. 1



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Fig. 2

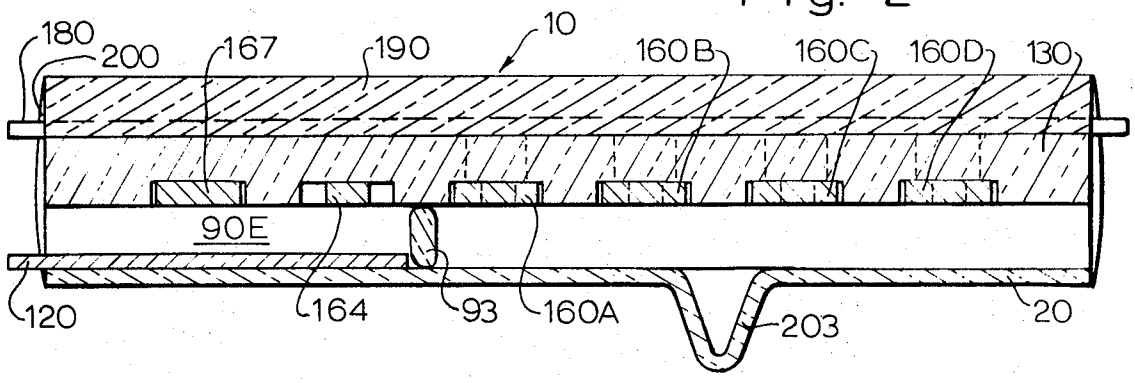


Fig. 3

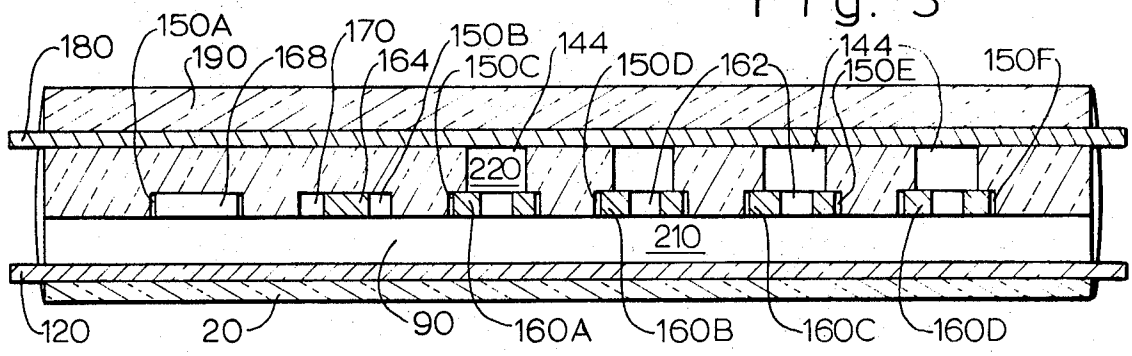
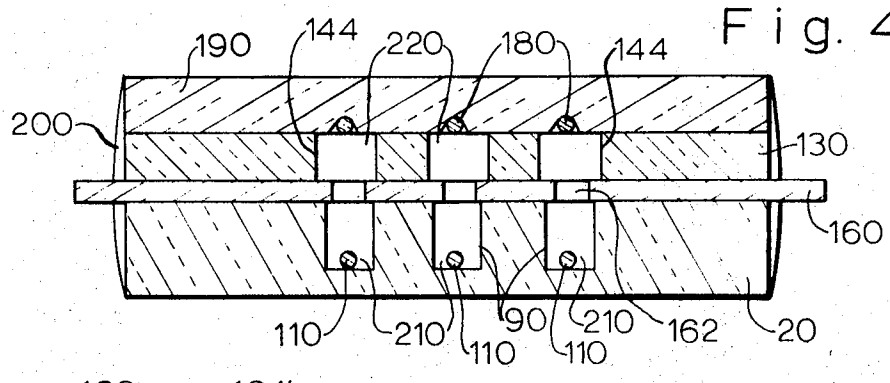


Fig. 4



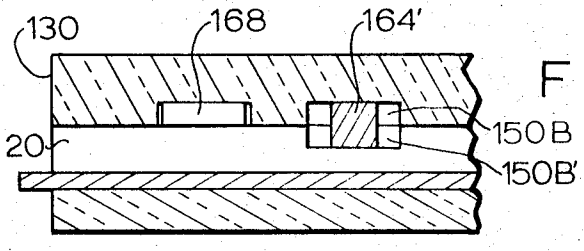


Fig. 3A

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Fig. 5

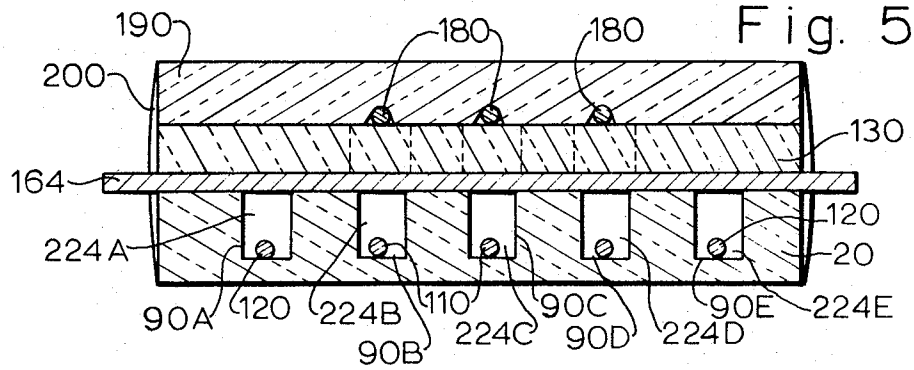
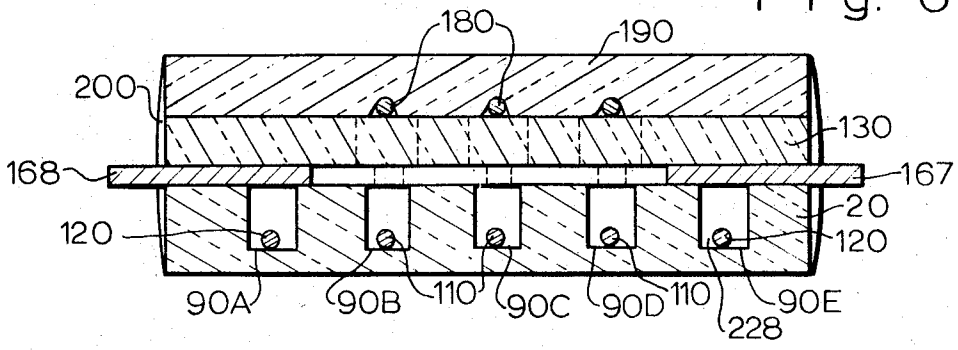


Fig. 6



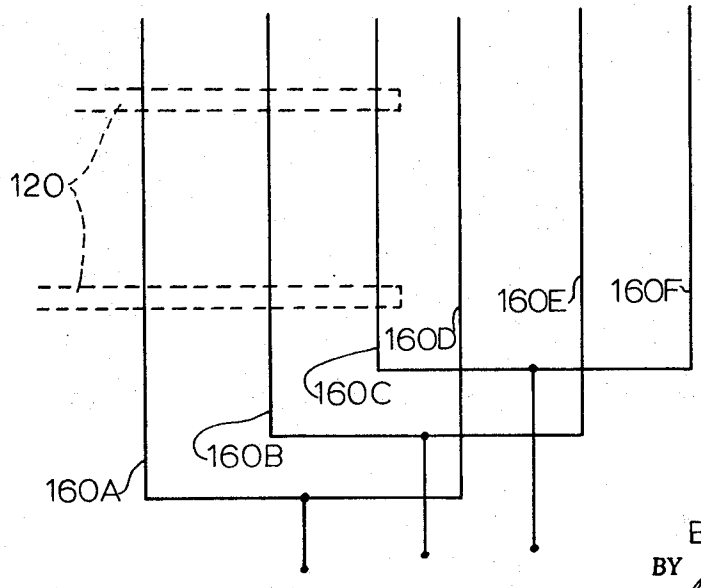


Fig. 7

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DISPLAY PANEL CONSTRUCTION

BACKGROUND OF THE INVENTION

Display panels comprising a plurality of gas-filled cells which can be turned on selectively to display a message are known in the art, but have thus far not become widely used commercial devices. In a recent development, a display panel has been developed which has two layers of cells, a first layer being used as a scanning or addressing layer for sequentially addressing the cells, one by one or column by column, and a second layer in which information is inserted to be displayed, and perhaps stored, as the first level is scanned. These multilayer devices have been constructed of several glass plates having various arrays of slots and a plurality of electrodes which perform various functions. Although these recently developed display panels have been operated successfully, there is always a need to improve operation and to provide economies in the numbers and different types of parts employed and to provide features which render panels readily reproducible in mass production.

SUMMARY OF THE INVENTION

Briefly, a display panel embodying of the invention comprises a gas-filled envelope and an assembly therein including a plurality of gas-filled cells and a plurality of electrodes which perform different functions. The various electrodes and the associated structural elements are interrelated and arranged to provide optimum operation with maximum economies and ease in construction.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded view in perspective of a display panel embodying the invention;

FIG. 2 is a sectional view along the lines 2—2 in FIG. 1 showing the panel assembled;

FIG. 3 is a sectional view along the lines 3—3 in FIG. 1 showing the panel assembled;

FIG. 3A is a sectional view of a portion of a modification of the invention;

FIG. 4 is a sectional view along the lines 4—4 in FIG. 1 showing the panel assembled;

FIG. 5 is a sectional view along the lines 5—5 in FIG. 1 showing the panel assembled;

FIG. 6 is a sectional view along the lines 6—6 in FIG. 1 showing the panel assembled; and

FIG. 7 is a schematic representation of one set of electrodes used in the panel of the invention and one method of connecting these electrodes in a circuit.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The display panel described herein is a thin, flat, sheetlike member which may have substantially any desired size and shape from, for example, postage stamp size to wall size, and it may include substantially any number of display cells. The panel 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.

A display panel **10** embodying the invention includes a bottom plate **20** of an hermetic, dielectric material, such as glass or ceramic, which has a top surface **30**, a bottom surface **40**, an upper edge **50**, a lower edge **60**, a left edge **70**, and a right edge **80**. The plate **20** has a plurality of parallel slots or channels **90** extending a convenient distance into the body of the plate from the top surface **30**. For purposes of illustrating and describing the invention, the panel is oriented so that the slots **90** extend horizontally across plate **20** from the left edge **70** to the right edge **80**.

The array of slots **90** is suitably positioned between the upper and lower edges of plate **20**, with the first slot **90A** being closest to the upper edge **50** of the plate, and the last slot **90E** being closest to the lower edge **60** of the plate.

The slots **90** are all identical in size, shape, width, depth, etc., and can be made by any suitable mass production process; however, first and last slots **90A** and **90E** are blocked and, in effect, terminated at a selected area along their lengths by an obstruction **93** (FIGS. **1** and **2**) such as a mass of a glass frit, for example, of the type known as Pyroceram. The slots **90A** and **90E** thus terminate nearer to left edge **70** of the plate **20** and of the panel, this being the end at which the scanning operation originates in one mode of operation of the panel.

Electrodes **110**, which are used as counting or scanning anodes in one mode of operation of the panel, are seated in the slots **90B**, C, and D, and these electrodes are long enough to extend beyond the left and right edges of plate **20** so that they are accessible outside the panel. Electrodes **110** are preferably individual wires; however, they may also be plated, evaporated or otherwise formed in the slots. The electrodes **110**, if separate wires, might also be secured in the slots **90** by means of a cement such as a fused-glass frit or the like. An auxiliary wire electrode **120**, also an anode, is seated in each of the shortened slots **90A** and **90E**, and these originate at the obstruction **93** and extend only beyond the left end **70** of the plate **20**.

Panel **10** also includes a center sheet or plate **130** of a dielectric material, like plate **20** if desired, which is seated on bottom plate **20** and has a top surface **132**, a bottom surface **134**, an upper edge **136**, a lower edge **138**, a left edge **140**, and a right edge **142**. The sheet **130** is provided with a plurality of rows and columns of apertures or holes **144**, and the bottom surface **134** thereof is provided with a plurality of generally rectangular, parallel slots **150**. Slots **150** have the same width and depth and extend along sheet **130** from the lower edge **138** to the upper edge **136**. The slots **150** are oriented at 90° to each of the slots **90**, and thus, in effect, cross each of the slots **90** in the bottom plate **20**. The array of slots **150** is suitably positioned between the left and right edges **140** and **142**, respectively, of center sheet **130**, with slot **150A** (FIGS. **1** and **3**) considered to be the first slot positioned close to the left edge **140** of sheet **130**, and the last **150F** being positioned close to the right edge **142** of sheet **130**. The columns in which apertures or holes **144** in center sheet **130** are arrayed are generally aligned with the slots **150C** to **150F**, as shown in FIG. **1**, and the rows in which they are arrayed are generally aligned with slots **90B**, C, and D in bottom plate **20**. The holes **144** are identical, and the slots **150** are identical, and each may be made by any suitable mass-production process.

A plurality of electrodes, operated as cathodes, are associated with center sheet **130**, and these include scanning cathode electrodes **160A**, B, C, and D seated in the slots **150C**, D, E, and F in sheet **130**. The scanning cathode electrodes **160** are metal strips which substantially fill the slots **150** and extend along the entire length thereof and beyond the upper and lower edges of sheet **130**. The cathodes **160** are oriented at 90° to the anodes **110**, and each cathode crosses each anode. Each electrode **160** is provided with a plurality of tiny apertures **162** disposed along its length, with each aperture **162** being generally centrally positioned over a slot **90** (FIG. **4**) in bottom plate **20** and beneath a hole **144** in center sheet **130**. The cathodes **160** are identical in size and shape and can be made by any suitable mass-production process.

A cathode electrode **164**, used as a reset cathode, is seated in slot **150B**. Cathode **164** has the same thickness and length as electrodes **160**; however, it is narrower so that there are spaces **170** on either side of it which extend all along the slot **150B**. Cathode **164** crosses all anodes **110** and **120**. In a modification of the invention shown in FIG. **3A**, reset cathode **164'** is seated in aligned slots **150B** in plate **130** and **150B'** in the top surface of bottom plate **20**. This brings the reset cathode closer to the lower anodes **110** and **120** which is desirable to ensure proper operation of the reset cells, and it also helps align and seat plates **130** and **20** with respect to each other.

The panel also includes a pair of cathode strip electrodes **167** and **168** (FIGS. **1** and **6**) used as keep-alive cathodes, and

seated in slot 150A, with electrode 167 having its inner end originating at a location between slot 90D and slot 90E and extending out of the panel beyond the lower edge of the panel. Similarly, the inner end of electrode 168 originates at a location between slot 190A and slot 190B, and the electrode extends out of the panel beyond the upper edge. Electrodes 167 and 168 are identical in size and shape to electrodes 160 so that they, too, fill the slot 150A. Thus, cathodes 167 and 168 can be formed by removing a center portion from a cathode 160.

A second group of wire electrodes 180, used as display anodes, are seated on the top surface 132 of sheet 130, or in slots (not shown) in top surface 132, each being aligned with or overlaying a row of holes 144 in center sheet 130. The electrodes 180 need not be centered over the holes; they need only communicate with the gas in the holes, with no particular alignment required.

A transparent cover or viewing plate 190 of a dielectric material such as glass completes the panel and is seated on center sheet 130. The wire electrodes 180 might be seated in slots in the bottom surface of top plate 190 (not shown), if desired. In the completed panel 10, the three plates 20, 130, and 190 are hermetically secured together by a seal 200 formed along their adjacent edges by any suitable means such as a fused-glass frit (Pyroceram) 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 203 (shown only in FIG. 2), secured to the bottom plate 20 and communicating with the portion of slot 90E or 90A to the right of mass 93.

As described, panel 10 includes a lower layer of counting or scanning gas cells 210 (FIGS. 3 and 4) arrayed in rows and columns, with each cell comprising a portion of a lower anode electrode 110 in slot 90, a portion of the apertured strip cathode electrode 160 above it, and the gas volume between them in slot 90. Thus, each column of counting cells is defined by each cathode 160 and its crossing of a slot 90 and the associated portion of a counting anode 110. As seen in FIG. 1, there are four columns of counting cells 210, and, for purposes of description, the first column is associated with cathode 160A, the second column with cathode 160B, the third column with cathode 160C, and the fourth column with cathode 160D. Each column of scanning cells 210 communicates with the adjacent column, that is, each scanning cell in one column communicates with the corresponding cell in the adjacent column, through the associated slot 90.

The panel 10 also includes an upper layer of display cells 220 associated with and vertically aligned with, the counting cells 210. Each display cell 220 (FIGS. 3 and 4) is made up of a portion of a cathode 160, the associated gas-filled hole or cell 144 in center sheet 130, and the associated portion of upper anode electrode 180. As with the counting cells, there are also four columns of display cells 220, each associated with a cathode 160, with the first column associated with cathode 160A, etc.

The panel 10 also includes a column of auxiliary cells which are known variously as starter cells, reset cells, particle-supply cells, or glow-spreading cells 224 (FIG. 5), and these cells supply excited particles to facilitate the turn-on of the first column of counting cells 210 associated with cathode 160A at the beginning of a scanning cycle. For convenience, cells 224 will be called reset cells. These reset cells are arrayed in a column to the left of the first column of counting cells and communicating therewith through slots 90B, C, and D. Cells 224 are constituted by the cathode strip 164 and the portion of each anode 110 and 120 which it crosses and the gas volume in the slots 90 therebetween.

Panel 10 also includes keep-alive cells 228 (FIG. 6) which are provided to ensure firing of the reset cells 224. Keep-alive cells 228 are constituted by cathodes 167 and 168 and the anode electrodes 120 which they cross and the gas volume between them in slots 90A and 90E. The keep-alive cells 228 communicate with the reset cells through slots 90A and 90E and through the portion of slot 150A between keep-alive cathodes 167 and 168 and through the slots 90B, C, and D which slot 150A crosses.

At this point, it might be noted that the extent to which the inner ends of the keep-alive anodes 120 can extend to the right in the panel as determined by the obstructions 93 is controlled by whether these anodes will interfere with the operation of any of the cathodes 160 and the associated counting cells. Thus, the anodes 120 and mass 93 (FIG. 2) might terminate inside the panel between reset cathode 164 and the first counting cathode 160A. If the counting cathodes are connected in groups and driven by common drivers, as described in copending Application Ser. No. 850,984 and as shown schematically in FIG. 7, with cathode 160A connected to cathode 160D, cathode 160B connected to cathode 160E, and cathode 160C connected to cathode 160F, then the anodes 120 could extend only to between cathodes 160C and 160D but not into operative relation with cathode 160D. This is because cathodes 160A and 160D are connected together and their normal operation in the scanning cycle would be disturbed.

In addition, as shown in FIG. 6, the keep-alive cathodes 167 and 168 may not extend into operative relation with the counting anodes 110.

In the description of the operation of the invention set forth below, reference is made to "scanning" or "glow transfer" from cell to cell or column to column. Several different types of actions occur including glow transfer from a keep-alive cell 228 to a reset cell 224, from a reset cell to a reset cell, from a reset cell 224 to a scanning or counting cell 210, from a scanning cell to a scanning cell, and from a scanning cell to a display cell 220. The exact mechanism by which each such operation occurs cannot be described with complete certainty; however, the operations 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, the keep-alive cells 228 communicate with the reset cells 224 through slots 90A and 90E primarily, and through slot 150A and slots 90B, C, and D, secondarily, and excited particles thus can diffuse from keep-alive cells 228 through both paths to the reset cells 224. The most direct path for diffusion is through slots 90A and 90E to the two immediately adjacent reset cells 224A and 224E (FIG. 6) associated with slots 90A and 90E between keep-alive cathodes 167 and 168 and then through slots 90B, C, and D to reset cells 224B, C, and D. As noted, the keep-alive cells are always on, and, when it is desired to turn on the reset cells 224, operating potential is applied to the reset cathode 164 and to all of the anodes 110 and 120. With the aid of the keep-alive cells, glow starts first in reset cells 224A and E and spreads immediately along the entire length of the reset cathode 164 in the spaces 170. This is the reason for having electrode 164 narrower than its slot 150B. The spread of glow along the reset cells is facilitated by the secondary diffusion path described above.

When the reset cells 224 have fired, the first column of counting cells 210 can be fired with the aid of excited particles generated in the reset cells and able to diffuse to the first column of counting cells through slots 90B, C, and D. An arrangement for using reset cells to fire counting cells is described and claimed in copending application Ser. No. 791,208. In addition, methods and apparatus including circuits for scanning columns of counting cells and energizing display cells therefrom are described and claimed in the above-mentioned application Ser. No. 850,984. These circuits are not shown here. In a typical scanning operation, the scanning or counting anodes 110 are connected to driver circuits for applying generally positive operating potential thereto, and each of the cathodes 160 is connected to a driver circuit for applying generally negative operating potential to each, sequentially, to cause each column of lower counting cells 120 to fire and glow. The firing of each column of count-

ing cells, after the first has been fired, is facilitated by the diffusion of excited particles through the slots **90** from ON counting cells to the adjacent OFF counting cells to be fired. The columns of counting cells **210** are fired sequentially from left to right, as seen in FIGS. **1** and **3**. This sequential firing of the columns of lower counting cells **210** is carried out cyclically from left to right. Each time the last column of counting cells at the right-hand edge of the panel is reached, the column of reset cells **224** at the left-hand edge of the panel is turned on again, with the aid of the keep-alive cells, and the above-described cycle is repeated. If desired, circuit means may be provided to sense the turn-on of the last column of counting cells **210** and automatically turn on the reset cells to start the cycle again.

When it is desired to fire cells **220** in the upper layer to represent the display of information or the like, generally positive operating potentials are applied to the proper upper anodes **180** associated with the cells **220** to be fired and glow transfers from the associated lower cells **210** through the apertures **162** in cathode electrodes **160** to the upper cells where the glow can be viewed through top plate **190**. As described above, the glow transfer is facilitated by the presence of excited particles in each of the lower counting cells **210** when it is fired.

It is clear from the foregoing description of the invention that, since there is optimum uniformity in the parts used in the display panel, optimum ease of assembly and operation can be achieved. Of course, considerable savings in parts and assembly time are also achieved.

It is clear that modifications may be made in the panels described within the scope of the invention. For example, although the panel as described is scanned from left to right, the scanning may be effected in other ways, and this might require a rearrangement of parts. In addition, although two keep-alive cells have been shown, one may be sufficient.

In general, the drawings are not intended to be dimensionally exact, and, in a typical display panel embodying the invention, the top plate **190** and bottom plate **20** are about one-fourth inch in thickness, and the center plate **130** is about 40 mils in thickness. In addition, in plate **20**, slots **90** are 10 mils wide and 35 mils deep, and electrodes **110** and **120** are 5 mils in diameter. In plate **130**, slots **150** are 36 mils wide and 1 to 3 mils deep, with cathodes **167**, **168**, and **160** having approximately the same dimensions. The holes **162** in the cathodes are 1 to 3 mils in diameter, the holes **144** in plate **130** are 18 to 24 mils in diameter and 40 mils deep, and electrodes **180** are about 3 mils in diameter.

What is claimed is:

1. A display panel comprising

a gas-filled envelope including a bottom plate, a center plate, and a top plate, all being of dielectric material and hermetically sealed together along their adjacent edges,

said bottom plate having a top surface, a bottom surface, a left edge, a right edge, an upper edge, and a lower edge,

said bottom plate also having a plurality of first parallel identical slots extending into said plate from said top surface and extending along the entire length of said plate,

at least one of said first slots having an obstruction close to one edge of said bottom plate and comprising a short slot,

a first electrode seated in all of said first slots except said short slot and extending along the entire length of said first slots and beyond the left and right edges of said bottom plate,

a second electrode seated in said short slot,

said center plate having a top surface, a bottom surface, a left edge, a right edge, an upper edge, and a lower edge,

a plurality of generally rectangular identical parallel slots formed in said bottom surface of said center plate and extending transversely to said first slots in said bottom plate, the first slot being considered to be adjacent to the left edge of said center plate and the last slot being considered to be adjacent to the right edge of said center plate,

a first flat strip electrode disposed in said first of said rectangular slots with the inner end thereof overlying said short slot in said bottom plate and extending therefrom out of said panel beyond said lower edge of said bottom plate, said first electrode being in operative relation with said second electrode seated in said short slot,

a second narrow flat strip electrode seated in the second of said rectangular slots and extending along the entire length of said second slot and beyond the upper and lower edges of said center plate, said narrow flat strip being narrower than said second slot, said second flat strip electrode being in operative relation with said first electrodes in said first slots and said second electrode in said short slot,

a plurality of third identical flat strip apertured electrodes seated in all of the others of said rectangular slots and filling said slots, said third flat strip electrodes being in operative relation with only said first electrodes,

a plurality of holes formed in said center plate and arrayed in rows and columns, each column of holes being aligned with one of said identical flat strip apertured electrodes, with each aperture in said apertured electrodes being generally aligned with one of said holes, each row of holes being generally aligned along one of said slots in said bottom plate, and

a plurality of fourth electrodes aligned with said rows of holes and disposed between said top plate and said center plate.

2. A display panel comprising

a gas-filled envelope including a bottom plate, a center plate, and a top plate, all being of dielectric material and hermetically sealed together along their adjacent edges,

said bottom plate having a top surface, a bottom surface, a left edge, a right edge, an upper edge, and a lower edge,

said bottom plate also having a plurality of first parallel identical slots extending into said plate from said top surface and extending along the entire length of said plate,

two of said first slots having an obstruction close to one edge of said bottom plate and comprising short slots,

a first electrode seated in all of said first slots except said short slot and extending along the entire length of said first slots and beyond the left and right edges of said bottom plate,

a second electrode seated in one of said two short slots and a third electrode seated in the other of said two short slots,

said center plate of insulating material having a top surface, a bottom surface, a left edge, a right edge, an upper edge, and a lower edge,

a plurality of generally rectangular identical parallel slots formed in said bottom surface of said center plate and extending transversely to said first slots in said bottom plate, the first slot being considered to be adjacent to the left edge of said center plate and the last slot being considered to be adjacent to the right edge of said center plate,

first and second flat strip electrodes both disposed in said first rectangular slot but spaced apart from each other with one in operative relation with said second electrode and one in operative relation with said third electrode,

a second narrow flat strip electrode seated in the second of said rectangular slots and extending along the entire length of said second slot and beyond the upper and lower edges of said center plate, said narrow flat strip being narrower than said second slot, said second flat strip electrode being in operative relation with said first and second electrodes,

a plurality of third identical flat strip apertured electrodes seated in all of the others of said rectangular slots and filling said slots, said third flat strip electrodes being in operative relation with only said first electrodes,

a plurality of holes formed in said center plate and arrayed in rows and columns, each column of holes being aligned

with one of said identical flat strip apertured electrodes, with each aperture in said apertured electrodes being generally aligned with one of said holes, each row of holes being generally aligned along one of said slots in said bottom plate, and

a plurality of fourth electrodes aligned with said rows of holes and disposed between said top plate and said center plate.

3. The panel defined in claim 2 wherein said first slots are disposed as a group between said upper and lower edges of said bottom plate, said two of said first slots being positioned one adjacent to said upper edge and the other adjacent to said lower edge of said bottom plate.

4. The panel defined in claim 1 wherein said at least one of said first slots is obstructed by a mass of insulating material deposited therein.

5. The panel defined in claim 1 and including an insulating exhaust tubulation secured to said bottom plate and communicating with the interior of said panel.

6. The panel defined in claim 1 and including an insulating exhaust tubulation secured to said bottom plate and communicating with the interior of said panel at a location between the obstruction therein and the right edge of said bottom plate.

7. The panel defined in claim 1 wherein said top surface of said bottom plate is provided with a cross slot which is parallel to and aligned with said second rectangular slot in said center plate, and said second narrow flat strip electrode is seated in both said cross slot and said second rectangular slot.