[11] **3,808,497**
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[54] **GASEOUS DISCHARGE DEVICE AND METHOD OF SPACING THE PLATES THEREOF**

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[52] **U.S. Cl.** ..... **313/182**, 313/109.5, 313/204, 313/268, 315/169 TV

[51] **Int. Cl.** **H01j 1/88**

[58] **Field of Search** ..... 313/109.5, 182, 204, 205, 313/220, 268; 315/169 TV, 169 R

[56] **References Cited**

UNITED STATES PATENTS

3,602,756	8/1971	Bonnet	313/109.5
3,499,167	3/1970	Baker et al.	313/220 X

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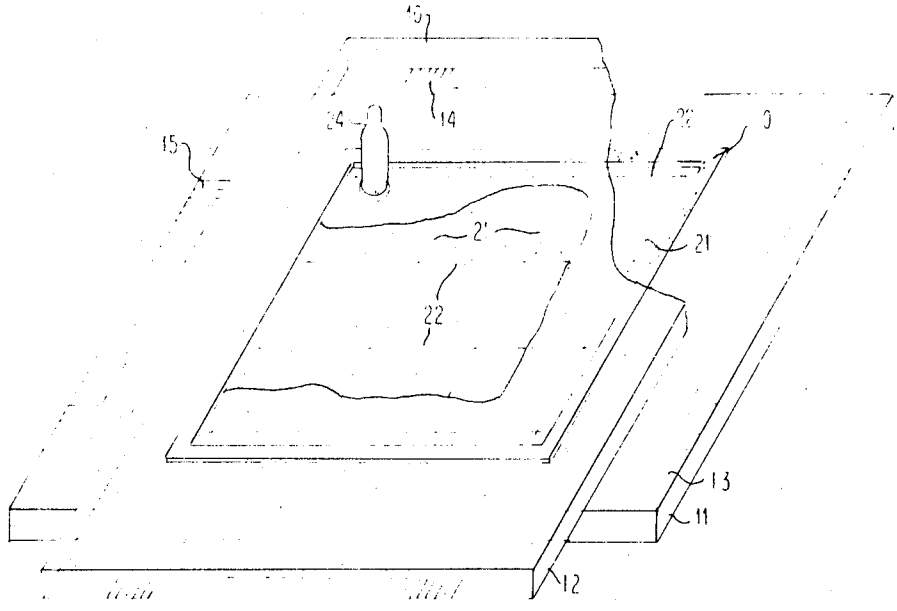
Assistant Examiner—Lawrence J. Dahl
Attorney, Agent, or Firm—Henry E. Otto, Jr., et al.

[57] **ABSTRACT**

A pair of glass plates of a gaseous discharge display or memory device are held precisely spaced by two sets of identically sized overlapping spacer rods. The rods crisscross orthogonally within a sealed gas-containing chamber to create gaps through which the gas can flow without significant restriction between areas of the chamber separated by said rods. Sealing rods of glass having a softening temperature lower than that of the spacer rods are disposed like a border around the spacer rods and are of significantly greater diameter or height than the combined height of the two superposed sets of spacer rods. Initially the upper plate is supported solely by sealing rods; but upon heating of the assemblage, the sealing rod glass reflows, and the upper plate settles until it contacts the upper set of spacer rods; whereupon the assembly is cooled and the sealing rods fuse with the plates to create an impermeable chamber between the now precisely spaced plates.

6 Claims, 4 Drawing Figures



2 2

FIG. 1

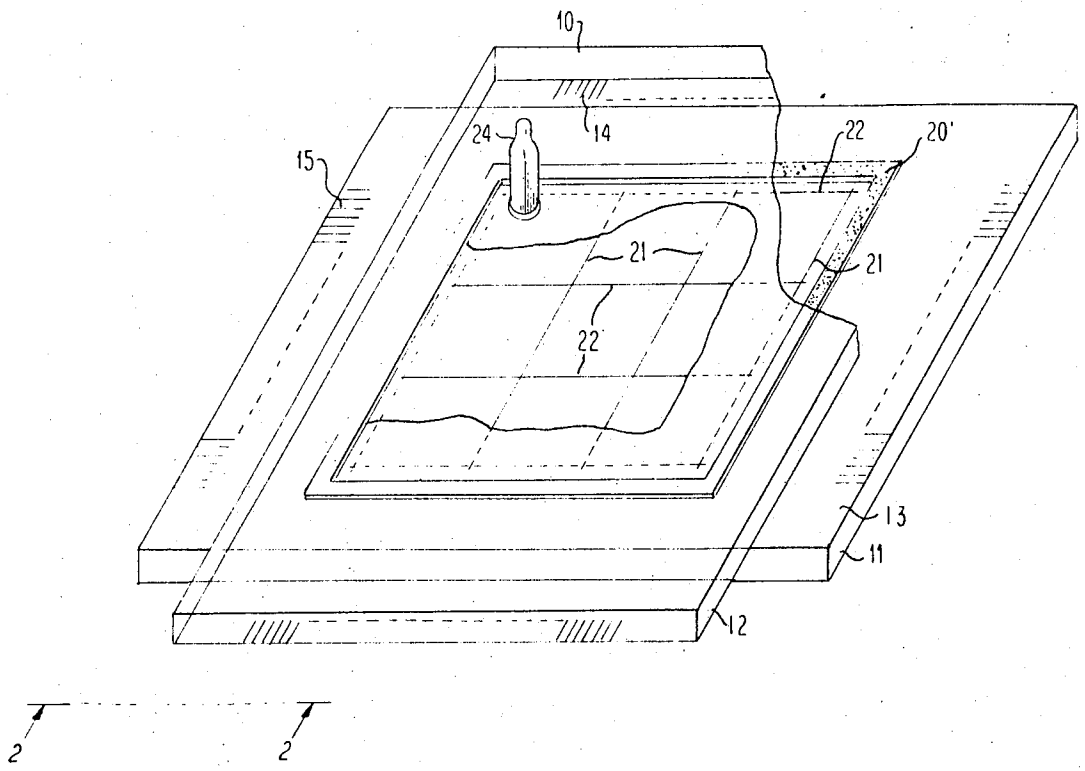


FIG. 2

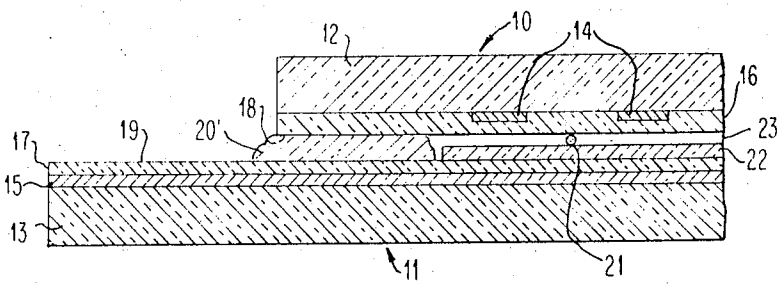


FIG. 3

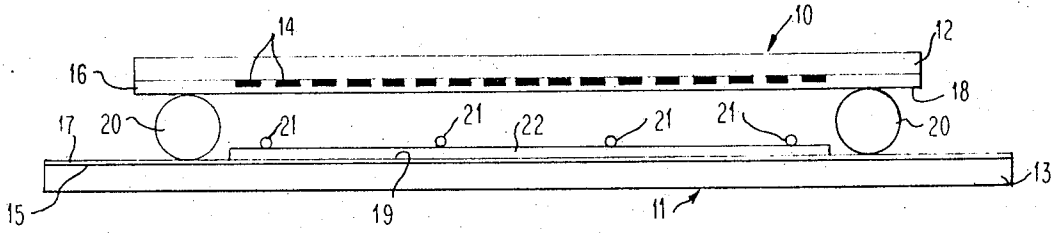
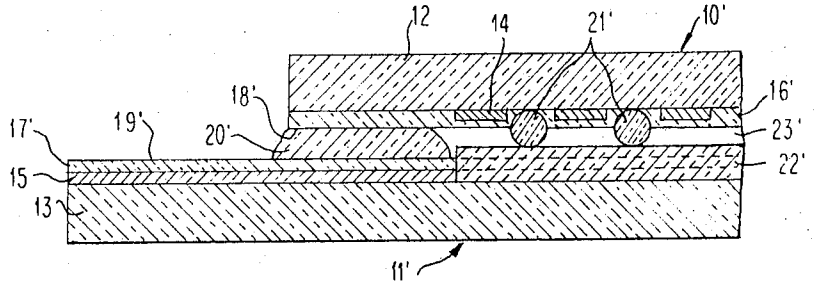


FIG. 4



GASEOUS DISCHARGE DEVICE AND METHOD OF SPACING THE PLATES THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

U. S. patent application of R. Langston et al., Ser. No. 214,298, filed Dec. 30, 1971, entitled "Sealing Technique for Gas Panel," assigned to the assignee of the present invention.

BACKGROUND OF THE INVENTION

This invention relates to gas discharge display and/or memory devices, and more particularly to improved devices of this type embodying a method of spacing the plates with spacer elements that do not inhibit flow of gas particles between areas separated by such spacer elements.

In the above-referenced copending application of R. Langston et al., there is disclosed a gaseous discharge display device in which the superposed glass plates are accurately spaced apart using a comination of low-softening-point sealing rods and high-softening-point spacer rods. The large diameter sealing rods are orthogonally arranged in a window frame-like border around the significantly smaller diameter orthogonally arranged single layer of spacer rods. When the plates and rods are heated, the glass of the sealing rods reflows, causing the upper glass plate to settle gradually into contact with the high-softening-point spacer rods for accurately spacing the upper plate relative to the lower plate. When the assembly is cooled, the sealing rods fuse to the plates, creating a chamber of precise constant height into which an illuminable gas is later introduced and sealed.

This device and method are very satisfactory where the ara of the plates is relatively small and the spacer rods need only frame the display area. However, as the plate area and hence the display area are increased, spacer rods must be introduced at other intermediate locations within the chamber to maintain the critical precise spacing between the plates. In such case, the spacer rods can extend only a short distance in either direction because wherever they are present (except at the edges of the display area) they present a barrier. This barrier impedes the flow of gas particles, metastable ions, photons, etc., between adjacent areas separated by the spacer rods; and it can also inhibit conditioning of cells, especially those immediately adjacent the spacer rods.

There is a need for a spacing arrangement that will provide accurate spacing of glass plates in gaseous discharge devices having large display areas requiring spacers at various places within the display area as well as around the periphery thereof. It would also be desirable to minimize the size of the spacer elements for aesthetic reasons so they will not be visible and mar the display area, and at the same time provide greater latitude in their location.

SUMMARY OF THE INVENTION

Toward this end, and according to the invention, applicants have found that these objectives can be achieved by an improved gaseous discharge display and/or memory device and method which, insofar as is known, have never heretofore been proposed. In this device and according to applicants' improved spacing

method, the plates are held precisely spaced at a preselected constant distance by two sets of identically sized crisscrossing spacer rods disposed orthogonally with respect to each other in overlapping lattice-like contact within the sealed gas-containing chamber. The spacer rods of one set contact the dielectric coating over the parallel conductors on one of the plates; and the spacer rods of the other set contact the dielectric coating over the orthogonally arranged parallel conductors on the other plate. Since these spacer rods have diameters equal to only one-half of said preselected constant distance, flow of gas particles between areas separated by the spacer rods is not significantly impeded. The spacer rods associated with the conductors on each plate are disposed between, and extend parallel to, the conductors on that particular plate. The diameters of the spacer rods preferably vary between approximately 0.002 inch and 0.0037 inch, according to which of the embodiments, hereinafter described, is employed.

Other objects and advantages will become apparent from the following more detailed description of the invention and from the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic perspective view, partly broken away, of a gaseous discharge display device embodying the invention;

FIG. 2 is a fragmentary sectional view, to substantially enlarged scale, taken along the line 2—2 of FIG. 1, showing a preferred embodiment of the invention;

FIG. 3 is a sectional view, to somewhat exaggerated scale, showing the assemblage before a heat fusion step that results in the configuration shown in FIG. 2; and

FIG. 4 is a fragmentary sectional view, similar to FIG. 2, but showing an alternate embodiment of the invention.

DESCRIPTION OF PREFERRED EMBODIMENT

The gaseous discharge display and/or memory device constructed according to this embodiment and illustrated in FIGS. 1–3 comprises, briefly, an upper glass plate **10** and a lower glass plate **11**, each including substrates **12,13**, respectively, on the facing surfaces of which are formed passivated metalized conductor arrays **14,15**, respectively. As illustrated, the arrays **14,15** each comprise respective pluralities of parallel conductors, the conductors of array **14** being disposed orthogonally relative to those of array **15**. The ends of the array on each plate extend beyond the edges of the other plate to facilitate connection to alternate conductors of the array, in conventional manner. As best shown in FIGS. **2,3**, the conductors of each array **14,15** are overlaid with respective transparent dielectric coatings **16,17**, preferably of glass, which provide flat surfaces **18,19**, respectively.

The plates **10,11** are fused into an integrated structure in the following manner. Unfused, heat-fusible sealing material, preferably in the form of rods **20** of low-softening-point glass, are placed in a window-frame border-like pattern on surface **19** of lower plate **11**. These rods **20** are of an identical diameter that is significantly greater than the precise preselected distance at which these plates are ultimately to be joined. According to the invention, two sets of identically sized upper and lower spacer rods **21,22** are then placed in overlaying relation in a two-stratum crisscross pattern

within the border. The lower rods **22** extend parallel to, and are equidistantly spaced between, adjacent pairs of conductors in array **15** and rest on flat surface **19**; whereas upper rods **21** overlay and rest on lower rods **22** in a predetermined lateral spacing hereinafter to be described. As will be noted from FIG. **3**, the combined height of the overlapped rods **21,22** is substantially less than the diameter of the sealing rods **20.**

The upper plate **10** is now positioned over the lower plate **11** with upper plate surface **18** contacting sealing rods **20** and transversely positioned such that the upper spacer rods **21** extend parallel to, and equidistant from, but substantially below, pairs of adjacent conductors of array **14** (as a result of the aforesaid predetermined spacing of rods **21** on rods **22**). Rods **21,22,** which are preferably formed of glass, have a significantly higher softening point than that of the sealing rods. Hence, when the unfused assemblage of discrete parts is thereafter heated in a vacuum oven to a temperature sufficient to cause melting and reflow of the sealing material of rods **20,** upper plate **10** will gradually settle from the position shown in FIG. **3** until surface **18** contacts upper spacer rods **21,** as shown in FIG. **2.**

The assemblage is now permitted to cool, causing the now reflowed sealing material, designated **20'** in FIG. **2,** to fuse to the surfaces **18,19** of the respective dielectric layers **16,17** and thereby fuse plates **11** into an integrated structure having an impermeable chamber **23** sealed about its periphery by the material **20'**. In accordance with conventional practice, this chamber **23** is now evacuated via an exhaust tube **24** (FIG. **1**), then charged with an illuminable gas at appropriate pressure; whereupon the tube is sealed to permanently entrap the gas within the chamber.

It will thus be seen that according to a feature of the invention, the plates will be maintained at a precise preselected distance by the crisscross pattern of overlapping spacer rods **21,22.** Because these spacer rods have a diameter which is equal to only one-half of the total constant space between the surfaces **18,19,** the gas particles, metastable ions, protons, etc., may flow without significant restriction between the various areas into which the chamber **23** is separated by the lattice arrangement of spacer rods.

In the preferred embodiment illustrated in FIG. **2,** the sealing rods **20** preferably have a diameter of about 0.040 inch, and the spacer rods **21,22** preferably have a diameter of approximately 0.002 inch; and dielectric coatings **16,17** have a softening temperature which is above the temperature to which the assemblage is subjected during the above-described fusing operation so that the rods **21,22** will contact, but not penetrate, the dielectric surfaces **18,19.** With this arrangement, the small size of the spacer rods renders them substantially indistinguishable from the glass plates and hence is aesthetically desirable. Also, blocking of the display area at the crossover points of the respective rods **21,22** is minimized by spacing these rods between conductors so as not to blank out any appreciable illumination upon firing of cells comprised of conductors adjacent to these rods.

DESCRIPTION OF ALTERNATE EMBODIMENT

The device and sealing method employed according to this embodiment (see FIG. **4**) are identical with those already described in connection with the embodiment of FIGS. **1–3,** except in the following respects: According to the instant embodiment, the upper and lower spacing rods **21',22'**, respectively, are of somewhat larger diameter, such as 0.0037 inch; and the coatings **16',17'** are of a dielectric having a softening temperature which is below the temperature to which the assemblage is heated during the fusing process. As a result, the spacer rods **21',22'** will penetrate the dielectric coatings until they contact the surfaces of the respective substrates **12,13.** Thus the constant spacing between the plates will be defined by respective contacts of the spacer rods **21',22'** with the substrates rather than with the dielectric coatings; however, the actual constant height of the chamber **23** will still be that corresponding to the precisely fixed spacing between the flat portions of surfaces **18',19'**.

It is to be understood that the conductor configuration and composition, the specific oven structure and temperatures used for the fusing operation, and the apparatus by which the chamber **23** is evacuated and then charged with illuminable gas may be as taught in the prior art, such as the above-referenced Langston et al. application; and hence they have not been described here in any more detail than is necessary for an understanding of the present invention.

While the invention has been shown and described with reference to preferred embodiments thereof, it will be understood that various substitutions and changes in form and detail may be made by those skilled in the art without departing from the spirit and scope of the invention. Accordingly, the gas discharge display and/or memory device herein disclosed and the method of making same are to be considered merely as illustrative, and the scope of the invention is to be limited only as specified in the claims.

What is claimed is:

1. A gaseous discharge display device comprising

a pair of glass plates each including substrates on which are provided parallel conductors overlaid with a dielectric coating to present a flat surface,

means including a frame-like border of low-softening-point sealing material sealing said plates in superposed spaced parallel relation, with said surfaces adjacent, to provide within the border a sealed chamber containing an illuminable gas, the conductors on each plate being orthogonal to those on the other plate, and

spacer means for maintaining said surfaces precisely spaced at a preselected constant distance,

said spacer means comprising two sets of spacer elements of identical height disposed orthogonally with respect to each other in overlapping lattice-like contact within the chamber, with all elements of each respective set contacting only a corresponding respective one of said surfaces, whereby the gas may flow either over or under the elements or around the crossover points thereof without significant restriction to substantially all areas of said sealed chamber separated by said spacer elements.

2. The device according to claim **1,** wherein the respective spacer elements that contact each surface are disposed parallel to conductors that are overlaid by such surface.

3. The device according to claim **1,** wherein at least one of the spacer elements that contacts said surface of one of said plates is disposed substantially equidistant

between, and extends parallel to, a pair of adjacent conductors on said one plate, and

at least one of the spacer elements that contacts the said surface of the other of said plates is disposed substantially equidistant between, and extends parallel to, a pair of adjacent conductors on said other plate.

4. The device according to claim **1**, wherein

said spacer elements are rods of glass having a softening point higher than that of said sealing means, and

said rods rest on and do not significantly penetrate one of said flat surfaces.

5. The device according to claim **1**, wherein

said spacer elements are rods of glass having a softening point higher than that of said sealing means and higher than that of the dielectric coating, and

said rods penetrate said dielectric coating and contact the substrate but project beyond the level of said surface to make said lattice-like overlapping space-defining contact with each other.

6. The device according to claim **1**, wherein said constant distance is approximately 0.004 inch to 0.006 inch, and each respective set of spacer elements extends sufficiently, from the surface it contacts, to provide one-half of said distance.

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