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- **Togasaki, Takeshi**
Tokyo (JP)
- **Shirai, Seiichiro**
Nagareyama-shi, Chiba-ken (JP)
- **Onuki, Toshifumi**
Hamamatsu-shi, Shizuoka-ken (JP)
- **Sakakura, Masatoshi**
Hamamatsu-shi, Shizuoka-ken (JP)

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(71) Applicant: **NICHIAS CORPORATION**
Tokyo (JP)

(72) Inventors:
• **Kubo, Hiroaki**
Tokyo (JP)

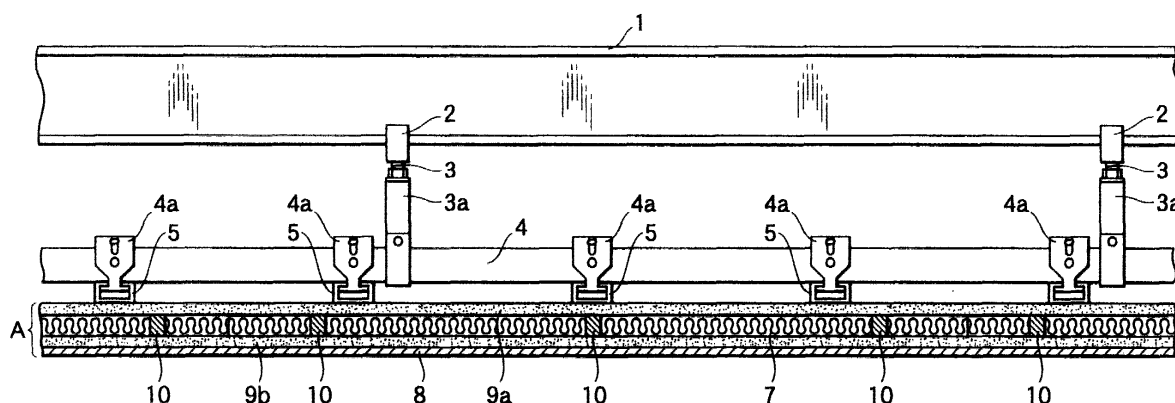
(74) Representative: **Allard, Susan Joyce et al**
BOULT WADE TENNANT,
Verulam Gardens
70 Gray's Inn Road
London WC1X 8BT (GB)

(54) **Refractory ceiling structure**

(57) A refractory ceiling structure makes it possible that it is superior structure for refractory performance, the roof-space is suit to exist only the minimum space for making construction of the cradling, and it can make wide of indoor space. The refractory ceiling structure is constituted in such a way that a refractory ceiling main

body is installed on a cradling provided in a roof space as a groundwork, and the refractory ceiling main body is constituted by inorganic fibriform heat insulating material, plaster boards superimposed at the both sides, and calcium silicate plate superimposed on plaster boards at the surface side of the ceiling.

FIG.1



Description

[0001] The present invention relates to a refractory ceiling structure which may be used in various kinds of buildings. More particularly, the present invention relates to an improved refractory ceiling structure which resists or prevents fire

[0002] A conventional general refractory ceiling structure is illustrated in Figure 7. In Figure 7: 1 is H-type steel frame beam provided at a rear side of a floor-slab of the upper stories; 2 is a cramp installed on the beam 1; 3 is a suspension bolt, which is screwed down from the cramp 2; 4 is a channel-type steel frame cradling receiver suspended with the suspension bolt 3; 5 is a channel-type steel frame cradling, which is fixed to the cradling receiver 4 by, for example, clips; 6 is an inorganic refractory board made of, for example, refractory plaster board or a calcium silicate plate with two layers, which is fixed to the cradling 5 by, for example, screws; and 7 is an organic fibriform blanket shaped heat insulating material made of, for example, rock wool or glass wool placed at the rear surface side of the inorganic refractory board.

[0003] In order to install the above described refractory ceiling structure, the suspension bolt 3 is hung from the steel-frame beam 1 in the roof-space. A light steel frame comprising the cradling receiver 4, the cradling 5 is then constructed. The inorganic fibriform blanket shaped heat insulating material 7 is then formed as a covering on the cradling 5. This is followed by screwing the inorganic refractory board 6 to the under side of the cradling 5.

[0004] In the above-described refractory ceiling structure, in order to cover the construction comprising the cradling receiver 4 and the cradling 5 with the blanket shaped heat insulating material 7, it is necessary to ensure that the roof-space is sufficiently wide to provide adequate working space at the time of construction. It is, however, difficult to form a covering of the blanket shaped heat insulating material 7 without leaving gap on the groundwork with severe rough such as the cradling 5, on the cradling receiver 4, the suspension bolt 3 and so forth. Furthermore, in order to enhance heat insulation, inserting the blanket shaped heat insulating material 7 with two-layers from the under side of the groundwork leads to additional complications.

[0005] The present invention aims to address at least some of the problems associated with the prior art. Accordingly, the present invention provides a refractory ceiling structure in which a refractory ceiling main body is installed on a cradling and the refractory ceiling main body is formed by inorganic fibriform heat insulating materials. Inorganic refractory boards superimposed at both sides of the inorganic fibriform heat insulating materials and inorganic refractory boards at the side of roof space may be provided and may be made of plaster board.

[0006] Spacers for adjusting the thickness may be provided in the organic fibriform heat insulating material in its position with required intervals.

[0007] The inorganic refractory board constituting the surface of the ceiling may be either two layers of plaster board or two layers of plaster board and calcium silicate plate.

[0008] The above and other objects and features of the invention will appear more fully hereinafter from a consideration of the following description taken in connection with the accompanying drawing wherein one example is illustrated by way of example, in which;

FIG. 1 is a sectional view of a refractory ceiling structure illustrating one embodiment of the present invention;
 FIG. 2 is a perspective view illustrating one embodiment of an inorganic fibriform heat insulating material;
 FIG. 3 is a sectional view of the refractory ceiling structure according to an embodiment of the present invention, which is constituted for the sake of refractory test;
 FIG. 4 is a sectional view of the conventional refractory ceiling structure, which is constituted as a comparison example 1 of the refractory test;
 FIG. 5 is a sectional view of the conventional refractory ceiling structure, which is constituted as a comparison example 2 of the refractory test;
 FIG. 6 is a graph illustrating a result of the refractory test; and
 FIG. 7 is a perspective view of the conventional refractory ceiling structure.

[0009] Embodiments of the present invention will now be described in detail with reference to accompanying drawings.

[0010] A preferred embodiment, as illustrated in FIG. 1, is that a refractory ceiling main body A, which is installed to a cradling 5 provided in the roof space as a groundwork, is constituted by an inorganic fibriform heat insulating material 7, plaster boards 9a, 9b superimposed at the both sides of the inorganic fibriform heat insulating material 7, and a calcium silicate plate 8 superimposed on the plaster board 9b at the front side of the ceiling.

[Embodiment]

[0011] One embodiment of the present invention will be illustrated in FIG. 1 and FIG. 2. Further, the same signs are

added to elements which are the same as that of FIG. 7 or which are similar to that of FIG. 7.

[0012] In FIG. 1 to FIG. 2, 1 is a steel frame beam, 2 is a cramp, 3 is a suspension bolt, 3a is a hanger, 4 is a cradling receiver, 4a is a clip and 5 is a cradling.

[0013] In the present embodiment, the refractory ceiling main body A installed on the above-described cradling 5 is constituted by the inorganic fibriform heat insulating material 7 (hereinafter referred to as heat insulating material), the plaster boards 9a and 9b superimposed at the both sides of the heat insulating material 7 and the calcium silicate plate 8 which is superimposed on the plaster board 9b at the front side of the ceiling.

[0014] Further, in the inorganic fibriform heat insulating material 7, for the sake of an object described later, a wooden rod with a degree of a diameter of 10 mm to 20 mm or an acrylic resin pipe or so forth which is cut into a column shaped spacer 10 with a thickness of the heat insulating material is crammed into parts with required intervals.

[0015] In order to install to construct the refractory ceiling main body A on the cradling, in the first place, the plaster board 9a is made to screw to the cradling 5, followed by fastening the heat insulating material 7 with a screw while passing through a plane washer. Subsequently, the ceiling surface is constituted in such a manner as to screw to fasten the plaster board 9b and the calcium silicate plate 8 at the lower side of the heat insulating material. In the example illustrated, the plaster board and the calcium silicate board are installed as the refractory board 9b of the lower side. However, it is suitable to employ only the inorganic refractory board such as the calcium silicate plate, or only plaster board or the like except for the above example.

[0016] In the above-described execution, if the plaster board 9b is made to screw from the lower side of the heat insulating material 7, and if the heat insulating material is hard in some degrees, it is possible to screw to fasten as it is by giving a circular hollow to a position of screw fastening of the plaster board (or calcium silicate plate) corresponding to thickness of the head of the screw beforehand.

[0017] Here, in a case where the heat insulating material 7 is soft, thickness of the heat insulating material is decreased as the plaster board 9b is made to screw from the lower side of the heat insulating material. However, as described-above, the thickness of the heat insulating material is not decreased by employing the heat insulating material 7 with the spacer 10 crammed.

[0018] According to this disposition, it is possible to keep the heat insulating material with required thickness, thus the plaster board 9b can be made to put up at the joint section without a difference in level. It is suitable to determine an interval of the spacer 10, which is made to enter into the heat insulating material 7, to the same pitch as a screw-pitch of the plaster board 9b superimposed on the heat insulating material 7.

[0019] Further, if a size of the spacer is a degree of a diameter of 10 to 20 mm, even though the spacer is inflammable material, there is no influence on the occasion of a fire.

[0020] According to the above-described constitution of the refractory ceiling structure, it becomes possible to carry out the execution if there is only space for combining the cradling in the roof space. As a result, it is possible to narrow down the roof space considerably, consequently, difficult work for covering the heat insulating material on the cradling is omitted. Further, the indoor space becomes broad while corresponding to the space of the roof space in connection with its narrowed space.

[0021] In the above-described plaster board constituting the refractory ceiling structure, generally the plaster board is capable of employing goods on the market. However, the plaster board with thickness more than 9.5 mm, and the specific gravity more than 0.65 is employed. The thickness and the specific gravity of the plaster board is made to change in accordance with refractory time that is required. It is preferred to employ the plaster board with thickness more than 9.5 mm in refractory of one hour, and the plaster board with thickness more than 12.5 mm in refractory two hours. If the thickness is thin, the refractory time that is required can not be kept.

[0022] As the inorganic fibriform blanket heat insulating material 7, it is possible to employ the heat insulating material such as rock wool, glass wool and so forth and blanket shape, felt shape, board shape and so forth respectively. However, in order to improve construction property with performance of two hours of refractory, a method with density of 100 to 200 kg/m³ and thickness of degree of 20 to 40 mm is preferred.

[0023] In addition thereto, in the above-described refractory ceiling structure, when a fire occurs indoor side, since the plaster board 9a is covered with upper side (side of roof space) of the heat insulating material 7, evaporation of water of crystallization of this plaster board is suppressed by the heat insulating material 7. For that reason, it is possible to design improvement of refractory performance.

[0024] When the indoor side of the heat insulating material 7 is covered by the plaster board 9b, even though some differences in level at the joint section exist, if further more than one layer board is covered at the lower side of this plaster board 9b, the difference in level of the joint section is solved. Evaporation of water of crystallization of the plaster board brings no preservation property of the board. Therefore, in a case where a more one layer board is covered at under side of the plaster board 9b, if the calcium silicate plate 8 is covered as the above embodiment, it is possible to prevent falling of the plaster board 9b. For that reason, refractory performance is more improved.

[0025] It is suitable that the above-described plaster board 9b is fundamentally the same method as that of the plaster board 9a.

[0026] The calcium silicate plate 8 is appropriate in that the plate is capable of supporting weight of the plaster board 9b when the plate 8 is heated from the indoor side. It is preferable that a plate thickness is more than 6 mm in the case of refractory one hour, or a plate thickness is more than 8 mm in the case of refractory two hours as a standard, and that specific gravity is more than 0.8.

[0027] Further, when the plaster board 9b is covered, also it is possible to cope with a roof space fire time, and refractory performance is enhanced in that evaporation of the water crystallization of the plaster board 9b is suppressed by the heat insulating material 7.

[0028] Furthermore, when it is intended to cope with also a fire from the roof space, it is desirable to use thickness of steel material of the cradling 5 more than 0.8 mm in order to suppress deformation of the cradling.

[0029] Here, the refractory ceiling structure according to the embodiment of the present invention illustrated in FIG. 3 and the conventional refractory ceiling structure illustrated in FIG. 4 and FIG. 5 are taken to be test samples. A result of a refractory test depending on indoor side heating on the basis of BS 476 : PART 22 is shown in a graph of FIG. 6 and table 1.

EMBODIMENT A (FIG. 3)

[0030] A method is that a steel made channel type cradling 5 whose dimension is of 50 mm in width, 25 mm in height, and 0.5 mm in thickness is inserted with 305 mm in pitch, a board shaped rock wool heat insulating material 7 whose dimension is of 25 mm in thickness, and 150 kg/m² in density intervenes between plaster boards 9a, 9b of 12.5 mm in thickness ($\rho = 0.7$), and a calcium silicate plate 8 of 9 mm in thickness ($\rho = 0.85$) is superimposed on the plaster board 9b at the lower side.

COMPARISON EXAMPLE B(FIG. 4)

[0031] A method is that the cradling 5 of the above embodiment is inserted with 305 mm in pitch, two layers of calcium silicate plates 8 of 9 mm in thickness ($\rho = 0.95$) are covered at the lower side of the cradling 5, and a felt shaped rock wool heat insulating material 7 whose dimension is of 100 mm in thickness, and 105 kg/m² in density is covered on the cradling 5.

COMPARISON EXAMPLE C (FIG. 5)

[0032] A method is that the cradling 5 of the above embodiment is inserted with 305 mm in pitch, two layers of plaster boards 9a and 9b of 12.5 mm in thickness ($\rho = 0.7$) are covered at the lower side of the cradling 5, further, calcium silicate plates 8 of 9 mm in thickness ($\rho = 0.85$) is covered at the lower side thereof, and a felt shaped rock wool heat insulating material 7 whose dimension is of 100 mm in thickness, and 105 kg/m² in density is covered on the cradling 5.

[TABLE 1]

Result of the Refractory Test

Structure	Surface weight (kg/m ²)	Thickness (mm)	Flame screening property
Embodiment A	29	59	○
Comparison example B	28	118	○
Comparison example C	36	134	× (at 114 minutes)

(continued)

(continued)

Average surface temperature (120 minutes), maximum one (°C) Heat screening property		Decision
Average 102	Maximum 116 ○	○
Average 239	Maximum 270 ×	×
Average 205	Maximum 610 × (at 114 minutes)	×

[0033] Decision reference in the Table

Heat screening property : average surface temperature < 140 °C + initial temperature : maximum surface temperature < 180 °C + initial temperature

Flame screening property : a crevice capable of being passed by a flame during heating does not occur

Decision : the heat screening property and the flame screening property are satisfied at 120 minutes

[0034] As shown in the above refractory test result (Table 1 and the graph of FIG. 6), at the first place, the embodiment A is compared with the comparison example B. Even though thickness of the ceiling is decreased into half under the same surface weight, it is ascertained that the embodiment A is considerably more superior than a conventional structure in connection with its heat screening property in the refractory performance. This is the reason why sharp evaporation of the water crystallization of the plaster board at the side of non heating surface is suppressed by the rock wool heat insulating material. The same effect about heating from the roof space can be found.

[0035] With respect to the comparison example C, preservation property of the plaster board disappears caused by heating, thus the calcium silicate plate existing at the under surface thereof can not withstand weight of two layers of the plaster boards. Subsequently, all of the calcium silicate plate and two layers of the plaster board are felled at the time of 114 minutes, and the rock wool heat insulating material is heated directly, then the flame is leaked from the joint section caused by contraction, as a result, rear surface temperature increases sharply.

[0036] In the structure (FIG. 3) according to the present invention, the plaster board is one layer, and the calcium silicate plate 8 is fastened at the under side of the plaster board 9b by the screws, accordingly, even though the preservation property of the plaster board 9b disappears, fall of a ceiling side panel does not occur due to the calcium silicate plate 8. Further, after evaporation of the water crystallization of the plaster board 9b, even though the rock wool heat insulating material 7 is contracted in some degree caused by heating, a flame is not leaked due to the plaster board 9a placed on the heat insulating material 7, thus a rise of a rear surface temperature is suppressed due to the water crystallization of the plaster board 9a.

[0037] As described specifically above, according to the present invention, the roof-space is suit to exist only the minimum space for making construction of the cradling in comparison with the conventional refractory ceiling structure, thus, it can not only make wide of corresponding indoor space thereto, but it is not necessary to make difficult work to cover the blanket shaped heat insulating material on the cradling. Such a refractory ceiling structure can be obtained easily. Further, since the plaster board is covered on the side of the roof space of the inorganic fibriform heat insulating material, evaporation of the water crystallization of the plaster board is suppressed. The refractory property is improved in spite of the same weight.

[0038] The present invention is not limited to the above described embodiments, and various variations and modifications may be possible without departing from the scope of the present invention.

Claims

1. A refractory ceiling structure comprising:

a first inorganic refractory board installed on a cradling;
a second inorganic refractory board; and
an inorganic heat insulating material arranged between the first inorganic refractory board and the second inorganic refractory board.

2. A refractory ceiling structure according to claim 1, wherein said first inorganic refractory board is a plaster board.

3. A heat ceiling structure according to claim 1 or claim 2, wherein said ceiling structure has a plurality of spacers which are buried in said inorganic heat insulating material.

4. A refractory ceiling structure according to any one of claims 1 to 3, wherein a third inorganic refractory board is installed on said second inorganic refractory board.

5. A refractory ceiling structure according to claim 4, wherein said third inorganic board is a calcium silicate plate.

6. A refractory ceiling structure according to any one of claims 1 to 5, wherein said second inorganic refractory board is a plaster board.

7. A refractory ceiling structure according to any one of claims 3 to 6, wherein said spacer has a column shape with diameter of from 10 to 20 mm.

8. A refractory ceiling structure according to any one of claims 2 to 7, wherein the plaster board has a thickness of ≥ 9.5 mm.

9. A refractory ceiling structure according to any one of claims 1 to 8, wherein the inorganic heat insulating material has a density of from 100 to 200 kg/m² and/or a thickness of from 20 to 40 mm.

10. A refractory ceiling structure according to any one of claims 5 to 9, wherein the calcium silicate plate has a thickness of ≥ 6 mm and/or a specific gravity of ≥ 0.8 .

FIG.1

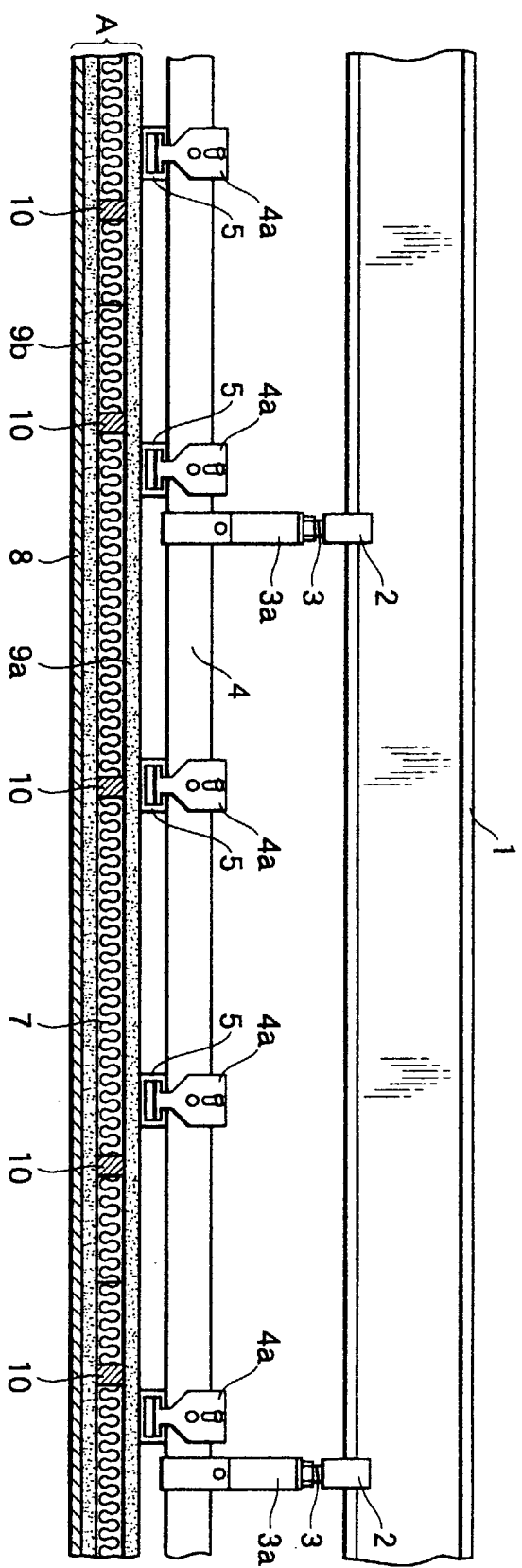


FIG.2

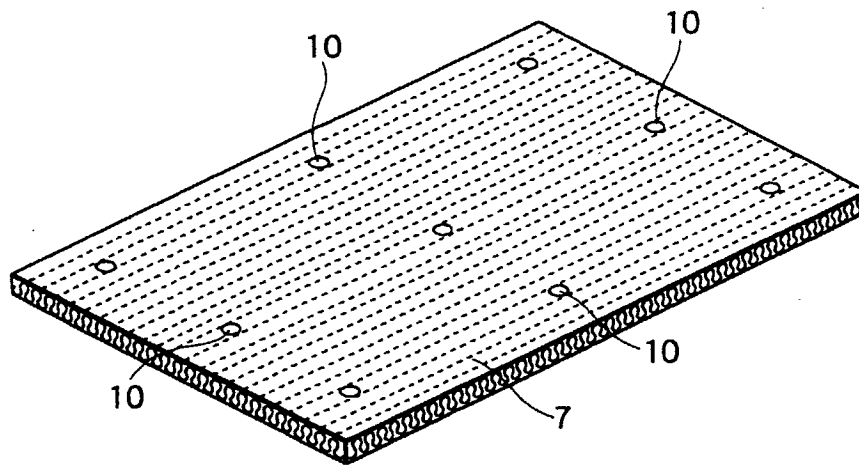


FIG.3

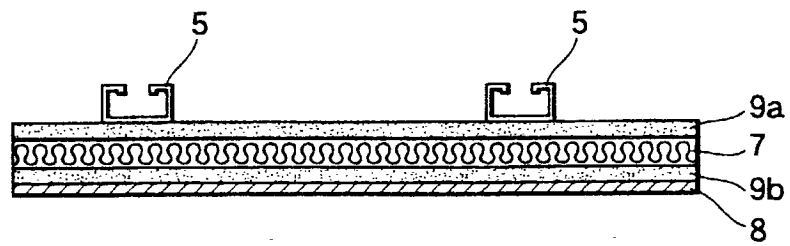


FIG.4

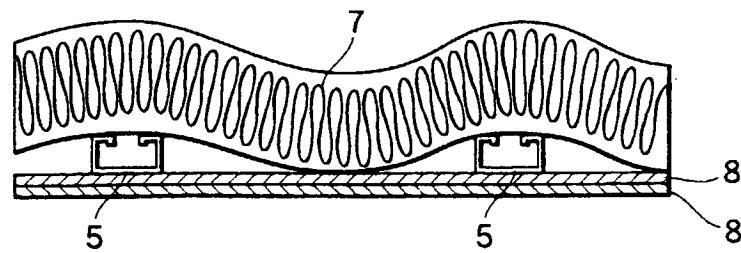


FIG.5

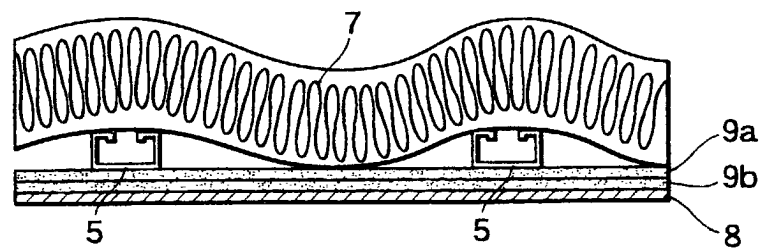


FIG.6

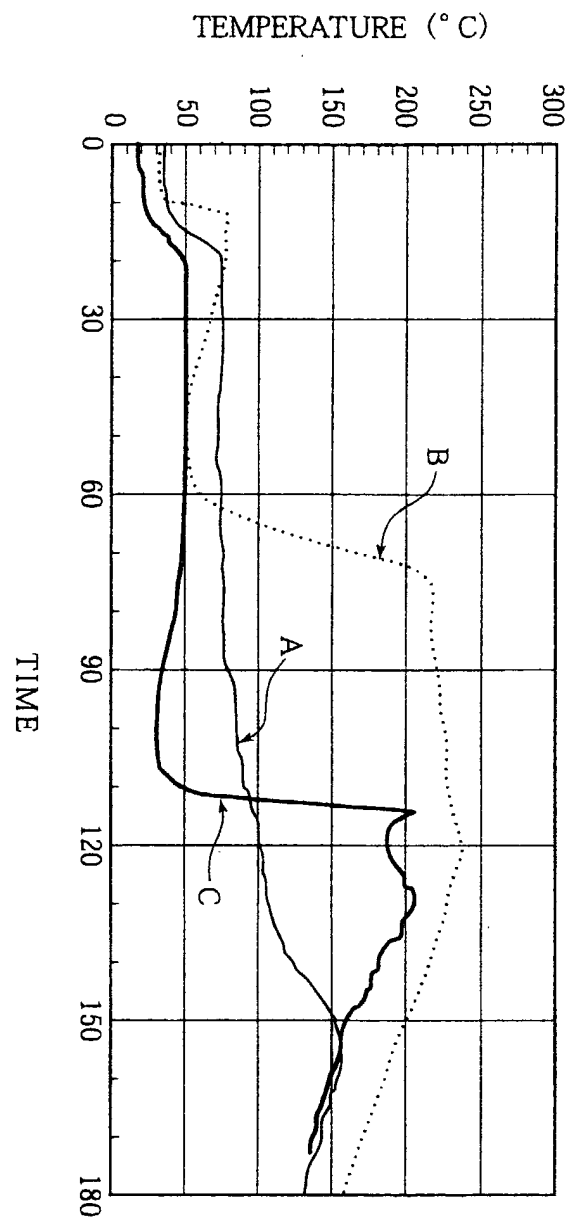


FIG. 7

