Oct. 22, 1974 J. VAN ESDONK ET AL 3,843,427

METHOD OF MANUFACTURING A GAS-DISCHARGE DISPLAY PANEL

Filed March 1, 1971 3 Sheets-Sheet 1

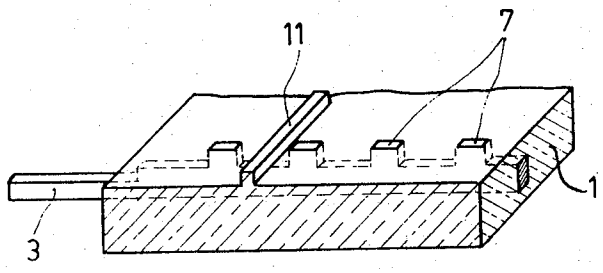

Fig.1

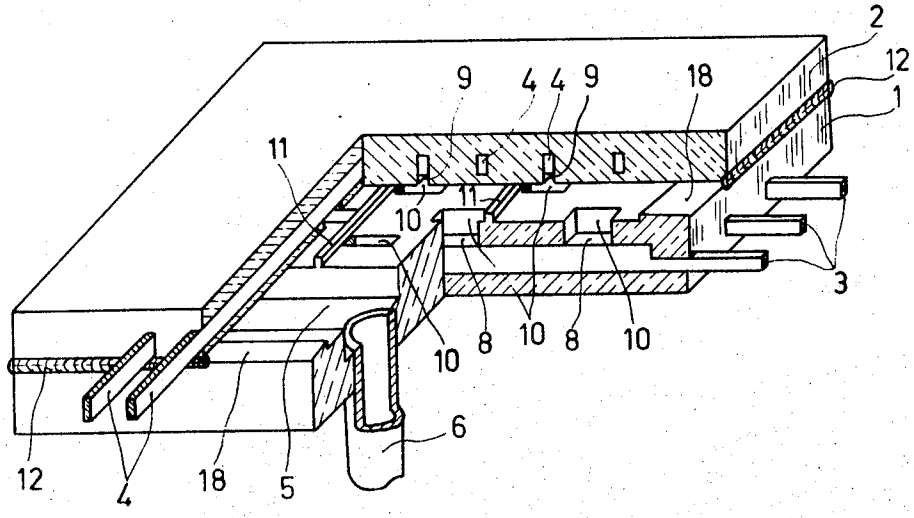

Fig.2

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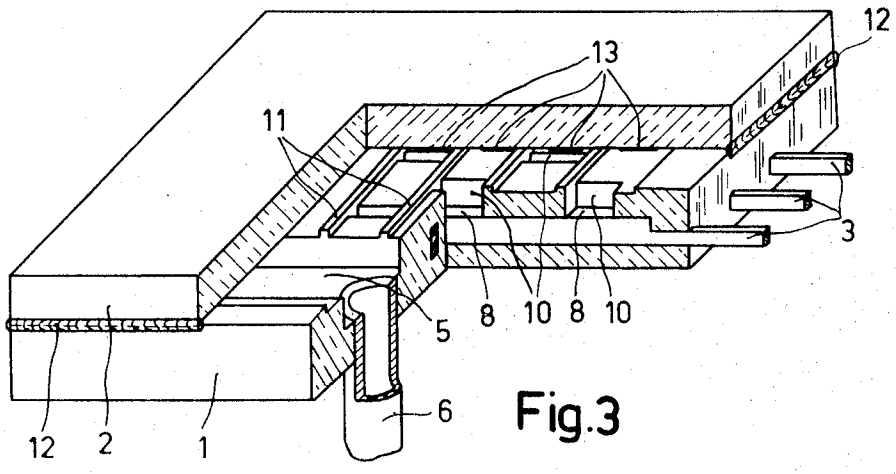

Fig.3

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METHOD OF MANUFACTURING A GAS-DISCHARGE DISPLAY PANEL

Filed March 1, 1971 3 Sheets-Sheet 3

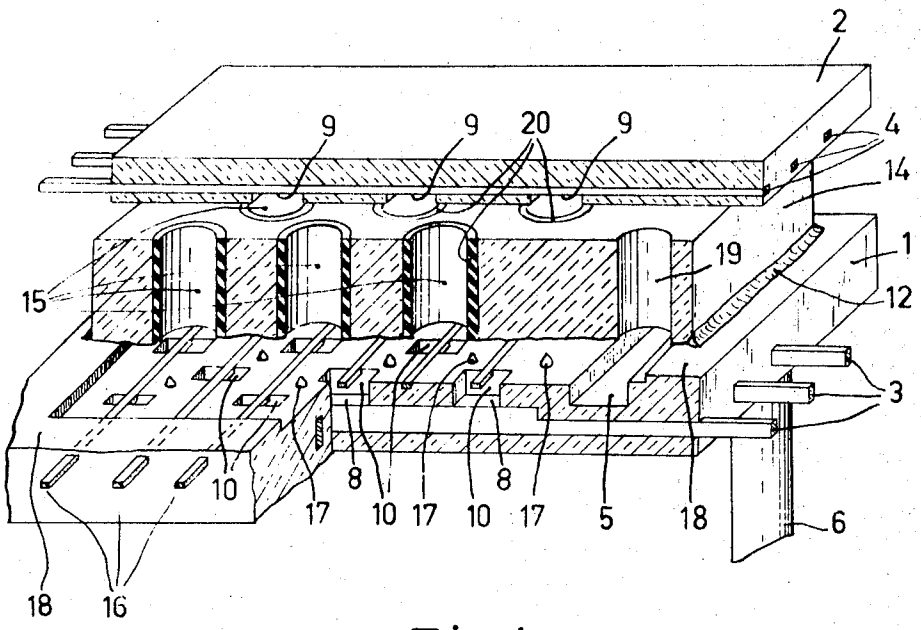

Fig.4

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METHOD OF MANUFACTURING A GAS-DISCHARGE DISPLAY PANEL

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U.S. Cl. 156—3 4 Claims

ABSTRACT OF THE DISCLOSURE

Method of manufacturing a gas discharge panel in which the discharge cavities are formed by etching away tines of comb-shaped conductors embedded in the bottom and/or top plates.

The invention relates to a method of manufacturing a gas-discharge display panel comprising at least one bottom plate and one top plate of insulating, transparent materials, the bottom and/or top plates being provided with a plurality of strip-shaped, relatively insulated conductors, parts of the surfaces of which are in contact with a gas atmosphere contained in cavities between the conductors.

It is not easy to provide cavities between the conductors of the bottom and top plates. In general, a perforated intermediate plate is arranged between the bottom and top plates, the openings of which are located at one end opposite a conductor of the bottom plate and at the other end opposite a conductor of the top plate.

In the method according to the invention at least part of the cavity is formed by embedding comb-shaped conductors in an insulating plate, the tines of the comb-shaped conductors extending to a surface of the plate, after which the tines are chemically etched away at least partly so that cavities are formed in the insulating plate.

Since the combs can be manufactured mechanically with great accuracy, identical plates with electrodes and cavities accurately distributed along the surface are thus obtained in a comparatively simple manner. Such plates can be joined with superimposition of the cavities so that two cavities together form one discharge cavity between two electrodes.

In order to connect all cavities with a pump channel and a pump tubing, the surfaces of the bottom and top plates may be arranged at a small distance from each other so that all cavities communicate with each other. This distance has to be small, if possible smaller than the free length of travel of the electrons in the gas contained in the cavities in order to avoid a jump of a discharge from one cavity to the adjacent cavities.

In order to avoid sagging of plates of large size supporting ridges may be provided on the surface of one of the plates. These ridges are preferably at right angles to the pump channel, in which case the ridges need not be interrupted. Instead of ridges local, for example, punctiform elevation may be provided on one of the plate surfaces, or alternatively a plurality of balls or grains, preferably of insulating material may be clamped between the plates or be stuck to one of the plate surfaces or to both of them or they may be sintered thereto.

The invention will be described more fully with reference to the accompanying drawing, in which:

FIG. 1 is a perspective, partial sectional view of a plate with embedded conductors,

FIGS. 2 and 3 show similar sectional views of two embodiments of gas-discharge panels manufactured by the method embodying the invention, and

FIG. 4 is a similar sectional view of a gas-discharge panel for the display of colour pictures.

Referring now to FIG. 1, reference numeral **1** designates a plate of insulating material such as glass, ceramic or an appropriate synthetic resin. In this plate **1** comb-shaped conductors **3** are embedded, only one of which is shown. The tines **7** of the comb extend just to the surface of the plate **1**. The plate **1** is provided in this case with ridges **11**, one of which is shown. The height of the ridges **11** is about 50 to 100/μ, which is in certain cases smaller than the free length of the path of the electrons in the gas of a discharge panel. The conductor **3** with the tines **7** can be pressed into the soft, insulating material of the plate **1** or the insulating material can be cast between the tines of conductor **3** arranged in a jig or it may be inserted in the form of a powder and melted.

Then the ends of the conductor **3** are covered by a protective layer and the plate **1** is introduced into a suitable etching solution so that the tines **7** are dissolved. The tines **7** are preferably dissolved until their top surfaces are level with the interface of the conductors. Thus a top plate **2** or a bottom plate **1** with cavities **10** is obtained.

As is indicated in FIG. 2 the top plate **2** is put down on a bottom plate **1** so that the conductors **4** of the top plate cross the conductors **3** of the bottom plate **1** in this case at right angles. Corresponding cavities **10** of the bottom and top plates together form a discharge cavity between the conductors **3** and **4**, whose parts previously formed by the tines **7** now serve as electrode faces **8** and **9** respectively.

The bottom plate **1** is provided with a pump channel **5** which communicates with a pump tubing **6**. Since the surfaces of the bottom and top plates are arranged at a small distance from each other, because the bottom plate **1** is provided with a fillet **18**, all cavities communicate with each other and with the channel **5** so that they can be exhausted and filled with a suitable gas through the pump tubing **6**. In order to avoid sagging of the plates due to the pressure of the open air, the bottom plate is provided with a plurality of ridges **11**, which are at right angles to the pump channel **5**. The ridges **11** have the same height as the fillet **18**.

The plates **1** and **2** are secured to each other in a vacuum-tight manner at the periphery by means of a suitable sealing means **12**, for example, cement, glaze or a synthetic resin.

The conductors in the top plate **2** need not be etched away, but their electrode faces **9** may be level with the surface of the plate **12**. Instead of tined conductors flat, strip-shaped conductors may be employed, one side of which is located in the plate surface or conductive layers **13** as shown in FIG. 3 may be employed. Then the discharge cavities have a height which is equal to the height of the ridges **11** and to the depth to which the tines of the conductors **3** are etched away. The cavities should have a given minimum depth, which exceeds the free length of the path of the electrons of the gas in the cavities. If fluorescent material is applied to the sidewalls of the cavities, it is advantageous with regard to the light output to increase the height of the cavities. A great height of the cavities requires, however, the use of long tines **7**, which have to be etched away completely so that considerable loss of material is involved. A suitable compromise is obtained with cavities having a height of about 5 mms. and transverse dimensions of about 1 to 2 mms. in accordance with the size of the panel.

In a gas-discharge panel for the display of colour pictures, the phosphors are applied to the inner faces of the cavities. Owing to the lower light output of these prosphors the cavities should have a greater height than in the case of monochrome panels. As is shown in FIG. 4, it is

then desirable to apply auxiliary anodes **16** at a small distance (about 0.2 mm.) from the cathodes **3**.

The auxiliary anodes **16** can be pressed into the bottom plate, after the tines of the conductors **3** are etched away, when this plate is heated to the softening point of the insulating material, the softness not being, however, such that the plate is deformed. If the conductors **16** themselves are also strongly heated, they may be pressed into the plate **1** without deformation of the cavities. In the panel shown in FIG. 4 a perforated plate **14** is sandwiched between the bottom plate **1** and the top plate **2**, the thickness of said plate being about 5 mms. The colour phosphors **20** are applied to the inner walls of the holes **15**, that is to say alternately red, green and blue in different holes **15**.

The top plate **2** of FIG. 4 is also provided with cavities formed by etching away tines of comb-shaped conductors. The same remark as made with respect to the top plate of FIGS. 2 and 3 applies in this case. In order to permit of exhausting and filling the cavities with a suitable gas, the bottom plate **1** is provided also in this case with an elevated fillet **18**. Since the use of ridges gives rise to difficulties in this case in connection with the presence of the auxiliary anodes **16**, a plurality of punctiform elevations **17** are provided for avoiding sagging of the plates **1**, **2** and **14**. The elevations may be formed by glass grains sintered to the surface of the plate **1** or **14**. The correct height is obtained by using grains of too large thickness and by flattening them partly by a flat plate pressed on the fillet **18**.

As an alternative in the embodiments of FIG. 4, when straight, strip-shaped conductors **4** without tines are used, it is possible to etch away the portions of the conductors **4** located within the fillet **18** throughout the length to an extent such that channels are formed which connect the cavities with openings **19** opening out in the channel **5**.

Although only three embodiments are described herein, other combinations of comb-shaped conductors, strip-shaped, smooth conductors or conductive layers, perforated plates and means for avoiding sagging of the plates may obviously be employed within the scope of the invention. For example, a thin perforated plate may be sandwiched between the cathodes **3** and the auxiliary anodes **16**.

What is claimed is:

1. In the method of manufacturing a gas-discharge display panel comprising at least one bottom plate and one top plate of insulating, transparent material, the bottom and top plates being provided with strip-shaped relatively insulated conductors, parts of the surfaces of which are in contact with a gas atmosphere in cavities between the conductors, the steps of embedding a comb-shaped conductor in an insulating plate with the tines of the comb-shaped conductor extending up to the surface of the plate, and thereafter chemically etching the tines to form cavities in the insulating plate.

2. A method as claimed in Claim **1** in which the comb-shaped conductor with the comb-shaped conductor is pressed into a plate of soft insulating material.

3. A method as claimed in Claim **1** in which an insulating material is cast between the tines of the comb-shaped conductor.

4. A method as claimed in Claim **3** in which powdered insulating material is inserted between the tines and melted.

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