

United States Patent

Caras

[15] 3,700,946

[45] Oct. 24, 1972

[54] **GASEOUS DISPLAY PANEL WITH
APERTURED, METALLIC STRIP-LIKE,
SCANNING CATHODES**

[72] Inventor: **Bernard Caras**, Princeton, N.J.

[73] Assignee: **Burroughs Corporation**, Detroit,
Mich.

[22] Filed: **Aug. 20, 1971**

[21] Appl. No.: **173,373**

[52] U.S. Cl.**313/188**, 313/196, 313/217,
313/220

[51] Int. Cl.**H01j 61/08**, H01j 61/30

[58] Field of Search.....313/210, 220, 217, 188, 196;
315/169 TV

[56] **References Cited**

UNITED STATES PATENTS

3,626,245 12/1971 Rosenberg et al. 313/220

Primary Examiner—Palmer C. Demeo

Attorney—Kenneth L. Miller et al.

[57] **ABSTRACT**

A gas-filled display panel includes a top plate, a bottom plate, an apertured center plate, and a plurality of arrays of electrodes associated therewith. The bottom plate is provided with slots for receiving an array of scanning anode electrodes; an array of scanning cathode electrodes is disposed between the bottom plate and the center plate, and an array of display anode electrodes is disposed between the center plate and the top plate. The electrodes and plates are inter-related to provide upper and lower layers of gas-filled cells. The cathode electrodes comprise metal strips which are elongated and have an array of apertures disposed along their lengths, each aperture providing communication between a cell in the lower layer and a cell in the upper layer. The cathode strips are of sufficient thickness to provide strength and rigidity except for a thinner central portion which extends along, and is aligned with, the array of apertures therein whereby the apertures are of minimum depth.

3 Claims, 11 Drawing Figures

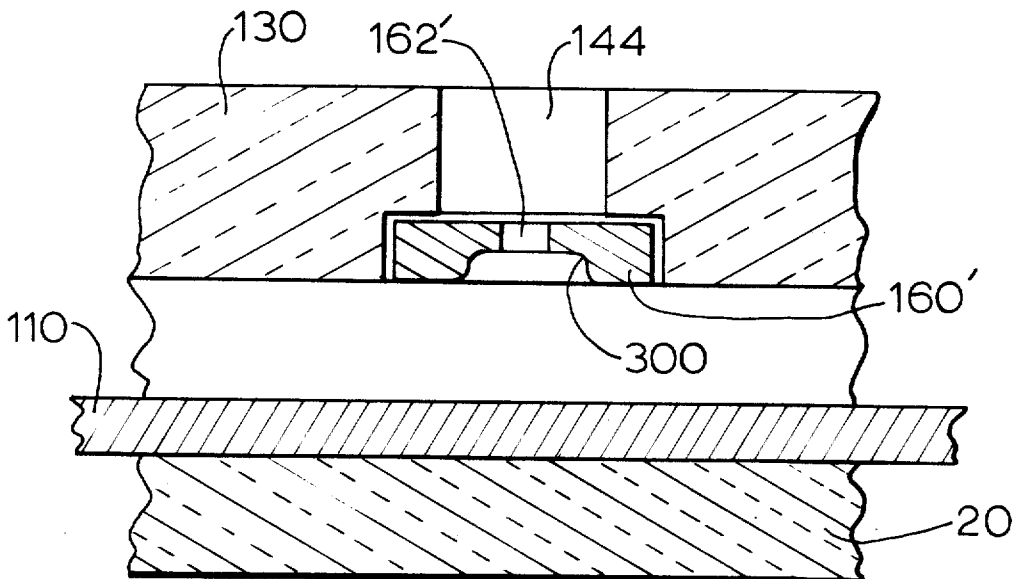
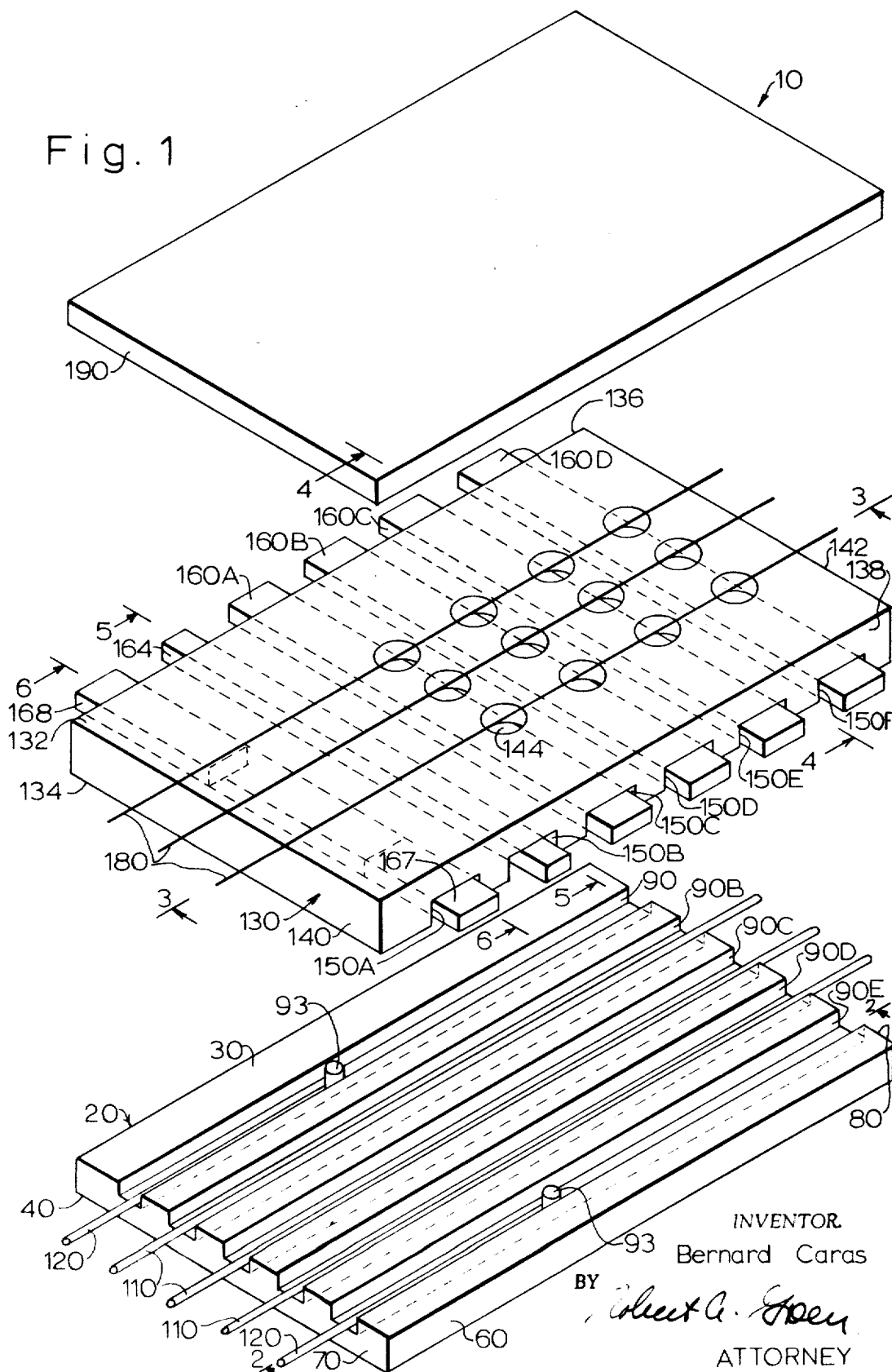


Fig. 1



INVENTOR
Bernard Caras
BY *Robert A. Green*
ATTORNEY

Fig. 2

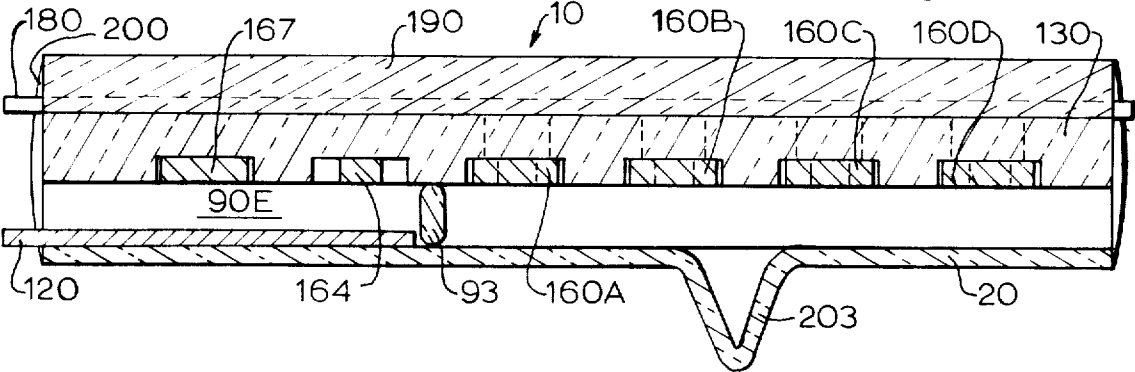


Fig. 3

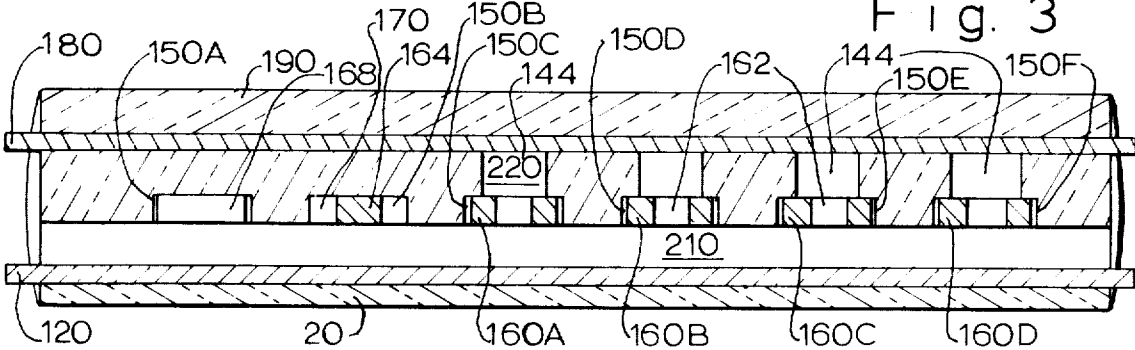


Fig. 4

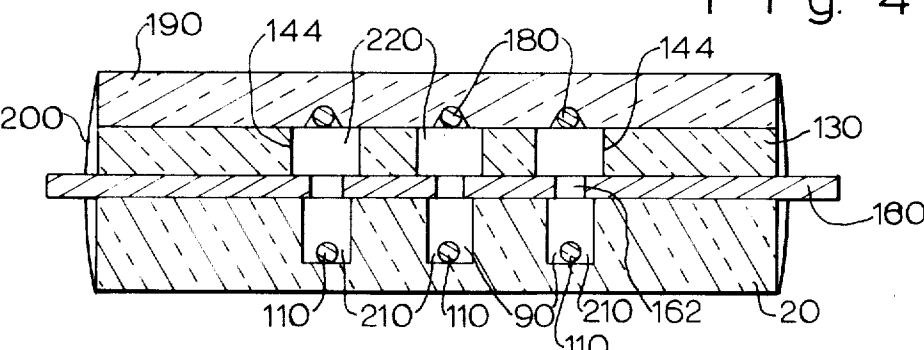
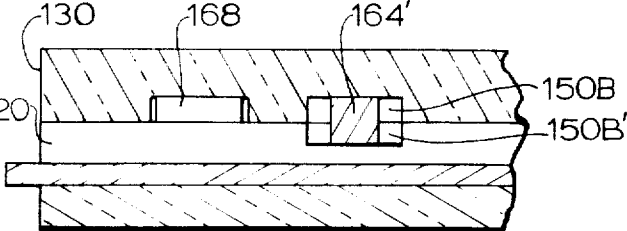


Fig. 3A



INVENTOR
Bernard Caras

Fig. 5

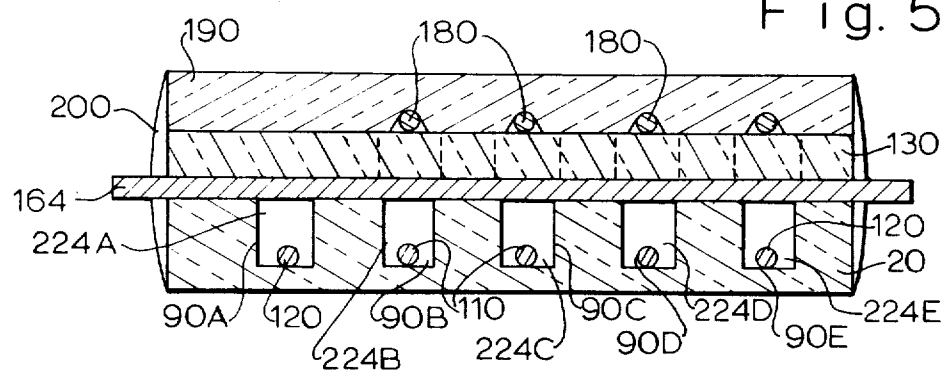


Fig. 6

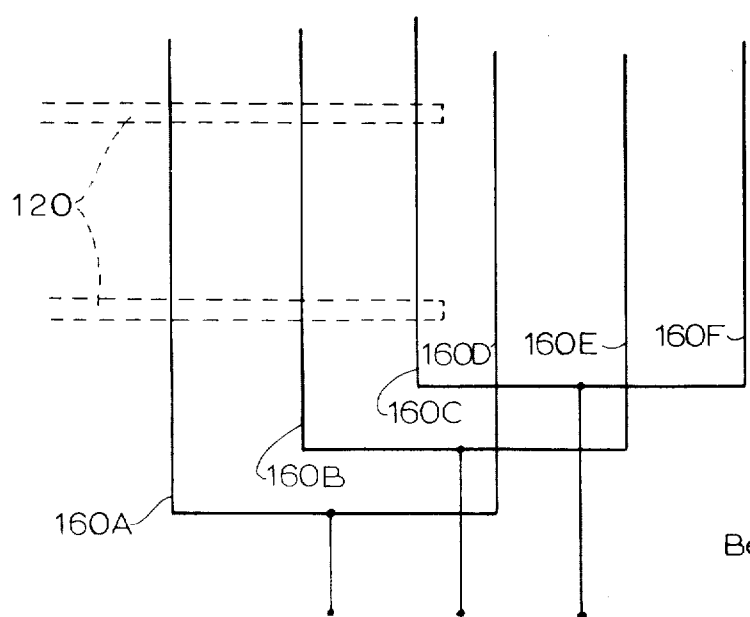
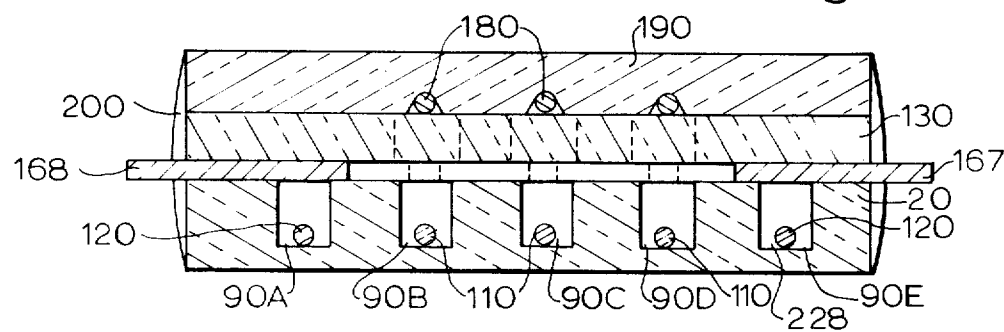


Fig. 7

INVENTOR
Bernard Caras

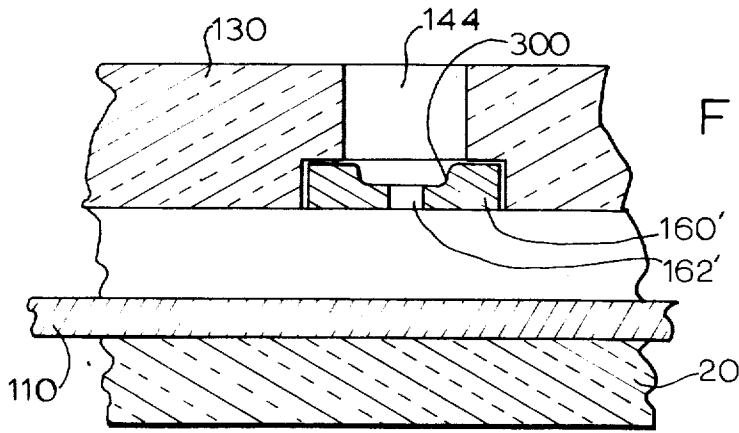


Fig. 9

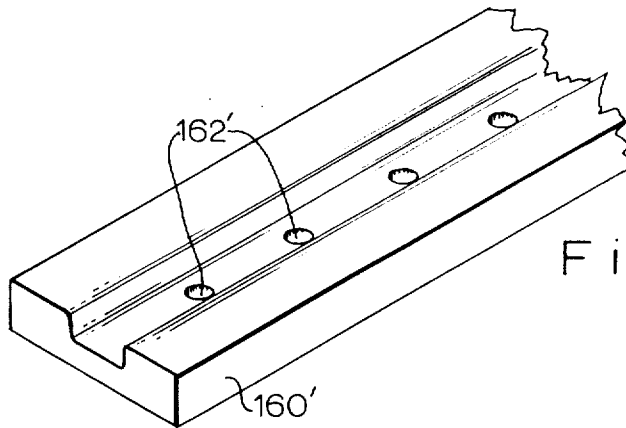


Fig. 8

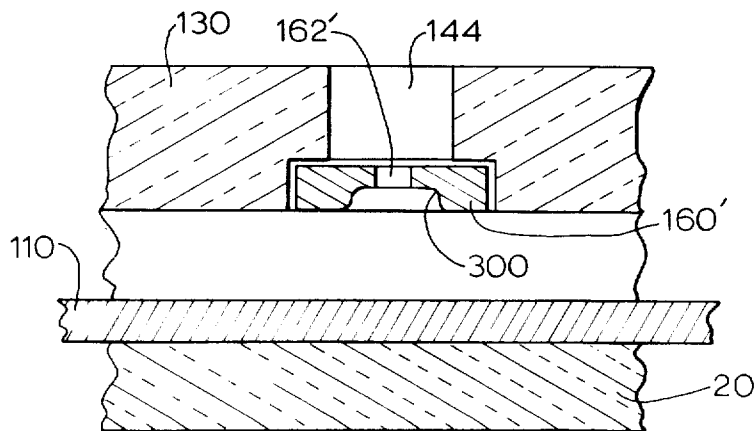


Fig. 10

INVENTOR.
Bernard Caras

GASEOUS DISPLAY PANEL WITH APERTURED, METALLIC STRIP-LIKE, SCANNING CATHODES

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 multi-layer devices have been constructed of several glass plates having various arrays of slots and a plurality of electrodes which perform various functions. Although these display panels have been operated successfully, there is always a need to improve operation, and the present invention provides such improvement, particularly in the cathodes therein.

SUMMARY OF THE INVENTION

Briefly, a display panel embodying 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. In particular, the cathodes comprise metal strips having optimum construction for providing strength while improving glow transfer between scanning cells and display cells.

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;

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;

FIG. 8 is a perspective view of a portion of a modified cathode electrode;

FIG. 9 is a sectional elevational view of a portion of a display panel using the cathode of FIG. 8; and

FIG. 10 is a sectional elevational view of a modification of the apparatus shown in FIG. 9.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The display panel described herein is a thin, flat, sheet-like 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 Pyrocera. 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 posi-

tioned 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 150' 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 insure 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 and 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 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 insure 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 counting 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 2. 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.

According to the invention, the cathodes 160 described above may be modified as cathodes 160' shown in FIG. 8. Cathodes 160' have a certain optimum thickness, as described above, to provide suitable strength and rigidity; however, the central axial portion, along which the apertures 162' extend, is of

reduced thickness to provide a through or depression 300. With this arrangement, it can be seen that the distance through a cathode aperture 162', through which excited particles must diffuse, from a scanning cell 210 to a display cell 220, is considerably reduced. A favorable aperture depth is one mil. It has been found that this structure provides improved and faster diffusion of excited particles from a scanning cell to a display cell, whereby firing of a display cell is facilitated and speeded.

It is to be noted that the cathode 160' may be positioned so that the concavity or trough 300 in each cathode faces the display cell 220 above it and the viewer of the panel, as shown in FIG. 9. With this arrangement, a hollow-cathode effect is achieved, and, when a display cell is fired, greater cell brightness is achieved. If the orientation of the cathode strip is reversed so that the concavity or depression 300 faces downwardly to the scanning cell 210, as shown in FIG. 10, then the glow in each scanning cell is concentrated at the cathode apertures. It is found that this provides improved priming and transfer of glow from a scanning cell to a display cell, at a lower total current than with cathodes 160 which do not have the depression 300.

What is claimed is:

1. A display panel comprising
 - a first insulating plate having a top surface and a bottom surface and a plurality of parallel grooves in said top surface,
 - a first electrode seated near the base of each said groove,
 - a plurality of second parallel electrodes spaced from said first electrodes by said first plate and oriented

at an angle to said first electrodes so that each second electrode crosses a plurality of first electrodes,

each crossing of a first electrode and the second electrode spaced therefrom defining a gas volume which comprises a gas cell,

each second electrode comprising a metal strip having a generally rectangular cross-section except for a depression formed along its longitudinal axis, there being an array of apertures formed along said axis in said depression,

a second plate having top and bottom surfaces and positioned above and in sandwich relation with said first plate and having a plurality of apertures arrayed in rows and columns, each aperture being aligned with a crossing of a second electrode and a first electrode,

third electrodes positioned on the top surface of said second plate, each aligned with a group of said apertures whereby a portion of each third electrode is aligned with a portion of a second electrode and a portion of a first electrode at each aperture, and

a top glass viewing plate covering said third electrodes, said first plate, second plate, and viewing plate being sealed together with an ionizable gas included inside said panel and in said cells.

2. The panel defined in claim 1 wherein said second electrodes are oriented so that said depressions face said first plate.

3. The panel defined in claim 1 wherein said second electrodes are oriented so that said depressions face said second plate.

* * * * *