United States Patent [19]

Brown

[11] **3,821,748**

[45] **June 28, 1974**

[54] **RECORDING OF INFORMATION FROM GASEOUS DISCHARGE DISPLAY/MEMORY PANEL**

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[73] Assignee: **Owens-Illinois, Inc.,** Toledo, Ohio

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[21] Appl. No.: **101,102**

[52] **U.S. Cl.** ..... **346/74 P,** 340/173 PL

[51] **Int. Cl.** .. **H01j 17/48,** H01j 61/33, H05b 41/44

[58] **Field of Search** ..... 346/74 ES, 74 P; 355/3, 355/5, 10; 307/88 ET; 340/173 PL

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[57] **ABSTRACT**

There is disclosed the generating and recording of image information from a multiple gaseous discharge display/memory panel having an electrical memory and capable of simultaneously producing information in the form of a visual or latent image, the panel being further characterized by an ionizable gaseous medium in a gas chamber formed by a pair of opposed dielectric material charge storage members which are respectively backed by a series of parallel-like conductor (electrode) members, the conductor members behind each dielectric material member being transversely oriented with respect to the conductor members behind the opposing dielectric material member so as to define a plurality of discrete discharge volumes, each of which constitutes a discharge unit, the visual or latent image being comprised of one or more discharge units, and image radiation from the discharge units being projected onto a photosensitive surface adapted to receive and record the image. The projected image radiation may be visible or latent (invisible) relative to the human eye.

12 Claims, 5 Drawing Figures

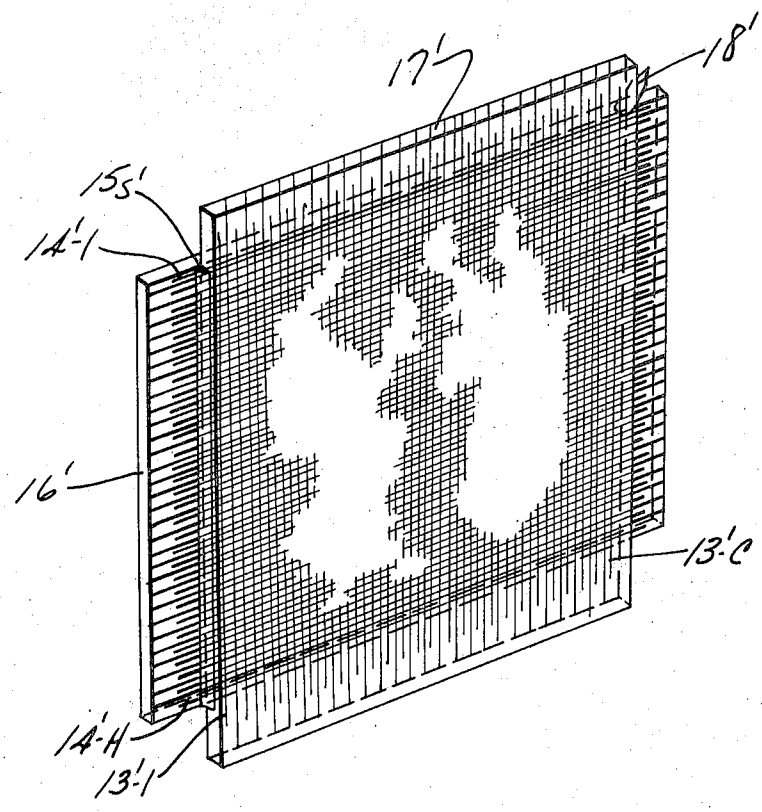


FIG. 2

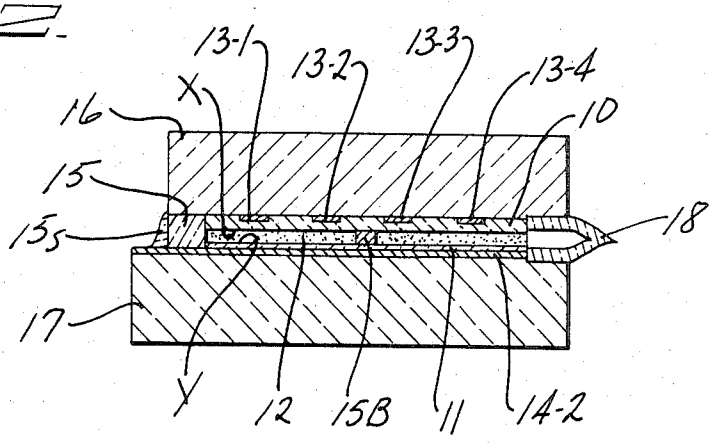

13-1
13-2
13-3
13-4
X
16
10
15
15s
18
17
Y
12
15B
11
14-2

FIG. 1

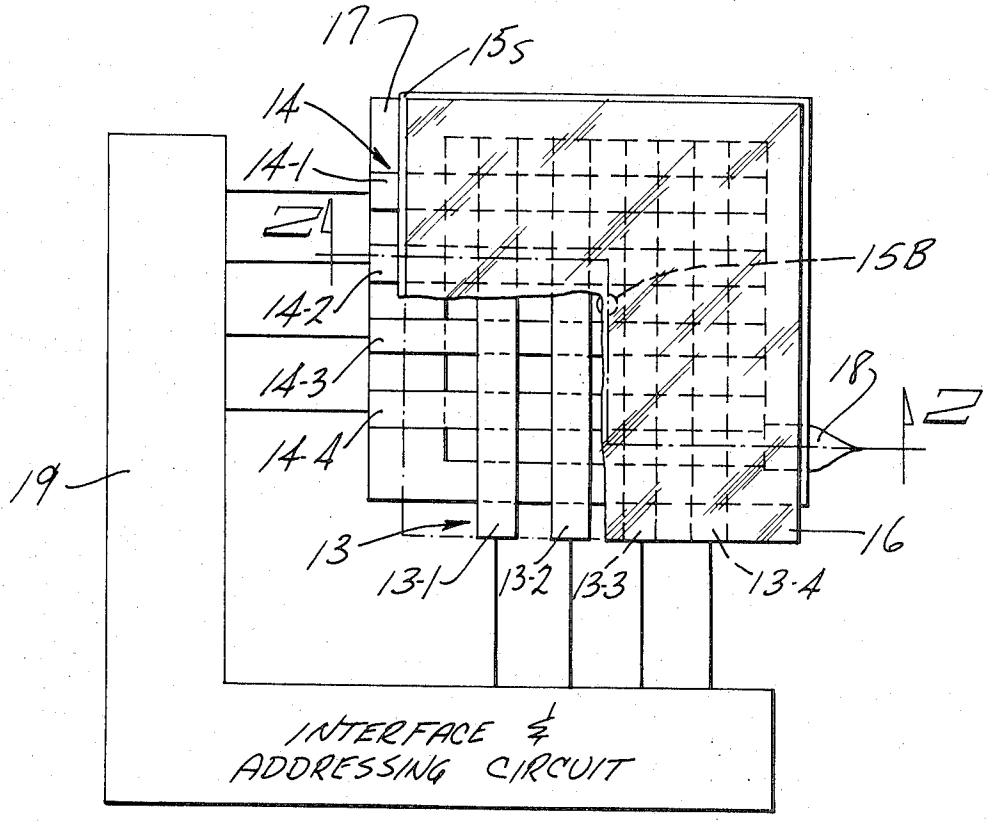

17
15s
14
14-1
Z
15B
14-2
14-3
18
Z
14-4
19
16
13
13-1
13-2
13-3
13-4
INTERFACE & ADDRESSING CIRCUIT

FIG. 3

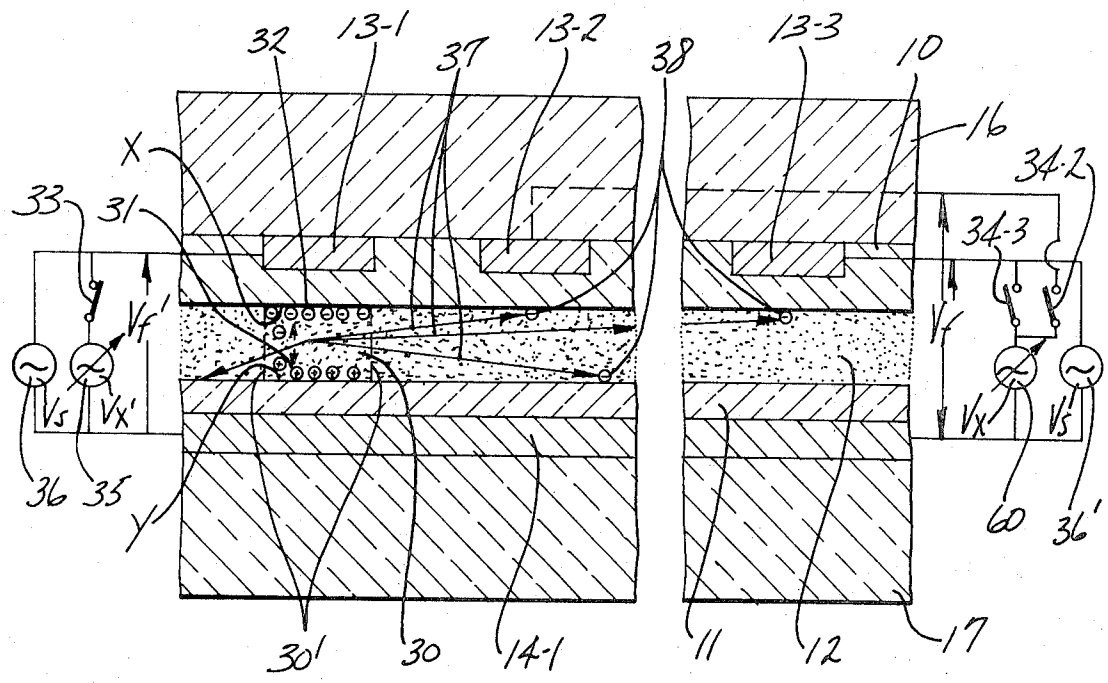
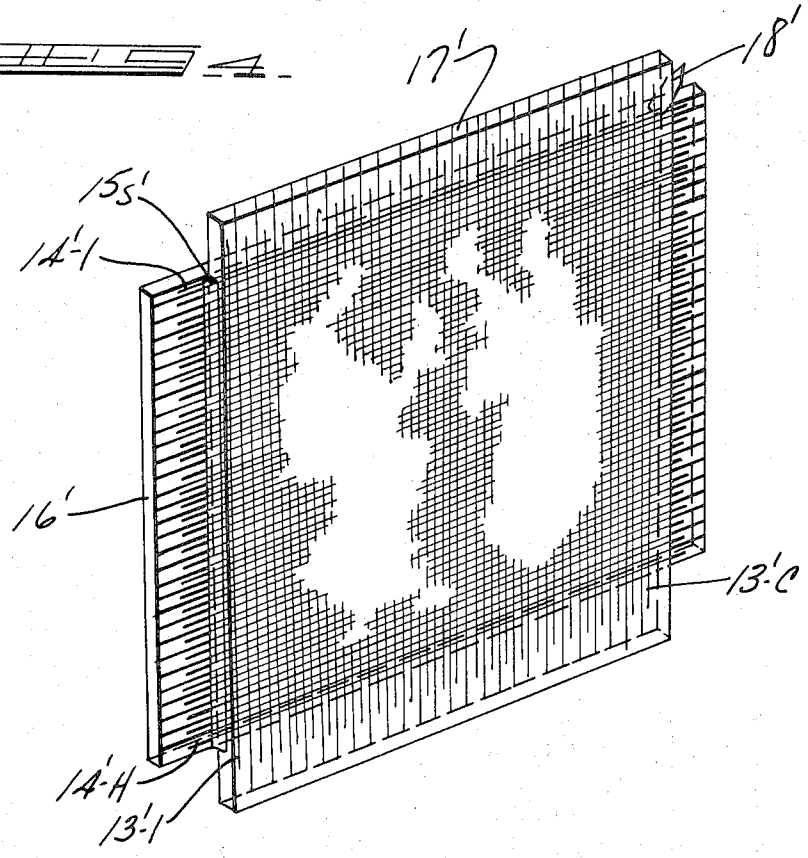

32
13-1
37
13-2
38
13-3
10
16
34-2
34-3
X
33
31
Vf'
Vs
Vx'
Vf
Vx
Vs'
36
35
Y'
60
36'
30'
30
14-1
11
12
17

FIG. 4


17'
18'
15s'
14'-1
16'
13'c
14'-H
13'-1

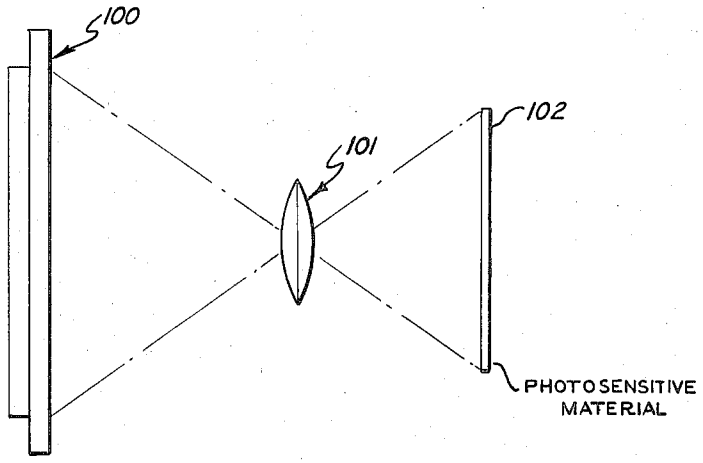


FIG. 5

RECORDING OF INFORMATION FROM GASEOUS DISCHARGE DISPLAY/MEMORY PANEL

THE INVENTION

This invention relates to novel multiple gas discharge display/memory panels which have an electrical memory and which are capable of producing a visual image display or a latent image, e.g. a representation of data such as numerals, letters, television display, radar displays, binary words, etc. More particularly, this invention relates to the generating and recording of visual or latent information from a gas discharge display/memory panel.

Multiple gas discharge display and/or memory panels of the type with which the present invention is concerned are characterized by an ionizable gaseous medium, usually a mixture of at least two gases at an appropriate gas pressure, in a thin gas chamber or space between a pair of opposed dielectric charge storage members which are backed by conductor (electrode) members, the conductor members backing each dielectric member being transversely oriented to define a plurality of discrete discharge volumes, each of which constitutes a discharge unit. In some prior art panels the discharge units are additionally defined by surrounding or confining physical structure such as by cells or apertures in perforated glass plates and the like so as to be physically isolated relative to other units. In either case, with or without the confining physical structure, charges (electrons, ions) produced upon ionization of the gas of a selected discharge unit, when proper alternating operating potentials are applied to selected conductors thereof, are collected upon the surfaces of the dielectric at specifically defined locations and constitute an electrical field opposing the electrical field which created them so as to terminate the discharge for the remainder of the half cycle and aid in the initiation of a discharge on a succeeding opposite half cycle of applied voltage, such charges as are stored constituting an electrical memory.

Thus, the dielectric layers prevent the passage of any conductive current from the conductor members to the gaseous medium and also serve as collecting surfaces for ionized gaseous medium charges (electrons, ions) during the alternate half cycles of the A.C. operating potentials, such charges collecting first on one elemental or discrete dielectric surface area and then on an opposing elemental or discrete dielectric surface area on alternate half cycles to constitute an electrical memory.

An example of a panel structure containing non-physically isolated or open discharge units is disclosed in U.S. Letters Patent 3,499,167 issued to Theodore C. Baker et al.

An example of a panel containing physically isolated units is disclosed in the article by D. L. Bitzer and H. G. Slottow entitled "The Plasma Display Panel — A Digitally Addressable Display With Inherent Memory," Proceeding of the Fall Joint Computer Conference, IEEE, San Francisco, California, Nov. 1966, pages 541–547.

In the operation of the panel, a continuous volume of ionizable gas is confined between a pair of dielectric surfaces backed by conductor arrays forming matrix elements. The cross conductor arrays may be orthogonally related (but any other configuration of conductor arrays may be used) to define a plurality of opposed pairs of charge storage areas on the surfaces of the dielectric bounding or confining the gas. Thus, for a conductor matrix having H rows and C columns the number of elemental discharge volumes will be the product $H \times C$ and the number of elemental or discrete areas will be twice the number of elemental discharge volumes.

The gas is one which produces light (if visual display is an objective) and a copious supply of charges (ions and electrons) during discharge. In an open cell Baker, et al. type panel, the gas pressure and the electric field are sufficient to laterally confine charges generated on discharge within elemental or discrete volumes of gas between opposed pairs of elemental or discrete dielectric areas within the perimeter of such areas, especially in a panel containing non-isolated units.

As described in the Baker et al. patent, the space between the dielectric surfaces occupied by the gas is such as to permit photons generated on discharge in a selected discrete or elemental volume of gas to pass freely through the gas space and strike surface areas of dielectric remote from the selected discrete volumes, such remote, photon struck dielectric surface areas thereby emitting electrons so as to condition other and more remote elemental volumes for discharges at a uniform applied potential.

With respect to the memory function of a given discharge panel, the allowable distance or spacing between the dielectric surface depends, inter alia, on the frequency of the alternating current supply, the distance typically being greater for lower frequencies.

While the prior art does disclose gaseous discharge devices having externally positioned electrodes for initiating a gaseous discharge, sometimes called "electrodeless discharges," such prior art devices utilize frequencies and spacings of discharge volumes and operating pressures such that although discharges are initiated in the gaseous medium, such discharges are ineffective or not utilized for charge generation and storage in the manner of the present invention.

The term "memory margin" is defined herein as

$$M.M. = V_f - V_s / V_s$$

where V_f is the magnitude of the applied voltage at which a discharge is initiated in a discrete conditioned (as explained in the aforementioned Baker, et al. patent) volume of gas defined by common areas of overlapping conductors and V_s is the magnitude of the minimum applied periodic alternating voltage sufficient to sustain discharges once initiated. It will be understood that basic electric phenomena utilized in this invention is the generation of charges (ions and electrons) alternately storable at pairs of opposed or facing discrete points or areas on a pair of dielectric surfaces backed by conductors connected to a source of operating potential. Such stored charges result in an electrical field opposing the field produced by the applied potential that created them and hence operate to terminate ionization in the elemental gas volume between opposed or facing discrete points or areas of dielectric surface. The term "sustain a discharge" means producing a sequence of momentary discharges, one discharge for each half cycle of applied alternating sustaining voltage, once the elemental gas volume has been fired, to maintain alternate storing of charges at pairs of opposed discrete areas on the dielectric surfaces.

The features and advantages of the invention will be better understood by reference to the following detailed description when considered in connection with the accompanying drawings. FIGS. 1 – 4 and the description of these figures are from the above mentioned Baker et al. U.S. Pat. No. 3,499,167.

FIG. 1 is a partially cut-away plan view of a gaseous display/memory panel as connected to a diagrammatically illustrated source of operating potentials,

FIG. 2 is a cross-sectional view (enlarged, but not to proportional scale since the thickness of the gas volume, dielectric members and conductor arrays have been enlarged for purposes of illustration) taken on the lines 2—2 of FIG. 1,

FIG. 3 is an explanatory partial cross-sectional view similar to FIG. 1 (enlarged, but not to proportional scale),

FIG. 4 is an isometric view of a larger gaseous discharge display/memory panel, and

FIG. 5 is a diagrammatic view of the combination of the gaseous discharge display/memory panel and a photosensitive element of a recording device.

The invention utilizes a pair of dielectric films or coatings **10** and **11** separated by a thin layer or volume of a gaseous discharge medium **12**, said medium **12** producing a copious supply of charges (ions and electrons) which are alternately collectable on the surfaces of the dielectric members at opposed or facing elemental or discrete areas X and Y defined by the conductor matrix on nongas-contacting sides of the dielectric members, each dielectric member presenting large open surface areas and a plurality of pairs of elemental X and Y areas. While the electrically operative structural members such as the dielectric members **10** and **11** and conductor matrixes **13** and **14** are all relatively thin (being exaggerated in thickness in the drawings) they are formed on and supported by rigid nonconductive support members **16** and **17** respectively. Preferably, one or both of nonconductive support members **16** and **17** pass light produced by discharge in the elemental gas volumes. Preferably, they are transparent glass members and these members essentially define the overall thickness and strength of the panel. For example, the thickness of gas layer **12** as determined by spacer **15** is under 10 mils and preferably about 5 to 6 mils, dielectric layers **10** and **11** (over the conductors at the elemental or discrete X and Y areas) is between 1 and 2 mils thick, and conductors **13** and **14** about 8,000 angstroms thick (tin oxide). However, support members **16** and **17** are much thicker (particularly larger panels) so as to provide as much ruggedness as may be desired to compensate for stresses in the panel. Support members **16** and **17** also serve as heat sinks for heat generated by discharges and thus minimize the effect of temperature on operation of the device. If it is desired that only the memory function be utilized, then none of the members need be transparent to light although for purposes described later herein it is preferred that one of the support members and members formed thereon be transparent to or pass ultraviolet radiation.

Except for being nonconductive or good insulators the electrical properties of support members **16** and **17** are not critical. The main function of support members **16'** and **17** is to provide mechanical support and strength for the entire panel, particularly with respect to pressure differential acting on the panel and thermal shock. As noted earlier, they should have thermal expansion characteristics substantially matching the thermal expansion characteristics of dielectric layers **10** and **11**. Ordinary one-fourth inch commercial grade soda lime plate glasses have been used for this purpose. Other glasses such as low expansion glasses or transparent devitrified glasses can be used provided they can withstand processing and have expansion characteristics substantially matching expansion characteristics of the dielectric coatings **10** and **11**. For given pressure differentials and thickness of plates the stress and deflection of plates may be determined by following standard stress and strain formulas (see R. J. Roark, Formulas for Stress and Strain, McGraw-Hill, 1954).

Spacer **15** may be made of the same glass material as dielectric films **10** and **11** and may be an integral rib formed on one of the dielectric members and fused to the other members to form a bakeable hermetic seal enclosing and confining the ionizable gas volume **12**. However, a separate final hermetic seal may be effected by a high strength devitrified glass sealant **15S**. Tubulation **18** is provided for exhausting the space between dielectric members **10** and **11** and filling that space with the volume of ionizable gas. For large panels small bead like solder glass spacers such as shown at **15B** may be located between conductors intersections and fused to dielectric members **10** and **11** to aid in withstanding stress on the panel and maintain uniformity of thickness of gas volume **12**.

Conductor arrays **13** and **14** may be formed on support members **16** and **17** by a number of well known processes, such as photoetching, vacuum deposition, stencil stressing, etc. In the panel shown in FIG. **4**, the center spacing of conductors in the respective arrays is about 30 mils. Transparent or semitransparent conductive material such as tin oxide, gold or aluminum can be used to form the conductor arrays and should have a resistance less than 3,000 ohms per line. It is important to select a conductor material that is not attacked during processing by the dielectric material.

It will be appreciated that conductor arrays **13** and **14** may be wires or filaments of copper, gold, silver or aluminum or any other conductive metal or material. For example, 1 mil wire filaments are commercially available and may be used in the invention. However, formed in situ conductor arrays are preferred since they may be more easily and uniformly placed on and adhered to the support plates **16** and **17**.

Dielectric layer members **10** and **11** are formed of an inorganic material and are preferably formed in situ as an adherent film or coating which is not chemically or physically effected during bake-out of the panel. One such material is a solder glass such as Kimble SG–68 manufactured by and commercially available from the assignee of the present invention.

This glass has thermal expansion characteristics substantially matching the thermal expansion characteristics of certain soda-lime glasses, and can be used as the dielectric layer when the support members **16** and **17** are soda-lime glass plates. Dielectric layers **10** and **11** must be smooth and have a dielectric strength of about 1,000 v. and be electrically homogeneous on a microscopic scale (e.g., no cracks, bubbles, crystals, dirt, surface films, etc.). In addition, the surfaces of dielectric layers **10** and **11** should be good photoemitters of electrons in a baked out condition. However, a supply of free electrons for conditioning gas **12** for the ionization

process may be provided by inclusion of a radioactive material within the glass or gas space. A preferred range of thickness of dielectric layers 10 and 11 overlying the conductor arrays 13 and 14 is between 1 and 2 mils. Of course, for an optical display at least one of dielectric layers 10 and 11 should pass light generated on discharge and be transparent or translucent and, preferably, both layers are optically transparent.

The preferred spacing between surfaces of the dielectric films is about 5 to 6 mils with conductor arrays 13 and 14 having center to center spacing of about 30 mils.

The ends of conductors 14-1 . . . 14-4 and support member 17 extend beyond the enclosed gas volume 12 and are exposed for the purpose of making electrical connection to interface and addressing circuitry 19. Likewise, the ends of conductors 13-1 . . . 13-4 on support member 16 extend beyond the enclosed gas volume 12 and are exposed for the purpose of making electrical connection to interface and addressing circuitry 19.

As in known display systems, the interface and addressing circuitry or system 19 may be relatively inexpensive line scan systems or the somewhat more expensive high speed random access systems. However, it is to be noted that a lower amplitude of operating potentials helps to reduce problems associated with the interface circuitry between the addressing system and the display/memory panel per se. Thus, by providing a panel having greater uniformity in the discharge characteristics throughout the panel, tolerances and operating characteristics of the panel with which the interfacing circuitry cooperate, are made less rigid.

One mode of initiating operation of the panel will be described with reference to FIG. 3, which illustrates the condition of one elemental gas volume 30 having an elemental cross-sectional area and volume which is quite small relative to the entire volume and cross-sectional area of gas 12. The cross-sectional area of volume 30 is defined by the overlapping common elemental areas of the conductor arrays and the volume is equal to the product of the distance between the dielectric surfaces and the elemental area. It is apparent that if the conductor arrays are uniform and linear and are orthogonally (at right angles to each other) related each of elemental areas X and Y will be squares and if conductors of one conductor array are wider than conductors of the other conductor array, said areas will be rectangles. If the conductor arrays are at transverse angles relative to each other, other than 90°, the areas will be diamond shaped so that the cross-sectional shape of each volume is determined solely in the first instance by the shape of the common area of overlap between conductors in the conductor arrays 13 and 14. The dotted lines 30 are imaginary lines to show a boundary of one elemental volume about the center of which each elemental discharge takes place. As described earlier herein, it is known that the cross-sectional area of the discharge in a gas is affected by, inter alia, the pressure of the gas, such that, if desired, the discharge may even be constricted to within an area smaller than the area of conductor overlap. By utilization of this phenomena, the light production may be confined or resolved substantially to the area of the elemental cross-sectional area defined by conductor overlap. Moreover, by operating at such pressure charges (ions and electrons) produced on discharge are laterally confined so as to not materially affect operation of adjacent elemental discharge volumes.

In the instant shown in FIG. 3, a conditioning discharge about the center of elemental volume 30 has been initiated by application to conductor 13-1 and conductor 14-1 firing potential V_x' as derived from a source 35 of variable phase, for example, and source 36 of sustaining potential V_s (which may be a sine wave, for example). The potential V_x' is added to the sustaining potential V_s as sustaining potential V_s increases in magnitude to initiate the conditioning discharge about the center of elemental volume 30 shown in FIG. 3. There, the phase of the source 35 of potential V_x' has been adjusted into adding relation to the alternating voltage from the source 36 of sustaining voltage V_s to provide a voltage V_f', when switch 33 has been closed, to conductors 13-1 and 14-1 defining elementary gas volume 30 sufficient (in time and/or magnitude) to produce a light generating discharge centered about discrete elemental gas volume 30. At the instant shown, since conductor 13-1 is positive, electrons 32 have collected on and are moving to an elemental area of dielectric member 10 substantially corresponding to the area of elemental gas volume 30 and the less mobile positive ions 31 are beginning to collect on the opposed elemental area of dielectric member 11 since it is negative. As these charges build up, they constitute a back voltage opposed to the voltage applied to conductors 13-1 and 14-1 and serve to terminate the discharge in elemental gas volume 30 for the remainder of a half cycle.

During the discharge about the center of elemental gas volume 30, photons are produced which are free to move or pass through gas medium 12, as indicated by arrows 37, to strike or impact remote surface areas of photoemissive dielectric members 10 and 11, causing such remote areas to release electrons 38. Electrons 38 are, in effect, free electrons in gas medium 12 and condition each other discrete elemental gas volume for operation at a lower firing potential V_f which is lower in magnitude than the firing potential V_f' for the initial discharge about the center of elemental volume 30 and this voltage is substantially uniform for each other elemental gas volume.

Thus, elimination of physical obstructions or barriers between discrete elemental volumes, permits photons to travel via the space occupied by the gas medium 12 to impact remote surface areas of dielectric members 10 and 11 and provides a mechanism for supplying free electrons to all elemental gas volumes, thereby conditioning all discrete elemental gas volumes for subsequent discharges, respectively, at a uniform lower applied potential. While in FIG. 3, a single elemental volume 30 is shown, it will be appreciated that an entire row (or column) of elemental gas volumes may be maintained in a "fired" condition during normal operation of the device with the light produced thereby being masked or blocked off from the normal viewing area and not used for display purposes. It can be expected that in some applications there will always be at least one elemental volume in a "fired" condition and producing light in a panel, and in such application it is not necessary to provide separate discharge of generation of photons for purposes described earlier.

However, as described earlier, the entire gas volume can be conditioned for operation at uniform firing potentials by use of external or internal radiation so that

there will be no need for a separate source of higher potential for initiating an initial discharge. Thus, by radiating the panel with ultraviolet radiation or by inclusion of a radioactive material within the glass materials or gas space, all discharge volumes can be operated at uniform potentials from addressing and interface circuit **19**.

Since each discharge is terminated upon a build up or storage of charges at opposed pairs of elemental areas, the light produced is likewise terminated. In fact, light production lasts for only a small fraction or a half cycle of applied alternating potential and depending on design parameters, is in the nanosecond range.

After the initial firing or discharge of discrete elemental gas volume **30** by a firing potential V_f', switch **33** may be opened so that only the sustaining voltage V_s from source **36** is applied to conductors **13-1** and **14-1**. Due to the storage of charges (e.g., the memory) at the opposed elemental areas X and Y, the elemental gas volume **30** will discharge again at or near the peak of negative half cycles of sustaining voltage V_s to again produce a momentary pulse of light. At this time, due to reversal of field direction, electrons **32** will collect on and be stored on elemental surface area Y of dielectric member **11** and positive ions **31** will collect and be stored on elemental surface area X of dielectric member **10**. After a few cycles of sustaining voltage V_s, the times of discharges become symmetrically located with respect to the wave form of sustaining voltage V_s. At remote elemental volumes, as for example, the elemental volumes defined by conductor **14-1** with conductors **13-2** and **13-3**, a uniform magnitude or potential V_x from source **60** is selectively added by one or both of switches **34-2** or **34-3** to the sustaining voltage V_s, shown as **36'** to fire one or both of these elemental discharge volumes. Due to the presence of free electrons produced as a result of the discharge centered about elemental volume **30**, each of these remote discrete elemental volumes have been conditioned for operation at uniform firing potential V_f.

In order to turn "off" an elemental gas volume (i.e., terminate a sequence of discharge representing the "on" state), the sustaining voltage may be removed. However, since this would also turn "off" other elemental volumes along a row or column, it is preferred that the volumes be selectively turned "off" by application to selected "on" elemental volumes a voltage which can neutralize the charges stored at the pairs of opposed elemental areas.

This can be accomplished in a number of ways, as for example, varying the phase or time position of the potential from source **60** to where that voltage combined with the potential form source **36'** falls substantially below the sustaining voltage.

It is apparent that the plates **16–17** need not be flat but may be curved, curvature of facing surfaces of each plate being complementary to each other. While the preferred conductor arrangement is of the crossed grid type as shown, herein, it is likewise apparent that where an infinite variety of two dimensional display patterns are not necessary, as where specific standarized visual shapes (e.g. numerals, letters, words, etc.) are to be formed and image resolution is not critical, the conductors may be shaped accordingly.

The device shown in FIG. **4** is a panel having a large number of elemental volumes similar to elemental volume **30** (FIG. **3**). In this case more room is provided to make electrical connection to the conductor arrays **13'** and **14'**, respectively, by extending the surfaces of support members **16'** and **17'** beyond seal **15S'**, alternate conductors being extended on alternate sides. Conductor arrays **13'** and **14'** as well as support members **16'** and **17'** are transparent. The dielectric coatings are not shown in FIG. **4** but are likewise transparent so that the panel may be viewed from either side.

In accordance with this invention, a latent or visual image is generated and recorded from a multiple gaseous discharge panel by projecting through a focusing lens **101** latent or visual image radiation from the gaseous discharges of the panel **100** onto the surface of a photosensitive material **102** as shown diagrammatically in FIG. **5** adapted to receive and record the image. It is contemplated that such projected radiation may be visible or invisible relative to the human eye; that is, the image as projected, received, recorded, and/or displayed may be any visible or invisible representation, likeness, copy, facsimile, etc., of the information represented by the gaseous discharge units.

As used herein, photosensitive surface is intended to include any plane or solid body of any suitable geometric shape, which plane or body is capable of receiving and recording the image radiation from the gaseous discharge. Also as used herein, recording is intended to include the storing, registering, duplicating, etc., of information in either visible or latent form corresponding to the projected image radiation. Such recording (or storing) can either be directly by the receiving surface or else modulated by such surface for recording or storing by a second surface member.

In the broad practice hereof, it is contemplated using a wide variety of materials and/or processes as the photosensitive surface.

In one specific embodiment, there is used a photoconductive insulating material capable of receiving and storing an image by means of persistent internal polarization.

Persistent internal polarization (abbreviated herein as PIP) involves the separation of positive and negative charges in a photoconductive insulating material by simultaneous irradiation and the application of an electric field. The charges are subsequently trapped and remain fixed or "frozen" in the photoconductor for a finite time to form an internal polarization field. This process and the theory thereof are well known in the art. See, for example, Electrophography by R. M. Schaffert, The Focal Press, London and New York (1965), pages 59–77, and Persistent Internal Polarization by Kallmann and Rosenberg, The Physical Review, vol. 97, No. 5 (Mar. 15, 1955), pages 1,596–1,610, both of which are incorporated herein by reference.

In this embodiment, the photosensitive surface is constructed out of a material capable of developing PIP when simultaneously exposed to irradiation from the gaseous discharge units and an electric field such that the panel image radiation is stored as a latent image via frozen or trapped charges within the PIP material. The latent image can be made into a visible image including hardcopy readout by means of a toner and toner receiving surface appropriately applied to the PIP surface, such PIP image development process being well known in the art.

The phenomenon of PIP can be achieved in any material which exhibits the following characteristics:

1. The material must have a high resistivity in the dark (a low density of free charges) whereby it is a good insulator in the absence of penetrating radiations such as light or high energy particles.
2. The material must be photoconductive; that is, it must have decreased resistivity when penetrated and excited with appropriate radiation.
3. The material must have a high density of carrier traps for trapping and freezing the charges separated by the simultaneous irradiation and application of the electric field.

Typical organic and inorganic PIP materials or substances contemplated in the practice of this invention include not by way of limitation zinc sulfide, cadmium sulfide, zinc selenide, cadmium selenide, zinc oxide, cadmium oxide, selenium, tellurium, anthracene, chrysene, alkaline earth halides, and mixtures of same, especially mixtures of selenium with tellurium, zinc-cadmium selenides, and zinc-cadmium sulfides. It is also contemplated that a small effective amount of a suitable activator, e.g. gold, silver, or copper, may be incorporated with the photoconducting PIP substance.

The commonly used powdered PIP materials are typically dispersed or mixed with a suitable resin binder such as a cellulose acetate, ether, or ester, silicones, vinyl resins, and/or epoxy resins.

In still another specific embodiment of this invention, the photosensitive receiving and recording surface comprises an ELECTROFAX process wherein there is used photoconductive pigment such as zinc oxide on a substrate such as a paper. This process differs from the PIP in that the panel image is directly reproduced on the photoconductive coated substrate and it does not have to be transferred to another surface. Likewise, it has the advantage that sensitized ELECTROFAX paper may be combined with negatively charged toner to give dark or light copy.

Another specific embodiment comprises the use of xerography, such as described in "Xerography and Related Processes" by John H. Dessauer and Harold E. Clark, Xerox Corporation, 1965, Focal Press.

In still a further embodiment hereof, there is used a system having the advantage of negative working, said system comprising image wise charge deposition onto a dielectric coated paper through a photoconductor sensitive to the radiation from the gaseous discharges. Such a system is described in U.S. Letters Patent 3,502,408.

This invention has several highly important advantages including photosensitive recording of an image from one side of a gaseous discharge panel while the image is being displayed and/or viewed from the other panel side without the use of mirrors.

Another most important advantage is that the image radiation emission can be different (if needed) for recording and for viewing, e.g. by the use of luminescent phosphors and various gaseous medium mixtures.

I claim:

1. In the operation of an apparatus comprising in combination a gaseous discharge display/memory panel and an image recording device, said panel being characterized by an ionizable gaseous medium in a gas chamber formed by a pair of dielectric material members having opposed charge storage surfaces, which dielectric material members are capable of transmitting light therethrough and are respectively backed by a series of parallel-like electrode members, the electrode members behind each dielectric material member being transversely oriented with respect to the electrode members behind the opposing dielectric material member so as to define a plurality of discrete discharge volumes, each of which constitutes a discharge unit, and wherein the gas is selectively ionized within each discharge unit by operating voltages applied to the transversely oriented electrode members, said image recording device being characterized by a photosensitive surface facing one of said dielectric material members for directly receiving and recording an image, the improvement which comprises generating an image comprised of one or more gaseous discharge units and then projecting image radiation from the discharge units in opposite directions through both said dielectric material members, said image radiation projected through said one dielectric material member being directly received and recorded on said photosensitive surface, whereby said image may be simultaneously observed directly through the other of said dielectric material members while it is being directly received and recorded on said photosensitive surface.

2. The improvement of claim **1** wherein the photosensitive surface is constructed out of a PIP material.

3. The improvement of claim **1** wherein the photosensitive surface comprises an ELECTROFAX system of photoconductive pigment on a substrate.

4. The improvement of claim **3** wherein the pigment is zinc oxide and the substrate is paper.

5. An image display and recording apparatus adapted to simultaneously display and record an image comprising in combination a gaseous discharge display/memory panel and an image recording device, said panel comprising an ionizable gaseous medium in a gas chamber formed by a pair of dielectric material members having opposed charge storage surfaces, which dielectric material members are capable of transmitting light therethrough and are respectively backed by a series of parallel-like electrode members, the electrode members behind each dielectric material member being transversely oriented with respect to the electrode members behind the opposing dielectric material member so as to define a plurality of discrete discharge volumes, each of which constitutes a discharge unit, and means for selectively applying operating voltages to said transversely oriented electrode members for selectively ionizing said discharge units for generating an image which is radiated in opposite directions through both said dielectric material members, and said image recording device including a photosensitive surface facing one of said dielectric material members for directly receiving and recording the image radiated from said discharge units through said one dielectric material member, whereby said image may be simultaneously observed directly through the other of said dielectric material members and directly received and recorded on said photosensitive surface.

6. The invention of claim **5** wherein the photosensitive surface is constructed out of a PIP material.

7. The invention of claim **5** wherein the photosensitive surface comprises an ELECTROFAX system of photoconductive pigment on a substrate.

8. The invention of claim **7** wherein the pigment is zinc oxide and the substrate is paper.

9. An image display and recording apparatus adapted to simultaneously display and record an image comprising in combination a gaseous discharge display/memory panel and an image recording device, said panel comprising a pair of spaced-apart non-conductive support members, a pair of conductor arrays arranged one on each of the confronting surfaces of said support members, the arrays being in transverse relative orientation so as to provide a series of cross-points therebetween, each defining a discharge unit, a thin dielectric material coating on the confronting surfaces of each of the support members and conductor arrays defining therebetween a sealed gas chamber, an ionizable gaseous medium contained in said chamber, said dielectric material coating being adapted to insulate said conductor arrays from said ionizable gaseous medium contained in said chamber and for storing charges emitted by said gaseous discharge and both said support members and dielectric material coatings being capable of transmitting light therethrough, and means for selectively applying operating voltages to said transversely oriented electrode members for selectively ionizing said discharge units for generating an image which is radiated in opposite directions through both said dielectric material coatings and support members; and said image recording device including a photosensitive surface facing one of said support members for directly receiving and recording the image radiated from said discharge units through said one support member whereby said image may be simultaneously directly observed through the other of said support members and directly received and recorded on said photosensitive surface.

10. The invention of claim 9 wherein the photosensitive surface is constructed out of a PIP material.

11. The invention of claim 9 wherein the photosensitive surface comprises an ELECTROFAX system of photoconductive pigment on a substrate.

12. The invention of claim 11 wherein the pigment is zinc oxide and the substrate is paper.

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