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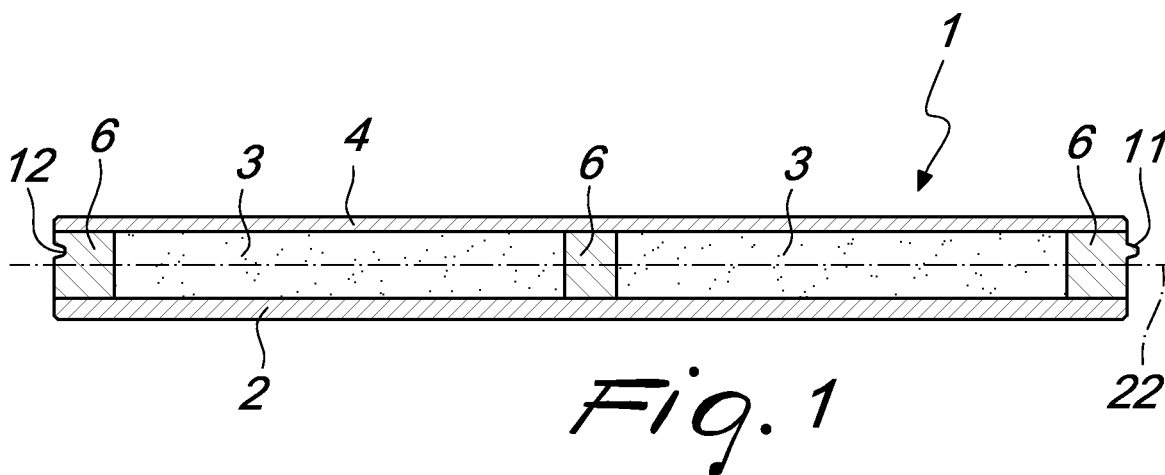
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(54) **Composite panel for civil, industrial and residential building, particularly for curtain walls, floor slabs and roofing panels in prefabricated buildings**

(57) A composite panel (1) for civil, industrial and residential building, particularly for curtain walls, floor slabs and roofing panels in prefabricated buildings, comprising at least one outer layer (2) made of concrete, at least one

intermediate layer (3) made of thermally insulating material and at least one inner layer (4) made of concrete, the outer layer (2) and the inner layer (4) having connecting and stiffening means made of a material selected among wood, composite material and resin.



Description

[0001] The present invention relates to a composite panel for civil, industrial and residential building, particularly for curtain walls, floor slabs and roofing panels in prefabricated buildings, having any shape, which is right on its plane but can also be curved.

[0002] Prefabricated panels are known which are used predominantly as curtain wall elements and are constituted by layers of wood which are mutually connected by ribs, also made of wood or steel, or by layers of reinforced concrete which are mutually connected by ribs also made of reinforced concrete or steel.

[0003] These layers of wood or reinforced concrete form a so-called "sandwich panel", i.e., a monolithic panel formed by an overlap of layers having different functions: structural, thermal insulation and soundproofing.

[0004] So-called "sandwich panels" made of reinforced concrete are in high demand and are used widely in industrial and civil reinforced concrete prefabrication. In particular, they are preferred to the former, which have wood layers, due to their characteristics of load bearing, durability and strength, related to the use of concrete.

[0005] However, this type of panel has a rather lower resistance to thermal penetration due to the many thermal bridges generated by the metallic reinforcement frame that holds them together and to the connecting and stiffening ribs made of a highly heat-conducting material, such as concrete and steel.

[0006] The ever-growing attention to the environmental problem and recent laws in terms of containment of atmospheric emissions require curtain wall panels to have a high thermal insulation performance. This has entailed the spread of curtain wall panels known as "thermal break" panels, which have a load-bearing concrete layer, which is optionally lightweight and thermally insulated, and a supported concrete layer, which protects the building against atmospheric agents, has an intrusion prevention function and has a certain aesthetic function. A thickness of thermally insulating material is further present between such two layers (the load-bearing one and the supported one). The thermal insulation, which separates these two layers almost entirely, except for the presence of special metallic inserts for coupling between the load-bearing layer and the supported layer, indeed provides the so-called "thermal break", limiting considerably the problem of thermal bridges.

[0007] However, this type of panel has entailed a considerable cost increase, due first of all to the fact that they require a complex production also due to these couplings.

[0008] Moreover, separation of the tasks and functionalities assigned to the various layers of concrete entails a great increase in the use of material.

[0009] Therefore, so-called "thermal break" panels, due to their cost and mass, have severe problems in terms of transport, as can be easily understood, and in terms of safety. In case of earthquake, the increase in

weight linked to the greater use of material is in fact a negative consequent increase in seismic action on the structures.

[0010] The special coupling inserts are constituted by elements made of steel or resin which are embedded in the castings of the load-bearing and supported concrete layers.

[0011] This type of insert comprises two types of product: one which has the function of supporting the outer layer and one with the function of stabilizing the outer layer, which however also allows free expansions due to thermal variations. As mentioned, such inserts, beside being rather expensive, entail a series of complications during casting and constitute themselves unwanted thermal bridges, albeit to a limited extent.

[0012] Currently it is also known to use contoured and perforated metal profiles, or electrically welded lattice girders made of galvanized steel or stainless steel, which are embedded during casting in the two concrete layers and pass through the thermal insulation layer that separates them. These metallic profiles, which replace the inserts, make the load-bearing layer and the supported layer collaborate statically.

[0013] However, although they are more advantageous than inserts from the point of view of costs and production, profiles of this type increase the phenomenon of thermal bridges, with all the imaginable consequences both for the energy efficiency of the building and for the formation of condensation, which can be dangerous for the integrity of the thermal insulation characteristics of the materials used for this purpose.

[0014] Finally, floor slab panels are known which are composed of concrete slabs which are substantially coupled to lightweight elements made of clay building materials, polystyrene or other materials. These panels are characterized by high weights per unit surface and are used with difficulty in renovation cases, or in any case when handling with lifting means is difficult or even disallowed.

[0015] These known types of floor slab panel generally do not correspond to the expected performance in terms of soundproofing and thermal insulation required by current statutory provisions, and therefore their use entails, in most cases, the need to lay additional thermal insulation layers after providing the floor slabs.

[0016] The aim of the present invention is to eliminate the drawbacks cited above in known types of composite panel for civil, industrial and residential building, particularly for curtain walls, floor slabs and roofing panels in prefabricated buildings, which provides for a simple and economically advantageous provision and provides the so-called "thermal break" between the inner layer and the outer layer, eliminating the phenomenon of the thermal bridge.

[0017] Within this aim, an object of the invention is to provide a composite panel for civil, industrial and residential building, particularly for curtain walls, floor slabs and roofing panels in prefabricated buildings, in which

the inner and outer layers are made of concrete, of the traditional or lightweight type, so as to retain all the characteristics of durability, load bearing, workability and finishing that cause this material to be preferred on the market.

[0018] Another object of the invention is to provide a panel in which the layers that compose it are all load-bearing and provide structural stiffenings despite allowing the insertion of thermally insulating materials between the concrete layers.

[0019] Another object of the invention is to provide a composite panel for civil, industrial and residential building, particularly for curtain walls, floor slabs and roofing panels in prefabricated buildings, which allows a significant reduction in weight per unit surface, thus optimizing transport and reducing seismic actions on buildings.

[0020] Another object of the invention is to provide a composite panel for civil, industrial and residential building, particularly for curtain walls, floor slabs and roofing panels in prefabricated buildings, with means that are easily commercially available and by using common materials, so that the panel is economically competitive.

[0021] This aim, as well as these and other objects that will become better apparent hereinafter, are achieved by a composite panel for buildings, particularly for curtain walls, floor slabs and roofing panels in prefabricated buildings, according to the invention, comprising at least one outer layer made of concrete, at least one intermediate layer made of thermally insulating material and at least one inner layer made of concrete, said outer layer and said inner layer having connecting and stiffening means, **characterized in that** said connecting and stiffening means are made of a material selected among wood, composite material and resin.

[0022] Further characteristics and advantages of the invention will become better apparent from the following detailed description of a preferred but not exclusive embodiment of the composite panel for civil, industrial and residential building, particularly for curtain walls, floor slabs and roofing panels in prefabricated buildings, illustrated by way of non-limiting example with the aid of the accompanying drawings, wherein:

Figure 1 is a sectional view of a composite panel, taken on a plane which is normal to the direction of extension of such panel;

Figure 2 is a sectional view of the composite panel, taken on a plane which is parallel to the direction of extension of such panel;

Figure 3 is a sectional view of the composite panel, taken along a plane which is normal to the direction of extension of such panel;

Figure 4 is a sectional view of the composite panel provided with concrete reinforcing ribs and coupling means of the male-female type, taken on a plane which is normal to the direction of extension of such panel;

Figure 5 is a sectional view of the composite panel

provided with concrete reinforcement ribs and coupling means provided with facing hollows, taken along a plane which is normal to the direction of extension of such panel;

Figure 6 is a sectional view of the composite panel provided with reinforcement ribs made of concrete, taken along a plane which is parallel to the direction of extension of such panel;

Figure 7 is a view of a detail of the coupling between a first panel and the subsequent panel by means of an element for interposition in the gap formed by hollows provided in panels that have concrete reinforcement ribs;

Figure 8 is an enlarged-scale view of a detail of the composite panel provided with the pins associated with the outer and inner layer;

Figure 9 is an enlarged-scale view of the detail of the composite panel provided with the pins associated with the outer and inner layer, in a different configuration with respect to the one shown in Figure 8;

Figure 10 is an enlarged-scale view of a detail of the composite panel provided with the gasket connected to the interface of the outer and inner layers;

Figure 11 is an exploded view of a concrete panel, particularly for curtain walls, provided with elements for connection between the footing beams and the longitudinal elements and with pins which can be associated with the outer and inner layers and protrude from the connection and stiffening means;

Figure 12 is an exploded view of the concrete panel with inserts made of composite material, particularly for curtain walls, provided with elements for connection between the footing beams and the longitudinal elements and with pins that protrude from metallic nets;

Figure 13 is a sectional view of the panel, taken along a plane which is normal to the transverse direction.

[0023] With reference to the figures, a composite panel for civil, industrial and residential building, particularly for curtain walls, floor slabs and roofing panels in prefabricated buildings, according to the invention, generally designated by the reference numeral 1, comprises at least one outer layer 2 made of concrete, at least one intermediate layer 3 made of thermally insulating material, and at least one inner layer 4 made of concrete. The outer layer 2 and the inner layer 4 have connection and stiffening means, also known as inner ribs.

[0024] A particular characteristic of the invention is that the connection and stiffening means are made of a material selected among wood, composite material and resin.

[0025] Advantageously, the connection and stiffening means or inner ribs comprise transverse elements 5, which are extended, on the plane of arrangement of the panel, in a direction that is substantially normal to the longitudinal direction 10 of the panel, i.e., normal to the longitudinal extension 10 of the panel.

[0026] Advantageously, the connection and stiffening means can also comprise longitudinal elements 6, which are extended in a direction that is substantially parallel to the direction 10.

[0027] In the preferred embodiment, the connection and stiffening means are made of solid or laminated wood.

[0028] Advantageously, the connection and stiffening means can have means for fixing between the transverse elements 5 and the longitudinal elements 6.

[0029] For example, such fixing means can comprise joining plates 21, which are connected to the elements 5 and 6 by means of screws, nails, et cetera.

[0030] Preferably, particularly for curtain wall panels, the connection and stiffening means can have at least one footing beam 19, for supporting the outer layer 2 and the inner layer 4, which can be associated with the longitudinal elements 6, for example by means of at least one connecting element 20 (see Figures 11 and 12).

[0031] In the embodiment presented here there are two beams 19 which are arranged in the peripheral portions of the panel.

[0032] The layers 2 and/or 4 can be provided by using traditional or lightweight concrete and the intermediate layer 3 can instead be made of sound-absorbing as well as of thermally insulating material.

[0033] For the intermediate layer 3 it is possible to use a material based on expanded polystyrene foam, optionally with one or more panels of polystyrene granulate, which is per se known and has for example air gaps 9 (see Figure 3).

[0034] Another per se known solution for the layer 3 can provide for the use of extruded polystyrene panels or plasterboard or chipboard panels that have the air gaps 9.

[0035] Other types of constructive solution, which are also already known, can provide for the use of polyurethane.

[0036] Advantageously, the connection and stiffening means or ribs have means for coupling to at least one between the layers 2 and 4, designed on the basis of the rotational momentum that is present in the connection to be provided.

[0037] With reference to Figure 11, the coupling means can have pins 16 made of metal, wood, resin or composite materials, which can be associated with at least one between the outer layer 2 and the inner layer 4 and protrude from the connection and stiffening means.

[0038] In another embodiment, shown in Figure 12, the pins 16 can protrude from a net 17 which is associated with at least one between the layers 2 and 4.

[0039] Advantageously, the transverse elements 5 and the longitudinal elements 6 can have elements for resting on at least one of the layers 2 or 4.

[0040] With reference to Figure 10, the resting elements can consist of at least one gasket 8, which is adapted to be connected to the interface of at least one of the two layers 2 and 4. The gasket 8 is preferably made of a material that has high elastic characteristics, such as

for example rubber or products that are known commercially by the name of neoprene and elastoprene and the like.

[0041] These thicknesses have the purpose of increasing the thermal insulation characteristics of the panel.

[0042] Advantageously, elements for coupling between a first panel to be coupled and a subsequent panel are provided.

[0043] With reference to Figures 1 and 4, in a first solution the coupling elements can comprise a male element 11 formed on a transverse thickness, with respect to a transverse direction 22, of the first panel. The male element 11 can be inserted in a female element 12 which is formed on a transverse thickness, with respect to the transverse direction 22, of the subsequent panel.

[0044] In a second solution, the coupling elements instead comprise an element 13 for interposition in the gap formed by the adjacent arrangement of a first recess 14 formed on a transverse thickness, with respect to the transverse direction 22, of the first panel, which faces a second recess 15 formed on a transverse thickness, with respect to the transverse direction 22, of the subsequent panel (see Figure 5).

[0045] Preferably, the interposition element 13 can consist of a concrete casting, to be performed in place.

[0046] Preferably, one or both of the outer and inner layers 2 and 3 can have at least one reinforcement strut 7, which is firmly associated with the longitudinal element 6, so as to provide a composite panel with connection and stiffening means or inner ribs made of mixed wood-concrete (or composite-concrete or resin-concrete) material, which is particularly adapted for use as a floor slab.

[0047] Advantageously, means for recirculating the air within the panel are provided.

[0048] Preferably, these recirculation means can provide for slots 23 for ventilation for the replacement air that arrives from outside, which are formed among the intermediate layer 3 and run along the direction 22. The slots 23 are interconnected in input and in output to through holes 24 formed in the elements 5. The holes 24 can be provided along an axis that is substantially parallel to the direction of extension 10 of the panel.

[0049] With reference to Figure 13, it is possible to provide an aerated and/or ventilated panel constituted for example by the layers 2 and 4 made of concrete which are mutually connected by means of the inner ribs and by the intermediate layer 3 made of insulating material.

[0050] The external air enters from the lower layer 2 through the holes 24, which can have variable dimensions depending on the quantity of replacement air provided. In the embodiment shown, the holes 24 have a substantially rectangular cross-section.

[0051] Subsequently, due to the difference in pressures and temperature, the air tends to rise to the outer curve of the panel, passing through the slots 23, and then tends to exit through the holes 24, again by means of the slots 23.

[0052] The composite panel of the type thus described can therefore be used as a curtain wall in prefabricated or traditional structures, coupling several panels in succession, by means of the male-female elements 11,12 or by means of the insertion of the element 13 between the recesses 14 and 15 until the perimeter of the building to be erected is completed. The panel can have any shape, in particular can be right on its plane but also curved.

[0053] Another provided application is also its use as a floor slab, either flat or optionally shaped like a roofing panel.

[0054] From what has been described above it is therefore evident that the composite panel according to the invention achieves the intended aim and objects, and in particular the fact is stressed that a composite panel for civil, industrial and residential building, particularly for curtain walls, floor slabs and roofing panels in prefabricated buildings, is provided which has a weight per unit surface that is up to one third of the weight of known panels.

[0055] In particular, the provision of a composite panel that is so light but by using traditional or lightweight concrete as a component of the inner and outer layers of the panel, allows any kind of finishing, smooth, glossy, bush-hammered, contoured, covered with bricks, in relief by using molds, rough by subsequent optional application of plaster, and so forth.

[0056] Moreover, the use of laminated wood, which has good fire resistance characteristics, enhances the fire resistance of the layers of concrete that protect it.

[0057] Another advantage of the invention is that the composite panel of this type can be provided by means of the industrialized systems that are widespread in the prefabrication of concrete, even in combination with prestressing and post-compression, or simple loose reinforcement.

[0058] In this manner, thanks to prestressing it is possible to obtain a construction material that is provided almost exclusively in a workshop, ensuring truly perfect manufactured elements, for the quality standards currently required by the building sector by more careful monitoring of the composition of the concrete. Moreover, with a prestressed concrete the maintenance intervals are greatly spaced, and this reduces the maintenance costs of buildings.

[0059] Finally, since generally speaking a prestressed article is lighter, more flexible, more resistant to fire, to impacts, to extraordinary events and to atmospheric agents, it is evident that the possibility to have composite panels according to the invention made of prestressed concrete is a highly competitive element.

[0060] Another advantage of the composite panel according to the invention is that since it is so light, it has reduced seismic actions on the buildings, since, as is well-known, the action of an earthquake is proportional to the mass of the structures that it affects.

[0061] Moreover, its light weight allows to reduce founda-

tion and transport costs or, for an equal weight, to provide larger structures.

[0062] Another advantage of the invention is that the coupling of concrete and wood or other composite lightweight materials makes it suitable in all crowded environments in which safety and thermal and acoustic insulation are primarily important.

[0063] Another advantage of the composite panel according to the invention is that the connection and stiffening means or inner ribs made of wood, composite materials or resins, connected to the concrete layers, enhance the static performance of the connected layers, increasing the sound-absorbing capacity of the panel and therefore making it particularly suitable for use in any type of civil and industrial building (shopping centers, auditoriums, school buildings, et cetera).

[0064] In particular, the insertion of the thicknesses made of neoprene and the like having very high insulation characteristics, enhances the above cited qualities.

[0065] Another advantage of the composite panel according to the invention is that the inner ribs or the connection and stiffening means made of wood, composite material or resins allow to provide panels that have very substantial thicknesses, on the order of 50 centimeters and even more, with a negligible increase in weight per unit surface. This allows excellent performance in terms of thermal insulation and soundproofing.

[0066] In particular, the provision of mixed internal ribs made of concrete and wood (or other composite materials or resins) allows to optionally insert additional reinforcement frames for special cases that have a particular static importance.

[0067] Moreover, the above cited connection and stiffening means, since they allow thinner panels to reach the insulation values required by applicable statutory provisions, reduce internal condensation considerably, increasing the lifespan of the panel itself.

[0068] Another advantage of the invention is that the inner ribs made of wood, composite materials or resins, or mixed ribs as described above, allow to provide coupling systems of various kinds: male-female, with organized structural joints, with dry connection.

[0069] Another advantage of the composite panel for civil, industrial and residential building, particularly for curtain walls, floor slabs and roofing panels in prefabricated buildings, according to the invention, allows quick laying and the panels can be assembled and/or coupled in a practical and quick manner in place, until the desired shape and dimensions are provided.

[0070] Another advantage of the invention is that when using the composite panel as a floor slab, it stresses the vertical structures with non-massive behaviors, dissipating considerable quantities of energy by hysteresis thanks to the mixed composition of the structure.

[0071] Another advantage of the composite panel according to the invention is that, thanks to its important characteristics of lower weight together with good stiffness, it facilitates building yard operations, making the

invention particularly adapted for renovating existing buildings.

[0072] Another advantage of the panel according to the invention is that the natural ventilation that is created by way of the means for recirculating external air not only improves the overall thermal and hygrometric efficiency of the panel but also helps to preserve over time the status and the essential characteristics of the composite materials used.

[0073] Not least, the use of wood, a renewable raw material, as an alternative to concrete and/or ferrous material, reduces energy consumption (and therefore atmospheric emissions). Moreover, the achievement of an excellent performance with a lower use of raw material, the elimination of thermal bridges and the synergy between the outer layer and the inner layer made possible by the inner ribs made of wood, composite materials or resin, allows to reduce energy consumption (and therefore atmospheric emissions) during production.

[0074] In addition to this, the weight reduction of the panel entails a considerable saving in transport and logistics, with a further reduction of the emissions of the means of transport.

[0075] The invention thus conceived is susceptible of numerous modifications and variations, all of which are within the scope of the appended claims.

[0076] All the details may further be replaced with other technically equivalent elements.

[0077] In practice, the dimensions may be any according to requirements and to the state of the art.

[0078] The disclosures in Italian Patent Application No. AR2009A000033 from which this application claims priority are incorporated herein by reference.

[0079] Where technical features mentioned in any claim are followed by reference signs, those reference signs have been included for the sole purpose of increasing the intelligibility of the claims and accordingly such reference signs do not have any limiting effect on the interpretation of each element identified by way of example by such reference signs.

Claims

1. A composite panel for civil, industrial and residential building, particularly for curtain walls, floor slabs and roofing panels in prefabricated buildings, comprising at least one outer layer (2) made of concrete, at least one intermediate layer (3) made of thermally insulating material and at least one inner layer (4) made of concrete, said at least one outer layer (2) and said at least one inner layer (4) having connecting and stiffening means, **characterized in that** said connecting and stiffening means are made of a material selected among wood, composite material and resin.
2. The panel according to claim 1, **characterized in that** said connecting and stiffening means comprise

transverse elements (5), which lie, on the plane of arrangement of the panel, in a direction that is substantially normal to the longitudinal direction (10) of the panel.

3. The panel according to one or more of the preceding claims, **characterized in that** said connecting and stiffening means comprise longitudinal elements (6) that lie substantially parallel to said longitudinal direction (10).
4. The panel according to one or more of the preceding claims, **characterized in that** said connecting and stiffening means comprise means for fixing between said transverse elements (5) and said longitudinal elements (6).
5. The panel according to one or more of the preceding claims, **characterized in that** said connecting and stiffening means comprise means for engagement with at least one between said at least one outer layer (2) and said at least one inner layer (4).
6. The panel according to one or more of the preceding claims, **characterized in that** said engagement means comprise pins (16), which are adapted to be associated with at least one between said at least one outer layer (2) and said at least one inner layer (4) and protrude from said connecting and stiffening means.
7. The panel according to one or more of the preceding claims, **characterized in that** said engagement means comprise pins (16), which are adapted to be associated with at least one between said at least one outer layer (2) and said at least one inner layer (4) and protrude from a net (17) that is associated with at least one between said at least one outer layer (2) and said at least one inner layer (4).
8. The panel according to one or more of the preceding claims, **characterized in that** said connecting and stiffening means comprise at least one end stringer (19) for supporting said at least one outer layer (2) and said at least one inner layer (4) which can be associated with said longitudinal elements (6).
9. The panel according to one or more of the preceding claims, **characterized in that** said transverse elements (5) and said longitudinal elements (6) comprise elements for resting on at least one between said at least one outer layer (2) and said at least one inner layer (4).
10. The panel according to one or more of the preceding claims, **characterized in that** said resting elements comprise at least one gasket (8), which is adapted to be connected to the interface of at least one be-

tween said at least one outer layer (2) and said at least one inner layer (4), said gasket (8) being made of a material that has high elastic characteristics.

11. The panel according to one or more of the preceding claims, **characterized in that** it comprises elements for mating between a first panel to be mated with a successive panel. 5

12. The panel according to one or more of the preceding claims, **characterized in that** said mating elements comprise a male element (11) formed on a thickness that lies transversely, with respect to a transverse direction (22), of said first panel to be mated, said male element (11) being insertable in a female element (12) that is formed on a thickness that lies transversely, with respect to said transverse direction (22), of said successive panel. 10
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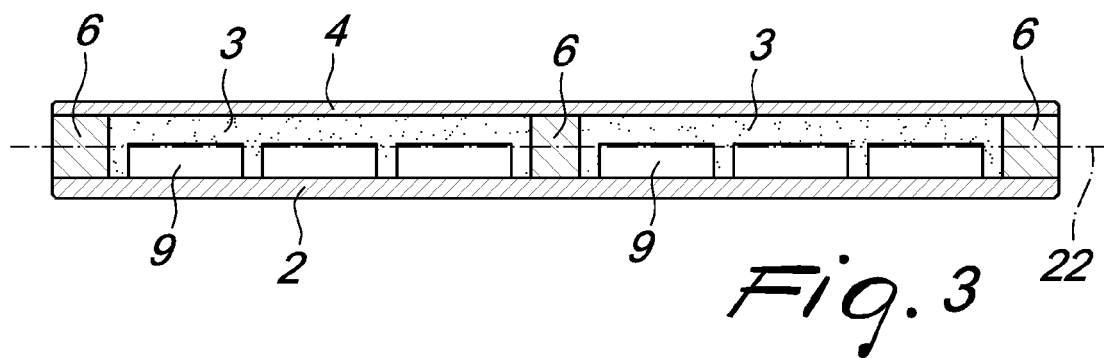
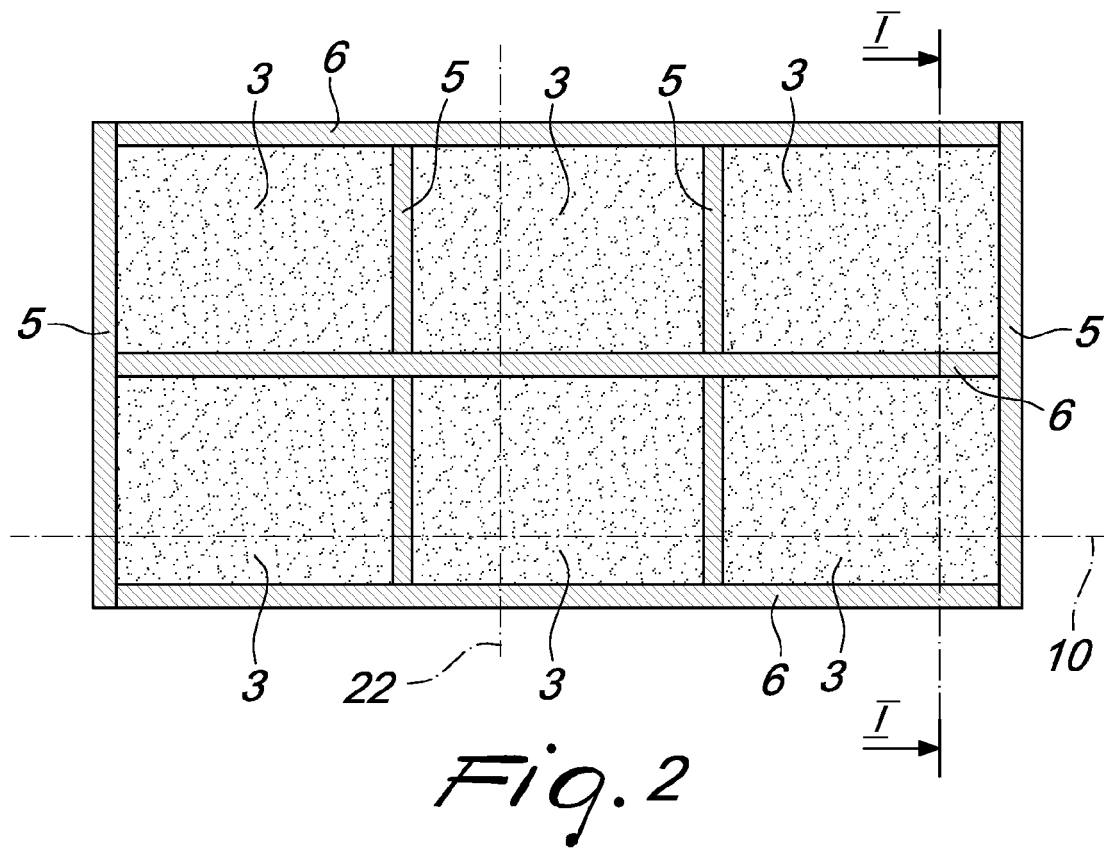
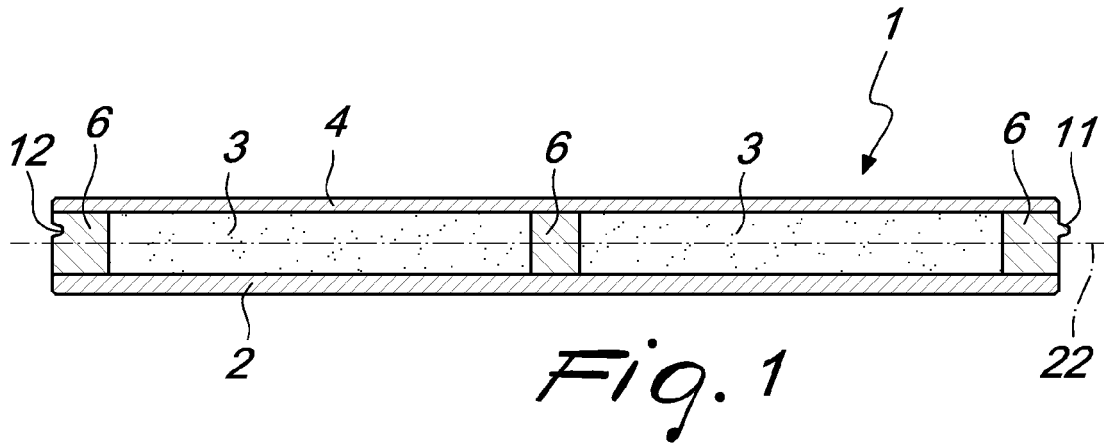
13. The panel according to one or more of the preceding claims, **characterized in that** said mating elements comprise an element for interposition (13) in the gap formed by the adjacent arrangement of a first recess (14) formed on a thickness that lies transversely, with respect to said transverse direction (22), of said first panel to be mated, which faces a second recess (15) that is formed on a thickness that lies transversely, with respect to said transverse direction (22), of said successive panel. 20
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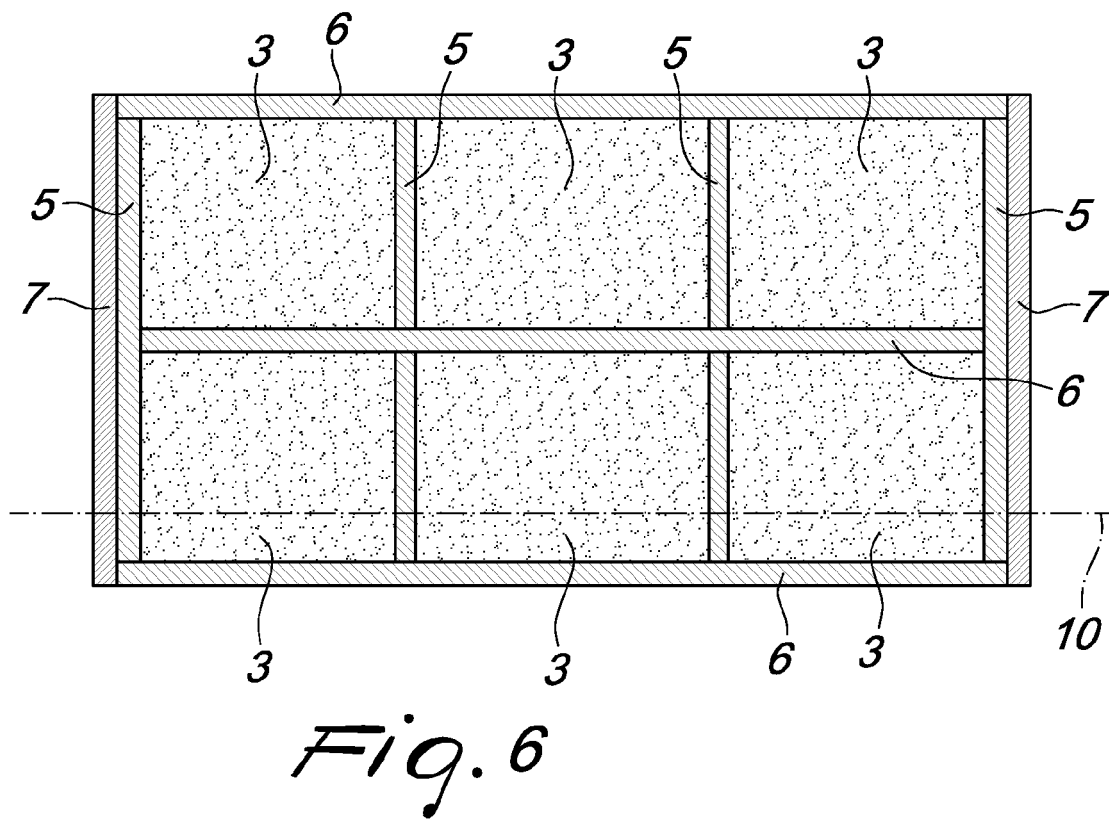
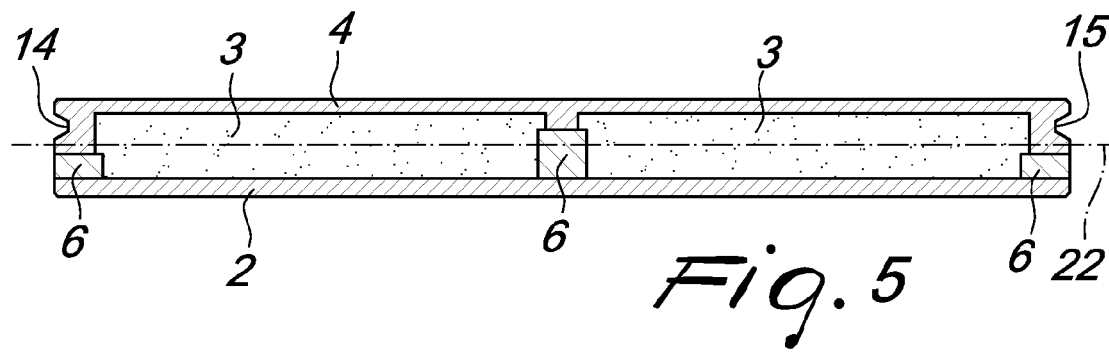
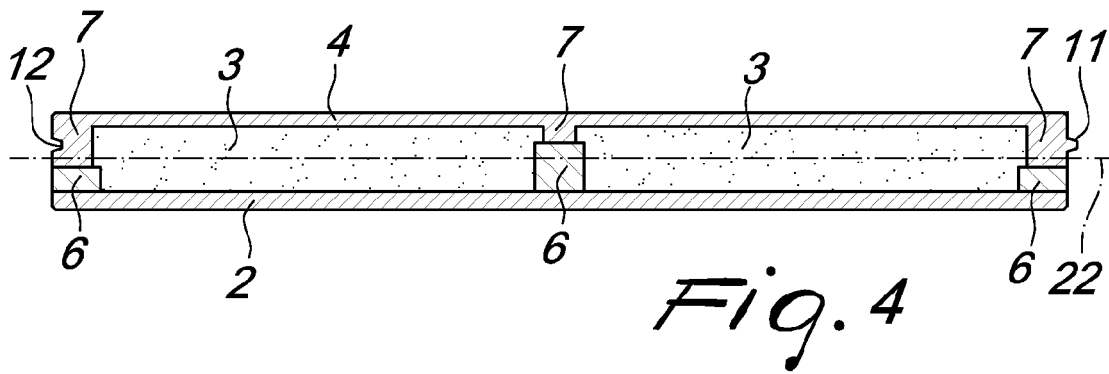
14. The panel according to one or more of the preceding claims, **characterized in that** at least one between said at least one outer layer (2) and said at least one inner layer (4) comprises at least one reinforcement strut (7), which is firmly associated with said transverse element (5) and/or with said longitudinal element (6). 35

15. The panel according to one or more of the preceding claims, **characterized in that** it comprises means for recirculating the air within the panel, which comprise slots (23) for ventilation for the replacement air that arrives from outside, which are formed on said intermediate layer (3) and run along said transverse direction (22), said slots (23) being interconnected in input and in output to through holes (24) formed in said transverse elements (5). 40
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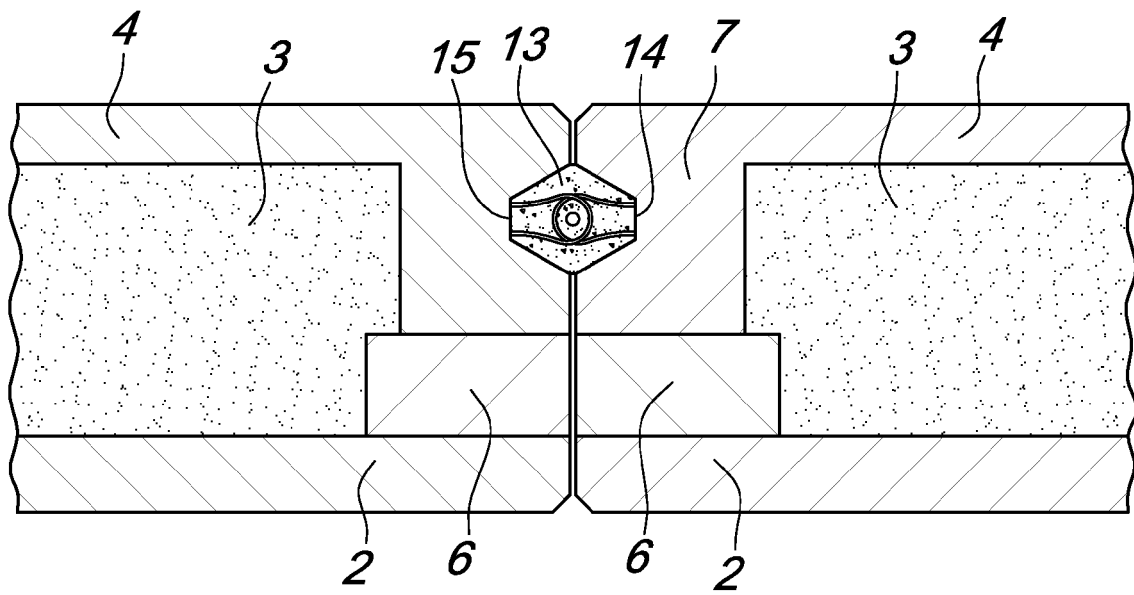


Fig. 7

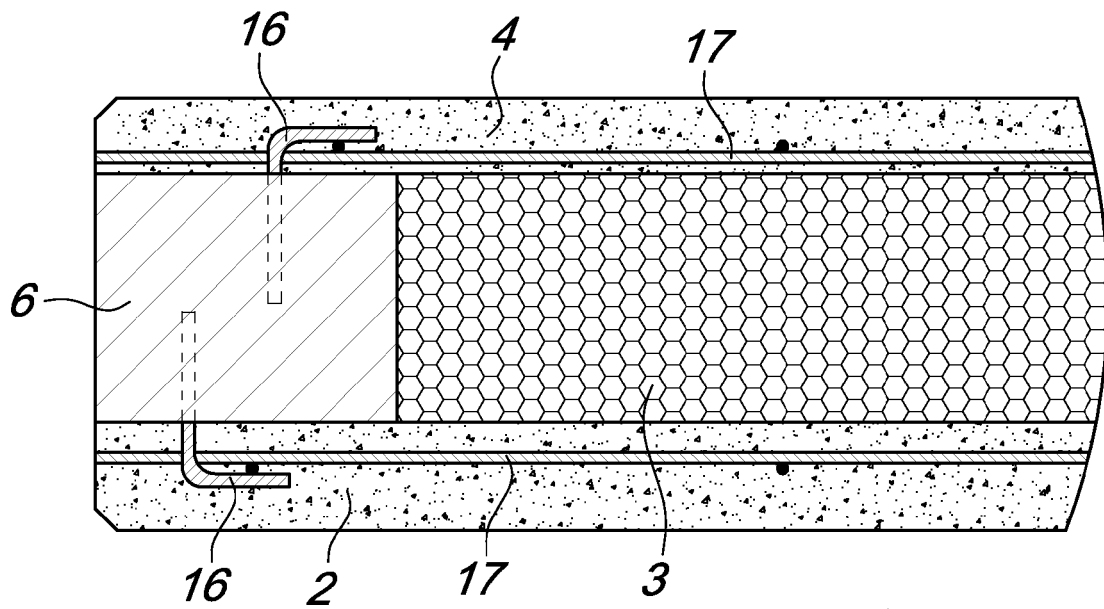


Fig. 8

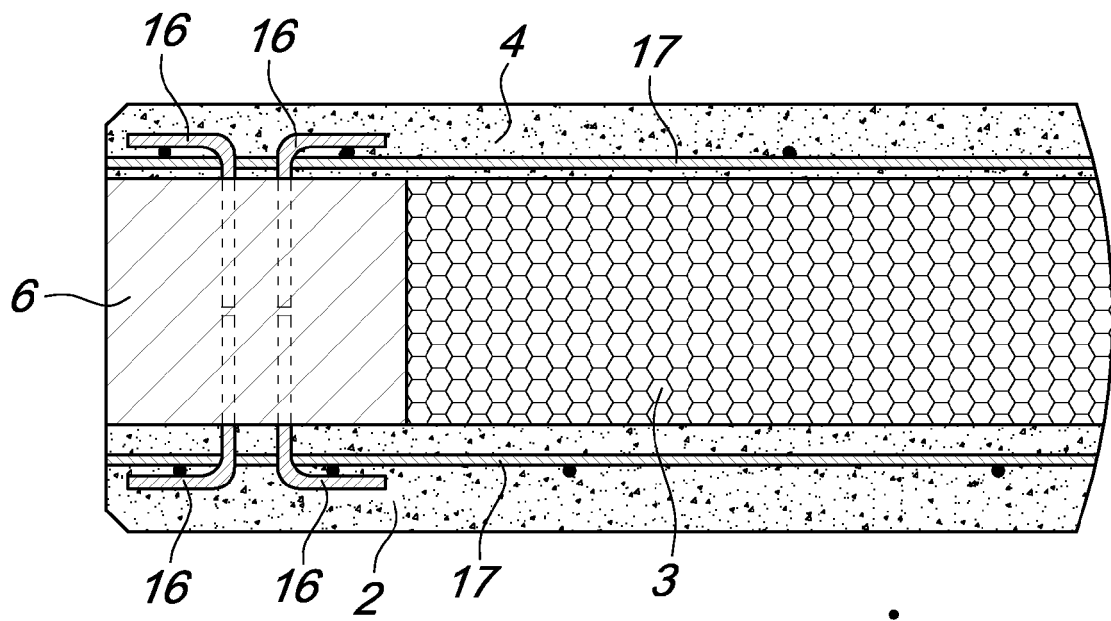


Fig. 9

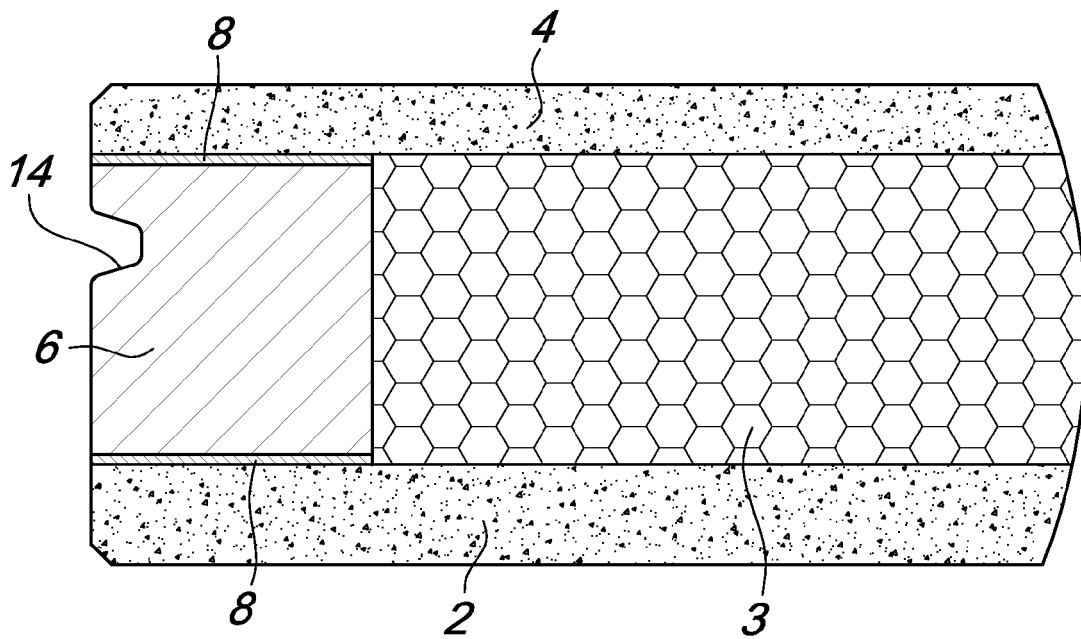


Fig. 10

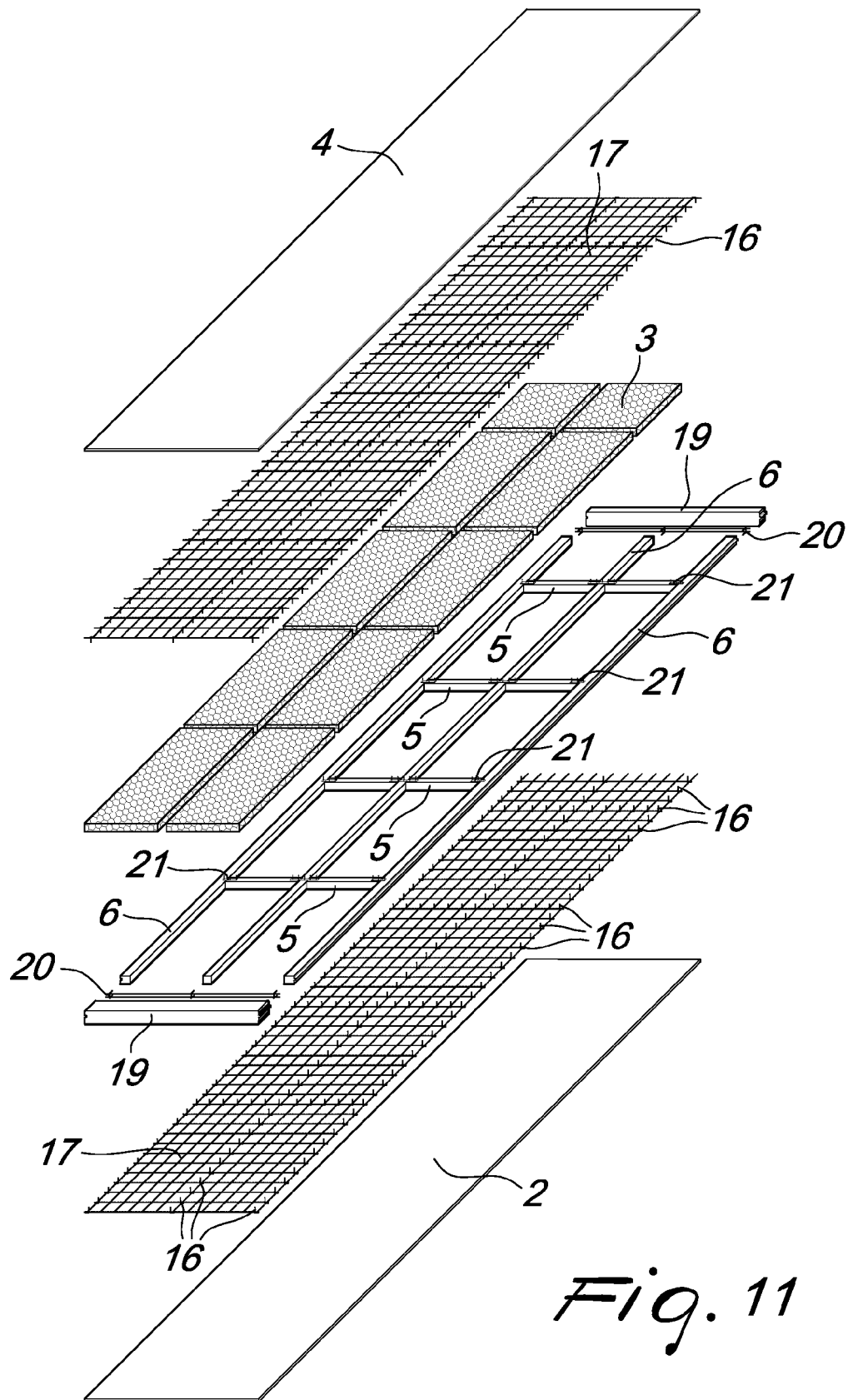


Fig. 11

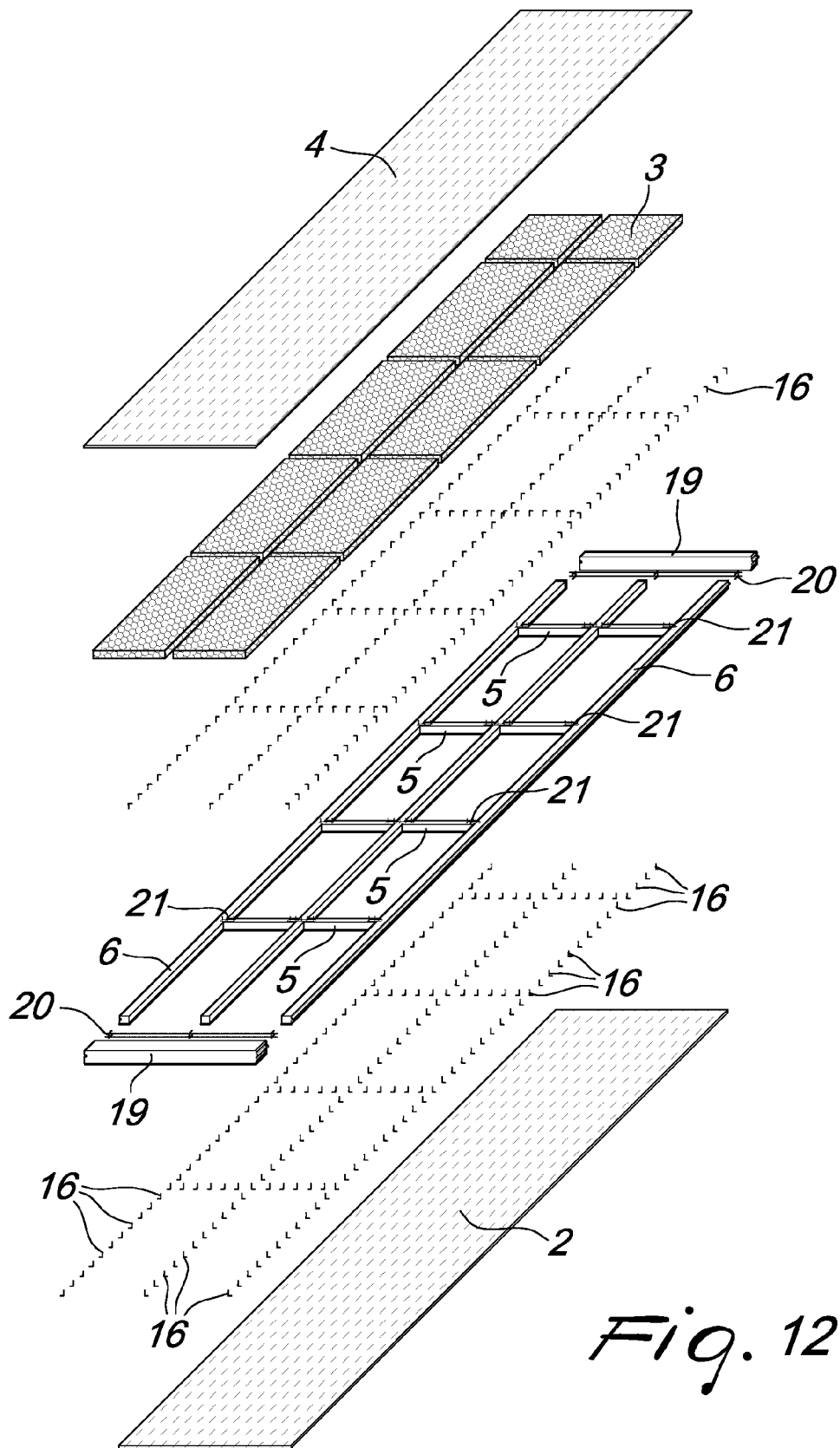


Fig. 12

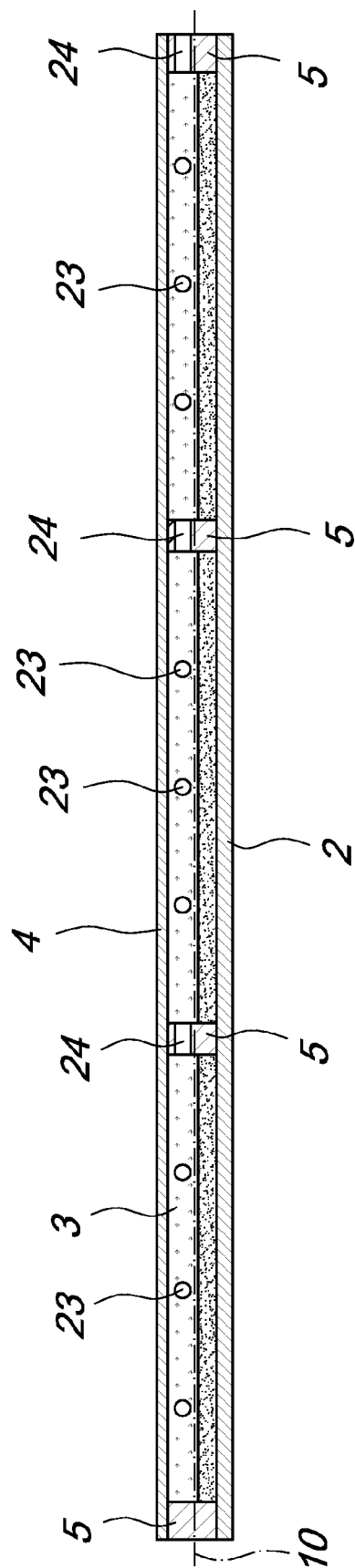


Fig. 13



EUROPEAN SEARCH REPORT

Application Number
EP 10 17 2210

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	FR 2 523 185 A1 (ARCHI [FR]) 16 September 1983 (1983-09-16) * the whole document *	1-8,11, 14	INV. E04C2/04 E04C2/288 E04C2/38 E04C2/52
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Y	-----		
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