

Jan. 10, 1961

J. W. SCHWARTZ
LUMINOUS DISPLAY PANEL

2,967,965

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2 Sheets-Sheet 1

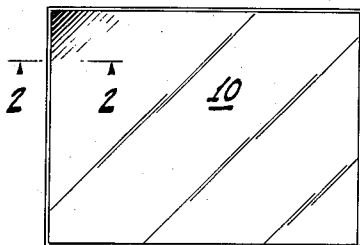


Fig. 1.

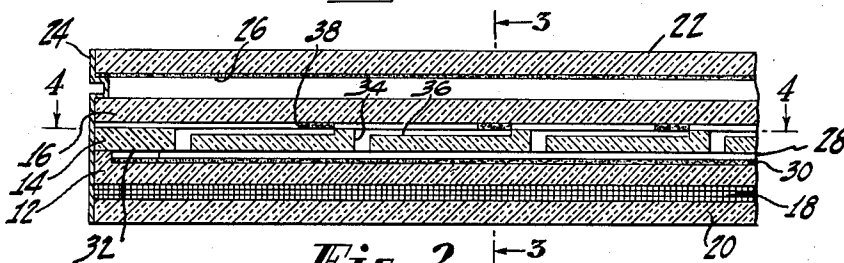


Fig. 2.

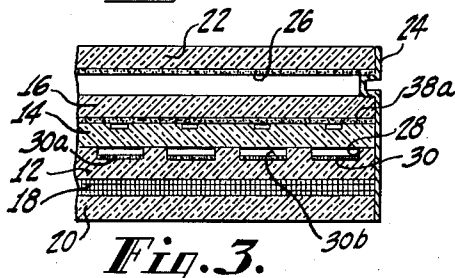


Fig. 3.

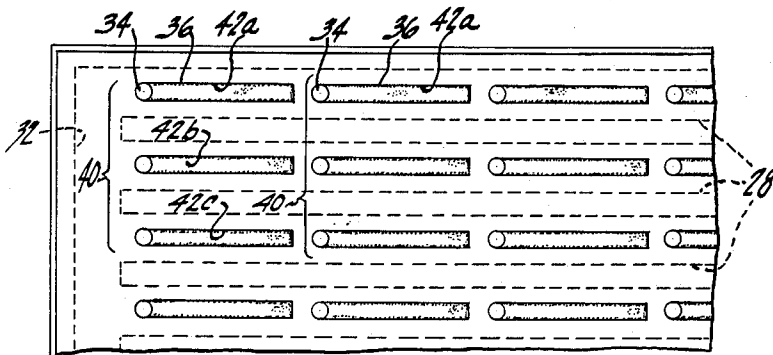


Fig. 4.

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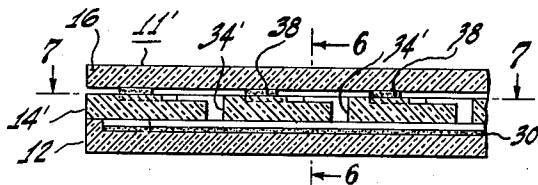


Fig. 5.

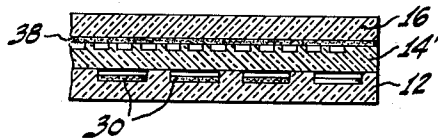


Fig. 6.

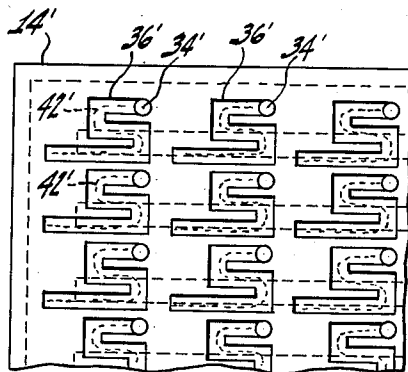


Fig. 7.

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2,967,965

LUMINOUS DISPLAY PANEL

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8 Claims. (Cl. 313—108)

This invention relates to luminous display panels useful for the reproduction of television images. It is directed particularly to panels of the type using gas discharges for producing the luminous display.

One type of display panel useful for reproducing television images utilizes two sets of conductors, one set being arranged horizontally and the other set serve as anodes. By applying energizing voltage to selected ones of horizontal and vertical conductors, the region where the conductors cross may be caused to glow. The inner section constitutes an elemental gas cell. The conductors may be switched at a desired rate to apply energizing voltage in sequence to produce a scanning affect. The intensity or the time of duration of the discharge at each point or picture element is indicative of the instantaneous brightness information of the incoming signal.

One serious problem in such display panels concerns the "sputtering" of metal from each of the cathode conductors. During the discharge, metal sputters from the cathode and deposits in areas nearby as a thin opaque film which interferes with the viewing of the display. Sputtering is caused by the bombardment of the cathode by positive ions.

Since there is communication between each of the elemental gas cells through the gaseous medium another problem with luminous display panels is the spreading of the glow discharge from an excited cell to an unexcited cell.

An object of this invention is to provide an improved luminous display panel.

Another object of this invention is to reduce sputtering in gas discharge luminous display panels.

Still another object of this invention is to reduce spreading of the glow discharge of active cells to inactive cells of gas discharge luminous display panels.

A further object is to provide a panel of gas cells having greater surface brightness than has heretofore been possible.

According to this invention several transparent non-conductive plates form a sandwich. The outer two plates have elongated conductors on their inside surfaces. The conductors of one set are perpendicular to the conductors of the other set. The conductors of one set communicate with the conductors of the other set through narrow elongated non-rectilinear gas cavities contained in the intermediate plate. The cavities are elongated in the plane of the center plate and connect elemental cathode and elemental anodes which are offset laterally with respect to each other. Any sputtering which occurs is confined to small areas adjacent to the cathode area, and the areas of the positive columns in which the luminous discharge takes place is relatively unaffected by sputtering.

In accordance with one important feature of the invention, the cross-sectional area of each elongated positive

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column is made small relative to the accessible cathode area. This permits higher currents to be passed in the cells without danger of sputtering and helps to achieve greater surface brightness.

In the various figures of the drawings, the same numeral is used to designate the same elements.

Figure 1 is a plan view showing the general form of a panel constructed in accordance with the teachings of the present invention;

Figure 2 is an enlarged partial sectional view taken along lines 2—2 of Figure 1;

Figure 3 is a section taken along lines 3—3 of Figure 2;

Figure 4 is a section taken along lines 4—4 of Figure 2;

Figure 5 is a partial sectional view of a modified panel in accordance with the invention;

Figure 6 is section taken along lines 6—6 of Figure 5; and

Figure 7 is a section taken along lines 7—7 of Figure 5.

Referring in detail to Figures 1—4, a form of the invention is shown for reproducing images. The display panel 10 comprises an assembly made up of three insulating plates 12, 14, 16, stacked together and sealed vacuum tight. The plates 12, 14, 16 may be cemented together by an epoxy resin applied to their contacting surfaces. The plates contain an assembly of cells and passageways which are filled with gas such as mercury vapor, neon, argon, or the like. The total gas pressure may be about 5 mm. of mercury, with the mercury vapor making up less than 10% of the pressure.

Mercury vapor performs more satisfactorily at an elevated temperature of about 100° C. Heater wires 18 are mounted adjacent to one of the plates 12. The wires 18 are covered with heat insulation material 20. To contain the heat within the panel and maintain the exterior cool, a glass plate 22 may be spaced from the sealed plate assembly by a metal framing member 24. The glass plate 22 is coated on its inside surface with a thin metallic film 26, such as tin oxide, which is transparent to visible light, but which is highly reflective in the infrared. Alternatively current may be passed through the tin oxide coating for heating the assembly by attaching conductors to the opposite sides of the metallic film coating 26. The space between the coated plate 20 and the plate assembly is filled with dry air at atmospheric pressure.

The back plate 12 is provided on its inside surface with an array of long ducts 28. The ducts 28 are all parallel to each other and have conductive strip coatings 30. The ducts 28 are connected together at one end by a single duct 32 running transversely, so that the gas pressure may be equalized in all the ducts. The connecting duct 32 is not coated, for it is essential that the strip coatings 30 be mutually insulated electrically. The strip coatings 30 serve as cathode buses when connected to a source of electric potential.

The middle plate 14 is provided with a great many cavities registered with the strip coatings 30 and extending from side to side of the plate. Each cavity comprises a perforation 34 (Figure 4) and a relatively long and narrow connecting phosphor coated groove 36 in the plate surface which is away from the strip coatings 30. Thus, the cavities may be described as bent, angular, crooked, or otherwise non-rectilinear. The grooves 36 can be semi-cylindrical in shape. The diameter of each groove 36 and connecting perforation 34 is small compared to the width of each strip coating 30.

The third plate 16 is provided on its inside surface with an array of conductive strips 38 (Figure 2) which run perpendicularly to the strip coatings 30. Strips 38 are

so thin that the plates 14 and 16 can be considered for all practical purposes as being in direct contact with each other. The strips 38 may be made of thin metal, such as gold, silver, or tin oxide. The strips 38 are aligned with the ends of the grooves 36 opposite the perforations 34. The strips 38 serve as anode buses when connected to a source of potential which is positive relative to the potential of the strip coatings 30 constituting the cathode buses.

Only the plates 16 and 22 need be transparent, for they are the plates through which the display is viewed. The other two plates 12 and 14 may or may not be transparent.

At each intersection of the cathode bus 30 and the anode bus 38 there is produced an elemental gas cell. A small anode area is defined by the portion of the anode bus 38 registered with the end of the groove 36. A cathode area is defined by the portion of the cathode bus 30 adjacent to the perforation 34. The gas cell consists of a portion of the gas medium contained in the groove 36 and perforation 34 communicating between said anode and cathode areas. The part of the cell constituted by the elongated groove 36 corresponds to the positive column region of the gas discharge and hence is referred to as an extended positive column. Any one of these gas cells can be made to light up by applying voltage to the proper cathode and anode buses. For example, if the anode bus 38a is made sufficiently positive with respect to the cathode bus 30a, the area at the intersection of these buses will glow. Similarly, if the anode bus 38a is made sufficiently positive with respect to the cathode bus 30b, the areas at their intersection will glow. Thus, by the proper switching of voltages in any well known fashion between the buses, any and all intersection points can be made to glow.

For reproducing images in color, the gas cells are arranged in trios 40, as shown in Figure 4. The grooves 36 in the middle plate 14 are arranged in groups of three, each trio 40 occupying an approximately square area corresponding to a picture element. The grooves of each trio bear different color emitting phosphor coatings 42a, 42b, 42c, which are excitable by ultra-violet light from the mercury vapor discharge to emit red, green, and blue light respectively. The material for the red emitting coating 42a may be cubic zinc selenide activated with copper; the material for the green emitting coating 42b may be zinc orthosilicate; and the material for the blue emitting coating may be calcium tungstate.

A number of advantages result from forming the cavities in the manner described. In the first place, by offsetting the elementary cathode from the anode by an extended positive column, the cathode sputtering path is considerably extended, and being an angular, bent, or crooked path it presents an obstruction to the deposition of cathode material from strip coatings 30 over the areas of the cells in general. Such deposition normally forms opaque regions which would reduce the light output. Hence, if sputtering does occur, it will occur only directly above the cathode in a small area of the plate 16 registered with the small perforation 34. No sputtering and no deposit will take place beyond the bend in the gas path in the extended positive column region, where most of the luminous emission occurs.

By making the positive column narrow as compared to the width of the cathode bus 30 and by disposing the cathode buses 30 in ducts 28, the cathode glow access area is markedly increased. That is, any time a particular cell is energized, the entire length and width of the strip coating 30 is available for distribution of the cathode glow. Hence, a great amount of current can be passed in a given cell and the cathode will remain in the normal glow condition. Since sputtering does not occur when the cathode is in the normal glow condition, it is seen that high currents can be passed without danger of sputtering. As a corollary to the passage of the high currents

through the cells, the brightness of the luminous discharge is increased. While the cathode glow access area may extend far beyond the region of the particular energized gas cell, the cathode glow is far too dim compared to the bright positive column region to affect the resolution.

The elemental gas cells communicate with each other through the ducts, and it would appear that the gas discharge in a lighted cell might spread to adjacent cells which normally should remain unenergized. However, since there are conductors, in this case the cathode strip coatings 30, disposed in the ducts there is no potential gradient along the length of each duct and there will be no plasma generation along the duct.

In the embodiment of Figures 5, 6 and 7, a modified plate assembly 11' is shown. Here a folded or double bend type of positive column cavity is used, which is more compact than the single bend cavity previously described. In the embodiment shown in Figures 5, 6 and 7, the middle plate 14' contains S-shaped cavities, each which is made up of a perforation 34' and an S-shaped groove 36' (Figure 7). The perforations 34', at one end of the S-shaped groove 36' are registered with the cathode buses 30 and the other ends of the S-shaped groove 36' are registered with the anode buses 38. Phosphor coatings 42' in this case may be all of one emission color, such as any of the well known white emitting photoluminescent phosphors or phosphor combinations. Otherwise the structure of the panel may be the same as that shown in Figures 1 through 4.

By means of the invention, a luminous display panel of the gas discharge type is provided in which cathode sputtering defects are minimized, spreading of the discharge to unwanted areas is prevented, and greater brightness is achieved. The panel is of simple and inexpensive construction.

Having thus described the invention, what is claimed is:

1. A luminous display panel including a first set of spaced apart conductors extending in one direction and in a single plane, a second set of spaced apart conductors extending in a direction transverse to the extension of said first set and in a plane parallel to the plane of said first set of conductors, and a member between said conductors having a multiplicity of elongated nonrectilinear cavities, said conductors of the first set communicating through and along the elongated dimension of said cavities with the conductors of the second set.

2. A luminous display panel including a first set of spaced apart conductors extending in one direction and in a single plane, a second set of spaced apart conductors extending in a direction transverse to the extension of said first set and in a plane parallel to the plane of said first set of conductors, a member between said sets of conductors and having a multiplicity of elongated nonrectilinear phosphor coated cavities containing mercury and extending between points on conductors of the first set of conductors and points on conductors of the second set of conductors, said cavities extending for a greater portion of their length in a plane parallel to the planes of said conductors, and heater means for raising the temperature of said cavities to vaporize said mercury.

3. A display panel comprising an envelope of extended length and width dimensions relative to its depth, a gaseous filling in said envelope, a member positioned in said envelope having non-rectilinear elongated cavities having a length greater than the depth of said envelope, and a multiplicity of laterally spaced cathode and anode elements in communication with each other through said elongated cavities extending therebetween.

4. A display panel comprising a substantially planar envelope, a gaseous filling within said envelope, a first set of spaced apart conductors extending in one direction, a second set of spaced conductors extending in a transverse direction and spaced within said envelope from said first set, and a multiplicity of bent elongated cavity elements extending between the conductors of

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said first set and the conductors of said second set, said cavity elements extending substantially in the plane of said envelope.

5. A luminous display panel comprising a first insulating sheet having a plurality of elongated ducts extending in one direction across a surface thereof, conductive coatings in said ducts, a second insulating sheet on the duct-bearing surface of said first sheet, a plurality of elongated nonrectilinear cavities in said second sheet, and a third insulating sheet on said second sheet and provided on its side adjacent to said second sheet with a plurality of elongated conductors extending transverse to said conductive coatings to produce a plurality of points of intersection, said conductors communicating with said conductive coatings through and along the elongated dimension of said plurality of elongated cavities in said second sheet.

6. A luminous display device comprising a first array of elongated conductors supported on a first insulating sheet, a second array of elongated conductors supported on a second insulating sheet and spaced from the first array by a third insulating sheet, the first array being arranged transverse to the second array, said third sheet containing a plurality of co-planar elongated cavities each consisting of a surface groove portion and an aperture through said third sheet communicating with its surface groove portion and connecting said first and second arrays, and a filling of ionizable gas in said cavities.

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7. The invention as in claim 6, wherein said surface groove portions have generally an S-shape.

8. A luminous display panel of the gas discharge type comprising a plate assembly of extended length and with dimensions relative to its depth and made up of three sandwiched insulating plates, a first one of said plates being provided with a plurality of mutually spaced ducts extending along one surface thereof, strip-like coatings in said ducts and coextensive therewith; a second one of said plates being spaced from said first plate by a third plate and bearing on its surface adjacent to said third plate a plurality of mutually spaced conductive strips extending transverse to said strip-like coatings and forming a plurality of intersections; and said third plate containing a plurality of elongated cavity elements providing communication along the elongated dimension thereof between said strips and strip-like coatings, each cavity element being defined by a perforation spaced from an intersection and opening into a duct, and further defined by a groove extending between said perforation and a conductive strip.

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