

May 16, 1967

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3,320,459

HERMETICALLY ENCASED ELECTROLUMINESCENT DISPLAY DEVICE

Filed Aug. 14, 1964

2 Sheets-Sheet 1

Fig. 2

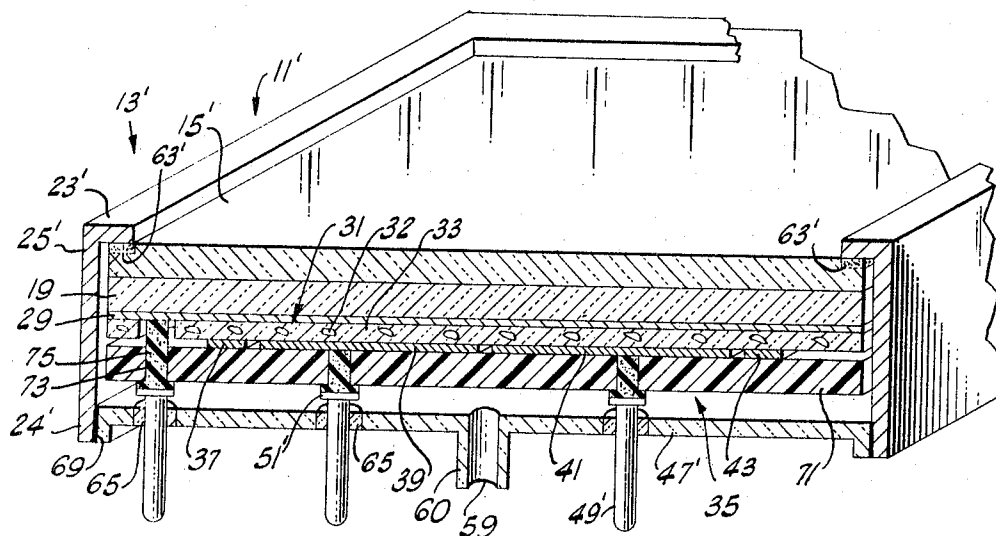


Fig. 1

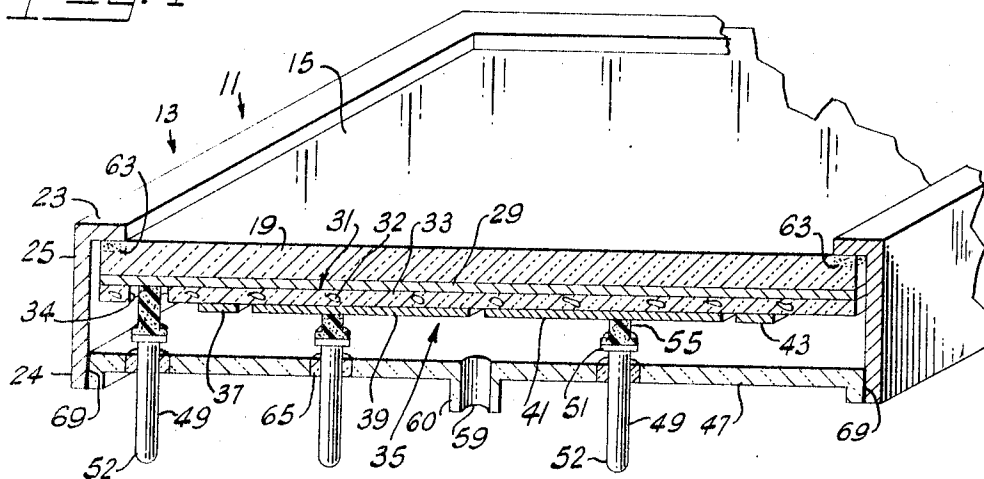
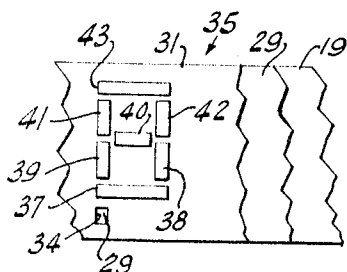


Fig. 3

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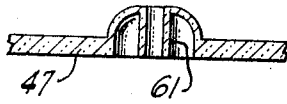


Fig. 4

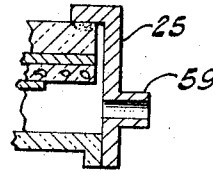


Fig. 5

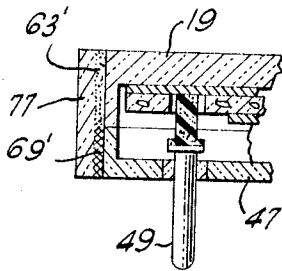


Fig. 6

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HERMETICALLY ENCASED ELECTROLUMINESCENT DISPLAY DEVICE

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6 Claims. (Cl. 313-108)

This invention relates to electroluminescent display devices and more particularly to hermetically encased electroluminescent devices and methods for fabricating the structures.

Many of the conventional electroluminescent displays, as for example, those adapted to present alpha and/or numeric information and other specific signs, symbols and configurations of a luminescent character have been fabricated with plastic connector plates and high temperature wax seals. While this wax sealed construction has afforded some protection for the device against moisture, it has not provided maximum benefit since the seal varies in thickness, is not abrasion resistant, and softens at high ambient temperatures in the vicinity of 80° C. A rupture or break in the wax seal exposes the lamp structure and electrode pattern to the deleterious effects of moisture and atmospheric gases which promote internal electrical leakage conditions. The protection afforded by the conventional plastic connector plate has also been of limited moisture resistance value and high temperature deterioration.

Accordingly, an object of this invention is to reduce the aforementioned disadvantages by providing a compact hermetically encased electroluminescent device that is capable of withstanding adverse environmental conditions including a temperature range of at least from -70° C. to +100° C.

Another object is to provide an encased electroluminescent device having a confined internal atmosphere conductive to efficient and reliable operation.

A further object is to provide a hermetically encased unitized assembly that can be advantageously manufactured and commercially utilized.

The foregoing objects are achieved in one aspect of the invention by the provision of the hermetic encasement of an electroluminescent display wherein the viewing panel, which is the substrate of device, is perimetrically sealed to the metallic or ceramic framing means encompassing the device. Oppositely disposed and bonded to the frame is a connector plate, compatible with the device and the frame and having a plurality of conductive pins insulatively sealed therein and extended therethrough. Electrical connection between the electrode segments of the display device and the inner portions of the pins is effected by resilient conductive means compressed therebetween. A sealable port may be included in the encasement to facilitate the establishment of controlled atmospheric content therein.

For a better understanding of the present invention, together with other and further objects, advantages, and capabilities thereof, reference is made to the following disclosure and appended claims in connection with the accompanying drawings in which:

FIGURE 1 is a cross-section of one embodiment of the invention;

FIGURE 2 is a cross-section of another embodiment of the invention;

FIGURE 3 is a partially sectioned plan view showing one type of electroluminescent electrode segment array display;

FIGURE 4 is a sectional view illustrating a recessed port;

FIGURE 5 is a partially sectioned perspective showing another port embodiment; and

FIGURE 6 is partial cross-section depicting another embodiment of framing means for the encasement.

With reference to FIGURE 1, there is shown a hermetic encasement 11 of an electroluminescent display device 13. This encasement, comprising a plurality of associated structural components, has a substantially transparent viewing panel 15 which in this instance is the substrate 19 of a conventional electroluminescent device. The viewing panel or substrate is premetrically sealed or hermetically bonded to the top portion 23 of an encompassing metal frame 25. Upon the substrate, within the frame, there is disposed a substantially transparent common electrode layer 29, overlaid with an electric field responsive phosphor-dielectric layer 31. Upon this layer, an array 35 of individually energizable electrode segments, of which 37, 39, 41, and 43 are illustrative examples, are disposed in an arrangement capable of inducing fluorescent information presentation upon selective energization as will be described. Hermetically sealed to the bottom portion 24 of frame 25 is an insulative ceramic connector plate 47 having a plurality of conductive pins 49 sealed therein and extended therethrough. As used in this specification, the term "ceramic" is intended to include glass and other related products made from earth by the agency of heat. The inner ends 51 of the pins are formed to accommodate resilient conductive caps 55 to provide compressive electrical connections with the electrode segments and the common electrode of the device. A sealable port 59 may be included in the connector plate 47 to facilitate the establishment of a desired gaseous content within the encasement. The energizing of the common electrode layer 29 in conjunction with a selected pattern of segments in the electrode array 35 creates an electric field in the phosphor-dielectric layer 31 therebetween to produce a luminescent information pattern visible through the viewing panel 15.

In greater detail, framing means in the form of a metal frame 25 is made of a high-chrome alloy metal, for example, "Carpenter 27" as produced by Carpenter Steel Company, Reading, Pa. This frame, formed to encompass an electroluminescent unit, has a top edge portion 23 adapted for sealing to a glass viewing panel 15 which, in this instance, is also the substrate 19 of the electroluminescent device. A tinted soda lime glass having a 60-70 percent light transmission characteristic is suitable for this usage. The perimetric deposition of a continuous bead of potash soda lead powdered glass or frit 63 between the contiguous edges of the viewing panel and the frame produces a graded hermetic bond in accordance with conventional sealing techniques.

A substantially transparent common electrode layer 29, as for example a coating of tin oxide, is adhered to the inner surface of substrate 19. A phosphor-dielectric layer 31 is suitably applied over the common electrode. This layer is formed, for example, of a mixture of an electric field responsive phosphor such as copper activated zinc sulfide and a leadless glass suitably fired so that the phosphor particles 32 are suspended in the dielectric glass 33. It will be noted that the dielectric layer has at least one aperture 34 therein to enable electrical connective access to the common electrode 29.

A patterned electrode array 35 defining a numeric as shown in FIGURE 3 is disposed on the phosphor-dielectric layer comprising a plurality of individually energizable electrode segments 37 to 43. Aluminum, silver, or gold are suitable metals from which this patterned array may be formed by vacuum metal deposition, photographic, stencil, or screen printing techniques.

A glass connector plate 47 as of G-8 soda lime glass available as "0080" from the Corning Glass Works, Corning, N.Y., is formed for perimetric engagement with the

bottom portion 24 of frame 25. This connector plate has a plurality of apertures discretely positioned therein into which a plurality of conductive pins 49 of, for example, nickel-chromium-iron alloy are sealed and extended therethrough. These pins are oriented to make contact with the individual electrode segments and the common electrode. Ceramic insulator sleeves 65, as of potash soda lead glass, are sealed to the pins and thence to the connector plate 47 to provide a graded seal between the pins and the plate. The outer ends 52 of the pins 49 are adapted to facilitate external electrical connections and the inner ends 51 are fabricated to accommodate the fitting therein or thereon of a resilient conductive cap 55. Each of the plurality of such caps may be of a conductive silicone rubber material formed with a compressible portion protruding beyond the end of the pin.

Upon fitting the connector plate 47 to compatibly engage the bottom portion 24 of the frame 25, the respective resilient conductive caps 55 are placed in compressive contact with the electrode segments and common electrode of the display device. A perimetric hermetic seal is consummated between the frame and the plate by incorporating a continuous bead of potash soda lead frit 69 therebetween whereupon heat is applied to complete the hermetic encasement of the device.

In instances where a specific atmospheric environment is desired within the encasement, a sealable port 59 is included in the connector plate 47. This port may be in the form of an extended tubulation 60 or a recessed tubulation 61 as shown in FIGURE 4. By means of this port, a vacuum may be drawn on the interior of the hermetically sealed encasement. If desired, either form of the port 59 or 61 may be incorporated within the frame 25 as illustrated in FIGURE 5. If desired, a specific gaseous atmosphere may be established therein prior to sealing of the port.

While the aforementioned electroluminescent display device 13 has been described as being sequentially fabricated upon a substrate 19 sealed within frame 25, the device may be prefabricated and then sealed within the frame as a unit. In this method, care must be exercised when sealing the device to the frame 25 to avoid temperature effects deleterious to the phosphor particles 31 contained therein.

Another embodiment of the invention is shown in FIGURE 2 wherein the encasement 11' having a substantially light-transmissive viewing panel 15', as of glass, is perimetrically sealed to the top portion 23' of metallic frame 25'. A graded hermetic bond is accomplished by utilizing a bead of frit 63' intermediate the frame and the glass panel.

A fabricated electroluminescent device 13' is positioned within the frame with the substantially light-transmissive substrate 19 contiguous to the viewing panel 15'.

An insulative connector board 71, as of soda lime glass, has therein a plurality of apertures 73 accommodating resilient conductive plugs 75 extended bilaterally therethrough and oriented to make electrical contact with the electrode segments and common electrode of the display device. These resilient conductive plugs may be of silicone rubber such as "K1516" as manufactured by Union Carbide Corporation, New York, N.Y.; or they may be in the form of compressed fine wire plugs of a material known as "Fuzz Buttons" available from Technical Wire Products, Inc., Springfield, N.J. As an aid to provide internal atmospheric control within the encasement, this connector board 71 may be of micro-cellular ceramic material such as "Vycor" glass as manufactured by Corning Glass Works, Corning, N.Y. This high silica cellular material has an affinity for moisture and provides additional atmospheric control when degassed prior to insertion within the encasement.

While metal framing means has been described in the foregoing embodiments, an encompassing frame formed of suitable ceramic or glass, having expansive and sealing

characteristics compatible with those of the adjacent structural components, can be utilized for the encasement.

A ceramic or glass connector plate 47' is formed for perimetric engagement with the bottom portion 24' of frame 25'. Discretely positioned and sealed within the connector plate, and extended therethrough, are a plurality of conductive pins 49' the inner ends 51' of which are oriented to make compressive electrical contact with the resilient conductive plugs 75 in connector board 71.

Upon fitting the connector plate 47' to the bottom portion 24' of frame 25', the inner ends 51' of pins 49' make compressive electrical contact with the resilient conductive plugs 75 which, in turn, make compressive contact with the respective segments of electrode array 35 and the common electrode 29. Perimetric sealing of the connector plate 47' to the frame 25' completes the hermetic encasement of the device. As described for the previous embodiment, a sealable port 59 may be incorporated in either the connector plate or the frame if so desired to facilitate the establishment of specific atmospheric control within the encasement.

Additional framing means or another frame embodiment is shown in FIGURE 6 wherein a frame band 77 substantially in the form of a metallic or glass perimetric bead is bonded to glass substrate 19 of the fabricated display device 13 and glass connector plate 47 by suitable bonding materials 63' and 69' such as, for example, glass frit for "Hanovia Platinum Paste #6939" available from Engelhard Industries, Inc., East Newark, N.J. The respective bonding materials are disposed and set by heat on the perimetric edges of the substrate 19 and connector plate 47. The band 77 may be of a compatible glass frit material such as soda lime, potash soda lead, or high lead solder sealing glass; or the band may be of a metallic high-lead-content solder alloy composition.

This banding embodiment of the assembly encasement is accomplished by predisposing the bonding materials 63' and 69' to the perimetric edges of the substrate 19 of the display device and the connector plate 47 as mentioned. Resilient conductive caps of suitable materials previously mentioned are positioned on the inner ends of the conductive pins in the connector plate, after which the parts of the assembly, i.e. the display device and the connector plate, are positioned in proper relationship in a fixture, not shown. After suitable preheating to prevent sealing temperature shock at the edges, the banding material is applied to the perimetric region and fused thereto by heat to form band 77 thereby consummating the hermetic seal. When a port is included in the connector plate, the gaseous content within the encasement may be regulated as previously described.

Thus, there is provided a compact, hermetically encased electroluminescent display device that is sealed against moisture penetration and capable of withstanding adverse environmental temperature conditions. The encased assembly has a confined internal atmosphere conductive for efficient and reliable operation.

While there have been shown and described what are at present considered the preferred embodiments of the invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention as defined by the appended claims.

What is claimed is:

1. In combination with an electroluminescent display device having a viewing panel in the form of a light-transmissive substrate with a substantially transparent electrode disposed thereon and separated from an array of individually energizable electrode segments by an electric field responsive phosphor-dielectric layer therebetween, a hermetic encasement of said device comprising:

an insulative ceramic connector plate formed for compatible engagement with the segment portion of said device, said plate having a sealable port therein and a plurality of conductive pins spacedly sealed therein and extended therethrough;

5

internal connective means providing electrical connection for said individual electrode segments and said common electrode with the inner ends of said respective pins;

framing means formed to perimetrically encompass said display device and said connector plate to effect a hermetic bond therebetween; and

a confined internal atmosphere effected through said sealable port and being of a desired gaseous content conductive to efficient and reliable operation of said device.

2. A hermetically encased electroluminescent display device according to claim 1 wherein said internal connective means comprises: a ceramic connector board having a plurality of apertures accommodating resilient conductive plugs extended bilaterally therethrough and oriented to make electrical contact with said electrode segments and said transparent electrode of said device.

3. A hermetically encased electroluminescent display device according to claim 2 wherein said connector board is of degassed high silica micro-cellular ceramic material to effect atmospheric control within said encasement.

4. In combination with an electroluminescent display device having a viewing panel in the form of a light-transmissive substrate with a substantially transparent electrode disposed thereon and separated from an array of individually energizable electrode segments by an electric field responsive phosphor-dielectric layer therebetween, a hermetic encasement of said device comprising:

a ceramic connector plate formed for compatible engagement with the segment portion of said device, said plate having a plurality of conductive pins spacedly sealed therein and extended therethrough, said plate having a sealable port therein;

internal connective means providing electrical connection for said individual electrode segments and said common electrode with said respective pins; and metallic framing means formed to perimetrically encompass said display device and said connector plate to effect a bond therebetween.

5. A method for fabricating a hermetic encasement of an electroluminescent display device having a substantially light-transmissive viewing panel-substrate and oppositely disposed electrodes, within encompassing perimetric framing means, a ceramic connector plate having a plurality of conductive pins spacedly sealed therein and extended therethrough, and a plurality of resilient conductive means interiorly positioned to provide electrical connection between said pins and said electrodes, said method comprising the steps of:

disposing a bonding material to the perimetric edges of said viewing panel-substrate of said display device and said connector plate;

6

positioning resilient conductive caps on the inner ends of said conductive pins in said connector plate;

orienting said display device in contiguous relationship to said connector plate to provide an assembly having compressive electrical connection between said electrodes and said caps;

preheating said assembly in preparation for perimetric bonding;

applying said framing means to the perimetric region of said assembly to contact said bonding material disposed therearound;

and fusing said framing means to said bonding material to form a hermetic perimetric seal for the encasement.

6. A method for fabricating a ported hermetic encasement of an electroluminescent display device having a substantially light-transmissive viewing panel-substrate and oppositely disposed electrodes, within encompassing perimetric framing means, a ceramic connector plate having a port and a plurality of conductive pins spacedly sealed therein and extended therethrough, and a plurality of resilient conductive means interiorly positioned to provide electrical connection between said pins and said electrodes, said method comprising the steps of:

disposing a bonding material to the perimetric edges of said viewing panel-substrate of said display device and said connector plate;

positioning resilient conductive caps on the inner ends of said conductive pins in said connector plate;

orienting said display device in contiguous relationship to said connector plate to provide an assembly having compressive electrical connection between said electrodes and said caps;

preheating said assembly in preparation for perimetric bonding;

applying said framing means to the perimetric region of said assembly to contact said bonding material disposed therearound;

fusing said framing means to said bonding material to form a hermetic perimetric seal for the encasement; regulating the atmospheric content of said encasement through said port; and

sealing said port to complete the hermetic closure of said device.

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