United States Patent [19]

Coleman et al.

[11] **3,909,825**

[45] **Sept. 30, 1975**

[54] **TWO PLATE VISUAL DISPLAY DEVICE**

[75] Inventors: **William E. Coleman; John L. Janning,** both of Dayton, Ohio

[73] Assignee: **NCR Corporation,** Dayton, Ohio

[22] Filed: **Oct. 2, 1969**

[21] Appl. No.: **863,111**

[52] **U.S. Cl.** ..... **340/366 R**

[51] **Int. Cl.²** **G08B 5/00**

[58] **Field of Search** ..... 340/336, 366, 378, 381; 313/109.5, 108 B; 315/169, 169 TV

[56] **References Cited**

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Primary Examiner—Robert L. Griffin
Assistant Examiner—Robert Hearn
Attorney, Agent, or Firm—J. T. Cavender; Albert L. Sessler, Jr.; Elmer Wargo

[57] **ABSTRACT**

An electroluminescent display device comprising a plurality of discrete gas cells formed by superimposing a first plate containing a plurality of chambers on a second plate containing a plurality of chambers equal in number to those on the first plate. One side of each cell is capacitively coupled to a common transparent electrode, and the other side of each cell is capacitively coupled to a corresponding segment electrode. The common transparent electrode and the segment electrodes of selected cells are alternately energized, thus resulting in the intermittent ionization, i.e., gas discharge, of the gas within the cell. The illumination provided by the occurrence of the gas discharge in the selected cells is sufficient for the visual display of numeric, symbolic, and alphabetic information.

1 Claim, 5 Drawing Figures

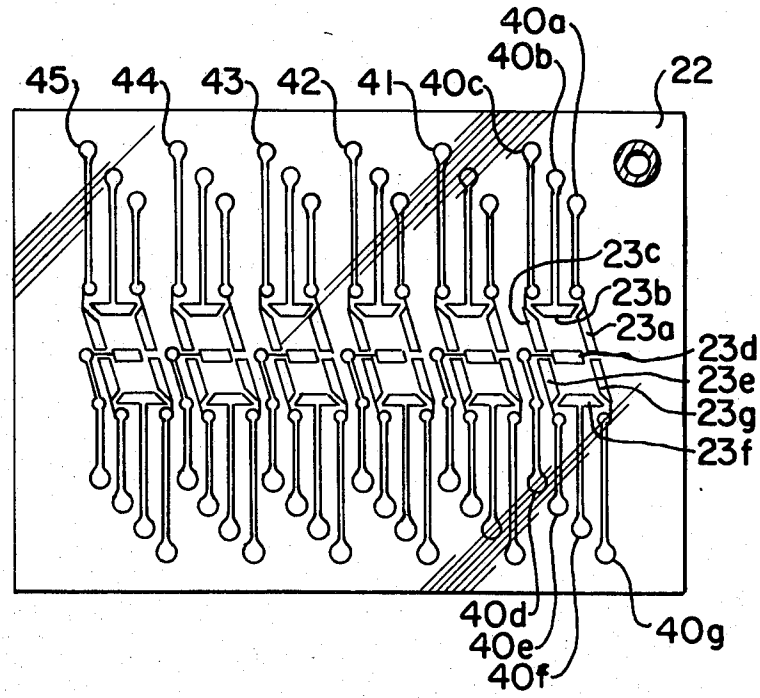


FIG. 1

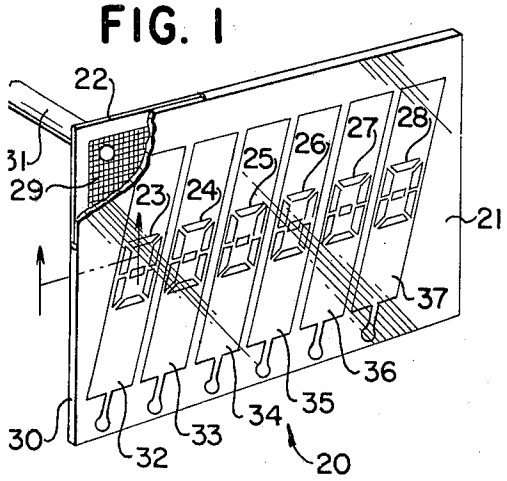


FIG. 2

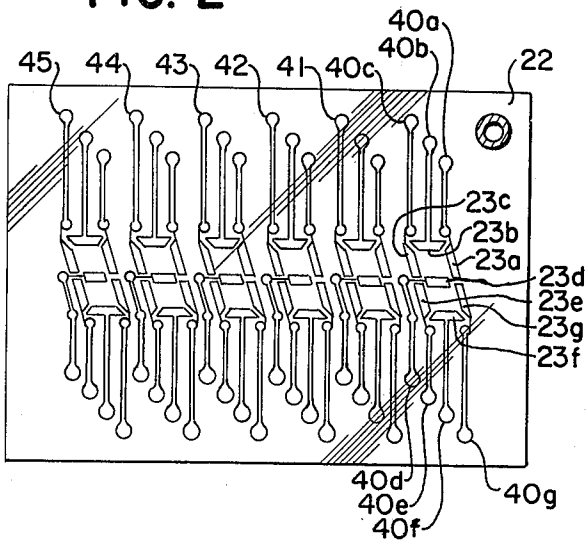
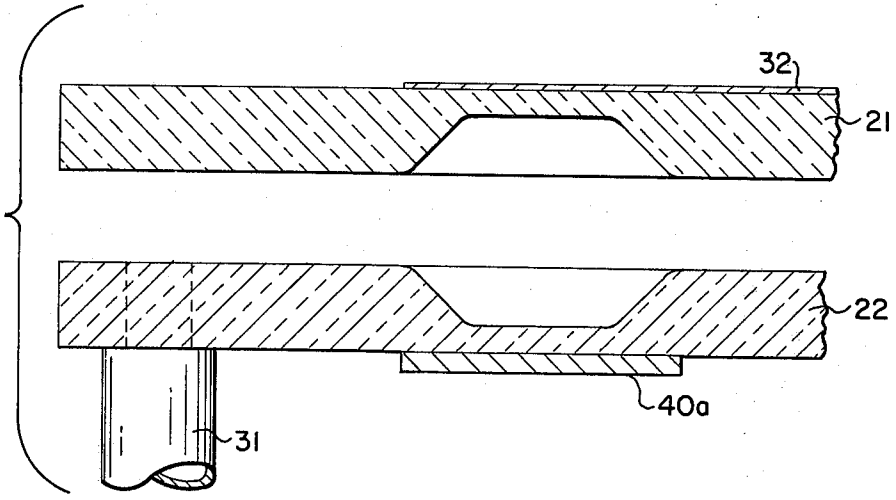


FIG. 3



INVENTORS
WILLIAM E. COLEMAN &
JOHN L. JANNING

BY Louis A Klein
Albert L. Sessler, Jr

THEIR ATTORNEYS

FIG. 4

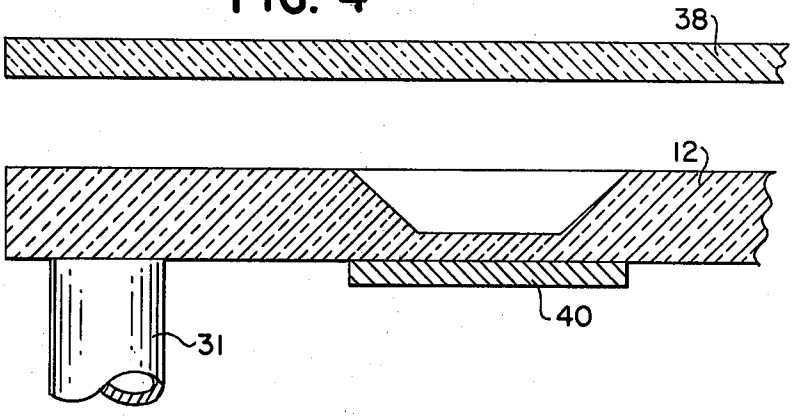
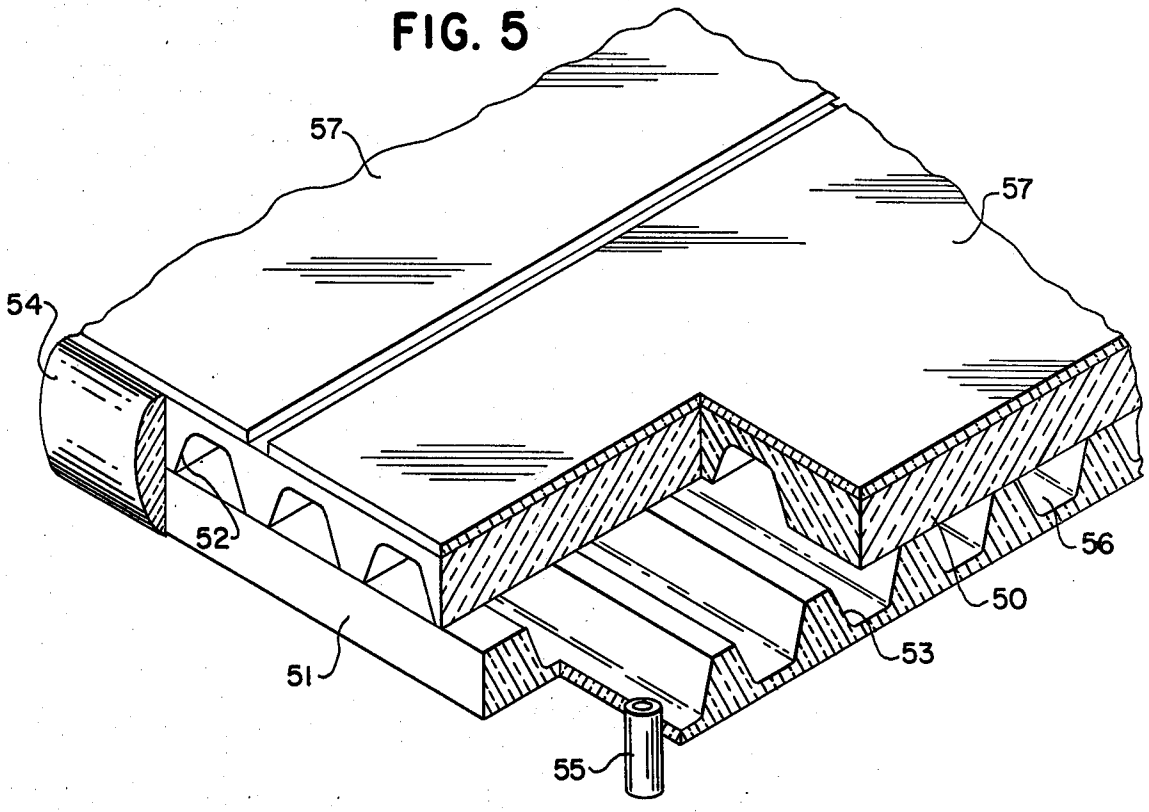


FIG. 5



INVENTORS
WILLIAM E. COLEMAN &
JOHN L. JANNING

BY Louis A Klein
Albert L. Sessler Jr

THEIR ATTORNEYS

TWO PLATE VISUAL DISPLAY DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to an electroluminescent display device for the visual display of information.

The prior art is replete with many different types of display devices which have been developed for the visual display of information. One form of such a device consists of a series of transparent plates, with intervening spacers, all assembled in a glass sandwich structure, for the containment of a gas. Internal electrodes in the shape of the symbol to be displayed are provided for the application of an electrical potential which causes the gas to glow. Undesirable features of this type of structure are the intervening spacer, which causes breakage problems during the fabrication process, and the internal electrodes, which tend to erode due to the arcing to which they are subjected.

Applicants' structure is novel in that it provides a simple structure fabricated from two plates, thereby decreasing breakage and the amount of materials needed to fabricate the panel. It also provides a display which is sustained with less voltage than is necessary to turn on the display. Applicants further provide, in one embodiment of the invention, a structure in which alignment between cells and electrodes is not necessary, thereby simplifying the fabrication process.

SUMMARY OF THE INVENTION

The invention relates to an electroluminescent display panel composed of first and second transparent plates, each plate having first and second sides. In one embodiment, the first side of each plate has a plurality of chambers equal in number and identical in configuration to those on the second plate. The two plates, when one is superimposed on the other, form a plurality of discrete cells for the containment of a gas, each cell being electrically isolated from the others. The first side of the first plate includes a conductive coating which functions as a common electrode for every cell which the conductive coating overlies. The first side of the second plate includes a plurality of segment electrodes, one electrode overlying each cell formed by the two plates. Either the common electrode or the segment electrodes may be transparent, to permit unimpeded observation of the characters formed by the illumination provided by the energized cells.

The illumination necessary for viewing is provided by applying an alternating electric field across selected cells, the application of which results in the ionization of the gas within the selected cell. The gaseous discharge which occurs within the selected cells provides the illumination necessary for the visual display and further results in a deposition of a wall charge on the inner cell wall surfaces. The wall charge lowers the voltage necessary to ignite the cells after the initial ionization.

In a second embodiment of the invention, cell-forming chambers are provided on only one of the two plates, thus simplifying fabrication of the device.

In a third embodiment of the invention, the cells are formed by intersections of channels provided in both of the plates, thus simplifying registration of the two plates, since the segment electrodes need not be positioned precisely with respect to particular cell locations.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an isometric view, partially in section, of a visual display device embodying the principles of the instant invention.

FIG. 2 is a rear view of the device shown in FIG. 1.

FIG. 3 is an enlarged cross-sectional view of an individual cell.

FIG. 4 is an enlarged cross-sectional view of a second embodiment of a specific cell.

FIG. 5 is an isometric view, partially in section, illustrating a third embodiment of the display device fabricated in accordance with the principles of applicants' invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIG. 1, the visual display panel is shown generally at **20.** The panel consists of two plates **21** and **22,** each having first and second sides, which may also be designated as outside and inside surfaces, respectively. At least one of the plates is transparent, and may be formed from a glass material. The display panel **20** shows six characters **23, 24, 25, 26, 27,** and **28,** which are capable of being illuminated, it being understood that the invention is not restricted to six characters and may comprise any suitable number of characters. Each character comprises a group of seven cells, *a, b, c, d, e, f,* and *g.* For example, the character **23** is composed of the cells **23***a*, 23*b*, 23*c*, 23*d*, 23*e*, 23*f*, and **23***g*. In the illustrated embodiment, each of the seven cells is in the shape of a bar and, as is well known in the art, may be utilized to display any number ranging from zero to nine. Alphabetic information may also be displayed simply by changing the arrangement of the cells or adding cells to the panel. The cells are formed by removing material from the second side of each plate **21** and **22** (FIG. 3), thus forming chambers on those respective sides. The chambers formed on one plate are the mirror images of those formed on the other plate. Alternatively, the chambers may be formed on just one of the plates, i. e., on either plate **21** or plate **22,** again forming a plurality of cells when a flat plate is superimposed on the plate containing the chambers. FIG. 4 shows one such embodiment, in which the plate **38** is flat. It is noted here that like numbers for like elements have been used throughout the specification and the drawings. The material may be removed by engraving, or by other well-known methods.

The plate **22,** illustrated in FIG. **1,** is the rear plate and is provided with a plurality of minute passages **29** in first and second directions, which connect all the chambers formed on the plate **22.** The passages **29** function as pressure equalization passages in the finished structure. Although the passages **29** are shown on the plate **22,** they could be provided on the plate **21** if desired. The plates **21** and **22** are superimposed upon each other in such a manner that the channels formed on the plates **21** and **22** are in full registration with each other, thus forming the cells *a, b, c, d, e, f,* and *g,* in each character of the display panel. A hole is cut into he plate **22,** into which is inserted a conduit **31,** which, in cooperation with the passages **29,** is utilized in evacuating air from the display panel **20** and for filling the cells with a gas mixture, after which the conduit is sealed. The plates **21** and **22** are sealed together by cement or glass frit **30,** thereby resulting in an airtight structure.

The unetched surface — that is, the first side of the plate **21** — is coated with character electrodes **32, 33,** 34, 35, 36, and **37,** which may be transparent, one electrode for each character on the panel **20.** The character electrodes may be tin oxide, cadmium oxide, or a thin gold film, and may be deposited by conventional methods such as metal deposition, or silk screen techniques. Similarly, segment electrodes **40, 41, 42, 43, 44,** and **45** of the characters **23** through **28,** which also may be transparent, are deposited on the first side of the plate **22** directly opposite and overlying every cell formed on the second side of the plate. Thus each cell has a corresponding segment electrode. The deposition may be accomplished by utilizing a metal mask or by employing silk screen techniques. The electrodes **32** through **37** and **40** through **45** of each character are capacitively coupled to the cells because of their positions on the outside surface of the cell walls. The gas-filled cells in the completed panel are all isolated from one another and function as individual gas discharge devices upon the application of a proper electric potential across the individual cells.

The panel, shown in FIG. **1,** lends itself quite readily to a time-shared mode of operation. What is meant by this is that, in operation of the display, the character **23** is scanned for a finite time, after which it is turned off and the character **24** is scanned, and so on until all six characters have been scanned, at which point the character **23** is turned back on. The frequency at which the characters are scanned must be high enough to create the illusion to a viewer that the characters are continuously on.

Because of the fact that the electrodes are capacitively coupled to the cells, it is necessary to utilize an alternating potential in order to ignite the cells. For example, in order to display the number seven in the character **23** position, it is necessary to apply a source of alternating potential between the transparent character electrode **32** and the segment electrodes **40***b*, 40*c*, and **40***e*. The alternating potential causes an electron multiplication process to occur within the selected cells, which continues until ignition occurs, i. e., a gaseous discharge occurs within the selected cells **23***b*, 23*c*, and **23***e*, providing illumination for the character display and also causing a positive charge to be deposited on the cell wall adjacent the electrode to which a negative potential is being applied, and electrons to be deposited on the cell walls adjacent the electrode to which a positive potential is being applied. The charges deposited on the inner-cell walls are known as wall charges and are trapped on the cell walls because of the capacitive coupling effect exerted by the cell walls. The wall charge thus has a polarity opposite to the applied voltage which initiated the discharge. The next cycle of the alternating potential results in the application of a voltage to the character electrode **32** and the segment electrodes **40***b*, 40*c*, and **40***e* of the character **23** which is of the same polarity as the previously-deposited wall charge, and therefore the two are additive. Consequently, it can be seen that after the first ignition, less voltage is required to fire the cells; in other words, the firing voltage after the first ignition can be of a magnitude which is equal to the original firing voltage less the wall charge. The selected cells will appear to be illuminated so long as the selected character electrodes and the selected segment electrodes corresponding to the selected character electrodes are alternately energized.

In order to aid those skilled in the art in the practice of the present invention, the following information for construction of one form of display panel in accordance with the invention is given by way of exemplification only.

In the embodiment illustrated in FIG. **1,** the channels were etched in glass plates having a thickness of 0.012 inch to a depth of 0.008 inch. Upon assembling the two plates together, and evacuating them of air, the formed cells were filled with a gas mixture of 99.7% neon, 0.1% argon, and 0.2% nitrogen to a pressure of 100 millimeters of mercury at room temperature. However, it was found that the display device could be satisfactorily operated with pressures ranging from 60 to 700 millimeters of mercury. The individual cells were energized with an alternating voltage of 250 volts, the pulses having a width of 2 microseconds. It was found that the display device could be satisfactorily operated with voltages ranging from 150 to 300 volts. The characters were scanned at a frequency of 20 KHz with satisfactory results. One example of a control which may be utilized with the present invention is found in United States patent application Ser. No. 847,141, now U.S. Pat. No. 3,614,769, filed Aug. 4, 1969, by William E. Coleman and Robert R. Skutt, which is of common ownership with the assignee of the present invention.

A modification of the device described in connection with FIG. **1** is shown in FIG. **5.** This device consists of two glass plates **50** and **51,** each having first and second sides. On the second side of the plate **50** are a plurality of minute parallel grooves **52** in a first direction. The second side of the plate **51** also includes a plurality of minute parallel spaced grooves **53** in a second direction. The two plates are superimposed on each other, forming a plurality of cells **56,** each cell isolated from the others by the glass walls of the grooves. The plates **50** and **51** are sealed together with a cement or glass frit **54,** thereby forming an airtight structure. A hole is cut into the plate **51,** into which is inserted a conduit **55,** which is utilized in evacuating the cells **56** and in filling them with a neon-argon-nitrogen gas mixture. The conduit is sealed upon the filling of these gas cells.

The first side of the plate **50,** which is the unetched side, is coated with character electrodes **57,** which may be transparent if desired and may be formed of tin oxide, cadmium oxide, or a thin gold film which may be deposited by conventional methods, such as metal deposition, or silk screen techniques. The first side of the plate **51,** which is the unetched side, is coated with a plurality of groups of segment electrodes, not shown, which are identical to those shown in FIG. **2** and which may be transparent if desired.

It is noted here that the segment electrodes do not have to be positioned opposite any specific cell, since the cells **56** are of such a size that each segment electrode will overlie a plurality of cells **56.** Therefore, no critical alignment problem exists, since the segment electrodes can be orientated on the first side of the plate **51** in any manner; the only requirement must be adhered to is that the segment electrodes must be positioned opposite a corresponding character electrode.

The mode of operation of the structure illustrated in FIG. **5** is similar to that shown in FIG. **1.** That is, when a sufficient voltage is impressed between the transparent character electrodes and any of the corresponding segment electrodes, the gas in those cells positioned between the energized electrodes will ionize, thereby pro-

ducing illumination for the display. A wall charge is also present in this embodiment, which permits the use of a lower voltage to sustain the ionization of the selected cells.

What is claimed is:

1. An electroluminescent display device comprising:

first and second insulating planar plates, each having inside and outside surfaces;

each of said plates having a plurality of aligned channels formed on the inside surface thereof; said inside surfaces of said first and second plates being in contacting relationship to enable said channels to be formed into a plurality of cells; said first and second plates being the sole means for forming said cells;

said cells being bar-like in shape and arranged in groups to enable each group of cells to form a character when selected cells of that group are energized;

a segment electrode for each said cell conforming in shape to the associated cell and being in registration therewith; said electrodes being located on the outside surface of said first plate;

a common electrode for each said group of cells, with each said common electrode being in registration with its associated group of cells, and with said common electrodes being located on the outside surface of said second plate;

an ionizable gas filling said cells, and

at least one of said plates having pressure equalization passages interconnecting said cells;

each said group of cells being able to produce a character when its associated common electrode and selected ones of its segment electrodes are alternately energized.

* * * * *