MULTI-POSITION CHARACTER DISPLAY PANEL

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ABSTRACT
The display panel is gas-filled and includes a base plate on which a plurality of groups of cathodes and their conductors are formed, each group of cathodes being operable to display a character. The panel also includes a face plate, spaced from the base plate, and carrying transparent conductive anodes, each associated with one group of cathodes. The panel includes a tubulation secured to the base plate through which gas and mercury vapor are introduced into the panel through a hole in the panel base plate. A fine mesh nickel screen is disposed in the tubulation adjacent to the hole in the base plate to prevent an excess of free mercury from entering the panel and, at the same time, to provide a source of mercury by way of the mercury which amalgamates with the screen.

21 Claims, 2 Drawing Figures
MULTI-POSITION CHARACTER DISPLAY PANEL

CROSS-REFERENCE TO RELATED APPLICATION

This application is a Continuation of application Ser. No. 224,069, filed Feb. 7, 1972.

BACKGROUND OF THE INVENTION

It is customary in cathode glow discharge devices, such as the display panel described above, to include mercury vapor in the gas atmosphere to minimize cathode sputtering. Generally, the mercury is introduced from a small glass capsule held in the tubulation which is secured to the panel base plate and communicates with the interior of the panel by way of a small hole in the base plate. The glass capsule containing the mercury is broken at a suitable time in the manufacture of the panel, after the tubulation has been sealed off, to release the mercury and to permit its vapor to enter the panel through the hole in the base plate.

The mercury provided in the glass capsule is a relatively small ball, and, when the capsule is broken, the mercury ball enters the tubulation and some of its vapor flows into the panel through the hole in the base plate. However, a quantity of the mercury ball remains in the tubulation, and, under some circumstances, when the panel or its assembly is physically manipulated, some or all of the mercury ball may enter the panel through the hole in the base plate and may cause shorts between electrodes or may cause other problems.

SUMMARY OF THE INVENTION

Briefly, a display device embodying the invention includes a base plate carrying a plurality of groups of cathode electrodes, and a face plate carrying a transparent conductive anode electrode for each group of cathode electrodes. The base plate is provided with a hole through which mercury vapor and the gas filling for the panel are introduced from a tubulation secured to the base plate. Means are provided in operative relation with this hole in the base plate and within the tubulation to prevent excess mercury from entering the panel.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective exploded view of a display panel embodying the invention; and FIG. 2 is a sectional view, along the lines 2—2 in FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The display panels described herein are thin, flat, sheet-like members which may have substantially any desired size and shape, and may include substantially any number of character display positions. The panels may also include any suitable ionizable gas such as neon, argon, xenon, etc., singly or in combination. A wide range of gas pressure may be used, for example, from about 20 to about 350 Torr or higher at ambient temperature, with about 75 to 120 Torr being a pressure range which is commonly and conveniently used. Those skilled in the art understand the interplay of parameters which affect the selection of a suitable gas pressure.

The principles of the invention are applicable to many types of cold cathode display devices, and the display panel shown and described herein is a segment-type device which includes an insulating base plate 20 of glass, ceramic, or the like which carries, on its top surface, a plurality of narrow conductive leads or runs 30 (A to G). The runs 30 are parallel to each other and aligned with the horizontal axis of the base plate. Seven runs 30A to 30G are shown; however, more or fewer may be provided, the number being determined by the total number and type of characters to be displayed. The runs 30 may be formed by an evaporation process, a silk-screen process, an electroleo plating process, arc plasma spraying, flame spraying, or the like, or they may be discrete strips of metal, heat sealed or otherwise secured to the insulating plate 20. A silk-screen printing process is particularly suitable because it is fast, efficient, and reproducible.

A thin layer 40 of insulating material such as glass or ceramic is provided on the conductive runs 30, preferably by a silk-screen or spraying process. The layer 40 is provided with a plurality of groups of apertures 50A to 50G, each aperture exposing one of the runs 30A to 30G. Thus, each group of apertures includes aperture 50A which exposes run 30A, aperture 50B which exposes run 30B, aperture 50C which exposes run 30C, etc.

Panel 10 also includes a group of cathode electrodes 60 (A to G) for each group of apertures 50; the cathodes are generally flat elongated bars or segments, and they are generally arrayed in a figure 8 pattern, as is well known in the art. The cathodes 60 may be formed by any of the processes mentioned above with a silk-screen process or the like performed with a conductive paste such as palladium-gold, platinum-gold, palladium-silver, or the like. Each cathode element fills its aperture 50, is in direct contact with one of the runs 30 exposed thereby, and covers a portion of the top surface of layer 40 to achieve the desired shape and size for each cathode.

The cathodes 6 may also be formed of discrete strips of metal, each of which is brazed to a conductive run 30 by means of a mass of brazing material deposited in each of the apertures 50 in the insulating layer 40. The brazing material may also be deposited by a silk-screen process or the like, with one suitable brazing material being a gold-germanium substance known as FOR-MON which is sold by DuPont.

Panel 10 also includes an anode electrode 90 for each group of cathode electrodes 60. The anode electrodes 90 preferably comprise transparent conductive films of gold, NESA, or the like deposited on the lower surface 96 of the panel face plate or viewing plate 100 which is made of glass. The anode films 90 are generally rectangular in shape, or they are otherwise shaped, depending on the orientation of the cathodes, and they are dimensioned and positioned so that they overlay the area defined by each group of cathode electrodes, as illustrated in FIG. 2. The anodes thus face the flat surfaces of the cathodes, and these surfaces generate cathode glow areas of the same general shape in operation of the panel. Alternatively, the anode electrodes may comprise separate screens (not shown) suitably supported above the groups of cathode electrodes.

The top glass cover plate 100 is spaced from the base plate 20 by a rectangular frame member 110 which may be integral with cover plate 100, or it may be a
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separate piece which is disposed between the top glass plate 100 and the insulating layer 40. The rectangular frame 110 serves to provide the desired spacing between each anode and its associated group of cathode electrodes.

The three glass members 20, 100, and 110 are sealed together by means of an hermetic seal 120 (FIG. 2) formed along the adjacent edges of the members by means of a glass frit or the like.

Suitable contact pins 122 are secured to the cathode runs 30, and contacts 124 are also made to anodes 90, and all contacts are embedded in seal 120.

The panel 10 is filled with the desired gas atmosphere through a tubulation 150 connected to the base plate 120 and communicating with the interior of the panel through a hole 160 in base plate 20.

The tubulation 150 has a flared end 153 which is secured to the surface of the base plate axially aligned with holes 160 and 170. According to the invention, a flat piece of relatively fine mesh nickel screen 180 is disposed across hole 160 within the tubulation 150 and, if desired, with its periphery disposed in the area of the seal between the tubulation and the base plate. The screen may be of the order of 500 mesh, and it is preferably relatively thin and flexible if it is secured in the tubulation seal area to permit it to adjust to the mating parts and, thus, to permit a good, air-tight seal to be made.

In addition, as well known in the art, a mercury capsule 190 is disposed within the tubulation 150 and is held in place in any suitable manner, for example, by means of a constriction in the tubulation. The mercury capsule 190, in one mode of operation, is made of infra-red absorbing glass and contains a small ball of mercury 200.

After panel 10 has been assembled and processed as required, it is filled with the desired gas through tubulation 150, and the tubulation is sealed off at a conveniently short length. Again, at a suitable time in the processing procedure, the glass capsule is broken, for example, by a suitable heating process, as by the application of infra-red energy to the capsule, and the mercury ball is thus freed from the capsule and deposited in the tubulation. Either mercury vapor from the mercury ball diffuses through the holes 160 and 170 gradually, or the panel may be heated to forcefully drive mercury vapor into the panel. Other processing steps are carried out as required to complete the manufacture of the panel 10. The panel is now ready for mounting in a suitable frame or carrier in association with printed circuit boards for ultimate inclusion in an instrument such as a desk top calculator. In these various operations, of course, the panel is handled and disposed in various orientations. It is noted that, during these manipulations, the screen 180 serves to prevent any solid mercury present in the tubulation from entering the panel through the holes 160 and 170. If the screen were not present, mercury droplets might enter the panel and cause shorts between closely spaced electrodes.

Another operating asset of the nickel screen arises from the fact that nickel amalgamates with mercury, and this amalgamation process occurs during processing and operation of the panel. Thus, the screen comprises a ready source of mercury which can be released, if desired, by the application of heat at any time during the life of the panel. The need for such a source of mercury arises, even though a small quantity of mercury remains in the tubulation at the end of the processing of the panel and when the panel is put into use, as the panel is operated, the remaining mercury disappears. Apparently, the mercury is adsorbed by the various mechanical elements of the panel. Thus, during the remainder of the life of the panel, the necessary mercury vapor can be replenished, in addition to other adsorbed mercury, by the mercury which has amalgamated with the nickel screen.

What is claimed is:

1. A display device comprising a gas-filled envelope including a base plate, a plurality of groups of cathode electrodes disposed in said envelope on said base plate, an anode electrode in operative relation with each said group of cathode electrodes, a tubulation secured to said base plate outside said envelope and communicating with the interior of said envelope through a hole in said base plate, said tubulation being adapted for introducing gas and mercury vapor into said panel through said hole in said base plate, and a fine mesh screen in the form of a thin, flat disk disposed in said tubulation and bearing against the outer surface of said base plate across said hole, said screen being of such fine mesh that it permits the flow of gas and mercury vapor into said envelope through said tubulation and said hole, but prevents the entry of relatively large globules of mercury from said tubulation through said hole into said envelope.

2. The device defined in claim 1 wherein said mesh screen is of nickel.

3. The device defined in claim 1 wherein said mesh screen is of the order of 500 mesh in fineness.

4. The device defined in claim 1 and including a ball of mercury disposed within said tubulation.

5. A display device comprising a gas-filled panel-like envelope including a base plate and a face plate spaced therefrom and containing a gas filling between them, at least one anode and one cathode electrode within said envelope, a hole in said base plate for permitting gas to enter and leave said envelope, a tubulation secured to said base plate and communicating with the interior of said envelope through said hole whereby said envelope can be exhausted and gas can be introduced into said envelope, a relatively large mass of mercury in said tubulation, and a fine mesh screen in the form of a thin flat disk disposed in said tubulation and bearing against the outer surface of said base plate covering said hole, said screen being of so fine a mesh that it permits the flow of gas and mercury vapor into said envelope through said hole, but prevents the entry of relatively large globules of mercury through said hole from said tubulation into said envelope.

6. A display device comprising a thin, flat, gas-filled panel-type envelope including a base plate and a face plate, a plurality of groups of cathode electrodes disposed in said envelope and spaced apart along said base plate, an anode electrode in operative relation with each said group of cathode electrodes,
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a tubulation secured to the outer surface of said base plate outside said envelope and communicating with the interior of said envelope through a hole in said base plate, said tubulation being adapted for introducing gas and mercury vapor into said panel through said hole in said base plate, said tubulation carrying a quantity of free mercury, and mechanical means disposed in said tubulation and positioned to block said hole in said panel, said mechanical means permitting the flow of gas and mercury vapor through said tubulation and said hole into said panel, but preventing the entry of relatively large globules of mercury from said tubulation through said hole into said envelope.

7. A gas discharge display device comprising an evacuated envelope containing an ionizable gas at a pressure capable of sustaining a glow discharge, a plurality of first electrodes spaced apart from one another along a first surface within said envelope, a plurality of second electrodes spaced from one another and from said first electrodes within said envelope, said first and second electrodes being selectively energizable to produce different glow discharge patterns between said first and second electrodes, a vaporizable material in a liquid state contained initially within a portion of said envelope, said envelope portion being separated from the remainder of the envelope by a small aperture, and a barrier member extending across said aperture and having passages therethrough substantially smaller than said aperture, said barrier member permitting the passage of vapor from said vaporizable material into the remainder of the envelope but being substantially impervious to the passage of said vaporizable material in its liquid state.

8. A gas discharge device as in claim 7 wherein said vaporizable material is a drop of mercury, the vapor of which imparts long life characteristics to said device.

9. A gas discharge display device as in claim 8 further including means to vaporize at least a portion of said drop of mercury to cause mercury vapor to pass through said barrier member and enter the remainder of the envelope.

10. A gas discharge display device as in claim 7 wherein said barrier is a fine metal mesh.

11. A gas discharge display device as in claim 10 wherein the envelope is a flat panel-like envelope with a short tubulation sealed to and extending therefrom, said tubulation constituting the envelope portion which contains the vaporizable material, and wherein the fine mesh screen is located within the tubulation and extends across the aperture which separates the tubulation from the panel-like portion of the envelope.

12. A gas discharge display device as in claim 11 wherein the fine mesh screen is positioned against the outer surface of the panel-like portion of the envelope with its periphery contiguous the seal between the tubulation and said outer surface.

13. A gas discharge display device as in claim 12 wherein said fine mesh screen is flat and flexible.

14. A gas discharge display device as in claim 8 wherein said barrier member is formed of a material which readily amalgamates with mercury.

15. A gas discharge display device as in claim 8 wherein said barrier member is metallic and is amalgamated with mercury.

16. A gas discharge display device comprising an evacuated envelope containing an ionizable gas at a pressure capable of sustaining a glow discharge, a plurality of first electrodes spaced apart from one another along a first surface within said envelope, a plurality of second electrodes spaced apart from one another and from said first electrodes within said envelope, said first and second electrodes being selectively energizable to produce different glow discharge patterns between said first and second electrodes, a vaporizable droplet of mercury in a liquid state contained initially within a portion of said envelope, and a barrier member separating said envelope portion containing the mercury droplet from the remainder of the envelope, said barrier member having passages therethrough of sufficient size to permit the passage of vapor from said vaporizable droplet into the remainder of the envelope but being substantially impervious to the passage of said vaporizable droplet in its liquid state.

17. A gas discharge display device as in claim 16 wherein said barrier comprises an apertured glass wall, with a metallic barrier extending across each such aperture, the metallic barrier being substantially impervious to the passage of said vaporizable droplet in its liquid state.

18. A gas discharge display device as in claim 17 wherein said metallic barrier is a fine mesh screen.

19. A gas discharge display panel having a plurality of side-by-side character positions along a predetermined line, in each of which any one of a predetermined number of characters can be displayed, comprising an envelope formed of front and rear plates sealed together along a predetermined perimeter surrounding the line of character positions, and an attached tubulation, to establish a gas tight enclosure about said character positions; an ionizable gas within said enclosure at a pressure capable of sustaining a glow discharge; a plurality of elongated conductive runs extending along the inside surface of the rear plate in the direction of the line of character positions, a layer of insulating material over said conductive runs with a group of apertures therethrough for each character position, the respective apertures in each such group being aligned with the respective conductive runs, a plurality of groups of cathode segments arranged side-by-side along the surface of said insulating layer to form the side-by-side character positions, each cathode segment being aligned with one of said apertures; a plurality of anodes insulated from each other and from said cathode segments, each such anode
being located adjacent and operatively associated with one of said cathode segment groups, means for selectively energizing said anodes and cathode segments to form a side-by-side character display over all of said character positions, a vaporizable material in a liquid state contained within a portion of said envelope, said envelope portion being separated from the remainder of the envelope by a small aperture, and a barrier member extending across said aperture and having passages therethrough substantially smaller than said aperture, the passages permitting the passage of vapor from said vaporizable material into the remainder of said envelope but being sub-
stantially impervious to the passage of said vaporizable material in its liquid state.

20. A gas discharge display device as in claim 19 wherein said vaporizable material is a drop of mercury, the vapor of which imparts long life characteristics to said device.

21. A gas discharge display device as in claim 20 wherein the drop of mercury is located within the tubulation and the barrier member is also located within the tubulation and extends across the aperture which separates the tubulation from the remainder of the envelope.

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