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# (54) BUILDING PANEL AND CORRESPONDING METHOD FOR MANUFACTURING A BUILDING PANEL

(57) The invention relates to a building panel (1) comprising a foam board (2) having a front side and a rear side opposite to the front side.

According to the invention, it is proposed that at least one reinforcing concrete bar (3) is embedded into the foam board (2), in particular at the front side or rear side of the foam board (2). The invention furthermore relates to a method of manufacturing a building panel.

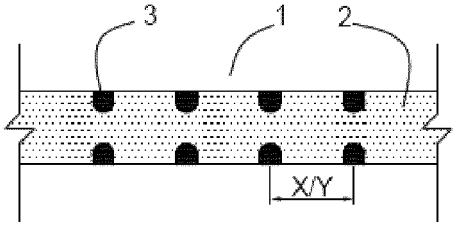


Figure 1 (a)

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## Description

**[0001]** The invention relates to a building panel comprising a foam board having a front side and a rear side opposite to the front side.

**[0002]** Building panels comprising a foam board are known from the prior art. Typically, the core consists of a foamed plastic, such as polystyrene or polyurethane foam. To achieve the required rigidity and strength, it is known to apply rigid thin facers on at least one side of the foam layer. The rigid thin facers may be based on cement or polymer with embedded reinforcing fabrics.

**[0003]** DE3423006C2, DE4234269C1, DE102011013739 and EP2758610B1 describe building panels with facers composed of thin bed mortars comprising embedded glass fiber mesh or fabric reinforcement.

**[0004]** Such building panels have already proven themselves is many areas, for example in so-called tile backer boards. However, they have the common disadvantage, especially when the facers are arranged on one side of the foam layer, only, that they lack the required dimensional stability and flatness.

**[0005]** This is especially the case when exposed to a variety of weathering conditions, such as warm or cold temperatures or humid or dry air. This is because of the significant differences between the expansion properties of the plastic foam layer and the rigid facing materials. The coefficient of linear thermal expansion of polystyrene foam, for example, is about 6 times higher than the coefficient of linear thermal expansion of a facing based on cement mortar.

**[0006]** As a consequence, it was an object of the invention to provide a building panel which overcomes the aforementioned problems as much as possible. In particular, it was an object of the invention to provide a building panel that is of low weight, higher mechanical strength and provides an improved dimensional stability and flatness when exposed to a variety of weathering conditions.

**[0007]** The invention solves the problem described above with respect to a building panel by at least one reinforcing concrete bar that is embedded into the foam board, in particular at the front side or rear side of the foam board (claim 1). The invention is based upon the finding that said panel provides an improved rigidity and bending strength, prevents the foam board from excessive expansion or contraction, and thus minimizes the risk of warping and bowing when the panel is exposed to changing weathering conditions. The building panel according to the invention is suitable for use in many building applications, for instance fertile backers. Preferably, the front side and/or the rear side are flat surfaces. According to another preferred embodiment, the reinforcing concrete bar is a high strength reinforcing concrete bar.

**[0008]** According to a preferred embodiment, a multitude of reinforcing concrete bars is embedded inside the foam board at said front side and/or rear side of the panel. This further increases the rigidity of the panel.

**[0009]** According to another preferred embodiment, the reinforcing concrete bars are arranged in parallel to one another or form a grid with one another. In this way, the mechanical properties are further improved. Preferably, the grid comprises a further reinforcing concrete bar surrounding said grid, in particular in the form of a rectangle surrounding said grid.

**[0010]** According to an alternative embodiment, the reinforcing concrete bar has the form of a circular ring and/or a rectangle.

**[0011]** Preferably, the foam board is made of or comprises at least one of the following materials: XPS foam, EPS foam, PU foam, PVC foam, phenolic foam or mineral wool. According to another preferred embodiment, the foam board comprises a thickness of 10 mm - 100 mm, in particular 20 mm - 50 mm. These materials and dimensions have been found to be beneficial for the intended application.

**[0012]** According to another preferred embodiment, the reinforcing concrete bars comprise at least one of the following: hydraulic binder, in particular cement or gypsum, aggregate, in particular well-graded aggregate, additive, in particular property-improving additive, reinforcing fibres, reinforcing wires. Preferably, the reinforcing concrete bars comprise a polymeric mortar, wherein the polymeric mortar comprises or is made of at least one of the flowing: epoxy, in particular solvent free epoxy, polyurethane, polyester.

**[0013]** These materials help to achieve beneficial mechanical properties, high tensile and compressive strength, low shrinkage, low coefficient of thermal expansion, high modulus of elasticity and high water resistance.

**[0014]** According to another preferred embodiment, the reinforcing concrete bars have a cross-sectional shape selected from the list: rectangular, polygonal, trapezoidal, triangular or circular. According to another preferred embodiment, the reinforcing concrete bars comprise a cross-sectional width of 4 mm - 40 mm, in particular 5 mm - 20 mm, and/or a cross-sectional depth of 6 mm - 50 mm, in particular 10 mm - 30 mm. These shapes and dimensions have been found to be beneficial for the intended use of said panels. In other words, the cross-sectional dimensions of the reinforcing bars and its configuration design is optimized regarding the dimension of the foam board regarding length, width and thickness, and the required panel rigidity and strength.

**[0015]** Preferably, the volume of the reinforcing concrete bars ranges between 1 % and 10 %, in particular between 2 % and 5 %, of the volume of the foam board. According to another preferred embodiment, the reinforcing concrete bars are spaced from one another perpendicular to a longitudinal axis of the reinforcing concrete bars by 20 mm - 500 mm, in particular by 50 mm - 300 mm. This has been found to be beneficial to provide an optimal weight/rigidity ratio of the panel.

**[0016]** According to another preferred embodiment, the building panel comprises at least one facing layer for protecting and strengthening the building panel, wherein the facing layer is arranged at the front side and/or the rear side of the foam board. Preferably, the facing layer comprises or is made of at least one of the following: cement, polymeric material, fleece. The facing layer protects the foam from environmental conditions, such as humidity or mechanical impacts. In this way, the usability of the panel is improved for applications like trafficked roofs, terraces and similar, when higher surface resistance to high pressure, abrasion and point loading are necessary.

**[0017]** According to a second aspect, the invention relates to a method of manufacturing a building panel. The method comprises: shaping a foam board comprising a front surface and a rear surface, forming at least one groove at the at least one surface of the foam board, in particular by cutting or molding, filling the at least one groove with concrete and/or mortar mix, and curing the concrete and/or mortar mix inside the grooves.

**[0018]** According to a third aspect, the invention relates to a further method of manufacturing a building panel. The method comprises: shaping a foam board comprising a front surface and a rear surface, forming at least one groove at the at least one surface of the foam board, in particular by cutting or molding, inserting at least one reinforcing concrete bar into said groove, securing the reinforcing concrete bar to said groove, in particular by utilizing adhesive.

**[0019]** The methods according to the second and third aspects take advantage of the same benefits and preferred embodiments as the building panel according to the invention. In this regard and in order to avoid unnecessary repetitive, reference is made to the above explanations.

**[0020]** Embodiments of a building panel will now be described, by way of example only, with reference to the accompanying figures, in which:

| | |
|---|---|
| Figs. 1 (a) - 1 (g) | show building panels according to the invention in cross-sectional views; |
| Figs. 2(a) - 2(e) | show building panels according to the invention in plan views; |
| Figs. 3(a) - 3(d) | show building panels according to invention with facing layers in cross-sectional views; |
| Figs. 4 and 5 | show a building panel in cross-sectional and plan views according to an example of the present invention; and |
| Fig. 6 | shows a building panel according to the state of the art in a cross-section. |

**[0021]** Figs. 1 (a)-(g) show building panels 1 in a cross-sectional view. The building panels 1 comprise reinforcement concrete bars 3. The reinforcement concrete bars 3 are formed in different shapes and sizes as for example, square, triangle trapezoidal or circular, embedded inside at least one side of the foam board 2.

**[0022]** The reinforcing bars 3 are made of a binder, well graded fillers and may include properties improving additives and reinforcing fibres orwires to achieve rigid, high strength, low shrink, water proof concretes. The binder can be hydraulic, as for example, but not limited to: cement, gypsum or anhydrite or polymeric, as for example, but not limited to: epoxy, polyurethane or polyester.

**[0023]** The cross-sectional width w of the reinforcing bars 3 is selected preferably between 4 mm and 20 mm, and more preferably between 6 mm and 12 mm. The depth d of the reinforcing bars 3 is selected preferably between 4 mm and 50 mm, and more preferably between 10 mm and 30 mm, depending on the thickness of the foam board 2 and required panel strengths.

**[0024]** The spacings X/Y between the reinforcing bars 3 lines longitudinally and transversally are selected preferably from between 20 mm and 500 mm and more preferably between 50 mm and 300 mm, depending on the desired panel strengths. The smaller the spacings, the more rigid and stronger the panel 1, while the smaller the spacings, the higher the weight and cost of the panel 1.

**[0025]** In Figs. 2(a) - 2(e) some selected designs of reinforcing bars 3 configurations are shown. In Figs. 2(a) - 2(c) the reinforcing bars 3 form a grid. The grid of Fig. 2(b) comprises a further reinforcing concrete bar 3 surrounding said grid in the form of a surrounding rectangle. The reinforcing concrete bar 3 of Fig. 2(d) has the form of a rectangle, the reinforcing concrete bar 3 of Fig. 2(e) the forms of a rectangle.

**[0026]** Figs. 3(a) - 3(d) illustrate a building panel 1 according to the present invention used as core element coated at least from one side with hydraulic, polymeric or plastic facing 4 selected from state of the art. The thickness of the facing 4 is preferably between 0,5 mm and 20 mm, more preferably between 1 mm and 10 mm.

**[0027]** Figs. 4 and 5 illustrate a building panel 1 in cross-sectional and plan views respectively. The panel 1 is in planar cuboid form having dimensions of 600x1200x30 mm (width A, length B and thickness t), and are made of standard XPS foam material of a density of 35 kg/m$^3$.

**[0028]** The reinforcing bars 3 are made of polymer modified cementitious mortar having a compressive strength of 300 kg/cm$^2$ and tensile strength of 40 kg/cm$^2$.

**[0029]** The cross-section of the reinforcing bars 3 have a pair of opposing parallel sides and an arcuate end, having width w of 8 mm, a total depth d of 15 mm and are spaced at X = Y= 275 mm in transverse and longitudinal directions respectively. The panel 1 is reinforced on one side with 1 mm polymeric cementitious layer 4 reinforced with fiber-glass mesh embedded in that facing layer 4 as shown in Fig. 4.

**[0030]** The above two mentioned panels have been produced at about 25° C and stored in plane position for 28 days until full curing of cementitious material.

**[0031]** Thereafter, they have been stored for 24 h at a low temperature of 5° C. The building panel 1 according to the state of the art of Fig. 6 have shown a convex bent at the middle of the facer side of about 4 mm, while the building panel 1 according to present invention as described above did not show practically any noticeable bent. The volume ratio of the reinforcing bars 3 embedded inside the foam board 2 is about 4 %, that results in decrease of the thermal resistance of the foam board 2 by not more than 4 %.

**[0032]** Fig. 6 represents a cross section of a building panel 1 according to state of the art, having the same dimensions as mentioned in the building panel 1 described in Figs. 4 and 5, however without reinforcing bars 3.

## Claims

1. Building panel (1) comprising a foam board (2) having a front side and a rear side opposite to the front side, **characterized in that** at least one reinforcing concrete bar (3) is embedded inside the foam board (2), in particular at the front side or rear side of the foam board (2).

2. Building panel (1) according to claim 1,
**characterized in that** a multitude of reinforcing concrete bars (3) is embedded inside the foam board (2) at said front side and/or rear side of the panel (1).

3. Building panel (1) according to one of the preceding claims,
wherein the reinforcing concrete bars (3) are arranged in parallel to one another and/or form a grid with one another.

4. Building panel (1) according to one of the preceding claims, **characterized in that** the foam board (2) is made of or comprises at least one of the following materials: XPS foam, EPS foam, PU foam, PVC foam, phenolic foam or mineral wool.

5. Building panel (1) according to one of claims 1 or 2, **characterized in that** the foam board comprises a thickness (t) of 10 mm - 100 mm, in particular 20 mm - 50 mm.

6. Building panel (1) according to one of claims 1 to 3, **characterized in that** the reinforcing concrete bars (3) comprise at least one of the following:

   - hydraulic binder, in particular cement or gypsum,
   - aggregate, in particular well graded aggregate,
   - additive, in particular property improving additive,
   - reinforcing fibres,
   - reinforcing wires.

7. Building panel (1) according to one of the claims 1 to 4, **characterized in that** the reinforcing concrete bars (3) comprise a polymeric mortar, wherein the polymeric mortar comprises or is made of at least one of the flowing:

   epoxy,
   polyurethane,
   polyester.

8. Building panel (1) according to one of the preceding claims, **characterized in that** the reinforcing concrete bars (3) have a cross-sectional shape selected from a list comprising: rectangular, polygonal, trapezoidal, triangular or circular.

9. Building panel (1) according to one of the preceding claims, **characterized in that** the reinforcing concrete bars (3) comprise a cross-sectional width of 4 mm - 40 mm, in particular 5 mm - 20 mm, and/or a cross-sectional depth of 6 mm - 50 mm, in particular 10 mm - 30 mm.

**10.** Building panel (1) according to one of the preceding claims, **characterized in that** the volume of the reinforcing concrete bars (3) ranges between 1 % and 10 %, in particular between 2 % and 5 %, of the volume of the foam board (2).

**11.** Building panel (1) according to one of the preceding claims, **characterized in that** the reinforcing concrete bars (3) are spaced from one another perpendicular to a longitudinal axis of the reinforcing concrete bars (3) by 20 mm - 500 mm, in particular by 50 mm - 300 mm.

**12.** Building panel (1) according one of the preceding claims, **characterized by** at least one facing layer (4) for protecting and strengthening the building panel (1), wherein the facing layer (4) is arranged at the front side and/or the rear side of the foam board (2).

**13.** Building panel (1) according to claim 10, **characterized in that** the facing layer (4) comprises or is made of at least one of the following:

- cement,
- polymeric material,
- fleece.

**14.** A method of manufacturing a building panel (1), in particular a building panel (1) according to any of claims 1-13, comprising:

- shaping a foam board (2) comprising a front surface and a rear surface;
- forming at least one groove at the at least one surface of the foam board (2), in particular by cutting or molding;
- filling the at least one groove with concrete and/or mortar mix;
- curing the concrete and/or mortar mix inside the grooves.

**15.** A method of manufacturing a building panel (1), in particular a building panel (1) according to any of claims 1-13, comprising:

- shaping a foam board (2) comprising a front surface and a rear surface;
- forming at least one groove at the at least one surface of the foam board (2), in particular by cutting or molding;
- inserting at least one reinforcing concrete bar (3) into said groove;
- securing the reinforcing concrete bar (3) to said groove, in particular by utilizing adhesive.

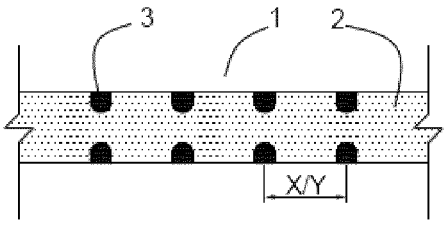


Figure 1 (a)

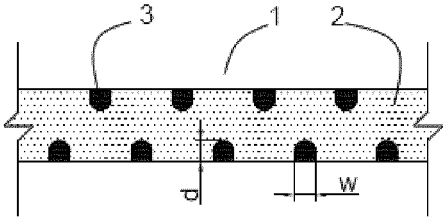


Figure 1 (b)

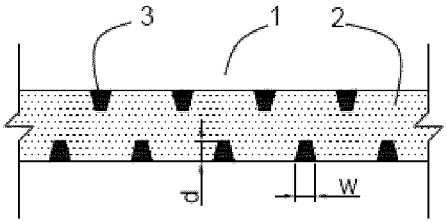


Figure 1 (c)

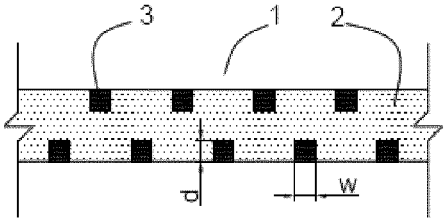


Figure 1 (d)

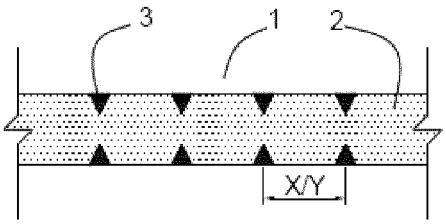


Figure 1 (e)

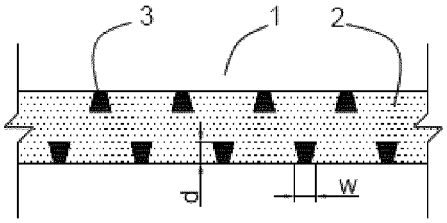


Figure 1 (f)

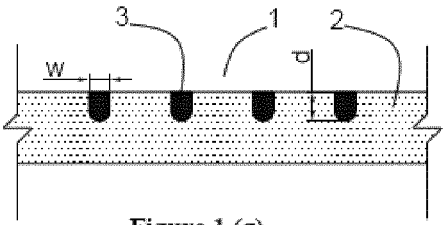


Figure 1 (g)

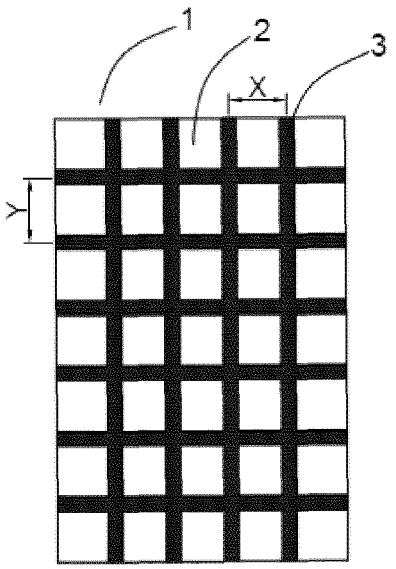


Figure 2 (a)

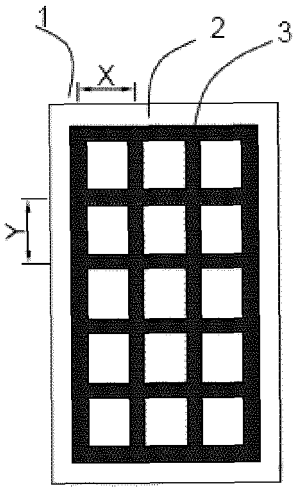


Figure 2 (b)

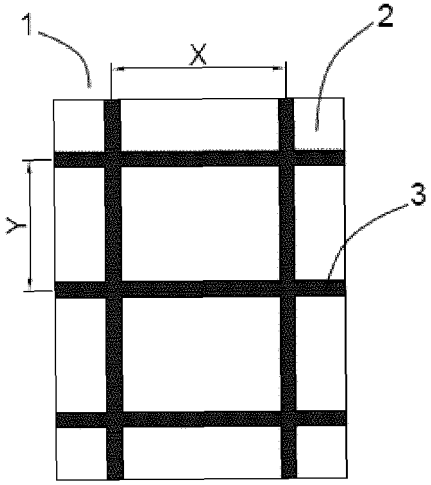


Figure 2 (c)

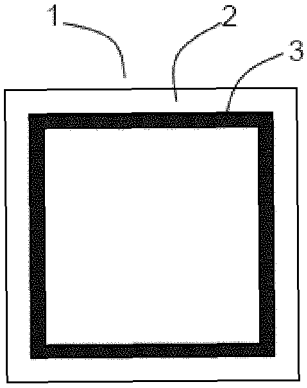


Figure 2 (d)

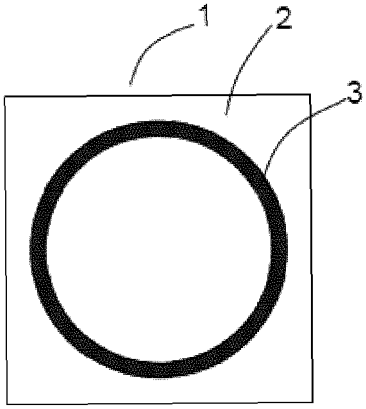


Figure 2 (e)

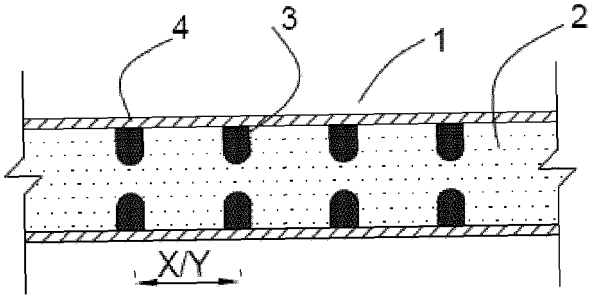


Figure 3 (a)

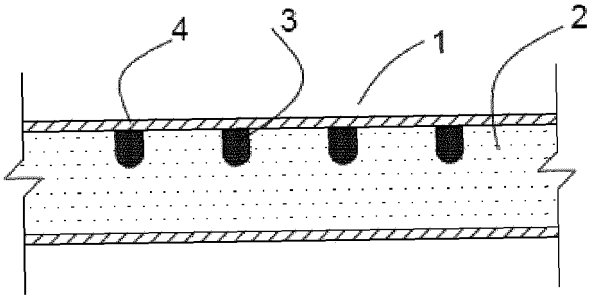


Figure 3 (b)

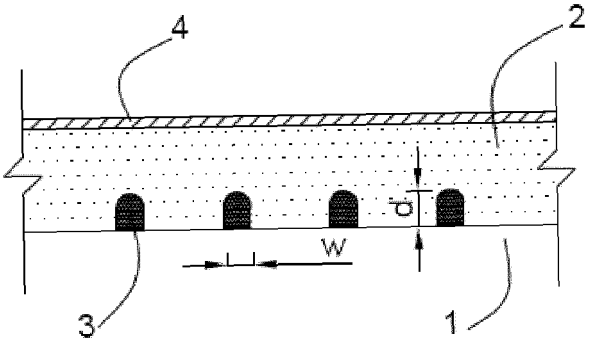


Figure 3 (c)

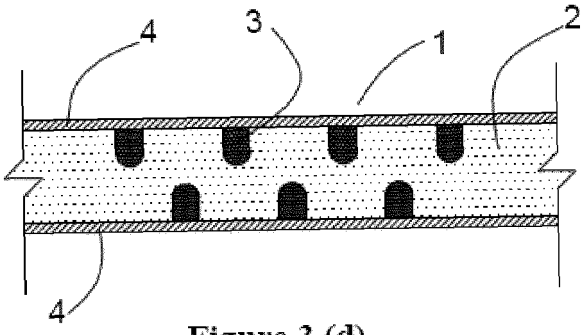


Figure 3 (d)

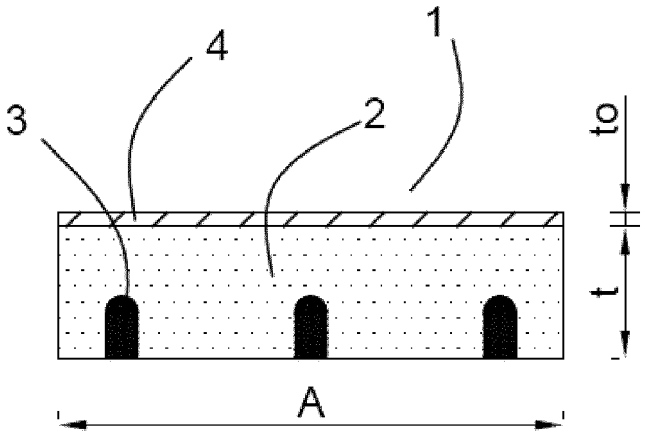


Figure 4

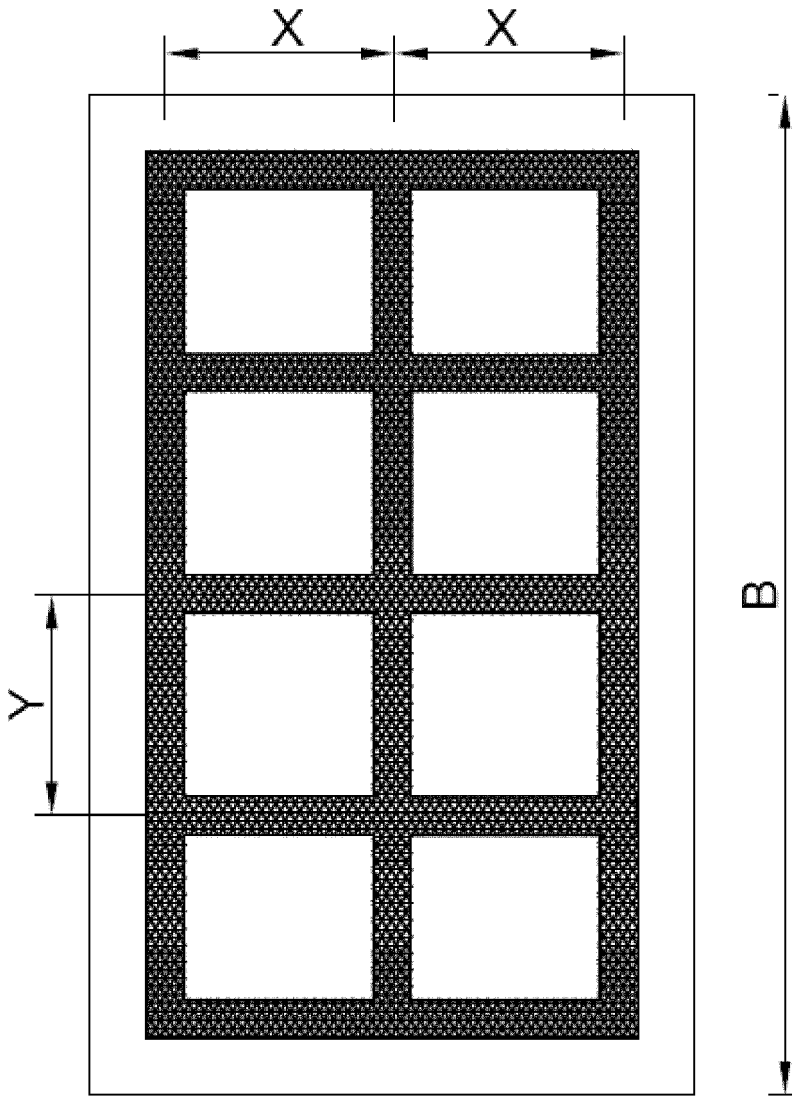


Figure 5

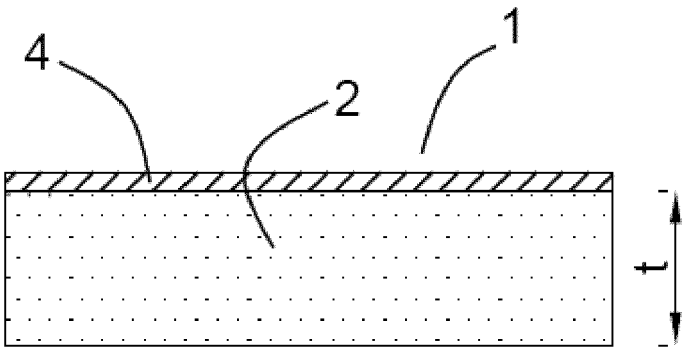


Figure 6

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# EUROPEAN SEARCH REPORT

Application Number
EP 21 15 8221

## 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 | DE 21 56 006 A1 (KONZUCH FRED)<br>26 July 1973 (1973-07-26)<br>* page 2 * | 1 | INV.<br>E04C2/20<br>E04C2/288 |
| X | GB 2 180 861 A (DICKENS LUTHER ISSAC)<br>8 April 1987 (1987-04-08)<br>* page 2, lines 94-120 * | 1 | |
| X | WO 02/38879 A1 (ZHANG MING [CN])<br>16 May 2002 (2002-05-16)<br>* paragraphs [0021] - [0026]; claims 6,7 * | 1-15 | |

TECHNICAL FIELDS SEARCHED (IPC)

E04C

The present search report has been drawn up for all claims

| Place of search | Date of completion of the search | Examiner |
|---|---|---|
| Munich | 25 June 2021 | Saretta, Guido |

CATEGORY OF CITED DOCUMENTS

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EPO FORM 1503 03.82 (P04C01)

## ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 21 15 8221

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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25-06-2021

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|---|---|---|---|
| DE 2156006 A1 | 26-07-1973 | NONE | |
| GB 2180861 A | 08-04-1987 | AU 586425 B2 | 13-07-1989 |
| | | GB 2180861 A | 08-04-1987 |
| WO 0238879 A1 | 16-05-2002 | AU 6373601 A | 21-05-2002 |
| | | CN 1288991 A | 28-03-2001 |
| | | CN 1444685 A | 24-09-2003 |
| | | WO 0238879 A1 | 16-05-2002 |

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

## REFERENCES CITED IN THE DESCRIPTION

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### Patent documents cited in the description


- DE 3423006 C2 **[0003]**
- DE 4234269 C1 **[0003]**
- DE 102011013739 **[0003]**
- EP 2758610 B1 **[0003]**