

[54] **DISPLAY PANEL**

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[51] Int. Cl. **H05b 37/00**

[58] Field of Search **315/169 R, 169 TV; 313/109.5**

[56]

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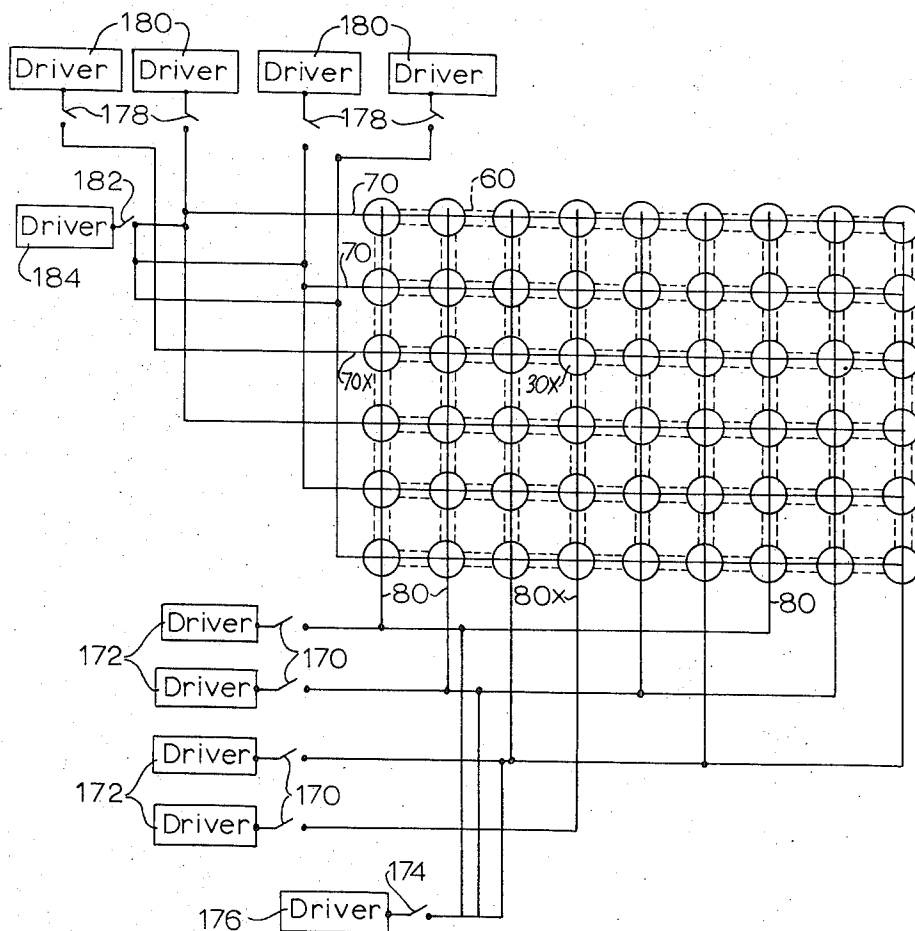
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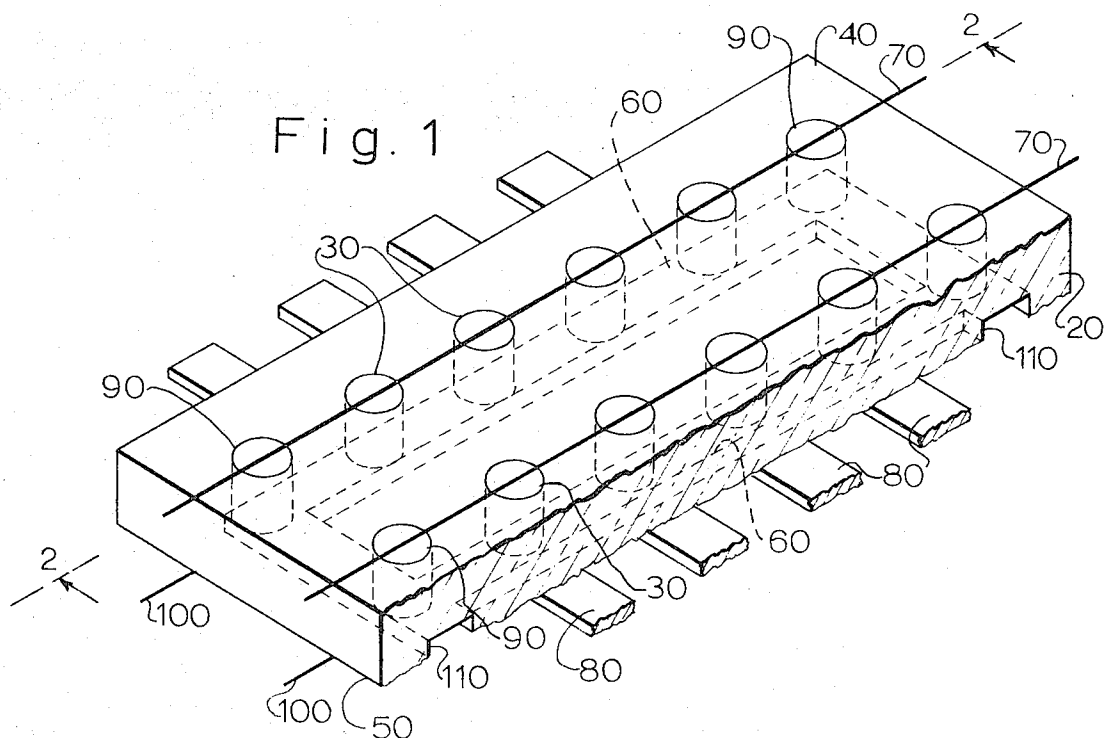
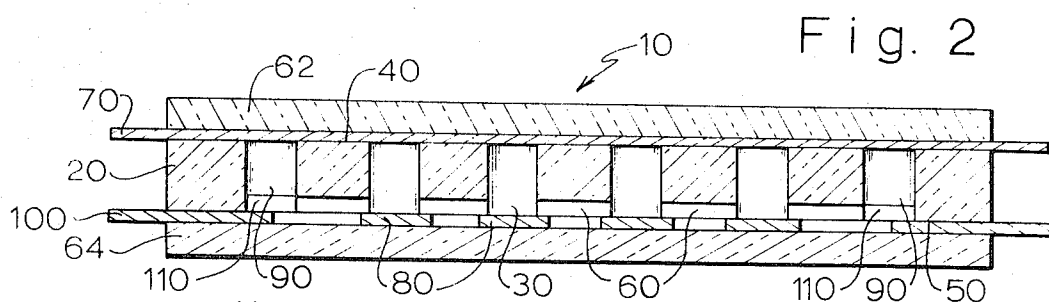
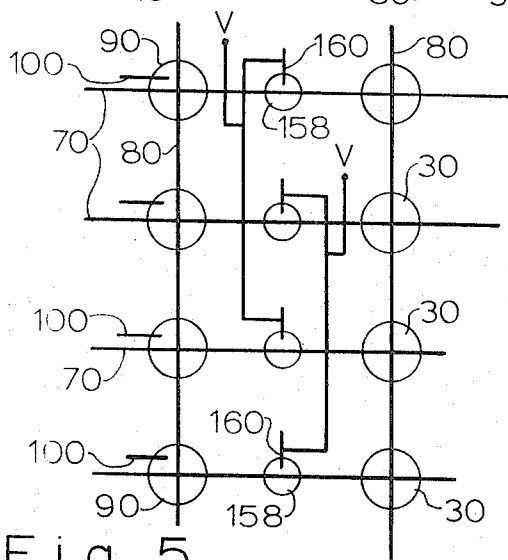
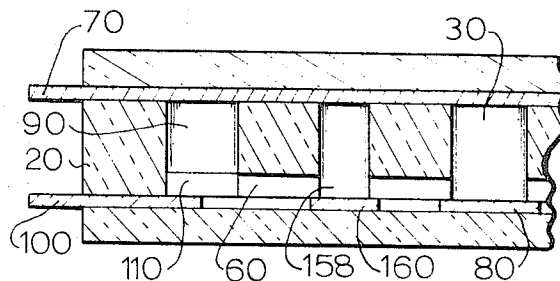
[57]

ABSTRACT

A display panel includes a plurality of rows and columns of display cells, each having an anode and a cathode and including a novel drive arrangement for selecting and energizing one cell at a time.

10 Claims, 12 Drawing Figures





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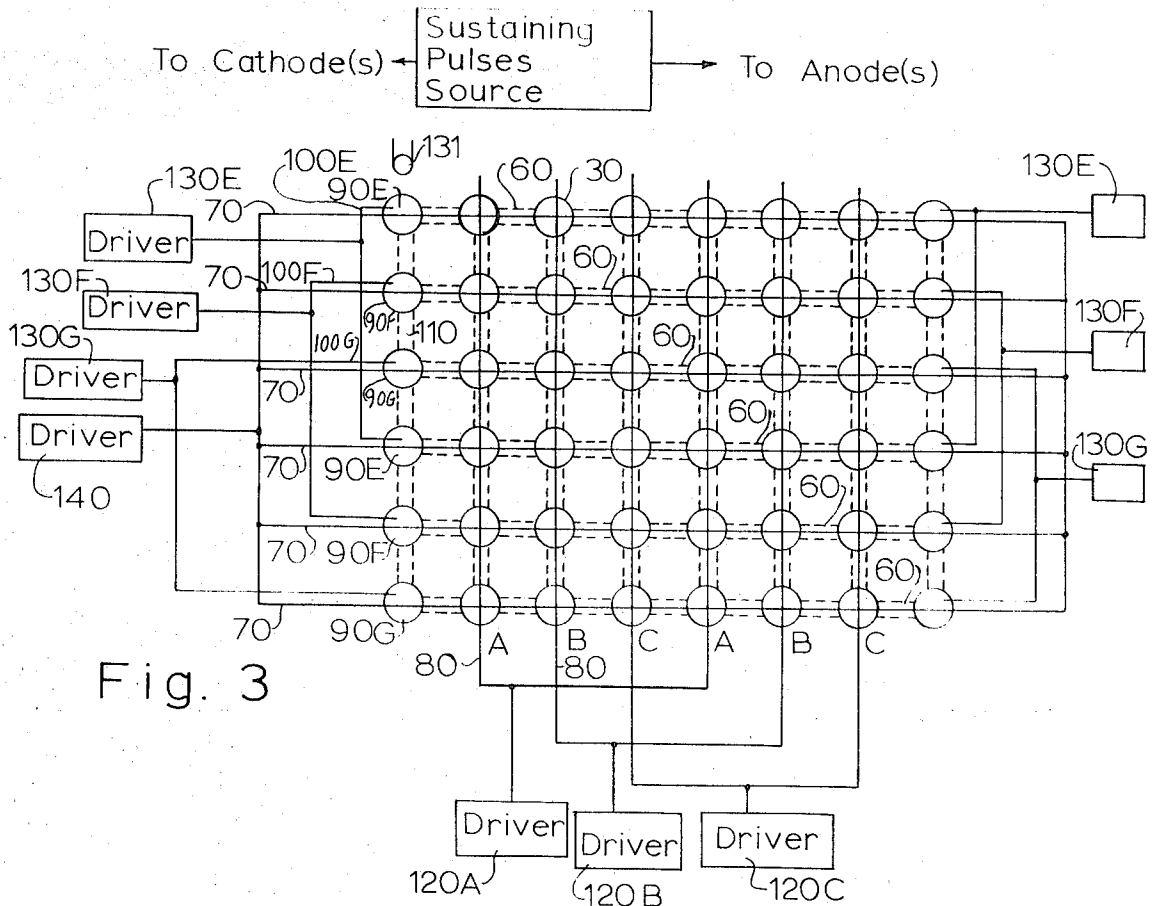


Fig. 3

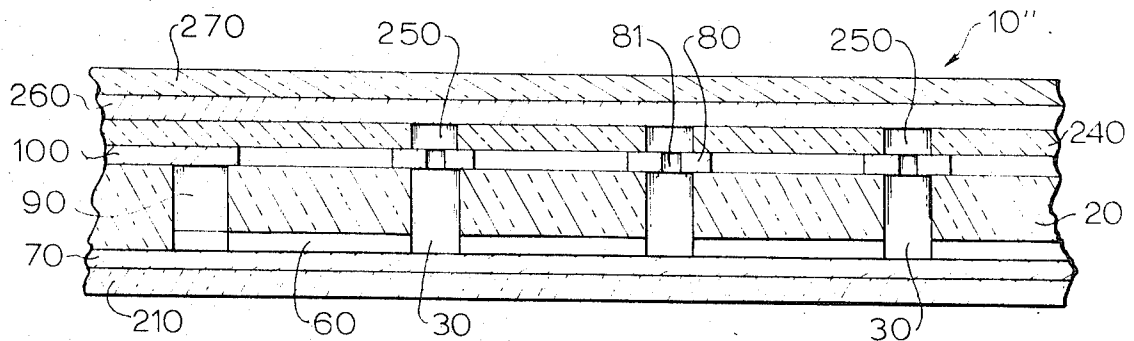
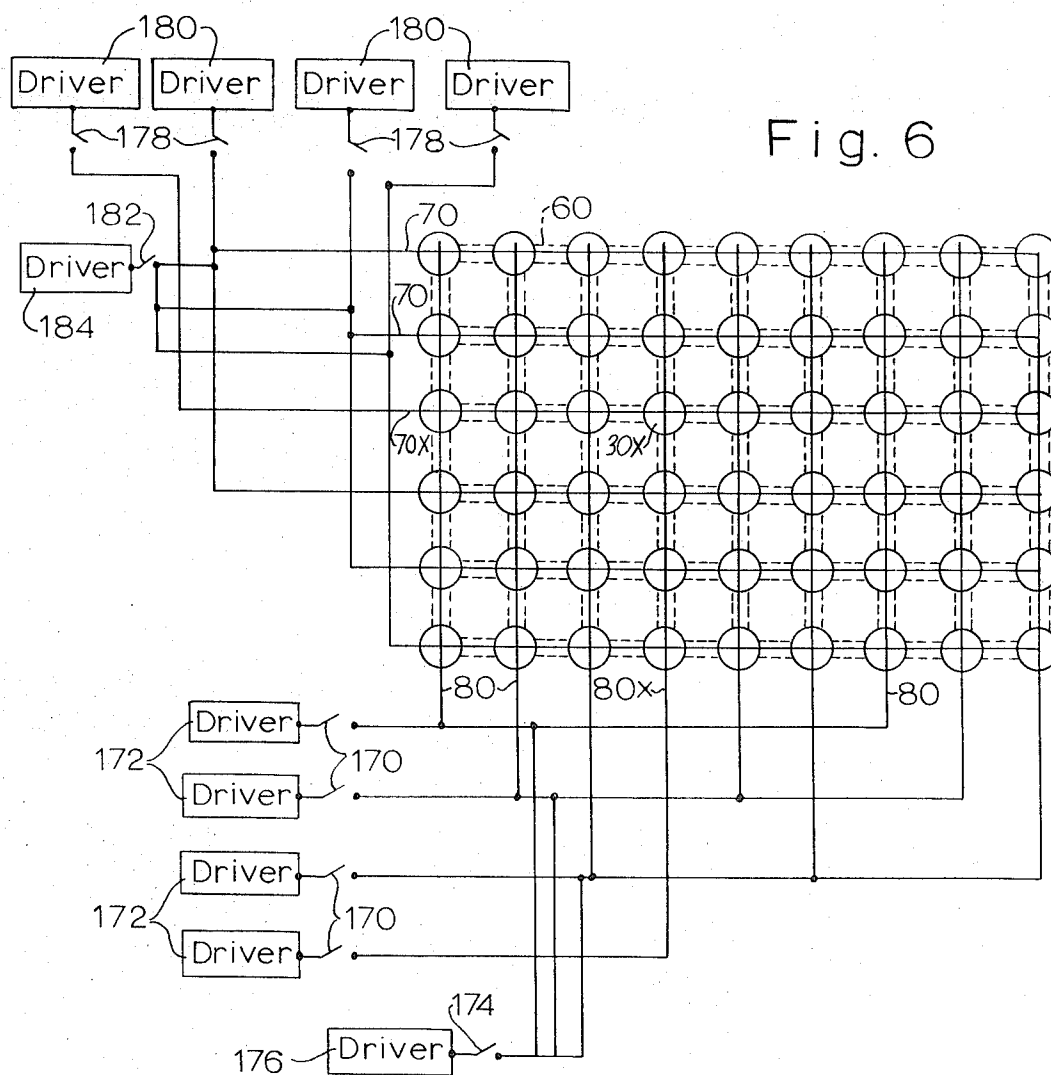
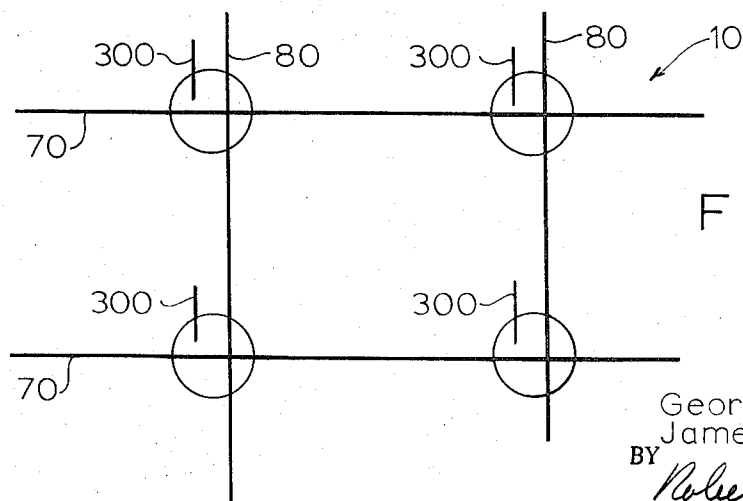


Fig. 7

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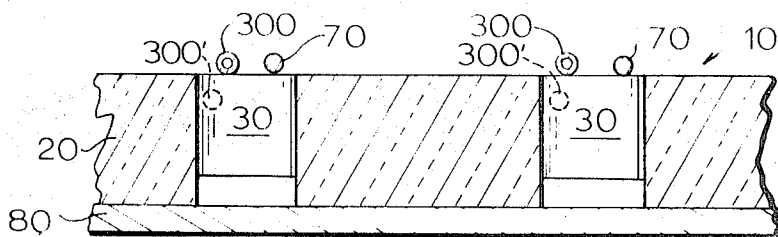


Fig. 9

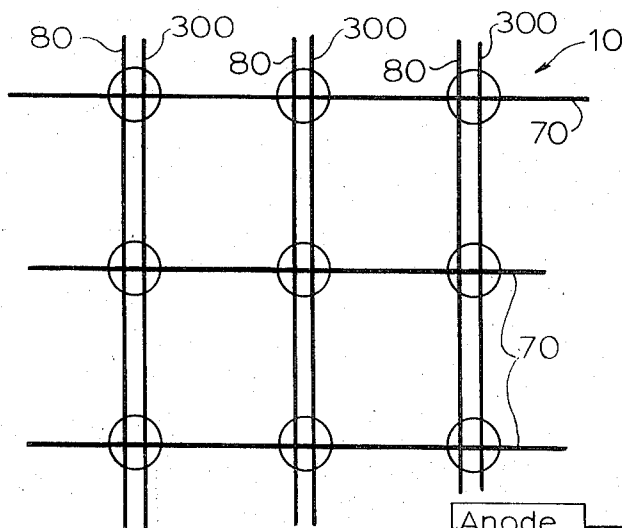


Fig. 10

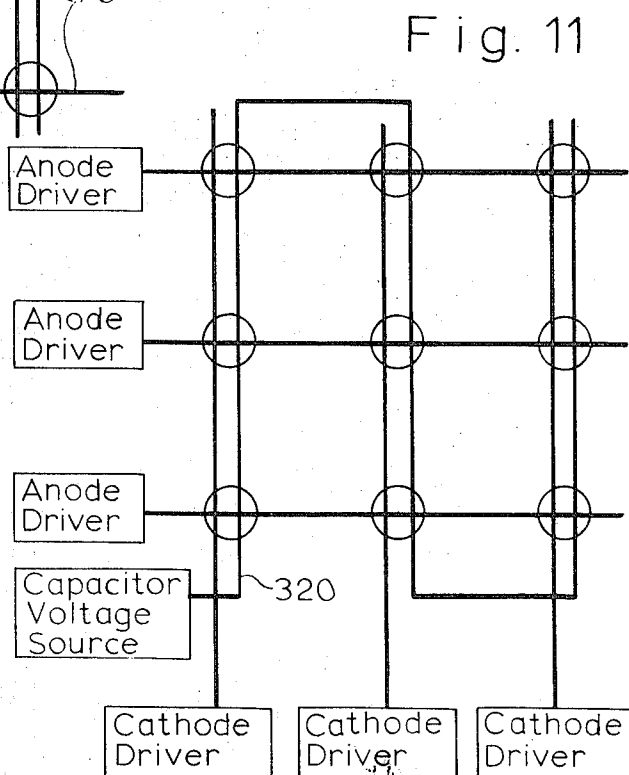
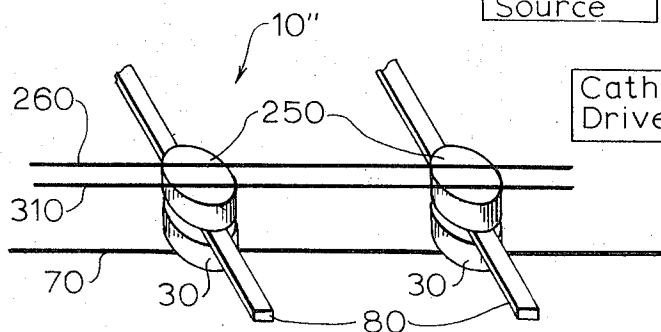


Fig. 11

Fig. 12



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DISPLAY PANEL

This is a continuation of application Ser. No. 881,660 filed Dec. 3, 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. In a recent development, Holz and Ogle have described a display panel and novel electrode connections therein which permit economies in driving circuitry. The present invention utilizes this teaching and expands upon it to provide a novel system for selecting and energizing one cell at a time in a multi-cell display panel.

SUMMARY OF THE INVENTION

Briefly, according to the invention, a display panel having a plurality of rows and columns of gas-filled display cells is provided with a cell and electrode arrangement which drives rows and columns in a novel manner to permit single cells to be readily selected and fired.

DESCRIPTION OF THE DRAWING

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

FIG. 2 is a sectional view, taken along lines 2—2 in FIG. 1;

FIG. 3 is a schematic representation of the display panel of the invention and a circuit in which it may be operated;

FIG. 4 is a sectional elevational view of a portion of a panel showing a modification of the invention;

FIG. 5 is a schematic representation of a plan view of the panel of FIG. 4;

FIG. 6 is a schematic representation of a modified display panel and circuit for its operation;

FIG. 7 is a sectional elevational view of another panel structure embodying the invention;

FIG. 8 is a schematic representation of a portion of a display panel illustrating a modification of the invention;

FIG. 9 is a sectional view of the panel represented in FIG. 8;

FIG. 10 is a schematic representation of another modification of the invention;

FIG. 11 is a schematic representation of still another modification of the invention; and

FIG. 12 is a schematic representation of another modification of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

It is to be understood that the display panel described herein may have substantially any desired size and shape, and it may include substantially any number of display cells.

Referring to FIGS. 1 to 3, one form of display panel 10 embodying the invention includes an insulating center plate 20 of glass, ceramic, or the like having a plurality of display cells 30 arrayed in rows and columns which extend through the plate from the top surface 40 to the bottom surface 50 thereof. Horizontal slots or channels 60 are formed in plate 20 at any convenient depth and extending from each cell in a column to the next adjacent cell in the adjacent column. The slots 60 thus form a continuous channel along each row of cells.

Top and bottom glass plates 62 and 64 (not shown in FIG. 1) cover the center plate and are suitably sealed thereto along their edges. The slots 60 are preferably positioned close to the cathodes 80.

Cathode electrodes 80 in the form of wires, flat strips, films, or the like, preferably strips, are positioned between the center plate 20 and the bottom plate 64, and each is aligned with a column of cells. Anode electrodes 70 in the form of wires or flat strips, preferably wires, are positioned between the top plate 62 and center plate 20, and each is aligned with a row of cells.

According to the invention, panel 10 is provided with an auxiliary column of cells 90 formed in plate 20 and located ahead of the first column of display cells 30 at the left end of the panel, as seen in FIG. 1. Each cell 90 is aligned with a row of cells 30, and each cell 90 has its own cathode electrode 100 disposed between the top plate and the center plate, and the cathodes 100 operate with the anodes 70 which extend along the cell 90. The cells 90 communicate with each other by means of vertical holes or slots 110 formed in plate 20, like slots 60. In addition, each cell 90 communicates with the adjacent cell 30 formed by means of a slot 60. A similar column of cells 90 including cathodes 100 and slots 60 and 110 are provided at the right end of panel 10 adjacent to and communicating with the last column of display cells 30.

Panel 10 includes a suitable ionizable gas such as neon, argon, xenon, or the like, alone or in combination.

Panel 10 and a circuit embodying the invention are shown schematically in FIG. 3. In order to operate panel 10 to select and fire any one cell 30, according to the invention, the cathode electrodes 80 (A,B,C, etc.) associated with the display cells 30 are connected in groups, with cathodes 80A, 80B, and 80C being in separate groups. Each group of cathodes is connected to a driver circuit 120 (A,B,C) for applying a generally negative or ground potential thereto. Similarly, cathodes 100 (E,F,G, etc.) associated with auxiliary cells 90 are connected in groups with cathodes E, F, and G in separate groups and with each group connected to its own driver circuit 30 (E,F,G). All of the anodes 70 are connected together to a common terminal which is connected to a single driver 140, preferably a current source.

With the circuit shown in FIG. 3, a single cell 30 can be selected and fired by a method which, in general terms, comprises first scanning the column of cells 90 to select a desired row of cells and then scanning along the selected row of cells to select and energize one cell in that selected row. With the anode driver 140 energized to apply a suitable positive potential to all anode electrodes 70, the first cathode driver 130E is turned on to apply operating potential to the cathodes 100 connected thereto. The first or uppermost cell 90E in the column of cells 90 is turned on preferentially over the other cells 90E by any suitable means, for example, by means of a small "keep alive" or starter cell 130 located adjacent thereto. Such a keep-alive cell includes its own anode and cathode (not shown), and it is energized when needed to assist in firing cell 90E.

When the top cell 90E fires, excited particles generated thereby, particularly metastable states, diffuse and flow through the slot 110 to the next adjacent cell 90F. Next, the first driver 130E is switched off and raises the

potential of its cathode 100, and the second driver 130F is operated to lower the potential of the second cathode 100 of adjacent cell 90F. Now, the second cell 90F in the first column fires, with the firing being facilitated by the presence of thP excited particles from the previously fired first cell 90E. Even though another remote cathode 100F is connected to the second driver 130F, it does not receive excited particles, and it does not have sufficient anode-to-cathode potential to fire. This switching operation is repeated again by raising the potential of the second cathode 100G and operating the third driver 130G to lower the potential of the third cathode 100 to turn on the third cell 90G. This operation of scanning the column of cells 90 is continued until the row is reached in which the single desired display cell 30 is to be turned on.

Assuming that the selected row is the third row down, when the third cell 90G in the first column of auxiliary cells 90 has fired, the vertical scanning operation is discontinued, and the same scanning operation is carried out in a horizontal direction through the selected row of cells 30 and using the cathodes 80 and their drivers 120. Since only one cell 90 is ON at this time, at the beginning of the next scanning operation, as the cathodes 80 are switched sequentially, just as the cathodes 100 were switched above, only the row of cells 30 aligned therewith can turn on. As above, the cathodes 80 and the cells 30 are scanned until the desired cell is reached and turned on and held on.

As described above with respect to the scanning of cells 90, each cell 30 in the selected row is turned on, in turn, with the aid of excited particles which flow from one ON cell 30 to the adjacent cell in the row through slot 60.

The foregoing procedure can be used to select and fire other display cells 30 in any row, and, if the procedure is carried out at a sufficiently high rate, a stationary but changeable message or character made up of the selected cells may be displayed to a viewer through top plate 62.

Alternatively, once a cell has been turned on, the firing potential can be removed, but glow can be sustained by applying sustaining pulses between the cell's anode and cathode. The sustaining pulses have an amplitude, time duration, and frequency which permit them to re-fire a cell, after firing potential has been removed, by utilizing ionization generated by metastable atoms. The sustaining pulses can have an amplitude which is smaller than the normal firing potential of the cell, and the pulses are tailored to re-fire the cell at a sufficient rate to make the glow appear to be continuous to a viewer. By properly interleaving the above-described scanning operation to fire new cells and applying sustaining pulses, different groups of cells can be turned on as desired. A source of sustaining pulses is shown schematically in FIG. 3. This mode of operating gas cells by means of sustaining pulses is described and claimed in copending application Ser. No. 780,099, filed Nov. 12, 1968.

In the mode of operation described above, the scanning operation can be performed as described to select a row of cells, scan across the row of cells to the right-hand end of the panel and then use the right-hand cells 90 to move up or down to select another row of cells which is scanned to the left. When the scanning operation has reached the left-hand end of the panel, it can

be moved up or down to select another row of cells for scanning.

It is clear also that TV-type scanning can be carried out by scanning across the top row of cells to the right, then moving down to the next lower row of cells, scanning to the left along the second row, moving down to the third row, scanning to the right along the third row, etc.

Under some circumstances, after a cell 90 has been selected and it is desired to energize the adjacent first display cell 30 in the selected row due to the diffusion of excited particles in both directions in slots 110 from the selected cell 90, a cell 30 in the row either above or below the desired cell might be fired. This problem can be eliminated, as shown schematically in a portion of a panel in FIGS. 4 and 5, by providing an auxiliary cell 158 in each row of cells between each cell 90 and the adjacent first (or last) display cell 30. Each auxiliary cell includes an aperture in plate 20 aligned with an anode 70 and a cathode electrode 160 positioned preferably on the bottom surface of plate 20 and in operative relation with the associated anode 70. Cells 158 are not shown at the right-hand end of the panels in FIGS. 4 and 5. Preferably, cathodes 160 are connected in groups with every other cathode connected together and to a voltage source V. This simplifies the associated electronic circuitry.

In operation, the auxiliary cell 158 immediately adjacent to the selected cell 90 is turned on when it is desired to scan to the right along a row of cells. The other auxiliary cathode electrodes 160 and their cells 158 are held OFF during this selection operation. This insures that scanning will take place directly from cell 90 along the proper row of cells. Of course, separate anodes other than anodes 70 might be provided to operate with cathodes 160 in cells 158, if desired. The provision of cells 158 is a matter of choice and may not be required.

In a modification of the invention illustrated schematically in FIG. 6, a panel 10' includes display cells 30 connected horizontally and vertically by slots 60. The panel includes row electrodes 70 and column electrodes 80, as described above. However, in this case, each set of electrodes can be either anodes or cathodes, and the sets are used as anodes or cathodes, depending on the desired scanning operation. The panel also includes a single column electrode 80X aligned with approximately the center column of cells 30 and a single row electrode 70X aligned with approximately the center row of cells 30, the two single electrodes being used to start the scanning operation at a cell 30X at about the center of the panel where they intersect. The other electrodes 70 and 80 are connected in groups and to drivers, as described above.

When electrodes 80 are used as cathodes, they are connected through suitable switch means 170 to cathode drivers 172. The electrodes 80 are connected to the drivers 172 in groups, as shown, to permit scanning from cell 30X left or right as desired. In addition, when the electrodes are used as anodes, they are connected together, as shown, through switch means 174 to an anode driver 176 which is preferably a current source.

Electrodes 70 are similarly connected in groups, as shown, through switch means 178 to cathode drivers 180 when they are to be operated as cathodes. Electrodes 80 are also connected together, as shown, through switch means 182 to an anode driver 184, a

current source, when they are to be operated as anodes.

In one mode of operation, the single electrodes 70X and 80X are energized to fire the cell 30X at their intersection. Now, with column electrodes 80 connected together and driven as anodes by drivers 176 and with the row electrodes 70 driven in groups as cathodes by drivers 180, glow can be moved up and down the column of cells which includes the starting cell 30X. Then, at any point along this column, if the roles of the electrodes are reversed and the electrodes 70 are connected together and operated as anodes by driver 184 and the electrodes 80 are driven in groups as cathodes by driver 172, glow can be moved to the left or right along the selected row of cells.

The principles of the invention are also applicable to the type of two-layer panel described and claimed in copending application Ser. No. 828,793, filed May 28, 1969. This type of panel includes a first layer of cells having a configuration similar to that of panel 10, and an identical second layer of cells is formed on the first layer, with each cell in the first layer communicating directly with a cell in the second layer. The first layer of cells is adapted to be scanned, as described above, with glow being transferable from any lower cell to the associated upper cell.

Referring to FIG. 7, a panel 10'' includes any of the panels described above as the lower layer of cells except that the bottom electrodes 70 are operated as anodes, and the electrodes 80 are operated as cathodes and are preferably in the form of strips having apertures 81 associated with each cell 30. Panel 10'' includes a second insulating plate 240 identical to the first plate 20 and having an identical number and array of cells 250 positioned over the first plate 20, positioned so that the cells 250 are vertically aligned with the cells 30 and the cathode electrodes are aligned with the columns of cells 250. A plurality of anode electrodes 260, each aligned with a row of cells 250, are placed on the top surface of the second plate, and a glass cover plate 270 completes the assembly.

In operation of panel 10'', the lower cells 30 are scanned and selected by any of the circuits and methods described above. When a selected cell 30 has been reached and it is desired to display this information to a viewer, a positive potential is applied to the upper anode 260 associated with the cell 250 positioned over the selected cell 30, and this upper cell is fired and glow appears therein visible to a viewer through the top viewing plate 260. The firing of the upper cell 250 is facilitated by the flow of excited particles, particularly metastable states, through the associated aperture 81 in the cathode 80 associated with the selected cell 30. Again, if scanning and the firing of cells 30 and 250 are carried out at a sufficiently high rate, a stationary but changeable message can be displayed by cells 250 to a viewer.

Again, in this embodiment of the invention as in any of the above, properly shaped sustaining pulses can be applied to display cells 250 in the upper layer to sustain their glow after they have been fired as described.

The versatility of the invention can be enhanced by the provision of a third electrode in each cell. Such an electrode is preferably provided and used as a capacitor and may comprise a wire coated with an insulating material. Such a third capacitor electrode may be provided as a separate wire 300 associated with each cell

30, as illustrated schematically in connection with a portion of panel 10 in FIG. 8, and it may be oriented at any desired angle. Each capacitor wire 300 may be located on the top surface of plate 20, like electrode 80, or it may be positioned at a suitable location between the top and bottom surfaces, as indicated by the dash line representation of electrode 300' (FIG. 9). Each capacitor wire 300 extends out of the panel to provide a separate accessible external terminal.

If desired, a single capacitor wire 310 may be associated with each row or column of cells, as illustrated schematically in FIG. 10, or adjacent ends of wires 310 may be connected together to form a single continuous wire 320 which extends throughout the entire panel and has only one or both ends accessible as an external terminal (FIG. 11). Although the capacitor wire 320 is continuous, and wire 310 is associated with more than one cell, the portion in each cell can be operated as an isolated entity.

The auxiliary capacitor electrodes 300, 310, or 320 can also be provided, in any of the forms described above, in operative relation with the cells 250 in the panel 10'' of FIG. 7, as shown in a portion of panel 10'' in FIG. 12.

The capacitor electrodes 300, 310, or 320 can be used in a number of ways by setting potentials thereon. A potential can be set on or across each capacitor element by applying a potential to the external terminal thereof at the time the cell is fired. Each cell can be set at a different potential, or groups can be set at the same potential. Subsequently, these cells can be re-fired by applying potentials to the external terminal of the capacitor such that the potential between the internal capacitor wire and either the anode or cathode exceeds the firing potential of the cell. The various anode, cathode, and capacitor drivers are illustrated schematically in FIG. 11.

It is to be understood that the designation used above of "rows" and "columns" is merely illustrative and parts so designated can be interchanged to achieve the same operation as described. Changes may also be made in the apparatus shown and described within the scope of the invention, as those skilled in the art will appreciate. For example, various ionizable gases and mixtures may be used, the relative sizes of parts may be modified, and the positions of anodes and cathodes may be reversed in the various single layer panels described.

A method and system for interconnecting electrodes to scan along rows or columns, as set forth above, is described and claimed in copending application Ser. No. 850,984, filed Aug. 18, 1969.

What is claimed is:

1. A display panel and system comprising a gas-filled envelope including an insulating plate containing a plurality of first gas-filled cells arrayed in rows and columns, there being a first column, a last column and intermediate columns of said first cells, gas communication channels formed in said plate and extending from cell to cell along each row of cells and from cell to cell along each column of cells, whereby when any one cell is turned ON, it generates excited particles which diffuse through said channels to the adjacent cells, a first column of auxiliary cells adjacent to said first column of first cells, with each cell thereof aligned

with a row of first cells and connected by a gas communication channel with the adjacent first cell in its row, the cells of said first column of auxiliary cells also being interconnected by gas communication channels,

a second column of auxiliary cells adjacent to said last column of first cells, with each cell thereof aligned with a row of first cells and connected by a gas communication channel with the adjacent first cell in its row, said second column of auxiliary cells also being interconnected by gas communication channels,

a first cathode electrode aligned with and in operative relation with each column of first cells,

an anode electrode aligned with and in operative relation with each row of first cells and the associated auxiliary cells,

said anode electrodes all being connected to a source of operating potential,

said first cathode electrodes being connected in a plurality of first groups with every two electrodes of one group being separated by one electrode of each of the other groups, each first group being connected to a first driver for applying operating potential thereto,

a second cathode electrode associated with each first auxiliary electrode, said second cathode electrodes being connected in a plurality of groups with every two electrodes of one group being separated by an electrode of the other groups, each group being connected to a second driver for applying operating potential thereto,

a third cathode electrode associated with each second auxiliary electrode, said third cathode electrodes being connected in a plurality of groups with every two electrodes of one group being separated by an electrode of the other groups, each group being connected to a third driver for applying operating potential thereto,

said electrodes being operable such that, when anode potential is applied to all of said first electrodes, each of said second drivers is operated in turn to transfer glow from one first auxiliary cell to the next adjacent auxiliary cell in said column of first auxiliary cells with the aid of excited particles which diffuse through said gas communication channels connecting said first auxiliary cells, operation of said second drivers being discontinued when a selected row of first cells is reached whereupon operation of each of said first drivers in turn causes glow to transfer from the associated first auxiliary cell to each of said first cells in said row in order, with the aid of excited particles which diffuse through said gas communication channels connecting said first cells in said selected row.

2. The panel and system defined in claim 1 wherein each cell includes an auxiliary electrode in contact with the gas therein in addition to its anode and cathode, said auxiliary electrode comprising a conductor having an insulating coating which can assume a charge when the gas in a cell is ionized.

3. The panel and system defined in claim 2 wherein each said auxiliary electrode includes an end portion accessible outside said panel whereby an electrical potential can be applied thereto.

4. The panel defined in claim 1 and including a separate auxiliary electrode which extends along each row

of cells in said panel and is disposed in the gas in each cell and comprises a conductive member coated with a layer of insulating material which can assume an electrical charge when the gas in a cell is ionized.

5. The panel defined in claim 4 wherein the auxiliary electrodes associated with adjacent rows of cells are connected together to form a single continuous insulating conductor which extends from one cell to the next throughout the entire panel.

6. The panel and system defined in claim 4 and including a second array of second gas-filled cells disposed adjacent to said cells of said first array, each cell of said second array being aligned with and in communication with one of the cells of said first array, each second cell including an anode electrode, a cathode electrode, and an auxiliary electrode disposed within the gas in the second cell, the auxiliary electrode comprising a conductor having an insulating coating which can assume an electrical charge when the gas in a cell is ionized, each first cell being adapted to transfer glow to the associated adjacent second cell by the application of potentials to a second cell when its associated first cell is glowing.

7. The panel and system defined in claim 6 and including a source of sustaining pulses coupled between and adapted to apply sustaining pulses between selected ones of said anodes and cathodes of said second cells which are glowing to sustain glow therein.

8. A display panel and system comprising a gas-filled envelope including an insulating plate containing a plurality of first gas-filled cells arrayed in rows and columns, there being a first column, a last column and intermediate columns of said first cells,

gas communication channels formed in said plate and extending from cell to cell along each row of cells and from cell to cell along each column of cells, whereby when any one cell is turned ON, it generates excited particles which diffuse through said channels to the adjacent cells,

a first column of auxiliary cells adjacent to said first column of first cells, with each cell thereof aligned with a row of first cells and connected by a gas communication channel with the adjacent first cell in its row, the cells of said first column of auxiliary cells also being interconnected by gas communication channels,

a first cathode electrode aligned with and in operative relation with each column of first cells,

an anode electrode aligned with and in operative relation with each row of first cells and the associated auxiliary cell,

said anode electrodes all being connected to a source of operating potential,

said first cathode electrodes being connected in a plurality of first groups with every two electrodes of one group being separated by one electrode of each of the other groups, each first group being connected to a first driver for applying operating potential thereto,

a second cathode electrode associated with each first auxiliary electrode, said second cathode electrodes being connected in a plurality of groups with every two electrodes of one group being separated by an electrode of the other groups, each group being connected to a second driver for applying operating potential thereto,

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a third cathode electrode associated with each second auxiliary electrode, said third cathode electrodes being connected in a plurality of groups with every two electrodes of one group being separated by an electrode of the other groups, each group being connected to a third driver for applying operating potential thereto, said electrodes being operable such that, when anode potential is applied to all of said first electrodes, each of said second drivers is operated in turn to transfer glow from one first auxiliary cell to the next adjacent auxiliary cell in said column of first auxiliary cells with the aid of excited particles which diffuse through said gas communication channels connecting said first auxiliary cells, operation of said second drivers being discontinued when a selected row of first cells is reached whereupon operation of each of said first drivers in turn causes glow to transfer from the associated first auxiliary cell to each of said first cells in said row in order, with the aid of excited particles which dif-

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fuse through said gas communication channels connecting said first cells in said selected row.

9. The panel and system defined in claim 8 and including gate means disposed between each second cell and the first display cell in the associated group of display cells, each said gate means being operable to prevent or permit the movement of glow from a second cell to the adjacent associated display cell.

10. The panel and system defined in claim 8 and including gate means disposed between each second cell and the first display cell in the associated group of display cells,

each said gate means being operable to prevent or permit the movement of glow from a second cell to the adjacent associated display cell,

each gate means comprising an auxiliary gas-filled cell having its own anode and cathode and adapted to be fired when it is desired to permit said movement of glow and held off when it is desired to prevent said movement of glow.

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