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(71) Applicant: **Yoshino Gypsum Co., Ltd.**
Tokyo 100-0005 (JP)

(72) Inventors:
• **YOKOO, Yuji**
Tokyo 101-0045 (JP)
• **HASEGAWA, Tomoya**
Tokyo 123-0872 (JP)
• **SUGAYA, Hiroyuki**
Tokyo 123-0872 (JP)
• **HAYASHI, Yukiteru**
Tokyo 123-0872 (JP)

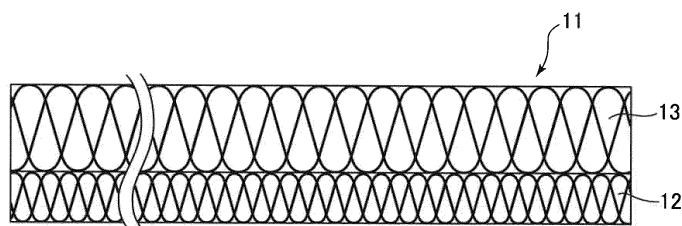
(74) Representative: **Zimmermann & Partner**
Patentanwälte mbB
Postfach 330 920
80069 München (DE)

(54) **HEAT-INSULATING SOUND-ABSORBING MATERIAL, AND PARTITION WALL**

(57) Provided are a heat-insulating and sound-absorbing material improved in construction workability, and a partition wall in which degradation in sound insulation performance is suppressed. The heat-insulating and sound-absorbing material 1 is comprised of an agglomerate of inorganic fibers, wherein the agglomerate has a density of 10 to 20 kg/m³ and the inorganic fibers of the agglomerate have a length-weighted average fiber

diameter of 2.0 to 8.7 μm, and wherein the agglomerate contains: 20 to 66% of inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm; and 13 to 58% of inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more. The partition wall comprises a hollow wall portion, and the above heat-insulating and sound-absorbing material installed in the hollow wall portion.

FIG.2



Description

TECHNICAL FIELD

5 **[0001]** The present invention relates to a heat-insulating and sound-absorbing material comprised of an agglomerate of inorganic fibers, and a partition wall comprising this heat-insulating and sound-absorbing material.

BACKGROUND ART

10 **[0002]** Heretofore, a heat-insulating and sound-absorbing material formed of an agglomerate of inorganic fibers such as glass wool is disposed inside a wall such as a partition wall, for the purpose of heat insulation and sound insulation. With regard to such a partition wall, for example, the below-mentioned Patent Document 1 discloses a structure in which two outer walls each comprised of a gypsum board are disposed, respectively, on both side of a central wall, and a heat-insulating and sound-absorbing material is disposed between the central wall and each of the outer walls.

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CITATION LIST

[Patent Document]

20 **[0003]** Patent Document 1: JP-A 2010-265645

SUMMARY OF INVENTION

[Technical Problem]

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[0004] Here, as the heat-insulating and sound-absorbing material, a glass wool having a density of 24 kg/m³ and a thickness of 50 mm is typically used. On the other hand, in recent years, labor shortage and aging of workers who construct such a partition wall have been progressing. Thus, the conventionally-used heat-insulating and sound-absorbing material having a relatively large weight imposes a heavy work burden on inexperienced or elderly workers. It is conceivable to reduce the density of the heat-insulating and sound-absorbing material to attain a reduction in weight, thereby improving construction workability. However, a technique of simply reducing the density causes deterioration in sound insulation performance.

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[0005] The present invention has been made in view of the above problem, and an object thereof is to provide a heat-insulating and sound-absorbing material capable of improving construction workability while suppressing deterioration in sound insulation performance, and a partition wall comprising this heat-insulating and sound-absorbing material.

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[Solution to Technical Problem]

[0006] When the density of the heat-insulating and sound-absorbing material is reduced, the weight of the heat-insulating and sound-absorbing material is reduced, and thus construction workability is improved. However, the reduction in the density of the heat-insulating and sound-absorbing material causes deterioration in sound insulation performance.

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[0007] Here, the deterioration in sound insulation performance due to the reduction in the density can be suppressed by reducing the fiber diameter of the inorganic fibers of the heat-insulating and sound-absorbing material. However, the reduction in the fiber diameter of the inorganic fibers of the heat-insulating and sound-absorbing material causes a reduction in the hardness of the heat-insulating and sound-absorbing material, resulting in deterioration in construction workability.

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[0008] Under the above circumstances, the inventors have found that it becomes possible to improve construction workability while suppressing deterioration in sound insulation performance, by improving the distribution of the fiber diameter of the inorganic fibers constituting the heat-insulating and sound-absorbing material.

50 **[0009]** According one aspect of the present invention, there is provided a heat-insulating and sound-absorbing material comprised of an agglomerate of inorganic fibers, wherein the agglomerate has a density of 10 to 20 kg/m³, and the inorganic fibers of the agglomerate have a length-weighted average fiber diameter of 2.0 to 8.7 μm, and wherein the agglomerate contains: 20 to 66% of inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm; and 13 to 58% of inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more. In this agglomerate, a sum of respective percents of the inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm, inorganic fibers having a length-weighted average fiber diameter of 4.0 μm to less than 7.0 μm, and the inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more is 100%. As used herein, the percent of the inorganic fibers having each length-weighted average fiber diameter means percent (%) by number of

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the inorganic fibers.

[0010] In the present invention having the above feature, the heat-insulating and sound-absorbing material is relatively lightweight, so that it is possible to improve construction workability. Further, the heat-insulating and sound-absorbing material has a construction-enabling hardness, so that it is possible to improve the construction workability and ensure sufficient sound insulation performance.

[0011] Preferably, in the heat-insulating and sound-absorbing material of the present invention, the agglomerate comprises a first layer and a second layer which are laminated together and is formed in a plate-like shape, wherein inorganic fibers of the first layer have a length-weighted average fiber diameter greater than that of inorganic fibers of the second layer by 0.1 to 3.0 μm .

[0012] According to this feature, the heat-insulating and sound-absorbing material has sufficient hardness, so that it is possible to improve the construction workability and improve the sound insulation performance.

[0013] Preferably, in the heat-insulating and sound-absorbing material of the present invention, the agglomerate comprises a first layer, a second layer and a third layer which are laminated together in this order and is formed in a plate-like shape, wherein inorganic fibers of the first layer and the third layer have a length-weighted average fiber diameter greater than that of inorganic fibers of the second layer by 0.1 to 3.0 μm .

[0014] According to this feature, the heat-insulating and sound-absorbing material has sufficient hardness, so that it is possible to improve the construction workability and improve the sound insulation performance.

[0015] Preferably, in the heat-insulating and sound-absorbing material of the present invention, the agglomerate comprises a plurality of layers which are laminated together and is formed in a plate-like shape, wherein inorganic fibers of an outermost one of the plurality of layers have a length-weighted average fiber diameter of 4.3 to 7.0 μm .

[0016] According to this feature, the heat-insulating and sound-absorbing material has sufficient hardness, so that it is possible to improve the construction workability and improve the sound insulation performance.

[0017] Preferably, in the heat-insulating and sound-absorbing material of the present invention, the inorganic fibers of the agglomerate have a length-weighted average fiber diameter of 3.8 to 5.3 μm .

[0018] According to this feature, it is possible to improve both the construction workability and the sound insulation performance.

[0019] Preferably, in the heat-insulating and sound-absorbing material of the present invention, the agglomerate contains the inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more, in an amount of 13 to 33%.

[0020] Preferably, in the heat-insulating and sound-absorbing material of the present invention, the agglomerate contains the inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm , in an amount of 41 to 66%.

[0021] According to these features, it is possible to more reliably satisfy both of high construction workability and high sound insulation performance.

[0022] Preferably, in the heat-insulating and sound-absorbing material of the present invention, the inorganic fibers are glass wool.

[0023] According to these features, it is possible to ensure the construction workability and cost reduction.

[0024] Preferably, in the heat-insulating and sound-absorbing material of the present invention, the agglomerate contains a binder for agglomerating the inorganic fibers, in an amount of 1.0 to 8.5% by weight, with respect to an overall weight of the agglomerate, wherein the binder has a binder strength of 3.6 to 6.1 N/mm^2 .

[0025] According to these features, the heat-insulating and sound-absorbing material can have sufficient rebound strength, and maintain the thickness thereof. Further, such a binder can be uniformly painted during production, and can facilitate installation thereof into a gap or the like. Further, it is possible to suppress skin irritation tactile sensation without providing a film or the like for suppressing skin irritation (tingling).

[0026] Any thermo-setting resin may be freely selected as a material to be used as a binder for agglomerating the inorganic fibers. For example, it may be selected from the group consisting of a phenol resin-based binder, a urea resin-based binder, a melamine resin-based binder, a resorcinol resin-based binder, an acrylic resin-based binder, a polyester resin-based binder, a sugar resin-binder, and a starch resin-based binder. Preferably, in the above heat-insulating and sound-absorbing material, the binder includes a thermo-setting resin curable by a reaction selected from the group consisting of amidation reaction, imidization reaction, esterification reaction and transesterification reaction.

[0027] According to another aspect of the present invention, there is provided a partition wall which comprises a hollow wall portion, and the above-mentioned heat-insulating and sound-absorbing material installed in the hollow wall portion.

[0028] In the partition wall of the present invention having this feature, the heat-insulating and sound-absorbing material is lightweight, so that it is possible to improve the construction workability. Further, the heat-insulating and sound-absorbing material has a construction-enabling hardness, so that it is possible to improve the construction workability and ensure sufficient sound insulation performance for the partition wall.

[0029] Preferably, the partition wall of the present invention comprises: a wall base comprising a lower runner disposed on a floor structure, an upper runner fixed to an upper story structure, and studs installed vertically between the lower runner and the upper runner, by a single-runner and staggered-stud construction method, a single-runner and common-stud construction method, a single-runner and common-stud construction method using a staggered backing pad ar-

rangement, a single-runner and staggered-stud construction method using a staggered backing pad arrangement, or a double-runner and parallel-stud construction method; and surface members installed on each of transversely opposite sides of the wall base to extend from the floor structure to the upper story structure.

[0030] According to this feature, the heat-insulating and sound-absorbing material can be easily disposed inside the partition wall.

[0031] Preferably, in the partition wall of the present invention, the surface member is comprised of a board of a noncombustible material or quasi-noncombustible material, or of a laminate comprising the board.

[0032] Preferably, in the partition wall of the present invention, the surface member is comprised of: a gypsum board such as a normal gypsum board, a fire-resistant gypsum board or a hard gypsum board; a fiber-reinforced gypsum board; or a laminate thereof.

[0033] Preferably, in the above partition walls, the surface member has a thickness of 20 mm or more.

[0034] According to these features, it is possible to give non-combustibility to the partition wall, in addition to heat insulation performance and sound insulation performance.

[Effect of Invention]

[0035] The present invention can provide a heat-insulating and sound-absorbing material improved in the construction workability without causing deterioration in the sound insulation performance, and a partition wall comprising the heat-insulating and sound-absorbing material.

BRIEF DESCRIPTION OF DRAWINGS

[0036]

FIG. 1 is a sectional view showing a heat-insulating and sound-absorbing material according to a first embodiment of the present invention.

FIG. 2 is a sectional view showing a heat-insulating and sound-absorbing material according to a second embodiment of the present invention.

FIG. 3 is a sectional view showing a heat-insulating and sound-absorbing material according to a third embodiment of the present invention.

FIG. 4 is a perspective view showing a partition wall according to a fourth embodiment of the present invention.

FIG. 5 is a horizontal sectional view showing the partition wall according to the fourth embodiment of the present invention.

FIG. 6 is a horizontal sectional view showing a partition wall according to a fifth embodiment of the present invention.

FIG. 7 is a horizontal sectional view showing a partition wall according to a sixth embodiment of the present invention.

FIG. 8 is a horizontal sectional view showing a partition wall according to a seventh embodiment of the present invention.

FIG. 9 is a horizontal sectional view showing a partition wall according to an eighth embodiment of the present invention.

FIG. 10 is a horizontal sectional view showing a partition wall according to a ninth embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

[0037] With reference to the drawings, various embodiments of a heat-insulating and sound-absorbing material and a partition wall of the present invention will now be described.

< First Embodiment >

[0038] FIG. 1 is a sectional view showing a heat-insulating and sound-absorbing material according to a first embodiment of the present invention. As shown in FIG. 1, the heat-insulating and sound-absorbing material 1 according to the first embodiment has a single-layer structure, wherein it is comprised of a plate-like agglomerate obtained by agglomerating inorganic fibers with a binder. When used for a partition wall, the thickness of the heat-insulating and sound-absorbing material 1 is preferably set in the range of 10 to 100 mm.

(Production Method for Heat-Insulating and Sound-Absorbing Material)

[0039] First of all, glass wool can be produced, for example, by melting or liquefying glass in a glass melting furnace, and extracting a given amount of the molten glass; and stretching the molten glass to obtain a fiber form, by means of

compressed air and heating by combustion of a gas-air mixture in a fiber forming apparatus. A fiber formation method may be exemplified by, but is not particularly limited to, a heretofore-known centrifugal method, a flame method, and a blowing method. Examples of a fiber forming apparatus using the centrifugal method include a spinner.

[0040] The heat-insulating and sound-absorbing material 1 can be produced by depositing glass wool as mat form. Specifically, a binder optionally containing an anti-dust agent and/or other additives is splayed to glass wool in a given amount, and after compressing a laminated body of the binder-containing glass wool by a laminate conveyor such that it has given weight per unit, placing the compressed body in an oven to cure the binder. Subsequently, the resulting body is subjected to slitting, trimming, cutting along a short-side direction of an intended product, etc., such that it is formed into a glass wool mat having a given size.

(Density of Heat-Insulating and Sound-Absorbing Material)

[0041] The agglomerate constituting the heat-insulating and sound-absorbing material 1 according to the first embodiment has a density of 10 to 20 kg/m³. The density of the agglomerate can be measured, for example, by a method according to JIS A9521.

[0042] If the density of the agglomerate is less than 10 kg/m³, sound insulation performance of the heat-insulating and sound-absorbing material becomes insufficient, and the heat-insulating and sound-absorbing material 1 becomes liable to bend or droop during construction, leading to difficulty in construction.

[0043] On the other hand, if the density of the agglomerate is greater than 20 kg/m³, the weight of the heat-insulating and sound-absorbing material 1 increases, and thus construction load in works of unloading and installation of the heat-insulating and sound-absorbing material 1 increases, leading to difficulty in performing such works by older or inexperienced workers. Further, construction weight per area increases, leading to deterioration in transport efficiency. Further, when cutting the heat-insulating and sound-absorbing material 1 into a given shape, the cutting itself becomes difficult. Further, a higher density of the agglomerate leads to a higher production cost.

[0044] By contrast, in the first embodiment, the density of the agglomerate is set in the range of 10 to 20 kg/m³, so that it is possible to ensure sufficient sound insulation performance, and allow the heat-insulating and sound-absorbing material 1 to have a construction-enabling rigidity and a relatively light weight, thereby improving construction workability. Further, the construction weight per area is relatively small, and the transport efficiency is improved. Further, the heat-insulating and sound-absorbing material 1 can be easily cut into a given shape, so that it is possible to reduce the production cost.

(Length-Weighted Fiber Diameter of Inorganic Fibers)

[0045] The inorganic fibers of the agglomerate constituting the heat-insulating and sound-absorbing material according to the first embodiment have a length-weighted average fiber diameter of 2.0 to 8.7 μm. In the first embodiment, the length-weighted average fiber diameter of the inorganic fibers was measured using cottonscopeHD manufactured by Cottonscope Pty Ltd, under the below-mentioned measurement conditions.

[0046] The length-weighted average fiber diameter denotes an average of 30,000 measurement values obtained by: magnifying inorganic fibers dispersed in water, using a microscope; taking an image of the magnified inorganic fibers by a camera; and importing the image into a computer to subject the image to image processing to measure respective diameters of the inorganic fibers. However, relatively short inorganic fibers, such as an inorganic fiber having a length 50 μm or less and an inorganic fiber having a length of three times or less the diameter thereof, are excluded from summing. Further, in order to perform summing in consideration of fiber length, with regard to a relatively long inorganic fiber having a length of greater than 50 μm, the length was automatically divided by the image processing, and respective diameters of the divided inorganic fibers were measured and summed.

TABLE 1

MEASUREMENT CONDITIONS	
Calibration Selection	
Use LWD	Yes
Width calculation	Arithmetic mean
Remove glass bundle	No
Diam slope	2.6355
Diam ofs	-2.8029

(continued)

MEASUREMENT CONDITIONS	
Calibration Selection	
Minimum width (μm)	0.00
Maximum width (μm)	65.00
Minimum fibre length (mm)	0.05
Minimum length-width ratio	3
Maximum Focus	10
Maximum density of sample	8
Minimum length confidence	0.9
Minimum span	2
Min width (μm) on graph	0.0
Max width (μm) on graph	30.0
Fibre limit	30000
Device name: cottonscopeHD, Manufacturer: Cottons cope Pty Ltd	

[0047] If the length-weighted average fiber diameter of the inorganic fibers is less than 2.0 μm , the rigidity of the heat-insulating and sound-absorbing material 1 becomes low, and thus becomes liable to bend or droop during construction, leading to difficulty in construction. On the other hand, if the length-weighted average fiber diameter of the inorganic fibers is greater than 8.7 μm , voids in the heat-insulating and sound-absorbing material become excessively large, leading to deterioration in the sound insulation performance. By contrast, in the first embodiment, the length-weighted average fiber diameter of the inorganic fibers of the agglomerate is set in the range of 2.0 to 8.7 μm , so that it is possible to allow the heat-insulating and sound-absorbing material 1 to have a higher rigidity (hardness), thereby improving the construction workability, and ensuring sufficient sound insulation performance.

[0048] Preferably, the inorganic fibers of the agglomerate constituting the heat-insulating and sound-absorbing material according to the first embodiment have a length-weighted average fiber diameter of 3.8 to 5.3 μm . Further, the fiber length is preferably 20 mm to 200 mm. As the fiber length becomes longer, the rigidity is likely to become higher. This makes it possible to allow the heat-insulating and sound-absorbing material 1 to maintain sufficient rigidity, thereby improving both the construction workability and the sound insulation performance.

(Length-Weighted Fiber Diameter Distribution of Inorganic Fibers)

[0049] The agglomerate constituting the heat-insulating and sound-absorbing material according to the first embodiment contains: 20 to 66% of inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm ; and 13 to 58% of inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more. Here, the sum of respective percents of the inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm , inorganic fibers having a length-weighted average fiber diameter of 4.0 μm to less than 7.0 μm , and the inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more is 100%. As used herein, the percent of the inorganic fibers having each length-weighted average fiber diameter means percent (%) by number of the inorganic fibers. In the first embodiment, the length-weighted average fiber diameter of the inorganic fibers was measured using cottonscopeHD manufactured by Cottonscope Pty Ltd, under the measurement conditions in Table 1. The length-weighted fiber diameter distribution was created as a histogram, using the measurement values of the length-weighted average fiber diameter, and each of the percent of the inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm and the percent of the inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more was calculated.

[0050] If the inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more is contained in the agglomerate in an amount of less than 13%, or if the inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm is contained in the agglomerate in an amount of greater than 66%, the rigidity of the heat-insulating and sound-absorbing material becomes excessively low, and the hardness of the heat-insulating and sound-absorbing material becomes insufficient, leading to deterioration in the construction workability. On the other hand, if the inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more is contained in the agglomerate in an amount

of greater than 58%, or if the inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm is contained in the agglomerate in an amount of less than 20%, voids in the heat-insulating and sound-absorbing material become excessively large, leading to deterioration in the sound insulation performance. By contrast, in the first embodiment, the agglomerate constituting the heat-insulating and sound-absorbing material contains 20 to 66% of inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm ; and 13 to 58% of inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more, so that it is possible to allow the heat-insulating and sound-absorbing material to have sufficient hardness for construction, thereby improving the construction workability and ensuring sufficient sound insulation performance

[0051] Preferably, the agglomerate contains the inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more, in an amount of 13 to 33%. This makes it possible to more reliably satisfy both of high construction workability and high sound insulation performance.

[0052] Preferably, the agglomerate contains the inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm , in an amount of 41 to 66%. This makes it possible to more reliably satisfy both of high construction workability and high sound insulation performance.

(Inorganic fibers)

[0053] As the inorganic fibers, it is possible to use any fibrous element comprised of an inorganic material such as glass wool, rock wool or slag wool. Among them, glass wool is preferable, in view of the construction workability, cost, etc.

(Binder)

[0054] As a material to be used as a binder for agglomerating the inorganic fibers, it is possible to freely select any thermo-setting resin. For example, it may be selected from the group consisting of a phenol resin-based binder, a urea resin-based binder, a melamine resin-based binder, a resorcinol resin-based binder, an acrylic resin-based binder, a polyester resin-based binder, a sugar resin-binder, and a starch resin-based binder. Preferably, the binder includes a thermo-setting resin curable by a reaction selected from the group consisting of amidation reaction, imidization reaction, esterification reaction and transesterification reaction.

[0055] Preferably, the percent by weight of the binder (resin content rate) of the agglomerate constituting the heat-insulating and sound-absorbing material is 1.0 to 8.5% by weight, with respect to the overall weight of the agglomerate. Here, the resin content rate can be obtained by conducting a process comprising: a step (1) of cutting a glass wool mat into a size of 100 mm $\times$ 100 mm to prepare a test piece, and measuring the weight (W_a) of this test piece; a step (2) of introducing the test piece into an electric furnace set at 530°C to decompose a binder component; a step (3) of extracting, from the electric furnace, the test piece after being subjected to the decomposition of the binder component, and measuring the weight (W_b) of this test piece to derive the resin content rate from a difference with the measurement value (W_a) in the step (1), using the following formula.

$$\text{Resin content rate (\% by weight)} = \{(W_a - W_b) / W_a\} \times 100$$

[0056] If the resin content of the agglomerate constituting the heat-insulating and sound-absorbing material is less than 1.0% by weight the rebound strength (resilience) of the heat-insulating and sound-absorbing material becomes excessively low, thereby making it impossible to maintain the thickness of the heat-insulating and sound-absorbing material. Further, if the resin content is less than 1.0% by weight it becomes unable to uniformly paint the binder during production.

[0057] On the other hand, if the resin content of the agglomerate constituting the heat-insulating and sound-absorbing material is greater than 8.5% by weight, the heat-insulating and sound-absorbing material becomes excessively hard, leading to difficulty in installation into a gap or the like. Further, if the resin content is greater than 8.5% by weight, the cost of the heat-insulating and sound-absorbing material increases.

[0058] By contrast, in the first embodiment, the percent by weight of the binder (resin content rate) of the agglomerate constituting the heat-insulating and sound-absorbing material is preferably set in the range of 1.0 to 8.5% by weight, so that it is possible to allow the heat-insulating and sound-absorbing material to have sufficient rebound strength, and maintain the thickness thereof. Further, it is possible to uniformly paint the binder during production, and facilitate installation into a gap or the like.

[0059] Further, the binder preferably has a binder strength of 3.6 to 6.1 N/mm². Here, the binder strength can be measured by a shell mold tensile strength measurement method comprising: a step (1) of introducing and mixing 2.7% by weight of binder into and with 150g of glass beads to obtain a mixture; a step (2) of uniformly packing the mixture

obtained in the step (1) in an iron mold, and heating the mold in an oven to cure the binder, and obtain a shell mold test piece (6 mm thickness $\times$ 27 mm width $\times$ 74 mm length, where the width of a clip portion: 42 mm); a step (3) of extracting the shell mold test piece obtained in the step (2) from the oven and cooling the extracted shell mold test piece to room temperature; and a step (4) of measuring the tensile strength of the cooled shell mold test piece at a tension rate of 5 mm/min, using a universal material testing machine.

[0060] If the binder strength of the heat-insulating and sound-absorbing material is less than 3.6 N/mm², it is necessary to increase the content of the resin for agglomerating glass wool fibers. On the other hand, if the binder strength of the heat-insulating and sound-absorbing material is greater than 6.1 N/mm², skin irritation tactile sensation of the inorganic fibers excessively increases. By contrast, in the first embodiment, the binder strength of the binder is preferably set in the range of 3.6 to 6.1 N/mm², so that it is possible to suppress the skin irritation tactile sensation without providing a film or the like for suppressing skin irritation (tingling). It should be noted here that the present invention is not limited to being implemented without any film, but a film may be attached to the heat-insulating and sound-absorbing material or provided to cover the heat-insulating and sound-absorbing material, so as to further improve the construction workability, or further suppress the skin irritation, and give a function of an anti-moisture performance. Such a film may be attached to one or each of opposite surfaces of the heat-insulating and sound-absorbing material, or may be provided to cover four surfaces or all of six surfaces of the heat-insulating and sound-absorbing material. The film may be attached to the heat-insulating and sound-absorbing material using an adhesive, or two or more films may be press-bonded or adhesively bonded together to cover the heat-insulating and sound-absorbing material. In the case where a film is attached to the heat-insulating and sound-absorbing material or provided to cover the heat-insulating and sound-absorbing material, the film may be optionally provided with one or more openings, thereby controlling the sound insulation performance, sound absorption performance and moisture permeation performance.

< Second Embodiment >

[0061] FIG. 2 is a sectional view showing a heat-insulating and sound-absorbing material according to a second embodiment of the present invention. As shown in FIG. 2, the heat-insulating and sound-absorbing material 11 according to the second embodiment has a two-layer structure, wherein it is comprised of a plate-like agglomerate obtained by agglomerating inorganic fibers with a binder. The agglomerate constituting the heat-insulating and sound-absorbing material 11 comprises a first layer 12 and a second layer 13. The first layer 12 is a layer which is formed in first when making up the heat-insulating and sound-absorbing material 11, and the second layer 13 is a layer which is formed on the first layer 12. When used for a partition wall, the thickness of the heat-insulating and sound-absorbing material 11 is preferably set in the range of 10 to 100 mm, wherein the thickness percent of the first layer 12 is preferably 25 to 75%.

(Production Method for Heat-Insulating and Sound-Absorbing Material)

[0062] First of all, glass wool can be produced, for example, by: melting or liquefying glass in a glass melting furnace; extracting a given amount of the molten glass; and stretching the molten glass to obtain a fiber form, by means of compressed air and heating by combustion of a gas-air mixture in a fiber forming apparatus. A fiber formation method may be exemplified by, but is not particularly limited to, heretofore-known methods such as a centrifugal method, a flame method, and a blowing method. Examples of a fiber forming apparatus using the centrifugal method include a spinner.

[0063] The heat-insulating and sound-absorbing material 11 can be produced by depositing glass wool to form a mat-like body. Specifically, a binder optionally containing an anti-dust agent and/or other additives is splayed to glass wool in a given amount. Then, on a laminate conveyer, a first layer 12 is formed by collecting the binder-containing glass wool such that it has given weight per unit area, and further a second layer 13 is formed on the first layer 12 by collecting the binder-containing glass wool such that it has given weight per unit area. Then, the resulting laminate of the first and second layers 12, 13 is placed in an oven to cure the binder. Subsequently, slitting, trimming, cutting along a short-side direction of an intended product, etc. are carried out, such that it is formed into a glass wool mat having a given size.

(Density of Heat-Insulating and Sound-Absorbing Material)

[0064] The agglomerate constituting the heat-insulating and sound-absorbing material 11 according to the second embodiment has a density of 10 to 20 kg/m³. As used herein, the density of the agglomerate constituting the heat-insulating and sound-absorbing material 11 means the density of the entire agglomerate comprising the first layer 12 and the second layer 13. In the second embodiment, the density of the agglomerate constituting the heat-insulating and sound-absorbing material 11 is also set in the range of 10 to 20 kg/m³, so that it is possible to bring out similar advantageous effects to those in the first embodiment. In the second embodiment, the first layer 12 and the second layer 13 preferably have the same density.

(Length-Weighted Fiber Diameter of Inorganic Fibers)

[0065] The inorganic fibers of the agglomerate constituting the heat-insulating and sound-absorbing material 11 according to the second embodiment have a length-weighted average fiber diameter of 2.0 to 8.7 μm . Preferably, the length-weighted average fiber diameter of the inorganic fibers of the agglomerate constituting the heat-insulating and sound-absorbing material 11 according to the second embodiment is 3.8 to 5.3 μm . As used herein, the length-weighted average fiber diameter of the inorganic fibers of the agglomerate constituting the heat-insulating and sound-absorbing material 11 means the length-weighted average fiber diameter of the inorganic fibers of the entire agglomerate comprising the first layer 12 and the second layer 13. In the second embodiment, the length-weighted average fiber diameter of the inorganic fibers is also 2.0 to 8.7 μm , preferably 3.8 to 5.3 μm , as mentioned above. Further, the fiber length is preferably 20 mm to 200 mm. As the fiber length becomes longer, the rigidity is likely to become higher. These make it possible to bring out similar advantageous effects to those in the first embodiment.

[0066] In the second embodiment, inorganic fibers of the first layer 12 have a length-weighted average fiber diameter greater than that of inorganic fibers of the second layer 13 by 0.1 to 3.0 μm . If a difference between the length-weighted average fiber diameter of the inorganic fibers of the first layer 12 and the length-weighted average fiber diameter of the inorganic fibers of the second layer 13 is less than 0.1 μm , it is unable to obtain sufficient hardness, leading to difficulty in improving the construction workability. On the other hand, if the difference between the length-weighted average fiber diameter of the inorganic fibers of the first layer 12 and the length-weighted average fiber diameter of the inorganic fibers of the second layer 13 is greater than 3.0 μm , the sound insulation performance deteriorates. By contrast, in the second embodiment, the length-weighted average fiber diameter of the inorganic fibers of the first layer 12 is greater by 0.1 to 3.0 μm than the length-weighted average fiber diameter of the inorganic fibers of the second layer 13, so that it is possible to obtain sufficient hardness, and thus improve the construction workability and the sound insulation performance.

[0067] Further, in the second embodiment, the inorganic fibers of the first layer 12 which is an outermost one of the first and second layers 12, 13 (in a two-layer structure as in the second embodiment, the outermost layer means a layer which is initially formed in direct contact with a production line when producing the heat-insulating and sound-absorbing material 11) have a length-weighted average fiber diameter of 4.3 to 7.0 μm . If the length-weighted average fiber diameter of the first layer 12 is less than 4.3 μm , it is unable to obtain sufficient hardness, leading to difficulty in improving the construction workability. On the other hand, if the length-weighted average fiber diameter of the first layer 12 is greater than 7.0 μm , the sound insulation performance deteriorates, although the hardness can be improved. By contrast, in the second embodiment, the length-weighted average fiber diameter of the inorganic fibers of the first layer 12 is set in the range of 4.3 to 7.0 μm , so that it is possible to obtain sufficient hardness, and thus improve the construction workability and the sound insulation performance.

(Length-Weighted Fiber Diameter Distribution of Inorganic Fibers)

[0068] The agglomerate constituting the heat-insulating and sound-absorbing material 11 according to the second embodiment contains: 20 to 66% of inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm ; and 13 to 58% of inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more. The agglomerate preferably contains the inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more, in an amount of 13 to 33%. Further, the agglomerate preferably contains the inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm , in an amount of 41 to 66%. As used herein, the length-weighted fiber diameter distribution of the heat-insulating and sound-absorbing material 11 means the length-weighted fiber diameter distribution of the entire agglomerate comprising the first layer 12 and the second layer 13. Further, the sum of respective percents of the inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm , inorganic fibers having a length-weighted average fiber diameter of 4.0 μm to less than 7.0 μm , and the inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more is 100%. Further, as used herein, the percent of the inorganic fibers having each length-weighted average fiber diameter means percent (%) by number of the inorganic fibers, as with the first embodiment. In the second embodiment, the inorganic fibers have the above fiber diameter distribution, so that it is possible to bring out similar advantageous effects to those in the first embodiment.

(Inorganic fibers)

[0069] As the inorganic fibers, it is possible to use any fibrous element comprised of an inorganic material such as glass wool, rock wool or slag wool. Among them, glass wool is preferable, in view of the construction workability, cost, etc.

(Binder)

[0070] As a material to be used as a binder for agglomerating the inorganic fibers, it is possible to freely select any

thermo-setting resin. For example, it may be selected from the group consisting of a phenol resin-based binder, a urea resin-based binder, a melamine resin-based binder, a resorcinol resin-based binder, an acrylic resin-based binder, a polyester resin-based binder, a sugar resin-binder, and a starch resin-based binder. Preferably, the binder includes a thermo-setting resin curable by a reaction selected from the group consisting of amidation reaction, imidization reaction, esterification reaction and transesterification reaction.

[0071] Preferably, the percent by weight of the binder (resin content rate) of the agglomerate constituting the heat-insulating and sound-absorbing material 11 is 1.0 to 8.5% by weight, with respect to the overall weight of the agglomerate. As used herein, the percent by weight of the binder of the agglomerate constituting the heat-insulating and sound-absorbing material 11 means the percent by weight of the binder of the entire agglomerate comprising the first layer 12 and the second layer 13. In the second embodiment, the percent by weight of the binder (resin content rate) is preferably set in the range of 1.0 to 8.5% by weight, so that it is possible to bring out similar advantageous effects to those in the first embodiment. The percent by weight of the binder in each of the first and second layers may be adjusted independently within the above range to adjust the hardness thereof.

[0072] Preferably, in the second embodiment, the binder also has a binder strength of 3.6 to 6.1 N/mm². In the second embodiment, the binder strength of the binder is preferably set in the range of 3.6 to 6.1 N/mm², so that it is possible to bring out similar advantageous effects to those in the first embodiment.

< Third Embodiment >

[0073] FIG. 3 is a sectional view showing a heat-insulating and sound-absorbing material according to a third embodiment of the present invention. As shown in FIG. 3, the heat-insulating and sound-absorbing material 21 according to the third embodiment has a three-layer structure, wherein it is comprised of a plate-like agglomerate obtained by agglomerating inorganic fibers with a binder. The agglomerate constituting the heat-insulating and sound-absorbing material 21 comprises a first layer 22, a second layer 23 and a third layer 24. The first layer 22 is a layer which is formed in first when making up the heat-insulating and sound-absorbing material 21. The second layer 23 is a layer which is formed on the first layer 22, and the third layer 24 is a layer which is formed on the second layer 23. When used for a partition wall, the thickness of the heat-insulating and sound-absorbing material 21 is preferably set in the range of 10 to 100 mm, wherein the thickness percents of the first layer 22, the second layer 23 and the third layer 24 are preferably 8 to 35%, 30 to 84%, and 8 to 35%, respectively. Here, the sum of respective thickness percents of the first to third layers 22, 23, 24 is 100%.

(Production Method for Heat-Insulating and Sound-Absorbing Material)

[0074] First of all, glass wool can be produced, for example, by: melting or liquefying glass in a glass melting furnace; extracting a given amount of the molten glass; and stretching the molten glass to obtain a fiber form, by means of compressed air and heating by combustion of a gas-air mixture in a fiber forming apparatus. A fiber formation method may be exemplified by, but is not particularly limited to, heretofore-known methods such as a centrifugal method, a flame method, and a blowing method. Examples of a fiber forming apparatus using the centrifugal method include a spinner.

[0075] The heat-insulating and sound-absorbing material 21 can be produced by depositing glass wool to form a mat-like body. Specifically, a binder optionally containing an anti-dust agent and/or other additives is splayed to glass wool in a given amount. Then, on a laminate conveyer, a first layer 22 is formed by collecting the binder-containing glass wool such that it has given weight per unit area, and then after forming a second layer 23 on the first layer 22 by collecting the binder-containing glass wool such that it has given weight per unit area, a third layer 24 is formed on the second layer 23 by collecting the binder-containing glass wool such that it has given weight per unit area. Then, the resulting laminate of the first, second and third layers 22, 23, 24 is placed in an oven to cure the binder. Subsequently, the resulting body is subjected to slitting, trimming, cutting along a short-side direction of an intended product, etc., such that it is formed into a glass wool mat having a given size.

(Density of Heat-Insulating and Sound-Absorbing Material)

[0076] The agglomerate constituting the heat-insulating and sound-absorbing material 21 according to the third embodiment has a density of 10 to 20 kg/m³. As used herein, the density of the agglomerate constituting the heat-insulating and sound-absorbing material 21 means the density of the entire agglomerate comprising the first layer 22, the second layer 23 and the third layer 24. In the third embodiment, the density of the agglomerate constituting the heat-insulating and sound-absorbing material 21 is also set in the range of 10 to 20 kg/m³, so that it is possible to bring out similar advantageous effects to those in the first and second embodiments. In the third embodiment, it is preferable that the first layer 22 and the third layer 23 have the same density, and it is more preferable that the first layer 22, the second layer 23 and the third layer 24 have the same density.

(Length-Weighted Fiber Diameter of Inorganic Fibers)

[0077] The inorganic fibers of the agglomerate constituting the heat-insulating and sound-absorbing material 21 according to the third embodiment have a length-weighted average fiber diameter of 2.0 to 8.7 μm . Preferably, the length-weighted average fiber diameter of the inorganic fibers of the agglomerate constituting the heat-insulating and sound-absorbing material 21 according to the third embodiment is 3.8 to 5.3 μm . As used herein, the length-weighted average fiber diameter of the inorganic fibers of the agglomerate constituting the heat-insulating and sound-absorbing material 21 means the length-weighted average fiber diameter of the inorganic fibers of the entire agglomerate comprising the first layer 22, the second layer 23 and the third layer 24. In the third embodiment, the length-weighted average fiber diameter of the inorganic fibers is also 2.0 to 8.7 μm , preferably 3.8 to 5.3 μm , as mentioned above. Further, the fiber length is preferably 20 mm to 200 mm. As the fiber length becomes longer, the rigidity is likely to become higher. These make it possible to bring out similar advantageous effects to those in the first and second embodiments.

[0078] In the third embodiment, inorganic fibers of the first layer 22 and the third layer 24 have a length-weighted average fiber diameter greater than that of inorganic fibers of the second layer 23 by 0.1 to 3.0 μm . If a difference between the length-weighted average fiber diameter of the inorganic fibers of the first and third layers 22, 24 and the length-weighted average fiber diameter of the inorganic fibers of the second layer 23 is less than 0.1 μm , it is unable to obtain sufficient hardness, leading to difficulty in improving the construction workability. On the other hand, if the difference between the length-weighted average fiber diameter of the inorganic fibers of the first and third layers 22, 24 and the length-weighted average fiber diameter of the inorganic fibers of the second layer 23 is greater than 3.0 μm , the sound insulation performance deteriorates. By contrast, in the third embodiment, the length-weighted average fiber diameter of the inorganic fibers of the first and third layers 22, 24 is greater by 0.1 to 3.0 μm than the length-weighted average fiber diameter of the inorganic fibers of the second layer 23, so that it is possible to allow the heat-insulating and sound-absorbing material 21 to have sufficient hardness, thereby improving the construction workability and the sound insulation performance.

[0079] Further, in the third embodiment, the inorganic fibers of the first and third layers 22, 24 each of which is an outermost layer among the first to third layers 22, 23, 24 have a length-weighted average fiber diameter of 4.3 to 7.0 μm . If the length-weighted average fiber diameter of the inorganic fibers of the first and third layers 22, 24 is less than 4.3 μm , it is unable to obtain sufficient hardness, leading to difficulty in improving the construction workability. On the other hand, if the length-weighted average fiber diameter of the inorganic fibers of the first and third layers 22, 24 is greater than 7.0 μm , the sound insulation performance deteriorates, although the hardness can be improved. By contrast, in the third embodiment, the length-weighted average fiber diameter of the inorganic fibers of the first and third layers 22, 24 is set in the range of 4.3 to 7.0 μm , so that it is possible to obtain sufficient hardness, and thus improve the construction workability and the sound insulation performance.

(Length-Weighted Fiber Diameter Distribution of Inorganic Fibers)

[0080] The agglomerate constituting the heat-insulating and sound-absorbing material 21 according to the third embodiment contains: 20 to 66% of inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm ; and 13 to 58% of inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more. Here, the sum of respective percents of the inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm , inorganic fibers having a length-weighted average fiber diameter of 4.0 μm to less than 7.0 μm , and the inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more is 100%. The agglomerate preferably contains the inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more, in an amount of 13 to 33%. Further, the agglomerate preferably contains the inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm , in an amount of 41 to 66%. As used herein, the length-weighted fiber diameter distribution of the heat-insulating and sound-absorbing material 21 means the length-weighted fiber diameter distribution of the entire agglomerate comprising the first layer 22, the second layer 23 and the third layer 24. Further, as used herein, the percent of the inorganic fibers having each length-weighted average fiber diameter means percent (%) by number of the inorganic fibers, as with the first embodiment. In the third embodiment, the inorganic fibers have the above fiber diameter distribution, so that it is possible to bring out similar advantageous effects to those in the first and second embodiments.

(Inorganic fibers)

[0081] As the inorganic fibers, it is possible to use any fibrous element comprised of an inorganic material such as glass wool, rock wool or slag wool. Among them, glass wool is preferable, in view of the construction workability, cost, etc.

(Binder)

[0082] As a material to be used as a binder for agglomerating the inorganic fibers, it is possible to freely select any thermo-setting resin. For example, it may be selected from the group consisting of a phenol resin-based binder, a urea resin-based binder, a melamine resin-based binder, a resorcinol resin-based binder, an acrylic resin-based binder, a polyester resin-based binder, a sugar resin-binder, and a starch resin-based binder. Preferably, the binder includes a thermo-setting resin curable by a reaction selected from the group consisting of amidation reaction, imidization reaction, esterification reaction and transesterification reaction.

[0083] Preferably, the percent by weight of the binder (resin content rate) of the agglomerate constituting the heat-insulating and sound-absorbing material 21 is 1.0 to 8.5% by weight, with respect to the overall weight of the agglomerate. As used herein, the percent by weight of the binder of the agglomerate constituting the heat-insulating and sound-absorbing material 21 means the percent by weight of the binder of the entire agglomerate comprising the first layer 22, the second layer 23 and the third layer 24. In the third embodiment, the percent by weight of the binder (resin content rate) is preferably set in the range of 1.0 to 8.5% by weight, so that it is possible to bring out similar advantageous effects to those in the first and second embodiments. The percent by weight of the binder in each of the first to third layers may be adjusted independently within the above range to adjust the hardness thereof.

[0084] Preferably, in the third embodiment, the binder also has a binder strength of 3.6 to 6.1 N/mm². In the third embodiment, the binder strength of the binder is preferably set in the range of 3.6 to 6.1 N/mm², so that it is possible to bring out similar advantageous effects to those in the first and second embodiments.

< Fourth Embodiment >

[0085] A partition wall according to a fourth embodiment of the present invention will be described below. The partition wall according to the fourth embodiment is constructed such that any one of the heat-insulating and sound-absorbing materials as described in the first to third embodiments is installed in a hollow wall portion formed thereinside.

[0086] FIG. 4 is a perspective view showing the partition wall according to the fourth embodiment of the present invention. FIG. 5 is a horizontal sectional view showing the partition wall according to the fourth embodiment of the present invention. As shown in FIG. 4, the partition wall 100 comprises: a wall base 110 formed between a floor structure 101 and an upper story structure 102 of a building; and a surface member 120 installed on each of transversely opposite sides of the wall base 110 to extend from the floor structure 101 to the upper story structure 102.

[0087] The wall base 110 comprises: a lower runner 111 disposed on the floor structure 101 of the building; an upper runner 112 fixed to the upper story structure 102 of the building; and a plurality of studs 114 each installed up vertically between the lower runner 111 and the upper runner 112.

[0088] The lower runner 111 is composed of, e.g., a steel elongate member formed in a sectionally angular C shape, and disposed on the floor structure 101 such that it opens upwardly. The lower runner 111 is fixed to the floor structure 101 by concrete nails or the like, and, as needed, through a runner bracket or the like.

[0089] The upper runner 112 is composed of, e.g., a steel elongate member formed in a sectionally angular C shape, and fixed to a lower surface of the upper story structure 102 such that it opens downwardly. Further, the upper runner 112 is disposed parallel to and just above the lower runner 111. The upper runner 112 is fixed to the upper story structure 102 by concrete nails or the like, and, as needed, through a runner bracket or the like.

[0090] Each of the studs 114 is composed of, e.g., a steel elongate member whose two sidewalls 114A, 114B stand perpendicularly, respectively, from transversely opposed edges of a baseplate thereof to form a cross-sectionally angular C shape, and installed vertically between the lower runner 111 and the upper runner 112.

[0091] In the fourth embodiment, the studs 114 are installed by a single-runner and staggered-stud construction method. That is, the studs 114 are installed such that they are arranged in a staggered pattern in lateral direction of the wall base 114 (arranged alternately offset in a direction perpendicular to wall surfaces). More specifically, studs 114 disposed such that one 114A of two transversely opposed sidewalls 114A, 114B thereof comes into contact with one 111A of two transversely opposed sidewalls 111A, 111B of the lower runner 111 and one 112A of two transversely opposed sidewalls 112A, 112B of the upper runner 112, and studs 114 disposed such that the other sidewall 114B thereof comes into contact with the other sidewall 111B of the lower runner 111 and the other sidewall 112B of the upper runner 112, are alternately installed.

[0092] Each of the surface members 120 is composed of a laminate of an underlaying board 121 and an overlaying board 122. One of the underlaying board 121 and the overlaying board 122, preferably, each of the underlaying board 121 and the overlaying board 122, is a board of a noncombustible material or quasi-noncombustible material, wherein it may be a single-layer board or may be a laminate comprising such a board. As used herein, the noncombustible material means a material specified in the Building Standards Act Article 2 (ix), and the quasi-noncombustible material means a material specified in the Building Standards Act Enforcement Ordinance Article 1 (v). The noncombustible material is a material satisfying the following requirements for 20 minutes after the start of heating when it is subjected

to heat due to a normal fire: (1) free from burning; (2) free from deformation, melting, crack and other damages, which are harmful to fire prevention; and (3) free from generation of smoke or gas which is harmful to evacuation.

[0093] The quasi-noncombustible material is a material satisfying the following requirements for 10 minutes after the start of heating when it is subjected to heat due to a normal fire: (1) free from burning; (2) free from deformation, melting, crack and other damages, which are harmful to fire prevention; and (3) free from generation of smoke or gas which is harmful to evacuation.

[0094] As the underlaying board 121 and the overlaying board 122, it is preferable to use a normal gypsum board, a fire-resistant gypsum board, a hard gypsum board, or a fiber-reinforced gypsum board. Preferably, the surface member has a thickness of 20 mm or more.

[0095] In the fourth embodiment, each of the opposed underlaying boards 121 is attached to every other stud 114 by, e.g., a tapping screw 130. Each of the opposed overlaying boards 122 is attached to the outer side of a corresponding one of the underlaying boards 121 by, e.g., an adhesive or a staple. In the partition wall configured as above, a hollow wall portion 140 is formed between the surface materials 120 installed on the transversely opposite sides of the wall base 110.

[0096] The heat-insulating and sound-absorbing material 1, 11 or 21 is disposed inside the hollow wall portion 140. Lower and upper edges of the heat-insulating and sound-absorbing material 1, 11 or 21 are in contact, respectively, with the lower runner 111 and the upper runner 112, and opposite side edges of the heat-insulating and sound-absorbing material 1, 11 or 21 are in contact, respectively, with adjacent two of the studs 114. For example, the lower and upper edges of the heat-insulating and sound-absorbing material 1, 11 or 21 may enter respective inner sides of the lower runner 111 and the upper runner 112 and come into contact with respective bottoms of the lower runner 111 and the upper runner 112, or may come into contact with respective outer sides of the lower runner 111 and the upper runner 112, without entering respective inner sides of the lower runner 111 and the upper runner 112. For example, one of the side edges of the heat-insulating and sound-absorbing material 1, 11 or 21 may enter the inner side of one of the studs 114 and come into contact with the bottom of the stud 114, and the other side edge of the heat-insulating and sound-absorbing material 1, 11 or 21 may come into contact with an outer surface of the bottom of the adjacent stud 114. Alternatively, the heat-insulating and sound-absorbing material may come into contact with the outer side of the stud without entering the inner side of the stud. In a case where each of the studs has a rectangular cross-sectional shape, the heat-insulating and sound-absorbing material may come into contact with the outer side of the stud without entering the inner side of the stud.

[0097] In the partition wall 100 according to the fourth embodiment, the heat-insulating and sound-absorbing material 1, 11 or 21 is installed in the hollow wall portion 140. In the fourth embodiment, the heat-insulating and sound-absorbing material 1, 11 or 21 is relatively lightweight, so that it is possible to improve the construction workability. Further, the heat-insulating and sound-absorbing material 1, 11 or 21 has a construction-enabling hardness, so that it is possible to improve the construction workability and allow the partition wall 100 to ensure sufficient sound insulation performance.

[0098] In the fourth embodiment, the studs 114 are installed by the single-runner and staggered-stud construction method. This makes it possible to easily dispose the heat-insulating and sound-absorbing material 1, 11 or 21 inside the partition wall 100.

< Fifth Embodiment >

[0099] A partition wall according to a fifth embodiment of the present invention will be described below. The partition wall according to the fifth embodiment is constructed such that any one of the heat-insulating and sound-absorbing materials as described in the first to third embodiments is installed in a hollow wall portion formed therein. In the partition wall according to the fifth embodiment, a single-runner and common-stud construction method is used as a stud installation method. In the fifth embodiment, any element or component similar or identical to that in the fourth embodiment is assigned with the same reference sign, and its detailed description will be omitted.

[0100] FIG. 6 is a horizontal sectional view showing the partition wall according to the fifth embodiment of the present invention. The partition wall 200 according to the fifth embodiment comprises a wall base 110, and a surface member 120 installed on each of transversely opposite sides of the wall base 110.

[0101] The configuration of the wall base 110 is different from that in the fourth embodiment in terms of the arrangement of a plurality of studs 214. In the fifth embodiment, each of the studs 214 is formed in, e.g., a rectangular cross-sectional shape in which two sidewalls 214A, 214B stand perpendicularly, respectively, from transversely opposite edges of a base plate, and installed vertically between a lower runner 111 and an upper runner 112.

[0102] In the fifth embodiment, the studs 214 are installed by a single-runner and common-stud construction method. That is, the studs 214 are arranged such that they are aligned in a straight line, wherein lower ends of the transversely opposed sidewalls 214A, 214B of each of the studs 214 come into contact, respectively, with transversely opposed sidewalls 111A, 111B of the lower runner 111, and upper ends of the sidewalls of the stud 214 come into contact,

respectively, with transversely opposed sidewalls 112A, 112B of the upper runner 112.

[0103] In the fifth embodiment, in the surface members 120, each of two underlying boards 121 is attached to a respective one of the sidewalls 214A, 214B of each of the studs 214 by, e.g., a tapping screw 130. Further, each of two overlaying boards 122 is attached to a respective one of the outer sides of the underlying boards 121 by, e.g., an adhesive or a staple. In the partition wall configured as above, a hollow wall portion 140 is formed between the surface materials 120 on the transversely opposite sides of the wall base 110.

[0104] The heat-insulating and sound-absorbing material 1, 11 or 21 is disposed inside the hollow wall portion 140. Lower and upper edges of the heat-insulating and sound-absorbing material 1, 11 or 21 are in contact, respectively, with the lower runner 111 and the upper runner 112, and opposite side edges of the heat-insulating and sound-absorbing material 1, 11 or 21 are in contact, respectively, with adjacent two of the studs 214. For example, the lower and upper edges of the heat-insulating and sound-absorbing material 1, 11 or 21 may enter respective inner sides of the lower runner 111 and the upper runner 112 and come into contact with respective bottoms of the lower runner 111 and the upper runner 112, or may come into contact with respective outer sides of the lower runner 111 and the upper runner 112, without entering respective inner sides of the lower runner 111 and the upper runner 112. In a case where each of the studs has an angular-C cross-sectional shape, one of two opposite side edges of the heat-insulating and sound-absorbing material may enter the inner side of one of the studs and come into contact with the bottom of the stud, and the other side edge of the heat-insulating and sound-absorbing material may come into contact with an outer surface of the bottom of the adjacent stud. Alternatively, the heat-insulating and sound-absorbing material may come into contact with the outer side of the stud without entering the inner side of the stud.

[0105] The partition wall according to the fifth embodiment can also bring out similar advantageous effects to those in the fourth embodiment.

< Sixth Embodiment >

[0106] A partition wall according to a sixth embodiment of the present invention will be described below. The partition wall according to the sixth embodiment is constructed such that any one of the heat-insulating and sound-absorbing materials as described in the first to third embodiments is installed in a hollow wall portion formed therein. In the partition wall according to the sixth embodiment, a single-runner and common-stud construction method using a staggered backing pad arrangement is used as a stud installation method. In the sixth embodiment, any element or component similar or identical to that in the fourth embodiment is assigned with the same reference sign, and its detailed description will be omitted.

[0107] FIG. 7 is a horizontal sectional view showing the partition wall according to the sixth embodiment of the present invention. In FIG. 7, inner wall surfaces of transversely opposed sidewalls of each of a lower runner 111 and an upper runner 112 are indicated by broken lines. The partition wall 300 according to the sixth embodiment comprises a wall base 110, and a surface member 120 installed on each of transversely opposite sides of the wall base 110.

[0108] The configuration of the wall base 110 is different from that in the fourth embodiment in terms of the arrangement of a plurality of studs 114. In the sixth embodiment, each of the studs 114 is formed in, e.g., an angular-C cross-sectional shape in which two sidewalls 114A, 114B stand perpendicularly, respectively, from transversely opposite edges of a base plate, and installed vertically between the lower runner 111 and the upper runner 112.

[0109] In the sixth embodiment, the studs 114 are installed by a single-runner and common-stud construction method using a staggered backing pad arrangement. That is, the studs 114 are arranged such that they are aligned in a straight line, wherein lower ends of the transversely opposed sidewalls 114A, 114B of each of the studs 114 come into contact, respectively, with transversely opposed sidewalls 111A, 111B of the lower runner 111, and upper ends of the sidewalls of the stud 214 come into contact, respectively, with transversely opposed sidewalls 112A, 112B of the upper runner 112.

[0110] In the sixth embodiment, in each of the surface members, an underlying board 121 is attached to every other stud 114 by, e.g., a tapping screw 130. In this process, a backing pad 132 is disposed between one of the sidewalls 114A, 114B of each of the studs 114 and the underlying board 121. The backing pads 132 are attached to one sidewall 114A of one of the studs 114, and the other sidewall 114B of the adjacent stud 114 in an alternate manner, so that they are arranged in a staggered pattern. In the partition wall configured as above, a hollow wall portion 140 is formed between the surface materials 120 installed on the transversely opposite sides of the wall base 110.

[0111] The heat-insulating and sound-absorbing material 1, 11 or 21 is disposed inside the hollow wall portion 140. Lower and upper edges of the heat-insulating and sound-absorbing material 1, 11 or 21 are in contact, respectively, with the lower runner 111 and the upper runner 112, and opposite side edges of the heat-insulating and sound-absorbing material 1, 11 or 21 are in contact, respectively, with adjacent two of the studs 114. For example, the lower and upper edges of the heat-insulating and sound-absorbing material 1, 11 or 21 may enter respective inner sides of the lower runner 111 and the upper runner 112 and come into contact with respective bottoms of the lower runner 111 and the upper runner 112, or may come into contact with respective outer sides of the lower runner 111 and the upper runner 112, without entering respective inner sides of the lower runner 111 and the upper runner 112. For example, one of the

side edges of the heat-insulating and sound-absorbing material 1, 11 or 21 may enter the inner side of one of the studs 114 and come into contact with the bottom of the stud 114, and the other side edge of the heat-insulating and sound-absorbing material 1, 11 or 21 may come into contact with an outer surface of the bottom of the stud 114. Alternatively, the heat-insulating and sound-absorbing material may come into contact with the outer side of the stud without entering the inner side of the stud.

[0112] The partition wall according to the sixth embodiment can also bring out similar advantageous effects to those in the fourth embodiment.

< Seventh Embodiment >

[0113] A partition wall according to a seventh embodiment of the present invention will be described below. The partition wall according to the seventh embodiment is constructed such that any one of the heat-insulating and sound-absorbing materials as described in the first to third embodiments is installed in a hollow wall portion formed therein. In the partition wall according to the seventh embodiment, a single-runner and staggered-stud construction method using a staggered backing pad arrangement is used as a stud installation method. In the seventh embodiment, any element or component similar or identical to that in the fourth embodiment is assigned with the same reference sign, and its detailed description will be omitted.

[0114] FIG. 8 is a horizontal sectional view showing the partition wall according to the seventh embodiment of the present invention. In FIG. 8, inner wall surfaces of transversely opposed sidewalls of each of a pair of lower runners 111 and a pair of upper runner 112 are indicated by broken lines. The partition wall 400 according to the seventh embodiment comprises a wall base 110, and a surface member 120 installed on each of transversely opposite sides of the wall base 110.

[0115] The configuration of the wall base 110 is different from that in the fourth embodiment in terms of the arrangement of a plurality of backing pads. In the seventh embodiment, each of a plurality of studs 114 is formed in, e.g., an angular-C cross-sectional shape in which two sidewalls 114A, 114B stand perpendicularly, respectively, from transversely opposite edges of a base plate, and installed vertically between the lower runner 111 and the upper runner 112.

[0116] In the seventh embodiment, the studs 114 are installed by a single-runner and staggered-stud construction method using a staggered backing pad arrangement. That is, the studs 114 are installed such that they are arranged in a staggered pattern in an lateral direction of the wall base 114 (arranged alternately offset in a direction perpendicular to wall surfaces). More specifically, a first stud 114 disposed such that one 114A of two transversely opposed sidewalls 114A, 114B thereof comes into contact with one 111A of two transversely opposed sidewalls 111A, 111B of the lower runner 111 and one 112A of two transversely opposed sidewalls 112A, 112B of the upper runner 112, and a second stud 114 disposed such that the other sidewall 114B thereof comes into contact with the other sidewall 111B of the lower runner 111 and the other sidewall 112B of the upper runner 112, are alternately installed.

[0117] In the seventh embodiment, in each of the surface members 120, an underlaying board 121 is attached to every other stud 114 by, e.g., a tapping screw 130. In this process, a backing pad 132 is disposed between one of the sidewalls 114A, 114B of each of the studs 114 and the underlaying board 121. The backing pads 132 are attached to one sidewall 114A of one of the studs 114, and the other sidewall 114B of the adjacent stud 114 in an alternate manner, so that they are arranged in a staggered pattern. In the partition wall configured as above, a hollow wall portion 140 is formed between the surface materials 120 installed on the transversely opposite sides of the wall base 110.

[0118] The heat-insulating and sound-absorbing material 1, 11 or 21 is disposed inside the hollow wall portion 140. Lower and upper edges of the heat-insulating and sound-absorbing material 1, 11 or 21 are in contact, respectively, with the lower runner 111 and the upper runner 112, and opposite side edges of the heat-insulating and sound-absorbing material 1, 11 or 21 are in contact, respectively, with adjacent two of the studs 114. For example, the lower and upper edges of the heat-insulating and sound-absorbing material 1, 11 or 21 may enter respective inner sides of the lower runner 111 and the upper runner 112 and come into contact with respective bottoms of the lower runner 111 and the upper runner 112, or may come into contact with respective outer sides of the lower runner 111 and the upper runner 112, without entering respective inner sides of the lower runner 111 and the upper runner 112. For example, one of the side edges of the heat-insulating and sound-absorbing material 1, 11 or 21 may enter the inner side of the studs 114 and come into contact with the bottom of the stud 114, and the other side edge of the heat-insulating and sound-absorbing material 1, 11 or 21 may come into contact with an outer surface of the bottom of the adjacent stud 114. Alternatively, the heat-insulating and sound-absorbing material may come into contact with the outer side of the stud without entering the inner side of the stud. In a case where each of the studs has a rectangular cross-sectional shape, the heat-insulating and sound-absorbing material may come into contact with the outer side of the stud without entering the inner side of the stud.

[0119] The partition wall according to the seventh embodiment can also bring out similar advantageous effects to

those in the fourth embodiment.

< Eighth Embodiment >

[0120] A partition wall according to an eighth embodiment of the present invention will be described below. The partition wall according to the eighth embodiment is constructed such that any one of the heat-insulating and sound-absorbing materials as described in the first to third embodiments is installed in a hollow wall portion formed therein. In the partition wall according to the eighth embodiment, a double-runner and parallel-stud construction method is used as a stud installation method. In the eighth embodiment, any element or component similar or identical to that in the fourth embodiment is assigned with the same reference sign, and its detailed description will be omitted.

[0121] FIG. 9 is a horizontal sectional view showing the partition wall according to the eighth embodiment of the present invention, wherein a plurality of studs are arranged to be displaced from each other in the lateral direction. In FIG. 9, inner wall surfaces of transversely opposed sidewalls of each of a lower runner 111 and an upper runner 112 are indicated by broken lines. The partition wall 500 according to the eighth embodiment comprises a wall base 110, and a surface member 120 installed on each of transversely opposite sides of the wall base 110.

[0122] The configuration of the wall base 110 is different from that in the fourth embodiment in terms of the arrangements of the upper runner, the lower runner and a plurality of studs 114. In the eighth embodiment, each of the pair of lower runners 111 and the pair of upper runners 112 are arranged such that they are aligned in a wall thickness direction of the partition wall 500. In the eighth embodiment, each of a plurality of studs 114 is formed in, e.g., an angular-C cross-sectional shape in which two sidewalls 114A, 114B stand perpendicularly, respectively, from transversely opposite edges of a base plate, and installed vertically between the pair of lower runners 111 and the pair of upper runners 112.

[0123] In the eighth embodiment, the studs 114 are installed by a double-runner and parallel-stud construction method. That is, the studs 114 are installed in the lateral direction of the wall base 110. More specifically, a first stud 114 installed between one of the pair of lower runners 111 and a corresponding one of the pair of upper runners 112 (e.g., between a lower one of the pair of lower runners 111 and a lower one of the pair of upper runners 112 in FIG. 9), and a second stud 114 installed between the other lower runner 111 and the other upper runner 112 (e.g., between an upper one of the pair of lower runners 111 and an upper one of the pair of upper runners 112 in FIG. 9), are arranged so as to offset from each other.

[0124] In the eighth embodiment, in each of the surface members 120, an underlaying board 121 is attached to every other stud 114 by, e.g., a tapping screw 130. Further, an overlaying board 122 is attached to the outer side of the underlaying board 121 by, e.g., an adhesive or a staple. In the partition wall configured as above, a hollow wall portion 140 is formed between the surface materials 120 installed on the transversely opposite sides of the wall base 110.

[0125] The heat-insulating and sound-absorbing material 1, 11 or 21 is disposed inside the hollow wall portion 140. Lower and upper edges of the heat-insulating and sound-absorbing material 1, 11 or 21 are in contact, respectively, with the pair of lower runners 111 and the pair of upper runners 112. For example, the lower and upper edges of the heat-insulating and sound-absorbing material 1, 11 or 21 may enter respective inner sides of the pair of lower runners 111 and the pair of upper runners 112 and come into contact with respective bottoms of the pair of lower runners 111 and the pair of upper runners 112, or may come into contact with respective outer sides of the pair of lower runner 111 and the pair of upper runners 112, without entering respective inner sides of the pair of lower runners 111 and the pair of upper runners 112. The lower and upper edges of the heat-insulating and sound-absorbing material 1, 11 or 21 is disposed in the hollow wall portion 140 to avoid or detour around the studs 114. Here, as the heat-insulating and sound-absorbing material, it is not necessary to use a continuous long heat-insulating and sound-absorbing material, but a plurality of heat-insulating and sound-absorbing material may be arranged. Further, the heat-insulating and sound-absorbing material may be disposed between adjacent two of the studs aligned in the lateral direction. In this case, one side edge of the heat-insulating and sound-absorbing material may be disposed to enter the inner side of one of the adjacent studs. In a case where each of the studs has a rectangular cross-sectional shape, the heat-insulating and sound-absorbing material may come into contact with the outer side of the stud without entering the inner side of the stud.

[0126] The partition wall according to the eighth embodiment can also bring out similar advantageous effects to those in the fourth embodiment.

< Ninth Embodiment >

[0127] A partition wall according to a ninth embodiment of the present invention will be described below. The partition wall according to the ninth embodiment is constructed such that any one of the heat-insulating and sound-absorbing materials as described in the first to third embodiments is installed in a hollow wall portion formed therein. In the partition wall according to the ninth embodiment, a double-runner and parallel-stud construction method is used as a stud installation method, wherein the ninth embodiment is different from the eighth embodiment in that each of a plurality of pairs of studs are arranged at the same position in the lateral direction. In the ninth embodiment, any element or

component similar or identical to that in the eighth embodiment is assigned with the same reference sign, and its detailed description will be omitted.

[0128] FIG. 10 is a horizontal sectional view showing the partition wall according to the ninth embodiment of the present invention, wherein each of a plurality of pairs of studs are arranged at the same position in the lateral direction. In FIG. 10, inner wall surfaces of transversely opposed sidewalls of each of a pair of lower runners 111 and a pair of upper runners 112 are indicated by broken lines. The partition wall 600 according to the ninth embodiment comprises a wall base 110, and a surface member 120 installed on each of transversely opposite sides of the wall base 110.

[0129] The configuration of the wall base 110 is different from that in the eighth embodiment in terms of only the arrangement of a plurality of studs 114. In the ninth embodiment, a first stud 114 installed between one of the pair of lower runners 111 and a corresponding one of the pair of upper runners 112, and a second stud 114 installed between the other lower runner 111 and the other upper runner 112, are arranged at the same position in the lateral direction to form a pair of studs 114, and the pair of studs 114 is provided plurally at given intervals in the lateral direction.

[0130] In the ninth embodiment, in each of the surface members 120, an underlaying board 121 is attached to one of each of the pairs of studs 114 by, e.g., a tapping screw 130. Further, an overlaying board 122 is attached to the outer side of the underlaying board 121 by, e.g., an adhesive or a staple. In the partition wall configured as above, a hollow wall portion 140 is formed between the surface materials 120 installed on the transversely opposite sides of the wall base 110.

[0131] The heat-insulating and sound-absorbing material 1, 11 or 21 is disposed inside the hollow wall portion 140. Lower and upper edges of the heat-insulating and sound-absorbing material 1, 11 or 21 are in contact, respectively, with one of the pair of lower runners 111 and a corresponding one of the pair of upper runners 112. For example, the lower and upper edges of the heat-insulating and sound-absorbing material 1, 11 or 21 may enter respective inner sides of one of the pair of lower runners 111 and a corresponding one of the pair of upper runners 112 and come into contact with respective bottoms of the lower runner 111 and the upper runner 112, or may come into contact with respective outer sides of one of the pair of lower runner 111 and a corresponding one of the pair of upper runners 112, without entering respective inner sides of the lower runner 111 and the upper runner 112. Further, the heat-insulating and sound-absorbing material is disposed between adjacent two of the studs 114 aligned in the lateral direction, wherein opposite side edges of the heat-insulating and sound-absorbing material are in contact, respectively, with the adjacent studs 114. For example, one of the side edges of the heat-insulating and sound-absorbing material enters the inner side of one of the adjacent studs 114 and comes into contact with the bottom of the stud 114, and the other side edge of the heat-insulating and sound-absorbing material comes into contact with an outer surface of the bottom of the stud 114. Alternatively, the heat-insulating and sound-absorbing material may come into contact with the stud 114 without entering the inner side of the stud 114. In the ninth embodiment, the heat-insulating and sound-absorbing material may be disposed in each of two hollow wall portions corresponding to the pair of lower or upper runners, as shown in FIG. 10, or may be disposed in only one of the hollow wall portions. In a case where each of the studs has a rectangular cross-sectional shape, the heat-insulating and sound-absorbing material may come into contact with the outer side of the stud without entering the inner side of the stud.

[0132] The partition wall according to the ninth embodiment can also bring out similar advantageous effects to those in the fourth embodiment.

[0133] Although the present invention has been described in detail with reference to specific embodiments, it is obvious to those skilled in the art that various changes and modifications may be made therein without departing from the spirit and scope thereof as set forth in appended claims.

EXAMPLES

[0134] The heat-insulating and sound-absorbing material of the present invention will be described in more detail based on its examples and comparative examples.

(Examples 1 and 7)

[0135] Examples 1 and 7 relate to a three-layer structured heat-insulating and sound-absorbing material corresponding to the third embodiment described with reference to FIG. 3. Examples 1 and 7 were produced by the production method described in the third embodiment.

(Examples 2 to 6)

[0136] Examples 2 to 6 relate to a two-layer structured heat-insulating and sound-absorbing material corresponding to the second embodiment described with reference to FIG. 2. Examples 2 to 6 were produced by the production method described in the second embodiment.

(Examples 8 to 10)

[0137] Examples 8 to 10 relate to a single-layer structured heat-insulating and sound-absorbing material corresponding to the first embodiment described with reference to FIG. 1. Examples 8 to 10 were produced by the production method described in the first embodiment.

(Comparative Examples 1 to 3)

[0138] Comparative Examples 1 to 3 relate to a single-layer structured heat-insulating and sound-absorbing material as with Examples 8 to 10. Comparative Examples 1 to 3 were produced by the production method described in the first embodiment, as with Examples 8 to 10.

(Measurements of Length-Weighted Average Fiber Diameter and Length-Weighted Fiber Diameter Distribution)

[0139] With regard to Examples 1 to 10 and Comparative Examples 1 to 3, measurements of the length-weighted average fiber diameter of an agglomerate, and the length-weighted fiber diameter distribution were conducted using cottonscopeHD manufactured by Cottonscope Pty Ltd. Further, with regard to Examples 1 to 7, the length-weighted average fiber diameter of each layer was also measured.

(Measurement of Density)

[0140] With regard to Examples 1 to 10 and Comparative Examples 1 to 3, the density of each agglomerate was measured by a method according to JIS A9521.

(Measurement of Binder)

[0141] With regard to Examples 1 to 10 and Comparative Examples 1 to 3, the binder strength of a binder used was measured. The binder strength was measured by a shell mold tensile strength measurement method comprising: a step (1) of introducing and mixing 2.7% by weight of binder into and with 150g of glass beads to obtain a mixture; a step (2) of uniformly packing the mixture obtained in the step (1) in an iron mold, and heating the mold in an oven to cure the binder, and obtain a shell mold test piece (6 mm thickness × 27 mm width × 74 mm length, where the width of a clip portion: 42 mm); a step (3) of extracting the shell mold test piece obtained in the step (2) from the oven and cooling the extracted shell mold test piece to room temperature; and a step (4) of measuring the tensile strength of the cooled shell mold test piece at a tension rate of 5 mm/min, using a universal material testing machine.

(Measurement of Resin Content Rate)

[0142] With regard to Examples 1 to 10 and Comparative Examples 1 to 3, a resin content rate of each agglomerate was measured. The resin content rate was obtained by conducting a process comprising: a step (1) of cutting a glass wool mat into a size of 100 mm × 100 mm to prepare a test piece, and measuring the weight (Wa) of this test piece; a step (2) of introducing the test piece into an electric furnace set at 530°C to decompose a binder component; a step (3) of extracting, from the electric furnace, the test piece after being subjected to the decomposition of the binder component, and measuring the weight (Wb) of this test piece to derive the resin content rate from a difference with the measurement value (Wa) in the step (1), using the following formula:

$$\text{Resin content rate (\% by weight)} = \{(W_a - W_b) / W_a\} \times 100$$

[0143] The length-weighted average fiber diameter, the density, the length-weighted fiber diameter distribution, the binder strength, the resin content rate, a thickness-directional layer configuration, the length-weighted average fiber diameter of each layer, and the thickness percent of each layer in each of Examples 1 to 10 and Comparative Examples 1 to 3 are shown in the following Table 2.

[0144]

Table 2

	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8	Example 9	Example 10	Comparative Example 1	Comparative Example 2	Comparative Example 3
Length-Weighted Average Fiber Diameter (μm)	4,3	4,3	5,1	4,3	4,3	4,3	3,8	5,1	5,1	5,1	3,3	7,8	8,7
Density (Kg/m^3)	14	14	16	20	14	14	10	16	16	16	14	24	20
Length-Weighted Fiber Diameter Distribution	7.0 μm or more	17,6	25,7	17,6	17,6	17,6	13,4	25,7	25,7	25,7	9,2	49,5	57,2
Less than 4.0 μm (%)	58,3	58,3	47,0	58,3	58,3	58,3	65,3	47,0	47,0	47,0	72,4	29,6	21,6
Binder Strength (N/mm^2)	4,9	4,9	4,9	4,9	8,1	4,9	6,0	4,9	6,1	3,3	4,9	8,1	8,1
Resin Content Rate % by weight	6,0	6,0	3,5	6,0	5,0	10,0	8,0	3,5	0,9	8,0	6,0	4,3	4,3
Thickness-Directional Layer Configuration (Number of Layers)	3	2	2	2	2	2	3	1	1	1	1	1	1
Length-Weighted Average Fiber Diameter of each Layer (μm)	4,6	4,7	5,9	4,7	4,7	4,7	4,3	5,1	5,1	5,1	3,3	7,8	8,7
First Layer	4,0	4,2	4,8	4,2	4,2	4,2	3,3	-	-	-	-	-	-
Second Layer	4,6	-	-	-	-	-	4,3	-	-	-	-	-	-
Third Layer	25,0	33,3	33,3	33,3	33,3	33,3	25,0	100	100	100	100	100	100
Thickness Percent of each Layer	50,0	66,7	66,7	66,7	66,7	66,7	50,0	-	-	-	-	-	-
First Layer	25,0	-	-	-	-	-	25,0	-	-	-	-	-	-
Second Layer													
Third Layer													

[0145] With regard to each obtained test piece of Examples 1 to 10 and Comparative Examples 1 to 3, work efficiency/cost, construction workability (skin irritation tactile sensation) and construction workability (product hardness) were evaluated in the following manner.

(Work Efficiency/Cost)

[0146] If the weight per unit area of the heat-insulating and sound-absorbing material comprised of inorganic fibers is excessively large, work efficiency of unloading and installation of the heat-insulating and sound-absorbing material deteriorates. Further, the excessively large weight per unit area leads to an increase in cost. Thus, with regard to each of Examples 1 to 10 and Comparative Examples 1 to 3, the weight per unit area of the heat-insulating and sound-absorbing material having a product thickness (a thickness in the form of a finished product) of 50 mm was measured, and the work efficiency/cost was evaluated as follows.

- ⊙: When the weight per unit area was less than 800 g/m²
- : When the weight per unit area was 800 g/m² to less than 1000 g/m²
- △: When the weight per unit area was 1000 g/m² to less than 1200 g/m²
- ×: When the weight per unit area was 1200 g/m² or more

(Construction Workability (Skin Irritation Tactile Sensation))

[0147] If tingling (skin irritation tactile sensation) when touching the heat-insulating and sound-absorbing material comprised of inorganic fibers is excessively large, the construction workability deteriorates. Thus, with regard to each of Examples 1 to 10 and Comparative Examples 1 to 3, a sensitivity test in which ten testers touch the surface of the heat-insulating and sound-absorbing material to evaluate skin irritation by 5-point scale of 1 to 5 in a semantic differential (SD) method was carried out to evaluate the construction workability (skin irritation tactile sensation) as follows.

- ⊙: When the average of evaluation values of the ten testers was less than 2.0
- : When the average of evaluation values of the ten testers was 2.0 to less than 3.0
- △: When the average of evaluation values of the ten testers was 3.0 to less than 4.0
- ×: When the average of evaluation values of the ten testers was 4.0 or more

(Construction Workability (Product Hardness))

[0148] If the hardness of the heat-insulating and sound-absorbing material comprised of inorganic fibers excessively decreases, the construction workability deteriorates. Thus, with regard to each of Examples 1 to 10 and Comparative Examples 1 to 3, a test comprising: a step (1) of placing a test piece of each heat-insulating and sound-absorbing material on a planar portion of a measurement table; a step (2) of sliding the test piece on the table at a speed of 10 cm/sec by manually pushing the test piece while lightly pressing down a longitudinal rear end thereof; and a step (3) of reading, by a scale, a droop length at a time when the leading edge of the test piece touches the surface of a shoot portion having an inclination angle of 45-degree, was carried out to evaluate the construction workability (product hardness) as follows. In this test, the droop length is on the basis of a product thickness of 50 mm, in all cases.

- ⊙: When the droop length was 580 mm or more
- : When the droop length was 530 mm to less than 580 mm
- △: When the droop length was 480 mm to less than 530 mm
- ×: When the droop length was less than 480 mm

[0149] The work Efficiency/cost, the construction workability (skin irritation tactile sensation) and the construction workability (product hardness) in each of Examples 1 to 10 and Comparative Examples 1 to 3 are shown in the following Table 3.

TABLE 3

	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Example 8	Example 9	Example 10	Comparative Example 1	Comparative Example 2	Comparative Example 3
Work Efficiency/Cost	⊙	⊙	○	Δ	⊙	⊙	⊙	○	○	○	⊙	×	Δ
Construction Workability	⊙	⊙	○	⊙	Δ	Δ	○	○	○	○	⊙	×	×
Skin Irritation Tactile Sensation													
Product Hardness	⊙	○	⊙	⊙	○	⊙	Δ	○	Δ	Δ	×	⊙	○

[0150] As can be understood from Tables 2 and 3, in Comparative Example 2 in which the density is set to 24 kg/m³, the weight increases largely, which causes deterioration in the work efficiency. Further, in Comparative Example 1 in which the percent of inorganic fibers having a fiber diameter of 7 μm or more is excessively small, the product hardness is insufficient, which causes deterioration in the construction workability. Further, when the length-weighted fiber diameter is as thick as 8.7 μm as in Comparative Example 3, the skin irritation tactile sensation is strong, which causes deterioration in the construction workability.

[0151] By contrast, in Examples 1 to 10, it is possible to obtain sufficient work efficiency, and construction workability (skin irritation tactile sensation and product hardness).

[0152] The partition wall of the present invention will be described in more detail based on its examples and comparative examples.

[0153] FIG. 4 is a perspective view showing the partition wall according to the present invention. FIG. 5 is a horizontal sectional view showing the partition wall according to the present invention.

[0154] A wall base 110 comprises: a lower runner 111 disposed on a floor structure such as floor slabs; an upper runner 112 fixed to a lower surface of an upper story structure 102 such as floor slabs of an upper story floor; and a large number of studs 114 each installed up vertically between the lower runner 111 and the upper runner 112. As shown in FIG. 5, the studs 114 are arranged along a center line of the wall in a staggered pattern.

[0155] A first layer 121 of a surface member 120 is fixed to a part of the studs 114 by a tapping screw 130, and a second layer 122 of the surface member 120 is fixed to the first layer 121 of the surface member 120 by a staple or an adhesive. The surface member 120 is installed on each of transversely opposite sides of the wall base 110, wherein a hollow wall portion 140 is formed between the first layers 121 of the surface members 120, and the heat-insulating and sound-absorbing material is loaded into the hollow wall portion 140.

[0156] As components of the partition wall in Example 11 of the present invention, the following building materials were used.

[0157]

Lower runner 111:

light-gauge steel (steel runner) C-75 mm × 40 mm × 0.8 mm

Upper runner 112:

light-gauge steel (steel runner) C-75 mm × 40 mm × 0.8 mm

Stud 114:

light-gauge steel (steel stud) C-65 mm × 45 mm × 0.8 mm

[0158] Underlying board 121: fire-resistant gypsum board with a thickness of 21 mm ("Tiger Board (registered trademark) Type Z" manufactured by Yoshino Gypsum Co., Ltd.)

[0159] Overlaying board 122: hard gypsum board with a thickness of 9.5 mm ("Tiger Super Hard (registered trademark)" manufactured by Yoshino Gypsum Co., Ltd.)

[0160] Heat-Insulating and Sound-Absorbing Material 11 (Example 2): length-weighted average fiber diameter: 4.3 μm, density: 14 kg/m³, thickness: 50 mm ("Stud Aclear" manufactured by Asahi Fiber Glass Co., Ltd.)

[0161] Further, the heat-insulating and sound-absorbing material 11 disposed inside the partition wall employs a two-layer structure corresponding to the second embodiment described with reference to FIG. 2, and was produced by the production method described in the second embodiment.

[0162] As components of the partition wall in Comparative Example 4 to be compared with Example 11 of the present invention, the following building materials were used.

[0163]

Lower runner 111:

light-gauge steel (steel runner) C-75 mm × 40 mm × 0.8 mm

Upper runner 112:

light-gauge steel (steel runner) C-75 mm × 40 mm × 0.8 mm

Stud 114:

light-gauge steel (steel stud) C-65 mm × 45 mm × 0.8 mm

[0164] Underlying board 121: fire-resistant gypsum board with a thickness of 21 mm ("Tiger Board (registered trademark) Type Z" manufactured by Yoshino Gypsum Co., Ltd.)

[0165] Overlaying board 122: hard gypsum board with a thickness of 9.5 mm ("Tiger Super Hard (registered trademark)" manufactured by Yoshino Gypsum Co., Ltd.)

[0166] Heat-Insulating and Sound-Absorbing Material 1 (Comparative Example 2): length-weighted average fiber diameter: 7.8 μm, density: 24 kg/m³, thickness: 50 mm ("GLASSRON (registered trademark) wool" manufactured by Asahi Fiber Glass Co., Ltd.).

[0167] Further, the heat-insulating and sound-absorbing material 1 disposed inside the partition wall employs a single-layer structure corresponding to the first embodiment described with reference to FIG. 1, and was produced by the production method described in the first embodiment.

[0168] As components of the partition wall in Example 12 of the present invention, the following building materials were used.

[0169]

Lower runner 111:

light-gauge steel (steel runner) C-75 mm × 40 mm × 0.8 mm

Upper runner 112:

light-gauge steel (steel runner) C-75 mm × 40 mm × 0.8 mm

Stud 114:

light-gauge steel (steel stud) C-65 mm × 45 mm × 0.8 mm

[0170] Underlying board 121: fire-resistant gypsum board with a thickness of 12.5 mm ("Tiger Board (registered trademark) Type Z" manufactured by Yoshino Gypsum Co., Ltd.)

[0171] Overlaying board 122: hard gypsum board with a thickness of 9.5 mm ("Tiger Hyper Hard C (registered trademark)" manufactured by Yoshino Gypsum Co., Ltd.)

[0172] Heat-Insulating and Sound-Absorbing Material 11 (Example 2): length-weighted average fiber diameter: 4.3 μm, density: 14 kg/m³, thickness: 50 mm ("Stud Aclear" manufactured by Asahi Fiber Glass Co., Ltd.).

[0173] Further, the heat-insulating and sound-absorbing material 11 disposed inside the partition wall employs a two-layer structure corresponding to the second embodiment described with reference to FIG. 2, and was produced by the production method described in the second embodiment.

[0174] As components of the partition wall in Comparative Example 5 to be compared with Example 12 of the present invention, the following building materials were used.

[0175]

Lower runner 111:

light-gauge steel (steel runner) C-75 mm × 40 mm × 0.8 mm

Upper runner 112:

light-gauge steel (steel runner) C-75 mm × 40 mm × 0.8 mm

Stud 114:

light-gauge steel (steel stud) C-65 mm × 45 mm × 0.8 mm

[0176] Underlying board 121: fire-resistant gypsum board with a thickness of 12.5 mm ("Tiger Board (registered trademark) Type Z" manufactured by Yoshino Gypsum Co., Ltd.)

[0177] Overlaying board 122: hard gypsum board with a thickness of 9.5 mm ("Tiger Hyper Hard C (registered trademark)" manufactured by Yoshino Gypsum Co., Ltd.)

[0178] Heat-Insulating and Sound-Absorbing Material 1 (Comparative Example 2): length-weighted average fiber diameter: 7.8 μm, density: 24 kg/m³, thickness: 50 mm ("GLASSRON (registered trademark) wool" manufactured by Asahi Fiber Glass Co., Ltd.).

[0179] Further, the heat-insulating and sound-absorbing material 1 disposed inside the partition wall employs a single-layer structure corresponding to the first embodiment described with reference to FIG. 1, and was produced by the production method described in the first embodiment.

[0180] As components of the partition wall in Example 13 of the present invention, the following building materials were used.

[0181]

Lower runner 111:

light-gauge steel (steel runner) C-75 mm × 40 mm × 0.8 mm

Upper runner 112:

light-gauge steel (steel runner) C-75 mm × 40 mm × 0.8 mm

Stud 114:

light-gauge steel (steel stud) C-65 mm × 45 mm × 0.8 mm

[0182] Underlying board 121: fire-resistant gypsum board with a thickness of 12.5 mm ("Tiger Board (registered trademark) Type Z" manufactured by Yoshino Gypsum Co., Ltd.)

[0183] Overlaying board 122: hard gypsum board with a thickness of 12.5 mm ("Tiger Board (registered trademark) Type Z" manufactured by Yoshino Gypsum Co., Ltd.)

[0184] Heat-Insulating and Sound-Absorbing Material 11 (Example 2): length-weighted average fiber diameter: 4.3 μm, density: 14 kg/m³, thickness: 50 mm ("Stud Aclear" manufactured by Asahi Fiber Glass Co., Ltd.)

[0185] Further, the heat-insulating and sound-absorbing material 11 disposed inside the partition wall employs a two-layer structure corresponding to the second embodiment described with reference to FIG. 2, and was produced by the production method described in the second embodiment.

[0186] As components of the partition wall in Comparative Example 6 to be compared with Example 13 of the present invention, the following building materials were used.

[0187]

Lower runner 111:

light-gauge steel (steel runner) C-75 mm × 40 mm × 0.8 mm

Upper runner 112:

light-gauge steel (steel runner) C-75 mm × 40 mm × 0.8 mm

Stud 114:

light-gauge steel (steel stud) C-65 mm × 45 mm × 0.8 mm

[0188] Underlying board 121: fire-resistant gypsum board with a thickness of 12.5 mm ("Tiger Board (registered trademark) Type Z" manufactured by Yoshino Gypsum Co., Ltd.)

[0189] Overlaying board 122: fire-resistant gypsum board with a thickness of 12.5 mm ("Tiger Board (registered trademark) Type Z" manufactured by Yoshino Gypsum Co., Ltd.)

[0190] Heat-Insulating and Sound-Absorbing Material 1 (Comparative Example 2): length-weighted average fiber diameter: 7.8 μm , density: 24 kg/m^3 , thickness: 50 mm ("GLASSRON (registered trademark) wool" manufactured by Asahi Fiber Glass Co., Ltd.).

[0191] Further, the heat-insulating and sound-absorbing material 1 disposed inside the partition wall employs a single-layer structure corresponding to the first embodiment described with reference to FIG. 1, and was produced by the production method described in the first embodiment.

(Sound Insulation Performance)

[0192] With regard to Examples 11 to 13 and Comparative Examples 4 to 6, sound insulation performance (transmission loss difference (TLD) value) is a numerical value indicative of a measurement result of the sound transmission loss of a single wall body measured by a measurement method defined in JIS A1416 (ISO140-3), wherein the numerical value is expressed by an evaluation method using an airborne-sound-insulation rating curve (D curve) as defined by the Architectural Institute of Japan.

[0193] The sound insulation performance in each of Examples 11 to 13 and Comparative Examples 4 to 6 is shown in the following Table 4.

TABLE 4

	Example 11	Example 12	Example 13	Comparative Example 4	Comparative Example 5	Comparative Example 6
Sound Insulation Performance TLD value	56	53	51	56	52	50
Heat-Insulating and Sound-Absorbing Material	Example 2			Comparative Example 2		
Length-Weighted Average Fiber Diameter (μm)	4.3			7.8		
Density (Kg/m^3)	14			24		

[0194] As can be understood from Table 4, the partition walls of Examples 11 to 13 could obtain sound insulation performance equal or superior to the conventional partition walls of Comparative Examples 4 to 6.

[0195] Here, it is clear that the sound insulation performance is improved when the length-weighted average fiber diameter is less than 4.3 μm , and the density is greater than 24 kg/m^3 .

LIST OF REFERENCE SIGNS

[0196]

1, 11, 21: heat-insulating and sound-absorbing material

12, 22: first layer

13, 23: second layer

24: third layer
 100, 200, 300, 400, 500, 600: partition wall
 101: floor structure
 102: upper story structure
 5 110: wall base
 111: lower runner
 111A: sidewall
 111B: sidewall
 112: upper runner
 10 112A: sidewall
 112B: sidewall
 114: stud (cross-sectionally angular C shape)
 114A: sidewall
 114B: sidewall
 15 120: surface member
 121: underlying board
 122: overlaying board
 130: tapping screw
 132: backing pad
 20 140: hollow wall portion
 214: stud (cross-sectionally rectangular shape)
 214: sidewall
 214B: sidewall

Claims

1. A heat-insulating and sound-absorbing material comprised of an agglomerate of inorganic fibers,

30 wherein the agglomerate has a density of 10 to 20 kg/m³, and the inorganic fibers of the agglomerate have a length-weighted average fiber diameter of 2.0 to 8.7 μm , and wherein the agglomerate contains: 20 to 66% of inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm ; and 13 to 58% of inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more, wherein a sum of respective percents of the inorganic fibers having a length-weighted average

35 fiber diameter of less than 4.0 μm , inorganic fibers having a length-weighted average fiber diameter of 4.0 μm to less than 7.0 μm , and the inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more is 100%.
2. The heat-insulating and sound-absorbing material as recited in claim 1, wherein the agglomerate comprises a first

40 layer and a second layer which are laminated together and is formed in a plate-like shape, wherein inorganic fibers of the first layer have a length-weighted average fiber diameter greater than that of inorganic fibers of the second layer by 0.1 to 3.0 μm .
3. The heat-insulating and sound-absorbing material as recited in claim 1, wherein the agglomerate comprises a first

45 layer, a second layer and a third layer which are laminated together in this order and is formed in a plate-like shape, wherein inorganic fibers of the first layer and the third layer have a length-weighted average fiber diameter greater than that of inorganic fibers of the second layer by 0.1 to 3.0 μm .
4. The heat-insulating and sound-absorbing material as recited in any one of claims 1 to 3, wherein the agglomerate

50 comprises a plurality of layers which are laminated together and is formed in a plate-like shape, wherein inorganic fibers of an outermost one of the plurality of layers have a length-weighted average fiber diameter of 4.3 to 7.0 μm .
5. The heat-insulating and sound-absorbing material as recited in any one of claims 1 to 4, wherein the inorganic fibers

55 of the agglomerate have a length-weighted average fiber diameter of 3.8 to 5.3 μm .
6. The heat-insulating and sound-absorbing material as recited in any one of claims 1 to 5, wherein the agglomerate contains the inorganic fibers having a length-weighted average fiber diameter of 7.0 μm or more, in an amount of 13 to 33%.

7. The heat-insulating and sound-absorbing material as recited in any one of claims 1 to 6, wherein the agglomerate contains the inorganic fibers having a length-weighted average fiber diameter of less than 4.0 μm , in an amount of 41 to 66%.

8. The heat-insulating and sound-absorbing material as recited in any one of claims 1 to 7, wherein the inorganic fibers are glass wool.

9. The heat-insulating and sound-absorbing material as recited in any one of claims 1 to 8, wherein the agglomerate contains a binder for agglomerating the inorganic fibers, in an amount of 1.0 to 8.5% by weight, with respect to an overall weight of the agglomerate, the binder having a binder strength of 3.6 to 6.1 N/mm².

10. The heat-insulating and sound-absorbing material as recited in claim 9, wherein the binder includes a thermo-setting resin curable by a reaction selected from the group consisting of amidation reaction, imidization reaction, esterification reaction and transesterification reaction.

11. A partition wall comprising a hollow wall portion, and the heat-insulating and sound-absorbing material as recited in any one of claims 1 to 10, installed in the hollow wall portion.

12. The partition wall as recited in claim 11, which comprises:

a wall base comprising

a lower runner disposed on a floor structure,

an upper runner fixed to an upper story structure, and

studs built up vertically between the lower runner and the upper runner, by a single-runner and staggered-stud construction method, a single-runner and common-stud construction method, a single-runner and common-stud construction method using a staggered backing pad arrangement, a single-runner and staggered-stud construction method using a staggered backing pad arrangement, or a double-runner and parallel-stud construction method; and

surface members installed on each of transversely opposite sides of the wall base to extend from the floor structure to the upper story structure.

13. The partition wall as recited in claim 12, wherein the surface member is comprised of a board of a noncombustible material or quasi-noncombustible material, or of a laminate comprising the board.

14. The partition wall as recited in claim 12 or 13, wherein the surface member is comprised of a gypsum or fiber-reinforced gypsum board, or of a laminate comprising the gypsum or fiber-reinforced gypsum board.

15. The partition wall as recited in claim 13 or 14, wherein the surface member has a thickness of 20 mm or more.

FIG.1

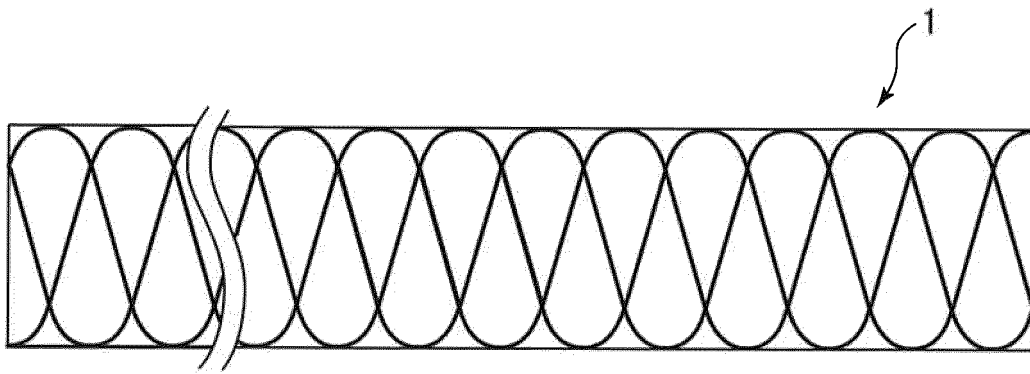


FIG.2

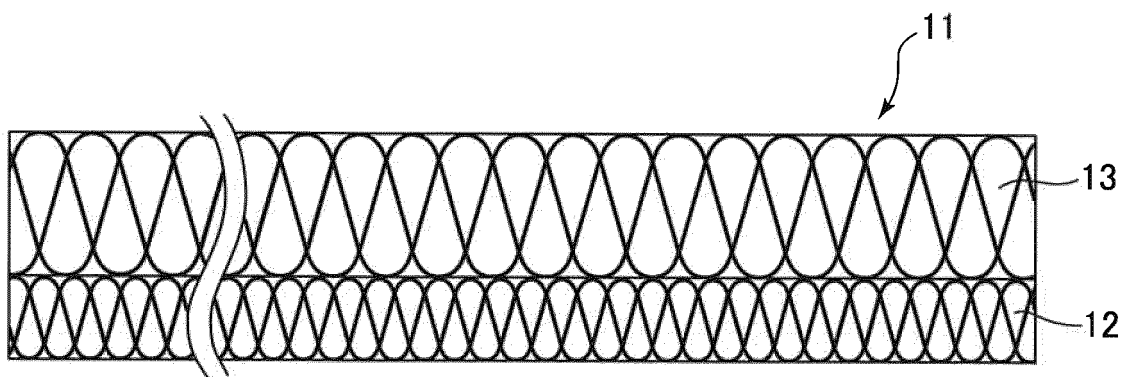


FIG.3

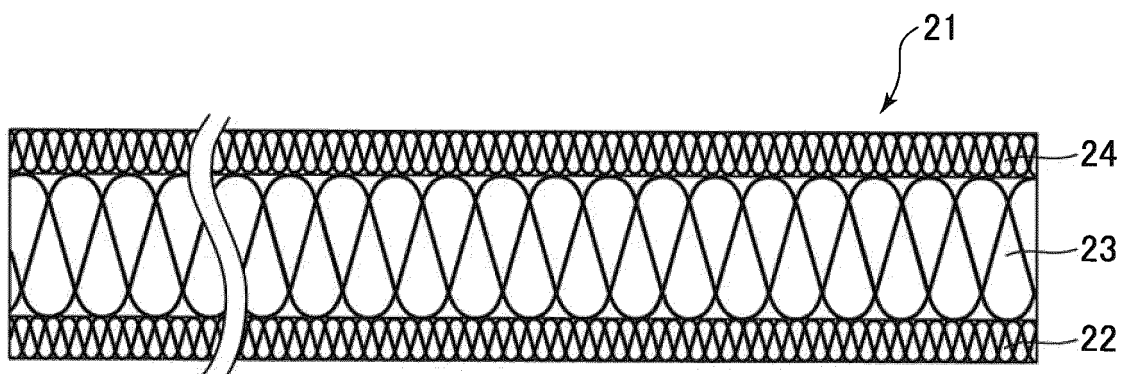


FIG.4

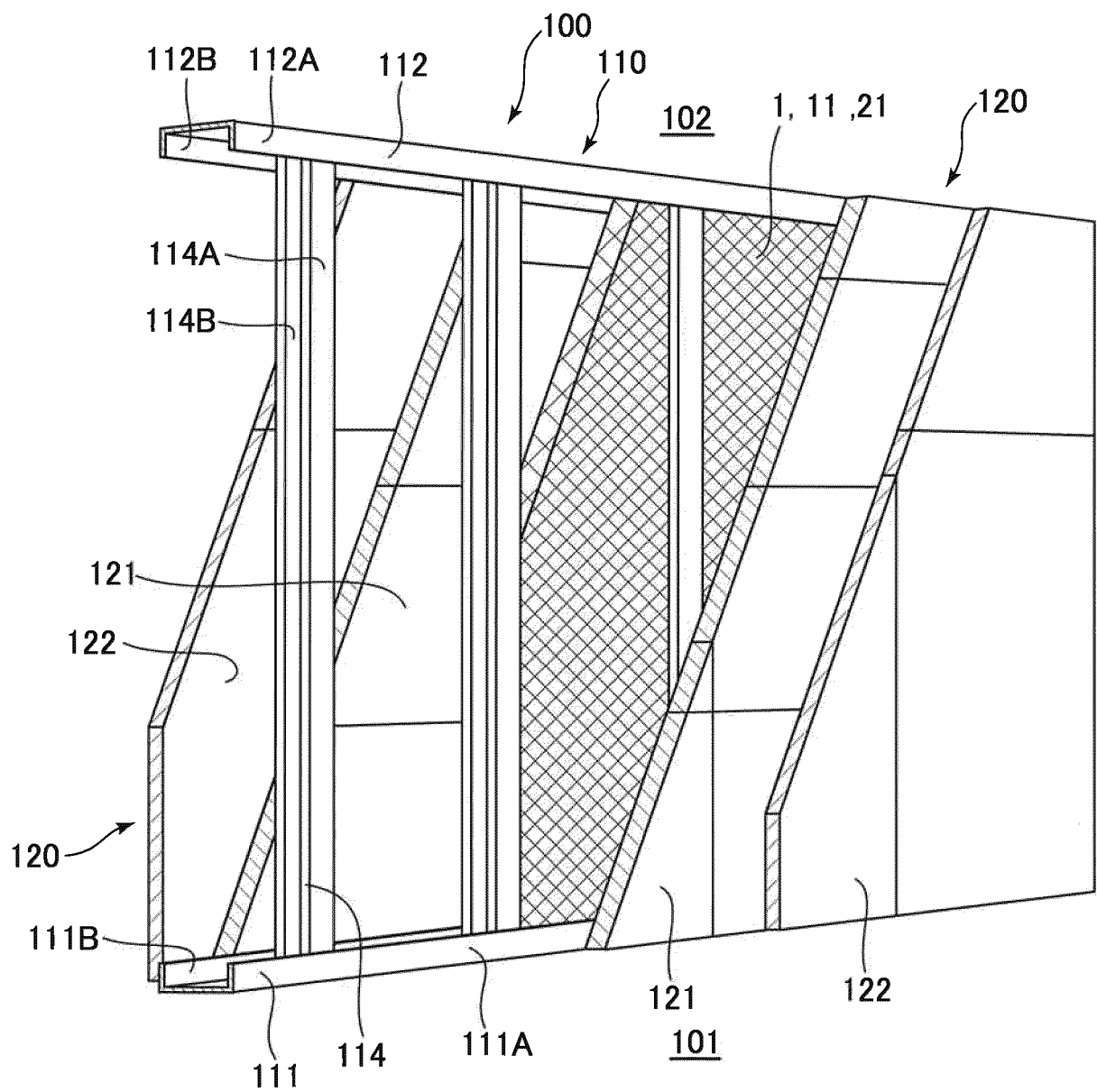


FIG.5

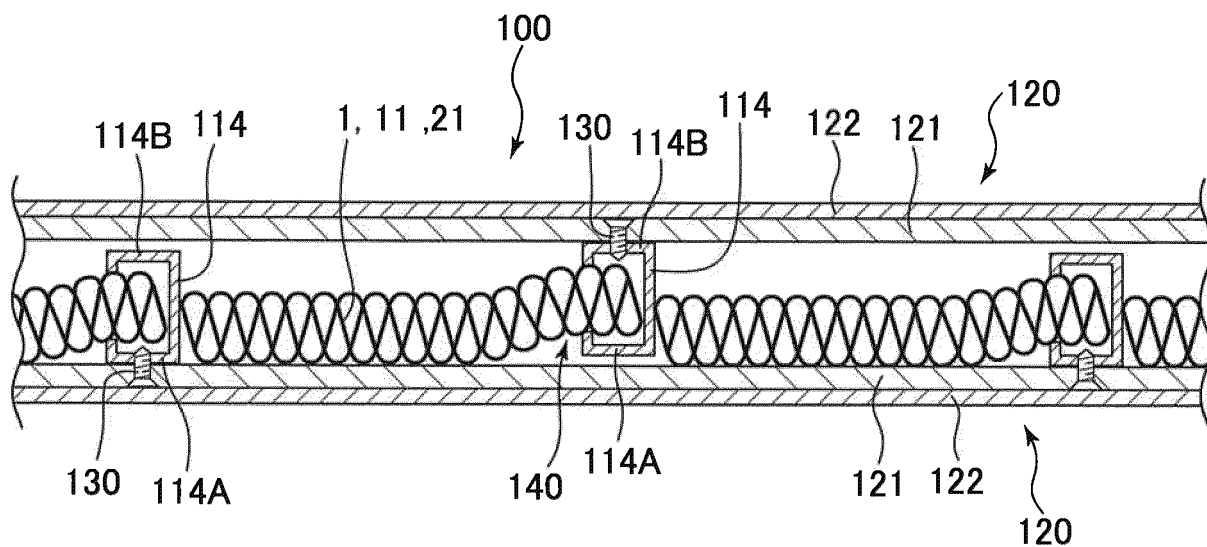


FIG.6

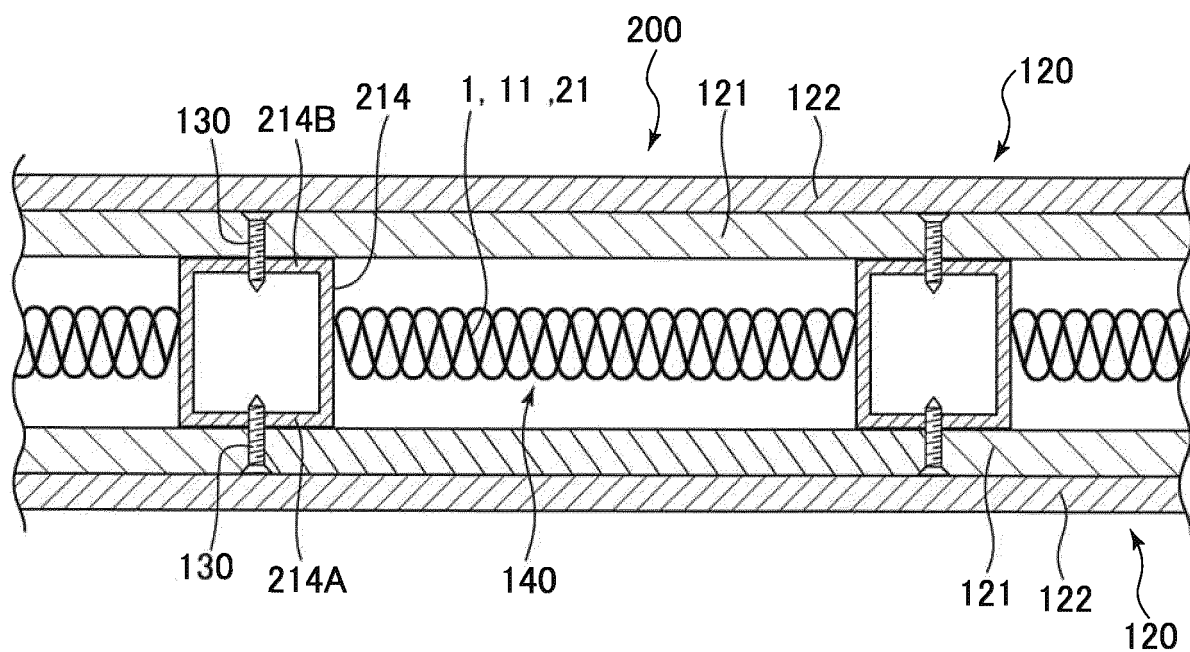


FIG.7

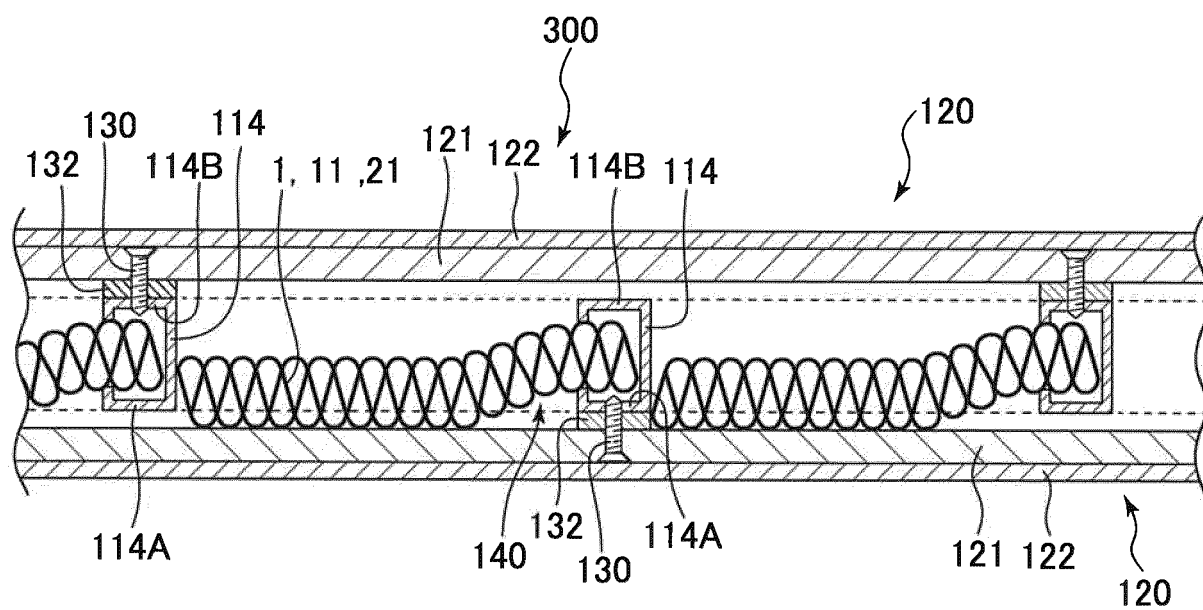


FIG.8

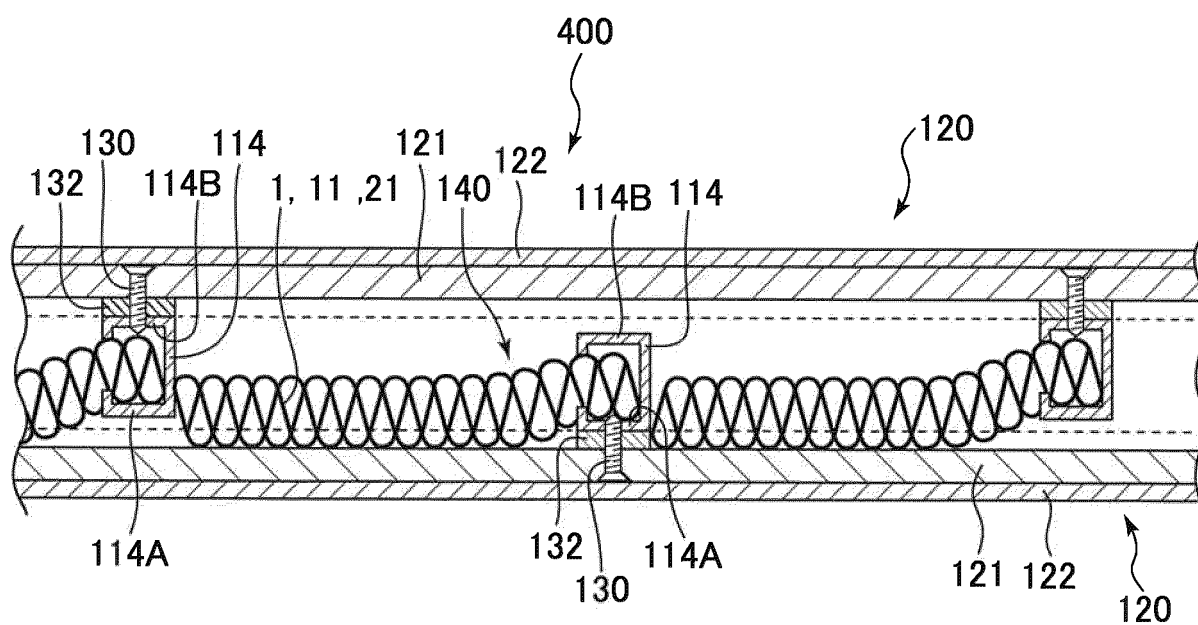


FIG.9

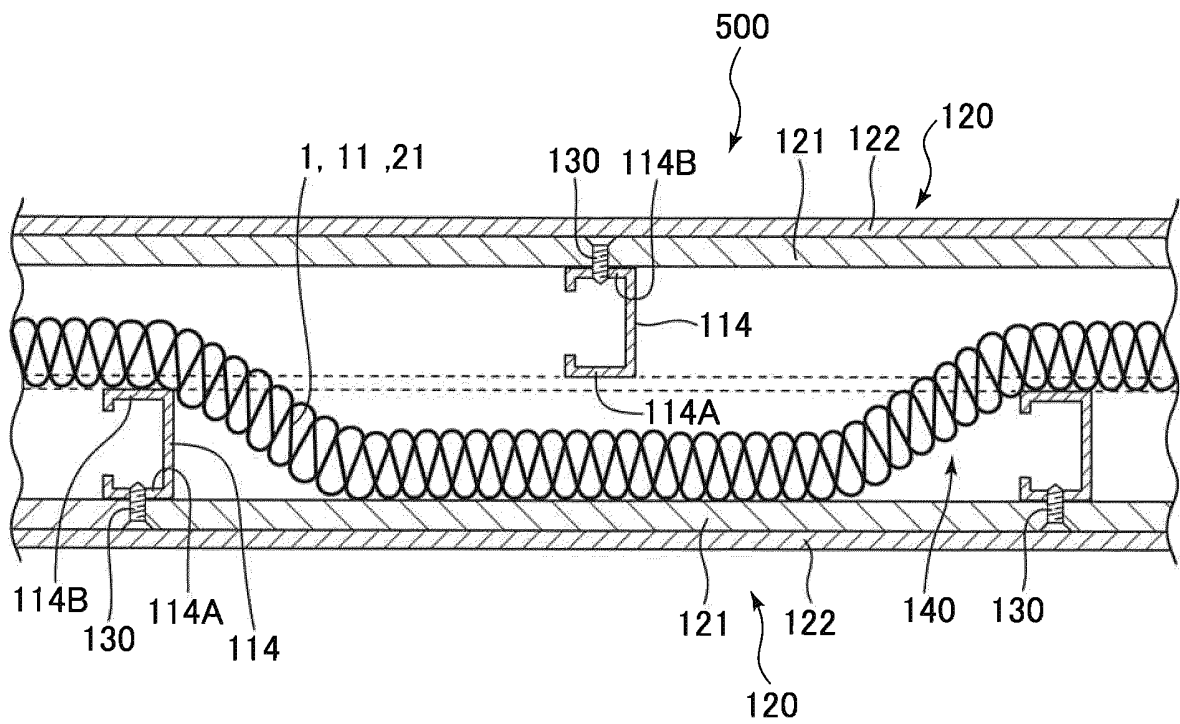
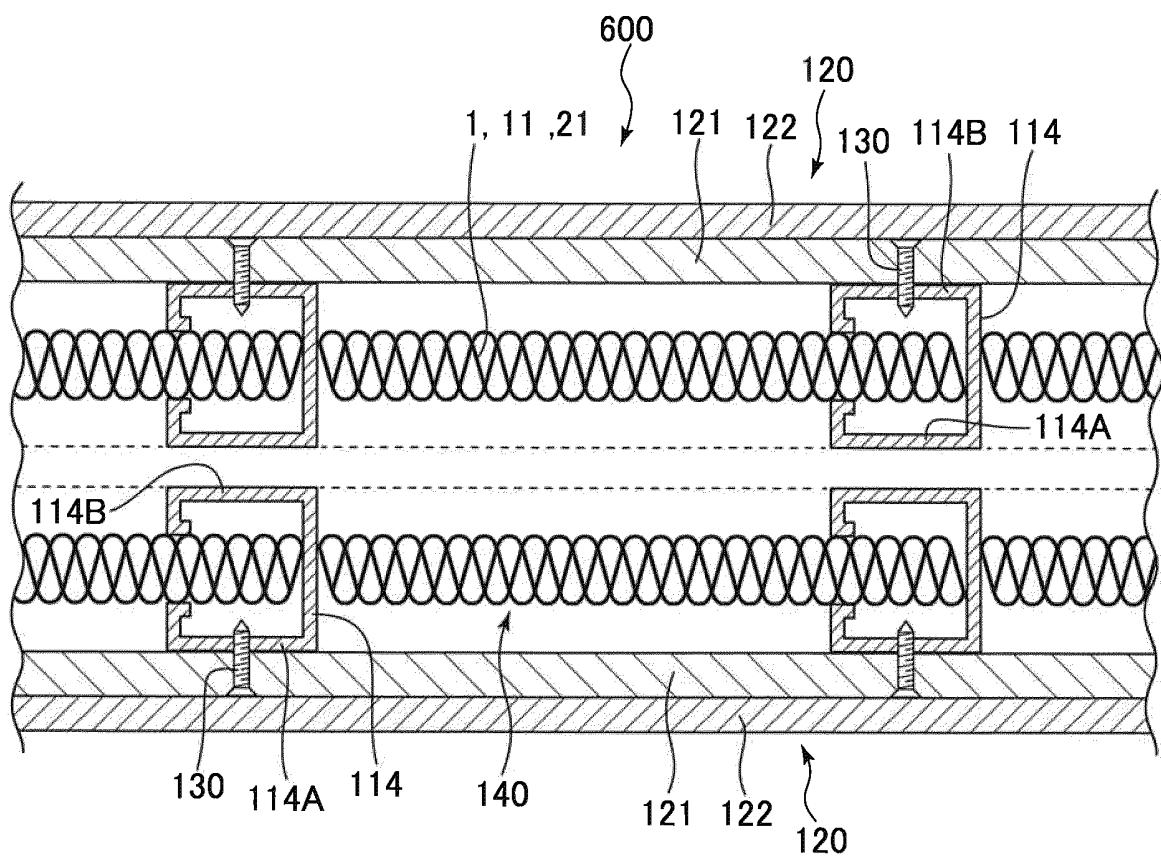


FIG.10



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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2020/032684

A. CLASSIFICATION OF SUBJECT MATTER

D04H 1/4209 (2012.01) i; D04H 1/4218 (2012.01) i; D04H 1/587 (2012.01) i; E04B 1/76 (2006.01) i; E04B 1/82 (2006.01) i; E04B 1/86 (2006.01) i; E04B 2/74 (2006.01) i

FI: E04B1/86 A; E04B1/82 W; E04B1/76 500F; E04B2/74 551A; D04H1/4209; D04H1/4218; D04H1/587

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

D04H1/4209; D04H1/4218; D04H1/587; E04B1/76; E04B1/82; E04B1/86; E04B2/74

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996

Published unexamined utility model applications of Japan 1971-2020

Registered utility model specifications of Japan 1996-2020

Published registered utility model applications of Japan 1994-2020

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 8-193370 A (ASAHI FIBER GLASS CO., LTD.) 30 July 1996 (1996-07-30) paragraphs [0014]-[0048]	1-15
Y	WO 2018/079529 A1 (OJI HOLDINGS CORPORATION) 03 May 2018 (2018-05-03) paragraphs [0019]-[0020]	1-15
Y	WO 2005/024107 A2 (PARAMOUNT GLASS MFG. CO., LTD.) 17 March 2005 (2005-03-17) specification, page 9, lines 10-24, fig. 6	2-15
Y	JP 2010-265645 A (YOSHINO GYPSUM CO., LTD.) 25 November 2010 (2010-11-25) paragraphs [0028], [0033], fig. 1-12	11-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"P" document published prior to the international filing date but later than the priority date claimed

"T"

later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X"

document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y"

document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&"

document member of the same patent family

Date of the actual completion of the international search
04 November 2020 (04.11.2020)

Date of mailing of the international search report
17 November 2020 (17.11.2020)

Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2020/032684

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
JP 8-193370 A	30 Jul. 1996	(Family: none)	
WO 2018/079529 A1	03 May 2018	US 2019/0247828 A1 paragraphs [0030]- [0031]	
WO 2005/024107 A2	17 Mar. 2005	EP 3530791 A1 US 2007/0017625 A1 paragraphs [0060]- [0061], fig. 6 US 2009/0004450 A1 paragraphs [0061]- [0062], fig. 6 EP 1669485 A2	
JP 2010-265645 A	25 Nov. 2010	(Family: none)	

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2010265645 A [0003]