

[54] DISPLAY PANEL

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Related U.S. Application Data

[63] Continuation of Ser. No. 208,181, Dec. 15, 1971, abandoned, which is a continuation of Ser. No. 855,448, Aug. 18, 1969, abandoned.

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

[51] Int. Cl. H01j 17/04, H05b 37/00

[58] **Field of Search** 313/201, 188, 214, 217,
313/220; 315/168, 169 R, 169 TV

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Primary Examiner—Herman Karl Saalbach

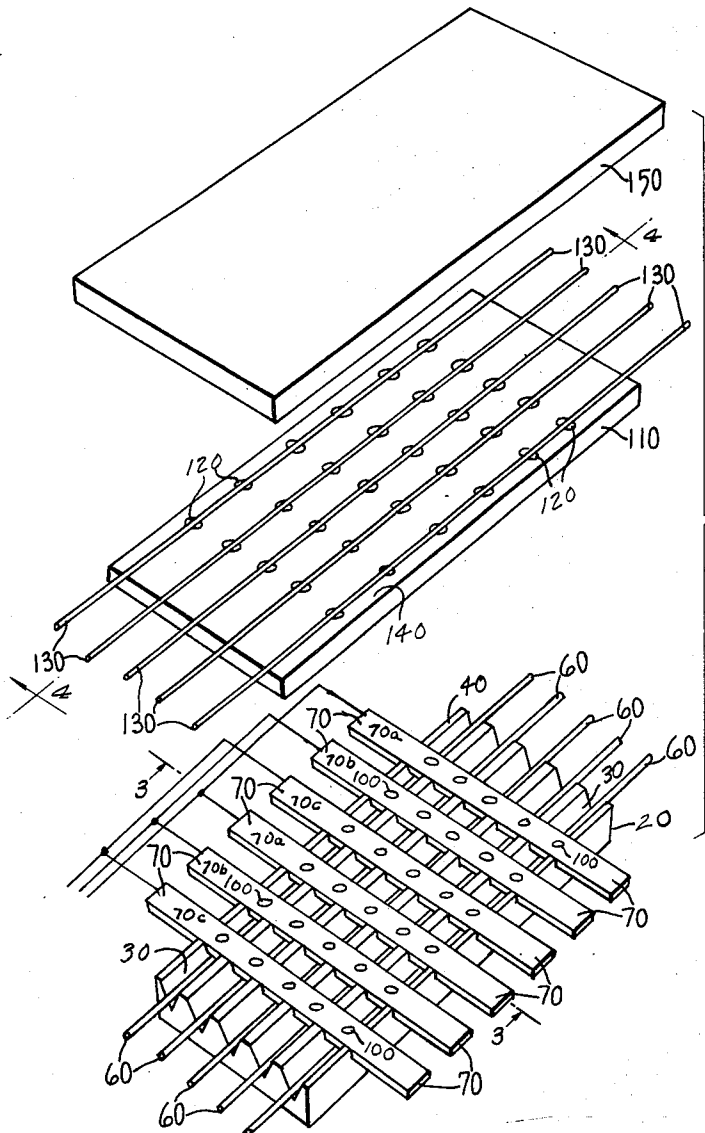
Assistant Examiner—Darwin R. Hostetter

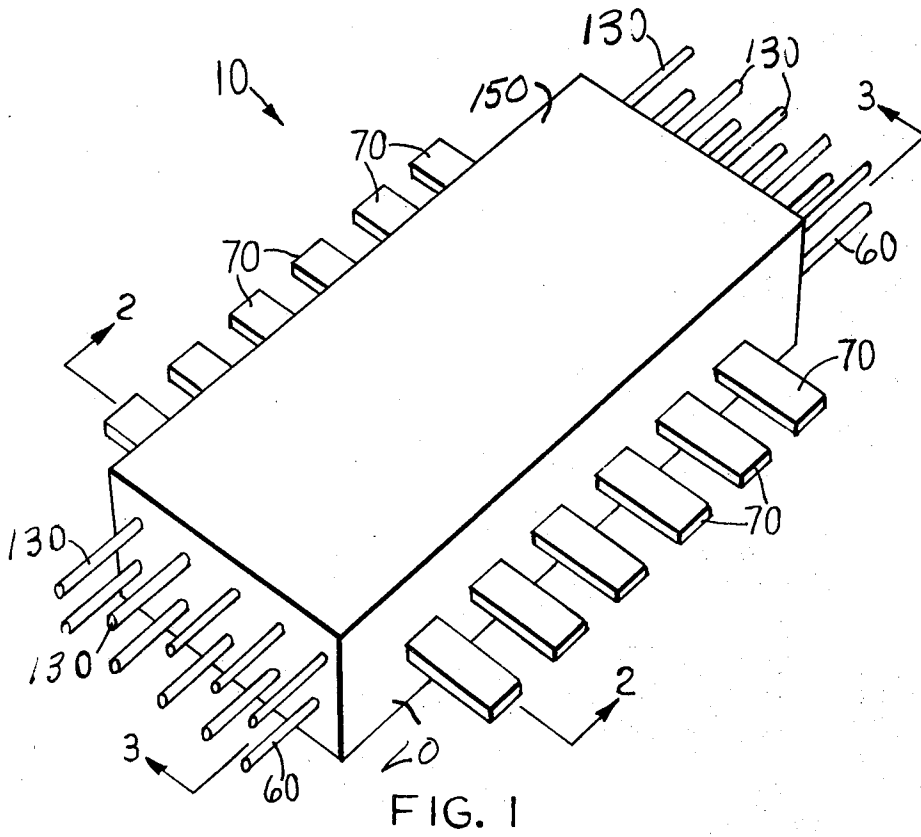
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[57] **ABSTRACT**

The display panel comprises first and second layers of communicating gas-filled display cells. The first layer includes a first plate having grooves, with first electrodes seated in the grooves, and second electrodes supported by the plate so that the first and second electrodes and the gas in the slots between them form a first layer of cells. The second layer includes a second plate having either grooves or apertures seated on the second electrodes, with third electrodes in the grooves of the second plate or on the top surface of the plate where an apertured plate is used, so that the second and third electrodes and the gas-filled space between them comprise the second layer of cells.

20 Claims, 10 Drawing Figures





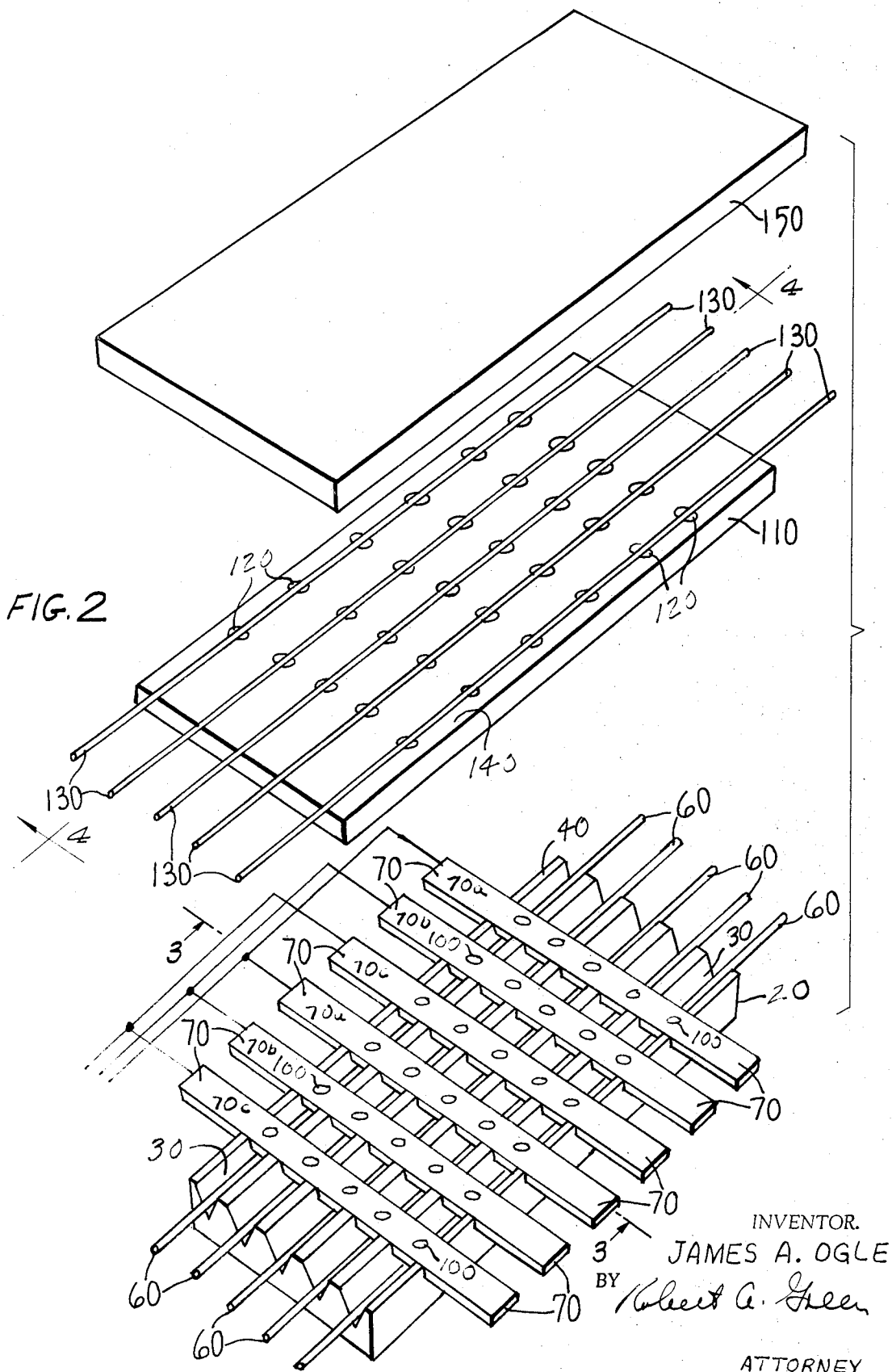
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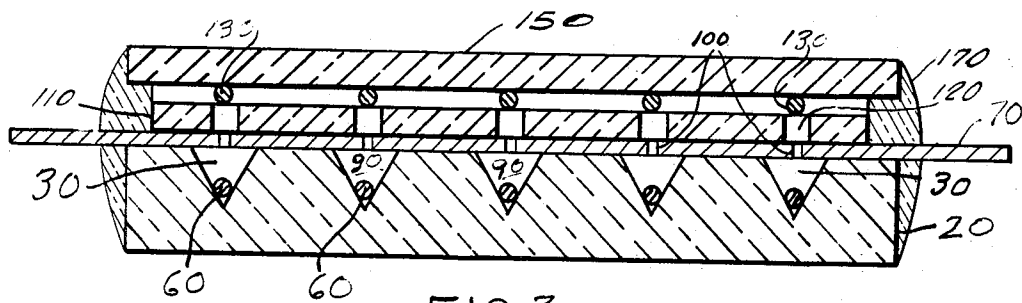


FIG. 3

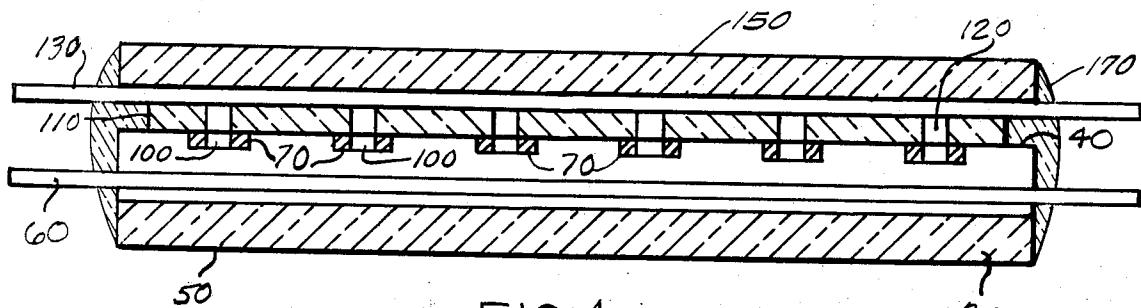


FIG. 4

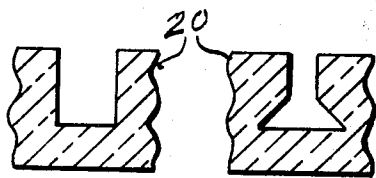


FIG. 5

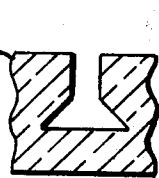


FIG. 6

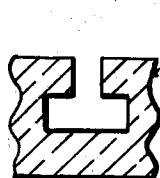


FIG. 7

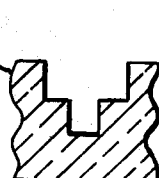


FIG. 8

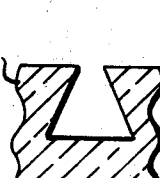
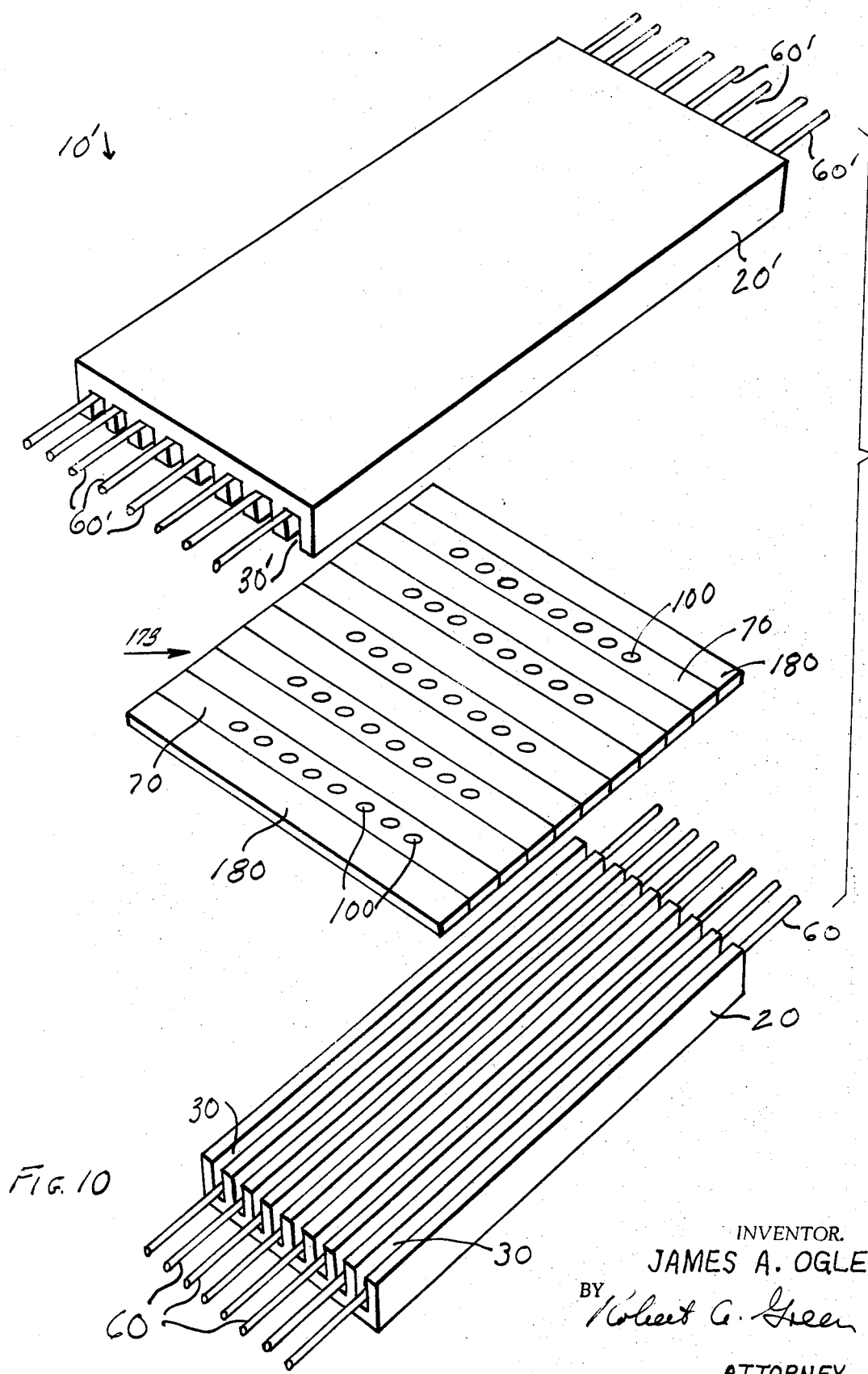


FIG. 9

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DISPLAY PANEL

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a Continuation of U.S. Pat. application Ser. No. 208,181, filed Dec. 15, 1971, now abandoned which in turn is a Continuation of U.S. Pat. application Ser. No. 855,448, filed Aug. 18, 1969, now abandoned.

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 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 or 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 at least four layers of glass or other insulating material with electrodes suitably positioned between them, at least two of the layers containing a matrix of closely spaced apertures which serve as gas cells. Although these devices have been operated successfully, there is a need to provide economies by eliminating component parts, such as one or both of the apertured glass plates.

SUMMARY OF THE INVENTION

Briefly, according to the invention, a multi-layer gasous display device combines either one or two plates containing slots and electrodes placed in such slots, each to carry out functions normally requiring two or more insulating plates, one containing a matrix of closely spaced and precisely located apertures.

DESCRIPTION OF THE DRAWING

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

FIG. 2 is an exploded view of the panel of FIG. 1;

FIG. 3 is a sectional view, taken along lines 3—3 of FIG. 2, but showing the display panel assembled, rather than in exploded view;

FIG. 4 is a sectional view along lines 4—4 of FIG. 2 showing the panel assembled;

FIGS. 5 to 9 show different modifications of a portion of the panel of the invention; and

FIG. 10 is an exploded view of another embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1 to 4, a display panel 10 embodying the invention includes a first insulating plate 20 of glass, ceramic, or the like having a plurality of parallel slots or channels 30 formed therein and extending from the top surface 40 to close to the bottom surface 50 thereof. For purposes of illustrating and describing the invention, the panel is oriented so that the slots extend horizontally. Relatively few slots have been shown, to simplify the drawing, but it should be understood that, in most applications, plate 20 would be considerably wider and many more slots added. The slots may have any suitable cross-section. A V-shaped cross-section is

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shown in FIGS. 1 to 4; however, any other suitable cross-section may be employed. For example, a rectangular or square cross-section is shown in FIG. 5, and in FIGS. 6 and 7, the slot has a narrow upper portion and an enlarged lower portion. In FIG. 8, the slot has a wide upper portion and a narrower lower portion, and in FIG. 9, the slot has a generally inverted V shape.

First electrodes 60 are seated at the bases of the slots, and, since the slots are parallel, so are the electrodes. Electrodes 60 may be wires, flat strips, or they may have any suitable shape, and the shape of the slot modified accordingly. These electrodes might also be plated or evaporated or otherwise formed in the slots. The electrodes 60 might also be secured by a cement such as a glass frit or the like at the ends of slots 30 or at any other suitable location.

The panel also includes second electrodes 70 seated on the top surface 40 of the first plate 20. The second electrodes 70 are also parallel to each other, and they are oriented generally perpendicular to the first electrodes 60, although they can be skewed. The electrodes 70 may also be flat strips or wires or the like, and they may also be seated in slots 80 formed in the top surface 40 of the plate 20, or in similar slots in the bottom surface of the second insulating plate 110 which is disposed above them, or partially in slots of each such plate. The region at which each second electrode 70 crosses a first electrode 60 defines a gas cell 90, and each electrode 70 has an aperture 100 at this region if it is a flat strip, or it is suitably shaped or offset or the like, so that communication can take place from electrode 60 through electrode 70 to other elements disposed above the electrodes 70 (to be described).

A second insulating plate 110 having a plurality of apertures or cells 120 arrayed in rows and columns is seated on the top surface of the electrodes 70 with each aperture or cell aligned with an aperture 100 and with a cell 90 which is defined by a crossing of a second electrode 70 and first electrode 60. Each aperture 120 thus comprises a cell which is vertically aligned with a cell 90 formed by the first and second electrodes and the portions of the slot 30 between them. The plate 110 may be of glass, ceramic, or the like.

The groupings of cells 90 in the lower plate 20 along the slots 30 will be referred to as rows of slots, and those in line with electrodes 70 as columns. Also, this same reference will apply to the slots in the upper plate 110.

Third electrodes 130 are seated on the upper surface 140 of the apertured plate 110, and they are preferably embedded either in slots in plate 110 or in slots in a transparent cover plate or viewing plate 150 which is seated on plate 110. The electrodes 130 are oriented parallel to and are aligned with the first electrodes 60, and each is aligned with a row of apertures 120 in the plate 110. The electrodes 130 may also be flat strips or wires or the like, and they are either apertured or otherwise suitably shaped, so that a viewer looking through top plate 150 will see the glow discharges which occur in cells 120.

In panel 10, the electrodes 60, 70, and 130 may be secured in place by means of a suitable cement such as a glass frit (not shown). They might also be held in place by a mechanical tight fit in slots or grooves in the plates. In addition, in the completed device, the plates 20, 110, and 150 are sealed together at their edges by means of a glass frit or the like 170 shown in FIGS. 3

and 4. For convenience in making this seal, top plate 150 and bottom plate 20 are usually made somewhat larger than center plate 110, as shown in FIGS. 3 and 4.

Panel 10 also includes an ionizable gas such as argon, neon, or the like, and preferably a Penning mixture of such gases, and including a small quantity of mercury, all at a suitable pressure for the intended purpose. The gas may be introduced by means of a tubulation (not shown) suitably secured to the panel, or it may be introduced in any other suitable manner.

The operation of multi-cell display panels such as panel 10, in which slots 30 operate as gas communication paths between adjacent cells, is described in detail in a co-pending U.S. Pat. application of Ogle and Holz, Ser. No. 850,984, filed Aug. 18, 1969 now abandoned as a continuation of U.S. Pat. Ser. No. 828,793, filed May 28, 1969, now abandoned, and reference is made to that application for a complete discussion of the operation. Briefly, in the operation of the device, electrodes 60 and 130 preferably serve as anodes and electrodes 70 as cathodes. Also, every third cathode 70 is electrically connected together, as shown in FIG. 2, so as to form three electrode sets 70a, 70b, and 70c, and each of the electrode sets is connected to a driving source (not shown). The lower cells 90 are scanned column-by-column by the sequential energization of the three cathode sets 70, and glow is produced in each column of cells 90 in turn. This sequential energization is repeated until the entire panel 10 has been scanned, and then continued so that the panel is scanned repetitively.

Since plate 20 is slotted, gaseous communication is provided between the adjacent columns of cells. As a consequence, when one column is glowing, it serves to prime the two adjacent columns. For example, when a column 70c is glowing, it primes the preceding and succeeding 70b and 70a columns. Therefore, when the next scanning pulse is applied to the 70a columns, even though it is applied simultaneously to all of the 70a cathodes, it will produce a glow discharge only in the 70a column which has been primed by the adjacent last-glowing 70c column. It is the presence of this selective priming which permits the cells in plate 20 to be scanned column-by-column using only three driving sources.

Simultaneously with the scanning, and synchronously with the scanning rate, information signals are applied to the anode electrodes 130, and, where ON signals are present, glow is transferred upwardly into cells 120, at an intensity determined by the level of the ON signals, to display a visible message. As each column of cells is scanned in turn, and information signals are applied, a stationary but changeable display is distributed to the columns of cells 120 and is visible through the top plate. The glow present in the lower cells 90, however, is not visible through the top plate, so that the internal scanning operation characteristic of the panel does not interfere with the display.

Turning to FIG. 10, a panel 10' is illustrated in which slotted plates 20 and 20' are employed on both sides of the central electrodes 70, plate 20' effectively replacing the apertured plate 110 and top plate 150 in the embodiment of FIGS. 1 to 4. The slots shown in FIG. 10 are rectangular, but it is understood that any of the disclosed shapes may be employed.

As in the embodiment of FIGS. 1 to 4, the regions located above the respective electrodes 60 and directly below electrodes 70 serve as individual gaseous cells. Similarly, in this embodiment, the regions below the respective electrodes 60' and directly above electrodes 70 serve as individual gaseous cells, and these latter cells are aligned with the cells in plate 20 to form a two-layer panel of the type discussed in connection with FIGS. 1 to 4.

In the operation of the panel of FIG. 10, as in the operation of the panel of FIGS. 1 to 4, electrodes 60 and 60' are employed as anodes, electrodes 70 as cathodes, and every third cathode 70 is electrically connected to form three cathode sets 70a, 70b, and 70c. Also, these three cathode sets are driven sequentially and repetitively by three driving sources (not shown), as already discussed.

When one of the cathode sets is energized, such as set 70b, in scanning the lower layer of the panel, and information signals are applied to the upper anodes 60', a glow discharge will be present in only one of the lower columns 70b, and hence the information ON signals can only draw up the glow above this column. In this manner, successive groupings of signal information are selectively distributed to the successive columns of cells in the upper panel 20', as already discussed, to produce a stationary but changeable display.

To achieve this operation, however, it is essential that each column in lower plate 20 communicate only with a single column of the upper plate 20', namely, the column directly aligned with it. This is achieved in the embodiment of FIGS. 1 to 4 by means of the confined gas cells formed by apertures 120 in the upper plate 110, which apertures are directly aligned with the apertures in the cathodes 70 and the open lower cells 90. However, with the open slot construction in the upper plate 20' of FIG. 10, as well as in the lower plate 20, to achieve only single column coupling between the cells of upper and lower plates, the cathodes 70 are formed as part of a solid sheet 170 having alternate regions of strip cathodes and intermediate insulation 180.

Sheet 170 can be formed by molding the cathode strips 70 in glass or similar material, and then deoxidizing the strips and etching or machining the apertures. Alternatively, this can be formed by printing conductive strips on a sheet of Fotoceram or Fotoform or the like, and then etching the apertures through both the strips and supporting sheet. Preferably, the strips are printed in registry on both sides of the sheet and the two sides interconnected electrically.

One advantage of the embodiment of FIG. 10, aside from its simplicity, is that the problem of registry with upper and lower apertures is eliminated. Also, skewed columns can be formed for achieving desired character shaping or the like simply by skewing the cathode electrodes, without making any changes in the upper and lower plates. Further, the skewed columns can alternatively be formed in a herringbone shape or any other line pattern, if this should be desired.

It will be apparent to one skilled in the art that various modifications may be made in the specific features shown within the scope of the invention.

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 ex-

tending from said top surface toward said bottom 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 a second electrode spaced therefrom defining a gas volume which comprises a gas cell,

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 said 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 first electrodes and said third electrodes are elongated and are oriented generally in the same directions, said second electrodes being elongated and oriented perpendicular to said first and third electrodes.

3. The panel defined in claim 1 wherein said first and third electrodes are elongated wires and said second electrodes are elongated flat strips.

4. The panel defined in claim 1 wherein said first and third electrodes are elongated wires and said second electrodes are elongated flat strips which have apertures at each region where a second electrode crosses a first electrode.

5. The panel defined in claim 1 wherein said first electrodes are seated in said grooves and said second electrodes are seated on the top surface of said first plate.

6. The panel defined in claim 1 wherein said grooves have a generally V-shaped cross-section.

7. The panel defined in claim 1 wherein said grooves have a generally rectangular cross-section.

8. The panel defined in claim 1 wherein said grooves have a generally inverted V-shaped cross-section.

9. A display panel comprising

a first insulating plate having a top surface and a bottom surface and a plurality of first relatively deep parallel grooves,

a first electrode seated near the base of each said groove,

a plurality of second parallel electrodes seated near the top of each said groove 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 a second electrode spaced therefrom defining a gas volume which comprises a first gas cell,

a top plate having top and bottom surfaces and positioned above in sandwich relation with said first plate and having a plurality of second relatively

deep parallel grooves extending from the bottom toward the top surface thereof, said second grooves being vertically aligned and parallel with said first grooves, and

third electrodes positioned in said second grooves in said top plate and oriented at an angle to said second electrodes, each crossing of a third electrode and a second electrode including a volume of gas between them defining a second gas cell, each second gas cell being vertically aligned with a first gas cell.

10. The panel defined in claim 1 wherein each second electrode includes an aperture which is positioned between each said gas cell and the associated aperture in said second plate.

11. A display panel comprising

a first insulating plate having top and bottom surfaces and a plurality of parallel grooves extending downwardly from the top surface,

a plurality of elongated first electrodes each seated in one of said grooves,

a second insulating plate having top and bottom surfaces and having a plurality of parallel grooves extending upwardly from said bottom surface and facing the grooves in the first insulating plate, the grooves in the second insulating plate being substantially parallel and aligned with the grooves in the first insulating plate,

a plurality of second elongated electrodes each seated in one of the grooves of said second insulating plate,

a gaseous atmosphere in the region between said first and second electrodes at a pressure capable of sustaining a cathode glow discharge,

a plurality of third elongated electrodes located intermediate said first and second electrodes and spaced from and crossing each of said first and second electrodes at an angle so that the space between each third electrode and each first electrode defines a first gaseous discharge cell and the space between each third electrode and each second electrode defines a second gaseous discharge cell, said third electrodes being shaped to provide communication between each first gaseous discharge cell and a second gaseous discharge cell, and means for isolating said first and second plurality of electrodes except in the regions where such electrodes cross the third plurality of electrodes.

12. A display panel as in claim 11 wherein the means for isolating the first and second plurality of electrodes constitutes a sheet which is apertured in the region where such electrodes cross the third plurality of electrodes.

13. A display panel as in claim 12 wherein said apertured sheet supports said plurality of third electrodes.

14. A display panel as in claim 12 wherein said apertured sheet is a composite of said third plurality of electrodes and insulating material spaced intermediate successive ones of such electrodes, and wherein each of said third plurality of electrodes is apertured in the regions where it crosses said first and second plurality of electrodes.

15. A display panel as in claim 12 wherein said apertured sheet is a composite of an apertured insulating sheet with said third plurality of electrodes formed as

printed conductive strips on at least one of its surfaces.

16. The display panel defined in claim 1 wherein at least a portion of each groove in said insulating plate, in which a first electrode is seated, has a generally V-shaped cross-section. 5

17. A display panel comprising

a first insulating plate having a top surface and a bottom surface and a plurality of parallel grooves extending from said top surface toward said bottom surface, 10

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, 15

each crossing of a first electrode and a second electrode spaced therefrom defining a gas volume which comprises a gas cell, 20

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, 25

third electrodes positioned adjacent to 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 said aperture, and 30

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.

18. A display panel comprising

a gas-filled envelope including

a first insulating plate having a top surface and a bottom surface and a plurality of parallel grooves extending from said top surface toward said bottom 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, 35

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

an array of second gas cells disposed adjacent to said second electrodes with each second gas cell aligned with and communicating with a first gas cell.

19. The panel defined in claim 18 and including a third electrode in operative relation with each said second cell. 40

20. The panel defined in claim 18 wherein said first gas cells are arrayed in rows and columns, and said second gas cells are arrayed in rows and columns, and including a plurality of third electrodes, each disposed parallel to a first electrode and aligned with a row of said second cells. 45

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