# United States Patent [19]

**Schott**

[11] **3,881,131**

[45] **Apr. 29, 1975**


[54] **GAS DISCHARGE DISPLAY PANEL SYSTEM WITH PROBE FOR IGNITING AND EXTINGUISHING CELLS**


[75] Inventor: **Dan J. Schott,** Phoenix, Ariz.

[73] Assignee: **Beckman Instruments, Inc.,** Fullerton, Calif.



[22] Filed: **Mar. 18, 1972**

[21] Appl. No.: **263,011**

**Related U.S. Application Data**

[63] Continuation of Ser. No. 39,201, May 21, 1970, abandoned.

[52] **U.S. Cl.** ..... **315/275;** 315/349; 315/169 TV

[51] **Int. Cl.** ..... **H05b 41/16;** H05b 41/24

[58] **Field of Search** ..... 340/166, 173 LT, 173 HR, 340/334, 336, 337, 173 PL; 315/169, 169 TV, 335, 340, 275, 349, 146; 313/108 B, 146, 198, 201, 234; 178/18



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,858,480 | 10/1958 | Shadowitz | 315/169 X |
| 3,559,307 | 2/1971 | Barrekette et al. | 340/337 X |



*Primary Examiner*—Nathan Kaufman

*Attorney, Agent, or Firm*—R. J. Steinmeyer; J. M. Thomson



[57] **ABSTRACT**

Apparatus including an external voltageless or grounded probe for selectively writing and erasing information on a gas discharge plasma display panel matrix. The plasma panel cells contain an ionizable gas and are subjected to a sustaining voltage. Proximity of the probe to a selected cell varies the field strength within the cell and accordingly ionizes or de-ionizes gas depending on whether the front or rear electrodes of the panel are grounded.


**6 Claims, 7 Drawing Figures**

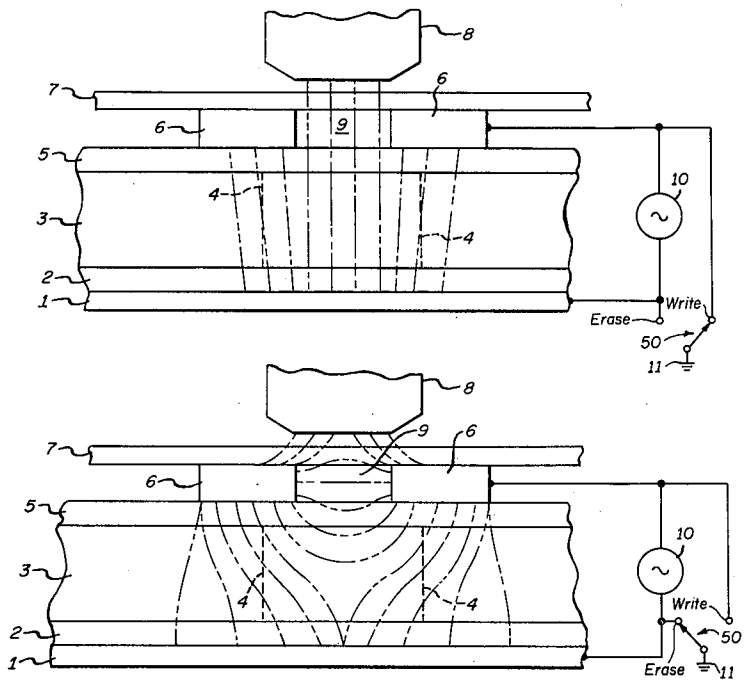


FIG. 1a.

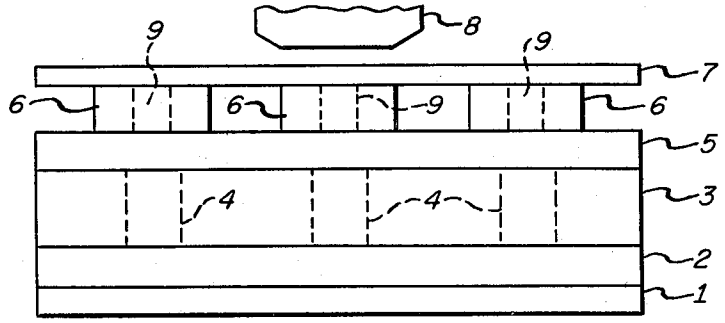
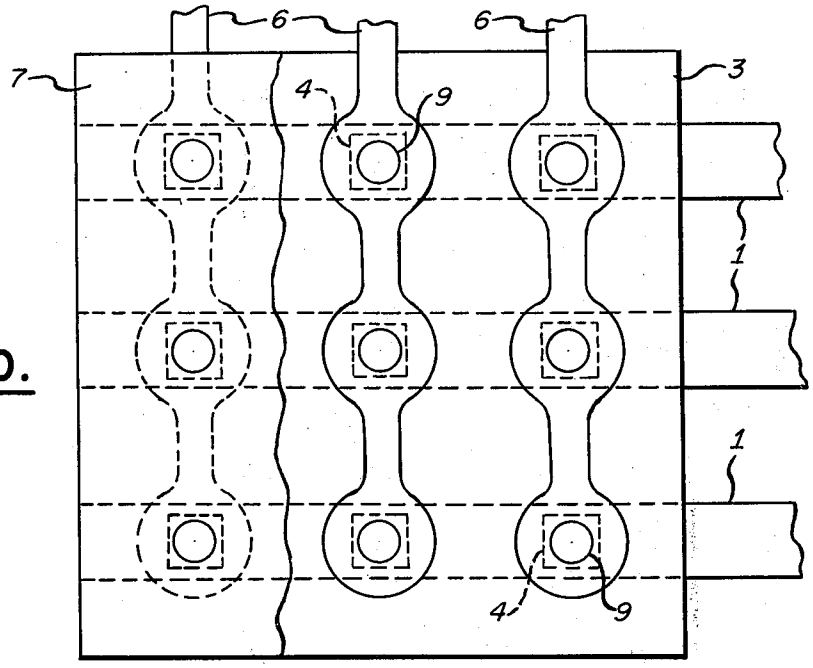



FIG. 1b.



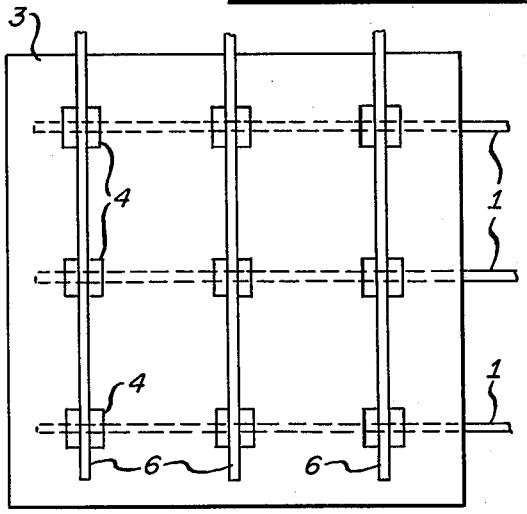




FIG. 2a.

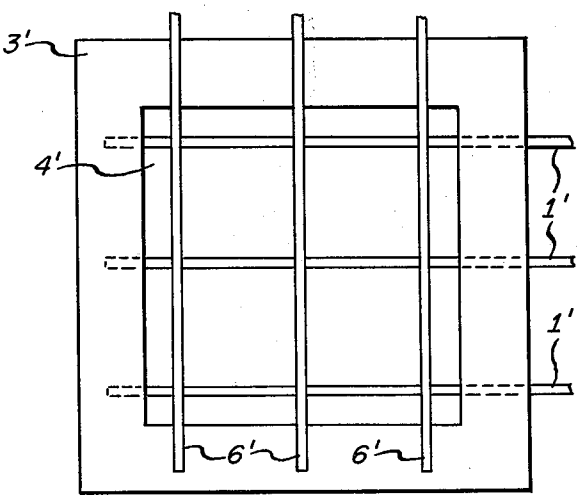



FIG. 2b.

INVENTOR
DAN J. SCHOTT
BY
ATTORNEY

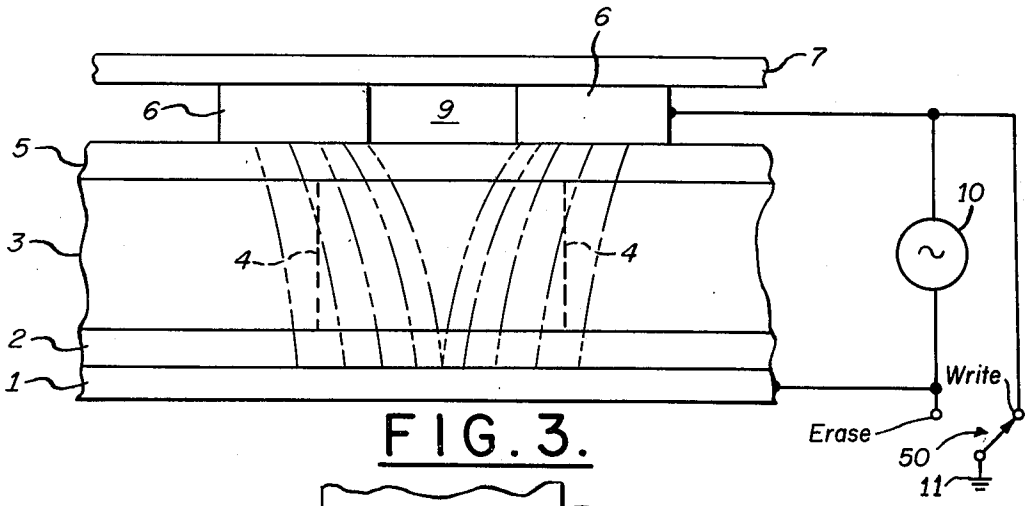



FIG. 3.

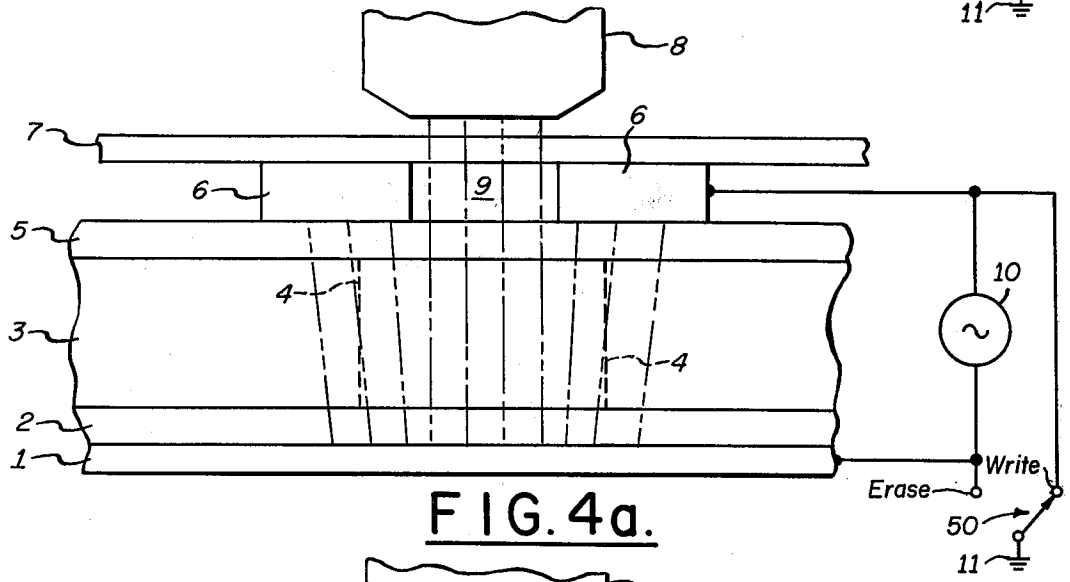



FIG. 4a.

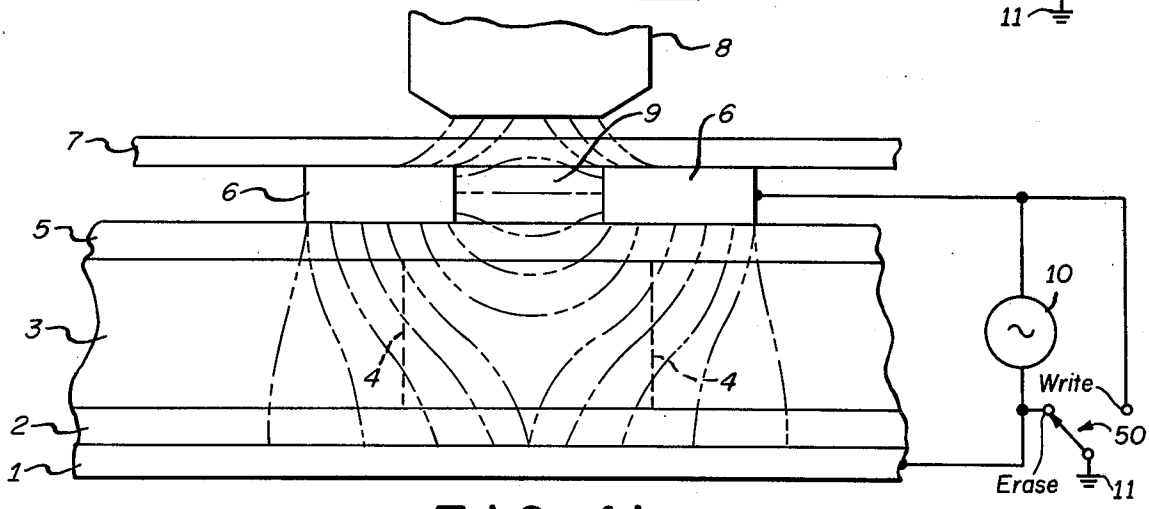



FIG. 4b.

INVENTOR
DAN J. SCHOTT
BY
ATTORNEY

# GAS DISCHARGE DISPLAY PANEL SYSTEM WITH PROBE FOR IGNITING AND EXTINGUISHING CELLS

This is a continuation of application Ser. No. 39,201 filed May 21, 1970, now abandoned.

## BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates to gas discharge display matrices having write/erase capability by way of an external probe.

2. Description of the Prior Art

Plasma panels having a central non-conducting sheet apertured at the electrode intersections and defining cells containing an ionizable gas mixture are well known. The operation of each cell may be characterized by three distinct modes of operation; application of less than a specified a.c. voltage to the cell electrodes will neither initiate nor sustain ionization, an intermediate voltage range will sustain ionization but will not initiate it, and a higher voltage will spontaneously ionize the gas and sustain ionization.

Since capacitive coupling to cells within a matrix is possible, an external electrical probe placed in proximity with the panel may be used to selectively fire or extinguish a cell. For operation in this manner, an a.c. sustaining voltage within the intermediate range is normally applied to the cell electrodes of the plasma panel. When an additional a.c. voltage properly phased with the sustaining signal is supplied to the probe, the effects are additive and selective ignition occurs; similarly, if the probe power supply is shifted 180°, the effects are subtractive and selective erasure occurs.

A distinct and severe disadvantage of the prior art systems of selective writing and erasure is the high frequency a.c. voltage at the probe which is likely to present a safety hazard to the operator. Other disadvantages include the requirement for additional power supplies and complex equipment with discrete phasing requirements.

## SUMMARY OF THE INVENTION

A gas discharge plasma panel is generally constructed of three thin-glass layers sealed at their periphery. A matrix of display elements defined by individual cells containing an ionizable gas are disposed within the panel. Externally located electrodes are associated with each cell. An a.c. voltage having an amplitude which is either less than an ionization sustaining value, equal to a sustaining value but less than a spontaneous ionizing value, or equal to a spontaneous ionizing value may be impressed upon the electrodes of each cell. The ionization sustaining voltage value effect on each cell may be increased or decreased without changing the voltage value of the external electrodes by the teaching of this invention. If the effect is increased, a non-ionized cell will become ionized and if the effect is decreased, an ionized cell will become de-ionized. Thus, writing and erasure may be accomplished.

A capacitively coupled probe, as generally taught in the prior art, may be used to modify the effectiveness of the sustaining voltage. More specifically, apparatus constructed in accordance with the present invention comprises a probe-panel combination which operates to control the field distribution in the cells so that the field strength is effectively enhanced or diminished to accomplish writing and erasing without the necessity for actually supplying additional voltage to additively or subtractively combine with the sustaining voltage. A preferred embodiment of the present invention utilizes a panel having a modified electrode configuration. By designing the electrode with a hole or aperture located over each cell, the electrical field within the cell will be poorer than that extant at the same voltage but without the hole. For the applied voltage signal to remain within the region of sustaining ionization some increase in externally applied voltage value may be necessary. If a conductive probe is placed in the proximity of the hole, the electrical field will be positively altered and the effective voltage value appearing across the cell can exceed the value sufficient for spontaneous ionization. That is, the externally applied voltage is not modified, but rather the distribution of the field within the cell is altered by the probe. For the condition where the electrode on the side of the panel adjacent the probe is grounded, the cell will ionize. Alternatively, if the electrode on the opposite side of the panel is grounded, the proximity of the conductive probe will negatively alter the electrical field within the cell causing the effective voltage value to decrease below the ionization sustaining value and as a result the cell will cease ionizing.

The write and erase modes of operation taught by the invention are also applicable in a cell-less panel. That is, a panel may have a discrete electrode matrix with one gaseous envelope common to each electrode intersection rather than one gaseous envelope common to only one electrode intersection of the electrode matrix.

A primary object of the invention is to provide a write/erase capability for a plasma display panel by means of a simple electrically conductive probe.

Another object of the invention is to provide a plasma panel for use as an interactive display that permits communication between man and computer.

Another object of the invention is to provide for a plasma display panel the capability of writing and erasing without a safety hazard.

Still another object of the invention is to provide for a plasma display panel a write/erase capability which is optically stable and insensitive to normal ambients.

A further object of the invention is to provide a relatively uncomplicated and inexpensive write/erase display panel.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1***a* is a side view of a display panel and cooperating probe;

FIG. **1***b* is a top view of the panel and electrode configuration shown in FIG. **1***a*;

FIGS. **2***a* and **2***b* illustrate modifications of the electrode and cell structure of the panel of FIG. **1***a*;

FIG. **3** depicts the electrical field in the vicinity of a single cell in the absence of the probe; and

FIGS. **4***a* and **4***b* depict the electrical field in the vicinity of a cell in the presence of the probe during write and erase modes, respectively.

## DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to FIGS. **1***a* and **1***b*, the central member or spacer piece **3**, constructed of glass or other suitable dielectric material, may contain a plurality of cells **4** of any configuration determined by ancillary criteria of manufacturing costs and methods. If desired, the cell interior may be coated with various substances to affect

the surface charge, discharge color, etc. of the display. In addition, the intercellular structure or portions thereof may be made opaque or reflective to enhance the display characteristics of the panel. The arrangement of the cells may be in a rectangular matrix or any other desired pattern. On either side of the central member **3** there are glass plates **5** and **2** forming the front and rear plates, respectively. During assembly, an ionizable gas at a predetermined pressure is introduced into the cells **4** and hermetically sealed therein by plates **2** and **5.**

Electrode **1** in the vicinity of, contained within, or attached to plate **2** may be a conductive sheet coating, layer or screen whose outer edge extends to and includes the outermost cells. Preferably, it is a series of electrode strips, each strip associated with a single row, a column, or other combination of cells. By suitable means, the electrode **1** may be electrically insulated from the surrounding environment. Electrodes **6** in the vicinity of, contained within, or attached to plate **5** may be a series of strips associated with a discrete group of cells, such as a row or column. Preferably, only one cell is mutually common to one group of cells associated with an upper electrode **6** and one group of cells associated with a lower electrode **1,** as in a matrix. The configuration of electrodes **6** may be generally narrow with wider portions where the electrode is adjacent to the cells, as shown in FIG. **1***b*. Each of these wider portions may contain an aperture **9** so that a portion of the cell **4** is not completely covered by the electrode. Other electrode configurations are also anticipated, such as one or more parallel electrode strips where the strip or combination does not completely cover the cell **4,** as in FIG. **2***a*. FIG. **2***b* illustrates a single cell **4'** having a plurality of intersecting electrodes **1'** and **6'**. This configuration may also be used to practice the invention.

A probe **8** of conductive material may be grounded or may be voltageless. The only restriction placed upon the probe **8** is that it have an electrically conductive tip and be of sufficient size to increase the effect of electrode **6,** adjacent cell **4,** that is, increase the effective area of the electrode adjacent the cell. Such a probe may be designated as a passive probe since the probe does not provide a source of non-zero potential. Preferably, in the configuration of FIG. **1***b* the probe tip should be at least as large or slightly larger than the electrode aperture while in the case of FIGS. **2***a* and **2***b* the probe tip should be at least as large or slightly larger than the cell aperture.

The operation of the apparatus will now be described with reference to FIGS. **3, 4***a* and **4***b*. Operation of any plasma panel evolves about three ranges of voltage applied to the electrodes bordering an ionizable gas cavity or cell. $V_E$ may be used to designate the maximum voltage level which will neither cause nor sustain ionization of the gas. $V_S$ may be used to designate a voltage within a range whose level will sustain ionization of the gas, if the ionization is initiated by some other means. $V_F$ may be used to designate the lowest voltage level which will spontaneously ionize the gas and sustain ionization. A transition between voltage levels can effect either writing or erasing. To write, when a gas cavity is not ionized, the $V_F$ level must be reached or exceeded. To erase, after the gas cavity is ionized, the voltage across the cavity must drop below the $V_E$ level.

In prior gas discharge plasma panel systems, which used an electric probe to write and erase, the transition between voltage levels was accomplished by additively or subtractively combining the potential produced by a probe source with the potential produced by the electrode lines. In practice, this required that the probe be "hot" electrically and presented an obvious safety hazard to the operator. Additional electronic signal generators were also required. In the instant invention, the inherent properties of the electrical field about the gas cavity are altered without changing the voltage applied to the electrode line. In other words, the shape of the electrical field is altered, rather than altering the intensity of a quiescently shaped field.

FIG. **3** shows part of spacer **3** containing a single cell **4.** As previously explained, plates **2** and **5** are disposed on either side of the cell and effectively seal it to contain an ionizable gas at a predetermined pressure. The gas type and pressure combination may be varied to effect ionization at a particular potential level as is well known. Electrode **1** is positioned to overlay the lower part of the cell, but removed therefrom by the thickness of plate **2.** Electrode **6** is positioned to overlay the upper part of the cell and likewise is removed therefrom by the thickness of plate **5.** While electrode **1** may be configured to partially or wholly cover the base of cell **4,** electrode **6** should be configured so that it only partially covers the upper part of the cell. Electrode **6,** of course, represents the electrode, as shown in FIG. **1**a, having an aperture **9** aligned with and of slightly smaller area than the cell **4.** A thin transparent nonconducting sheet **7** may be disposed upon electrode **6** to physically and/or electrically insulate the electrode from the environment.

An a.c. source **10** is connected between electrodes **1** and **6.** Initially, preparatory to writing or erasing, the potential across the cell must be in the $V_S$ range (determined mathematically or empirically) and in the absence of the probe the field distribution will be as shown in FIG. **3.** This field strength, as determined by the selection of $V_S$, will be insufficient to initiate ionization but sufficient to maintain ionization once it commences. Superpositioning the probe **8** adjacent the electrode aperture significantly alters the electric field strength and distribution within the cell as a consequence of capacitive coupling between the probe and panel electrodes. For the condition where the side of a.c. source **10** connected to electrode **6** is coupled to ground **11** through, for example, a switch **50** positioned to a WRITE contact thereof, the presence of the probe produces a field distribution as shown in FIG. **4***a*. The induced increase in field strength shifts the effect of the applied electrode voltage from the $V_S$ range into a range above $V_F$, causing the gas to ionize even though the actual potential difference between the panel electrodes has not been altered. If desired, the probe may also be grounded to assure a zero potential difference between the probe and electrode **6.** When the probe is removed the field returns to the condition shown in FIG. **3** but the ionization process continues inasmuch as the effective potential is within the $V_S$ range.

Alternatively, when the side of a.c. source **10** connected to electrode **1** is coupled to ground through the switch **50,** now positioned to an ERASE contact thereof and in the presence of probe **8** positioned adjacent the cell, the field appears as shown in FIG. **4***b*. This causes an effective reduction in the field strength. The slow reduction in electric field which will occur with probe traverse speeds associated with normal writing

speeds results in permanent erasure of the cells, as is well known in the art. This is contrasted to abrupt reduction in the field, which does not result in erasure. It is believed that through several cycles, the static charg commonly referred to as "wall charge" will reduce and in combination with $V_s$ will no longer be sufficient to sustain ionization of the gas. Consequently, for probe erasure, the ionization ceases and the cell will no longer light even after removal of the probe. Likewise, a subsequent switching of a.c. voltage source **10** to the write mode (i.e., changing the ground reference) in the absence of the probe will not reionize the gas in the erased cells. Those cells that were not erased, of course, remain ionized.

The non-volatile memory capability of the device may range from milliseconds to seconds, depending on the construction techniques used. For a more detailed discussion see D. L. Bitzer and H. G. Slottow, "The Plasma Display Panel — A Digitally Addressable Display with Inherent Memory," Proceedings of the Fall Joint Computer Conference, San Francisco, Calif., November 1966.

Although the present invention has been explained above in terms of the switch **50** for selectively grounding the electrodes **1** and **6** of the device, it is appreciated that other equivalent grounding means may be utilized. For example, a grounding lead (not shown) may be selectively manually connected to either side of the voltage source **10** thereby providing the desired function.

It will be appreciated that although the invention has been described in terms of selectively grounding the electrodes in the WRITE and ERASE modes, ground or zero potential is merely exemplary of a reference potential to which the system may conveniently be referenced.

The structure of the panel is not limited to a cellular structure as described above to practice the teaching of the invention. A modified structure, such as a cell-less panel having an electrode matrix as described but a common rather than segregated gas envelope for each electrode intersection, is also capable of operation under the teaching of the invention. The write and erase modes of operation would be accomplished in the same manner and produce the same results. Ionization or de-ionization of undesired electrode intersections, however, is somewhat more critical than for the cellular structure. In any case, adequate control is obtainable by the physical sizing and spacing of the components.

The use of the device is distinctly and uniquely applicable as an interface device between man and computer. Manual inputs may be sensed by the computer in a number of ways. The sustaining signal may be periodically interrupted and then selectively applied to the cells for reading out information stored therein. Those cells which were previously lighted will relight upon selective reapplication of the sustaining signal and thus may be conveniently read out by a photocell. Alternatively, the cells may be interrogated by a current sensor. A reverse process may also be used whereby the computer selectively fires the cells for visual communication with an operator.

While the invention has been described in its preferred embodiment, it is to be understood that the words which have been used are words of description rather than limitation and that changes within the purview of the appended claims may be made without departing from the true scope of the invention in its broader aspects.

I claim:

**1.** In a gas discharge plasma display panel system including an a.c. gas discharge display cell for containing an ionizable gas, the combination comprising

first and second electrode means disposed on either side of said cell, respectively, for applying an a.c. gas discharge sustaining potential thereacross by connection to a source of a.c. gas discharge sustaining potential,

said first electrode means being constructed to expose a portion of said cell,

selective connection means coupled to said first and second electrode means for selectively grounding either said first or said second electrode means, and

passive probe means of electrically conductive material positionable in proximity to said exposed portion of said cell for selectively igniting or extinguishing a gas discharge in said cell in accordance with said selective connection means grounding said first or said second electrode means respectively and said probe positioned in proximity to said exposed portion of said cell.

**2.** In the system of claim **1** in which said probe means comprises a passive probe without electrical connection thereto

**3.** In the system of claim **1** in which said probe means comprises a passive grounded probe.

**4.** In the system of claim **1** in which

said first electrode means comprises an electrode having an aperture adjacent said cell thereby exposing said portion thereof,

said probe means includes a tip of electrically conductive material having a surface area at least as large as said aperture.

**5.** In the system of claim **1** in which said first electrode means comprises an electrode having a width adjacent said cell less than that of said cell thereby exposing said portion thereof.

**6.** In the system of claim **1** in which said gas discharge display cell comprises

a central member having a cavity for containing said ionizable gas, and

first and second electrically insulating members disposed on either side of said central member and sealing either side of said cavity for electrically insulating said first and second electrode means from said cavity, respectively, thereby providing capacitive coupling between said electrode means and said cavity.

* * * * *