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Tsui et al.

[11] **3,790,841**

[45] **Feb. 5, 1974**

[54] **GAS DISCHARGE DISPLAY FIELD FOR MULTICOLOR DISPLAY**

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[73] Assignee: **International Business Machines Corporation,** New York, N.Y.

[22] Filed: **Jan. 15, 1973**

[21] Appl. No.: **323,585**

[52] U.S. Cl. ..... **313/108 B,** 313/188, 313/220

[51] **Int. Cl.** **H01j 1/62**

[58] **Field of Search**..... 313/108 A, 108 B, 188, 220

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Assistant Examiner—Darwin R. Hostetter
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[57] **ABSTRACT**

A gas discharge display/storage apparatus in which a multicolor display is achieved by a combination of a modified plasma display apparatus and associated cell driving configuration. The apparatus includes two display panels in a sandwich arrangement having one common drive line, the drive system comprising a three-coordinate nonorthogonal selections system, each of the coordinates being displaced by 120°. The individual cells may be arranged in various configurations, each cell having a phosphor representative of one of three basic colors, red, blue and green, whereby coincident selection of selected cells provide the multicolor display.

10 Claims, 7 Drawing Figures

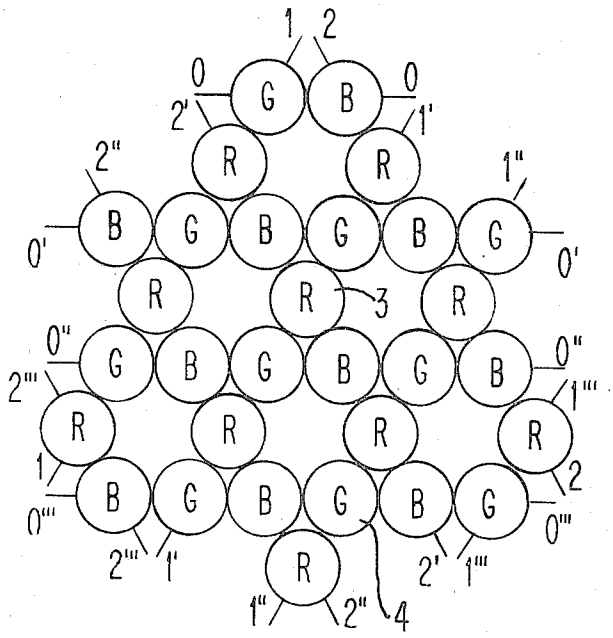


FIG. 1

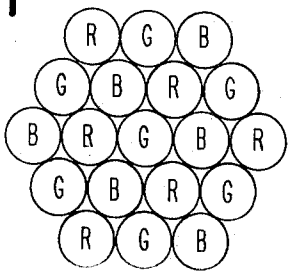


FIG. 2

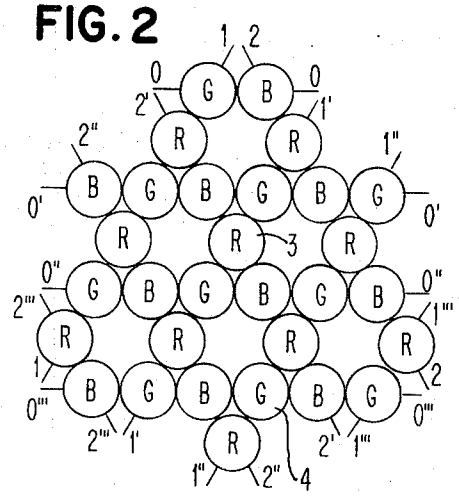


FIG. 3

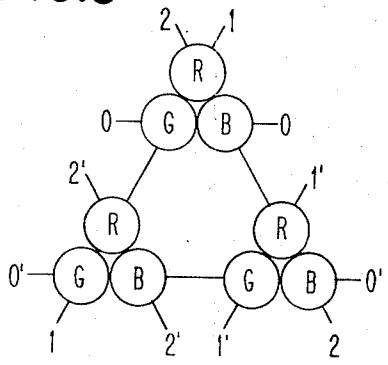


FIG. 4

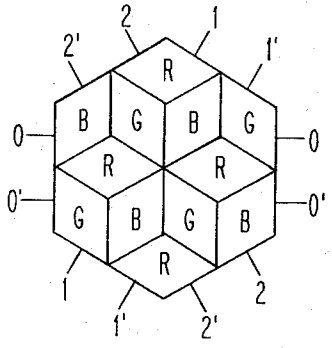


FIG. 5

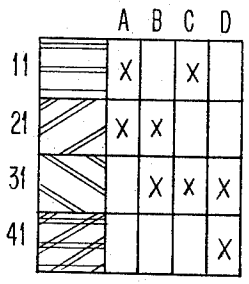


FIG. 6

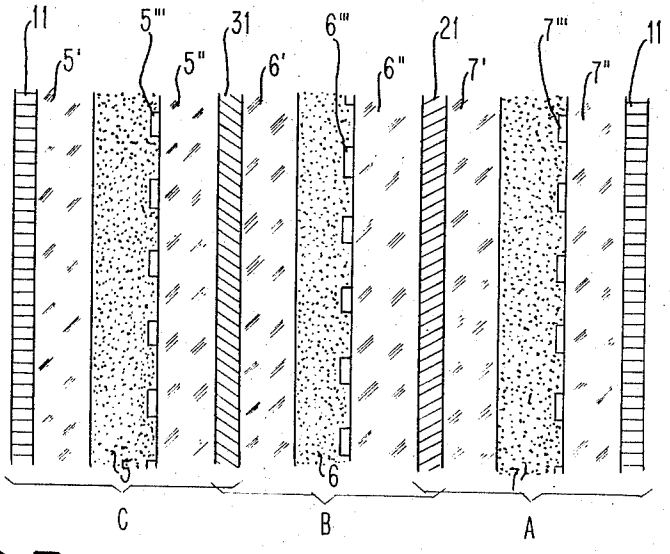
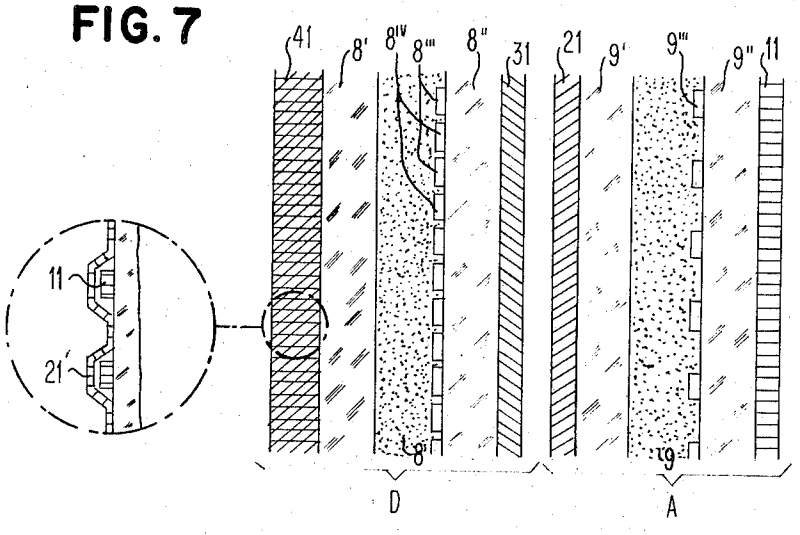


FIG. 7



GAS DISCHARGE DISPLAY FIELD FOR MULTICOLOR DISPLAY

CROSS-REFERENCE TO RELATED APPLICATIONS

Application Ser. No. 214,348 filed Dec. 30, 1971 by P. H. Haberland et al. for "Gas Panel Fabrication."

Application Ser. No. 268,219 filed June 23, 1972 by T. N. Criscimagna et al. for "Method and Apparatus for Gas Display Panel."

BAKCGROUND OF THE INVENTION

The invention relates to a gas discharge display field or device for multicolor information display by means of selective combinations of the three basic colors, red, blue and green, utilizing suitably modified gas discharge display devices, each device comprising a flat gas-filled discharge panel made to emit light by ionization of selected cells and whose opposite sides, limiting the discharge path, include a plurality of parallel electric conductors suitably insulated from the gas by a glass dielectric whereby the conductors of the the two plates forming a conductor pair are oriented in different directions, the crossings or intersections of the conductors defining discharge cells or sites. Gas discharge display/storage devices of this kind are used to display information, such as characters, numbers, graphical representations, etc., and may have utility in computer input/output units. In contrast with color television receivers, the known gas discharge display/storage devices are used mainly for single color display. Known, too, are gas discharge display devices comprising a flat gas-filled discharge panel which is made to emit light by ionization of selected sites and whose opposite sides, defining the discharge path, are covered by one field each of parallel electric conductors, whereby the two conductor fields are disposed orthogonally and in matrix shape in relation to each other, and whereby each crossing of the conductor matrix is associated with a discharge cell, the conductors associated with each discharge cell being subjectable to a sustain signal sustaining the state of a fired or a nonfired discharge cell, and to an additional voltage or write signal which combined with a sustain signal causes a selected discharge cell to be fired. In other known arrangements using the same principle as described above, the discharge cells are physically separated from each other by means of nonconducting cell walls. All these arrangements have one feature in common - they are merely suitable for the single color display of information.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a gas discharge display/storage device for the multicolor display of information. Similar in color formation to color television tubes, it utilizes the principle that a color can consist of or be derived from combinations of the basic colors red, blue and green.

To this end the invention is characterized in that at least two discharge panels are provided which are separated from each other in the direction of discharge, that the conductors associated with each of the two discharge panels are disposed at an angle of about 60° in relation to each other, that the conductors of all conductor field pairs are disposed in three directions differing from each other by about 60°, that in each of these directions discharge cells for two of the three basic colors are alternately arranged, one discharge cell for one basic color being common to two directions.

In accordance with a further embodiment of the invention used for transillumination projection, the two successive unidirectionally disposed light-emitting areas of the discharge cells for two basic colors, which form one subgroup, adjoin each other without gaps and the various subgroups are physically separated from each other in such a manner that each such configuration comprises three light-emitting areas for the three basic colors.

In arrangements without transillumination projection the light-emitting areas of the discharge cells are preferably diamond-shaped, adjoining each other without any gaps.

A further preferred embodiment of the invention is characterized in that the discharge cells are not physically separated from each other by walls, and that an element phosphorescent in one of the three basic colors is associated with the discharge cells of the discharge spaces.

Yet a further extremely simple embodiment of the gas discharge display field in accordance with the invention, which comprises only two gas layers, is characterized in that there are provided for one of the three basic colors a first discharge space with one conductor field pair, and for the remaining two basic colors a second discharge space with a conductor field X on one side and two conductor fields Y and Z extending in different directions on the other side, and that discharge cells of one basic color in the second discharge space are addressable via the conductor field pair X and Y, the discharge cells for the other basic color in the second discharge space being addressable via the conductor field pair X and Z.

Embodiments of the invention will be explained in greater detail below with the aid of the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an arrangement comprising elements phosphorescent in several colors for conventional color television picture screen.

FIG. 2 is a first embodiment of an arrangement of cells comprising elements phosphorescent in several colors in a gas discharge display field.

FIG. 3 is a second embodiment of an arrangement of cells comprising elements phosphorescent in several colors in a gas discharge display field.

FIG. 4 is a third embodiment of the cell arrangement of the instant invention comprising elements phosphorescent in several colors in a gas discharge display field.

FIG. 5 is a table depicting four grids used in the gas discharge display fields in accordance with FIGS. 6 and 7.

FIG. 6 is a diagrammatic sectional view of a gas discharge display field for three gas layers and four grids, elements phosphorescent in one color being associated with the discharge cells of each gas layer.

FIG. 7 is a diagrammatic sectional view of a gas discharge display field with two gas layers, green phosphorescent elements being associated with the discharge cells of one layer, red and blue phosphorescent elements being respectively associated with the discharge cells in the second gas layer.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 shows the arrangement of the elements phorphorescent in the basic colors red (R), blue (B) and green (G) in conventional shadow mask color television receivers. Each of these elements can be selectively caused to emit light when impinged by a cathode ray. A required mixed color can be obtained by superimposing the basic colors red and/or blue and/or green upon each other. The arrangement shown in FIG. 1 is not suitable for gas discharge display devices for two reasons; the arrangement shown does not provide a coordinate selection system for addressing the individual discharge cells for the three basic colors, and if the discharge cells are associated with phosphorescent elements, such an arrangement, in which the elements are arranged closely adjacent to each other, does not permit transillumination projection since the individual phosphor elements are opaque.

FIG. 2 illustrates a cell configuration in accordance with which the elements phosphorescent in several colors may be associated with the discharge cells of a gas discharge display field. Each of the circular phosphorescent elements is associated with one discharge cell. The elements are arranged so that the elements for two basic colors are alternately sequentially disposed on one line. On the lines designated **1**, **1'**, **1''** and **1'''**, the elements for the basic colors red (R) and green (G) alternately follow each other, whereas on lines **2**, **2'**, **2''** and **2'''** and **0**, **0'**, **0''** and **0'''**, the elements for the basic colors blue (B) and red (R) and the elements for the basic colors blue (B) and green (G) respectively, alternately and sequentially succeed each other. All lines designated by the same number extend parallel to each other, with lines **1**, **1'**, **1''**, **1'''** being oriented at an angle of about 60° in relation to lines **0**, **0'**, **0''**, **0'''**, and lines **2**, **2'**, **2''**, **2'''** being oriented at an angle of about −60° in relation to lines **0**, **0'**, **0''**, **0'''**. These lines or grids are representative of the drive conductors for the various discharge cells, which are used for cell selection and addressing. In such an arrangement it is possible to address any discharge cell via the two drive conductors with which it is associated.

So, for example, the discharge cell with which the red (R) phosphorescent element **3** is associated can be addressed via lines **1'** and **2'**, and the cell for the green (G) phosphorescent element **4** is addressed via lines **1''** and **0'''**. In an arrangement in accordance with FIG. **2**, the gas discharge display field can be subjected to transillumination projection, provided transparent drive lines are used. The ratio of the area occupied by phosphorescent elements and the blank area in the preferred embodiment is about 2.8 : 1, which may be reduced, if required.

FIG. 3 shows another arrangement in which the ratio of the areas occupied by color phosphorescent elements and the blank area is smaller than in FIG. **2**. In this arrangement of FIG. **3**, the individual color phosphorescent elements are grouped in the triade configuration, with a space being left between groups of two successive elements on one line, so that in each case three adjacent elements are formed for the colors red (R), blue (B) and green (G). The individual triades are physically separated from and do not immediately adjoin each other, as shown in FIG. **2**.

FIG. 4 shows an arrangement of phosphorescent elements for a gas discharge display field without transmillumination projection which could be used, for example, for television and TV telephone applications. In such an arrangement, the area not occupied by the phosphorescent elements should be kept as small as possible. To this end the phosphorescent elements are printed in lozenge (FIG. 4) or ellipse shape, with the coordinate conductors being associated with the individual elements in the same manner as in FIGS. **2** and **3**. When lozenge-shaped phosphorescent elements are used in accordance with FIG. **4**, the area not occupied by these elements is eliminated completely. The individual elements rather adjoin each other without any gaps in keeping with the principle that for coordinate conductors the elements for two basic colors invariably alternate.

As previously mentioned, the individual coordinate conductors serving to address the discharge cells are transparent. The individual conductor grids used in the gas discharge fields of FIGS. **6** and **7** are depicted in a table in FIG. **5**. The grids are designated in the table by the numbers **11**, **21** and **31**, grid **41** comprising a double grid extending in the same direction as grids **11** and **21**. The two conductor fields forming a grid pair and which in FIGS. **6** and **7** are associated with one discharge space are designated as A, B, C or D. The information in the table of FIG. **5** indicates that grid pair A is formed by grids **11** and **21**, grid pair B by grids **21** and **31**, grid pair C by grids **11** and **31**, and grid pair D by grid **31** and double grid **41**.

FIG. **6** is a diagrammatic expanded sectional view of a gas discharge display field with three discharge spaces **5**, **6** and **7**. The individual discharge spaces **5**, **6** and **7** are sandwiched one on top of the other each discharge space being limited by two glass layers **5'** and **5''**, **6'** and **6''**, **7'** and **7''**, respectively. The blue phosphorescent elements **5'''** are associated with the discharge cells of discharge space **5**, the red phosphorescent elements **6'''** with the discharge cells of discharge space **6**, and the green phosphorescent elements **7'''** with the gas cells of discharge space **7**. Elements **5'''**, **6'''** and **7'''** should be positioned in relation to each other in the manner shown in FIGS. **2**, **3** or **4**. The discharge cells of discharge space **5** are addressed via the conductors of grid **11**, which is disposed on grid layer **5'**, and via the conductors of grid **31** which is sandwiched between glass layers **5''** and **6'**. The conductors of each grid are disposed parallel to each other, while the conductors of grid **11** are disposed at an angle of about 60° with respect to the conductors of grid **31**. The gas cells of discharge space **6** are addressed via the conductors of grid **31** and **21**, grid **21** being sandwiched between glass layers **6''** and **7'**. The conductors of grid **21** are disposed at an angle of about 60° with respect to the conductors of grid **31** as shown in FIGS. **2**, **3** and **4**. The discharge cells of discharge space **7** are addressed via the conductors of grid **21** **7''**. grid **11**, the latter arranged on glass layer **7**The conductors of these two grids **21** and **11** are disposed at an angle of about 60° in relation to each other. When a cell is fired, the phosphorescent element associated with it is excited, emitting colored light which may be either red, blue or green. By suitably combining the red, blue or green light-emitting elements, a desired mixed color can be obtained. It is also possible to provide an arrangement in which the discharge cells are physically separated from each other by walls and are filled with gases from each one of the three basic colors red, blue and green.

FIG. 7 is an enlarged diagrammatic representation of a gas discharge display field with only two discharge spaces 8 and 9. Both spaces 8 and 9 are limited by glass layers 8′ and 8″ and 9′ and 9″, respectively. The two limited discharge spaces 8 and 9 are arranged one above the other. The discharge cells of discharge space 9 are associated with green phosphorescent elements 9‴, while discharge space 8 comprises alternate discharge cells associated with the blue phosphorescent elements 8‴ and the red phosphorescent elemtns 8^{IV}, respectively. The cells of discharge space 9 are addressed via the conductors of grid 11, arranged on glass layer 9″, and grid 21, arranged on glass layer 9′. Those discharge cells of discharge space 8 with which blue phosphorescent elements 8‴ are associated are addressed via the conductors of grid 31, arranged on glass layer 8″, and via the conductors of grid 11, the latter being a part of double grid 41 which is arranged on glass layer 8′. The discharge cells in discharge space 8 with the red phosphorescent elements 8^{IV}, on the other hand, are addressed via the conductors of grid 31 and grid 21, which forms a part of double grid 41 as shown in FIG. 4. The two grids 11 and 21 on glass layer 8′, as shown in enlarged form in FIG. 7, form the double grid 41, the conductors of these two grids being electrically insulated from each other. The conductors of grid 21′ extending in the same direction as grid 21 are disposed in meander fashion between and on top of the conductors of grid 11. The red phosphorescent elements 8^{IV}, blue phosphorescent elements 8‴ and green phosphorescent elements 9‴ in the gas discharge display field of FIG. 7 are aligned with respect to each other in the manner shown in FIGS. 2, 3 and 4. FIGS. 2, 3 and 4 also show the direction in which the conductors of the various grid planes extend. The conductors of each grid are disposed parallel to each other. With respect to the conductors of grid 11, the conductors of grid 21 are disposed at an angle of about 60°, whereas the conductors of grid 31 are disposed at an angle of about 60° with respect to those of grid 21; the directions in which the conductors of double grid 41 and grids 11 and 21 extend are identical.

The invention as described has the special advantage that addressing of the various discharge cells is made very easy with the aid of nonorthogonal coordinates. In addition, the sandwich structure of the gas discharge arrangement as described can be readily manufactured. A further advantage consists in the fact that the gas discharge display field for the three basic colors requires only two discharge spaces.

While the invention has been particularly shown and described with reference to a preferred embodiment thereof, it will be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. Gas discharge display apparatus for multicolor information display by means of the three basic colors red, blue and green utilizing suitably modified gas discharge devices (known from single color display) comprising in combination,

a flat gas-filled discharge display panel made to emit light by ionization and whose opposite sides limiting the discharge path include a plane of parallel electric conductors, the conductors of the two sides being oriented in different directions, the crossings of the conductor pairs defining discharge cells,

characterized in that at least two discharge spaces (8, 9) are provided which are separated from each other in the direction of discharge,

that the conductors of a conductor field pair are disposed at an angle of about 60° in relation to each other,

that the conductors of all conductor field pairs are disposed in three directions differing from each other by about 60°,

and that in each of these directions discharge cells for two of the three basic colors are alternately arranged, each discharge cell for one basic color being common to two directions.

2. An arrangement in accordance with claim 1, characterized in that the light-emitting area of a discharge cell is circular for each basic color.

3. An arrangement in accordance with claim 2, characterized in that the circular light-emitting areas of the discharge cells for the different basic colors adjoin each other without gaps.

4. An arrangement in accordance with claim 2, characterized in that the two successive unidirectionally disposed light-emitting areas of the discharge cells for two basic colors, which form one subgroup, adjoin each other without gaps, and that the various subgroups are physically separated from each other in such a manner that each group comprises three light-emitting areas for the three basic colors.

5. An arrangement in accordance with claim 1, characterized in that the light-emitting area of said discharge cells for one basic color are diamond-shaped.

6. An arrangement in accordance with claim 5, characterized in that said diamond-shaped light-emitting areas of said discharge cells adjoin each other without gaps.

7. An arrangement in accordance with claim 1, characterized in that said discharge cells are not physically separated from each other by walls, and that an element (3, 4) phosphorescent in one of the three basic colors is associated with said discharge cells of said discharge spaces.

8. An arrangement in accordance with claim 1 characterized in that said discharge cells are physically separated from each other by walls and are filled with gases for each one of the three basic colors red, blue and green.

9. An arrangement in accordance with claim 8, characterized in that for each of the three basic colors one discharge space (5, 6, 7) is provided, and that between the external spaces (5, 7) and the center discharge spaces (6) a conductor field (21, 31) is sandwiched which is common to the two discharge spaces.

10. An arrangement in accordance with claim 8, characterized in that there is provided for one of the three basic colors a first discharge space (9) with one conductor field pair, and for the remaining two basic colors a second discharge space (8) with a conductor field X (31) on one side, and two conductor fields Y and Z (11 and 21) extending in different directions on the other side, and that the discharge cells of one basic color in the second discharge space (8) are addressable via the X and Y conductor field pairs (31 and 11), the discharge cells for the other basic color in the second discharge space (8) being addressable via the conductor field pair X and z (31 and 21).

* * * * *

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,790,841

DATED : Feb. 5, 1974

INVENTOR(S) : Frank Tsui, Katherine Tsui

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Please add the priority data as follows:

Claims priority, application Germany January 26, 1972, P2203572.9

Claim 10, last line, change "z" to ---Z---.

Signed and Sealed this

Thirtieth Day of November 1976

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

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Commissioner of Patents and Trademarks