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(54) **FLOOR SHEET ASSEMBLY**

(75) Inventors: **Naoto Ishii**, Saitama (JP); **Yasuyuki Tamane**, Saitama (JP); **Mitsuhiko Nishizaka**, Saitama (JP); **Kaoru Aoyagi**, Saitama (JP); **Kazutaka Ano**, Saitama (JP)

Correspondence Address:  
**AREN'T FOX PLLC**  
**1050 CONNECTICUT AVENUE, N.W.**  
**SUITE 400**  
**WASHINGTON, DC 20036 (US)**

(73) Assignee: **HONDA MOTOR CO. LTD**

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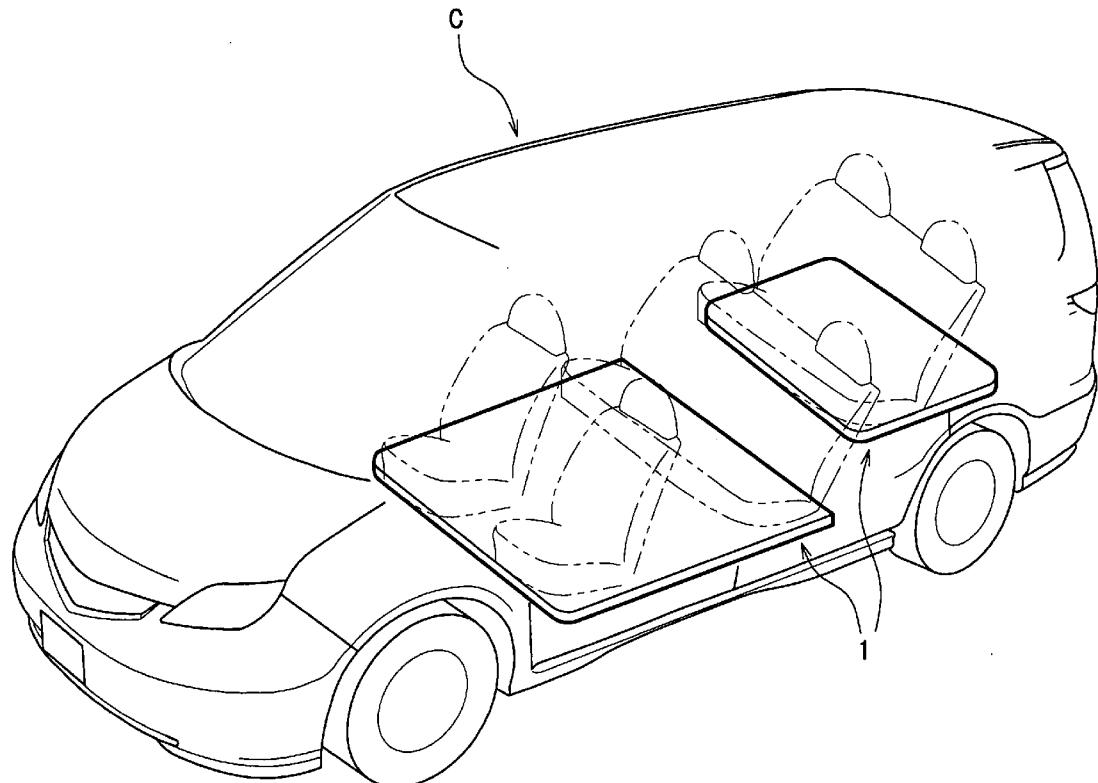
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(57) **ABSTRACT**

A floor sheet assembly has an intermediate member and a pair of sheet members. The intermediate member includes at least a thin panel, on which a plurality of hollow projections is formed. The pair of sheet members sandwiches the intermediate member. The intermediate member and the pair of sheet members form a honeycomb structure.



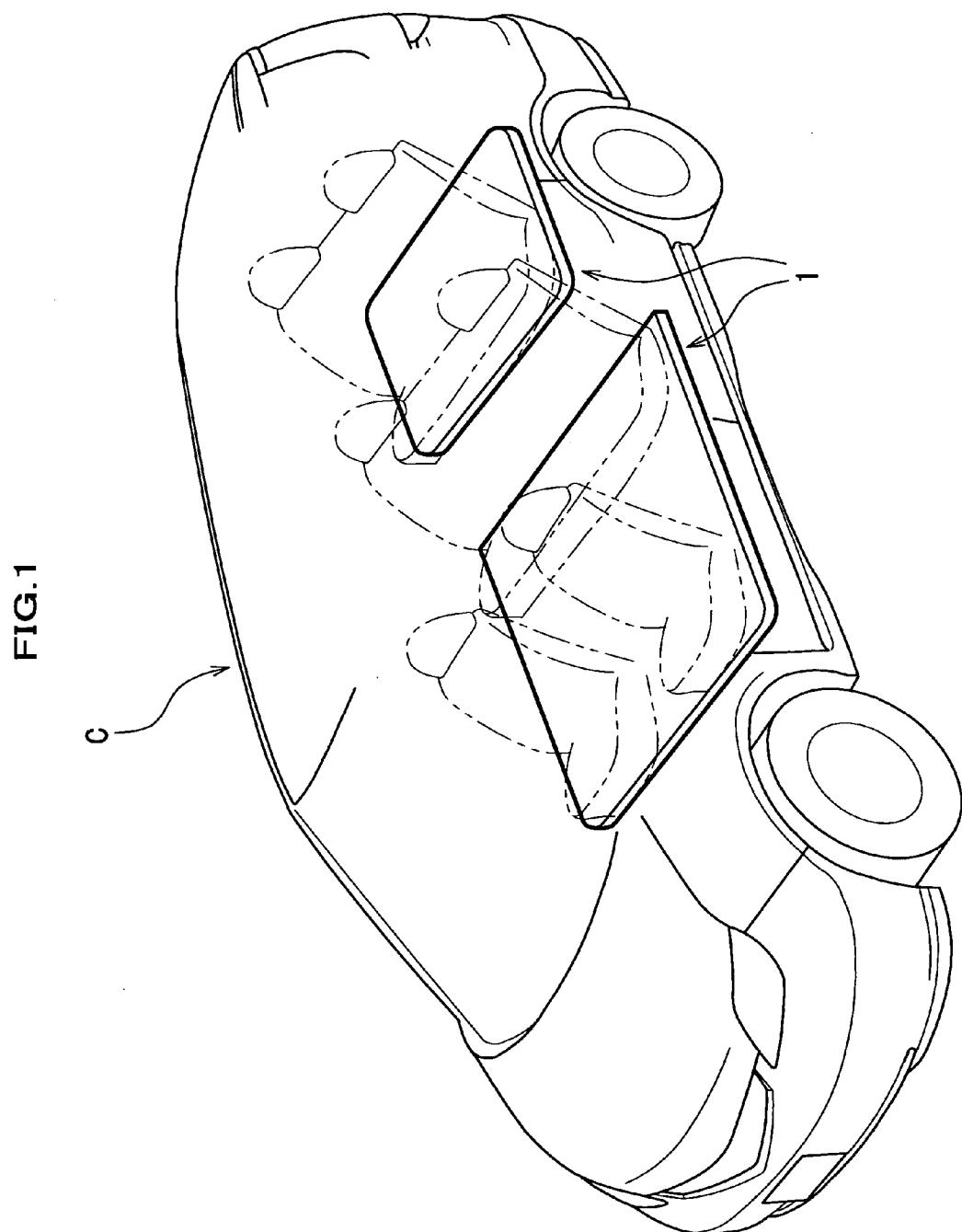


FIG.2

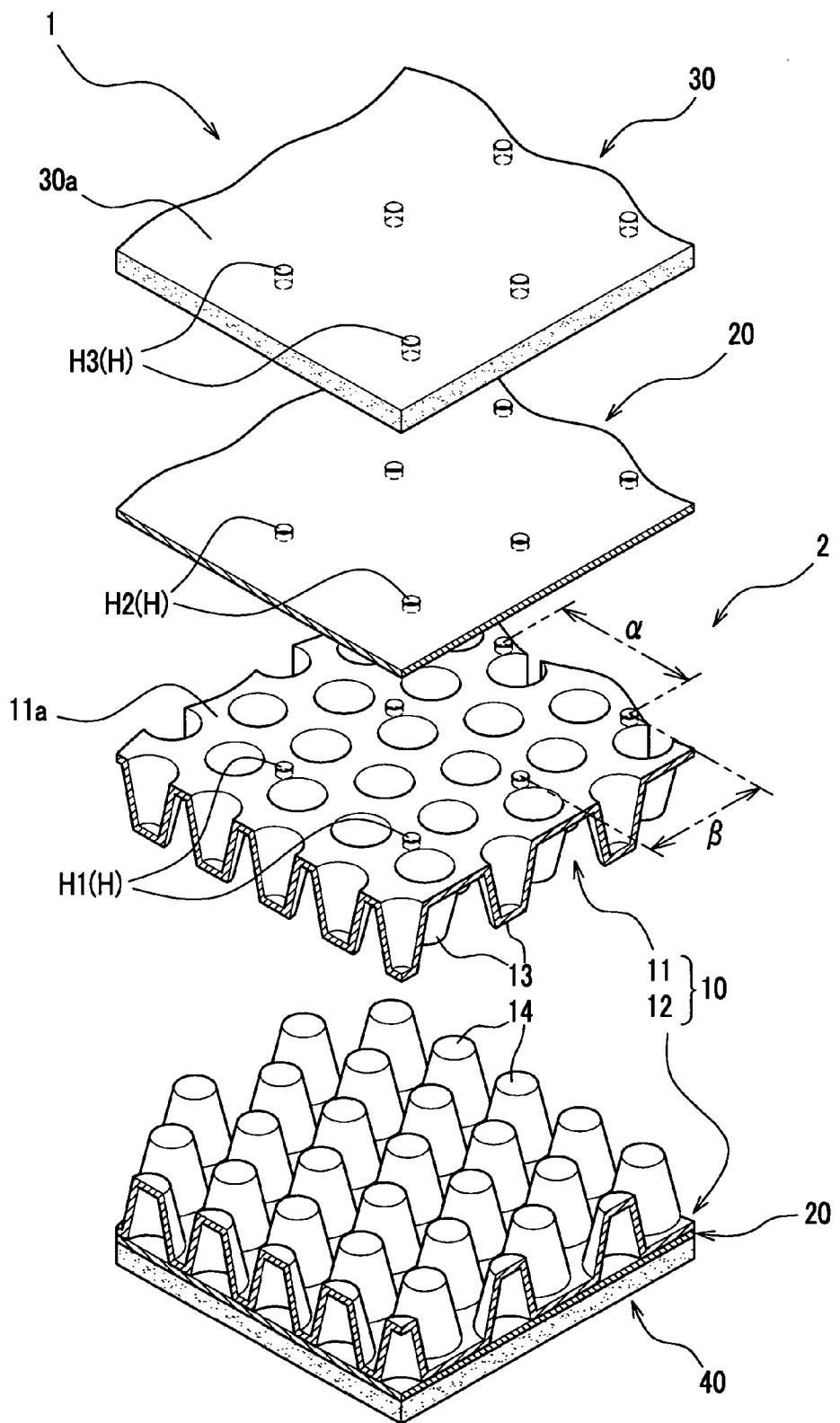


FIG.3A

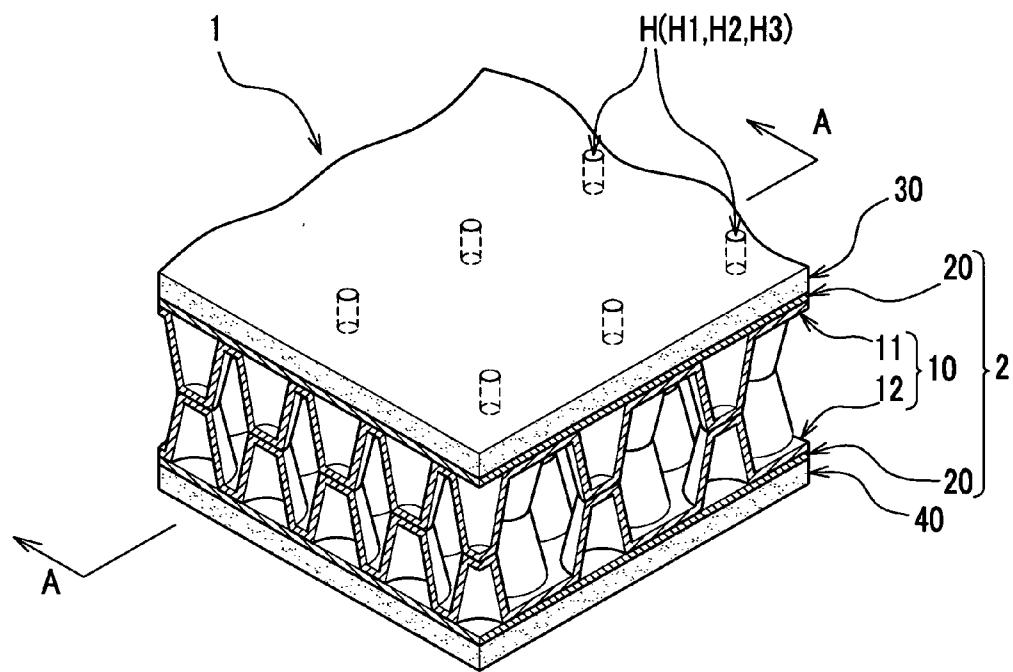


FIG.3B

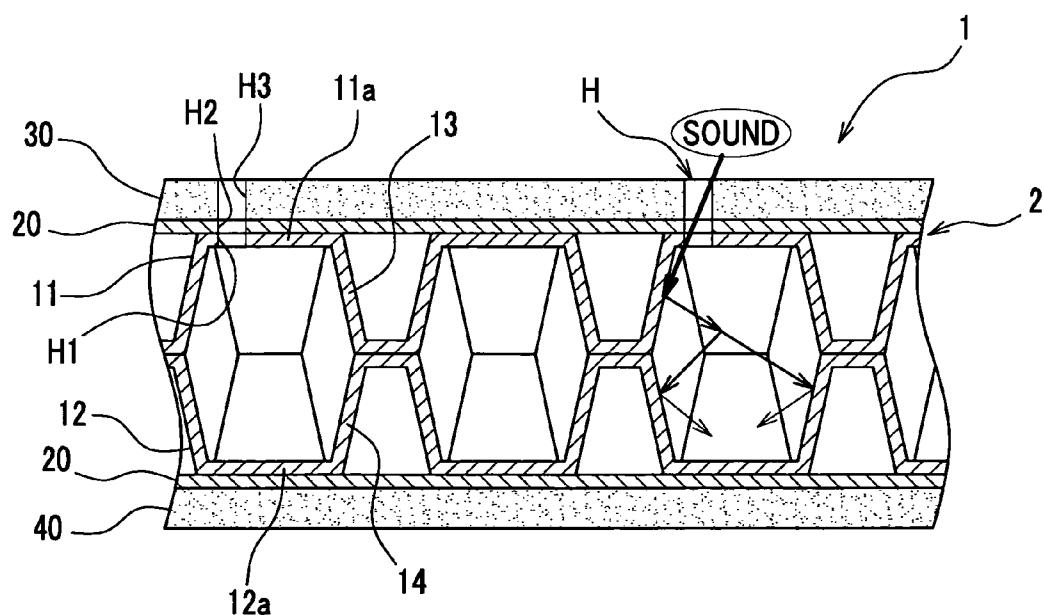
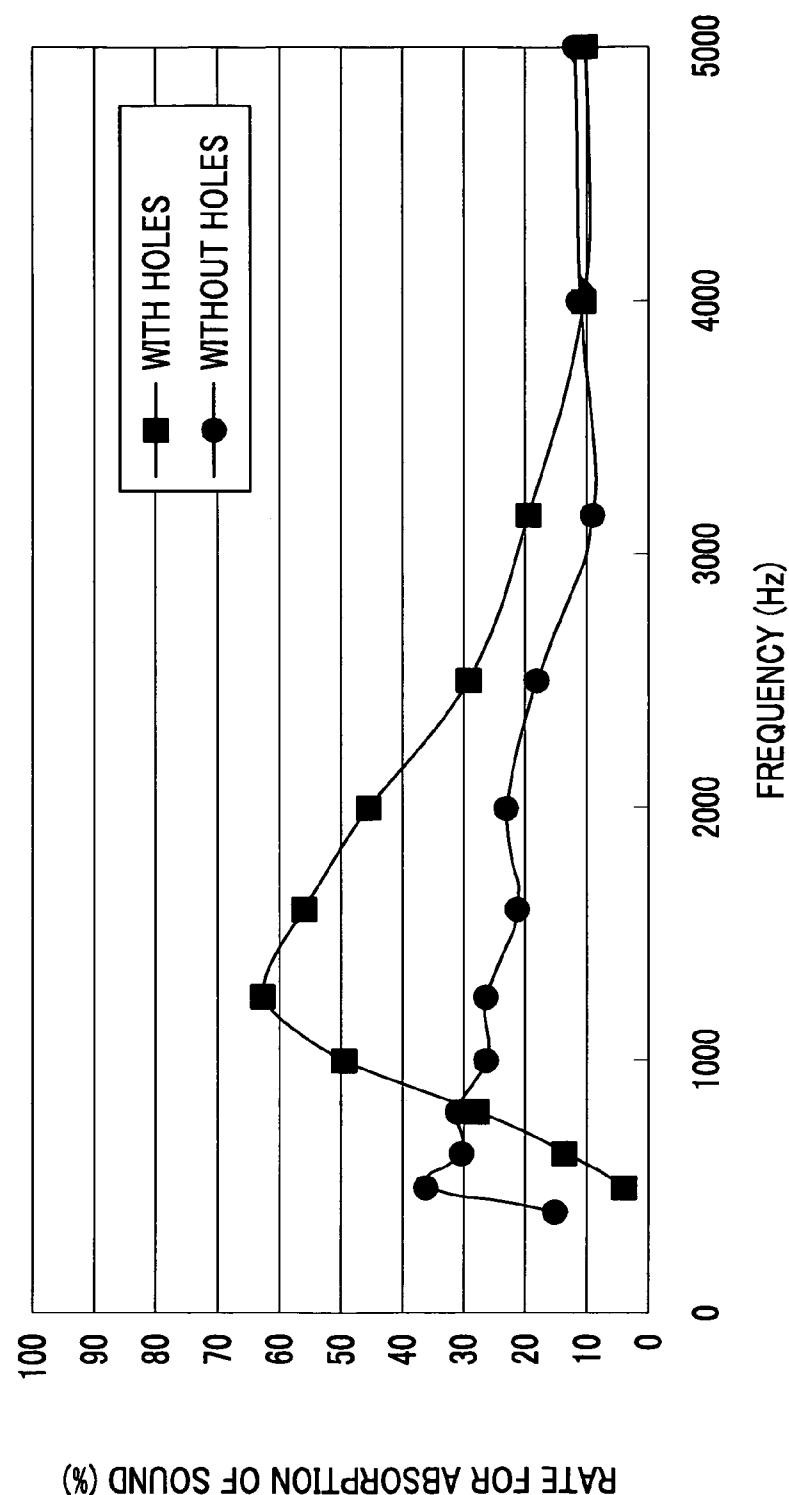


FIG.4



## FLOOR SHEET ASSEMBLY

### BACKGROUND OF THE INVENTION

[0001] The present invention relates to a floor sheet assembly, which is attached to a floor of a vehicle or house.

[0002] A floor sheet used for a room of a house is known, which employs flooring that is decorated with grain and bonded to a sheet of plywood (See patent document 1, for example). Because such a floor sheet not only is more elaborately designed than a carpet used for a vehicle but also has a characteristic of washability, it has been expected that such a floor sheet will be applied to a vehicle, a minivan, for example.

Patent document 1: Japanese Published Patent Application 11-62197

[0003] However, it has not been appropriate that the floor of a vehicle should be covered with a conventional floor sheet without modification, which is developed for application to a house. This is attributed to the fact that this conventional floor sheet is adapted to be relatively thick so as to increase its sound absorption and stiffness, which leads to an increase in a gross weight of the vehicle.

### SUMMARY OF THE INVENTION

[0004] The present invention seeks to provide a floor sheet assembly which is able not only to restrain an increase in a gross weight of a vehicle, but also to increase sound absorption as well as stiffness of the vehicle.

[0005] It is an aspect of the present invention to provide a floor sheet assembly, which comprises an intermediate member and a pair of sheet members. The intermediate member includes at least a thin panel, on which a plurality of hollow projections is formed. The pair of sheet members sandwiches the intermediate member. The intermediate member and the pair of sheet members form a honeycomb structure.

[0006] The invention described above, which introduces the honeycomb structure that has a plurality of spaces defined by the intermediate member and the pair of sheet members, excels in its light weight and high stiffness. If the floor sheet assembly according to the invention is applied to a floor of a vehicle, for example, it is possible not only to restrain an increase in a gross weight of the vehicle but also to increase sound absorption and stiffness of the floor.

[0007] It is another aspect of the present invention to provide a floor sheet assembly, in which an intermediate member has a plurality of thin panels and a plurality of hollow projections formed on one thin panel abuts a plurality of hollow projections formed on another thin panel.

[0008] The invention described above, which provides a larger space within the intermediate member without increasing a height of the projections, is able to increase not only stiffness but also impulse absorption and sound absorption of the floor sheet assembly.

[0009] It is still another aspect of the present invention to provide a floor sheet assembly, in which holes providing fluid communication with outside air to space within a honeycomb structure are bored at least on one side of the floor sheet assembly.

[0010] The holes described above are bored in the following manner. The holes are bored in both sheet member and solid portion of a thin panel at overlapping locations. In contrast, the holes are bored only in the sheet member at locations where the sheet member confronts hollow projections of the thin panel, which appear to be concave as seen from the sheet member.

[0011] Because the holes are bored at least on one side of the floor sheet assembly according to the invention described above, it is possible to guide noise reaching the sheet member, which lies on the same side, into a honeycomb structure so that the noise is efficiently absorbed, even if the sheet member does not breathe.

[0012] It is yet another aspect of the present invention to provide a floor sheet assembly, which further comprises a surface member. Holes are bored in the surface member which is attached to a sheet member. And the holes are aligned with the holes which are bored in the sheet member. The surface member is made of one of wood and plastic.

[0013] According to the invention described above, the surface member which usually does not breathe has the holes, which are aligned with the holes bored in the sheet member. As a result, it is possible for the floor sheet assembly not only to have a honeycomb structure efficiently absorb noise generated in a cabin, but also to satisfy an owner of a vehicle by providing free selection of a favorite surface material.

### BRIEF DESCRIPTION OF THE DRAWINGS

[0014] FIG. 1 is a perspective view illustrating a vehicle, to which a floor sheet assembly according to the present invention is applied.

[0015] FIG. 2 is an exploded perspective view showing in detail a floor sheet assembly illustrated in FIG. 1.

[0016] FIG. 3A is a perspective view showing a floor sheet assembly in FIG. 2 in a piled configuration. FIG. 3B is a sectional view taken along line A-A of FIG. 3A.

[0017] FIG. 4 is a graph showing sound absorption of a floor sheet assembly.

### DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] An embodiment of the present invention is now described with reference to drawings.

[0019] As shown in FIG. 1, a floor sheet assembly 1 is applied to a vehicle C as flooring. The floor sheet assembly 1 includes, as shown in FIG. 2, an intermediate member 10 and a pair of sheet members 20 which sandwiches the intermediate member 10. Of the pair of sheet members 20, flooring (a surface member) 30 is bonded to an upper sheet member 20, and an insulator 40 is bonded to a lower sheet member 20. The intermediate member 10 and the pair of sheet members 20 together form a honeycomb structure 2.

[0020] As shown in FIG. 2, the intermediate member 10 includes two sheets of thin panels 11 and 12, which are geometrically arranged to be in upper and lower positions, respectively. Hollow projections 13 and 14 are formed on the thin panels 11 and 12, respectively. The projections 13 are arranged so that between any neighboring lines of the

projections 13, a projection 13 in one line is located in between two projections 13 in the other line with respect to a linear direction. So are the projections 14. An end portion of a projection 13 abuts an end portion of a projection 14, and these portions are fixed to each other (See **FIGS. 3A and 3B**). First holes H1 for absorbing sound are bored in a flat portion 11a of the upper thin panel 11 in a vertical direction, where no projections 13 are formed. Furthermore, the first holes H1 are bored in the thin panel 11 at intervals  $\alpha$  in a linear direction, in which the projections 13 are arranged in a line. When arrangement of the first holes H1 is viewed in the other direction perpendicular to the one described above, they are bored at intervals  $\beta$ .

[0021] The sheet member 20 is a member configured like a sheet which does not breathe. Two sheet members 20 are fixed to upper and lower surfaces of the intermediate member 10 described above, respectively. Of these two sheet members 20, second holes H2 for absorbing sound, which have the same shape and interval as the first holes H1 described above, are bored in the upper sheet member 20. The second holes H2 are adapted to be aligned with the first holes H1.

[0022] It is, preferably but not necessarily, recommended that polypropylene (PP) should be adopted for the sheet member 20 and the intermediate member 10. However, the present invention does not limit material selection, and it may be alternatively possible to adopt engineering plastics and other olefinic plastics than polypropylene. As examples for these other olefinic plastics, polyethylene and a mixture of polypropylene and rubber composition (TPO) may be listed. As engineering plastics, polycarbonate, polyamide, modified polyphenyleneether, polyethylene terephthalate, polybutylene terephthalate, polyacetal and polyphenylene sulfide may be listed. In this connection, it may be possible to adopt methods for manufacturing a honeycomb structure 2 such as a method using a vacuum molding device and a method with injection molding, which the inventor disclosed in Japanese Published Patent Application 2000-326430.

[0023] The flooring 30, whose surface 30a is decorated with a pattern such as grain and which does not breathe, is fixed to the upper sheet member 20. Third holes H3, which have the same shape and interval as the second holes H2, are bored in the flooring 30 so that the third holes H3 are aligned with the second holes H2.

[0024] The holes H1, H2 and H3, which are together referred to as holes H hereinafter, are preferably but not necessarily bored simultaneously from outside to the space within the honeycomb structure 2 after the intermediate member 10, the sheet member 20 and the flooring 30 are placed one upon another and fixed each other. It may be possible to arbitrarily select an appropriate size and number of the holes H, taking into account a level and frequency of noise to be absorbed.

[0025] The insulator 40, which is made of a sound absorbing material, principally absorbs noise (road noise) coming from a side closer to a road surface.

[0026] Description is given of mechanism for sound absorption carried out by the floor sheet assembly 1 according to the present embodiment.

[0027] As shown in **FIG. 3B**, when a sound is created in a cabin, it enters the space within the intermediate member

10 through a hole H. This space is defined by flat portions 11a and 12a of the thin panels 11 and 12 and externally circumferential surfaces of the projections 13 and 14. When the sound entering the space is repeatedly reflected by the projections 13 and 14, a level of the sound gradually decreases as a result of transformation of energy in the form of vibration which the sound induces on the projections 13 and 14. In this way, the sound is ultimately absorbed by the intermediate member 10.

[0028] As described above, the present embodiment brings about the following advantages.

[0029] Because the holes H are bored in the thin panel 11, sheet member 20 and flooring 30, each of which does not breathe, it is possible not only to efficiently absorb noise in the cabin, but also to provide free selection of flooring 30 according to a taste of an owner of a vehicle, which makes the owner feel more satisfied.

[0030] Furthermore, because the honeycomb structure 2, which is characterized by high stiffness, sound absorption and light weight, is introduced as a member of the floor sheet assembly 1, a heavy sound insulating material, which has been conventionally attached to the floor of a vehicle, can be removed. As a result, it is possible to contribute to a decrease in a gross weight of a vehicle.

[0031] In addition, the honeycomb structure 2, which has internally complex structure, can provide fire resistance to the floor sheet assembly 1.

[0032] It will now be appreciated from the foregoing description that the present invention is not limited to the particularly illustrated embodiment discussed above and may be carried out in various modified forms.

[0033] In the embodiment described above, the floor sheet assembly 1 is applied to the floor of the vehicle. However, the invention is not limited to this application and it is possible to apply the floor sheet assembly 1 to a house. In addition, it may be possible to select steel, for example, instead of plastic for the intermediate member 10 and the sheet member 20.

[0034] The invention is not limited to the embodiment described above, which has the holes H that are bored in the upper thin panel 11, upper sheet member 20 and flooring 30. For example, when holes are bored to provide fluid communication between outside air and a space, which is defined by a hollow projection 13 and a sheet member 20, it may be possible to bore the holes only in the sheet member 20 and flooring 30. In addition, it is not mandatory that the holes are perpendicularly bored in the thin panel 11, upper sheet member 20 and flooring 30 as described in the embodiment described above. For example, it may be possible to bore the holes diagonally with respect to these components.

## EXAMPLE

[0035] Description is given of an example (test results) of sound absorption obtained by the floor sheet assembly 1 according to the embodiment described above. Conditions under which testing was carried out are as follows:

- (1) material for an intermediate member 10 and sheet member 20: polypropylene (PP)
- (2) material for an insulator 40: urethane

- (3) diameter of a hole H: 2 mm
- (4) interval a of holes H: 40 mm
- (5) interval  $\beta$  of holes H: 30 mm
- (6) height of projections **13** and **14**: 5.5 mm
- (7) diameter of end portion of projections **13** and **14**: 2 mm
- (8) diameter of base portion (opening) of projections **13** and **14**: 7 mm
- (9) interval of projections **13** and **14**: 11 mm
- (10) thickness of thin panels **11** and **12**: 0.5 mm
- (11) thickness of a sheet member **20**: 5.5 mm
- (12) thickness of flooring **30**: 2 mm
- (13) thickness of an insulator **40**: 20 mm

**[0036]** Description is given of sound absorption by the floor sheet assembly **1**, which satisfies the conditions described above, with reference to **FIG. 4**.

**[0037]** As shown in **FIG. 4**, it is demonstrated that the floor sheet assembly **1** (with holes H) achieves better performance in terms of sound absorption when a frequency of a sound approximately falls in a range of 800 to 4000 Hz, in comparison with a floor sheet assembly, which has the same setup as the floor assembly **1** except for the holes H. It is noted that the floor sheet assembly **1** increases sound absorption by 20% for a sound with a range of 1000 to 2000 Hz in comparison with the floor sheet assembly without the holes H. In this connection, the performance in terms of sound absorption is meant to represent a rate, which is obtained by a division, a dividend of absorbed sound energy and a divisor of generated sound energy.

**[0038]** It is concluded that the embodiment described above, which has the holes H bored in the floor sheet assembly **1**, is able to efficiently absorb sound having a certain range of frequency.

**[0039]** Foreign priority document, JP 2004-289818 filed on Oct. 1, 2004, is hereby incorporated by reference.

What is claimed is:

1. A floor sheet assembly comprising:
  - an intermediate member including at least a thin panel, on which a plurality of hollow projections is formed; and
  - a pair of sheet members sandwiching the intermediate member;wherein the intermediate member and the pair of sheet members form a honeycomb structure.
2. A floor sheet assembly according to claim 1, wherein the intermediate member has a plurality of thin panels and a plurality of hollow projections formed on one thin panel abuts a plurality of hollow projections formed on another thin panel.
3. A floor sheet assembly according to claim 1, wherein holes, which provide fluid communication with outside air to space within the honeycomb structure, are bored at least on one side of the floor sheet assembly.

4. A floor sheet assembly according to claim 3, further comprising a surface member:

wherein holes are bored in the surface member which is attached to a sheet member, and the holes are aligned with the holes which are bored in the sheet member, and

wherein the surface member is made of one of wood and plastic.

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