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Galves et al.

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[54] **GAS-DISCHARGE DISPLAY PANEL WITH MATRIX OF ORTHOGONAL INSULATING LAYERS**

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[30] **Foreign Application Priority Data**

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[52] **U.S. Cl.** **313/190;** 313/220; 313/268

[51] **Int. Cl.** **H01j 61/10**

[58] **Field of Search** ..... 313/220, 268, 201, 188, 313/204, 203, 190; 315/169 TV

[56] **References Cited**

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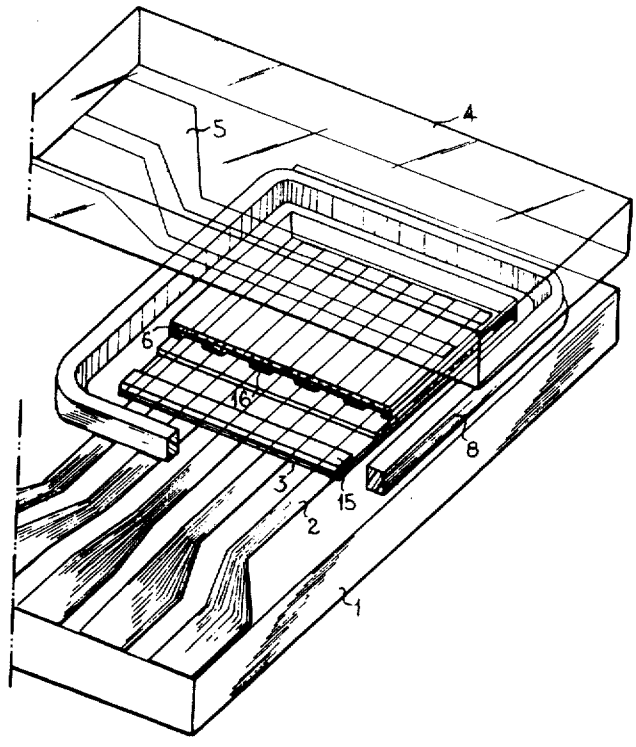
[57] **ABSTRACT**

A gas-discharge display panel including slab carrying networks of conductors and an improved matrix, within the thickness of which the gas discharge takes place. The improved matrix is produced on the slabs carrying the networks of conductors, in the form of two sets of insulating strips oriented with respect to one another in order to form a rectangular pattern. These strips act as a spacer between the slabs.

3 Claims, 7 Drawing Figures



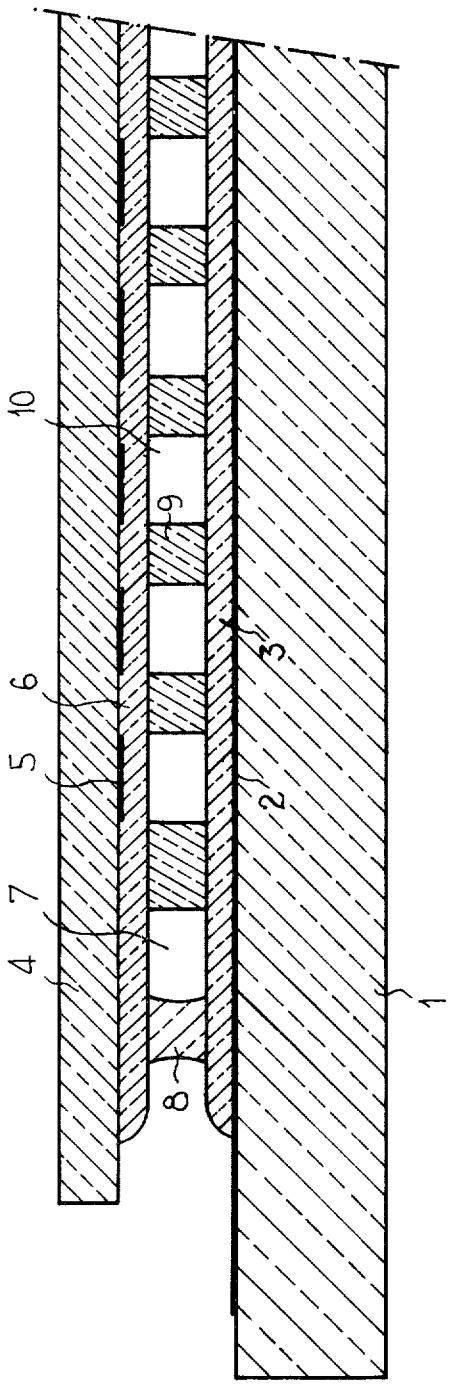


FIG. 1
PRIOR ART

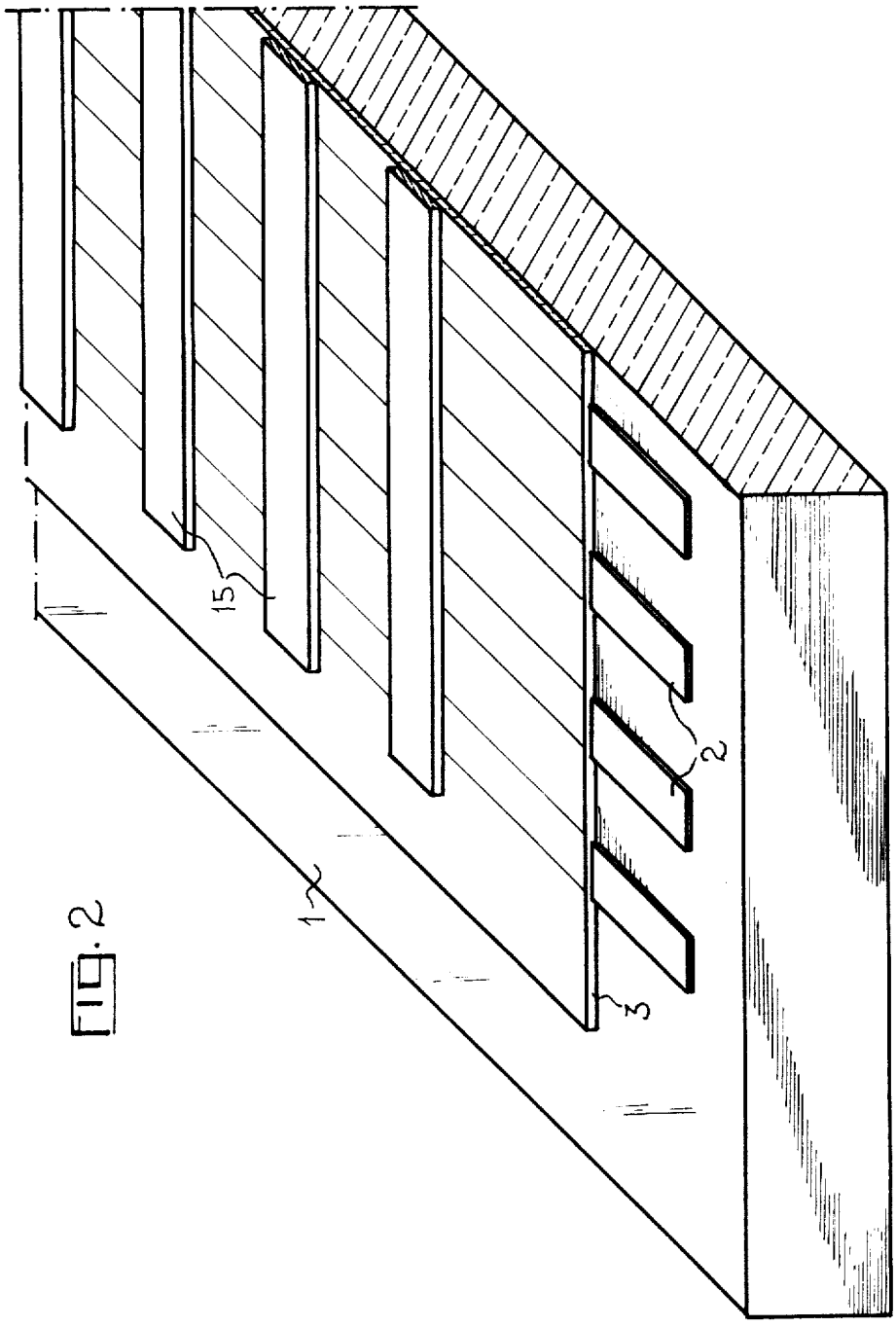


FIG. 2

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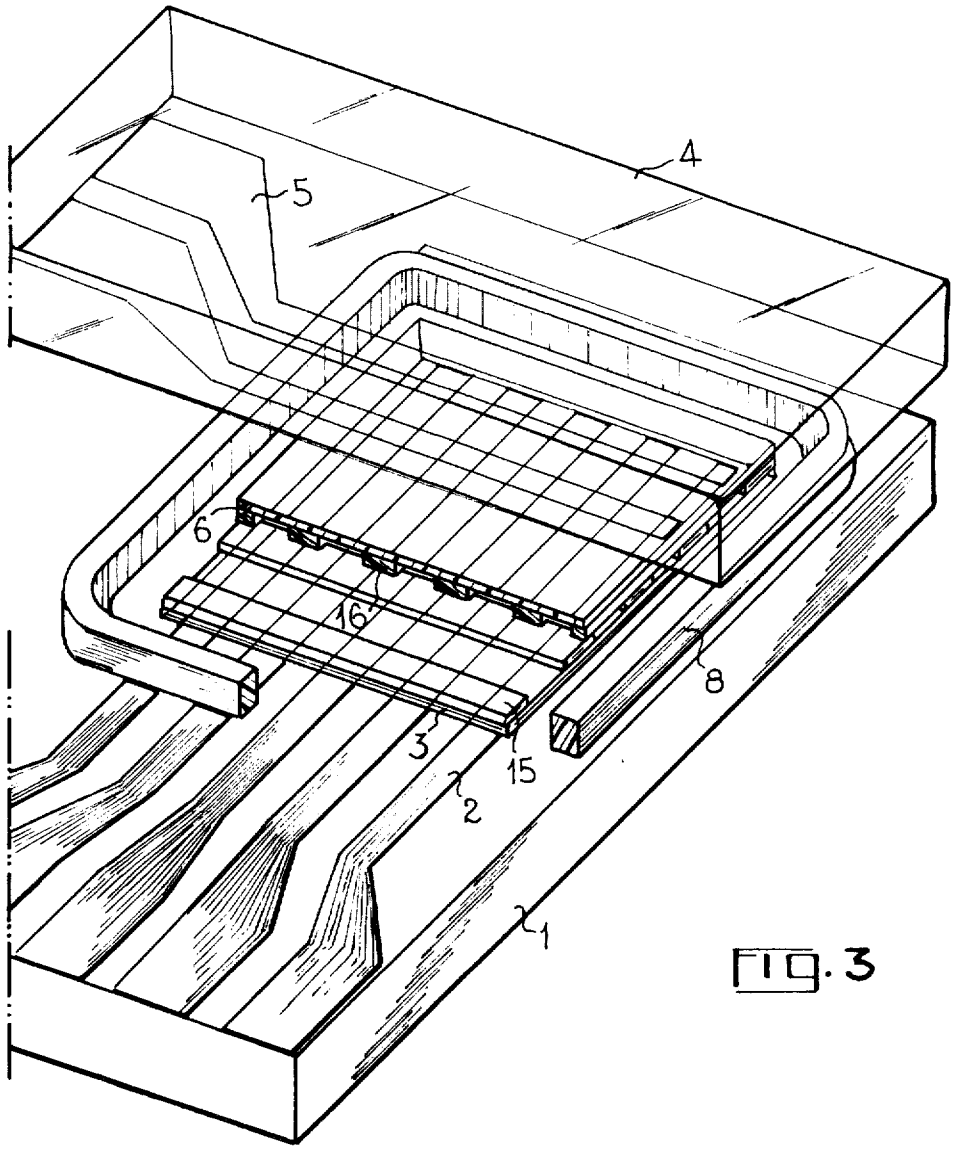

Fig. 3

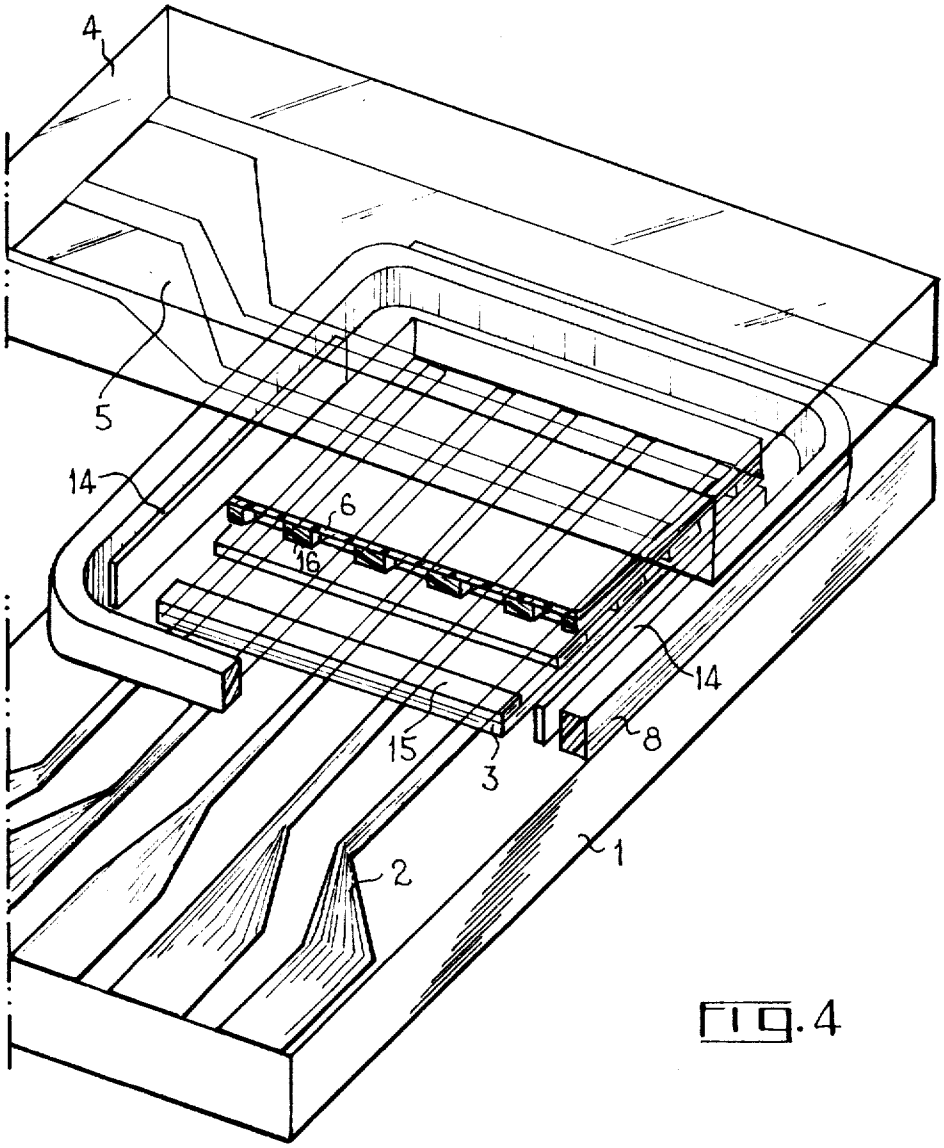

FIG. 4

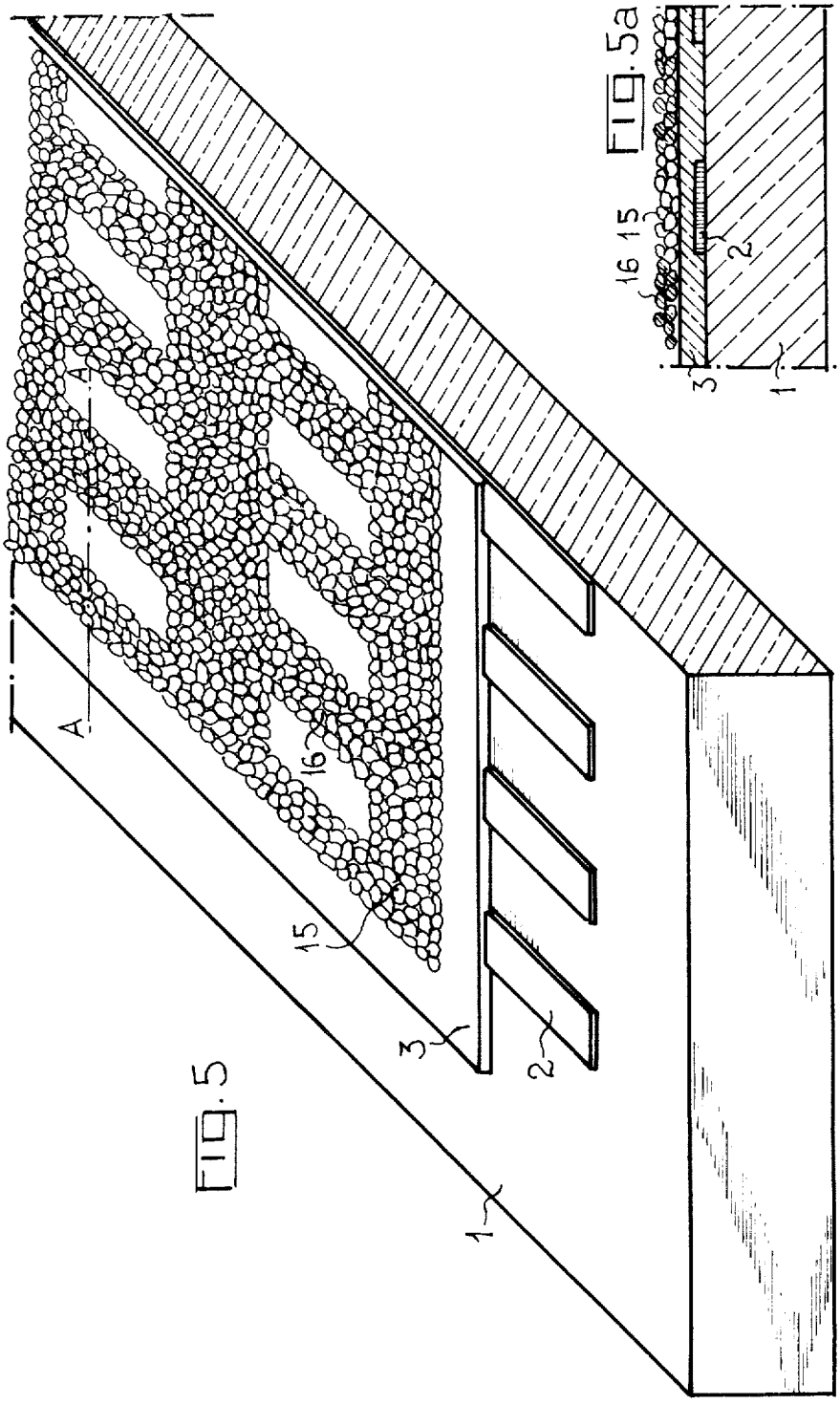

FIG. 5

FIG. 5a

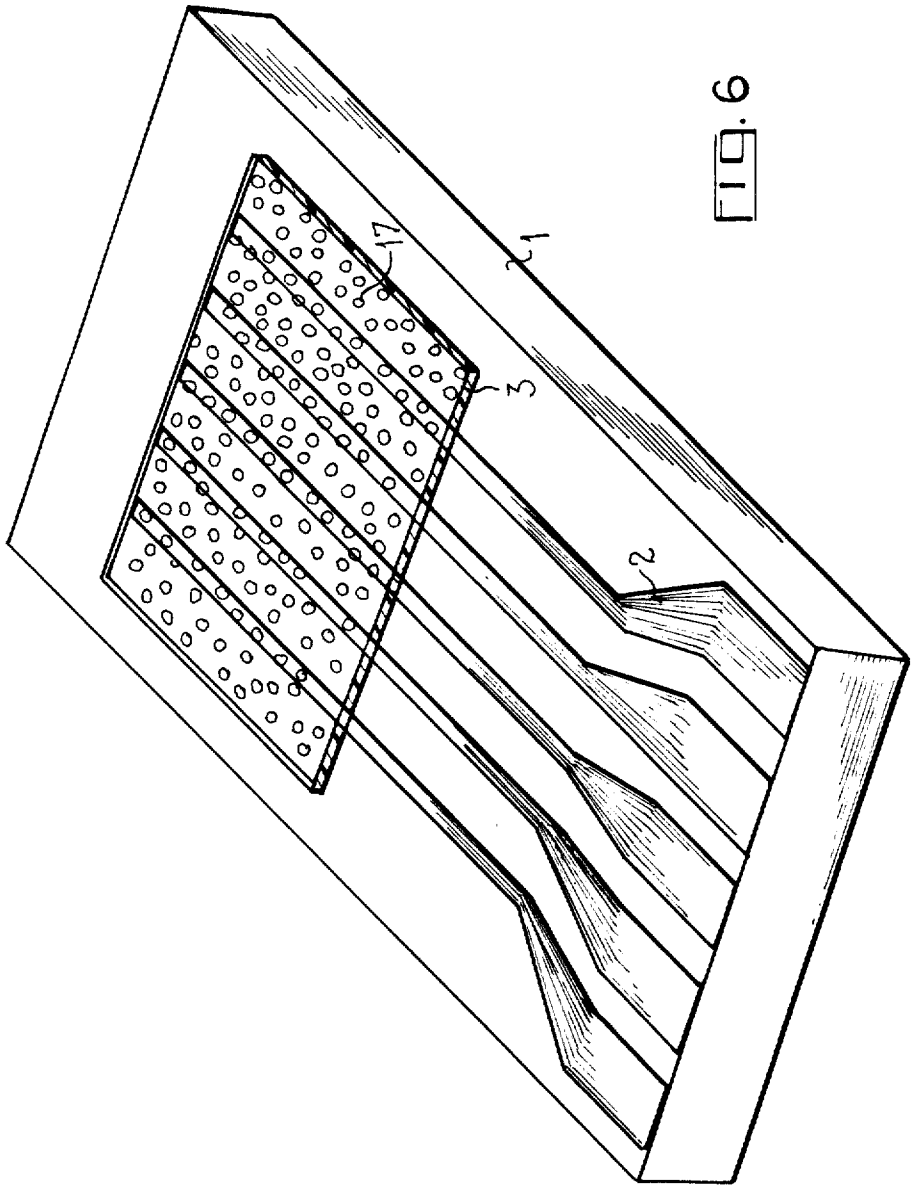

FIG. 6

GAS-DISCHARGE DISPLAY PANEL WITH MATRIX OF ORTHOGONAL INSULATING LAYERS

The present invention relates to gas-discharge display panels.

It relates more particularly to panels of the kind in which the display is obtained by using a matrix of insulating material containing gas filled holes. Two transparent plates are provided which are attached to the matrix. Two linear electrically conductive electrode networks are set out on the two transparent plates and crossing the holes. In a plan view of the assembly of the two networks and the matrix, the two networks cross one another at points located within the section of the holes.

A voltage applied between two of the electrodes, one of which belongs to the first network and the other to the second, produces ionization of the gas contained in the hole located at their point of intersection, and thus the display of this point. By appropriate switching, display of the points which form the symbol, or more generally the message, which is to be displayed, are made to light up. It should be added, of course, that generally speaking two layers of insulating material are arranged between the matrix and the two conductor networks, these layers insulating each of the networks from the gas contained in the holes.

In one prior art arrangement, the matrix additionally acts as a spacer because the two transparent plates are applied on the matrix, the latter then spacing apart the two electrode networks carried by the plates.

With this kind of arrangement, the matrix must necessarily satisfy the following requirements:

it must be an insulating plate of substantial lateral size and small thickness (a superficial area of several square decimeters for a thickness of some few tenths of a mm are frequently encountered dimensions).

it must be flat and true so that there is no defective attachment to the matrix of the plates which carry the electrode networks.

it must contain a very large number of holes having a diameter on the order of 1 mm and often less, in aligment with the electrodes, that is to say exactly opposite the points of intersection between same.

All these requirements mean corresponding technical difficulties in the manufacture of the matrix and consequently of the display panels equipped with these matrices.

The object of the present invention is to overcome these difficulties.

The invention will be better understood from a consideration of the attached drawing given by way of non-limitative example, in which:

FIG. 1 is a transverse section of a gas-discharge display panel of the nearest prior art;

FIG. 2 is a perspective view of an embodiment of one of the elements involved in the construction of a gas-discharge display panel in accordance with the invention;

FIGS. 3 and 4 are perspective-cut-away assembly views of gas-discharge display panels in accordance with the invention, utilizing assemblies of the kind shown in FIG. 2;

FIGS. 5 and 6 are other examples of assemblies involved in the construction of a panel in accordance with the invention; and

FIG. 5*a* is an enlarged detail of FIG. 5.

FIG. 1 illustrates a prior art structure for a gas-discharge display panel.

In this Figure, there can be distinguished a first rigid slab 1 upon which there is arranged a network of conductors 2, itself covered by an insulating layer 3 beyond which the ends of the conductors ... extend, as indicated at the extreme left of the Figure. A second slab 4 carries a network of electrodes 5 which is covered by an insulating layer 6. In the example shown in the Figure, each of these networks is constituted by mutually parallel conductors, the conductors of the two networks being perpendicular to one another. Of course, if not both, then at least one of the two slabs must be made of a transparent material, glass for example, in order to provide the desired display.

Between the two networks, there can be seen a matrix 9 containing holes 10, upon which there are placed the two slabs 1 and 4. The matrix 9 acts as a spacer between the two slabs 1 and 4. A seal 8, produced by prior art methods, and surrounding the matrix, provides a gas-tightness vis-a-vis the exterior. The whole of the interior volume within the seal 8, that is to say the volumes 7 and 10, is filled with a gas whose pressure is selected as a function of its nature, of the other characteristics of the panel, and of the operating conditions.

FIG. 2 illustrates by way of example, part of one of the structures utilized in the design of a gas discharge display panel in accordance with the invention.

In this Figure, there can be seen a slab 1, for example of thick transparent glass, and, arranged thereon, a network of mutually parallel conductors 2. On the network, in contact with the slab 1, there is deposited an insulating layer 3 of good transparency. Finally, on the insulating layer 3, there is deposited a network of mutually parallel insulating strips 15, perpendicular to the network of conductors 2.

The elements 1, 2, 3 are in all respects similar to those used in the construction of the prior art panels and are accordingly manufactured in accordance with one of the prior art techniques using one of the materials conventionally used in these techniques. The thicknesses of the elements 1, 2, 3 are respectively some few mm, some few μm and some few hundredths of a mm.

As far as the network 15 of insulating strips characteristic of the invention is concerned, there are made of an insulating material which will withstand the relatively high temperature of 450°C, in order to be able without modification to undergo the stoving operations to which the panel is subjected during the course of its manufacture. This material has excellent mechanical strength, in particular in the situation where, as we shall see later, it has to withstand a certain clamping force, and, finally, ... having a low vapor tension so that the gas discharge conditions are not substantially modified during the operation of the panel.

For these various reasons, the material of which the bands or strips 15 are made will, depending upon the circumstances, be glass, enamel, silicon resin or an organic polymer such as one of the polyimides, and in this latter context the product Kapton produced by Dupont de Nemours could be mentioned, although this mention is in no way intended to be limitative of the scope of the invention. These strips have a thickness of some few hundredths of a mm.

In addition, the material of the strips 15 should have the best possible anisotropy in order to prevent diffu-

sion of the discharge in any direction in the plane of the strips **15**, without inhibiting diffusion in the direction perpendicular to the strips. The materials referred to hereinbefore generally present such anisotropy in a sufficient degree.

Another assembly, identical to that shown in FIG. **2** and constituted by the elements **4, 5, 6** and **16**, is prepared separately.

The two assemblies are then placed one atop the other with their networks of insulating strips **15** and **16** opposite each other in a manner indicated by the simplified cut-away views of FIGS. **3** and **4**, and sealed together at **8**.

The two assemblies are either in contact with one another through their networks of insulating strips **15** and **16** in this case the two networks play the part of a spacer between the two slabs **1** and **4**, or are maintained at a certain distance from one another, in which case spacers **14** are provided in order to establish the desired interval between the slabs **1** and **4**; in the latter case, the space left between the networks of strips **15** and **16** is very small, being at the most on the order of some few hundredths of a mm. In these Figures, the two slabs **1** and **4** are made of a transparent material.

In a variant embodiment of the invention, shown in FIG. **5**, the insulating strips **15** are provided in a granular material in order to increase the anisotropy referred to hereinbefore. The material of the strips **15** consists in this case of a granulate of one of the materials enumerated hereinbefore. In this case, in order to maintain the material in position during the manufacture of the panel, insulating layer **3** is coated with a thin film of adhesive, not visible in the drawing of FIG. **5**, for example a silicon adhesive, in order to ensure that the granulate adheres to the insulating layer **3**.

In this variant embodiment of the invention, further more, the two networks of insulating strips **15** and **16** may be arranged on one and the same slab **1** in a rectangular pattern .... of the kind shown in the Figure by the application of an adhesive to the insulating component **3**, in accordance with this pattern, prior to the deposition of the granulate. The other slab **4**, which is involved in the final structure in the finished panel, simply carries the network of conductors **5** and the insulating layer **6**, the finished panel being constituted by the two slabs assembled one atop the other and the insulating layer **6** applied to the network of strips **15** and **16**. The preparation of the panel obviously, in this case as in the preceding cases, involves the provision of a sealing bead and .... a pumping pip in one of the slabs which pip has been assumed to be located in the cut-away part of the Figures.

It is equally possible to produce the rectangular granule arrangement **15, 16** by some other prior art technique, for example by first of all depositing the uniform layer **15, 16** of granular material upon the insulating layer **3** and applying a selective solvent to the layer **15, 16** through a mask of appropriate shape.

FIG. **5***a* is a sectional view, on an enlarged scale, taken on the line A—A of FIG. **5**.

In another variant embodiment of the invention (FIG. **6**), the granular material is deposited upon one of the slabs alone, that is to say upon the insulating layer **3** in the example of the Figure, in a thinly scattered layer **17**. The second slab **4** simply carries the network of conductors **5** and the insulating layer **6**. It is essential in this case that the layer comprises at least some few grains of granular material between two successive conductors of the network of conductors **2**. On the other hand, these few grains are sufficient to prevent the diffusion of the discharge parallel to the plane of the conductors of the network **2** whilst, conversely, it is found that one or more grains, located on one of the said conductors, does not substantially affect diffusion in the direction perpendicular to the plane of said network. The application of adhesive could usefully be provided, as in the foregoing cases, prior to the deposition of the granular material.

In addition, in the case of this latter variant embodiment it is possible, using glass balls as the granular material for example, to avoid having to provide a spacer of the kind used in the case of FIG. **4**, for example, in order to maintain the desired interval between the slabs; in other words, among ... these balls, the largest ones provide the spacing function themselves, and experience shows that, even with average commercial tolerances, adequate parallelism of the two slabs for proper operation of the panel is achieved.

Of course, the invention is not limited to the embodiment described and shown which was given solely by way of example.

What is claimed is:

1. A gas discharge display panel comprising:

a. two insulating slabs, at least one of which is transparent, said two slabs being sealed at their periphery by a sealing ring and defining in assembly parallel pairs of inner and outer surfaces;

b. an ionizable gas contained between the slabs inside said ring;

c. a network of conducting electrodes disposed on each of the inner surfaces of said slabs, the two networks being crossed in such a way that the application of suitable voltages between two electrodes respectively of each network produces a gaseous discharge in the intersection zones of these electrodes;

d. a first continuous layer of insulating material covering each of the two networks; and

e. a second discontinuous layer of insulating material deposited on each one of said first layers, each of said second discontinuous layers being constituted by a network of raised insulating strips orthogonal to the network of electrodes of the corresponding slab so as to allow discharges to be produced in the intersection zones and to prevent the discharges from spreading beyond said zones, the presence of insulating material along the electrodes between their intersection zones preventing the electric field from extending into the gas along said electrodes, said second layers thus assuming the function of a matrix.

2. A display panel according to claim **1**, wherein said two second discontinuous layers of said two slabs are in contact.

3. A display panel according to claim **1**, further comprising a spacer being provided between said two slabs, so that said two second discontinuous layers of said two slabs are not in contact.

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