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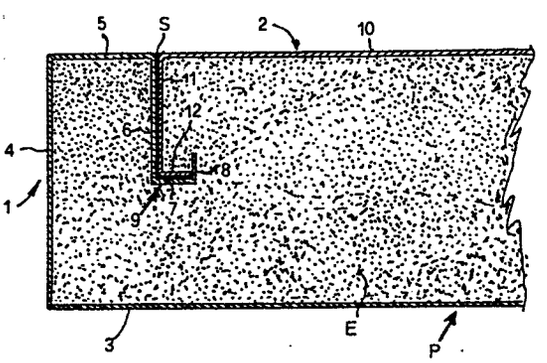
(54) Box-shaped, hermetically closed, internally insulated panel and method of producing the same.

(57) A panel comprising a box-shaped element of metal sheet having inwardly bent edges designed to cooperate with mating bent edges of a panel cover, the bent edges of these two elements acting as fastening means between the box and the cover when a material capable of expanding into a rigid-type structure has been injected into the panel, whereby a one-piece, insulated and hermetically closed panel is obtained without the aid of any conventional type of fastening means. The panel is mainly intended for use in air conditioning and processing plants, especially when highly uncontaminated air is required.

A method for obtaining a panel according to the invention comprises the steps of forming a box-shaped element provided with particularly profiled edges, forming a cover with mating edges, fitting the edges of the cover into the edges of the box-shaped element, and injecting in the thus formed panel a material capable of foaming "in situ" while blowing out the air contained in the panel, upon polymerization of the foamable material, the latter forming a permanent bond which will hold the two parts of the panel firmly joined together hermetically.



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BOX-SHAPED, HERMETICALLY CLOSED, INTERNALLY INSULATED PANEL AND METHOD OF PRODUCING THE SAME.

This invention relates, in general, to closure panels for air conditioning and processing plants and, more particularly, to a panel of a new conception which enables all the deficiencies of the known panels of this type to be overcome and which is also suitable for use in other fields of applications due to its peculiar characteristics.

As is known, closure insulated panels are required in air conditioning and processing plants in order to maintain the required thermal insulation, the panels forming the walls of the different modules forming parts of such plants. This thermal insulation was hitherto achieved by applying a layer or band of a foamed material to the inside surface of the panel by glueing or other procedures. Such a type of insulation has a serious deficiency in that it is exposed to circulating air and, thus subjected to both mechanical and physico-chemical degradation which will finally cause the insulation to disintegrate with the undesirable consequence that insulation particles are carried along with the air circulating in the rooms conditioned by the plant.

This is particularly undesirable when rooms required sterile high purity air, such as operating theaters or the like, are to be conditioned.

In an effort to overcome this serious drawback, double-walled panels have been provided in which the insulation is sandwiched between the two conveniently profiled panel walls so that the insulation no longer contacts the circulating air and acts as a bond means for the two walls. In these panels, however, the insulation which is usually made from a foamed plastic material, is not sealingly enclosed by the two panel walls, the sides being exposed to ambient air. Moreover, this type of panels are fastened to one another and the bearing structure by means of screws or like fasteners which penetrate the insulating material and

thus create passages to air and the surrounding atmosphere. The combined action of humidity, atmospherical agents and temperature changes to which these panels are subjected will again cause, with the passing of time, degradation of the insulating material to an extent that it will eventually crush such that it no longer serves the intended purpose of thermal insulation. All of these situations are detrimental to efficient operation of an air conditioning and processing plants.

Attempts made to avoid the exposition to air of the open sides of the above type of panel have included providing the panel with an external frame closing the panel sides but this frame has to be secured by means of screws or the like which again create passages for the wearing agents so that degradation of the insulating material contained in the panel results in any case and leads to the panel being put out of use as the time goes on.

There is, therefore, a need fora panel that should be free from the above mentioned deficiencies of the prior art panels.

Thus, the object of this invention is to overcome all of the problems that were associated hiterto with this type of panel by providing a panel of a new design which will take into account the requirements to be met, namely to improve thermal insulation while extending the insulation life, to be not a cause of air pollution inside the air conditioning and processing plant, to ensure that the insulating material should be undeteriorated in the course of time, to provide a manufactured product which is light in weight while being rugged in construction, which is hermetically sealed and unexpensive.

More specifically, the insulating panel according to the invention is characterized in that it comprises a box-shaped element having edges inwardly bent to a given profile and a cover having edges that are bent to a profile mating the profile of the box-shaped element, said bent edges, once fitted into one another, acting as fastening means between the box-shaped element and the cover when a foamable plastic material has been injected into the panel, so as to obtain an integrally

insulated and hermetically closed panel without using any conventional type of fastening means.

A method of producing a panel according to the invention is characterized in that it comprises:

-bending the edges of the box-shaped element first 90° inwardly and then 90° downardly followed by forming an open-top undercut end portion;

-bending the edges of the cover 90° downwardly followed by forming a mating undercut portion designed to fit into said undercut end portion of the box-shaped element;

-providing the box-shaped element with an air outlet opening and an injection opening;

-mounting the cover to the box-shaped element such that the undercut portions of the former fit into the undercut portions of the latter thereby to form a closed panel;

-injecting into the thus formed panel a plastic material capable of foaming "in situ", and

-hermetically closing the air outlet and injection openings in the panel allowing for the foamable plastic material to polymerize inside the panel to form the insulation therein.

The invention will now be described in more detail in connection with one preferred embodiment thereof shown by way of a non-limiting example in the accompanying drawings, in which:

Figure 1 is a plan view as seen from the above showing the box-shaped element of a panel according to the invention;

Figure 2 is a view like Figure 1 showing the cover element of the panel according to the invention;

Figure 3 is a partly sectional view of the panel elements in Figures 1 and 2 when in an intermediate position during the step of fitting them together;

Figure 4 is a view like Figure 3 when the panel components have been completely fitted together and the injection of plastic material is completed;

Figure 5 is a perspective view of the finished panel, and

Figure 6 is a detail, sectional view of a plug for closing the air outlet and injection openings in box-shaped element.

As it can be seen from Figures 1 to 4, a panel according to this invention comprises a box-shaped element 1 and a cover 2. The box-shaped element is formed by a suitably stamped length 3 of metal sheet such as to have four shaped borders each of which includes, in succession, an upright wall 4 obtained by bending the sheet at 90° upwardly, a horizontal wall 5 obtained by further bending at 90° inwardly, an upright wall 6 obtained by further bending the sheet downwardly at 90° and being smaller in width than the upright wall 4, a horizontal wall 7 of small width obtained by bending the sheet inwardly at 90° and merging into a last upright wall 8 obtained by bending the sheet upwardly at 90° and being smaller in width than the wall 7. There is thus obtained the box-shaped element 1 which, as indicated by its name, takes the form of a hollow-walled box having on its inner side a channel 9 defined by the wall-portions 6, 7 and 8.

The cover 2 is formed by a suitably stamped piece 10 of metal sheet, such as to have, in turn, four shaped borders each of which includes an upright wall-portion 11 obtained by bending the sheet at 90° downwardly, and a horizontal wall-portion 12 obtained by bending the sheet at 90° inwardly, this wall 12 being substantially of the same width as the wall 7 of the box-shaped element 1 forming the bottom of the channel 9.

The junctions 13 at the corners of both the box-shaped element 1 and the cover 2 are all sealingly closed either by using a cement or a sealing compound, preferably of the silicone type, or by welding, the plasma jet welding being the most preferred procedure. When all of the corner junctions have been carried out, a liquid-type sealant S is introduced to the bottom 7 of channel 9 whereupon the cover 2 is assembled to the box-shaped element 1 in such a way as to obtain that the horizontal wall-portion 12 of the cover fits into the channel 9 until it rests against the horizontal wall-portion 7 of the box-shaped

element. As a result, the wall-portions 11 and 6 of the cover 2 and the element 1 respectively are brought into side-by-side relationship to define a capillary labyrinth therebetween in which the liquid sealant is thoroughly distributed by squeezing action, thereby to close hermetically the gap between the box-shaped element and the cover.

Thus, there is formed the panel P which is in the form of a box being closed hermetically on all sides thereof except for the two holes 16 that are provided in the wall-portion 4 of the box-shaped element 1 for the injection "in situ" of the plastic foamable material and, respectively, for enabling the air contained in panel P to escape during the injection of said material designed to form the insulation E.

At this stage of the panel formation, the box-like hermetically closed panel is placed between the pressing plates of a press whereupon the insulating material E (which is of a type capable of foaming "in situ") is injected into the panel using an injection pressure of about 1 atm. In this case, it is preferably used a polyurethane which is obtained by reacting a polyether-polyol with a diisocyanate, according to the prepolymer method, to obtain the so-called foaming "in situ" by addition of an aqueous solution containing the catalysts and silicones that are required to enable foaming and polymerization to occur. The mixture swells in a few seconds to produce a foam that will fill throughout the panel P to cause the air contained therein to be blown out through the outlet hole 16, the foam adhering to the inside surfaces of the panel and forming a cellular rigid mass that acts as a permanent mechanical bond between the box-shaped element 1 and the cover element, particularly at the juxtaposed walls 6 and 11 and the walls 7, 8 and 12 thereof, thereby to make said elements not separable from one another.

A preferred polyurethane for use in this invention is a foamable polyurethane having self-extinguishing ability, preferably of the URECOR 1220 HE type having a density of 35 -40 kg/m^3 and thermal conductivity lambda = 0.016 - 0.020 Kcal/m.h.°C, that is the lowest thermal conductivity coefficient of the known insulating materials, among which

the most widely used are:

-expanded polyurethane

-expanded phenolic resins

-glass fibers

-mineral wool

-diatomite

-cellular cork

-asbestos fibers

-cellular glass

-cellular cement

-pumice,etc.

At the completion of injection, which is carried out under press action in order to prevent distorsion of the panel upon polymerization of the polyurethane, each hole 16 is closed by means of a plastic plug, such as the plug T in Figure 6, which is a preferred type of plug at present.

This plug T has a portion 17 which is compliant in character due to the provision of strips 15 connecting it integrally with the plug T, the portion 17 being designed to abut against the wall-portion 6 of the box-shaped element. The plug T has an annular groove 14 into which the edge of the hole 16 is received by snap action , thereby to achieve the hermetic closure of the hole.

From the above description it can be appreciated that the panel according to the invention is obtained by bending a metal sheet in such a manner as to ensure that all the junction zones are thoroughly sealed by the action itself of the injected insulating material. The sealing is such that the panel is totally free from both external burr and zones lacking in internal penetration so that efficient and constant insulating effect is ensured at a highest degree throughout the structures utilizing the panel. The fully sealed condition of the panel also ensures that the physico-chemical properties of the insulating material and thus its overall insulating effect, are maintained

unchanged in the course of time. The fact that the two panel elements are rigidly locked together mechanically by the foamed material enables the usual separate fasteners used hiterto in fabricating or fixing such panels, to be dispensed with, which ensures that no passage may be created for humidity and atmospherical agents to enter the panel, so that degradation of the insulating material contained therein is prevented.

The following advantages are obtained when using the insulated and sealed panel according to the invention in air conditioning and processing plants:

(1) Improved thermal insulation since use is made of an insulating material having a minimum coefficient of conductivity;

(2) No contamination is caused to the air processed inside the plant since the panel has a smooth metal surface contacting the air;

(3) No deterioration is induced in the insulating material since the insulated material is enclosed hermetically on all sides by the panel walls and, due to the absence of screws or like fastening means, no passage communicating with the exterior is created;

(4) The panel is light in weight and is, at the same time, of rugged construction since the used insulating material is very light but rigid in structure;

(5) Low cost of the panel. The cost price of this panel (taking its peculiar characteristics into account) is substantially the same as that of the conventional commercially available panel product;

(6) A permanent, mechanical locking together of the two parts forming the panel is ensured, while a simultaneous hermetic seal is provided by action of the liquid sealant filling the capillary labyrinth that is defined between the juxtaposed wall portions of the box-shaped element and the cover.

It has to be noted that the insulated hermetically closed panel of the invention, in addition to being used in air conditioning plant applications, may also be utilized, as a long-life insulating panel, in

other fields of application, for example in building construction, in public works and in the industrial field in general.

CLAIMS

1.- A hermetically sealed internally insulated box-like panel, characterized in that it comprises a box-shaped element having edges bent inwardly to a given profile and a cover having edges bent to a profile mating the profile of the box-shaped element, said bent edges, once fitted into one another, acting as fastening means between the box-shaped element and the cover when a foamable plastic material has been injected into the panel, such that a one-piece insulated and hermetically closed panel is obtained without recourse being made to any conventional fastening means.

2.- The panel according to claim 1, characterized in that the inwardly bent edges of the box-shaped element and the cover have profiles defining undercut portions.

3.- The panel according to claims 1 and 2, characterized in that each bent edge of the box-shaped element includes a 90° inwardly bent portion, with respect to a plane of the element, followed by a 90° downwardly bent portion, and the undercut portion is formed by a further 90° inwardly bent portion followed by a 90° upwardly bent portion.

4.- The panel according to claims 1 and 2, characterized in that each bent edge of the cover is formed by a 90° downwardly bent portion, and the undercut portion is formed by a 90° inwardly bent portion.

5.- The panel according to the preceding claims, characterized in that the junctions at the corners of the box-shaped element and the cover are sealed by means of a sealing compound or by plasma jet welding.

6.- The panel according to any preceding claim, characterized in that

the injected plastic material is a foaming polyurethane having preferably a density of 35-40 Kg/m^3 and a thermal conductivity of 0.016 - 0.020 Kcal/m.h.°C.

7.- The panel according to any preceding claim, characterized in that the box-shaped element has at least one injection hole and one air outlet hole provided therein, which holes are, in the finished panel, closed hermetically by means of plugs preferably of a type capable of snapping in place.

8.- A method of producing a hermetically closed internally insulated box-like panel according to the preceding claims 1 to 7, characterized in that it comprises:

- bending the edges of the box-shaped element first inwardly at 90° and then downwardly at 90° and subsequently forming an open-top undercut end portion;

- bending the edges of the cover at 90° downwardly and then forming a mating undercut portion designed to fit into said end undercut portion of the box-shaped element;

- providing the box-shaped element with an air outlet opening and an injection opening;

- mounting the cover to the box-shaped element such that the undercut portions in the cover fit into the undercut portions in the box-shaped element, thereby to form a closed panel;

- injecting into the thus formed panel a plastic material capable of foaming "in situ";

- hermetically closing the air outlet and injection openings in the panel allowing for the plastic foamable material to polymerize inside the panel to form the insulation therein.

9.- The method according to claim 8, characterized in that the step of injecting into the panel a plastic material capable of foaming "in

situ" is carried out under the action of a press.

10.- The method according to claims 8 and 9, characterized in that the open-top end undercut portion in the box-shaped element is obtained by each edge thereof being further bent at 90° inwardly and then again at 90° upwardly, whereby an open-top U-shaped channel is formed.

11.- The method according to claims 8 and 9, characterized in that the end undercut portion in the cover is formed by having each edge thereof further bent at 90° inwardly.

12.- The method according to any one of the preceding claims 8 to 11, characterized in that, before injecting into the panel a plastic material capable of foaming "in situ", the junctions at the corners of the box-shaped element and the cover are sealed by means of a sealing compound, or by previous injection of said foamable plastic material, or by plasma jet welding.

13.- The method according to any one of the claims 8 to 12, characterized in that the injected plastic material is a foamed rigid-type polyurethane having preferred density of 35 - 40 Kg/m^3 and preferred thermal conductivity of 0.016 - 0.020 Kcal/m.h.°C.

14.- The method according to claim 8, characterized in that the step of hermetically closing the air outlet and injection openings in the panel is performed by the aid of plugs made of a compliant material capable of snap action.

15.- A panel according to claims 1 to 7 obtained by the method according to claims 8 to 14, intended to be used as a covering element for air conditioning and processing plants.

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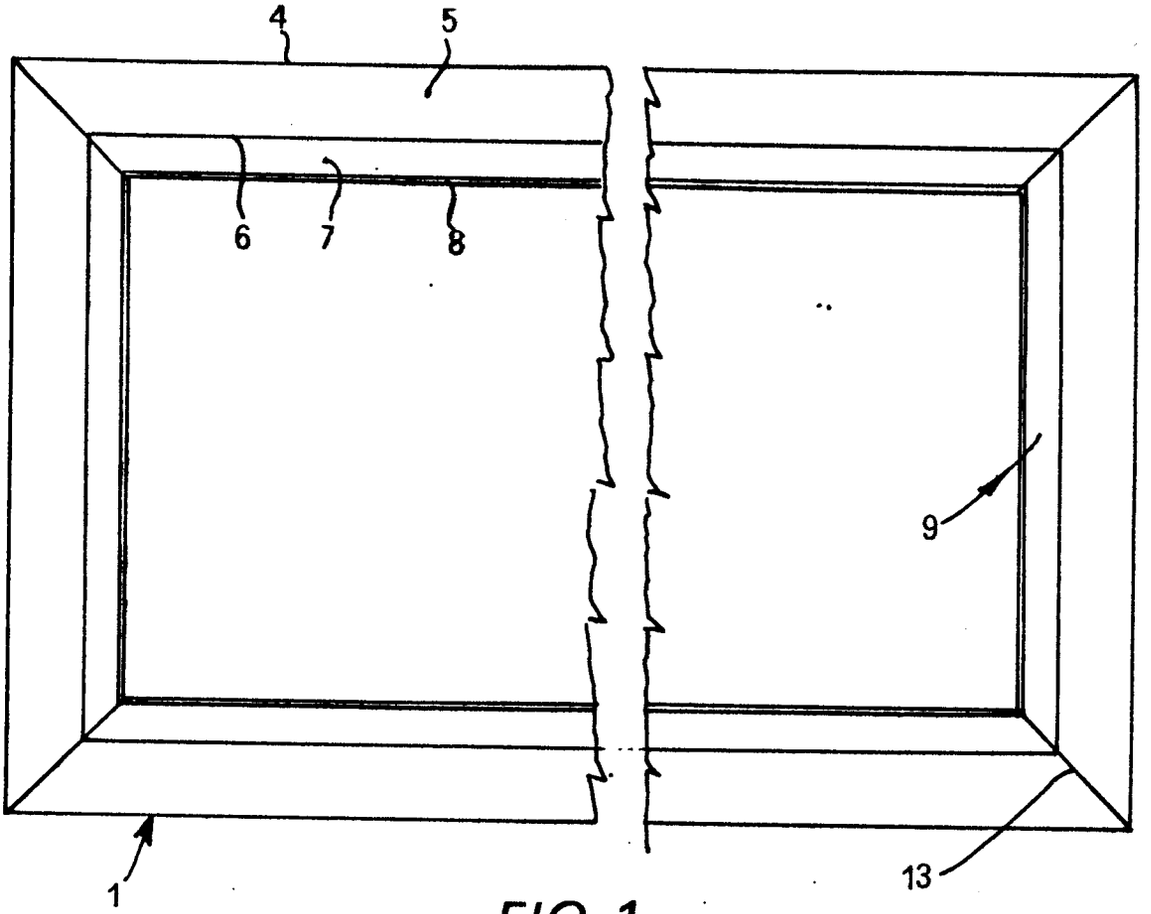

FIG 1

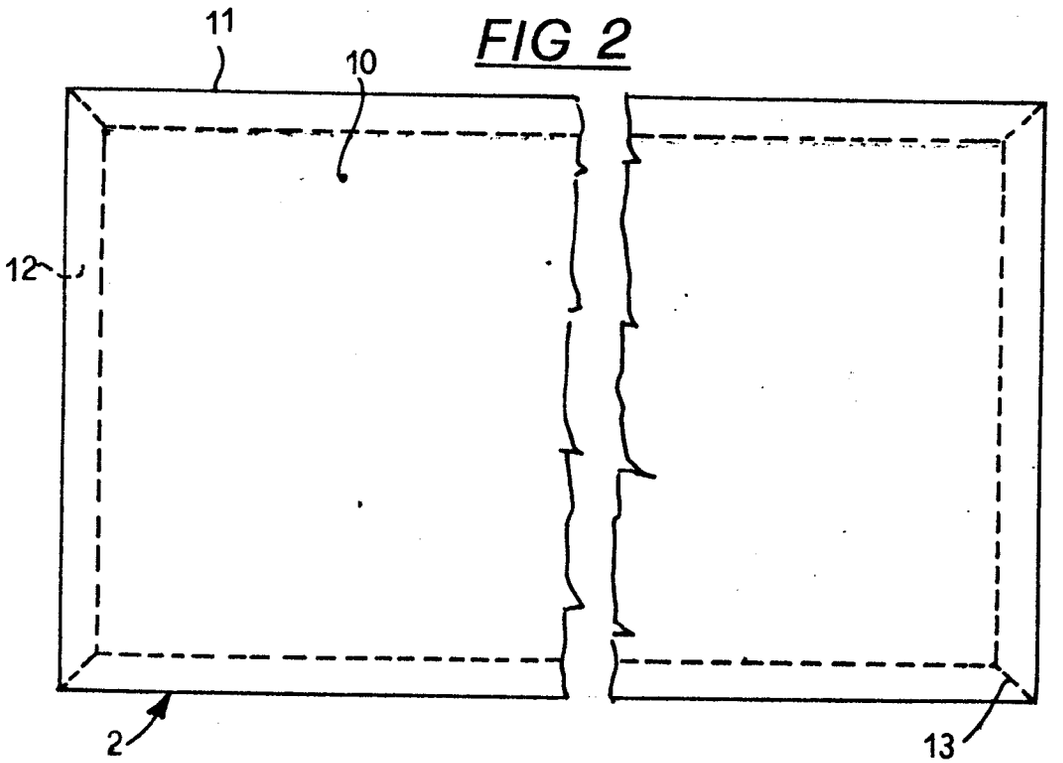

FIG 2

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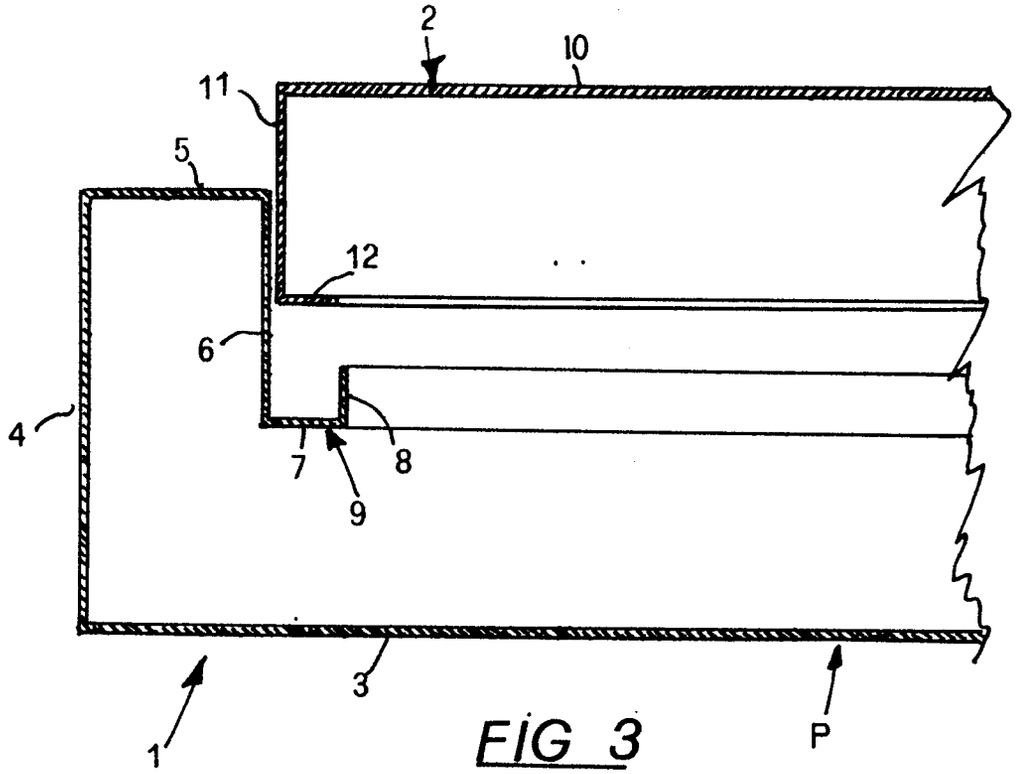

FIG 3

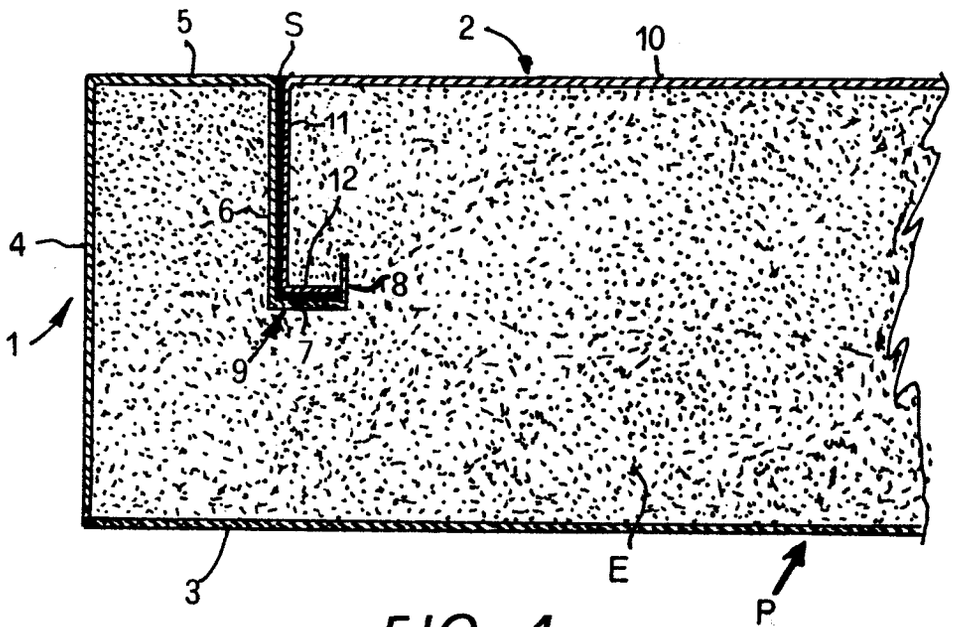

FIG 4

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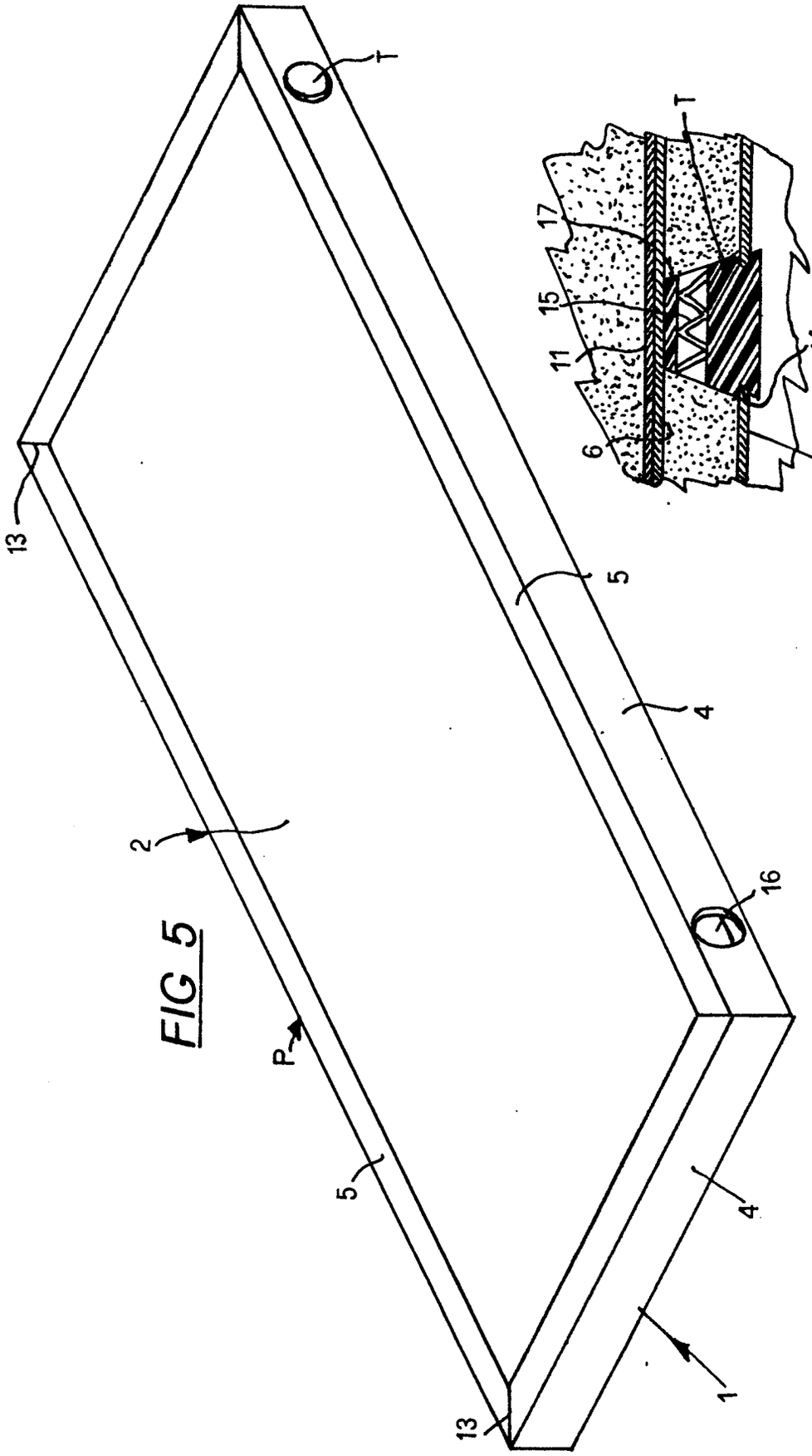

FIG 5

FIG 6