

DESCRIPTION

TITLE OF THE INVENTION

SOUND ABSORBING STRUCTURE

5 TECHNICAL FIELD

[0001]

The present invention relates to a sound absorbing structure using a porous plate.

10 BACKGROUND ART

[0002]

A sound absorbing structure has conventionally been known that absorbs sounds by use of the principle of the Helmholtz resonator by disposing, through an air layer, a porous plate where a multiplicity of through holes are formed and a rigid wall where no holes are formed. In such a sound absorbing structure, when a sound in the vicinity of a specific frequency (resonance frequency) corresponding to the diameter of the through holes, the volume of the air layer or the like enters the air layer from the through holes, resonance occurs, friction is caused between the inner walls of the through holes and air by the vibrations of the air in the through holes, and part of the vibration energy is converted into heat energy, thereby causing a sound absorbing action. When the volume of the air layer is increased, the resonance frequency is

decreased.

[0003]

As such a sound absorbing structure using the Helmholtz resonance principle, a structure is present in which partitions
5 in a direction orthogonal to a porous plate are disposed between the porous plate and a rigid wall and this partitions divide the space between the porous plate and the rigid wall into a plurality of air layers aligned in the direction of the surface of the porous plate (see, for example, Patent Reference 1).

10 When the width (the length in the direction of the surface of the porous plate) of the air layer is long, there are cases where a resonance phenomenon of sounds traveling in the direction of the above-mentioned width occurs in the air layer and this significantly degrades sound absorption performance.

15 For this reason, in the sound absorbing structure of Patent Reference 1, to suppress such degradation of sound absorption performance due to the resonance phenomenon in the air layer, partitions are provided to reduce the width.

[0004]

20 As a sound absorbing structure using the principle of the Helmholtz resonator, for example, there has conventionally been a sound absorbing structure 901 as shown in FIG. 18. The sound absorbing structure 901 is provided with a housing 902 having, on one surface thereof, a surface plate 902a formed
25 of a porous plate, and in the housing 902, a plurality of porous

plates 90 and 91 parallel to the surface plate 902a and a plurality of resin partitioning walls 92 to 94 extending in a direction orthogonal to the surface plate 902a are provided. The partitioning walls 92 are disposed in the space between
5 the surface plate 902a and the porous plate 90, and divides this space into a plurality of spaces 95 aligned in the direction of the length. Like the partitioning walls 92, the partitioning walls 93 and 94 are disposed between the porous plate 90 and the porous plate 91 and between the porous plate
10 91 and a back plate 902b, respectively, and divide the spaces therebetween into a plurality of spaces 96 and 97 aligned in the direction of the length, respectively.

CITATION LIST

15 PATENT REFERENCE

[0005]

Patent Reference 1: JP-A-2006-113323

SUMMARY OF THE INVENTION

20 PROBLEMS THAT THE INVENTION IS TO SOLVE

[0006]

In the above-described sound absorbing structure of Patent Reference 1, although the degradation of sound absorption performance due to the resonance phenomenon in the
25 air layer can be surely suppressed, since there is only one

air layer that communicates with the through holes of the porous plate, only sounds in the vicinity of one resonance frequency corresponding to this air layer can be absorbed and the sound absorption band is extremely narrow.

5 [0007]

In the case of the sound absorbing structure 901 as shown in FIGS. 18A and 18B, the three air layers 95 to 97 aligned in the direction orthogonal to the surface plate 902a communicate through the porous plates 90 and 91. For this reason, this sound absorbing structure 901 absorbs sounds in the vicinity of the resonance frequencies corresponding to the volumes of the air layers 95 to 97, and is also capable of absorbing, for example, sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of the two air layers 95 and 96 and sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of the three air layers 95 to 97. Consequently, the lowest frequency of the sound absorption frequency band of this sound absorbing structure 901 is the resonance frequency corresponding to the volume of the space which is the aggregate of all the three air layers 95 to 97.

[0008]

However, the space which is the aggregate of all the three air layers 95 to 97 is a space divided by the partitioning walls

92 to 94 with respect to the direction of the surface of the surface plate 902a, and its volume is comparatively small. For this reason, the resonance frequency corresponding to the volume of this space is a comparatively high frequency.

5 Consequently, with the conventional sound absorbing structure 901 as shown in FIGS. 18A and 18B, high sound absorption performance can be obtained only in a comparatively narrow frequency band in the high frequency area.

[0009]

10 Accordingly, an object of the present invention is to provide a sound absorbing structure with high sound absorption efficiency capable of widening the sound absorption frequency band.

15 MEANS TO SOLVE THE PROBLEM

[0010]

According to a first aspect of the invention, there is provided a sound absorbing structure including: a housing having a surface plate formed of a porous plate on one surface;
20 a first porous plate disposed so as to face the surface plate inside the housing, and dividing an internal space of the housing into a plurality of spaces aligned in a direction orthogonal to the surface plate; and a second porous plate disposed in a direction intersecting the surface plate inside
25 the housing, and dividing the internal space of the housing

into a plurality of spaces aligned in a direction of a surface of the surface plate.

[0011]

According to a second aspect of the invention, there is
5 provided a sound absorbing structure including: a housing having a surface plate formed of a porous plate on one surface; and a plurality of porous plate units disposed so as to be aligned in a direction of a surface of the surface plate inside the housing, and each formed of a porous plate, wherein the
10 porous plate units include: a flat portion disposed so as to face the surface plate, and dividing an internal space of the housing into a plurality of spaces aligned in a direction orthogonal to the surface plate; and a side portion coupled to the flat portion, placed on an inner surface of the housing,
15 extending in a direction intersecting the surface plate, and dividing the internal space of the housing into a plurality of spaces aligned in the direction of the surface of the surface plate.

[0012]

20 According to a third aspect of the invention, the sound absorbing structure according to the second aspect, wherein the side portions of the adjoining two porous plate units are disposed with a gap in between.

[0013]

25 According to a fourth aspect of the invention, the sound

absorbing structure according to the second or third aspect,
wherein the side portion of the porous plate unit, adjoining
the inner surface of the housing, of the plurality of porous
plate units is disposed with a gap from the inner surface of
5 the housing.

[0014]

According to a fifth aspect of the invention, the sound
absorbing structure according to the third or fourth aspect,
wherein the side portion has a protrusion protruding toward
10 a side opposite to the flat portion.

[0015]

According to a sixth aspect of the invention, the sound
absorbing structure according to any one of the second to fifth
aspects, wherein the flat portion and the side portion are
15 integrally formed by bending one porous plate.

[0016]

According to a seventh aspect of the invention, the sound
absorbing structure according to any one of the second to fifth
aspects, wherein an end portion of the flat portion is fixed
20 to the side portion.

[0017]

According to an eighth aspect of the invention, the sound
absorbing structure according to the second aspect, wherein

the side portion is formed of a porous plate, and has
25 a nipping portion nipping the end portion of the flat portion

while pressing the end portion from both surface sides.

[0018]

According to a ninth aspect of the invention, the sound absorbing structure according to any one of the second to eighth
5 aspects, wherein: the side portion is disposed so as to surround the flat portion when viewed from the direction orthogonal to the surface plate; and the flat portion is coupled to the side portion on an entire perimeter thereof.

[0019]

10 According to a tenth aspect of the invention, the sound absorbing structure according to the ninth aspect, wherein: the porous plate units have a plurality of boxes formed of a bottom wall serving as the flat portion and four side walls serving as the side portion; and lengths of the plurality of
15 boxes in the direction orthogonal to the surface plate are different from each other, sizes of openings surrounded by the four side walls of the plurality of boxes are substantially the same, and the plurality of boxes are nested with sides of the openings being in contact with a surface facing the surface
20 plate of the housing.

EFFECTS OF THE INVENTION

[0020]

According to the above-described first aspect, in the
25 internal space of the housing, the plurality of spaces into

which the internal space is divided by the first porous plate and the second porous plate are formed. These plurality of spaces communicate through the holes formed in the first porous plate and the second porous plate. For this reason, the sound absorbing structure not only can absorb sounds in the vicinity of the resonance frequencies corresponding to the spaces into which the internal space is divided by the first porous plate and the second porous plate and sounds in the vicinity of the resonance frequency corresponding to a space which is the aggregate of the plurality of spaces aligned in the direction orthogonal to the surface plate, but also can absorb sounds in the vicinity of the resonance frequency corresponding to a space which is the aggregate of the plurality of spaces aligned in the direction of the surface of the surface plate. Therefore, in the sound absorbing structure, the sound absorption frequency band can be widened toward the low frequency area side compared with the case where a plate member where no through holes are formed is used instead of the second porous plate. Moreover, since the sound absorbing structure not only absorbs sounds by using the holes formed in the surface plate and the first porous plate but also absorbs sounds by using the holes formed in the second porous plate, sound absorption efficiency improves.

[0021]

According to the above-described second aspect, in the

internal space of the housing, the plurality of spaces into which the internal space is divided by the flat portion and the side portion of the plurality of porous plate units are formed. These plurality of spaces communicate through the
5 holes formed in the flat portion and the side portion. For this reason, the sound absorbing structure not only can absorb sounds in the vicinity of the resonance frequencies corresponding to the spaces into which the internal space is divided by the flat portion and the side portion and sounds
10 in the vicinity of the resonance frequency corresponding to a space which is the aggregate of the plurality of spaces aligned in the direction orthogonal to the surface plate, but also can absorb sounds in the vicinity of the resonance frequency corresponding to a space which is the aggregate of
15 the plurality of spaces aligned in the direction of the surface of the surface plate. Therefore, in the sound absorbing structure, the sound absorption frequency band can be widened toward the low frequency area side compared with the case where a plate member where no through holes are formed is used as
20 the side portion. Moreover, since the sound absorbing structure not only absorbs sounds by using the holes formed in the surface plate and the flat portion but also absorbs sounds by using the holes formed in the side portion, sound absorption efficiency improves. Further, since the method in
25 which the plurality of porous plate units formed of porous

plates are placed inside the housing is easy compared with the case where porous plates in a direction facing the surface plate and porous plates in the direction intersecting the surface plate are directly placed on the inner surface of the housing, the sound absorbing structure can be easily manufactured. Moreover, by changing the number of porous plate units or by changing some of the plurality of porous plate units to porous plate units formed of porous plates having a different hole diameter or the like, the sound absorption characteristic of the sound absorbing structure can be easily adjusted according to the intended use or the like.

[0022]

According to the above-described third aspect, when the side portions of the adjoining two porous plate units are disposed in close contact with each other, the holes of one side portion are liable to be closed by the other side portion, and to prevent the holes from being closed, it is necessary that the positions of the holes of both side portions coincide with each other, which makes the manufacture difficult. On the other hand, in the present invention, since the side portions of the adjoining two porous plate units are disposed with a gap in between, the plurality of spaces aligned in the direction of the surface can be made to communicate through the holes of the side portions without the need for the positions of the holes of both side portions to coincide with

each other.

[0023]

According to the above-described fourth aspect, the sound absorbing structure can absorb sounds in the vicinity of the resonance frequencies corresponding to the spaces surrounded by the side portions and the flat portions, and can also absorb sounds in the vicinity of the resonance frequency corresponding to a space which is the aggregate of the spaces surrounded by the side portions and the flat portions and a space formed of the above-mentioned gap. Consequently, in the sound absorbing structure, the sound absorption frequency band can be widened compared with the case where no gap is formed between the side portion of the porous plate unit and the inner surface of the housing.

[0024]

According to the above-described fifth aspect, since the protrusion is provided, the side portions of the adjoining two porous plate units, or the inner surface of the housing and the side portion are never in close contact with each other, so that a gap is always formed therebetween.

[0025]

According to the above-described sixth aspect, since the flat portion does not readily vibrate in the direction orthogonal to the surface thereof, the degradation of sound absorption performance due to vibrations can be suppressed.

[0026]

According to the above-described seventh aspect, since the flat portion does not readily vibrate in the direction orthogonal to the surface thereof, the degradation of sound absorption performance due to vibrations can be suppressed.

[0027]

According to the above-described eighth aspect, since the end portion of the flat portion can be fixed to the side portion without any particular use of members other than porous plates, the manufacturing cost of the porous plate unit can be reduced.

[0028]

According to the above-described ninth aspect, the strength of the porous plate unit increases.

15 [0029]

According to the above-described tenth aspect, the porous plate unit can be easily manufactured. Moreover, by changing the number of boxes constituting the porous plate units or the length of the boxes in the depth direction, the sound absorption characteristic of the sound absorbing structure can be easily adjusted according to the intended use or the like.

BRIEF DESCRIPTION OF THE DRAWINGS

25 [0030]

FIG. 1A is a longitudinal cross-sectional view of a sound absorbing structure according to a first embodiment of the present invention.

FIG. 1B is a cross-sectional view along the line A-A of
5 FIG. 1A.

FIG. 1C is a cross-sectional view along the line B-B of FIG. 1A.

FIG. 2 is a cross-sectional view of a sound absorbing structure of another embodiment of the present invention.

10 FIG. 3 is a cross-sectional view of a sound absorbing structure according to a second embodiment of the present invention, and a view corresponding to FIG. 1B.

FIG. 4A is a cross-sectional view of a sound absorbing structure according to a third embodiment of the present
15 invention.

FIG. 4B is a partially enlarged view of FIG. 4A.

FIG. 5A is a cross-sectional view of a sound absorbing structure of another embodiment of the present invention.

FIG. 5B is an example of a cross-sectional view along
20 the line C-C of FIG. 5A.

FIG. 5C is an example of a cross-sectional view along the line C-C of FIG. 5A.

FIG. 6 is a cross-sectional view of a sound absorbing structure of another embodiment of the present invention.

25 FIG. 7 is a perspective view of a sound absorbing

structure according to a fourth embodiment of the present invention.

FIG. 8 is a perspective view of a sound absorbing structure according to a fifth embodiment of the present invention.

FIG. 9 is a perspective view of a sound absorbing structure of another embodiment of the present invention.

FIG. 10 is a perspective view of a sound absorbing structure of another embodiment of the present invention.

FIG. 11 is a perspective view of a sound absorbing structure according to a sixth embodiment of the present invention.

FIG. 12 is a perspective view of a sound absorbing structure of another embodiment of the present invention.

FIG. 13 is a perspective view of a sound absorbing structure according to a seventh embodiment of the present invention.

FIG. 14 is a perspective view of a sound absorbing structure of another embodiment of the present invention.

FIG. 15 is a longitudinal cross-sectional view of a sound absorbing structure according to an eighth embodiment of the present invention.

FIG. 16 is a cross-sectional view of a sound absorbing structure of another embodiment of the present invention.

FIG. 17A is a longitudinal cross-sectional view showing

a sound absorbing structure of an example.

FIG. 17B is a cross-sectional view along the line D-D of FIG. 17A.

FIG. 18A is a longitudinal cross-sectional view showing
5 the sound absorbing structure of a conventional example and a comparative example.

FIG. 18B is a cross-sectional view along the line E-E of FIG. 18A.

FIG. 19 is a graph showing the sound absorption
10 coefficients of a sound absorbing structure of the example and the comparative example.

MODE FOR CARRYING OUT THE INVENTION

[0031]

15 Hereinafter, a first embodiment of the present invention will be described. As shown in FIGS. 1A to 1C, a sound absorbing structure 1 of the first embodiment of the present invention includes a rectangular parallelepiped housing 2 and a plurality of porous plate units 3 disposed inside the housing 2. The
20 housing 2 has, on one surface thereof, a rectangular surface plate 2a where a multiplicity of through holes are formed. The sound absorbing structure 1 is disposed so that the side of the surface plate 2a is the side of the sound source. In the following description of the sound absorbing structure 1,
25 description will be given with the direction of the length and

the direction of the width of the surface plate 2a being defined merely as the longitudinal direction and the lateral direction, respectively, and a direction orthogonal to the surface plate 2a being defined as the depth direction.

5 [0032]

As shown in FIGS. 1A and 1B, the housing 2 includes: the surface plate 2a formed of a porous plate; a back plate 2b disposed so as to face the surface plate 2a; and a frame portion 2c formed integrally with the back plate 2b. As for the size
10 of the housing 2, for example, the length in the longitudinal direction is 2000 mm, the length in the lateral direction is 500 mm, and the length in the depth direction is 95 mm. However, the size of the housing 2 is not limited to the above-mentioned one.

15 [0033]

The back plate 2b and the frame portion 2c are formed of a metal material such as iron or stainless steel, fiber reinforced resin, or the like.

[0034]

20 The surface plate 2a may be detachably attached to an end portion of the frame portion 2c with screws or the like, or may be fixed to an end of the frame portion with rivets or by engagement. As the surface plate 2a, for example, a porous plate is used which is an aluminum plate with a plate thickness
25 of approximately 1.0 mm and where a multiplicity of circular

through holes are formed. The diameter of the through holes of the surface plate 2a is, for example, approximately 0.3 to 3.0 mm, and the aperture ratio of the surface plate 2a is, for example, not more than 10%. The shape of the through holes is not limited to a circle but may be a polygon such as a square or a triangle. The through holes may be formed of slits. In the case of such through holes having a shape other than a circle, the diameter of the through holes is the diameter of a circular hole having an equivalent hole area. The plate thickness, the aperture ratio and the diameter of the through holes of the surface plate 2a are set so as to cause a viscosity on the air passing through the through holes. When a viscosity acts on the air passing through the through holes, the conversion of air vibrations into heat energy is promoted, so that sound absorption performance improves. It is desirable that the through holes be closed by a sheet or the like being pasted to the area of the surface plate 2a that is in contact with a later-described space 9 (not shown).

[0035]

Inside the housing 2, a plurality of (12 in the present embodiment) porous plate units 3 are disposed so as to be aligned in the direction of the surface of the surface plate 2a. The porous plate unit 3 is formed of a porous plate, and has an outside shape of a square tube extending in the depth direction. As shown in FIG. 1C, a plurality of porous plate

units 3 are disposed six in the longitudinal direction and two in the lateral direction.

[0036]

As shown in FIGS. 1A and 1B, the porous plate unit 3 includes: a first member 4 formed in a box shape that is opened on the side of the back plate 2b; and a second member 5 whose cross-sectional shapes in the lateral direction and the longitudinal direction are H-shaped.

[0037]

The first member 4 is disposed on the back plate 2b. While the first member 4 may be fixed to the back plate 2b, it is not essential that it be fixed. The first member 4 includes: a flat portion 4a disposed so as to face the surface plate 2a; and a side portion 4b extending in the depth direction.

The side portion 4b is disposed so as to surround the flat portion 4a when viewed from the depth direction, and the flat portion 4a is coupled to an end portion, on the surface plate 2a side, of the side portion 4b on the entire perimeter thereof.

[0038]

The second member 5 is attached to an end portion, on the surface plate 2a side, of the first member 4. The second member 5 includes: a flat portion 5a disposed so as to face the surface plate 2a; and a side portion 5b extending in the depth direction. The side portion 5b is disposed so as to surround the flat portion 5b when viewed from the depth

direction, and the flat portion 5a is coupled to a substantially central portion, in the depth direction, of the side portion 5b on the entire perimeter thereof. The second member 5 is fixed by its opened end portion on the back plate 2b side being
5 fitted onto the outside of an end portion, on the surface plate 2a side, of the first member 4. In addition to this fixing by fitting, the second member 5 may be fixed by further using a stapler, an adhesive agent, adhesive tape or the like.

[0039]

10 The flat portions 4a and 5b are each parallel to the surface plate 2a. The side portions 4b and 5b each include two surfaces orthogonal in the longitudinal direction and two surfaces orthogonal in the lateral direction. The side portion of the porous plate unit of the present invention
15 includes the side portion 4b of the first member 4 and the side portion 5b of the second member 5.

[0040]

The length of the porous plate unit 3 in the depth direction is substantially the same as the length of the
20 internal space of the housing 2 in the depth direction. The lengths of the first member 4 and the second member 5 in the longitudinal direction are substantially the same as each other, and their lengths in the depth direction are also substantially the same as each other. The lengths of the first member 4 and
25 the second member 5 in the longitudinal direction will be

referred to as W1, and their lengths in the lateral direction will be referred to as W2.

[0041]

As shown in FIG. 1A, the side portions 4b (5b) of the two porous plate units 3 adjoining with respect to the longitudinal direction are disposed with a gap d1 in between. The side portion 4b (5b) of the porous plate unit 3 adjoining the frame portion 2c with respect to the longitudinal direction is disposed with a gap D1 from the frame portion 2c. As shown in FIG. 1B, the side portions 4b (5b) of the two porous plate units 3 adjoining with respect to the lateral direction are disposed with a gap d2 in between. The side portion 4b (5b), adjoining the frame portion 2 with respect to the lateral direction, of the porous plate unit 3 is disposed with a gap D2 from the frame portion 2c. Further, as shown in FIG. 1C, the spaces formed of the plurality of gaps D1, D2, d1 and d2 communicate with one another, and form the space 9.

[0042]

In the internal space of the housing 2, one space surrounded by the side portions 4b and 5b, the surface plate 2a and the back plate 2b is formed. That is, the side portion of one porous plate unit 3 divides the internal space of the housing 2 into a plurality of spaces aligned in the direction of the surface of the surface plate 2a. The space surrounded by the side portions 4b and 5b, the surface plate 2a and the

back plate 2b is divided into three air chambers 6 to 8 aligned in the depth direction by the two flat portions 4a and 5a.

[0043]

The air chamber 6 is a space surrounded by the surface plate 2a, the flat portion 5a and the side portion 5b. The air chamber 7 is a space surrounded by the flat portion 5a, the flat portion 4a and the side portion 5b. The air chamber 8 is a space surrounded by the flat portion 4a, the back plate 2b and the side portion 4b.

[0044]

It is desirable that the widths W1 of the air chambers 6 to 8 in the longitudinal direction (the lengths of the first member 4 and the second member 5 in the longitudinal direction) be set so as to be smaller than $1/2$ the wavelength of the sound to be absorbed. It is desirable that the widths W2 of the air chambers 6 to 8 in the lateral direction (the lengths of the first member 4 and the second member 5 in the longitudinal direction) be also set so as to be smaller than $1/2$ the wavelength of the sound to be absorbed like the lengths in the longitudinal direction. The reason will be mentioned later. While the lengths of the air chambers 6 to 8 in the depth direction may be different from one another, they may be the same.

[0045]

The first member 4 and the second member 5 are each formed

by bending one porous plate. For this reason, the flat portion 4a and the side portion 4b are integrally formed. The flat portion 5a and the side portion 5b are also integrally formed. Of the side portion 5b of the second member 5, a part on the surface plate 2a side of the flat portion 5a has a dual structure by being folded back.

[0046]

The porous plate constituting the first member 4 and the second member 5 is, for example, an aluminum thin plate (foil) with a plate thickness of approximately 0.1 mm and where a multiplicity of circular through holes are formed. The diameter of the through holes of the porous plate is, for example, 0.05 mm to 0.15 mm, and the aperture ratio thereof is, for example, 0.1 to 1.0%. While the through holes may be holes formed by punching, they may be holes formed by the following method: In a thin plate serving as the material of the porous plate, mountain-shaped portions and valley-shaped portions are continuously formed in alternate order, and the tips of these mountain-shaped and valley-shaped portions are ductile-fractured, thereby forming minute holes. The shape of these holes is not circular but a shape close to a cross. When the through holes are formed by punching, the shape of the through holes is not limited to a circle but may be a polygon such as a square or a triangle. Or the through holes may be slit-formed. In the case of such through holes having a shape

other than a circle, the diameter of the through holes is the diameter of a circular hole having an equivalent hole area. The aperture ratio, the plate thickness and the diameter of the through holes of the porous plate are set so as to cause
5 a viscosity on the air passing through the through holes for a similar reason to that of the porous plate constituting the surface plate 2a. As the porous plates constituting the first member 4 and the second member 5, porous plates having different aperture ratios, hole diameters and plate thicknesses may be
10 used, respectively.

[0047]

Next, the sound absorbing action of the sound absorbing structure 1 will be described. The sound from the sound source first enters the air chamber 6 from the through holes of the
15 surface plate 2a. At this time, when a sound in the vicinity of a specific frequency (resonance frequency) corresponding to the aperture ratio, the hole diameter or the like of the surface plate 2a enters the air chamber 6 from the through holes of the surface plate 2a, resonance occurs, friction is caused
20 between the inner walls of the through holes and air by the vibrations of the air in the through holes, and part of the vibration energy is converted into heat energy, thereby causing a sound absorbing action. Part of the sound having entered the air chamber 6 enters the air chamber 7 from the through
25 holes of the flat portion 5a, and further, enters the air

chamber 8 from the through holes of the flat portion 4a. As in the case where the sound passes through the through holes of the surface plate 2a, when a sound in the vicinity of a specific frequency corresponding to the aperture ratio or the like of the flat portions 4a and 5a passes through the through
5 holes of the flat portions 4a and 5a, part of the sound is absorbed.

[0048]

Part of the sound having entered the air chambers 6 to
10 8 enters the space 9 through the through holes of the side portion 4b or the side portion 5b, and further, enters the air chambers 6 to 8 of the adjoining porous plate unit 3. At this time, as in the case where the sound passes through the through holes of the surface plate 2a, when a sound in the vicinity
15 of a specific frequency corresponding to the aperture ratio or the like of the side portions 4a and 5a passes through the through holes of the side portions 4a and 5a, part of the sound is absorbed. Since the sound absorbing structure 1 not only absorbs sounds by using the through holes of the surface plate
20 2a and the flat portions 4a and 5a but also absorbs sounds by using the through holes of the side portions 4b and 5b as described above, sound absorption efficiency improves.

[0049]

Next, the frequencies of the sounds that the sound
25 absorbing structure 1 can absorb will be described. While the

sound absorbing structure 1 absorbs sounds by using the through holes of the surface plate 2a, a plurality of flat portions 4a and 5b and a plurality of side portions 4b and 5b as described above, description will be given by taking, particularly, the frequencies of the sounds that can be absorbed in the through holes of the surface plate 2a as an example.

[0050]

Since the air chambers 6 to 8 communicate through the through holes of the flat portions 4a and 5a, the sound absorbing structure 1 can absorb sounds in the vicinity of the resonance frequency corresponding to the volume of the air chamber 6, and can also absorb sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of the air chamber 6 and the air chamber 7 and sounds in the vicinity of the resonance frequency corresponding to a space which is the aggregate of all the air chambers 6 to 8. Since a plurality of air chambers 6 aligned in the longitudinal direction and in the lateral direction and the space 9 communicate through the through holes of the side portions 5b, for example, the following sounds can also be absorbed: sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of the air chamber 6 and the space 9; sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of the two air chambers 6 aligned

with respect to the longitudinal direction or the lateral direction and the space 9; and sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of a space which is the aggregate of the two air chambers 6 aligned in the longitudinal direction and the space 9 and a space which is the aggregate of the two air chambers 7 disposed below the two air chambers 6 in FIG. 1A in the depth direction.

[0051]

Moreover, regarding the flat portions 4a and 5a and the side portions 4b and 5b, like the surface plate 2a, sounds in the vicinity of a plurality of resonance frequencies corresponding to the spaces communicating with the through holes thereof can also be absorbed.

[0052]

From the above, the sound absorbing structure 1 not only can absorb sounds in the vicinity of the resonance frequencies corresponding to the volumes of the air chambers 6 to 8 and sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of the air chambers 6 to 8 aligned in the depth direction but also can absorb sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of a plurality of air chambers 6 (or air chambers 7 or 8) aligned in the direction of the surface of the surface plate 2a and

the space 9. According to the principle of the Helmholtz resonator, the larger the volume of the air layer communicating with the resonant holes is, the lower the resonance frequency corresponding to this air layer is. Therefore, in the sound absorbing structure 1, the sound absorption frequency band can be widened toward the low frequency area side compared with the case where the side portions 4b and 5b are formed of plate members where no through holes are formed.

[0053]

Here, when the side portions 4b (5b) of the adjoining two porous plate units 3 are disposed in close contact with each other, the through holes of one side portion 4b (5b) are liable to be closed by the other side portion 4b (5b) and to prevent the through holes from being closed, it is necessary that the positions of the through holes of both side portions 4b (5b) coincide with each other, which makes the manufacture of the sound absorbing structure 1 difficult.

[0054]

On the other hand, in the present embodiment, the side portions 4b (5b) of the two porous plate units 3 adjoining with respect to the longitudinal direction or the lateral direction are disposed with the gap d1 or the gap d2 in between. For this reason, a plurality of air chambers 6 to 8 adjoining with respect to the longitudinal direction or the lateral direction can be made to communicate through the through holes of the

side portions 4b and 5b without the need for the positions of the through holes of both side portions 4b (5b) to coincide with each other.

[0055]

5 Since the side portion 4b (5b) of the porous plate unit adjoining the frame portion 2c is disposed with the gap D1 or the gap D2 from the frame portion 2c, the sound absorbing structure 1 not only can absorb sounds in the vicinity of the resonance frequencies corresponding to the air chambers 6 to 10 8 but also can absorb sounds in the vicinity of the resonance frequency corresponding to a space which is the aggregate of the air chambers 6 to 8 and a space formed of the gap D1 or the gap D2. For this reason, in the sound absorbing structure 1, the sound absorption frequency band can be widened compared 15 with the case where no gap is formed between the side portion 4b of the porous plate unit 3 and the frame portion 2c.

[0056]

 Since the space 9 is a space into which the spaces formed of a plurality of gaps D1, D2, d1 and d2, respectively, are 20 coupled, its volume is comparatively large. Further, this space 9 communicates with all of the air chambers 6 to 8 of a plurality of porous plate units 3. For this reason, the sound absorbing structure 1 can deliver high sound absorption performance in the low frequency area.

25 [0057]

Moreover, in general use of the sound absorbing structure 1 such as use for freeways, sounds of various magnitudes (sound pressures) enter the air chamber 6 through the surface plate 2a. Consequently, there are cases where the magnitudes (sound pressures) of the sounds in the air chamber 6 of the adjoining two porous plate units 3 are different. In this case, a sound in the air chambers 6 to 8 having a higher sound pressure readily enters the space 9. Moreover, when the through holes in the area, in contact with the space 9, of the surface plate 2a are closed, sounds more readily enter the space 9 from the air chambers 6 to 8 since external sounds do not directly enter the space 9. When sounds readily enter the space 9 from the air chambers 6 to 8 as mentioned above, the sound absorption coefficient improves at the resonance frequency corresponding to a space which is the aggregate of the air chambers 6 to 9 and the space 9 and at frequencies in the vicinity thereof. [0058]

Moreover, part of the sound entering through the through holes of the surface plate 2a or the flat portions 4a and 5a travels in the longitudinal direction or in the lateral direction in the air chambers 6 to 8. At this time, when the width W_1 of the air chambers 6 to 8 is larger than $1/2$ the wavelength of the sound to be absorbed, there are cases where a resonance phenomenon of sounds traveling in the longitudinal direction occurs in the air chambers 6 to 8, sounds do not

readily enter the air chambers 6 to 8 from the through holes and this degrades sound absorption performance. When the width W2 of the air chambers 6 to 8 is larger than $1/2$ the wavelength of the sound to be absorbed, similarly, there are cases where sound absorption performance is degraded. On the other hand, in the present embodiment, since the widths W1 and W2 of the air chambers 6 to 8 are smaller than $1/2$ the wavelength of the sound to be absorbed, the resonance in the air chambers 6 to 8 is prevented, and as a consequence, sounds readily enter the air chambers 6 to 8 from the through holes of the surface plate 2a or the flat portions 4a and 5a, so that sound absorption performance improves.

[0059]

Further, according to the method in which a plurality of porous plate units 3 formed of porous plates are disposed inside the housing 2, the sound absorbing structure 1 can be easily manufactured since the method is easy compared with the case where a plurality of porous plates in a direction facing the surface plate 2a and a plurality of porous plates in a direction orthogonal to the surface plate are directly placed on the inner surface of the housing 2.

[0060]

Moreover, by changing the number of porous plate units 3 or by changing some of a plurality of porous plate units 3 to porous plate units formed of porous plates having a different

hole diameter or the like, the sound absorption characteristic of the sound absorbing structure 1 can be easily adjusted according to the intended use or the like.

[0061]

5 Moreover, since the porous plate unit 3 is formed only of a porous plate and, for example, the resin partitioning walls 92 to 94 and the like are not used unlike the conventional sound absorbing structure 901 shown in FIGS. 18A and 18B, material cost can be reduced, and weight can be reduced.

10 [0062]

 Moreover, as described above, the first member 4 and the second member 5 are each formed by bending one porous plate, and the flat portions 4a and 5a and the side portions 4b and 5b are each integrated. For this reason, the flat portions 15 4a and 5a do not readily vibrate with respect to a direction orthogonal to the surface direction thereof (the depth direction). When the flat portions 4a and 5b vibrate, the friction between the inner walls of the through holes and air is decreased, so that sound absorption performance is degraded. 20 In the present embodiment, since the vibrations of the flat portions 4a and 5a are suppressed, the degradation of sound absorption performance due to vibrations can be suppressed.

[0063]

 Moreover, since the side portions 4b and 5b are disposed 25 so as to surround the flat portions 4a and 5a when viewed from

the depth direction and the flat portions 4a and 5a are coupled to the side portions 4b and 5b on the entire perimeters thereof, the porous plate unit 3 has comparatively high strength.

[0064]

5 In the sound absorbing structure 1, the porous plate units 3 may be disposed in a state of being rotated 180° about an axis in the direction orthogonal to the surface plate 2a. That is, a structure may be adopted in which the second member 5 is disposed on the back plate 2b and the second member 4 whose
10 surface plate 2a side is opened is attached to the surface plate 2a side of the second member 5.

[0065]

Moreover, as shown in FIG. 2, the sound absorbing structure may be provided with a plurality of porous plate units
15 3' formed of two second members 5 coupled in the depth direction.

[0066]

Next, a second embodiment of the present invention will be described with the focus on differences from the first
20 embodiment. Here, elements having the same structure as those of the first embodiment are denoted by the same reference numerals and descriptions thereof are omitted as appropriate.

[0067]

In a sound absorbing structure 21 of the second
25 embodiment, although the shape of the porous plate unit is

different, the structures other than that are the same as those of the first embodiment.

[0068]

As shown in FIG. 3, a porous plate unit 23 of the second
5 embodiment includes: a large box 24 whose back plate 2b side is opened; and a small box 25 disposed inside the large box 24 and whose back plate 2b side is opened. The large box 24 and the small box 25 are each fixed to the back plate 2b.

[0069]

10 The large box 24 includes a bottom wall (flat portion) 24a disposed so as to face the surface plate 2a and a side wall portion (side portion) 24b extending in the depth direction. The small box 25 includes a bottom wall (flat portion) 25a disposed so as to face the surface plate 2a and a side wall
15 portion (side portion) 25b extending in the depth direction.

[0070]

The bottom walls 24a and 25a are each parallel to the surface plate 2a. The side wall portions 24b and 25b each include two side walls orthogonal in the longitudinal direction
20 and two side walls orthogonal in the lateral direction. The side wall portions 24b and 25b are disposed so as to surround the bottom walls 24a and 25a when viewed from the depth direction, respectively. The bottom walls 24a and 25a are coupled to the surface plate 2a side end portions of the side
25 wall portions 24b and 25b on the entire perimeters thereof,

respectively. The side wall portion 24b of the large box 24 and the side wall portion 25b of the small box constitute the side portion of the porous plate unit of the present invention.

[0071]

5 The length of the large box 24 in the longitudinal direction is shorter than the length of the internal space of the housing 2 in the depth direction. The length of the small box 25 in the depth direction is shorter than the length of the large box 24 in the depth direction. That is, the lengths
10 of the large box 24 and the small box 25 in the depth direction are different from each other. While the lengths of the small box 25 in the longitudinal direction and in the lateral direction are substantially the same, the large box 24 is slightly larger. The large box 24 and the small box 25 are
15 nested with the opening sides thereof fixed to the back plate 2b.

[0072]

The side wall portions 24b of the two porous plate units 23 adjoining with respect to the longitudinal direction are
20 disposed with a gap in between. The side wall portion 24b of the porous plate unit 23 adjoining the frame portion 2c with respect to the longitudinal direction is disposed with a gap from the frame portion 2c. The side wall portions 24b of the two porous plate units 23 adjoining with respect to the lateral
25 direction are disposed with a gap in between, and the side wall

portion 24b of the porous plate unit 23 adjoining the frame portion 2c with respect to the lateral direction is disposed with a gap from the frame portion 2c (see FIG. 3). The spaces formed of these gaps communicate, and form a space 29.

5 [0073]

In the internal space of the housing 2, one air chamber 26 surrounded by the bottom walls 24a of a plurality of porous plate units 23, the surface plate 2a and the frame portion 2c is formed. That is, the bottom walls 24a divide the internal
10 space of the housing 2 into two spaces aligned in the depth direction. This air chamber 26 communicates with the above-described space 29.

[0074]

Moreover, in the internal space of the housing 2, a space
15 is formed that is surrounded by the side wall portion 24b (and the side wall portion 25b) and the bottom wall 24a of the porous plate unit 23 and the back plate 2b. That is, the side wall portion 24b (and the side wall portion 25b) of one porous plate unit 23 divides the internal space of the housing 2 into a
20 plurality of spaces aligned in the direction of the surface of the surface plate 2a. The space surrounded by the side wall portion 24b, the bottom wall portion 24a and the back plate 2b is divided into two air chambers 27 and 28 aligned in the depth direction by the bottom wall 25a.

25 [0075]

The large box 24 and the small box 25 are each formed by bending one porous plate. For this reason, the bottom wall 24a and the side wall portion 24b, and the bottom wall 25a and the side wall portion 25b are each integrally formed. Thereby,
5 the bottom walls 24a and 25a do not readily vibrate in a direction orthogonal to the surfaces thereof (the depth direction), so that the degradation of sound absorption performance due to vibrations can be suppressed.

[0076]

10 As the porous plates constituting the large box 24 and the small box 25, similar porous plates to those in the first embodiment may be used. As the porous plates constituting the large box 24 and the small box 25, porous plates having different aperture ratios, hole diameters and plate
15 thicknesses may be used.

[0077]

The sound absorbing structure 21 having the above-described structure not only can absorb sounds in the vicinity of the resonance frequencies corresponding to the
20 volumes of the air chambers 26 to 28 and sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of the air chambers 26 to 28 aligned in the depth direction but also can absorb sounds in the vicinity of the resonance frequency corresponding to the volume
25 of a space which is the aggregate of a plurality of air chambers

27 (or air chambers 28) aligned in the direction of the surface of the surface plate 2a. Therefore, in the sound absorbing structure 21, the sound absorption frequency band can be widened toward the low frequency area side compared with the case where the side wall portions 24b and 25b are formed of plate members where no through holes are formed.

[0078]

Moreover, since not only sound absorption is performed by using the through holes of the surface plate 2a and the bottom walls 24a and 25a but also sound absorption is performed by also using the through holes of the side wall portions 24b and 25b, sound absorption efficiency is improved.

[0079]

Moreover, the lengths of the air chamber 26 in the longitudinal direction and in the lateral direction are the same as the lengths of the internal space of the housing 2 in the longitudinal direction and in the lateral direction. For this reason, the widths of the air chamber 26 and the air chamber 27 in the longitudinal direction are different from each other, and further, the positions of both end portions, in the longitudinal direction, of the air chambers 26 and 27 are different from each other. For this reason, sound interference (sound pressure interference) occurs between the air chambers 26 and 27, so that resonance of sounds traveling in the longitudinal direction in the air chambers 26 and 27

do not readily occur. Thereby, sounds easily enter the air chambers 26 and 27, so that sound absorption performance improves. Moreover, in the lateral direction, as in the longitudinal direction, similar effects are produced since the widths and the positions of both end portions of the air chambers 26 and 27 are different from each other.

[0080]

Moreover, since the large box 24 and the small box 25 are formed by bending and the porous plate unit 23 has a simple structure in which the large box 24 and the small box 25 are nested, they can be easily manufactured.

[0081]

Moreover, by replacing the large box 24 or the small box 25 with a box having a different length in the depth direction or replacing it with a box having a different aperture ratio, the sound absorption characteristic of the sound absorbing structure 21 can be easily adjusted according to the intended use or the like.

[0082]

While the porous plate unit 23 of the present embodiment has a structure in which the two boxes 24 and 25 are nested, it may have a structure in which three or more boxes having different lengths in the depth direction are nested. Moreover, it may have a structure in which, for example, two or more boxes are disposed so as to be aligned in the direction of the surface

of the surface plate 2a inside the large box 24.

[0083]

Next, a third embodiment of the present invention will be described with the focus on differences from the first embodiment. Here, elements having the same structure as those of the first embodiment are denoted by the same reference numerals and descriptions thereof are omitted as appropriate.

[0084]

A sound absorbing structure 31 of the third embodiment is different only in the shape of the porous plate unit, and the structures other than that are the same as those of the first embodiment.

[0085]

As shown in FIG. 4A, a porous plate unit 33 of the third embodiment includes: two flat portions 33a disposed so as to face the surface plate 2a; and a side portion 33b extending in the depth direction.

[0086]

The two flat portions 33a are each parallel to the surface plate 2a, and are disposed so as to be aligned in the depth direction. The side portion 33b is disposed so as to surround the flat portions 33a when viewed from the depth direction, and the flat portions 33a are each fixed to the side portion 33b on the entire perimeters thereof. The side portion 33b includes two surfaces orthogonal in the longitudinal direction

and two surfaces orthogonal in the lateral direction. The length of the side portion 33b in the direction of extension (the depth direction) is substantially the same as the length of the internal space of the housing 2 in the depth direction.

5 [0087]

The two flat portions 33a are each formed of one porous plate. The side portion 33b is formed of one or more than one porous plate. As the porous plates constituting the flat portions 33a and the side portion 33b, similar porous plates
10 to those in the first embodiment may be used. As the porous plates constituting the flat portions 33a and the side portion 33b, porous plates having different aperture ratios, hole diameters and plate thicknesses may be used.

[0088]

15 The side portion 33b is provided with two nipping portions 33c nipping the two flat portions 33a to support them, respectively. The nipping portions 33c are formed of part of the porous plate constituting the side portion 33b. The nipping portions 33c nip the flat portions 33a on the entire
20 perimeters thereof. As shown in FIG. 4B, the nipping portions 33c are formed so as to protrude outward (the side opposite to the flat portions 33a), and nip the end portions of the flat portions 33a by pressing them from both sides. The nipping portions 33c are formed, for example, by bending part of the
25 porous plate constituting the side portion 33b so as to be in

close contact with both surfaces of the end portions of the flat portions 33a when the side portion 33b is formed.

[0089]

The end portions of the nipping portions 33c abut on the side portion 33b of the adjoining porous plate unit 33. The nipping portions 33c of the adjoining two porous plate units 33 are formed so as to be different in height (position in the depth direction). It is desirable that the upper surfaces (or the lower surfaces) of the nipping portions 33c be formed at a height that is in contact with the lower surfaces (or the upper surfaces) of the adjoining nipping portions 33c. This applies to the nipping portions 33c. This is because the strength of the nipping portions 33c can be improved thereby.

[0090]

Since the provision of such nipping portions 33c enables the end portions of the flat portions 33a to be fixed to the side portion 33b without any particular use of members other than porous plates, the manufacturing cost of the porous plate unit 33 can be reduced. Moreover, since the side portion 33b is formed of an aluminum thin plate of approximately 0.1 mm, the nipping portions 33c can be easily formed by the above-described method.

[0091]

Moreover, since the nipping portions 33c are formed so as to protrude outward, the side portions 33c of the two porous

plate units 33 adjoining with respect to the longitudinal direction or the lateral direction are disposed with a gap in between. Moreover, the side portion 33b of the porous plate unit 33 adjoining the frame portion 2c with respect to the longitudinal direction or the lateral direction is disposed with a gap from the frame portion 2c. Moreover, the spaces formed of these gaps communicate with respect to the direction of the surface, whereas they are divided into three spaces 37 to 39 aligned in the depth direction by the two nipping portions 33c.

[0092]

In the internal space of the housing 2, one space surrounded by the surface plate 2a, the side portion 33b and the back plate 2b is formed. Further, this space is divided into three air chambers 34 to 36 aligned in the depth direction by the two flat portions 33a.

[0093]

The sound absorbing structure 31 having the above-described structure not only can absorb sounds in the vicinity of the resonance frequencies corresponding to the volumes of the air chambers 34 to 36 and sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of the air chambers 34 to 36 aligned in the depth direction but also can absorb sounds in the vicinity of the resonance frequency corresponding to the volume

of a space which is the aggregate of a plurality of air chambers 34 (or air chambers 35 or 36) aligned in the direction of the surface of the surface plate 2a. Therefore, in the sound absorbing structure 31, the sound absorption frequency band
5 can be widened toward the low frequency area side compared with the case where the side portion 33b is formed of a plate member where no through holes are formed.

[0094]

Moreover, since not only sound absorption is performed
10 by using the through holes of the surface plate 2a and the flat portions 33a but also sound absorption is performed by using the through holes of the side wall portions 33b, sound absorption efficiency is improved.

[0095]

Moreover, as described above, the end portions of the
15 flat portions 33a are fixed to the nipping portions 33c. For this reason, the flat portions 33a do not readily vibrate in a direction orthogonal to the direction of the surface thereof (the depth direction), so that the degradation of sound
20 absorption performance due to vibrations can be suppressed.

[0096]

While the nipping portions 33c nip the flat portions 33a on the entire perimeter in the porous plate unit 33 of the present embodiment, the present invention is not limited to
25 this structure. For example, as shown in FIG. 5A, nipping

portions 133c may be formed on a side portion 133b so as to nip both ends, in the longitudinal direction (or the lateral direction), of a flat portion 133a.

[0097]

5 In this case, of the four side surfaces constituting the side portion 133b, the two side surfaces where no nipping portions are formed and the flat portion 133a may be integrally formed by bending. Specifically, for example, a porous plate unit 133 may be adopted in which as shown in FIG. 5B, the shape
10 of the cross section in the lateral direction is a shape where two H-shaped members 133A and 133B are coupled with respect to the depth direction. The H-shaped members 133A and 133B are each formed by bending one porous plate so that the cross section in the lateral direction is H-shaped. Moreover, for
15 example, a porous plate unit 133' may be adopted in which as shown in FIG. 5C, the shape of the cross section in the lateral direction is a shape where two Z-shaped members 133C and 133D are coupled with respect to the depth direction. The Z-shaped members 133C and 133D are each formed by bending both end
20 portions of one porous plate in opposite directions.

Here, in this case, hardly any gap is formed between porous plate units adjoining with respect to the lateral direction.

[0098]

While the nipping portions 33c formed of a porous plate
25 are used as the means for fixing the flat portions 33a to the

side portion 33b in the porous plate unit 33 of the present embodiment, the present invention is not limited to this structure. For example, a porous plate unit 33' may be adopted in which, as shown in FIG. 6, end portions of the flat portions 5 33a are bent and the bent portions are fixed to the side portion 33b by using an adhesive agent or the like.

[0099]

Next, a fourth embodiment of the present invention will be described with the focus on differences from the first 10 embodiment. Here, elements having the same structure as those of the first embodiment are denoted by the same reference numerals and descriptions thereof are omitted as appropriate.

[0100]

As shown in FIG. 7, a sound absorbing structure 41 of 15 the fourth embodiment includes: a housing 2 similar to that of the first embodiment; and a plurality of porous plate units 43 aligned in the longitudinal direction inside the housing 2.

[0101]

20 The porous plate unit 43 includes: a U-shaped member 44 whose shape of the cross section orthogonal to the lateral direction is a U shape whose back plate 2b side is opened; and a U-shaped member 45 disposed inside the U-shaped member 44, being substantially similar to the U-shaped member 44 and whose 25 length in the depth direction is shorter than that of the

U-shaped member 44. The two U-shaped members 44 and 45 are each fixed to the back plate 2b.

[0102]

The U-shaped members 44 and 45 include flat portions 44a and 45a disposed so as to face the surface plate 2a and side portions 44b and 45b extending in the depth direction, respectively. The side portions 44b and 45b each include two surfaces orthogonal in the depth direction. The opposing two end portions of the flat portions 44a and 45a are coupled to the surface plate 2a side end portions of the side portions 44b and 45b. The side portions 44b and 45b of the two U-shaped members 44 and 45 constitute the side portion of the porous plate unit of the present invention.

[0103]

The length of the U-shaped member 44 in the depth direction is shorter than the length of the internal space of the housing 2 in the depth direction. The length of the U-shaped member 45 in the depth direction is shorter than the length of the U-shaped member 44 in the depth direction. While the lengths of the U-shaped members 44 and 45 in the longitudinal direction and in the lateral direction are each substantially the same, the U-shaped member 44 are slightly larger. The U-shaped member 44 and the U-shaped member 45 are nested with the opened sides thereof being fixed to the back plate 2b.

[0104]

The side portions 44b of the two porous plate units 43 adjoining with respect to the longitudinal direction are disposed with a gap in between. A space formed of this gap will be referred to as a space 49. The side portion 44b of the porous plate unit 43 adjoining the frame portion 2c with respect to the longitudinal direction is disposed with a gap from the frame portion 2c. A space formed of this gap will be referred to as a space 49a.

[0105]

An air chamber 46 is formed of the flat portions 44a of a plurality of U-shaped members 44, the surface plate 2a and the frame portion 2c (see FIGS. 1A to 1C). The air chamber 46 communicates with the above-mentioned spaces 49 and 49a.

In the internal space of the housing 2, one space surrounded by the side portion 44b and the flat portion 44a of the porous plate unit 43 and the back plate 2b is formed, and further, this space is divided into two air chambers 47 and 48 aligned in the depth direction by the flat portion 45a.

[0106]

The two U-shaped members 44 and 45 are each formed by bending one porous plate. For this reason, the flat portion 44a and the side portion 44b, and the flat portion 45a and the side portion 45b are each integrally formed. Thereby, the flat portions 44a and 45a do not readily vibrate in a direction

orthogonal to the surfaces thereof (the depth direction), so that the degradation of sound absorption performance due to vibrations can be suppressed.

[0107]

5 As the porous plates constituting the side portions 44b and 45b and the flat portions 44a and 45a, similar porous plates to those in the first embodiment may be used. As the porous plates constituting the side portions 44b and 45b and the flat portions 44a and 45a, respectively, porous plates having
10 different aperture ratios, hole diameters and plate thicknesses may be used.

[0108]

 The sound absorbing structure 41 having the above-described structure not only can absorb sounds in the
15 vicinity of the resonance frequencies corresponding to the volumes of the air chambers 46 to 48 and sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of the air chambers 46 to 48 aligned in the depth direction but also can absorb sounds in the
20 vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of a plurality of air chambers 47 (or air chambers 48) aligned in the direction of the surface of the surface plate 2a and the space 49 or the space 49a. Therefore, in the sound absorbing structure 41, the sound
25 absorption frequency band can be widened toward the low

frequency area side compared with the case where the side portions 44b and 45b are formed of plate members where no through holes are formed.

[0109]

5 Moreover, since not only sound absorption is performed by using the through holes of the surface plate 2a and the flat portions 44a and 45a but also sound absorption is performed by using the through holes of the side portions 44b and 45b, sound absorption efficiency is improved.

10 [0110]

 Next, a fifth embodiment of the present invention will be described with the focus on differences from the first embodiment. Here, elements having the same structure as those of the first embodiment are denoted by the same reference numerals and descriptions thereof are omitted as appropriate.

15 [0111]

 As shown in FIG. 8, a sound absorbing structure 51 of the fifth embodiment includes: a housing 2 similar to that of the first embodiment; and a plurality of porous plate units 53 aligned in the longitudinal direction inside the housing 2.

[0112]

 The porous plate unit 53 is formed by bending one porous plate. The porous plate unit 53 includes a flat portion 54, a pair of attachment portions 56 and a side portion 55.

25

[0113]

The flat portion 54 is disposed so as to face the surface plate 2a. The flat portion 54 is rectangular, and end portions thereof extend in the longitudinal direction and in the depth direction, respectively. The flat portion 54 divides the internal space of the housing 2 into two spaces aligned in the depth direction.

[0114]

The pair of attachment portions 56 are coupled to the end portions, opposing with respect to the lateral direction, of the flat portion 54. The pair of attachment portions 56 extend from the flat portion 54 toward the surface plate 2a side in the depth direction, and further, are formed in a shape where the end thereof are bent outward. The portions bent outward will be referred to as hook portions 56a. The hook portions 56a are hooked onto the end portion of the frame portion 2c, and the surface plate 2a is placed thereon. The hook portions 56a are sandwiched between the end portion of the frame portion 2c and the surface plate 2a, and the surface plate 2a is fixed to the end portion of the frame portion 2c with rivets or the like. Thereby, the porous plate unit 53 is fixed to the housing 2.

[0115]

The side portion 55 includes two side walls 55a coupled to the end portions, opposing with respect to the longitudinal

direction, of the flat portion 54. The side walls 55a extend from the flat portion 54 toward the surface plate 2a side in the depth direction. While the ends of the side walls 55a may be in contact with the surface plate 2a, a slight gap may be formed between the surface plate 2a and them. The side walls 55a divide the space between the surface plate 2a and the flat portion 54 into a plurality of spaces aligned in the longitudinal direction. While the side walls 55a and the attachment portion 56 may be coupled together, it is not essential that they be coupled together.

[0116]

Moreover, while a gap may be formed between the opposing side walls 55a of the adjoining two porous plate units 53, hardly any gap may be formed therebetween.

[0117]

In the internal space of the housing 2, a plurality of air chambers 57 surrounded by the surface plate 2a and the flat portion 54 and side portion 55 of the porous plate unit 53 and one air chamber 58 surrounded by the back plate 2b and the flat portions 54 of a plurality of porous plate unit 53 are formed.

[0118]

The porous plate unit 53 is formed by bending one porous plate as mentioned above. Specifically, after a notch or a cut is formed in the four corners of a rectangular porous plate, one opposing end portions of this porous plate are vertically

bent so that the porous plate is U-shaped, and further, the end portions thereof are bent outward. That is, the porous plate is formed into a hat shape. Thereby, a pair of attachment portions 56 are formed. Then, the other opposing end portions
5 of the porous plate are vertically bent toward the side opposite to the attachment portions 56 to form the two side walls 55a and the flat portion 54. The attachment portions 56 may be formed after the side walls 55a are formed.

[0119]

10 Since the sound absorbing structure 51 having the above-described structure has the side walls 55a formed of a porous plate, it not only can absorb sounds in the vicinity of the resonance frequencies corresponding to the volumes of the air chambers 57 and 58 and sounds in the vicinity of the
15 resonance frequency corresponding to the volume of a space which is the aggregate of the air chamber 57 and the air chamber 58 aligned in the depth direction but also can absorb sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of the air chambers
20 57 adjoining in the longitudinal direction. Therefore, in the sound absorbing structure 51, the sound absorption frequency band can be widened toward the low frequency area side compared with the case where the side portions 55a are formed of a plate member where no through holes are formed.

25 [0120]

Moreover, since the hook portions 56a are fixed to the end portion of the frame portion 2c together with the surface plate 2a as described above, the porous plate unit 53 never moves in the housing 2.

5 [0121]

Moreover, since the sound absorbing structure 51 is manufactured by an easy method in which the hook portions 56a of the porous plate unit 53 formed by bending one porous plate are hooked on the end portion of the frame portion 2c and the surface plate 2a is placed thereon and fixed, manufacturing cost can be reduced.

[0122]

While the two side walls 55a of the side portion 55 extend from the flat portion 54 toward the surface plate 2a side in the porous plate unit 53 of the present embodiment, a porous plate unit 153 may be adopted in which as shown in FIG. 9, two side walls 155a of a side portion 155 extend from the flat portion 54 toward the back plate 2b side.

[0123]

20 Moreover, a porous plate unit 253 may be adopted in which as shown in FIG. 10, one of two side walls 255a of a side portion 255 extends from the flat portion 54 toward the surface plate 2a side and the other side wall 255a extends from the flat portion 54 toward the back plate 2b side.

25 [0124]

Moreover, while the porous plate unit 53 of the present embodiment has the two side walls 55a, it may have only one of the side walls 55a. In this case, the space in the housing 2 can also be divided into a plurality of spaces aligned in the longitudinal direction by the side wall 55a.

[0125]

Moreover, it is not essential that the porous plate unit 53 have the two side walls 55a. In this case, however, the space in the housing 2 is not divided with respect to the longitudinal direction.

[0126]

Moreover, a new porous plate unit may be formed by nesting a plurality of porous plate units 53 having different lengths in the depth direction. Thereby, the internal space of the housing 2 can be divided into a plurality of spaces with respect to the depth direction.

[0127]

Next, a sixth embodiment of the present invention will be described with the focus on differences from the first embodiment. Here, elements having the same structure as those of the first embodiment are denoted by the same reference numerals and descriptions thereof are omitted as appropriate.

[0128]

As shown in FIG. 11, a sound absorbing structure 61 of the sixth embodiment includes: a housing 62 whose outside shape

is substantially a rectangular parallelepiped; and a plurality of porous plate units 63 disposed so as to be aligned in the longitudinal direction in the housing 62.

[0129]

5 The housing 62 is provided with the surface plate 2a formed of a porous plate; a back plate 62b disposed so as to face the surface plate 2a; and the frame portion 2c formed integrally with the back plate 62b. The back plate 62b has a protrusion 62d protruding toward the surface plate 2a side.

10 The protrusion 62d includes a convex portion 62e formed on the back plate 62b and a spacer block 62f placed on the concave portion 62e.

[0130]

 The porous plate unit 63 is formed by bending one porous

15 plate. The porous plate unit 63 includes a flat portion 64, a pair of contact portions 66 and a side portion 65.

[0131]

 The flat portion 64 is disposed so as to face the surface plate 2a. The flat portion 64 is rectangular, and end portions

20 thereof extend in the longitudinal direction and in the depth direction, respectively. The flat portion 64 divides the internal space of the housing 62 into two spaces aligned in the depth direction. The flat portion 64 is placed on the protrusion 62d. Consequently, the protrusion 62d divides the

25 space between the flat portion 64 and the back plate 62b into

two spaces aligned in the lateral direction. While it is necessary for the flat portion 64 only to be placed on the protrusion 62d, it may be fixed with rivets or the like.

[0132]

5 The pair of contact portions 66 are coupled to the end portions, opposing with respect to the lateral direction, of the flat portion 64. The pair of contact portions 66 extend from the flat portion 64 toward the surface plate 2a side in the depth direction. The length of the contact portions 66
10 in the depth direction is substantially the same as the length from the end of the protrusion 62d to the surface plate 2a, and the ends of the contact portions 66 are in contact with the surface plate 2a. As described above, the ends of the pair of contact portions 66 extending from the opposing end portions
15 of the flat portion 64 are in contact with the surface plate 2a with the flat portion 64 being placed on the protrusion 62d, whereby the porous plate unit 63 is fixed in the housing 6.

[0133]

 The side portion 65 includes two side walls 65a coupled
20 to the end portions, opposing with respect to the longitudinal direction, of the flat portion 64. The side walls 65a extend from the flat portion 64 toward the surface plate 2a side in the depth direction. While the ends of the side walls 65a may be in contact with the surface plate 2a, a slight gap may be
25 formed between the surface plate 2a and them. The side walls

65a divide the space between the surface plate 2a and the flat portion 64 into a plurality of spaces aligned in the longitudinal direction. While the side walls 65a and the contact portions 66 may be coupled together, it is not essential
5 that they be coupled together.

[0134]

Moreover, while a gap may be formed between the opposing side walls 65a of the adjoining two porous plate units 63, hardly any gap may be formed therebetween.

10 [0135]

In the internal space of the housing 62, a plurality of air chambers 67 surrounded by the surface plate 2a and the flat portion 64 and side portion 65 of the porous plate unit 63 and two air chambers 68 and 69 surrounded by the back plate 62b,
15 the protrusion 62d and the flat portions 64 of a plurality of porous plate unit 63 are formed.

[0136]

The porous plate unit 63 is formed by bending one porous plate as mentioned above. Specifically, it is formed by
20 forming a notch or a cut in the four corners of a rectangular porous plate and then, vertically bending the peripheral portions of this porous plate.

[0137]

Since the sound absorbing structure 61 having the
25 above-described structure has the side walls 65a formed of a

porous plate, it not only can absorb sounds in the vicinity of the resonance frequencies corresponding to the volumes of the air chambers 67 to 69 and sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of the air chamber 67 and the air chamber 68 (69) aligned in the depth direction but also can absorb sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of the air chambers 67 adjoining in the longitudinal direction.

Therefore, in the sound absorbing structure 61, the sound absorption frequency band can be widened toward the low frequency area side compared with the case where the side walls 65a are formed of a plate member where no through holes are formed.

[0138]

Moreover, since the porous plate unit 63 is fixed in the housing 62 by the ends of the pair of contact portions 66 being in contact with the surface plate 2a with the flat portion 64 being placed on the protrusion 62d as mentioned above, the porous plate unit 63 never moves in the housing 62.

[0139]

Moreover, since the sound absorbing structure 61 is manufactured by an easy method in which the porous plate unit 63 formed by bending one porous plate is placed on the protrusion 62d and the surface plate 2a is fixed to the frame

portion 2c, manufacturing cost can be reduced.

[0140]

While the two side walls 65a extend from the flat portion 64 toward the surface plate 2a side in the porous plate unit 63 of the present embodiment, a porous plate 163 may be adopted in which as shown in FIG. 12, two side walls 165a of a side portion 165 extend from the flat portion 64 toward the back plate 62b side. Moreover, a porous plate unit may be adopted in which one of the two side walls extends from the flat portion 64 toward the surface plate 2a side and the other one extends from the flat portion 64 toward the back plate 62b side.

[0141]

Moreover, while the porous plate unit 63 of the present embodiment has the two side walls 65a, it may have only one of the side walls 65a. In this case, the space in the housing 2 can also be divided into a plurality of spaces aligned in the longitudinal direction by the side wall 65a.

[0142]

Moreover, it is not essential that the porous plate unit 63 have the side portion 65. In this case, however, the space in the housing 2 is not divided with respect to the longitudinal direction.

[0143]

Moreover, when the ends of the two side walls 65a are in contact with the surface plate 2a, it is not essential that

the pair of contact portions 66 be provided. In this case, the porous plate unit 63 is fixed in the housing 62 by the ends of the two side walls 65a being in contact with the surface plate 2a with the flat portion 64 being placed on the protrusion
5 62d.

[0144]

Next, a seventh embodiment of the present invention will be described with the focus on differences from the first embodiment. Here, elements having the same structure as those
10 of the first embodiment are denoted by the same reference numerals and descriptions thereof are omitted as appropriate.

[0145]

As shown in FIG. 13, a sound absorbing structure 71 of the seventh embodiment includes: a housing 2 similar to that
15 of the first embodiment; and a plurality of porous plate units 73 disposed so as to be aligned in the longitudinal direction inside the housing 2.

[0146]

The porous plate unit 73 is formed by bending one porous
20 plate. The porous plate unit 73 includes a flat portion 74 and a side portion 75.

[0147]

The flat portion 54 is disposed so as to face the surface plate 2a. The flat portion 54 is rectangular, and end portions
25 thereof extend in the longitudinal direction and in the depth

direction, respectively. The flat portion 74 divides the internal space of the housing 2 into two spaces aligned in the depth direction.

[0148]

5 The side portion 75 includes two side walls 75a coupled to the end portions, opposing with respect to the longitudinal direction, of the flat portion 74 and two side walls 75b coupled to the end portions, opposing with respect to the lateral direction, of the flat portion 74. The two side walls 75a
10 extend from the flat portion 74 toward the surface plate 2a side in the depth direction, and the two side walls 75b extend from the flat portion 74 toward the back plate 2b side in the depth direction. The sum of the length of the side walls 75a in the depth direction and the length of the side walls 75b
15 in the depth direction (the length of the porous plate unit 73 in the depth direction) is substantially the same as the length in the longitudinal direction in the housing 2. Consequently, the ends of the side walls 75a and 75b are in contact with the surface plate 2a and the back plate 2b,
20 respectively, and by this, the porous plate unit 73 is fixed in the housing 2. The side walls 75a divide the space between the surface plate 2a and the flat portions 74 into a plurality of spaces aligned in the longitudinal direction.

[0149]

25 Moreover, while a gap may be formed between the opposing

side walls 75a of the adjoining two porous plate units 73, hardly any gap may be formed therebetween.

[0150]

In the internal space of the housing 2, a plurality of
5 air chambers 76 surrounded by the surface plate 2a and the flat portion 74 and side portion 75a of the porous plate unit 73 and one air chamber 77 surrounded by the back plate 72b and the flat portions 74 and side walls 75b of a plurality of porous plate unit 73 are formed.

10 [0151]

The porous plate unit 73 is formed by bending one porous plate as mentioned above. Specifically, it is formed by forming a notch in the four corners of a rectangular porous plate and then, vertically bending the peripheral portions of
15 this porous plate so that the adjoining end portions are oriented in opposite directions.

[0152]

Since the sound absorbing structure 71 having the above-described structure has the side walls 75a formed of a
20 porous plate, it not only can absorb sounds in the vicinity of the resonance frequencies corresponding to the volumes of the air chambers 76 and 77 and sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of the air chamber 76 and the air chamber
25 77 aligned in the depth direction but also can absorb sounds

in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of the air chambers 76 adjoining in the longitudinal direction. Therefore, in the sound absorbing structure 71, the sound absorption frequency band can be widened toward the low frequency area side compared with the case where the side portions 75a are formed of a plate member where no through holes are formed.

[0153]

Moreover, since the porous plate unit 73 is fixed in the housing 2 by the ends of the two side walls 75a being in contact with the surface plate 2a and the ends of the two side walls 75b being in contact with the back plate 2b as mentioned above, the porous plate unit 73 never moves in the housing 2.

[0154]

Moreover, since the sound absorbing structure 71 is manufactured by an easy method in which the porous plate unit 73 formed by bending one porous plate is placed in the housing 2 and the surface plate 2a is fixed to the frame portion 2c, manufacturing cost can be reduced.

[0155]

While the side walls 75a extend toward the surface plate 2a side and the side walls 75b extend toward the back plate 2b side in the porous plate unit 73 of the present embodiment, a porous plate 173 may be adopted in which as shown in FIG. 14, two side walls 175a opposing with respect to the

longitudinal direction extend toward the back plate 2b side and two side walls 175b opposing with respect to the longitudinal direction extend toward the back plate 2a side. In this case, the side walls 175a divide the space between the back plate 2b and the flat portion 74 into a plurality of spaces aligned in the longitudinal direction.

[0156]

Moreover, the porous plate unit 73 of the present embodiment and the above-described porous plate unit 173 may be alternately disposed in the longitudinal direction in the housing 2. Thereby, the space between the surface plate 2a and the flat portion 74 is divided by the side walls 75a of the porous plate unit 73, and the space between the back plate 2b and the flat portion 74 is divided by the side walls 175a of the porous plate unit 173.

[0157]

Next, an eighth embodiment of the present invention will be described with the focus on differences from the first embodiment. Here, elements having the same structure as those of the first embodiment are denoted by the same reference numerals and descriptions thereof are omitted as appropriate.

[0158]

As shown in FIG. 15, a sound absorbing structure 81 of the eighth embodiment includes: a housing 2 similar to that of the first embodiment; two first porous plates 82 and 83

disposed so as to face the surface plate 2a in the housing 2;
and a plurality of second porous plates 84 to 86 disposed in
a direction orthogonal to the surface plate 2a in the housing
2.

5 [0159]

The first porous plates 82 and 83 are each disposed
parallel to the surface plate 2a. The first porous plates 82
and 83 are formed substantially in the same size as the surface
plate 2a. The plurality of second porous plates 84 to 86 are
10 disposed in a direction orthogonal to the longitudinal
direction.

[0160]

The internal space of the housing 2 is divided into three
spaces aligned in the depth direction by the first porous plates
15 82 and 83. The plurality of second porous plates 84 are
disposed between the first porous plate 82 and the surface plate
2a, and divide the space between the first porous plate 82 and
the surface plate 2a into a plurality of air chambers 87 aligned
in the longitudinal direction. The plurality of second porous
20 plates 85 are disposed between the first porous plate 82 and
the first porous plate 83, and divide the space between the
first porous plate 82 and the first porous plate 83 into a
plurality of air chambers 88 aligned in the longitudinal
direction. The plurality of second porous plates 86 are
25 disposed between the back plate 2b and the first porous plate

83, and divide the space between the back plate 2b and the first porous plate 83 into a plurality of air chambers 89 aligned in the longitudinal direction.

[0161]

5 While as a method of placing the first porous plates 82 and 83 and the second porous plates 84 to 86 in the housing 2, for example, a method is available in which the end portions of the first porous plates 82 and 83 and the second porous plates 84 to 86 are directly fixed to the frame portion 2c, the present
10 invention is not particularly limited to this method.

[0162]

 As the first porous plates 82 and 83 and the second porous plates 84 to 86, porous plates similar to the ones constituting the porous plate unit 3 of the first embodiment are used. As
15 the porous plates constituting the first porous plates 82 and 83 and the second porous plates 84 to 86, respectively, porous plates having different aperture ratios, hole diameters and plate thicknesses may be used.

[0163]

20 The sound absorbing structure 81 having the above-described structure not only can absorb sounds in the vicinity of the resonance frequencies corresponding to the volumes of the air chambers 87 to 89 and in the vicinity of the resonance frequency corresponding to the volume of a space
25 which is the aggregate of the air chambers 87 to 89 aligned

in the depth direction but also can absorb sounds in the vicinity of the resonance frequency corresponding to the volume of a space which is the aggregate of a plurality of air chambers 87 (or air chambers 88 and 89) aligned in the direction of the surface of the surface plate 2a. Therefore, in the sound absorbing structure 81, the sound absorption frequency band can be widened toward the low frequency area side compared with the case where plate members where no through holes are formed are used instead of the second porous plates 84 to 86.

[0164]

Moreover, since not only sound absorption is performed by using the through holes of the surface plate 2a and the first porous plates 82 and 81 but also sound absorption is performed by using the through holes of the second porous plates 84 to 86, sound absorption efficiency is improved.

[0165]

While the first to eighth embodiments have been described above as preferred embodiments of the present invention, the shape of the housing 2 of the sound absorbing structure of the present invention is not limited to a rectangular parallelepiped. For example, the shape of the surface plate 2a and the back plate 2b may be circular or triangular.

[0166]

Moreover, a housing 102 may be adopted in which the shape of the cross section orthogonal to the longitudinal direction

is a parallelogram as shown in FIG. 16. In this case, a triangular gap is formed between a frame portion 102c of the housing 102 and the side portion of the porous plate unit 3. The volume of a space 102d formed of this triangular gap is larger than the volume of the space formed between the frame portion 2c and the side portion of the porous plate unit in the first to fourth embodiments. For this reason, the rate of increase in sound absorption frequency band compared with the case where the side portion is formed of a plate member where no holes are formed is higher than that of the sound absorbing structures of the first to eighth embodiments. That is, in the case of the housing 102 having such a shape, making the space 102d and the air chambers communicate with each other is particularly effective for widening the sound absorption frequency band.

[0167]

Moreover, while the flat portion of the porous plate unit or the first porous plates are disposed parallel to the surface plate 2a in the first to eighth embodiments, they may be disposed in a direction slightly inclined from the surface plate 2a. Moreover, while the side portion of the porous plate unit or the second porous plates are disposed in the direction orthogonal to the surface plate 2a in the first to eighth embodiments, they may be disposed in a direction other than the orthogonal direction as long as it is a direction

intersecting the surface plate 2a.

[0168]

While the plurality of porous plate units all have the same shape in the first to seventh embodiments, the present invention is not limited thereto. For example, the plurality of porous plate units may be different in the length in the longitudinal direction or in the length in the lateral direction.

[0169]

Moreover, while the plurality of porous plate units are disposed two in the lateral direction and six in the longitudinal direction in the first to third embodiments, the number of disposed units is not limited thereto. For example, they may be disposed one in the lateral direction and more than one in the longitudinal direction.

EXAMPLE

[0170]

Next, a concrete example of the present invention will be described.

[0171]

As an example, a sound absorbing structure 801 shown in FIGS. 17A and 17B was made. The sound absorbing structure 801 of the example was provided with six porous plate units 803, and these six porous plate units 803 were disposed so as to

be aligned in the longitudinal direction inside the housing 802. As the porous plate units 803, porous plates having a similar structure to that of the porous plate units 3 of the first embodiment were used. The following of the sound absorbing structure 801 of the example are shown in Table 1:
the plate thicknesses, the aperture ratios and the diameters of the through holes of a surface plate 802a, flat portions 804a and 805a and side portions 804b and 805b; and the sizes of air chambers 806 to 808 and gaps D1 and d1.

[0172]

[Table 1]

		PLATE THICKNESS [mm]	HOLE DIAMETER [mm]	APERTURE RATIO [%]	SPACE THICKNESS (LENGTH IN DEPTH DIRECTION) [mm]	SPACE WIDTH (LENGTH IN LONGITUDINAL DIRECTION) [mm]
EXAMPLE	SURFACE PLATE 802a	0.8	0.8	3.5	-	-
	FLAT PORTION 805a	0.1	0.1	1.5	-	-
	FLAT PORTION 804a	0.1	0.1	0.5	-	-
	AIR CHAMBER 806	-	-	-	20	290
	AIR CHAMBER 807	-	-	-	20	290
	AIR CHAMBER 808	-	-	-	50	290
	SIDE PORTION 805b	0.1	0.1	1.0	-	-
	SIDE PORTION 804b	0.1	0.1	0.5	-	-
	GAP D1	-	-	-	90	12.5

	GAP d1	-	-	-	90	10
COMPARATIVE EXAMPLE	SURFACE PLATE 802a	0.8	0.8	3.5	-	-
	POROUS PLATE 90	0.1	0.1	1.0	-	-
	POROUS PLATE 91	0.1	0.1	0.5	-	-
	AIR CHAMBER 95	-	-	-	20	290
	AIR CHAMBER 96	-	-	-	20	290
	AIR CHAMBER 97	-	-	-	20	290

[0173]

As a comparative example, the conventional sound absorbing structure 901 shown in FIGS. 18A and 18B was made.

5 The sound absorbing structure 901 was provided with inside the housing 902: the porous plates 90 and 91 parallel to the surface plate 902a of the housing 902; and the plurality of partitioning walls 92 to 94 extending in the direction orthogonal to the surface plate 902a. The partitioning walls 92 were disposed
10 between the surface plate 902a and the porous plate 90, and divided the space between the surface plate 902a and the porous plate 90 into the plurality of spaces 95 aligned in the longitudinal direction. The partitioning walls 93 and 94 were disposed between the porous plate 90 and the porous plate 91
15 and between the porous plate 91 and the back plate 902b,

respectively, and divided the spaces therebetween into the plurality of spaces 95 to 97 aligned in the longitudinal direction, respectively. The following of the sound absorbing structure 901 of the comparative example are shown in Table

1: the plate thicknesses, the aperture ratios and the diameters of the through holes of the surface plate 902 and the porous plates 90 and 91; and the sizes of the air chambers 95 to 97.

[0174] The reverberation room method sound absorption coefficients, by actual measurement, of the sound absorbing structures 801 and 901 of the example and the comparative example were measured. The results are shown in FIG. 19. The vertical axis of FIG. 19 represents the sound absorption coefficient for the sound from the sound source, and the horizontal axis represents the 1/3 octave band frequency (Hz).

[0175]

As shown in FIG. 19, although the sound absorption coefficient of the sound absorbing structure 801 of the example is substantially the same as that of the sound absorbing structure 901 of the comparative example in the range of 400 Hz to 630 Hz, it is improved compared with that of the comparative example in the other frequency areas. In particular, the sound absorption coefficient in a low frequency area of 250 Hz to 315 Hz is improved. Therefore, it is understood that in the sound absorbing structure 801 of the

example, the sound absorption frequency band is widened compared with the sound absorbing structure 901 of the comparative example.

5 EXPLANATION OF THE REFERENCE NUMERALS

[0176]

1, 21, 31, 41, 51, 61, 71, 81, 801 sound absorbing structure

2, 62, 102, 802 housing

10 2a, 802a surface plate

2b, 62b back plate

2c, 102c frame portion

3, 3', 23, 33, 33', 43, 53, 63, 73, 133, 133', 153, 163, 173, 253, 803 porous plate unit

15 4a, 5a, 24a, 25a, 33a, 44a, 45a, 54, 64, 74, 133a, 804a, 805a flat portion

4b, 5b, 24b, 25b, 33b, 44b, 45b, 55, 65, 75, 133b, 155, 165, 175, 255, 804b, 805b side portion

4 first member

20 5 second member

6-8, 26-28, 34-36, 46-48, 57, 58, 67-79, 76, 77,

87-89, 806-807 air chamber

9, 29, 37-39, 49, 49a, 102d space

24 large box

25 25 small box

33c, 133c, nipping portion
44 U-shaped member
45 U-shaped member
56 a pair of attachment portions
56a hook portion
62d protrusion
66 a pair of contact portions
82, 83 first porous plate
84-86 second porous plate

CLAIMS

1. A sound absorbing structure comprising:

a housing having a surface plate formed of a porous plate

5 on one surface;

a first porous plate disposed so as to face the surface plate inside the housing, and dividing an internal space of the housing into a plurality of spaces aligned in a direction orthogonal to the surface plate; and

10 a second porous plate disposed in a direction intersecting the surface plate inside the housing, and dividing the internal space of the housing into a plurality of spaces aligned in a direction of a surface of the surface plate.

15 2. A sound absorbing structure comprising:

a housing having a surface plate formed of a porous plate on one surface; and

a plurality of porous plate units disposed so as to be aligned in a direction of a surface of the surface plate inside
20 the housing, and each formed of a porous plate, wherein

the porous plate units include:

a flat portion disposed so as to face the surface plate, and dividing an internal space of the housing into a plurality of spaces aligned in a direction orthogonal to the
25 surface plate; and

a side portion coupled to the flat portion, placed on an inner surface of the housing, extending in a direction intersecting the surface plate, and dividing the internal space of the housing into a plurality of spaces aligned in the
5 direction of the surface of the surface plate.

3. The sound absorbing structure according to claim 2, wherein

the side portions of the adjoining two porous plate units
10 are disposed with a gap in between.

4. The sound absorbing structure according to claim 2, wherein

the side portion of the porous plate unit, adjoining the
15 inner surface of the housing, of the plurality of porous plate units is disposed with a gap from the inner surface of the housing.

5. The sound absorbing structure according to claim
20 3, wherein

the side portion has a protrusion protruding toward a side opposite to the flat portion.

6. The sound absorbing structure according to claim
25 2, wherein

the flat portion and the side portion are integrally formed by bending one porous plate.

7. The sound absorbing structure according to claim
5 2, wherein

an end portion of the flat portion is fixed to the side portion.

8. The sound absorbing structure according to claim
10 7, wherein

the side portion is formed of a porous plate, and has a nipping portion nipping the end portion of the flat portion while pressing the end portion from both surface sides.

15 9. The sound absorbing structure according to claim 2, wherein:

the side portion is disposed so as to surround the flat portion when viewed from the direction orthogonal to the surface plate; and

20 the flat portion is coupled to the side portion on an entire perimeter thereof.

10. The sound absorbing structure according to claim 9, wherein:

25 the porous plate units have a plurality of boxes formed

of a bottom wall serving as the flat portion and four side walls serving as the side portion; and

lengths of the plurality of boxes in the direction orthogonal to the surface plate are different from each other,
5 sizes of openings surrounded by the four side walls of the plurality of boxes are substantially the same, and the plurality of boxes are nested with sides of the openings being in contact with a surface facing the surface plate of the housing.