(19) DANMARK

(10) **DK/EP 2016251 T3**

(12) Oversættelse af europæisk patentskrift

Patent- og Varemærkestyrelsen

(51) Int.Cl.: *E 06 B 5/20 (2006.01)* *E 04 B 1/86 (2006.01)* *E 06 B 3/70 (2006.01)*

(45) Oversættelsen bekendtgjort den: **2017-10-02**

(80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2017-06-28**

(86) Europæisk ansøgning nr.: **07748439.2**

(86) Europæisk indleveringsdag: **2007-04-26**

(87) Den europæiske ansøgnings publiceringsdag: **2009-01-21**

(86) International ansøgning nr.: **SE2007050278**

(87) Internationalt publikationsnr.: **WO2007126379**

(30) Prioritet: **2006-04-28 SE 0600969**

(84) Designerede stater: **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**

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(56) Fremdragne publikationer:
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CH-A5- 660 389
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DE-U1- 8 714 436
FR-A- 1 073 718
JP-A- 2002 348 986
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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 preambule 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 spacers 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/m^3.

[0011] The insulation layers consist of an insulating fibre material with a density from 125 kg/m^3 up to and including 265 kg/m^3. 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/m^3 up to and including 500 kg/m^3. 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; Foamglass; 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.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US5416285A [0003]

Patentkrav

1. Dør (1) omfattende et laminat af et første udvendigt lag (2) og et andet udvendigt lag (3) med en isolerende indretning (4) derimellem, hvor den isolerende indretning (4) omfatter mindst to isolerende lag (8), der er adskilt fra hinanden og fra de udvendige lag af luftspalter (9), hvilken isolerende indretning (4) omfatter afstandselementer (10), der er anbragt mellem de isolerende lag (8) og indrettet til danne luftspalterne (9), **kendetegnet ved, at** afstandselementerne (10) er anbragt på en sådan måde, at to afstandselementer (10) aldrig er anbragt lige over for hinanden på begge sider af det isolerende lag (8).

2. Dør (1) ifølge krav 1, **kendetegnet ved, at** den isolerende indretning (4) omfatter fire isolerende lag (8) og fem luftspalter (9).

3. Dør (1) ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** hver luftspalte har en vidde på mindst 0,5 mm.

4. Dør (1) ifølge krav 3, **kendetegnet ved, at** hver luftspalte har en vidde på mindst 1 mm op til og indbefattende 2,6 mm.

5. Dør (1) ifølge krav 4, **kendetegnet ved, at** afstandselementerne (10) omfatter tre strimler af et ikke-stift og mindst delvist eftergiveligt materiale med en bredde, der overstiger vidden, som er ca. 2,5-3 mm.

6. Dør (1) ifølge krav 5, **kendetegnet ved, at** afstandselementerne (10) har en længde på op til og indbefattende i det væsentlige hele den langsgående udstrækning af isoleringslaget og har en bredde på op til og indbefattende ca. 100 mm.

7. Dør (1) ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** det første udvendige lag (2) og/eller det andet udvendige lag (3) omfatter et laminat af to lag af fiberplade med høj massefylde med et lag af letmetal derimellem.

8. Dør (1) ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** det første udvendige lag (2) og/eller det andet udvendige lag (3) omfatter lag af fiberplade med høj massefylde med en massefylde på højst 1050 kg/m<3>.

9. Dør (1) ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** hvert isoleringslag (8) har en tykkelse på mindst 5 mm.

10. Dør (1) ifølge krav 9, **kendetegnet ved, at** hvert isoleringslag (8) har en tykkelse fra 12 mm til og med 20 mm.

11. Dør (1) ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** hvert isoleringslag (8) omfatter et materiale med en massefylde fra 25 kg/m<3> til og med 500 kg/m<3>.

12. Dør (1) ifølge krav 12, **kendetegnet ved, at** hvert isoleringslag (8) omfatter et isolerende fibermateriale med en massefylde fra 125 kg/m<3> til og med 265 kg/m<3>.

13. Dør (1) ifølge et hvilket som helst af de foregående krav, **kendetegnet ved, at** døren har en lyddæmpningsevne på mindst 43 dB.

DRAWINGS

Fig. 1

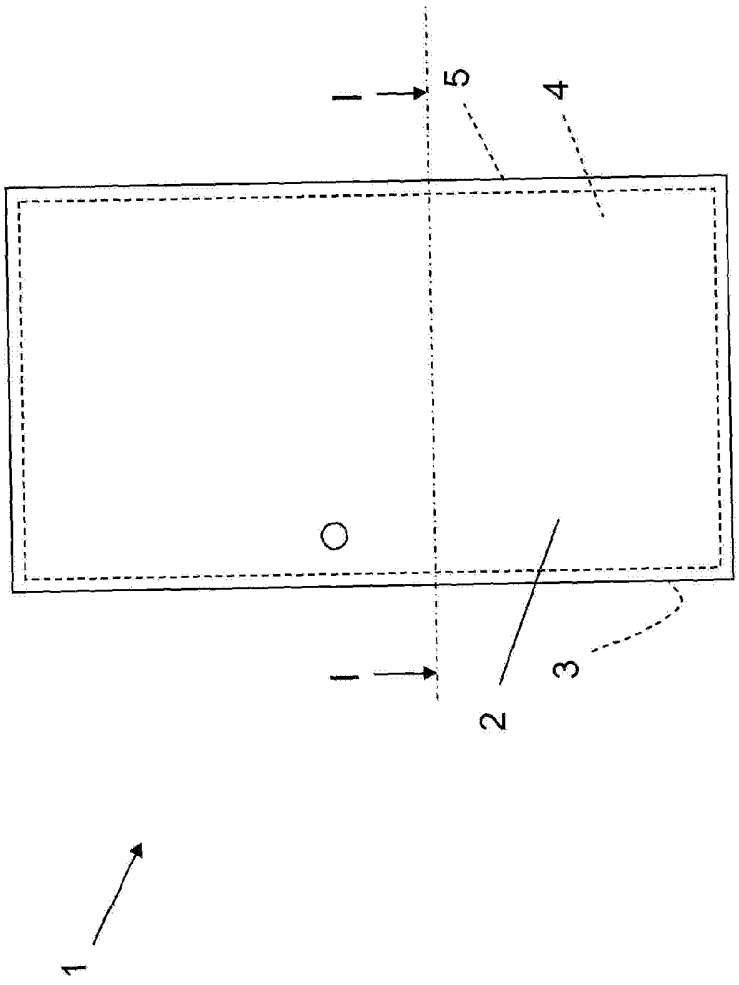

Fig. 2

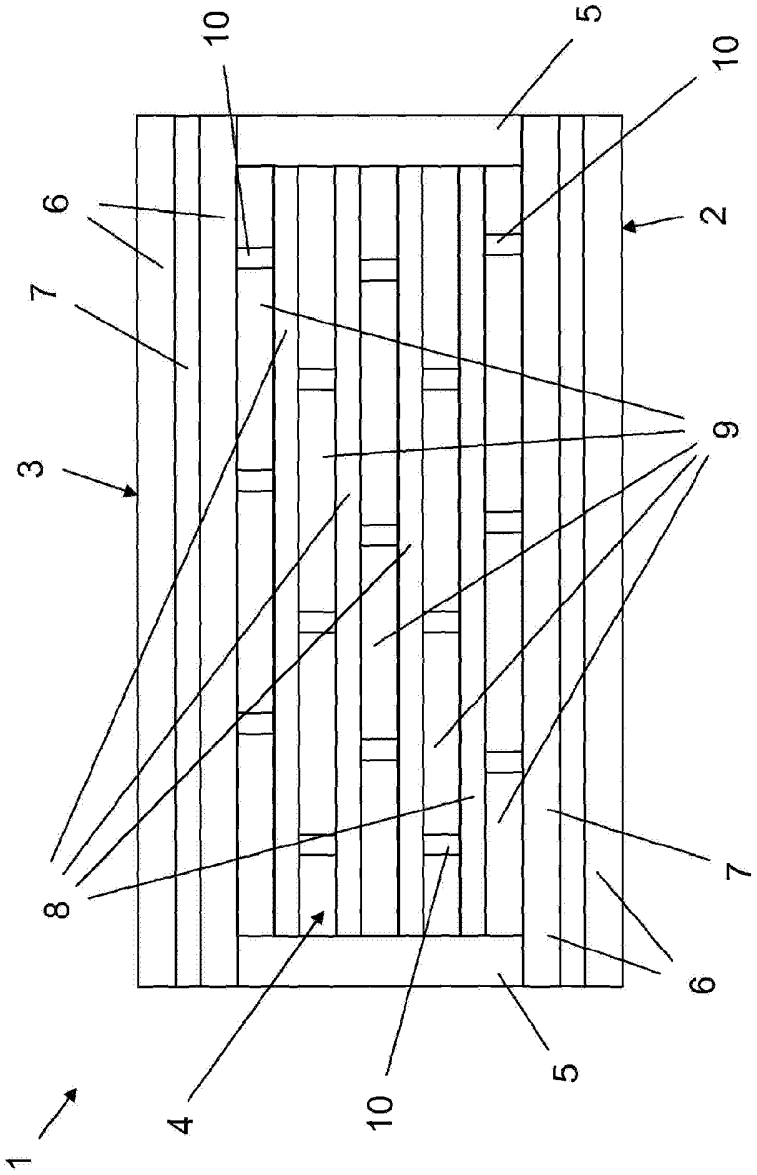

Fig. 3