

[54] **GAS DISCHARGE PANEL WITH APERTURED CENTER PLATE HAVING AN OXIDIZED SURFACE**

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Related U.S. Application Data

[63] Continuation of Ser. No. 204,460, Dec. 3, 1971, abandoned.

[52] U.S. Cl. **313/188, 313/204, 313/220, 313/221**

[51] Int. Cl. **H01j 61/35**

[58] Field of Search **313/188, 204, 220, 221, 313/109.5; 315/169 TV**

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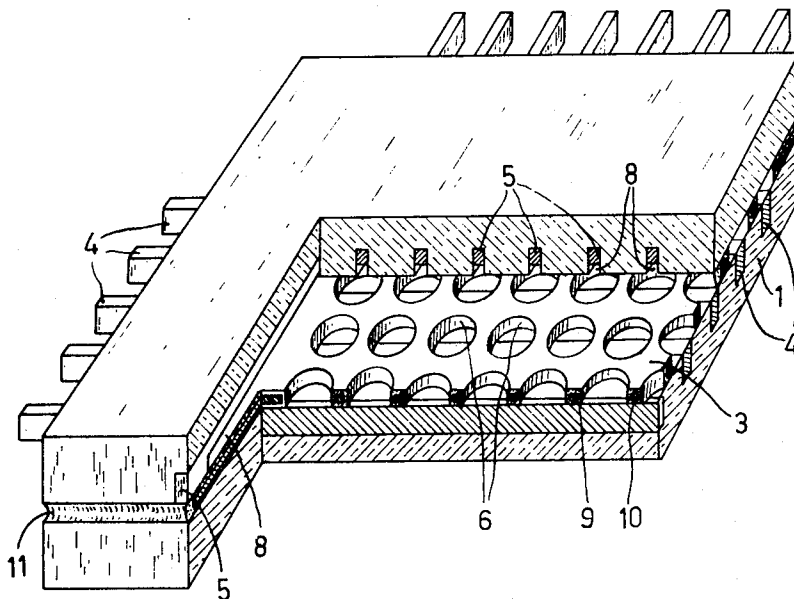
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[57] ABSTRACT

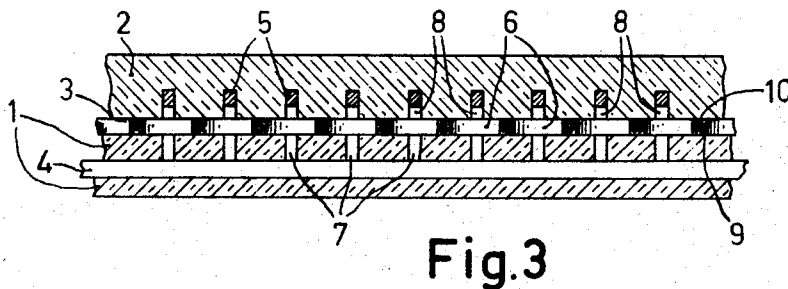
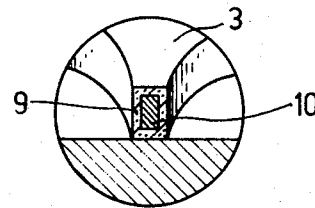
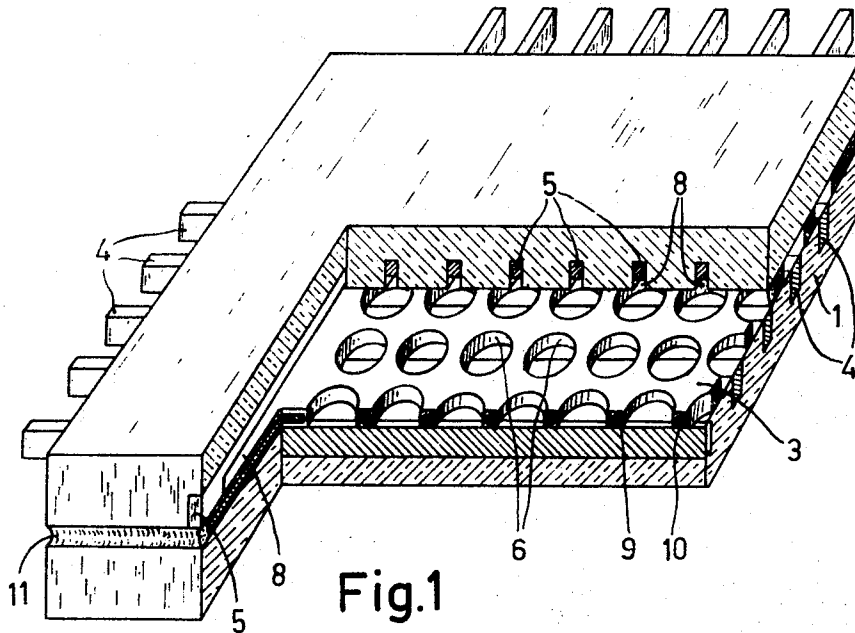
A metal article, for example, in the form of a lead-in or sealing conductor or a perforated intermediate plate of a gas discharge panel for picture display preferably consisting of anodized aluminium, in which the thickness of the oxide layer and of the underlying metal core are chosen to be so that the thermal expansion of the article is also determined by the oxide layer.

4 Claims, 3 Drawing Figures



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GAS DISCHARGE PANEL WITH APERTURED CENTER PLATE HAVING AN OXIDIZED SURFACE

This application is a continuation of application Ser. No. 204,460, filed Dec. 3, 1971, and now abandoned.

The invention relates to a metal article the surface of which is covered with an adherent oxide layer by oxidation. The invention furthermore relates to a fusing or sealing of such an article to or in an insulating material in particular a vitreous material, and to a gas discharge panel for picture display at least consisting of a base plate, an upper plate of a light-pervious insulating material, and a perforated intermediate plate, the base plate and/or the upper plate comprising a number of strip-shaped mutually insulated electrodes a part of the surface of which communicates with a number of cavities also formed by the holes of the intermediate plate, which intermediate plate may consist of such an article.

In known embodiments of gas discharge panels as described, for example, in the U.S. Pat. specification 3,334,269, the intermediate plate consists of glass. Such a plate must be comparatively thick, particularly in the case of panels having large dimensions, since otherwise the plate is too fragile. In this case, however, the provision of the holes is difficult. Drilling the holes mechanically is very time-consuming and hence expensive, while the provision of the holes according to a photographic etching method is not possible since the diameter of the holes will not be constant as a result of the large thickness of the plate. The same drawbacks apply to intermediate plates which consist of other insulating materials useful for this purpose.

When a metal intermediate plate is used, the thickness with a view to the mechanical rigidity could be smaller so that chemical etching of the holes becomes possible. However, the use of a thicker intermediate plate is to be preferred since the thickness of the intermediate plate is also decisive of the length of the gas discharge path.

However, the use of a metal intermediate plate has the drawback that the coefficient of thermal expansion of the metal generally is larger than that of the transparent material of the upper plate and usually also of the base plate. The use of an oxidized aluminium base plate as described in the said U.S. Pat. specification No. 3,334,269 shows the same drawback of the large coefficient of thermal expansion so that in particular in the case of large panels the holes at the edges can be displaced relative to the electrodes of the upper plate and the base plate. On the other hand the use of a ductile metal such as aluminium has the advantage that the mechanical working and the provision of the holes is comparatively simple.

The drawback of the too large coefficient of thermal expansion of a metal article with oxidized surface can be avoided, however, if, according to the invention, the thickness of the oxide layer and the thickness of the underlying metal core are chosen to be so that the coefficient of thermal expansion of the article is also determined by that of the oxide layer. As a result of this it is possible for such an article, for example, an aluminium lead-in conductor or a cylindrical aluminium tube provided with such an oxide layer, to be directly sealed in or fused to, for example, glass. When such an article is used as a perforated intermediate plate for a gas dis-

charge panel, the coefficient of thermal expansion of the intermediate plate can thus be adapted to that of the base plate and the upper plate by a suitable choice of the thickness of the oxide layer and of the underlying core. The underlying core of the intermediate plate must have a small thickness, for example smaller than 0.5 mm, while the thickness of the oxide layer is approximately 10 to 50 percent of that of the core, and the holes are so large as is admissible with a view to the intermediate walls between the holes and the rigidity of the plate. The thickness of the intermediate plate as such, however, may have any desirable value. Moreover, the intermediate plate is insulated from the conductors by the oxide layer. The coefficient of thermal expansion of the intermediate plate, however, may also be adapted to that of the material of the base plate and the upper plate since the intermediate plate may consist of an alloy of iron with one or more other metals, for example, chromium, nickel or cobalt, the coefficient of expansion of which is substantially equal to that of a glass base plate and upper plate, in which case it should be ensured that the plate is insulated from the conductors of the base plate and the upper plate, for example, in that the conductors are inset relative to the surface of the base plate and the upper plate or by providing an insulating oxide layer on the surface of the intermediate plate. Such an alloy, however, is expensive and difficult to work. Such an intermediate plate could be made so thin, however, that the holes can be provided according to a photographic etching method.

The holes in an intermediate plate may be much larger than the electrode surfaces which take part in the discharges, since the smallest distance between the electrodes is determined by the leakage path and the electric conditions for the insulation so that the edges of the electrode surfaces must be located farther from each other than the edges of the holes in the intermediate plate. Moreover, in this case a larger light spot is obtained as a result of the larger diameter of the holes in the intermediate plate.

In order that the invention may be readily carried into effect, two embodiments thereof will now be described in greater detail, by way of example, with reference to the accompanying drawing, in which

FIG. 1 is a perspective partial cross-sectional view of a gas discharge panel comprising a metal article in the form of a perforated intermediate plate according to the invention, while

FIG. 2 shows a detail of FIG. 1, and

FIG. 3 is a sectional view of another embodiment.

Referring now to FIGS. 1 and 3, reference numeral 1 denotes a base plate consisting of an insulating material, for example glass, 2 denotes an upper plate which consists of a light-pervious material, for example also glass, and 3 is an intermediate plate consisting of electrically oxidized aluminium. A number of strip-shaped electrodes 4 are sealed in the base plate 1 in such a manner that a longitudinal side of each strip 4 lies in the upper surface of the base plate 1. Strip-shaped electrodes 5 are sealed in the upper plate 2 in which, however, a part of the strips 5 is removed over its length, preferably by etching, so that channels 8 are formed through which the discharge cavities formed by the holes 6 of the intermediate plate 3 communicate with each other. The channels 8 open into an exhaust duct not shown so that the cavities can be evacuated and filled with a suitable gas. The holes 6 are much larger

than the active surfaces of the electrodes 4 and 5. Since the partitions between the holes 6 are thin, as is shown in FIG. 2, the thermal expansion of the plate 3 is also determined by the comparatively thick aluminium oxide layer 9 which has a smaller thickness, it is true, but nevertheless a larger rigidity than the aluminium core 10.

In order to lengthen the discharge path, cavities 7 may be provided in the base plate 1 as is shown in FIG. 3, for which cavities the strips 4 constitute the bottom. The plates 1, 2 and 3 are connected together in a vacuum-tight manner by means of a suitable readily melting type of glass.

Although in the examples described only aluminium is mentioned as a material for the core 10 of the intermediate plate 3, said plate may also consist of other metals or metal alloys, provided they themselves have a suitable coefficient of thermal expansion adapted to the base plate and the upper plate, for example alloys of iron with one or more of the metals chromium, nickel or cobalt, or if said metals can be covered with such an oxide skin that said oxide skin can also determine the coefficient of thermal expansion.

From measurements it has appeared that the coefficient of thermal expansion of an aluminium core (10) of 0.2 mm which is surrounded by an Al_2O_3 layer (9) with a thickness of 40 μm or more corresponds entirely to that of Al_2O_3 , while an Al_2O_3 layer thinner than 10 μ has substantially no influence on the coefficient of thermal expansion of the core (10). In the case of layer thicknesses between 10 and 40 μ , the coefficient of thermal expansion of the assembly occurs substantially in a straight line from that of aluminium to that of Al_2O_3 , so from $230 \cdot 10^{-7}$ to approximately $70 \cdot 10^{-7}$ m per $^{\circ}C$.

A layer thickness from 10 to 50 percent of the thickness of the core will be chosen in practice.

If the thickness is smaller than 1 mm, the intermediate plate 3 can very readily be manufactured according to one of the known photographic etching methods, al-

though certain mechanical methods are also considered. In addition, the composition and the number of plates of the panel may be varied within the scope of the invention. For example, several electrode plates and intermediate plates may be used, for example, for displaying coloured pictures. The metal intermediate plate may also be given a certain potential. The invention may furthermore be applied to lead-in conductors and seals of such metal articles in or to insulating vitreous materials.

What is claimed is:

1. A gas discharge panel for displaying pictures comprising a base plate, an upper plate of a light-pervious material and an intermediate plate having a thickness less than 0.5 mm hermetically sealed between said upper and base plates, said intermediate plate having a plurality of apertures therein filled with an ionizable gas and consisting of a metal covered with an adherent oxide layer having a thickness which is between 10 and 50 percent of that of the metal whereby the coefficient of thermal expansion is determined by the oxide layer to substantially match those of the upper and base plates, and a plurality of strip-shaped electrodes between each of the intermediate plate and base and upper plates respectively and electrically insulated from the intermediate plate, said electrodes each extending over a number of the apertures in the intermediate plate.

2. A gas discharge panel as claimed in claim 1, wherein the metal is an alloy of iron and an element selected from the group consisting of chromium, nickel and cobalt.

3. A gas discharge panel as claimed in claim 1 in which the metal is aluminum.

4. A gas discharge panel as claimed in claim 3 in which the thickness of the aluminum is 0.2 mm and the thickness of the oxide layer thereon is between 20 and 40 μ .

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,842,308 Dated October 15, 1974

Inventor(s) Johannes Van Esdonk et al

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

On the title page section [21] insert after

"Appl. No.: 382,896" --[30] Foreign Application Priority
Data Dec. 12, 1970 Netherlands
7018158--

Signed and Sealed this

seventeenth Day of February 1976

[SEAL]

Attest:

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