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(54) **FLOOR DECK**

(57) The present invention relates to a floor deck for a multi-storey building, comprising a surface layer having a first surface layer side and a second surface layer side, a second layer having a sound dampening effect having a first side and a second side, a supporting layer having a first support side and a second support side, the distance from the first support side to the second support side defining the height of the supporting layer, wherein the supporting layer is an uninterrupted layer seen vertically over its mounted position, made from a plurality of planks combined to form one supporting unit, the planks having a plank thickness defined from a first wide face to a second wide face, a plank width defined by a first narrow face and an opposing second narrow face and a plank length the plank length defined from a first end to a second end. Moreover, the present invention also relates to the use of the floor deck buildings having two or more storeys.

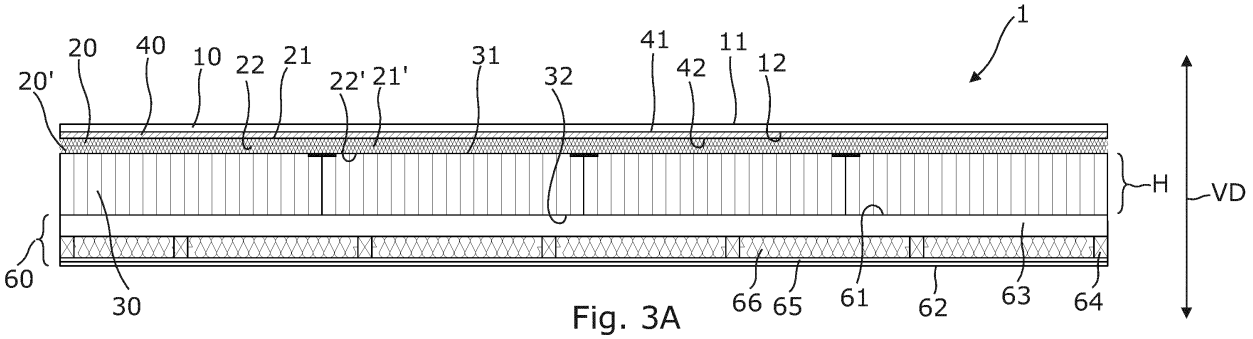

Fig. 3A

EP 3 926 118 A1

Description

[0001] The present invention relates to a floor deck for a multi-storey building. Moreover, the present invention also relates to the use of the floor deck in buildings having two or more storeys.

[0002] In multi-storey buildings, it is a constant challenge to mitigate sound travelling from one storey to another and hence reduce noise in such buildings. In residential buildings in particular, sound spreading in the building originates mainly from two sources. The first category of sound is airborne sound, for example speech in general, including speech and sound from televisions and other types of media sources and also sound emanating from domestic appliances such as vacuum cleaners, food processors etc. The second category is sound originating from contact with the building itself, for example sound emanating from the contact between parts of the building e.g. the floor and people, for example people walking. The latter category can also be described as impact sound. In particular, when the people living in apartments or working in offices people in the apartments or offices generate sound from footsteps. If people are wearing shoes, the problem of footsteps is significant, but also just the contact between a bare foot and a floor creates soundwaves that often transfers from one apartment to the other via the floor deck. This second category of sound also includes sound originating from furniture used on a daily basis, for example chairs being repositioned.

[0003] Recent studies have shown that sound originating from the neighbouring inhabitants may result in not only discomfort for the persons affected but in much more serious illnesses such as stress, post-traumatic stress disorder or similar diseases.

[0004] Hence, reduction in sound or noise has become regulated by law for new buildings. In the present application, the term sound is used generally, however, it is to be understood that undesired sound may also be called noise.

[0005] In view of the first and second category of sound mentioned above, they are respectively best stopped or reduced in different ways. Hence, reducing sound migration it is not just a matter of increasing the density of a floor deck in order to reduce the adverse transmission of sound.

[0006] Typically, within construction of multi-storey buildings, concrete has been the preferred material. Concrete has a good ability to stop airborne sound. However, lately trends are moving towards using less concrete due to its high adverse environmental impact. Thus, multi-storey buildings are starting to be built using lighter materials such as wood. If the building itself is made of wood, it causes complications to use concrete for the floor decks both due to the weight of the concrete and due to the use of an additional construction material. Furthermore, it is counter-intuitive to use concrete as a floor deck if the rest of the building is substantially made from wood due to environmental reasons.

[0007] It is an object of the present invention to wholly or partly overcome the above disadvantages and drawbacks of the prior art. More specifically, it is an object to provide an improved floor deck that is lighter than traditional concrete decks.

[0008] The above objects, together with numerous other objects, advantages and features, which will become evident from the below description, are accomplished by a solution in accordance with the present invention of a floor deck for a multi-storey building, comprising:

- a surface layer having a first surface layer side and a second surface layer side,
- a second layer having a sound dampening effect having a first side and a second side,
- a supporting layer having a first support side and a second support side, the distance from the first support side to the second support side defining the height of the supporting layer,

wherein the supporting layer is an uninterrupted layer seen vertically over its mounted position, made from a plurality of planks combined to form one supporting unit, the planks having a plank thickness defined from a first wide face to a second wide face, a plank width defined by a first narrow face and an opposing second narrow face and a plank length, the plank length defined from a first end to a second end.

[0009] In this way, it is achieved that the regulations in at least Denmark is fulfilled i.e. the Danish Building Regulations year 2020 (BR 18) that demands a sound reduction in airborne sound at 55db through a floor deck. It is further achieved that a sound reduction of at least 50db of impact/contact sound, for example from people walking on the floor above is achieved. This is achieved without the use of concrete and despite having a substantially small overall thickness of the floor deck. The thickness of the floor deck is defined as the distance from the first surface layer side to the second support side of the supporting layer. The floor deck may be delivered at the construction site as a cassette. Additional layers may be added to the cassette on site. For example, an additional layer may be added to the second support side of the supporting layer. In this way, it is possible to adjust the thickness of the floor deck as per requirements on site.

[0010] Moreover, the planks may be made from wood or wood fibre.

[0011] Furthermore, the planks may be glued together.

[0012] In addition, the planks may be combined into plank sections, the plank sections being combined to form a supporting unit.

[0013] Also, the plank sections may be combined by a joining element such as metal brackets or pieces of wood. In one embodiment, the plank sections may be combined to each other by tilted fastening means such as screws or nails. The screws or nails may be tilted in order to spread the load on the local areas of the plank sections.

In a mounted state, the fastening means are inserted at an angle of approximately 45° from the vertical direction. Hence, the fastening means connection is inserted in the one plank section and continued into the neighbouring or abutting plank section. This may be continued until the desired size is achieved. In one embodiment, the plank sections may comprise an overlapping section such that fastening means, for example screws or nails may be inserted substantially in a perpendicular manner to the plank sections in order to combine two neighbouring or abutting plank sections. In one embodiment, the neighbouring plank sections may also be held together by glue alone or glue in addition to the fastening means.

[0014] Furthermore, the plank sections may have an extension measured perpendicularly over the wide side of the plurality of planks of 500mm-2000mm or 750mm-1750mm or more preferred 1000mm-1500mm.

[0015] Additionally, the floor deck may comprise an intermediate layer placed between the surface layer and the second layer. In this way, further sound dampening is achieved. Furthermore, the intermediate layer may be made from chip wood, cross-laminated wood, composites or similar. The intermediate layer may comprise floor heating, for example tubes for waterborne floor heating. In this way, it is achieved that both the floor heating system and the material of the intermediate layer add to the sound dampening effect.

[0016] In an embodiment, the intermediate layer may be made of chipboard. In this way, a rigid layer that is dimensionally stable is achieved.

[0017] Moreover, the second layer may comprise two or more individual layers. In this way, it is possible to adjust the sound dampening capabilities to the specific requirements of the situation. Different storeys within a building may need different sound dampening measures, hence it may be easier and cheaper to perform customised individualisation by adding or removing an individual layer as required.

[0018] In an embodiment, the second layer may be 25-95mm or 35-75mm or 45-55mm. In an embodiment, the second layer may be made of mineral wool such as Rockwool or Isover. In this way, a sound dampening effect is achieved.

[0019] In an embodiment, the supporting layer may be affixed to the walls of the building by brackets.

[0020] In an embodiment, the supporting layer may rest on the inner wall of the building.

[0021] In addition, the supporting layer may be glued laminated wood. The glued laminated wood (abbreviated as glulam) may be made of smaller planks or smaller pieces of lumber. These may also be called laminating stock or lamstock.

[0022] Furthermore, the height of the supporting layer may be 100mm-500mm or 125mm-400mm or 150mm-300 mm.

[0023] The glued laminated wood (for short glulam) may be made of smaller planks or smaller pieces of lumber. These may also be called laminating stock or lamstock. The general idea of glulam is the possibility to use smaller pieces of lumber to form large sections. This technique does not affect the sound dampening capabilities of the wood.

[0024] In an embodiment, the height of the supporting layer may be 200mm. In this way, the supporting layer may span up to approximately 7 metres from the first end to the second end of the planks or combined lumber pieces. The span may be longer than 7 meters.

[0025] In an embodiment, the second side of the supporting layer may have an additional layer comprising at least one layer of gypsum boards. In this way, airborne sound and/or impact (contact) sound is further reduced through the floor deck. Having the possibility to adjust the thickness and weight of the floor deck as a whole facilitates that the capabilities of the floor deck may be adjusted to exactly the needs in the particular situation. The additional layer may have a different density than the supporting layer.

[0026] In one embodiment, the additional layer may be made of gypsum. The thickness of the additional layer may be 1mm-200mm or 13mm-180mm or 26mm-160mm. In one embodiment, the additional layer comprises two layers of gypsum. Each layer of gypsum may be 13mm. In this way, an additional layer having a different sound dampening effect than wood is achieved. Further, the gypsum provides a higher fire resistance than wood.

[0027] In one embodiment, the additional layer may comprise a wooden structure to which a number of gypsum layers are attached. In this way, it is achieved that a volume is created between the supporting layer and the gypsum layers of the additional layer. In this way, it is achieved that the volume is dampening airborne sound.

[0028] Also, the supporting layer may comprise insulation.

[0029] In this way, it is possible to achieve additional sound insulation as well as heat insulation. Furthermore, insulation using e.g. brands as Rockwool or Isover may improve fire resistance.

[0030] Additionally, the supporting layer may comprise sound dampening elements. Such sound dampening elements and/or vibration dampening material may be made from viscoelastic material or rubber. The sound dampening elements may be arranged at least at some or at all points of contact with the walls or brackets supporting the supporting layer.

[0031] In this way, it is achieved that sound and/or vibrations are dampened, and hence it is achieved that sound waves are absorbed in the supporting layer. The sound projected towards the floor deck and hence the supporting layer is at least partially prevented from migrating into the structural part of the building of which the supporting layer is resting.

[0032] Moreover, the surface layer may be made from gypsum. The surface layer may have a thickness of 13-50mm.

[0033] In this way, a layer of different density from wood is achieved thereby reducing the spreading of sound waves.

[0034] Furthermore, the layers above the supporting layer of the floor deck may be floating. In this way, it is achieved that no sound is transferred from layer to layer via any connecting means such as nails or screws.

[0035] Finally, the present invention relates to the use of the floor deck in buildings having two or more storeys. The floor decks reduce the sound migration or transfer as well as being strong enough to be part of the structural part of the building as a whole.

[0036] The invention and its many advantages will be described in more detail below with reference to the accompanying schematic drawings, which for the purposes of illustration show some non-limiting embodiments and in which:

Fig. 1 shows in a schematic view a multi-storey building having three multilayer decks separating the storeys in the vertical direction,

Fig. 2 shows in a schematic view a multi-storey building having three multilayer decks according to a further embodiment of the invention,

Fig. 3A shows an enlarged view of the floor deck shown in Fig. 1,

Fig. 3B shows an enlarged view of the floor deck shown in Fig. 2,

Fig. 3C shows a further embodiment of the floor deck,

Fig. 3D shows a further embodiment of the floor deck having an additional layer,

Fig. 4 shows the contact point between the wall and a bracket supporting the floor deck,

Fig. 5 shows floor decks installed and held by the inner wall of a building, and

Fig. 6 shows a detailed view of the contact between a wall and a floor deck as schematically shown in Fig. 5.

[0037] All the figures are highly schematic and not necessarily to scale and show only those parts which are necessary in order to elucidate the invention, other parts being omitted or merely suggested.

[0038] Fig. 1 shows a number of floor decks 1 arranged in a multi-story building 2. An airborne sound source 3 projects a sound towards the floor deck. A contact sound source 4 is shown in contact with the surface layer 10 of the floor deck 1. The contact sound source 4 may also be called impact sound (source). In the embodiment, shown the floor deck 1 comprises an additional layer 60. In this embodiment, the additional layer 60 is the ceiling of the apartment below seen in the vertical direction VD. As will be shown later, an additional layer may also be one or more gypsum plates glued together and otherwise attached to the layers vertically above.

[0039] As is common with floor decks, the floor decks 1 are arranged substantially parallel to the horizontal direction HD. Hence, when defining the floor deck height FH of a floor deck 1 as a whole it is to be understood that it is seen over the vertical direction VD. In a similar manner, the width W of the floor deck 1 is defined along the horizontal direction HD. Obviously, the floor deck 1 has a depth D (not shown in the present two-dimensional drawing) extending perpendicular to the width W.

[0040] Similar to Fig. 1, Fig. 2 shows a multi-story building 2 having a number of floor decks 1. It is shown that the floor decks 1 do not have the additional layer 60 shown in Fig. 1.

[0041] Figs. 3A and 3B show the detailed build-up of the embodiments of the floor deck shown in Fig. 1 and Fig. 2, respectively. Fig. 3C shows an additional embodiment of the build-up of a floor deck 1. Some reference numerals may be shown on all of Fig. 3A, Fig. 3B, Fig. 3C and Fig. 3D. Other reference numbers may be shown only in one of the figures, but embodiments having the same features have the same numbers on all the figures just not shown. Reference numerals 60-66 that exclusively refer to features are shown only in Fig. 3A. Reference numerals 68 and 68' refer to a feature shown only in Fig. 3D. The feature of gypsum layers 68 and 68' is also shown in Fig. 1, Fig. 3A and Fig. 4 but not marked with reference numerals.

[0042] In Fig. 3A and 3B, the floor deck 1 comprise a surface layer 10 having a first surface layer side 11 and a second surface layer side 12. The surface layer 10 may be made of gypsum or similar. In this embodiment, an intermediate layer 40 having a first intermediate layer side 41 and a second intermediate layer side 42 is positioned between the surface layer 10 and the second layer 20. In other words, the second surface layer side 12 faces the first intermediate side 41 of the intermediate layer 40 and the second intermediate layer side 42 faces the first side 21 of the second layer 20. In this embodiment, the second layer 20 is divided into two individual second layers 20, 20'. In other embodiments, the second layer 20 may be one layer. In this embodiment, the second side 22' of the second layer 20' faces the first support side 31 of the supporting layer 30. Hence, the supporting layer 30 has a first support side 31 and a second support side 32 where the distance from the first support side 31 to the second support side 32 defines the height H of the supporting layer 30.

[0043] Fig. 3A shows an additional layer 60. In this embodiment, the additional layer may comprise a first additional layer side 61 and a second additional layer side 62. The first additional layer side 61 is connected to the second support side 32. In this embodiment, the additional layer 60 comprises first horizontal joists 63 and

second horizontal joists 64 where the first and second joists 63, 64, respectively are substantially perpendicular to each other. Finishing plates 65 are attached to the second joists 64. The additional layer 60 also comprises insulation 66.

[0044] The supporting layer 30 shown in both Fig. 3A and Fig. 3B is the same. The supporting layer 30 is an uninterrupted layer seen vertically over its height H in its mounted position. The supporting layer 30 is uninterrupted over the height H or in other words a substantially solid layer made from a plurality of planks 50 combined to form one supporting unit 36. The planks 50 having a plank thickness PT defined between a first wide face 51 and a second wide face 52 , a plank width PW defined by a first narrow face 53 and an opposing second narrow face 54 and a plank length PL (not shown) the plank length defined from a first end 55 to a second end 56 (neither are shown). It is seen that the width of a single plank 50 in this embodiment is equal to the height H of the supporting layer 30. Hence, in the shown orientation of the planks the width W may also be called the height i.e. the dimension perpendicular the plank thickness PT. The term plank is defined as an element having a substantially uniform cross-section over the length, but it may be combined by two or more pieces of lumber. However, the supporting layer 30 may have cut-outs whereby the individual plank 50 may have a varying cross-section over its length. The planks may have a smaller dimension measured parallel to the horizontal direction HD compared to the vertical direction VD. In other words, in the installed position the plank 50 may be higher than it is thick.

[0045] The planks 50 may be of wood or wood composites and may be glued together forming glued laminated wood.

[0046] In Fig. 3A, 3B, 3C and 3D, it is shown that the supporting layer 30 is divided into plank sections 58 (see Fig. 3B). The plank sections 58 are held together by connectors 59. The connectors 59 may be metal connectors or brackets or simply cross laminated wood keeping the two abutting plank sections together. In this way, the smaller plank sections 58 form the full supporting layer 30. It is understood, that a supporting layer 30 may also comprise just one plank section if a narrow floor deck is to be achieved.

[0047] It is to be understood that in an embodiment the supporting layer 30 may also be one section, that is not being divided into smaller plank sections 58.

[0048] Fig. 3C shows an embodiment of the floor deck 1. The floor deck 1 comprises a surface layer 10 and a second layer 20, 20'. The second layer is shown having two individual layers 20, 20'. However, it is to be understood that in one embodiment the second layer 20 may be of one layer also. In the shown embodiment, the surface layer 10 may be thicker than shown in the embodiments shown in Fig. 3A and 3B.

[0049] Fig. 3D shows an embodiment of the floor deck 1 having an additional layer 60 attached to the second side 32 of the supporting layer 30. In this embodiment, the additional layer 60 comprises two additional gypsum layers 68, 68'. Using the additional gypsum layers 68, 68' it is possible to add a different material from the supporting layer and hence be able to stop different sound migration e.g. sound having a different wavelength. By splitting the additional layer 60 into two separate gypsum layers 68, 68' it is possible to keep the weight of the floor deck 1 as a whole at the minimum to meet the specific sound dampening requirements. However, it is to be understood that if a single gypsum layer is enough this is also an embodiment of the present invention.

[0050] Fig. 4 shows the embodiment of the floor deck 1 having an additional layer 60 installed in a multi-storey building 2. The supporting layers 30 are attached to the walls 80 of the building via brackets 85. The brackets 85 may also be various types of hangers, e.g. hidden or visible. In order to dampen the sound originating from contact with the floor deck 1, a dampening element 86 is installed between the supporting layer 30 and the bracket 85. Such dampening element 86 may also be installed between a hanger or similar bracket.

[0051] Fig. 5 shows a floor deck 1 installed in a multi-storey building 2 having an inner wall 87 and an outer wall 88. The floor deck 1 is positioned so that the supporting layer 30 is supported by the inner wall 87. The contact surfaces between the inner wall 87 and the supporting layer 30 may be of sound or vibration dampening material 86 in order to minimise sound mitigation in the inner wall 87.

[0052] Fig. 6 shows a more detailed view of a floor deck 1 being installed in a way that the supporting layer 30 is resting on a wall 87. It is seen that rubber or a dampening element 86 are positioned in a manner to minimise the spreading of sound from either the floor deck 1 to the wall 87 or vice versa via the contact between the two.

[0053] Although the invention has been described in the above in connection with preferred embodiments of the invention, it will be evident for a person skilled in the art that several modifications are conceivable without departing from the invention as defined by the following claims.

Claims

1. Floor deck (1) for a multi-storey building, comprising:

- a surface layer having a first surface layer side and a second surface layer side,
- a second layer having a sound dampening effect having a first side and a second side,
- a supporting layer having a first support side and a second support side, the distance from the first support side to the second support side defining the height of the supporting layer,

wherein the supporting layer is an uninterrupted lay-

er seen vertically over its mounted position, made from a plurality of planks combined to form one supporting unit, the planks having a plank thickness defined from a first wide face to a second wide face, a plank width defined by a first narrow face and an opposing second narrow face and a plank length the plank length defined from a first end to a second end.

2. Floor deck (1) for multi-storey buildings according to claim 1, wherein the planks are made from wood or wood fibre.

3. Floor deck (1) for a multi-storey building according to claim 1 or 2, wherein the planks are glued together.

4. Floor deck (1) for a multi-storey building according to claim 1, 2 or 3, wherein planks are combined into plank sections, and the plank sections are combined to form a supporting unit.

5. Floor deck (1) for a multi-storey building according to claim 4, wherein the plank sections are combined by brackets.

6. Floor deck (1) for a multi-storey building according to claim 1, wherein the plank sections have an extension measured perpendicularly over the wide side of the plurality of planks of 500mm-2000mm or 750mm-1750mm or the more preferred 1000mm-1500mm.

7. Floor deck (1) for a multi-storey building according to any of the preceding claims, wherein the floor deck comprises an intermediate layer placed between the surface layer and the second layer.

8. Floor deck (1) for a multi-storey building according to claim 1, wherein the second layer may comprise two or more individual layers.

9. Floor deck (1) for a multi-storey building according to any of the preceding claims, wherein the supporting layer is glued laminated wood.

10. Floor deck (1) for a multi-storey building according to any of the preceding claims, wherein the height of the supporting layer is 100mm-500mm or 125mm-400mm or 150mm-300 mm.

11. Floor deck (1) for a multi-storey building according to any of the preceding claims, wherein the supporting layer may comprise insulation.

12. Floor deck (1) for a multi-storey building according to any of the preceding claims, wherein the supporting layer comprises vibration dampening material such as a visco-elastic material or rubber at any points of contact with the walls or brackets supporting the supporting layer.

13. Floor deck (1) for a multi-storey building according to any of the preceding claims, wherein the surface layer may be made from gypsum.

14. Floor deck (1) for a multi-storey building according to any of the preceding claims, wherein the layers above the supporting layer of the floor deck are floating.

15. Use of the floor deck according to any of claims 1-14 for buildings having two or more storeys.

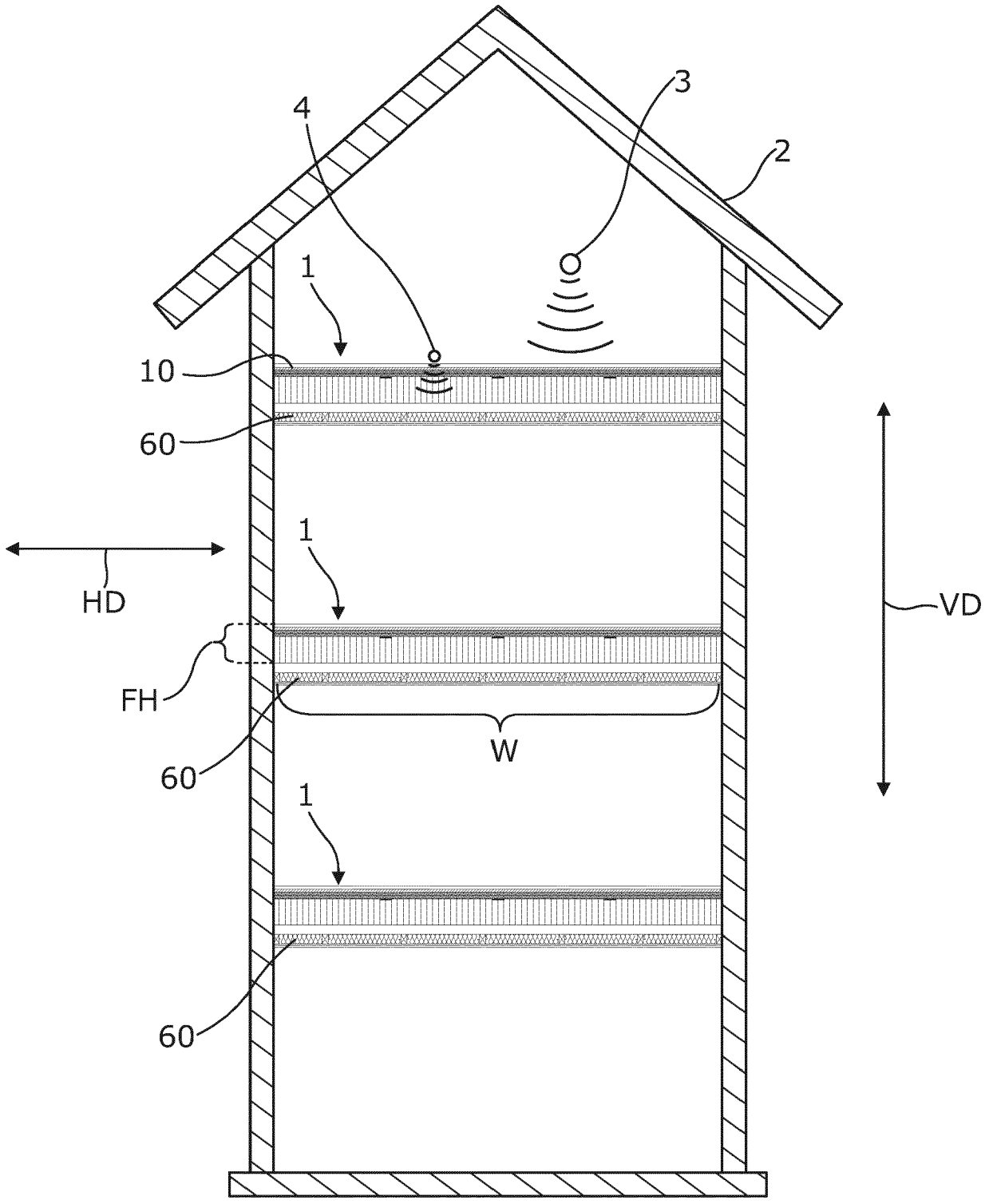

Fig. 1

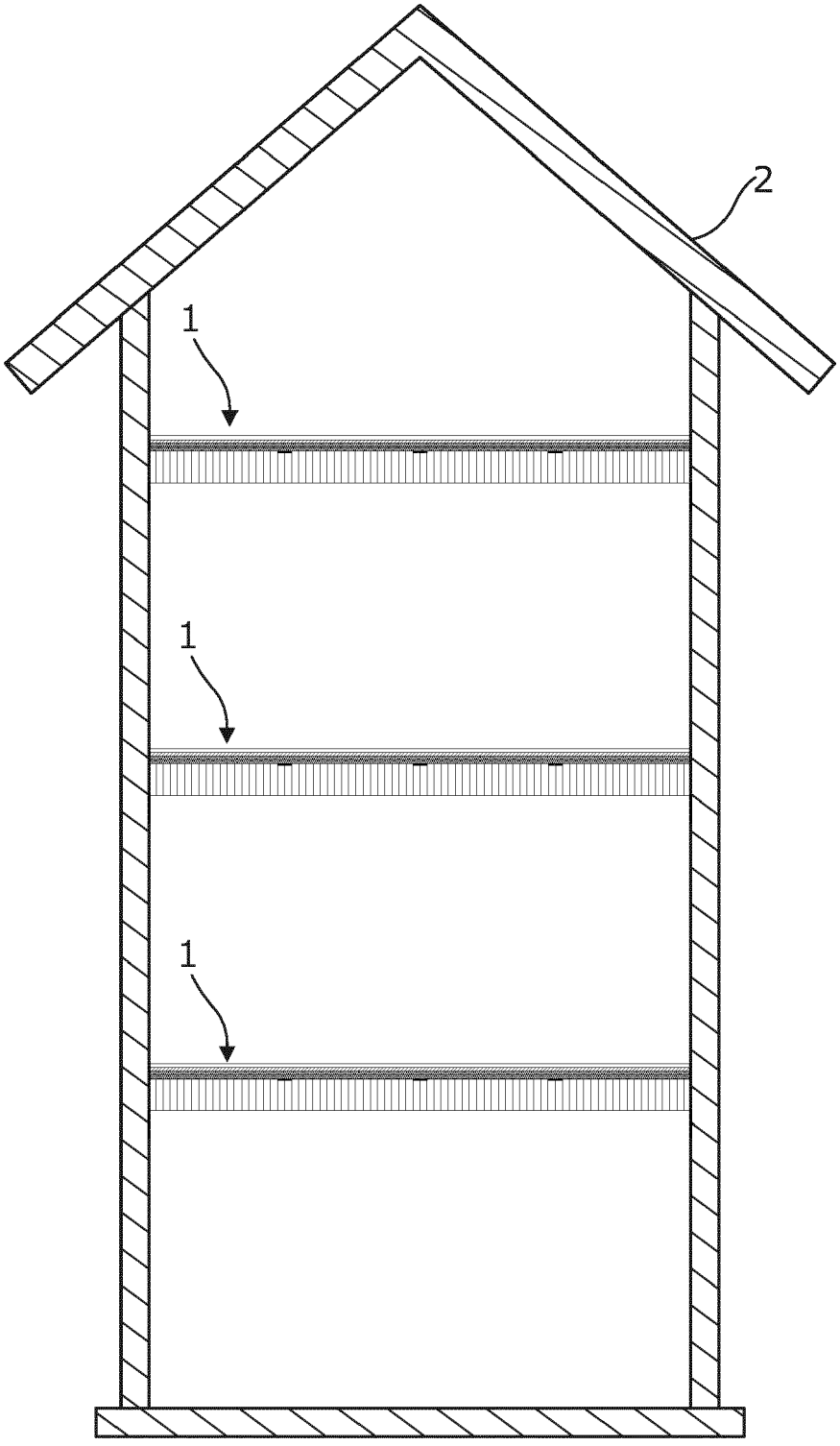

Fig. 2

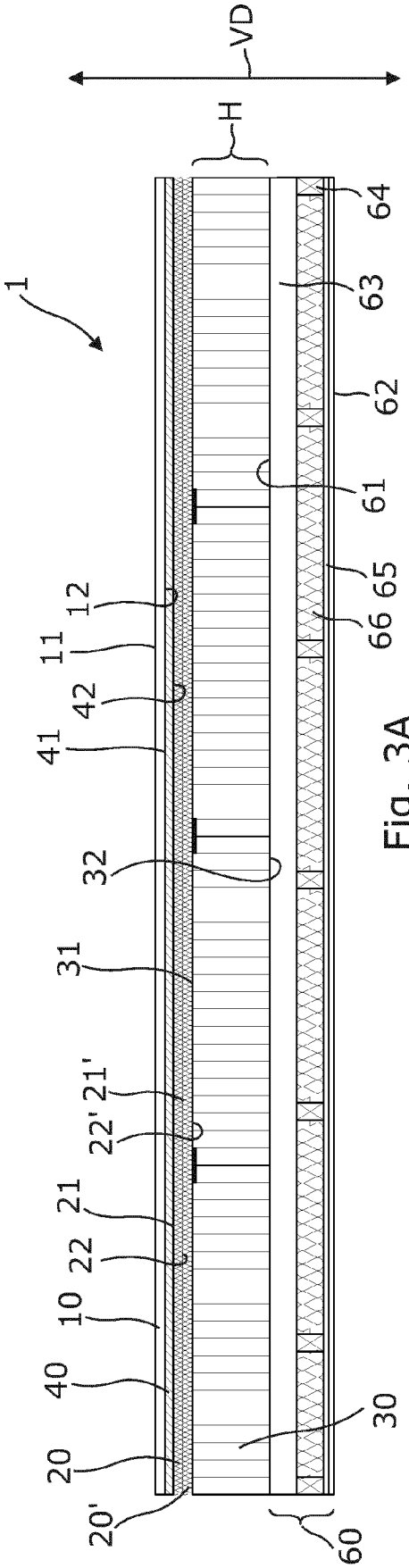
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Fig. 3A

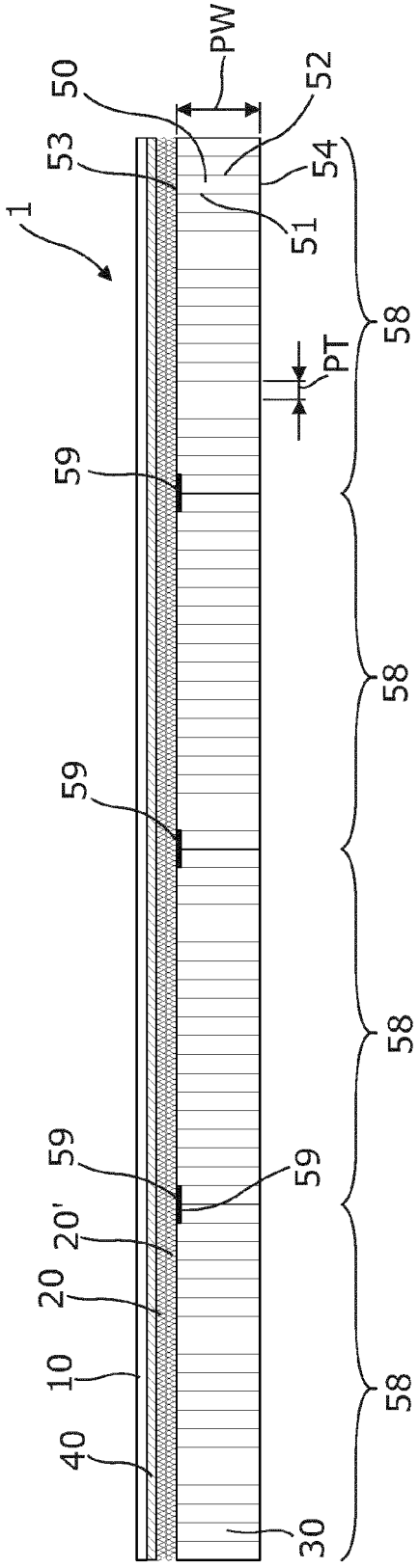
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Fig. 3B

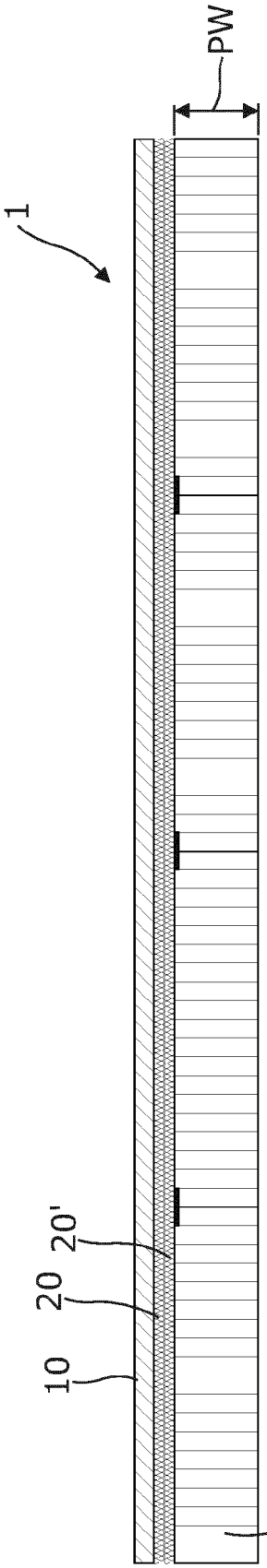

Fig. 3C

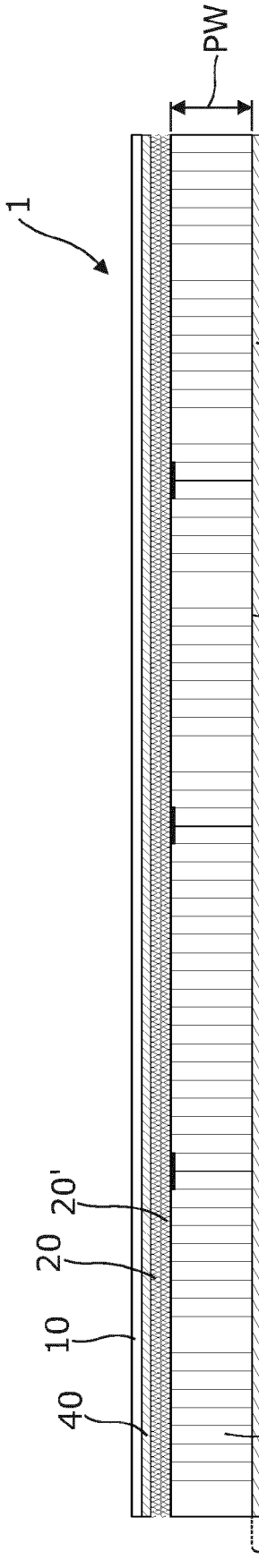

Fig. 3D

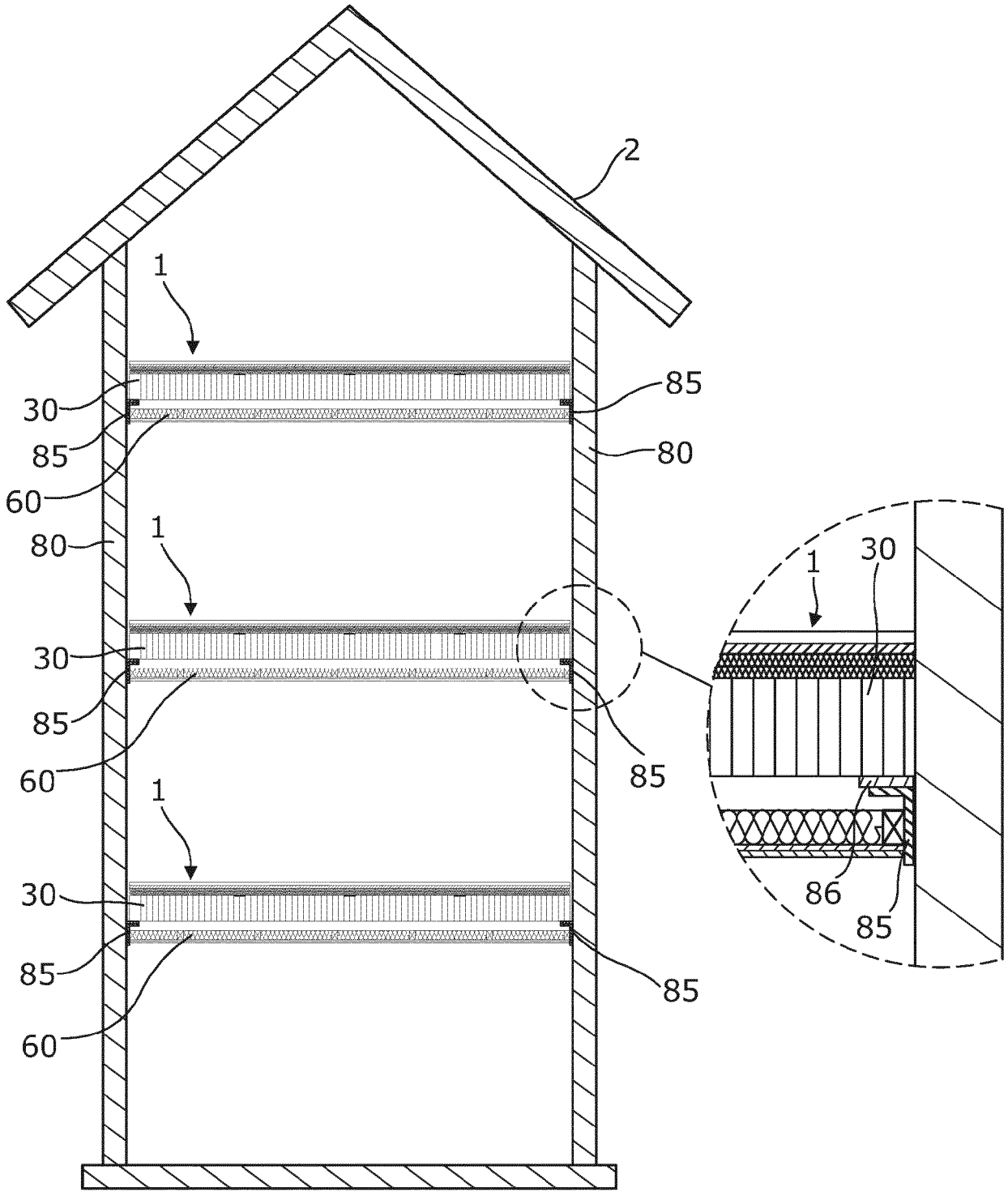

Fig. 4

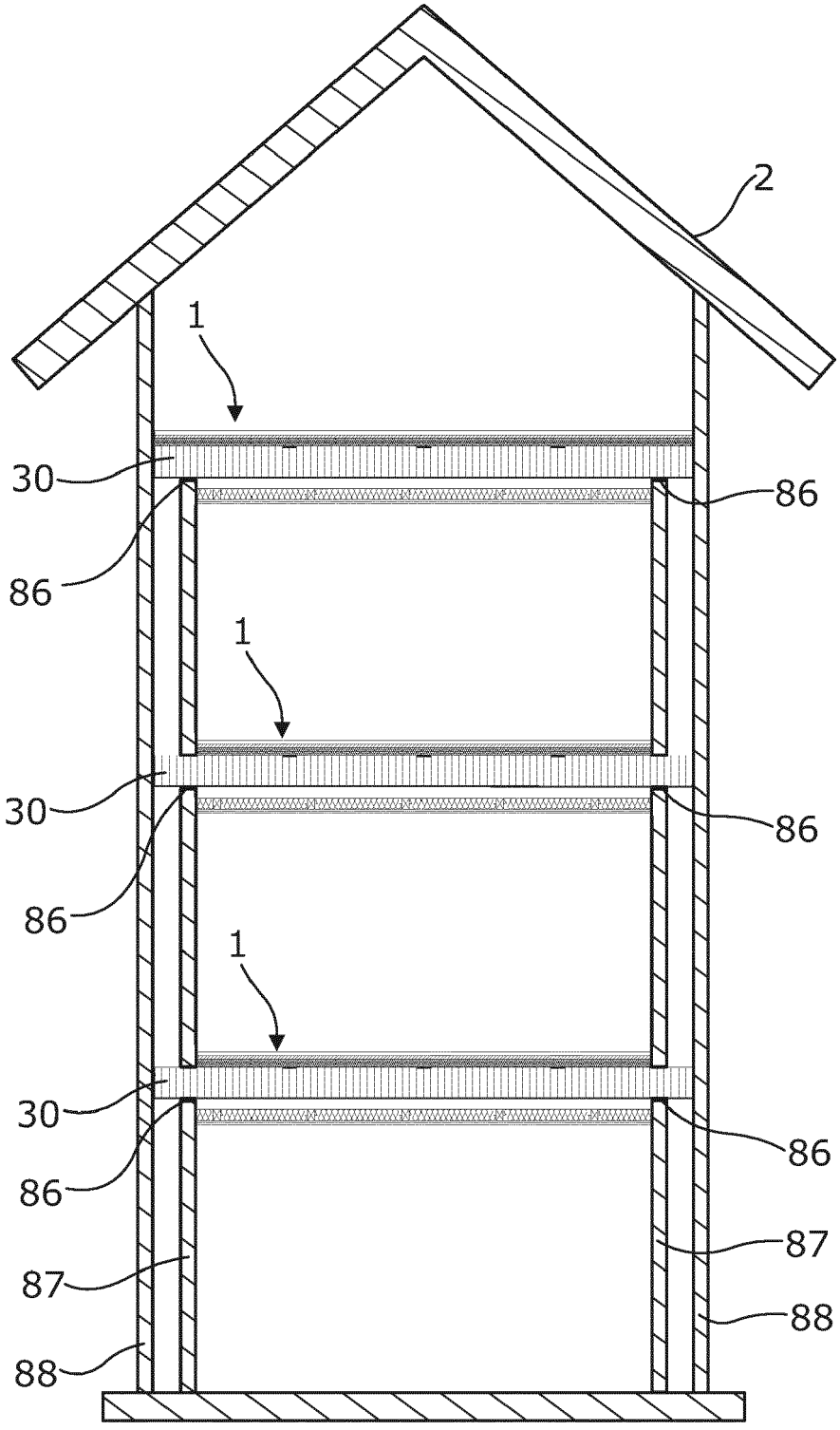

Fig. 5

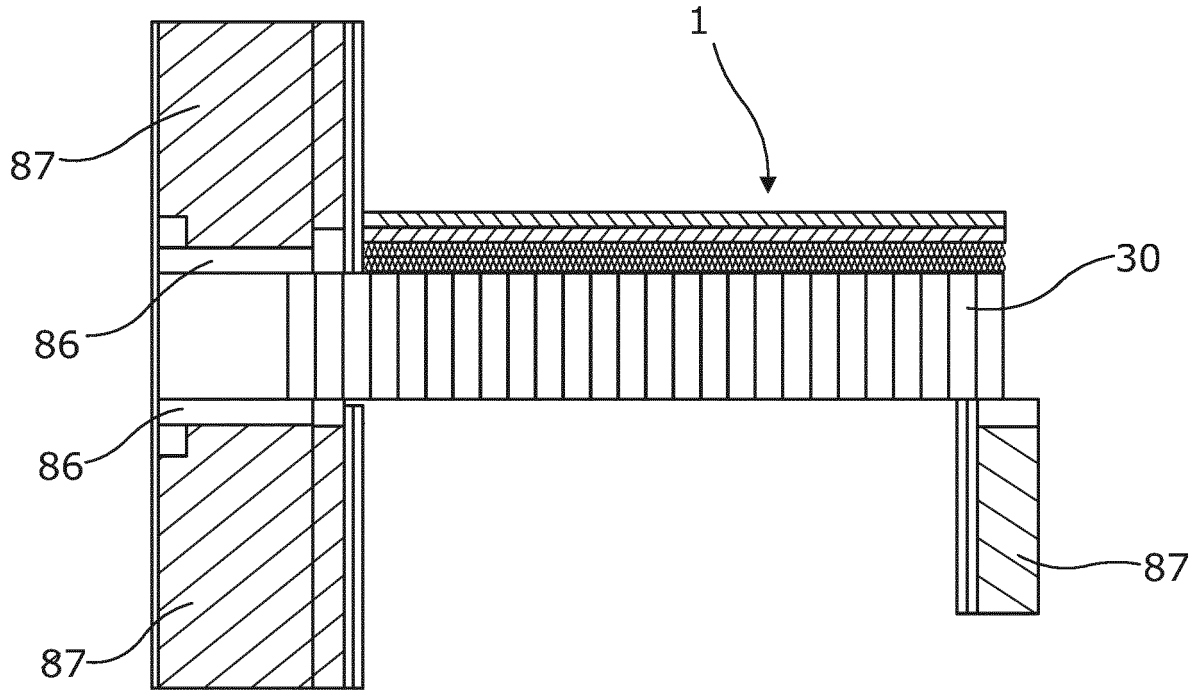

Fig. 6

Europäisches Patentamt
European Patent Office
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EUROPEAN SEARCH REPORT

Application Number
EP 20 18 0867

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 Y	US 6 032 434 A (GRAF DRAGICA [DE]) 7 March 2000 (2000-03-07) * figure 22 *	1-6,9, 10,13-15 7,8,11, 12	INV. E04B5/12 E04C2/24 E04B5/02
Y	DE 20 2015 106395 U1 (METSÄLIITTO OSUUSKUNTA [FI]) 2 February 2016 (2016-02-02) * figures 1, 2 *	7,8	
Y	DE 198 03 569 A1 (HDB WEISSINGER GMBH [DE]) 5 August 1999 (1999-08-05) * figure 2 *	12	
Y A	DE 200 17 574 U1 (WIEGAND THOMAS [DE]) 25 January 2001 (2001-01-25) * figure 6 *	11 7,8,13, 14	
A	US 2018/328019 A1 (COLLINS ARLAN [US] ET AL) 15 November 2018 (2018-11-15) * paragraph [0050]; figure 3 *	7,8,13, 14	TECHNICAL FIELDS SEARCHED (IPC) E04B E04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	2 December 2020	Bauer, Josef

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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L : document cited for other reasons

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