

(19)



(11)

EP 2 016 251 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
28.06.2017 Bulletin 2017/26

(51) Int Cl.:
E06B 5/20 (2006.01) E04B 1/86 (2006.01)
E06B 3/70 (2006.01)

(21) Application number: **07748439.2**

(86) International application number:
PCT/SE2007/050278

(22) Date of filing: **26.04.2007**

(87) International publication number:
WO 2007/126379 (08.11.2007 Gazette 2007/45)

(54) **SOUND-INSULATING DOOR**

SCHALLDÄMMENDE TÜR

PORTE D'ISOLATION PHONIQUE

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR

(30) Priority: **28.04.2006 SE 0600969**

(43) Date of publication of application:
21.01.2009 Bulletin 2009/04

(73) Proprietor: **Jeld-Wen Sverige AB**
265 81 Åstorp (SE)

(72) Inventor: **BRESMAN, Jonas**
S-260 60 Kvidinge (SE)

(74) Representative: **Zacco Sweden AB**
P.O. Box 5581
114 85 Stockholm (SE)

(56) References cited:
CA-A- 708 393 CH-A5- 660 389
DE-C- 665 387 DE-U1- 8 714 436
FR-A- 1 073 718 JP-A- 2002 348 986
US-A- 5 020 292 US-A- 5 416 285
US-A- 6 112 496

EP 2 016 251 B1

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

Description

TECHNICAL FIELD:

[0001] The invention relates to a door comprising a laminate of a first outer layer and a second outer layer with an insulating arrangement between them.

BACKGROUND ART:

[0002] It is already known that doors provide a certain degree of sound insulation and that the weight of the door determines how much a door damps sound passing from one side to the other. A normal door for a house comprises an outer layer and an inner layer manufactured of a laminate of wood and aluminium, with a layer of insulation between the layers. While such a door damps sound, it only does so relatively poorly. If there is a requirement for a door providing better sound insulation, the materials in the door and/or the thickness of the layers must be changed in order to improve the sound-insulating capability.

[0003] There is a requirement in Sweden that a sound-insulating door in sound class Rw40 must have a sound-damping capability of at least 43 dB. The requirement is laid down by the National Board of Housing, Building and Planning (Boverket) which is a government authority in Sweden. On 13.4.2004, the Swedish National Testing and Research Institute drew up a list of the sound classes. For sound-insulating doors, the use of material with a high density to obtain good sound insulation is already known. With previously-known doors, to achieve sound-damping according to the requirement for Rw40, a door has been required with a weight of at least 80 kg with an outer layer consisting of a steel plate and an insulating arrangement consisting of a layer of insulation material with a relatively high density. This combination of materials results in doors that have such a great weight that they are difficult to handle during installation or repair. In addition, the materials are heavy and difficult to work with during manufacture of the door. In addition, the materials are expensive to buy. A door with the features of the preamble of claim 1 is known from US5416285.

[0004] There is thus a need for a door that has a low weight but has a good sound-insulating capability, and, in addition, that is cheap to manufacture.

DISCLOSURE OF INVENTION:

[0005] The invention relates to a door comprising a laminate of a first outer layer and a second outer layer with an insulating arrangement between them, wherein the insulating arrangement comprises at least two insulation layers separated from each other and from the outer layers by air gaps, and wherein the insulating arrangement comprises spacers placed between the insulation layers and arranged to create the air gaps. The door according to the invention is characterised in that the spac-

ers are positioned in such a way that two spacers are never positioned exactly opposite each other on either side of said insulation layer. An advantage of the invention is that the relative positioning of the layers provides a damping of sound that is surprisingly good, considering the weight of the door. The design according to the invention makes it possible to use outer layers of a combustible material, for example wood, to obtain a sound-insulating capability that corresponds to that of a door comprising outer layers of steel plate or similar non-combustible material. According to the invention, the air gaps are created by spacers being placed between the insulation layers. The spacers are advantageously constructed of a non-rigid material that absorbs vibrations and thus does not transmit sound from layer to layer. In addition, the spacers are advantageously designed in such a way that the surface that is in contact with the layers is as small as possible in order to minimise the possibility of sound being transmitted from layer to layer via the spacers. It is known that the smaller the contact surface, the less possibility there is of the transmission of sound. The spacers must, however, be sufficiently rigid so that they do not collapse during the manufacture or use of the door. In addition, the spacers must have a sufficiently large total contact surface in order for the air gaps to be able to be maintained without the risk of the insulation layers coming into contact with each other or with the outer layers in the areas that are between the spacers. If the spacers are positioned incorrectly, contact can arise between the insulation layers as a result of relative movement of the layers in the door when the door is manufactured or used. Such a contact between the layers results in a deterioration in the sound-insulating capability, as the sound is transmitted at the points of contact. It should, however, be mentioned that the spacers can consist of strips of material with a relatively large contact surface if the material is not particularly rigid, since a less rigid material transmits sound less effectively than a more rigid material.

[0006] Sound insulation is a very advanced technical field which means that it is difficult or impossible to forecast the sound-insulating effects of different combinations of material precisely by theoretical means. It is also difficult or impossible to explain certain phenomena that arise when different materials are combined.

[0007] An example of an external door is described below that is based on an experimentally-produced door that has been found to be a preferred embodiment of the invention. It should, however, be emphasized that certain changes in the material and number of layers can be possible within the framework of the invention in order to obtain a door with improved sound insulation in comparison with previously-known doors.

[0008] The door has external dimensions of 77 mm x 925 mm x 2031 mm and outer frame dimensions of 988 mm x 2080 mm, that is module 10x21. The external dimensions of the door also apply as dimensions for the outer layers. The insulating arrangement has external

dimensions of approx. 845 mm x 1861 mm and comprises four insulation layers and five air gaps which are 63 mm thick in total. In addition, the door comprises a peripheral strip of wood with a cross-section of 63 mm x 45 mm that encloses the insulation between the two outer layers. At the upper and lower part of the door, two such strips are arranged alongside each other across the width of the door. The two outer layers overlap the peripheral strip all round. The size of the door is of no actual significance for the sound-insulating effect, it being the air gaps together with the other materials that are of importance for the invention.

[0009] The outer layers consist of a laminate of two sheets of wood with a 0.7 mm aluminium plate between. The three layers are glued together.

[0010] The sheets of wood comprise a sheet of high density fibreboard (HDF) with a thickness of 3.2 mm and a density of 1050 kg/m³.

[0011] The insulation layers consist of an insulating fibre material with a density from 125 kg/m³ up to and including 265 kg/m³. The material can, for example, be a sheet of mineral wool or some other suitable insulating material. The insulation layers can each have a thickness of 12.5 mm.

[0012] The air gaps are each nominally 2.6 mm in width, but this varies slightly due to the fact that the insulating boards are not completely flat. By variation it is meant here that not only are the gaps are different sizes, but also that each air gap has variations. The narrowest air gap is, however, at least 1 mm.

[0013] The spacers consist of three strips of foamed plastic/cellular plastic that are 100 mm wide and approx. 2.5-3 mm thick and are laid along almost the whole of the insulation, extending to essentially the whole of the insulation layer, that is approx. 1861 mm.

[0014] The door according to the example weighs approx. 51 kg and has a sound-damping capability of 43 dB or more, which means that the door is in the class Rw 40. Previously-known doors in the class Rw 40 with the same dimensions have a weight of approx. 81 kg with outer layers consisting of steel plate, which means that the door according to the invention has a sound-insulating effect per kilo of door that greatly exceeds that which was previously known.

End of example.

[0015] The door can be manufactured from other materials and with different dimensions while continuing to have a low weight, whereby the sound-damping capability per kilo remains the same or is slightly reduced. Even if the sound-damping capability per kilo is somewhat reduced, the ratio between sound insulation and weight continues to be high in comparison to previously-known doors, thanks to the air gaps. As an example, it can be mentioned that if the door were to be given an outer layer of steel plate, the gaps according to the invention in combination with the insulation material would result in a door

that could be classified higher than Class Rw40, which is also an improvement in comparison with previously-known technology. The air gaps according to the invention thus provide an improvement in the sound-insulating capability, irrespective of what material is used, but the door according to the example provides surprisingly good sound insulation per kilo of door.

[0016] The air gaps have advantageously a width from 0.5 mm up to and including 5 mm, but are most advantageously approx. 2.6 mm wide according to the example, as the thickness of the door is then minimal while providing optimal sound damping.

[0017] The insulation layer can have a thickness from 5 mm upwards, but has a preferred thickness of 12 mm up to and including 20 mm. The insulation layers can consist of a material with a density from 25 kg/m³ up to and including 500 kg/m³. The thickness of the insulation layers can be determined on the basis of the density in such a way that the door has a weight that remains low in comparison to previously-known doors. The following materials can be used as insulation in the door: insulating fibreboard; cellular plastic such as polystyrene, polyurethane, phenol, PVC, acrylic plastic, cellular plastic, etc; mineral wools such as glass wool or rock wool; Foam-glass; cork; straw; flax particle board; etc.

[0018] The outer layers can each be made of wood, plywood, high density fibreboard (HDF) or medium density fibreboard (MDF), metal, plastic or a combination of the different materials. The outer layers can thus consist of plywood, MDF, HDF, fibreglass, PVC, aluminium plating, steel plating, etc. In addition, the outer layers can comprise a number of combinations of materials in separate layers, for example plywood combined with aluminium sheeting, etc. The total thickness of the layers is from 0.7 mm for a steel door and 3-12 mm for a plywood door. The invention can be used for internal doors or external doors.

[0019] The spacers can consist of any previously-known resilient material such as foamed plastic, rubber, etc. The spacers can comprise a number of strips of a non-rigid and at least partly resilient material with a breadth exceeding its thickness. The strips can extend between the insulation layers in order to create the air gaps. For example, the strips can be up to 100 mm x 100 mm in size and there can be 10-30 strips per air gap. As mentioned above, it is difficult or impossible to state a theoretical upper and lower limit for the size, number and material required to obtain the required effect from the air gaps in the door, for which reason the strips described above are only to be regarded as working examples. However, in the example above, spacers have been described that have been found by experiment to be advantageous for the invention. The spacers can thus have an extent up to and including essentially the whole of the longitudinal extent of the insulation layer and a breadth of up to and including approx. 100 mm.

[0020] The number of air gaps is always more than the number of insulation layers, which in turn is always at

least two. Hence, the number of insulation layers in the door according to the invention can be two, three, four, five or any other suitable integer. According to the above, the number of air gaps will thus be the number of insulation layers plus one.

[0021] The air gaps are decisive for the invention as sound takes the easiest path, i.e. sound travels more readily through the air gaps than through the insulation layer. As mentioned above, it is difficult to explain certain acoustic phenomena purely theoretically, but it is possible that in this case the air gaps enable the sound wave to travel along the surface of each insulation layer and then to be reflected off the peripheral strip and back in towards the middle of the door. In this way, the sound is reduced more quickly than if it only had to pass through an insulation layer. According to one embodiment of the invention, it has been shown experimentally that relatively large holes can be made in the insulation layers without reducing the insulating capability significantly, but reducing the weight as a result. The holes in the different layers are not aligned in the direction of the thickness of the door, but are displaced in relation to each other in such a way that they overlap each other to a certain extent in the direction of the height of the door. A hole right through all the layers would provide a direct passage from outer layer to outer layer which is undesirable. The fact that it is possible to make holes in the layers proves, however, that the sound waves tend to diverge in the air gaps before they pass through the next layer of insulation.

[0022] The door according to the invention has the best sound-insulating capability per kilo when the door weighs from 45 kg up to and including 65 kg, and from 51 kg it has a sound-damping capability of at least 43 dB.

BRIEF DESCRIPTION OF DRAWINGS:

[0023] The invention will be described in the following with reference to a number of drawings, in which:

Figure 1 shows schematically a view of a door according to the invention with a first outer layer facing the viewer.

Figure 2 shows schematically a cross-section of the door along the line I-I in Figure 1 according to a first embodiment of the invention, and

Figure 3 shows schematically a cross-section of the door along the line I-I in Figure 1 according to a non claimed embodiment of a door.

MODES FOR CARRYING OUT THE INVENTION:

[0024] Figure 1 shows schematically a view of a door 1 with a first outer layer facing the viewer. The door consists of a laminate of a first outer layer 2, a second outer layer 3 placed at a distance from and parallel to the first outer layer 2, and an insulating arrangement 4 between

the outer layers 2, 3. In addition, the door comprises a peripheral edging strip 5 that surrounds the insulating arrangement.

[0025] Figure 2 shows a cross-section of the door along the line I-I in Figure 1. The first outer layer comprises a sheet of wood 6 and a light metal sheet 7 of aluminium. The second outer layer 3 is constructed in the same way as the first outer layer 2 and also comprises a sheet of wood 6 and a light metal sheet 7 of aluminium.

[0026] The insulating arrangement 4 comprises four insulation layers 8 in the form of insulating boards 8 and five air gaps 9. The insulating arrangement 4 comprises spacers 10 arranged to create the air gaps 9 between the insulation layers 8. Figure 2 shows that the spacers 10 are positioned in such a way that two spacers are never positioned exactly opposite each other on either side of an insulation layer 8. The reason for this is to prevent two spacers forming a bridge for the transmission of an impulse caused by a sound.

[0027] It should, however, be mentioned that in a non claimed embodiment of the door shown in Figure 3, the spacers 10 comprise three strips of a non-rigid and at least partially resilient material that consists of foam rubber/cellular plastic. Such a material is particularly sound-absorbent, which means that the spacers can be positioned completely or partially opposite each other, without the sound-insulating capability being affected significantly.

Claims

1. A door (1) comprising a laminate of a first outer layer (2) and a second outer layer (3) with an insulating arrangement (4) between them, wherein the insulating arrangement (4) comprises at least two insulation layers (8) separated from each other and from the outer layers by air gaps (9), the insulating arrangement (4) comprises spacers (10) placed between the insulation layers (8) and arranged to create the air gaps (9), **characterised in that** the spacers (10) are positioned in such a way that two spacers (10) are never positioned exactly opposite each other on either side of said insulation layer (8).
2. The door (1) according to claim 1, **characterised in that** the insulating arrangement (4) comprises four insulation layers (8) and five air gaps (9).
3. The door (1) according to any one of the preceding claims, **characterised in that** each air gap has a width of at least 0.5 mm.
4. The door (1) according to claim 3, **characterised in that** each air gap has a width of at least 1 mm up to and including 2.6 mm.
5. The door (1) according to claim 4, **characterised in**

that the spacers (10) comprise three strips of a non-rigid and at least partially resilient material with a breadth exceeding the width which is approx. 2.5-3 mm.

6. The door (1) according to claim 5, **characterized in that** the spacers (10) have a length of up to and including essentially the whole of the longitudinal extent of the insulation layer and have a breadth of up to and including approx. 100 mm.
7. The door (1) according to any one of the preceding claims, **characterized in that** the first outer layer (2) and/or the second outer layer (3) comprise a laminate of two sheets of high density fibreboard with a light metal sheet between them.
8. The door (1) according to any one of the preceding claims, **characterized in that** the first outer layer (2) and/or the second outer layer (3) comprise sheets of high density fibreboard with a density of at most 1050 kg/m³.
9. The door (1) according to any one of the preceding claims, **characterized in that** each insulation layer (8) has a thickness of at least 5 mm.
10. The door (1) according to claim 9, **characterized in that** each insulation layer (8) has a thickness from 12 mm up to and including 20 mm.
11. The door (1) according to any one of the preceding claims, **characterized in that** each insulation layer (8) comprises a material with a density from 25 kg/m³ up to and including 500 kg/m³.
12. The door (1) according to claim 12, **characterized in that** each insulation layer (8) comprises an insulating fibre material with a density from 125 kg/m³ up to and including 265 kg/m³.
13. The door (1) according to any one of the preceding claims, **characterized in that** the door has a sound-damping capability of at least 43 dB.

Patentansprüche

1. Tür (1) umfassend ein Laminat aus einer ersten Außenschicht (2) und einer zweiten Außenschicht (3) mit einer zwischenliegenden Dämmungsvorrichtung (4), wobei die Dämmungsvorrichtung (4) mindestens zwei Dämmschichten (8) umfasst, die voneinander getrennt sind und durch Luftspalte (9) von den Außenschichten getrennt sind, wobei die Dämmungsvorrichtung (4) zwischen den Dämmschichten (8) angeordnete und zur Bildung der Luftspalte (9) ausgebildete Abstandselemente (10) umfasst, **dadurch**

gekennzeichnet, dass die Abstandselemente (10) derart angeordnet sind, dass zwei Abstandselemente (10) nie genau einander gegenüberliegend an jeweils einer Seite der Dämmschicht (8) angeordnet sind.

2. Tür (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Dämmungsvorrichtung (4) vier Dämmschichten (8) und vier Luftspalte (9) umfasst.
3. Tür (1) nach einem der vorgehenden Ansprüche, **dadurch gekennzeichnet, dass** jeder Luftspalt eine Breite von mindestens 0,5 mm aufweist.
4. Tür (1) nach Anspruch 3, **dadurch gekennzeichnet, dass** jeder Luftspalt eine Breite von mindestens 1 mm bis zu und einschließlich 2,6 mm aufweist.
5. Tür (1) nach Anspruch 4, **dadurch gekennzeichnet, dass** die Abstandselemente (10) drei Streifen aus einem nicht steifen und zumindest teilweise elastischen Material mit einer Breite umfasst, die die Weite überschreitet, die etwa 2,5-3 mm überschreitet.
6. Tür (1) nach Anspruch 5, **dadurch gekennzeichnet, dass** die Abstandselemente (10) eine Länge von bis zu und einschließlich im Wesentlichen der Gesamtheit der Längserstreckung der Dämmschicht und eine Breite von bis zu und einschließlich etwa 100 mm aufweisen.
7. Tür (1) nach einem der vorgehenden Ansprüche, **dadurch gekennzeichnet, dass** die erste Außenschicht (2) und/oder die zweite Außenschicht (3) ein Laminat aus zwei Schichten aus hochdichter Faserplatte mit einem dazwischen vorgesehenen leichten Metallblech umfasst bzw. umfassen.
8. Tür (1) nach einem der vorgehenden Ansprüche, **dadurch gekennzeichnet, dass** die erste Außenschicht (2) und/oder die zweite Außenschicht (3) Platten aus hochdichter Faserplatte mit einer Dichte von höchstens 1050 kg/m³ umfasst bzw. umfassen.
9. Tür (1) nach einem der vorgehenden Ansprüche, **dadurch gekennzeichnet, dass** jede Dämmschicht (8) eine Dicke von mindestens 5 mm aufweist.
10. Tür (1) nach Anspruch 9, **dadurch gekennzeichnet, dass** jede Dämmschicht (8) eine Dicke von ab 12 mm bis zu und einschließlich 20 mm aufweist.
11. Tür (1) nach einem der vorgehenden Ansprüche, **dadurch gekennzeichnet, dass** jede Dämmschicht (8) ein Material mit einer Dichte von ab 25 kg/m³ bis zu und einschließlich 500 kg/m³ umfasst.

12. Tür (1) nach Anspruch 12, **dadurch gekennzeichnet, dass** jede Dämmschicht (8) einen Faserdämmstoff mit einer Dichte von ab 125 kg/m^3 bis zu und einschließlich 265 kg/m^3 umfasst.
13. Tür (1) nach einem der vorgehenden Ansprüche, **dadurch gekennzeichnet, dass** die Tür eine Schalldämpfungsfähigkeit von mindestens 43 dB aufweist.

Revendications

1. Porte (1) comprenant un stratifié d'une première couche extérieure (2) et une deuxième couche extérieure (3) avec un agencement isolant (4) entre elles, ledit agencement isolant (4) comprenant au moins deux couches isolantes (8) l'une séparée de l'autre et des couches extérieures par des espaces d'air (9), ledit agencement isolant (4) comprenant des cales d'espacement (10) positionnées entre les couches isolantes (8) et agencées pour créer les espaces d'air (9), **caractérisée en ce que** les cales d'espacement (10) sont positionnées d'une telle manière que les deux cales d'espacement (10) ne sont jamais positionnées exactement l'une opposée à l'autre sur les deux côtés de la couche isolante (8).
2. Porte (1) selon la revendication 1, **caractérisé en ce que** l'agencement isolant (4) comprend quatre couches isolantes (8) et cinq espaces d'air (9).
3. Porte (1) selon l'une quelconque des revendications précédentes, **caractérisée en ce que** chaque espace d'air présente une largeur d'au moins 0,5 mm.
4. Porte (1) selon la revendication 3, **caractérisée en ce que** chaque espace d'air présente une largeur comprise entre 1 mm et 2,6 mm.
5. Porte (1) selon la revendication 4, **caractérisée en ce que** les cales d'espacement (10) comprennent trois bandes d'un matériau non rigide et au moins partiellement élastique avec une largeur supérieure à la largeur qui est comprise entre environ 2,5 et 3 mm.
6. Porte (1) selon la revendication 5, **caractérisée en ce que** les cales d'espacement (10) ont une longueur allant jusqu'à et incluant essentiellement l'ensemble de l'étendue longitudinale de la couche isolante et ont une largeur allant jusqu'à et incluant environ 100 mm.
7. Porte (1) selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la première couche extérieure (2) et/ou la deuxième couche extérieure (3) comprennent un stratifié de deux feuilles de panneau de fibres à haute densité avec une tôle

légère entre elles.

8. Porte (1) selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la première couche extérieure (2) et/ou la deuxième couche extérieure (3) comprennent des feuilles de panneau de fibres à haute densité avec une densité d'au plus 1050 kg/m^3 .
9. Porte (1) selon l'une quelconque des revendications précédentes, **caractérisée en ce que** chaque couche isolante (8) présente une épaisseur d'au moins 5 mm.
10. Porte (1) selon la revendication 9, **caractérisée en ce que** chaque couche isolante (8) présente une épaisseur comprise entre 12 mm et 20 mm.
11. Porte (1) selon l'une quelconque des revendications précédentes, **caractérisée en ce que** chaque couche isolante (8) comprend un matériau ayant une densité comprise entre 25 kg/m^3 et 500 kg/m^3 .
12. Porte (1) selon la revendication 12, **caractérisée en ce que** chaque couche isolante (8) comprend un matériau fibreux isolant ayant une densité comprise entre 125 kg/m^3 et 265 kg/m^3 .
13. Porte (1) selon l'une quelconque des revendications précédentes, **caractérisée en ce que** la porte a une capacité d'amortissement du son d'au moins 43 dB.

Fig. 1

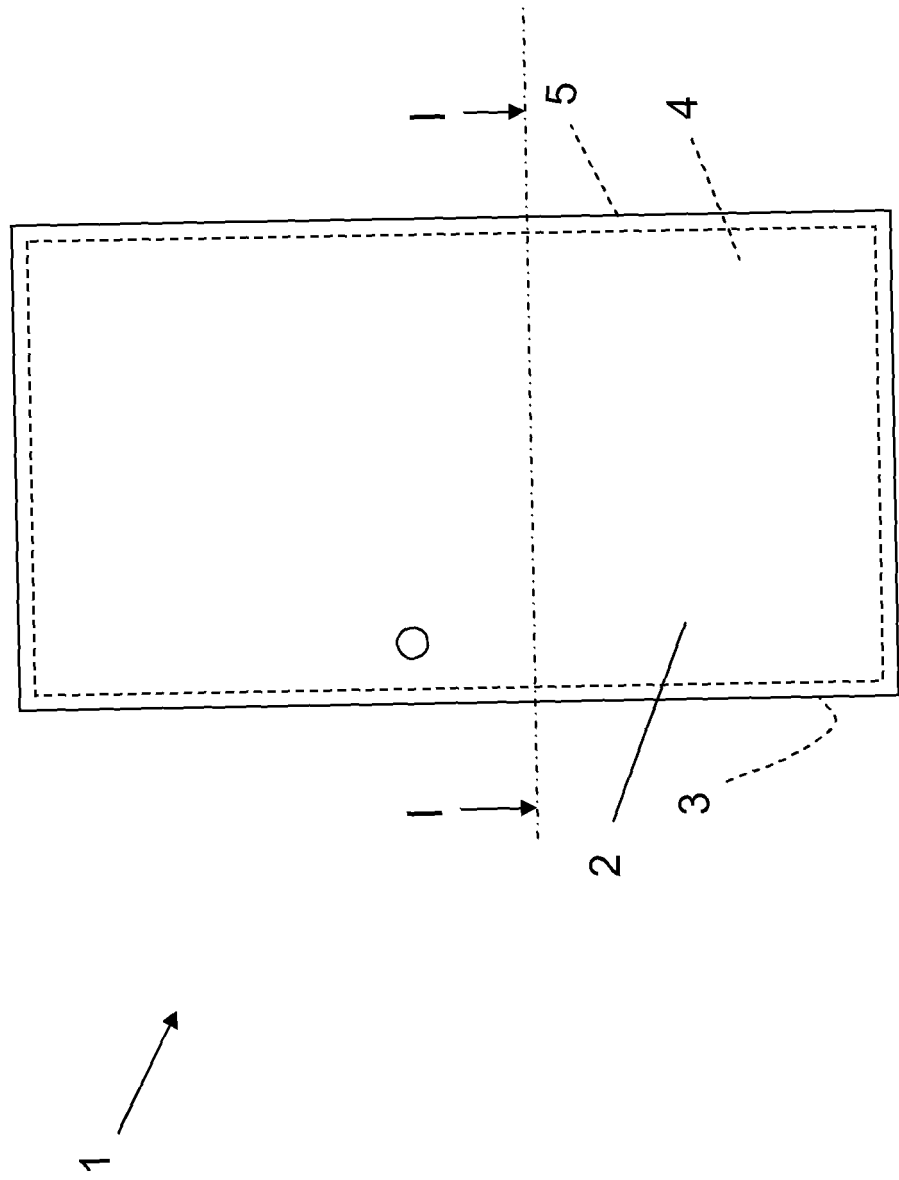


Fig. 2

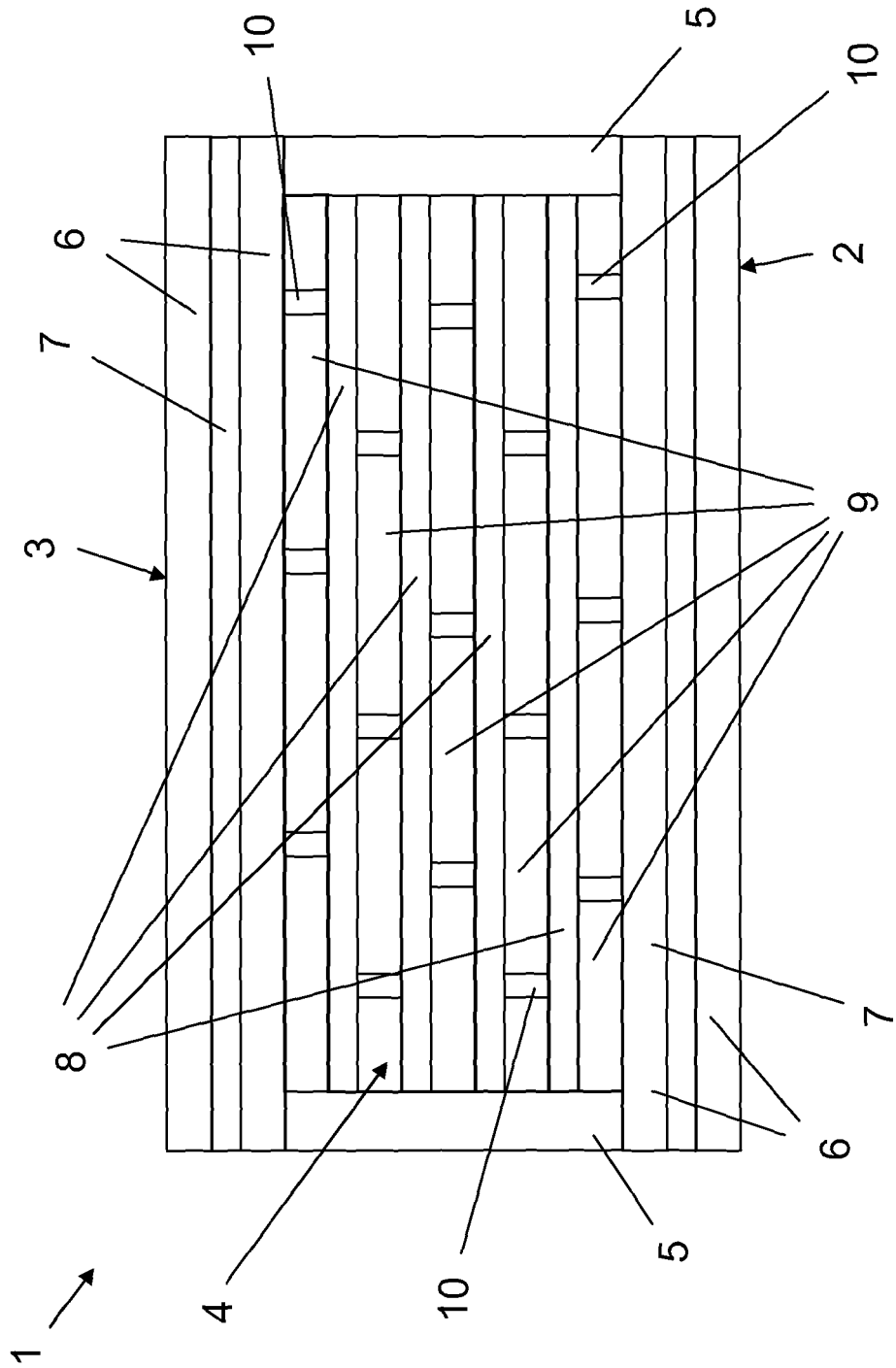
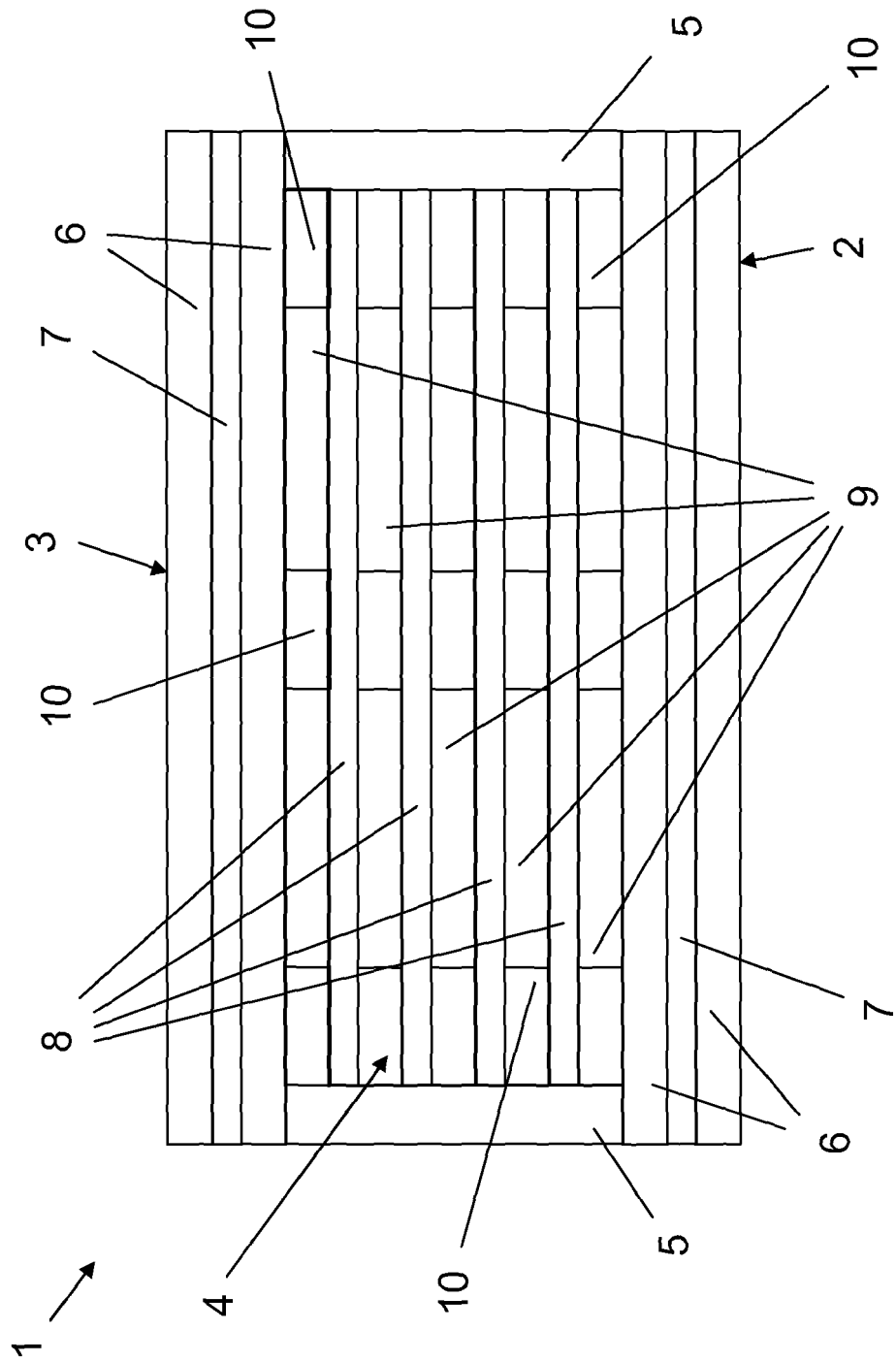


Fig. 3



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US 5416285 A [0003]