

DESCRIPTION

SPEAKER AND SPEAKER HOUSING

5 Technical Field

[0001]

The present invention relates to a double-walled structure speaker and a speaker housing that is applied to the speaker.

[0002]

10 Usually, a speaker is provided with a speaker unit that emits sound waves in a forward direction (hereinafter, referred to as “forward waves”) by causing air to vibrate depending on an electrical signal that is input, and a housing that supports the speaker unit. The housing is provided in order to prevent sound waves which are unnecessary sound waves of the opposite phase to the above-mentioned forward waves, and which are
15 emitted to a rear section of the speaker unit (hereinafter, referred to as “rearward waves”), from interfering with forward waves, and is made into a shape in which a space at the rear section of the speaker unit is shielded.

[0003]

However, there are cases in which the space on a housing inner side vibrates due
20 to pressure fluctuations caused by rearward waves which are emitted from the rear section of the speaker unit, and the wall surfaces of the housing vibrate as a result of the vibrations of the above-mentioned space becoming further excited. Further, sound waves propagate to an outer part of the housing as a result of air in the outer part of the housing vibrating due to the wall surfaces of the housing vibrating. If this kind of
25 propagation of sound waves through the housing arises, a problem in which the sound

waves which are emitted from the housing to the outer part, interfere with forward waves which are emitted to a front section of the speaker unit, occurs.

[0004]

As a method that solves this problem, a method that limits the vibration of the wall surface of the housing by making a wall part of the housing extremely thick, thereby improving the rigidity thereof, could be considered. However, in this method, there is a separate problem in that the weight of the housing is increased significantly.

[0005]

In such an instance, speakers in which the propagation of sound waves through the housing is limited by providing a vacuum airtight space, which limits the propagation of vibrations, between an inner wall part and an outer wall part of the housing, which is set as a double-walled structure, were suggested in PTLs 1 and 2. In these speakers, it is possible to limit the propagation of sound waves through the housing without significantly increasing the weight of the housing.

15

Citation List

Patent Literature

[0006]

[PTL 1] Japanese Unexamined Utility Model Application, First Publication No.

20 63-15691

[PTL 2] Japanese Unexamined Patent Application, First Publication No.

2003-92791

Summary of Invention

25 Technical Problem

[0007]

In a double-walled structure housing, there is an airtight space between an inner wall part and an outer wall part. Therefore, it is possible to limit circumstances in which vibrations, which are perpendicular to the inner wall part, and are excited by rearward waves, propagate to the outer wall part through the airtight space.

However, in a double-walled structure housing, there are circumstances in which vibrations, which propagate to the outer wall part without passing through the airtight space, are generated. More specifically, vibrations in which vibrations of the inner wall part, which are excited by rearward waves, propagate from the inner wall part to the outer wall part through connection portions between the inner wall part and the outer wall part (hereinafter, referred to as “wraparound vibrations”), and vibrations in which vibrations of the inner wall part, which are excited by rearward waves, propagate to the housing directly from the speaker unit through contact portions between the speaker unit and the housing (hereinafter, referred to as “direct vibrations”), are generated, and the outer wall part vibrates as a result of these vibrations.

[0008]

In this manner, it is difficult to sufficiently limit vibration of the outer wall part by solely setting the housing to have a double-walled structure. Therefore, in a double-walled structure housing, it is necessary to limit vibrations that propagate along the wall surfaces of the inner wall part and the outer wall part.

Additionally, in vibrations that are transmitted along the wall surfaces of the inner wall part and the outer wall part, which form a double-walled structure, there are vertical waves (compressional waves), which are parallel to a direction of propagation, and horizontal waves, which are perpendicular to the direction of propagation. Among these, the vertical waves are vibrations which are parallel to the wall surface, and mostly

do not cause a problem since it is difficult to cause air in the periphery of the wall surface to vibrate. However, the horizontal waves are vibrations which are perpendicular to the wall surface, and cause a serious problem since the horizontal waves are the main source that generate sound waves in the outer part of the housing by causing the air in the
5 periphery of the wall surface to vibrate.

[0009]

In the speaker that is suggested in PTL 1, vibrations that propagate to the outer wall part are limited by providing an elastic body for absorbing vibrations, in a vibration propagation pathway that reaches from the speaker unit to the outer wall part. However,
10 since it is necessary to provide elastic bodies at joining parts between the outer wall part and the inner wall part in order to limit the wraparound vibrations, a structure in which the risk that the vacuum of the airtight space will collapse as a result of impact, deterioration over time or the like, is high, is formed (refer to FIG. 2 of PTL 1).

[0010]

15 In addition, in a structure such as that of the speaker that is suggested in PTL 2, which includes an enclosure fixing reinforcement material, the limitation of vibrations (in particular, direct vibrations) in the outer wall part is insufficient. Therefore, in a speaker with this structure, it is necessary to provide a sound absorption material on an outer side of the outer wall part in order to limit a negative effect on sound waves that are caused by
20 vibrations of the outer wall part, and to further provide a designated case for retaining the sound absorption material on the outer side. Therefore, the structure of the speaker becomes unnecessarily large and complicated.

Accordingly, from a viewpoint of reducing the size of, and simplifying the structure of a speaker, it can be said that adopting a structure in which it is possible to
25 limit vibrations that are generated in the outer wall part in advance is preferable to limit

the negative effect on sound waves that are caused by vibrations, which are generated in the outer wall part, retroactively.

[0011]

An object of the present invention is to provide a speaker and a speaker housing
5 that are capable of limiting both wraparound vibrations and direct vibrations with a simple structure, and which limit the propagation of sound waves through the housing as a result.

[0012]

In order to achieve the above-mentioned object, the present invention provides a
10 speaker with the following features.

[0013]

That is, the present invention provides a speaker including: a speaker unit; and a housing, in which the housing is a double-walled structure that is provided with an inner wall part, a part of which is open, and which has a space on an inner side thereof, and an
15 outer wall part, a part of which is open, and in which the inner wall part is disposed in a space on an inner side of the outer wall part, in which respective open end parts of the inner wall part and the outer wall part are integrated to form a rim part, in which an airtight space is formed between the inner wall part and the outer wall part, and in which at least a part of the speaker unit comes into contact with and is supported by the inner
20 wall part in the space on the inner side of the inner wall part, in a direction parallel to an opening surface, which has an outer circumference formed by the rim part.

[0014]

In the speaker, the speaker unit comes into contact with the inner wall part in a direction parallel to the opening surface. That is, the speaker unit comes into contact
25 with the inner wall part in a direction perpendicular to the inner wall part. Therefore,

the impedance with respect to a direction perpendicular to the inner wall part is large, and therefore, in the inner wall part, it is possible to provide a region in which it is difficult for horizontal waves to propagate toward the outer wall part. Accordingly, it is possible to limit wraparound vibrations, which are mainly horizontal waves, by being excited by rearward waves of the speaker unit.

[0015]

In addition, a principal vibration direction of the speaker unit (that is, a direction in which forward waves are emitted) is a direction perpendicular to the opening surface. Furthermore, it is easy for vibrations in a direction perpendicular to the inner wall part (that is, horizontal waves) to propagate to the inner wall part since the impedance of the inner wall part is comparatively small, and it is difficult for vibrations in a direction parallel to the inner wall part (that is, vertical waves) to propagate to the inner wall part since the impedance of the inner wall part is comparatively large. In this instance, if the speaker unit comes into contact with the inner wall part in a direction parallel to the opening surface, a principal vibration direction of the speaker unit approaches a direction parallel to the inner wall part. As a result of this, direct vibrations that propagate from the speaker unit to the inner wall part mainly become vertical waves, but since, in the manner described above, it is difficult for vertical waves to propagate to the inner wall part, it is possible to reduce direct vibrations. Accordingly, it is possible to limit direct vibrations.

[0016]

In addition, even if vertical waves were to propagate to the outer wall part as either wraparound vibrations or direct vibrations, since it is difficult for vertical waves to cause the air in the periphery of the outer wall part to vibrate, very few sound waves are emitted from the outer wall part.

Furthermore, even if a part of the vertical waves were to change into horizontal waves midway through propagation to the outer wall part, since the energy of the vibrations decreases during the change, very few sound waves are emitted from the outer wall part.

5 [0017]

In addition, in the speaker of the present invention, it is preferable that at least a part of the speaker unit comes into contact with and is supported by the inner wall part in the space on the inner side of the inner wall part, and at a position spaced apart from the rim part, and that a shape of the rim part in a cross-section perpendicular to the opening
10 surface is a V-shape.

[0018]

According to this speaker, since the rim part is folded sharply, it becomes difficult for vibrations to pass through the rim part. Therefore, it is possible to limit wraparound vibrations and direct vibrations.

15 Additionally, when a direction that runs from the opening surface toward the space on the inner side of the inner wall part, is set as a rearward direction, and a direction opposite to the rearward direction is set as the forward direction, the rim part is an end part that is furthest on the forward side of the housing. Further, from a viewpoint of limiting the passage of vibrations, it is preferable that the rim part is a shape
20 folded into a V-shape at an acute angle.

[0019]

Furthermore, the present invention provides the following speaker.

[0020]

That is, a speaker including a speaker unit, and a housing, in which the housing
25 is a double-walled structure that is provided with an inner wall part, a part of which is

open, and which has a space on an inner side thereof, and an outer wall part, a part of which is open, and in which the inner wall part is disposed in a space on an inner side of the outer wall part, in which respective open end parts of the inner wall part and the outer wall part are integrated to form a rim part, in which an airtight space is formed between the inner wall part and the outer wall part, in which at least a part of the speaker unit comes into contact with and is supported by the inner wall part in the space on the inner side of the inner wall part, and at a position spaced apart from the rim part, and in which the shape of the rim part in a cross-section perpendicular to the opening surface, which has an outer circumference that is formed by the rim part, is a V-shape.

10 [0021]

In addition, in the speaker with the above-mentioned characteristics, it is preferable that at least a part of the speaker unit comes into contact with and is supported by the inner wall part in the space on the inner side of the inner wall part, in a direction parallel to the opening surface.

15 [0022]

In addition, in the speakers with the above-mentioned respective characteristics, it is preferable that the shape of the rim part in a cross-section perpendicular to the opening surface is a V-shape folded back by protruding outside the airtight space surrounded by the inner wall part and the outer wall part.

20 [0023]

In addition, in the speakers with the above-mentioned respective characteristics, it is preferable that the shape of the rim part in a cross-section perpendicular to the opening surface is a V-shape folded once only.

[0024]

25 In addition, in the speakers with the above-mentioned respective characteristics,

it is preferable that the shape of the rim part in a cross-section perpendicular to the opening surface is a V-shape folded at an angle smaller than 70° .

[0025]

According to these speakers, it is possible to effectively limit the passage of
5 vibrations at the rim part.

[0026]

In addition, in the speakers with the above-mentioned respective characteristics, the speaker unit may be provided with a vibration plate, a driving part that causes the vibration plate to vibrate by driving the vibration plate depending on an input electrical
10 signal, and a unit support part that supports at least the driving part, and the unit support part may come into contact with and be supported by the inner wall part.

[0027]

Furthermore, in the speakers with the above-mentioned respective characteristics, it is preferable that, when a direction that runs from the opening surface toward the space
15 on the inner side of the inner wall part, is set as the rearward direction, and a direction opposite to the rearward direction is set as a forward direction, at least a part of the unit support part comes into contact with and is supported by the inner wall part at a position further rearward than a front section end part of the vibration plate.

[0028]

20 According to this speaker, it is possible to increase a distance between a connection position between the unit support part and the inner wall part, and the rim part. Therefore, it is possible to effectively limit wraparound vibrations by increasing the distance for the dampening of wraparound vibrations.

[0029]

25 In addition, in the speakers with the above-mentioned respective characteristics,

when a direction that runs from the opening surface toward the space on the inner side of the inner wall part, is set as the rearward direction, and a direction opposite to the rearward direction is set as the forward direction, a front section end part of the speaker unit may be positioned further forward than the rim part.

5 [0030]

In this speaker, since the speaker unit is further forward than the rim part, it is possible to prevent a part of the forward waves that the speaker unit emits from interfering with normally emitted forward waves as a result of being unnecessarily reflected or scattered by the rim part. In addition, since it is possible to avoid the

10 above-mentioned interference, it is possible to make the shape of the rim part an arbitrary shape (in particular, a shape applied in order to limit wraparound vibrations and direct vibrations).

[0031]

Furthermore, in the speakers with the above-mentioned respective characteristics, 15 it is preferable that an outer edge of the speaker unit extends up to the front section of the rim part, and is spaced apart from the rim part.

[0032]

According to this speaker, it is possible to effectively limit direct vibrations since the outer edge of the speaker unit does not come into contact with the rim part.

20 [0033]

In addition, in the speakers with the above-mentioned respective characteristics, it is preferable that at least a part of the speaker unit comes into contact with and is supported in the space on the inner side of the inner wall part in a state of being pressed against the inner wall part along a direction parallel to the opening surface.

25 [0034]

According to this speaker, stress along a contact direction with the inner wall part is applied as a result of the speaker unit being pressed against the inner wall part along a direction parallel to the opening surface. Therefore, it is possible to effectively limit wraparound vibrations.

5 [0035]

In addition, in the speakers with the above-mentioned respective characteristics, it is preferable that at least a part of an outer side surface of the speaker unit inserted into the space on the inner side of the inner wall part, comes into contact with and is supported by the inner wall part opposed thereto.

10 [0036]

According to this speaker, the outer side surface of the speaker unit and the inner wall part, which oppose one another, only need to be fixed together when the speaker unit is fixed to the inner wall part. Therefore, it is possible to easily fix the speaker unit to the inner wall part.

15 [0037]

In addition, in the speakers with the above-mentioned respective characteristics, it is preferable that the shape of a cross-section of a portion of the speaker unit inserted into the space on the inner side of the inner wall part, which is parallel to the opening surface, gradually becomes larger from the space on the inner side of the inner wall part toward the opening surface.

20 [0038]

According to this speaker, when the speaker unit is inserted into the space on the inner side of the inner wall part, stress along a contact direction with the inner wall part is applied as a result of the speaker unit being pressed against the inner wall part along a direction parallel to the opening surface. Therefore, it is possible to effectively limit

25

wraparound vibrations.

[0039]

In addition, in the speakers with the above-mentioned respective characteristics, the inner wall part may be a bottomed tube, and an axial center of the inner wall part may
5 pass through the opening surface.

[0040]

In addition, in the speakers with the above-mentioned respective characteristics, it is preferable that a stepped part which protrudes toward the inside of the space on the inner side, is provided in the inner wall part, and the speaker unit is supported by the
10 inner wall part in a state where an end part of the speaker unit which is inserted in the space on the inner side of the inner wall part, abuts against the stepped part.

[0041]

According to this speaker, it is possible to easily determine a position of the speaker unit in the space on the inner side of the inner wall part.

15 [0042]

In addition, in the speakers with the above-mentioned respective characteristics, it is preferable that the air pressure in the airtight space between the inner wall part and the outer wall part is lower than atmospheric pressure.

[0043]

20 According to this speaker, it is possible to limit vibrations that propagate from the inner wall part to the outer wall part through the airtight space. In addition, if the airtight space between the inner wall part and the outer wall part reaches a negative pressure, stress is applied to the inner wall part as a result of the inner wall part being pulled to the outer wall part side. Therefore, it is possible to effectively limit
25 wraparound vibrations.

[0044]

In addition, in the speakers with the above-mentioned respective characteristics, it is preferable that at least a part of the speaker unit is screwed together with and is supported by the inner wall part.

5 [0045]

According to this speaker, it is possible to freely detach the speaker unit from the housing. Therefore, it is possible for a user to obtain a speaker with properties that match their taste by selectively combining favorites from among a variety of speaker units and housings with different properties.

10 [0046]

In addition, according to this speaker, it is possible to arbitrarily adjust a support state of the speaker unit depending on the housing. For example, it is possible to reduce the volume of a space (the air volume), which is in a rear section of the speaker unit, and is surrounded by the inner wall part by increasing a screwing amount of the speaker unit, and it is possible to increase the volume of the space, by decreasing the screwing amount of the speaker unit, or the like. Further, it is possible to change the resonance state of the speaker unit by performing this kind of adjustment.

[0047]

Furthermore, in the speakers with the above-mentioned respective characteristics, it is preferable that an external diameter of a screw thread of the speaker unit, which screws together with the inner wall part, gradually increases from the space on the inner side of the inner wall part toward the opening surface.

[0048]

According to this speaker, the speaker unit is pressed against the inner wall part in accordance with screwing of the speaker unit. That is, stress along a direction

25

perpendicular to the inner wall part is applied to the inner wall part in accordance with screwing of the speaker unit. Accordingly, it is possible to effectively limit wraparound vibrations.

[0049]

5 Furthermore, in the speakers with the above-mentioned respective characteristics, it is preferable that a stepped part which protrudes toward the inside of the space on the inner side, is provided in the inner wall part, that a screw thread, which is provided in the speaker unit and screws together with the inner wall part, and a screw thread, which is provided in the inner wall part and screws together with the speaker unit, respectively
10 include flanks inclined with respect to a surface that is perpendicular to a screwing direction, and that the speaker unit is supported by the inner wall part in a state where an end part of the speaker unit which is inserted in the space on the inner side of the inner wall part, abuts against the stepped part.

[0050]

15 According to this speaker, stress in a direction (a direction which parallel to the screwing direction, and that runs from the space on the inner side of the inner wall part toward the opening surface) opposite to a fastening direction is applied from the stepped part to the speaker unit by bringing the speaker unit into contact with the stepped part (in particular, pressing the speaker unit by fastening tightly). When this happens, stress in a
20 direction perpendicular to the flanks is applied from the flanks of the screw thread on the speaker unit side to the flanks of the screw thread of the inner wall part side, which are in contact with the flanks. At this time, due to the fact that the flanks of the screw thread of the inner wall part side are inclined toward a surface (that is, a surface that is perpendicular to the inner wall part) that is perpendicular to a screwing direction, the
25 stress that has a direction component perpendicular to the inner wall part (a direction

component that presses the inner wall part against an outer side). Accordingly, it is possible to effectively limit wraparound vibrations.

[0051]

In addition, the present invention provides the following speaker housing.

5 [0052]

That is, the present invention is a speaker housing which is a double-walled structure including an inner wall part, a part of which is open, and which has a space on an inner side thereof, and an outer wall part, a part of which is open, and in which the inner wall part is disposed in a space on an inner side of the outer wall part, in which
10 respective open end parts of the inner wall part and the outer wall part are integrated to form a rim part, and in which an airtight space is formed between the inner wall part and the outer wall part, in which a support structure for causing at least a part of the speaker unit to come into contact with and be supported by the inner wall part in the space on the inner side of the inner wall part, in a direction parallel to an opening surface, which has
15 an outer circumference that is formed by the rim part, is provided in the inner wall part.

[0053]

Meanwhile, the present invention also provides a speaker housing with the following features.

[0054]

20 That is, the present invention provides a speaker housing which is a double-walled structure including an inner wall part, a part of which is open, and which has a space on an inner side thereof, and an outer wall part, a part of which is open, and in which the inner wall part is disposed in a space on an inner side of the outer wall part, in which respective open end parts of the inner wall part and the outer wall part are
25 integrated to form a rim part, and in which an airtight space is formed between the inner

wall part and the outer wall part, in which a support structure for causing at least a part of the speaker unit to come into contact with and be supported by the inner wall part in the space on the inner side of the inner wall part, in the space on the inner side of and at a position spaced apart from the rim part, is provided in the inner wall part, and in which
5 the shape of the rim part in a cross-section perpendicular to the opening surface, which has an outer circumference that is formed by the rim part, is a V-shape.

Advantageous Effects of Invention

[0055]

10 Since the speakers with the above-mentioned respective characteristics and the speaker housings with the above-mentioned respective characteristics are provided with a simple configuration of the speaker unit coming into contact with and being supported by the inner wall part, it is possible to limit both wraparound vibrations and direct vibrations, and it is possible to limit the propagation of sound waves through the housing as a result.

15

Brief Description of Drawings

[0056]

FIG. 1 shows a schematic perspective view of a speaker according to an embodiment of the present invention.

20 FIG. 2 shows a cross-sectional view that shows an A-A cross-section of FIG. 1.

FIG. 3 shows an exploded perspective view of the speaker in FIG. 1.

FIG. 4 shows a cross-sectional view that shows a first example of a speaker according to an embodiment of the present invention.

FIG. 5 shows a cross-sectional view that shows a second example of a speaker
25 according to an embodiment of the present invention.

FIG. 6 shows a cross-sectional view that shows a third example of a speaker according to an embodiment of the present invention.

FIG. 7 shows a cross-sectional view that shows a fourth example of a speaker according to an embodiment of the present invention.

5 FIG. 8 shows a lateral view that shows an experiment method.

FIG. 9 shows lateral views that show the shapes of respective samples.

FIG. 10 shows graphs that show measurement results of vibrations in a sample V.

10 FIG. 11 shows graphs that show measurement results of vibrations in a sample U.

FIG. 12 shows graphs that show results of vibrations in a sample C.

FIG. 13 shows graphs that show measurement results of vibrations in a sample inverted S.

FIG. 14 shows graphs that show measurement results of vibrations in a sample S.

15 FIG. 15 shows a graph that shows amounts of dampening of the respective samples (plate thickness: 0.5 mm) that are shown in FIG. 9.

FIG. 16 shows a graph that shows amounts of dampening of the respective samples (plate thickness: 1.0 mm) that are shown in FIG. 9.

FIG. 17 shows lateral views that show the shapes of respective samples.

20 FIG. 18 shows a graph that shows amounts of dampening of the respective samples (plate thickness: 0.5 mm) that are shown in FIG. 17.

FIG. 19 shows a graph that shows amounts of dampening of the respective samples (plate thickness: 1.0 mm) that are shown in FIG. 17.

25 FIG. 20 shows a cross-sectional view that shows a fifth example of a speaker according to an embodiment of the present invention.

FIG. 21 shows a cross-sectional view that shows a sixth example of a speaker according to an embodiment of the present invention.

FIG. 22 shows a cross-sectional view that shows a seventh example of a speaker according to an embodiment of the present invention.

5 FIG. 23 shows an exploded perspective view of the speaker in FIG. 22.

FIG. 24 shows a cross-sectional view that shows an eighth example of a speaker according to an embodiment of the present invention.

FIG. 25 shows a cross-sectional view that shows a ninth example of a speaker according to an embodiment of the present invention.

10 FIG. 26 shows perspective view that shows an example of a manufacturing method of a speaker housing according to an embodiment of the present invention.

FIG. 27 shows perspective view that shows an example of a manufacturing method of a speaker housing according to an embodiment of the present invention.

15 FIG. 28 shows perspective view that shows an example of a manufacturing method of a speaker housing according to an embodiment of the present invention.

FIG. 29 shows a cross-sectional view of a speaker housing that is manufactured using the manufacturing method that is shown in FIGS. 26 to 28.

Description of Embodiments

20 [0057]

<Basic Configuration>

Firstly, a basic configuration of a speaker according to an embodiment of the present invention will be described with reference to the drawings. FIG. 1 shows a schematic perspective view of a speaker according to an embodiment of the present invention. In addition, FIG. 2 shows a cross-sectional view that shows an A-A

25

cross-section of FIG. 1. In addition, FIG. 3 shows an exploded perspective view of the speaker in FIG. 1.

[0058]

As shown in FIGS. 1 to 3, a speaker 1 includes a speaker unit 10 and a housing
5 20. The speaker unit 10 is a component that emits sound waves by causing air to
vibrate depending on an input electrical signal. In addition, the housing 20 is a
component that supports the speaker unit 10.

[0059]

Hereinafter, a direction in which the speaker unit 10 is provided when viewed
10 from the housing 20 in FIGS. 1 to 3 is set as forward (an upper direction in FIGS. 1 to 3),
and a direction in which the housing 20 is disposed when viewed from the speaker unit
10 is set to rearward (a lower direction in FIGS. 1 to 3).

[0060]

The speaker unit 10 includes a vibration plate 11, a driving part 12, a unit
15 support part 13 and an edge part 14.

[0061]

The vibration plate 11 is a thin plate, and is formed from an elastic material such
as a resin or paper, or a metal for example. The vibration plate 11 is supported by the
driving part 12 and the edge part 14 in a state where a first end of the vibration plate 11 is
20 connected to the driving part 12, and a second end thereof is connected to the edge part
14. In addition, a center cap 111 is provided in the vibration plate 11 in a manner that
covers the driving part 12. Additionally, the center cap 111 may be a component
formed from the same material as the vibration plate 11, or may be a component formed
from a different material from the vibration plate 11.

25 [0062]

The driving part 12 is, for example, provided with a magnet and a coil. The driving part 12 causes the vibration plate 11, which is connected to the driving part 12, to reciprocate forward and rearward due to an electromagnetic force that is generated depending on an input electrical signal. As a result of this, the vibration plate 11
5 (including the center cap 111) vibrates, thereby emitting sound waves (forward waves) toward the front section of the vibration plate 11, and emitting sound waves (rearward waves) toward the rear section of the vibration plate 11.

[0063]

The unit support part 13 is a frame of the speaker unit 10 and is, for example,
10 formed from a resin, a metal or the like. The vibration plate 11, the driving part 12 and the edge part 14 are respectively disposed on an inner side of the unit support part 13. In addition, the unit support part 13 respectively supports the driving part 12 and the edge part 14. In this instance, a part of a rear section end part of the unit support part 13 is open, and the driving part 12 is positioned in the opening section. Therefore, rearward
15 waves that are emitted from the vibration plate 11 penetrate inside a space on an inner side of the housing 20.

[0064]

The edge part 14 is a thin film, and is, for example, formed from a flexible material such as cloth or urethane. A forward space and a rearward space of the
20 vibration plate 11 are isolated as a result of one end of the edge part 14 being connected to the above-mentioned second end of the vibration plate 11, which is connected to the driving part 12.

[0065]

The housing 20 includes an inner wall part 21, a part of which is open, and
25 which has a space on an inner side thereof, and an outer wall part 22, a part of which is

open, and in which the inner wall part 21 is disposed in a space on an inner side of the outer wall part 22. Respective open end parts of the inner wall part 21 and the outer wall part 22 are integrated to form a rim part 23. As a result of this, the housing 20 forms a double-walled structure in which an airtight space is formed between the inner wall part 21 and the outer wall part 22. Additionally, the rim part 23 is an end part that is furthest on the forward side of the housing 20.

[0066]

In this instance, a surface, which has an outer circumference that is formed by the rim part 23, is set as an opening surface 24. At this time, the direction that runs from the opening surface 24 toward the space inside the inner wall part 21 is rearward, and the direction opposite thereto is forward.

[0067]

The housing 20 that is shown as an example in FIGS. 1 to 3 is a housing in which the inner wall part 21 and the outer wall part 22 are a bottomed tube (;more specifically, a cylinder in which one end part is open, and the other end part is closed), and in which the axial centre of the inner wall part 21 and the outer wall part 22 pass through the opening surface 24 (more specifically, the axial centre of the tube and the opening surface 24 intersect in a perpendicular manner). In addition, FIG. 2 is a cross-section (that is, a cross-section perpendicular to the opening surface 24) that passes through the axial centre of the inner wall part 21 and the outer wall part 22.

[0068]

It is possible to use a metal material such as a ferrous material (for example, a steel such as stainless steel), an aluminum-based material, a magnesium-based material, a titanium-based material, a copper-based materials (for example, brass) a material that contains gold, silver or the like, in the housing 20.

In addition, it is also possible to use a resin-based material such as Carbon Fiber Reinforced Plastic (CFRP), Glass Fiber Reinforced Plastic (GFRP), soarnol (registered trademark), X-BARRIER (registered trademark), or an inorganic material other than a metal material such as glass or a ceramic.

5 Furthermore, it is also possible to use a composite material in which, for example, a gas barrier film and a substrate (for example, a resin material) have been combined.

 Additionally, as the material that forms the housing 20, it is also possible to use materials other than those mentioned above, but it is preferable to use a material having
10 high rigidity, and a material that has properties which are capable of limiting vibrations.

[0069]

 In the speaker 1, at least a part of the speaker unit 10 is disposed in the space on the inner side of the inner wall part 21, and comes into contact with and is supported by the inner wall part 21 in a manner that is parallel to the opening surface 24. More
15 specifically, for example, the outer side surface of the unit support part 13 is parallel to the opening surface 24, and comes into contact with and is supported by the inner wall part 21 along a direction that runs from the axial centre of the housing 20 to an outer side. At this time, the outer side surface of the unit support part 13 comes into contact with and is supported by the inner wall part 21 at a position further rearward than at least part of
20 the unit support part 13 (an end part that is connected to a front section end part of the vibration plate 11, or in other words, the edge part 14).

[0070]

 In addition, as shown in FIG. 2, a front section end part of the speaker unit 10 is positioned further forward than the rim part 23. Furthermore, an outer edge of the
25 speaker unit 10 extends up to the front section of the rim part 23, and is spaced apart

from the rim part 23. Further, at least part of the speaker unit 10 comes into contact with and is supported by the inner wall part 21 opposed thereto. More specifically, at least a part of the speaker unit 10 that is close to the rear section of the outer side surface (the outer side surface of the unit support part 13) of a portion, which is inserted into the space on the inner side of the inner wall part 21, comes into contact with and is supported by the inner wall part 21 opposed thereto.

[0071]

In the speaker 1 of the present example, the speaker unit 10 comes into contact with a side surface of the inner wall part 21 in a direction parallel to the opening surface 24 (in the present example, a direction that runs from the axial centre of the housing 20 toward an outer side). That is, the speaker unit 10 comes into contact with inner wall part 21 in a direction perpendicular to the side surface of the inner wall part 21.

Therefore, the impedance with respect to a direction perpendicular to the inner wall part 21 is large, and therefore, in the inner wall part 21, it is possible to provide a region (in the present example, a region that the unit support part 13 comes into contact with) in which it is difficult for horizontal waves to propagate toward the outer wall part 22. Accordingly, it is possible to limit wraparound vibrations, which are mainly horizontal waves, by being excited by rearward waves of the speaker unit 10.

[0072]

In addition, a principal vibration direction of the speaker unit 10 (that is, a direction in which forward waves are emitted) is a direction perpendicular to the opening surface 24. Furthermore, it is easy for vibrations in a direction perpendicular to the side surface of the inner wall part 21 (that is, horizontal waves) to propagate to the inner wall part 21 since the impedance of the inner wall part 21 is comparatively small, and it is difficult for vibrations in a direction parallel to the side surface of the inner wall part 21

(that is, vertical waves) to propagate to the inner wall part 21 since the impedance of the inner wall part 21 is comparatively large.

In this instance, if the speaker unit 10 comes into contact with the inner wall part in a direction parallel to the opening surface 24, a principal vibration direction of the speaker unit 10 approaches a direction parallel to the inner wall part 21. As a result of this, direct vibrations that propagate from the speaker unit 10 to the inner wall part 21 mainly become vertical waves, but since, in the manner described above, it is difficult for vertical waves to propagate to the inner wall part 21, it is possible to reduce direct vibrations. Accordingly, it is possible to limit direct vibrations.

[0073]

In addition, even if vertical waves were to propagate to the outer wall part 22 as either wraparound vibrations or direct vibrations, since it is difficult for vertical waves to cause the air in the periphery of the outer wall part 22 to vibrate, very few sound waves are emitted from the outer wall part 22. Furthermore, even if a part of the vertical waves were to change into horizontal waves midway through propagation to the outer wall part 22, since the energy of the vibrations decreases during the change, very few sound waves are emitted from the outer wall part.

[0074]

The speaker 1 according to an embodiment of the present invention is capable of limiting the propagation of sound waves through the housing 20 by limiting both wraparound vibrations and direct vibrations with a simple configuration of the speaker unit 10 coming into contact with and being supported by the inner wall part 21.

[0075]

In addition, in the speaker 1, it is possible to increase a distance between a connection position between the unit support part 13 and the inner wall part 21 that is

close to the rear section, and the rim part 23. Therefore, it is possible to effectively limit wraparound vibrations by increasing the distance for the dampening of wraparound vibrations.

[0076]

5 Furthermore, in the speaker 1, the speaker unit 10 is further forward than the rim part 23. As a result of this, it is possible to prevent a defect in which a part of the forward waves that the speaker unit 10 emits from interfering with normally emitted forward waves as a result of being unnecessarily reflected or scattered by the rim part 23.

In addition, it is possible to make the shape of the rim part 23 an arbitrary shape
10 (in particular, a shape applied in order to limit wraparound vibrations and direct vibrations).

Furthermore, in the speaker 1, it is possible to effectively limit direct propagation vibrations since the outer edge of the speaker unit 10 does not come into contact with the rim part 23.

15 [0077]

Additionally, as a contact and support method of the speaker unit 10 in the inner wall part 21, as long as the speaker unit 10 comes into contact with the inner wall part 21 in a direction parallel to the opening surface 24, any method may be selected. For example, the speaker unit 10 may be supported by the inner wall part 21 as a result of
20 fixing the speaker unit 10 to the inner wall part 21 using an adhesive or the like. In addition, for example, a support structure that is formed from an uneven surface may be provided in at least one of the speaker unit 10 and the inner wall part 21, and the speaker unit 10 may be supported by the inner wall part 21 as a result of fixing the speaker unit 10 to the inner wall part 21 using the support structure (for example, refer to example 1
25 and FIG. 4, which will be described later). In addition, for example, a support structure

may be provided in at least one of the speaker unit 10 and the inner wall part 21, and the speaker unit 10 may be supported by the inner wall part 21 as a result of fixing the speaker unit 10 to the inner wall part 21, and further firmly fixing the speaker unit 10 to the inner wall part 21 using an adhesive or the like.

5 [0078]

<Examples>

Next, various examples in which a variety of modifications have been added to the speaker 1 with the above-mentioned basic configuration as a base, will be described with reference to the drawings. Additionally, in the following text, the description of parts that are the same as those of the basic configuration, which is mentioned above, will be omitted, and only portions that are characteristic of the respective examples will be described. In addition, it is possible to implement the invention by arbitrarily combining the respective characteristic portions of the respective examples which will be described later.

15 First Example

[0079]

FIG. 4 shows a cross-sectional view that shows a first example of a speaker according to an embodiment of the present invention, and is a cross-sectional view that shows a cross-section that corresponds to the cross-section (the A-A cross-section, refer to FIG. 1) that is shown in FIG. 2.

[0080]

As shown in FIG. 4, in a speaker 1A of the present example, the speaker unit 10 is fixed to and supported by the inner wall part 21 using a support structure that is provided in a contact portion between the speaker unit 10 and the inner wall part 21. More specifically, in the speaker 1A of the present example, the speaker unit 10 is fixed

to and supported by the inner wall part 21 as a result of a convex part 211, which is provided on the inner wall part 21, and a concave part 131, which is provided on an outer side surface of the unit support part 13, engaging with one another.

[0081]

5 In this case, for example, the convex part 211 and the concave part 131 are engaged with one another by passing a rear section end part of the unit support part 13, which is inserted into the space on the inner side of the inner wall part 21, through a space contracted by the convex part 211 using elastic deformation of at least one of the unit support part 13 and the housing 20.

10 [0082]

 Additionally, in FIG. 4, a structure in which the convex part 211 is provided on the inner wall part 21, and the concave part 131 is provided on the outer side surface of the unit support part 13, is shown as an example, but a structure that is the reverse of this in which the concave part is provided on the inner wall part 21 and the convex part is provided on the unit support part 13 may also be used. In addition, a structure in which engaging shapes other than those of the convex part 211 and the concave part 131 that are shown in FIG. 4, are provided on the inner wall part 21 and the outer side surface of the unit support part 13, may also be used.

[0083]

20 In addition, a support structure such as the convex part 211 and the concave part 131 may be provided around the entire circumferences of the inner side of the inner wall part 21 and the outer side of the unit support part 13, or may be partially provided on the inner side of the inner wall part 21 and the outer side of the unit support part 13.

[0084]

25 In addition, in the same manner as the speaker 1 with the above-mentioned basic

configuration, in the speaker 1A of the present example also, at least part of the speaker unit 10 is disposed in the space on the inner side of the inner wall part 21, and comes into contact with and is supported by the inner wall part 21 in a direction that has a direction (in the present example, a direction that runs from the axial centre of the housing 20 toward an outer side) component parallel to the opening surface 24.

Second Example

[0085]

FIG. 5 shows a cross-sectional view that shows a second example of a speaker according to an embodiment of the present invention, and is a cross-sectional view that shows a cross-section that corresponds to the cross-section (the A-A cross-section, refer to FIG. 1) that is shown in FIG. 2.

[0086]

As shown in FIG. 5, in a speaker 1B of the present example, a cross-sectional (a cross-section in a left-right direction in the drawing) shape (external diameter) of a portion of the speaker unit 10 that is inserted into the space on the inner side of the inner wall part 21, which is parallel to the opening surface 24, gradually becomes larger from the space on the inner side of the inner wall part 21 toward the opening surface 24. More specifically, in the speaker 1B of the present example, a tapered surface 132, the cross-sectional (a cross-section in a left-right direction in the drawing) shape, which is parallel to the opening surface 24, of which gradually becomes larger toward a front section is provided on the outer side surface of the unit support part 13.

[0087]

When the speaker unit 10, which includes this kind of tapered surface 132, is inserted into the space on the inner side of the inner wall part 21, stress along a contact direction with the inner wall part 21, which has a direction (in the present example, a

direction that runs from the axial centre of the housing 20 toward an outer side)
component parallel to the opening surface 24, is applied as a result of the speaker unit 10
being pressed against the inner wall part 21 along the contact direction. Therefore, it is
possible to effectively limit wraparound vibrations.

5 [0088]

Additionally, without being limited to the structure of the speaker 1B of the
present example, as long as at least part of the speaker unit 10 comes into contact with
and is supported in the space on the inner side of the inner wall part 21 along a direction
parallel to the opening surface 24 in a state of being pressed against the inner wall part 21,
10 the same effect can be obtained. That is, since stress along a contact direction with the
inner wall part 21 is applied as a result of the speaker unit 10 being pressed against the
inner wall part 21 along a direction which has a direction component parallel to the
opening surface 24, it is possible to effectively limit wraparound vibrations.

Third Example

15 [0089]

FIG. 6 shows a cross-sectional view that shows a third example of a speaker
according to an embodiment of the present invention, and is a cross-sectional view that
shows a cross-section that corresponds to the cross-section (the A-A cross-section, refer
to FIG. 1) that is shown in FIG. 2.

20 [0090]

As shown in FIG. 6, in a speaker 1C of the present example, a neck part 212 (a
stepped part) which protrudes toward the inside of the space on the inner side, is
provided in the inner wall part 21. Further, the speaker unit 10 is supported by the inner
wall part 21 in a state where an end part of the speaker unit 10 which is inserted in the
25 space on the inner side of the inner wall part 21, abuts against the neck part 212.

[0091]

In this manner, if the neck part 212 is provided in the inner wall part 21, it is possible to easily determine a position of the speaker unit 10 in the space on the inner side of the inner wall part 21.

5 [0092]

Additionally, as long as the neck part 212 (the stepped part) is a shape (that is, a shape that forms a step by protruding in the space on the inner side of the inner wall part 21) that can abut against the end part of the speaker unit 10, which is inserted in the space on the inner side of the inner wall part 21, it is possible to obtain the above-mentioned
10 effect. Therefore, as long as the above-mentioned effect is obtained, the neck part 212 (the stepped part) may be any shape. For example, the neck part 212 may be a shape in which the inner diameter of the rear section end part of the inner wall part 21 is smaller than the inner diameter of the front section end part thereof (or in other words, a shape that reaches the bottom surface of the inner wall part 21 as a result of the neck part 212 of
15 FIG. 6 extending up to the rear section). In addition, for example, the neck part 212 (the stepped part) may be a component provided around the entire circumference of the inner side of the inner wall part 21, or may be a component that is partially provided on the inner side of the inner wall part 21.

[0093]

20 In addition, in the same manner as the speaker 1 with the above-mentioned basic configuration, in the speaker 1C of the present example also, at least part of the speaker unit 10 is disposed in the space on the inner side of the inner wall part 21, and comes into contact with and is supported by the inner wall part 21 in a direction that has a direction (in the present example, a direction that runs from the axial centre of the housing 20
25 toward an outer side) component parallel to the opening surface 24.

Fourth Example

[0094]

FIG. 7 shows a cross-sectional view that shows a fourth example of a speaker according to an embodiment of the present invention, and is a cross-sectional view that shows a cross-section that corresponds to the cross-section (the A-A cross-section, refer to FIG. 1) that is shown in FIG. 2.

[0095]

As shown in FIG. 7, in a speaker 1D of the present example, a shape of a rim part 231 in a cross-section perpendicular to the opening surface 24 (the A-A cross-section, refer to FIG. 1), is a V-shape. More specifically, for example, the rim part 231 forms a shape in which the inner wall part 21 and the outer wall part 22 gradually approach one another in accordance with movement toward the front section (an upper direction in the drawing).

[0096]

In this manner, if the rim part 231 is set to have a shape folded sharply, it becomes difficult for vibrations to pass through the rim part 231. Therefore, it is possible to limit vibrations that propagate from the inner wall part 21 to the outer wall part 22. At this time, from a viewpoint of limiting the passage of vibrations, it is preferable that the rim part 23 is a shape folded into a V-shape at an acute angle in the manner that is shown as an example in Fig. 7.

[0097]

Additionally, the rim part 231 that has this kind of shape can, for example, be formed by disposing in a manner in which end parts of the inner wall part 21 and the outer wall part 22 come into contact with one another with a predetermined angle as shown in FIG. 7, and joining the end parts, which are in contact with one another, by

welding, soldering, or the like.

[0098]

In addition, with respect to the rim part 231, the inner wall part 21 and the outer wall part 22 may be integrated using any method. More specifically, for example, the rim part 231 may be formed by curving either one or both of the inner wall part 21 and the outer wall part 22 so that the respective end parts thereof gradually approach one another, and joining the end parts, which are in contact with one another, by welding, soldering, or the like.

[0099]

In addition, in the same manner as the speaker 1 with the above-mentioned basic configuration, in the speaker 1D of the present example also, at least part of the speaker unit 10 is disposed in the space on the inner side of the inner wall part 21, and comes into contact with and is supported by the inner wall part 21 in a direction that has a direction (in the present example, a direction that runs from the axial centre of the housing 20 toward an outer side) component parallel to the opening surface 24. However, it is even possible to limit the propagation of sound waves through the housing 20 by limiting both wraparound vibrations and direct vibrations in the same manner as the above-mentioned basic configuration by merely making the rim part 231 into a V-shape. Therefore, in a case in which the fourth example is adopted, as long as at least part of the speaker unit 10 comes into contact with the inner wall part 21 in the space on the inner side of the inner wall part 21, and at a position spaced apart from the rim part 231, at least part of the speaker unit 10 need not necessarily come into contact with the inner wall part 21 in a direction parallel to the opening surface 24.

[0100]

In addition, an experiment was performed in order to verify the limiting effect

on the passage of vibrations due to the V-shaped rim part 231 that is mentioned above.

The results of the experiment will be described with reference to the following drawings.

[0101]

FIG. 8 shows a lateral view that shows an experiment method. As shown in
 5 FIG. 8, the experiment was performed on this occasion was an experiment that fixed one
 end part of a sample plate in which a central part is bent, applying a shock to the fixed
 end part side, and respectively measuring vibrations that are generated on both sides
 between which the central part is interposed using distortion gauges SG1 and SG2. In
 this instance, the central part of the sample, which is bent, corresponds to the rim part,
 10 the fixed end part side (hereinafter, referred to as the inner side) to which the shock is
 applied corresponds to the inner wall part, and the side opposite thereto (hereinafter,
 referred to as the outer side) corresponds to the outer wall part.

[0102]

Respective samples that are used in the present experiment were prepared with a
 15 curving process only without performing welding or the like in order to confirm the
 limiting effect on the passage of vibrations that is caused by the shape of the rim part
 only. In addition, the length of the samples between the distortion gauges SG1 and SG2
 was set to 100 mm in all of the samples regardless of the shape thereof, and the distortion
 gauges SG1 and SG2 were disposed in positions that were equidistant from the central
 20 parts of the samples. In addition, the width of the each of the samples was 10 mm, and
 the thickness of the each of the samples was 0.5 mm or 1.0 mm.

[0103]

In addition, FIG. 9 shows lateral views that show shapes of respective samples.
 As shown in FIG. 9, a total of five shapes of sample were used in the experiment. The
 25 sample that is shown in FIG. 9(a) is a V-shaped sample (hereinafter, referred to as a

“sample V”) in which the central part has been folded at an acute angle (20° in the present example). The sample that is shown in FIG. 9(b) is a U-shaped sample (hereinafter, referred to as a “sample U”) in which the central part has been curved in the form of a curved surface without being folded. The sample that is shown in FIG. 9(c) is a C-shaped sample (hereinafter, referred to as a “sample C”) in which two locations, an inner side portion and an outer side portion, of the central part have been folded at 90° . The sample that is shown in FIG. 9(d) is an inverted S-shaped sample (hereinafter, referred to as a “sample inverted S”) in which an inner side portion of the central part has been folded at an acute angle, and an outer side portion thereof has been curved into an uneven surface in the form of a curved surface. The sample that is shown in FIG. 9(e) is an S-shaped sample (hereinafter, referred to as a “sample S”) in which an outer side portion of the central part has been folded at an acute angle, and an inner side portion thereof has been curved into an uneven surface in the form of a curved surface.

[0104]

FIG. 10 shows graphs that show measurement results of vibrations in the sample V. FIG. 11 shows graphs that show measurement results of vibrations in the sample U. FIG. 12 shows graphs that show measurement results of vibrations in the sample C. FIG. 13 shows graphs that show measurement results of vibrations in the sample inverted S. FIG. 14 shows graphs that show measurement results of vibrations in the sample S. Additionally, in FIGS. 10 to 14, the respective (a) graphs show the measurement results of the distortion gauge SG1 (measurement results of vibrations on the inner side), and the respective (b) graphs show the measurement results of the distortion gauge SG2 (measurement results of vibrations on the outer side).

[0105]

In addition, in FIGS. 10 to 14, the respective graphs that are shown by (a) and

(b) are graphs that were standardized so that a time at which vibrations reached the distortion gauge SG1 was defined as 0, and in which a maximum displacement of the distortion gauge SG1 in the measurement results was 1. Furthermore, in FIGS. 10 to 14, a dotted line that connects peaks in displacement in the (a) graphs (that is, a line that shows temporal fluctuations in amplitude on the inner side) is displayed in the (a) graphs and the (b) graphs. In addition, the graphs that are shown in FIGS. 10 to 14 are graphs that show the measurement results of vibrations in samples in which the plate thickness was 0.5 mm.

[0106]

In the graphs that are shown in FIGS. 10 to 14, the limiting effect on the passage of vibrations that is caused by the shape of the sample is displayed particularly intensely immediately after the generation of vibrations (for example, from approximately 0 to 0.2 seconds). Meanwhile, as time passes after the generation of vibrations (for example, from 0.2 seconds onwards), the influence of specific vibrations of the sample and the like are displayed more intensely than the limiting effect on the passage of vibrations. In such an instance, hereinafter, evaluation of the limiting effects on the passage of vibrations that are caused by the respective shapes of the samples will be performed focusing on some results of the measurement of vibrations immediately after the generation of vibrations, in particular.

[0107]

As shown in FIG. 10, in the sample V, the amplitude of vibrations that was measured on the outer side was significantly lower than the amplitude of vibrations that was measured on the inner side. In contrast to this, as shown in FIGS. 11 to 14, in the sample U, the sample C, the sample inverted S and the sample S, a fixed amount of reduction in amplitude is seen, but there is no significant reduction in amplitude such as

that in the sample V.

[0108]

In this instance, the extent of the reduction in amplitude in the respective samples was evaluated quantitatively using amounts of dampening. The amount of dampening was a value in which a sum of squares of the displacement of vibrations that were measured on the outer side of the samples in 0.2 seconds from the initiation of measurement were multiplied by a sum of squares of the displacement of vibrations that were measured on the inner side of the samples.

[0109]

FIGS. 15 and 16 are graphs that show amounts of dampening of the respective samples that are shown in FIG. 9. FIG. 15 shows a graph that shows amounts of dampening of samples in which the plate thickness was 0.5 mm, and FIG. 16 shows a graph that shows amounts of dampening of samples in which the plate thickness was 1.0 mm. Additionally, the amounts of dampening that are shown in FIGS. 15 and 16 were amounts that were obtained by respectively preparing five samples each of the five shapes that are shown in FIG. 9., obtaining a total of 25 measurement results by performing the above-mentioned experiment five times on each of the five samples of each shape, and averaging the 25 amounts of dampening that were calculated from the 25 measurement results.

[0110]

As shown in FIGS. 15 and 16, the amounts of dampening in the sample V were significantly reduced in comparison with those of the other samples. Additionally, as shown in FIG. 16, if only the samples with plate thicknesses of 1.0 mm are looked at, the amounts of dampening in the sample C were reduced to the same extent as the sample V.

However, regardless of whether the plate thickness of the sample V was 0.5 mm or 1.0

mm, the amounts of dampening were significantly reduced in comparison with those of the other samples.

[0111]

In this manner, it is understood that it is possible to effectively limit the passage
5 of vibrations by making the rim part 231 a V shape.

[0112]

Given that, with respect to the sample inverted S and the sample S, if only the folded portions are focused on, it can be said that these samples are V-shapes that are folded at acute angles in the same manner as the sample V. However, when compared
10 to the sample V, the limiting effects on the passage of vibrations in the sample inverted S and the sample S were small.

[0113]

The cause of this may be the fact that, in the sample inverted S and the sample S, different from the sample V, the central part folded back by protruding inside a space
15 surrounded by the inner side and the outer side. Therefore, in shapes such as those of the sample inverted S and the sample S, even though the passage of vibrations is limited in a portion that forms a V-shape, since the samples form a spring-like shape overall, unnecessary vibrations are generated and the limiting effect on the passage of vibrations that is obtained is reduced (for example, refer to the portion of the graph of FIG. 13 from
20 0.2 seconds onwards).

[0114]

In such an instance, the same experiment as the above-mentioned experiment (refer to FIG. 8) was performed in order to verify a shape that can effectively limit the passage of vibrations in a case in which the rim part 231 is set to have a V-shape. The
25 results of this experiment will be described with reference to the following drawings.

[0115]

FIG. 17 shows lateral views that show shapes of respective samples. As shown in FIG. 17, a total of four shapes of sample that were used in the experiment. The sample that is shown in FIG. 17(a) is a V-shaped sample (hereinafter, referred to as a “sample V20”) in which the central part has been folded back at an angle of 20° by protruding outside the airtight space surrounded by the inner side and the outer side, and is the same sample as the sample that is shown in FIG.8(a). The sample that is shown in FIG. 17(b) is a V-shaped sample (hereinafter, referred to as a “sample V70”) in which the central part has been folded back at an angle of 70° by protruding outside the airtight space surrounded by the inner side and the outer side. The sample that is shown in FIG. 17(c) is a V-shaped sample (hereinafter, referred to as a “sample V120”) in which the central part has been folded back at an angle of 120° by protruding outside the airtight space surrounded by the inner side and the outer side. The sample that is shown in FIG. 17(d) is an M-shaped sample (hereinafter, referred to as a “sample M”) in which the central part has been folded back at an angle of 30° by protruding inside a space surrounded by the inner side and the outer side.

[0116]

FIGS. 18 and 19 are graphs that show amounts of dampening of the respective samples that are shown in FIG. 17. FIG. 18 shows a graph that shows amounts of dampening of samples in which the plate thickness was 0.5 mm, and FIG. 19 shows a graph that shows amounts of dampening of samples in which the plate thickness was 1.0 mm. Additionally, the amounts of dampening that are shown in the graphs of FIGS. 18 and 19 were amounts that were calculated using the same method as the amounts of dampening that are shown in the graphs of FIGS. 15 and 16.

[0117]

As shown in FIGS. 18 and 19, the amounts of dampening in the sample M were not reduced to the extents of the other V-shaped samples. That is, it is understood that even if the sample is formed from a shape folded at an acute angle into a V-shape, the limiting effect on the passage of vibrations is reduced if the shape is folded back by protruding inside a space surrounded by the inner side and the outer side. In other words, even if the sample is formed from a shape folded at an acute angle into a V-shape, the limiting effect on the passage of vibrations is reduced if the sample is a shape folded a plurality of times.

[0118]

Furthermore, as shown in FIGS. 18 and 19, when the experiment results of the sample V20, the sample V70, and the sample V120 are compared, it is understood that the limiting effect on the passage of vibrations increases as the folding and curving angle of the sample decreases (that is, the more sharply folded the sample). In particular, it is understood that in comparison with the sample V70 and the sample V120 in which the folding and curving angles are comparatively large, the limiting effect on the passage of vibrations of significantly greater in the sample V20 in which the folding and curving angle is comparatively small. Therefore, it is understood that from a viewpoint of increasing the limiting effect on the passage of vibrations, it is preferable that the folding and curving angle is set to smaller than 70° .

[0119]

Accordingly, it is possible to effectively limit the passage of vibrations by setting the rim part 231 to be a V-shape that protrudes outside the space surrounded by the inner wall part 21 and the outer wall part 22, and is folded back once only. In addition, it is possible to effectively limit the passage of vibrations by setting the rim part 231 to be a V-shape folded at an angle smaller than 70° .

Fifth Example

[0120]

FIG. 20 shows a cross-sectional view that shows a fifth example of a speaker according to an embodiment of the present invention, and is a cross-sectional view that shows a cross-section that corresponds to the cross-section (the A-A cross-section, refer to FIG. 1) that is shown in FIG. 2.

[0121]

As shown in FIG. 20, in a speaker 1E of the present example, an air pressure of the airtight space between the inner wall part 21 and the outer wall part 22 is a negative pressure (a pressure that is lower than atmospheric pressure, for example, greater than or equal to 10^{-2} Pa but less than or equal to 10 Pa). More specifically, the speaker 1E of the present example includes a exhaust opening 221 that penetrates a part of the outer wall part 22 (the bottom part in the example that is shown in FIG. 20), a sealing material 25, which is provided so as to block the exhaust opening 221, and a protective plate 26, which is provided so as to cover the outer surface of the sealing material 25.

[0122]

The sealing material 25 is, for example, a brazing filler metal that is formed from an alloy of a tin simple substance or tin and silver, an alloy of copper and zinc, and is formed from a material with a melting point that is less than that of the material from which the housing 20 is made. In addition, the protective plate 26 is, for example, formed from the same material as the housing 20.

[0123]

In a case of preparing the speaker 1E of the present example, firstly, a space between the inner wall part 21 and the outer wall part 22 is depressurized through the exhaust opening 221 by vacuum drawing a cabinet that is in the housing 20. Next, after

melting (softening) the sealing material 25 by raising the temperature inside the cabinet and sealing the exhaust opening 22 by adhering the sealing material 25 thereto, the temperature of the cabinet is reduced. As a result of this, the space between the inner wall part 21 and the outer wall part 22 becomes an airtight space, and retains a negative pressure state. Further, the housing 20 is removed from the cabinet, and the protective plate 26 is joined to the outer wall part 22 by welding, soldering or the like so as to cover the outer surface of the sealing material 25.

[0124]

In this manner, if the airtight space between the inner wall part 21 and the outer wall part 22 is set to a negative pressure, it is possible to limit vibrations that propagate from the inner wall part 21 to the outer wall part 22 through the airtight space. In addition, if the airtight space between the inner wall part 21 and the outer wall part 22 is a negative pressure, stress is applied to the inner wall part 21 as a result of the inner wall part 21 being pulled to the outer wall part 22 side. Therefore, it is possible to effectively limit wraparound vibrations.

[0125]

Additionally, even in a case in which the airtight space between the inner wall part 21 and the outer wall part 22 is not a negative pressure (that is, a case in which a gas such as air is sealed inside the airtight space), since the gaseous matter inside the airtight space acts as a damper, it is possible to limit vibrations that propagate from the inner wall part 21 to the outer wall part 22 through the airtight space to a certain extent.

[0126]

In addition, in the same manner as the speaker 1 with the above-mentioned basic configuration, in the speaker 1E of the present example also, at least part of the speaker unit 10 is disposed in the space on the inner side of the inner wall part 21, and comes into

contact with and is supported by the inner wall part 21 in a direction that has a direction (in the present example, a direction that runs from the axial centre of the housing 20 toward an outer side) component parallel to the opening surface 24.

Sixth Example

5 [0127]

FIG. 21 shows a cross-sectional view that shows a sixth example of a speaker according to an embodiment of the present invention, and is a cross-sectional view that shows a cross-section that corresponds to the cross-section (the A-A cross-section, refer to FIG. 1) that is shown in FIG. 2.

10 [0128]

As shown in FIG. 21, in a speaker 1F of the present example, a penetration hole 27, which penetrates the inner wall part 21 and the outer wall part 22 is provided in a part of the housing 20 (the center of bottom part in the present example), and a bass-reflex port 28 is provided inside the penetration hole 27. However, even if the penetration hole 27 and the bass-reflex port 28 are provided, the space between the inner wall part 21 and the outer wall part 22 is an airtight space, and the housing 20 is a double-walled structure.

[0129]

In this manner, even if the penetration hole 27 and the bass-reflex port 28 are provided in the housing 20, it is possible to effectively limit the propagation of sound waves through the housing 20 in the same manner as speaker with the above-mentioned basic configuration, and the speakers 1A to 1E of the first to fifth examples.

[0130]

Additionally, without being limited to the penetration hole 27 and the bass-reflex port 28 mentioned above, as long as the housing 20 is a double-walled structure, any

modification may be added to the housing 20.

[0131]

In addition, in the same manner as the speaker 1 with the above-mentioned basic configuration, in the speaker 1F of the present example also, at least part of the speaker
5 unit 10 is disposed in the space on the inner side of the inner wall part 21, and comes into contact with and is supported by the inner wall part 21 in a direction that has a direction (in the present example, a direction that runs from the axial centre of the housing 20 toward an outer side) component parallel to the opening surface 24.

Seventh Example

10 [0132]

FIG. 22 shows a cross-sectional view that shows a seventh example of a speaker according to an embodiment of the present invention, and is a cross-sectional view that shows a cross-section that corresponds to the cross-section (the A-A cross-section, refer to FIG. 1) that is shown in FIG. 2. In addition, FIG. 23 shows an exploded perspective
15 view of the speaker in FIG. 22.

[0133]

As shown in FIGS. 22 and 23, in a speaker 1G of the present example, the speaker unit 10 is screwed together with and is supported by the inner wall part 21. More specifically, in the speaker 1G of the present example, the speaker unit 10 is fixed
20 to and supported by the inner wall part 21 as a result of a screw thread 133, which is provided on the outer side surface of the unit support part 13, and a screw thread 213, which is provided on the inner wall part 21 being screwed together. At this time, flanks 1331 of the screw thread 133, which is provided on the speaker unit 10, and flanks 2131 of the screw thread 213, which is provided on the inner wall part 21 abut against one
25 another. Additionally, “flanks” are surfaces that connect the top and bottom portions of

the screw threads.

[0134]

In this manner, when the speaker unit 10 is screwed together with and is supported by the inner wall part 21, it is possible to freely detach the speaker unit 10 from the housing 20. Therefore, it is possible for a user to obtain a speaker 1G with properties that match their taste by selectively combining favorites from among a variety of speaker units 10 and housings 20 with different properties. In this instance, in addition to properties that relate to sound quality (for example, the material of the vibration plate 11, the volume of a space (the air volume), which is in a rear section of the speaker unit 10, and is surrounded by the inner wall part 21, and the like), external appearance properties such as color and shape are included in the properties of the speaker unit 10 and the housing 20.

[0135]

In addition, if the speaker unit 10 is screwed together with and supported by the inner wall part 21, it is possible to arbitrarily adjust a support state of the speaker unit 10 depending on the housing 20. For example, it is possible to reduce the volume of a space (the air volume), which is in a rear section of the speaker unit 10, and is surrounded by the inner wall part 21 by increasing a screwing amount of the speaker unit 10, and it is possible to increase the volume of the space, by decreasing the screwing amount of the speaker unit 10, or the like. Further, it is possible to change the resonance state of the speaker unit 10 by performing this kind of adjustment.

[0136]

Additionally, in FIGS. 22 and 23, a structure in which the screw threads 133 and 213 are respectively formed with three circuits is shown as an example, but a structure in which the screw threads 133 and 213 are formed with only one or two circuits may also

be used, and a structure in which the screw threads 133 and 213 are formed with four circuits or more may also be used. In addition, in the respective numbers of the screw threads 133 and 213 may be different. In addition, in FIGS. 22 and 23, a case in which the screw threads 133 and 213 are respectively a shape that is one long cylinder, and is
5 connected, is shown as an example, but the screw threads 133 and 213 may be a shape divided midway therethrough, or may be a multiple spiral form in which the screw threads are twisted in parallel.

[0137]

In addition, in the same manner as the speaker 1 with the above-mentioned basic
10 configuration, in the speaker 1G of the present example also, at least part of the speaker unit 10 is disposed in the space on the inner side of the inner wall part 21, and comes into contact with and is supported by the inner wall part 21 in a direction that has a direction (in the present example, a direction that runs from the axial centre of the housing 20 toward an outer side) component parallel to the opening surface 24.

15 Eighth Example

[0138]

FIG. 24 shows a cross-sectional view that shows an eighth example of a speaker according to an embodiment of the present invention, and is a cross-sectional view that shows a cross-section that corresponds to the cross-section (the A-A cross-section, refer
20 to FIG. 1) that is shown in FIG. 2.

[0139]

As shown in FIG. 24, in a speaker 1H of the present example, the speaker unit 10 is screwed together with and is supported by the inner wall part 21 in the same manner as the above-mentioned seventh example. More specifically, in the speaker 1H of the
25 present example, the speaker unit 10 is fixed to and supported by the inner wall part 21 as

a result of a screw thread 134, which is provided on the outer side surface of the unit support part 13, and a screw thread 214, which is provided on the inner wall part 21 being screwed together. At this time, flanks 1341 of the screw thread 134, which is provided on the speaker unit 10, and the flanks 2141 of the screw thread 214, which is provided on the inner wall part 21 abut against one another.

[0140]

However, in the speaker 1H of the present example, the external diameter of the screw thread 134 of the speaker unit 10 side gradually becomes larger from the space on the inner side of the inner wall part 21 toward the opening surface 24. In addition, in the speaker 1H of the present example, the internal diameter of the screw thread 214 of the inner wall part 21 also gradually becomes larger from the space on the inner side of the inner wall part 21 toward the opening surface 24 to match the external diameter of the screw thread 134 of the speaker unit 10 side.

[0141]

In this manner, when external diameter of the screw thread 134 of the speaker unit 10 side is set to gradually become larger from the space on the inner side of the inner wall part 21 toward the opening surface 24, the speaker unit 10 is pressed against the inner wall part 21 in accordance with screwing of the speaker unit 10. That is, stress along a direction perpendicular to the inner wall part is applied to the inner wall part 21 in accordance with screwing of the speaker unit 10. Accordingly, it is possible to effectively limit wraparound vibrations.

[0142]

Additionally, it is possible to interpret the eighth example as a modification example of the above-mentioned seventh example. In particular, it is possible to interpret the eighth example as an example that combines the above-mentioned second

example with the above-mentioned seventh example.

Ninth Example

[0143]

FIG. 25 shows a cross-sectional view that shows a ninth example of a speaker
5 according to an embodiment of the present invention, and is a cross-sectional view that shows a cross-section that corresponds to the cross-section (the A-A cross-section, refer to FIG. 1) that is shown in FIG. 2.

[0144]

As shown in FIG. 25, a speaker 1I of the present example is a component in
10 which the neck part 212 (the stepped part) in the speaker 1C (refer to FIG. 6) of the third example is provided in the speaker 1G (refer to FIG. 22) of the seventh embodiment in which the speaker unit 10 is screwed together with and is supported by the inner wall part 21.

[0145]

15 However, in the speaker 1I of the present example, the respective screw threads 133 and 213 are shapes in which the bottom portions are thick and the top portions are thin, and are set to have flanks 1331 and 2131, which are inclined with respect to a surface that is perpendicular to a screwing direction (an up-down direction in the drawing). More specifically, for example, it is preferable that the screw threads 133 and
20 213 are screw threads in a triangular screw thread or a trapezoidal screw thread.

[0146]

In this manner, when the speaker unit 10 comes into contact with the neck part 212 (the stepped part) (in particular, when pressed by fastening tightly), stress in a direction (a direction parallel to the screwing direction, and runs from the space on the
25 inner side of the inner wall part 21 toward the opening surface 24. The upper direction

in the drawing) opposite to a fastening direction is applied from the neck part 212 to the speaker unit 10. When this happens, stress in a direction perpendicular to the flanks 2131 is applied from the flanks 1331 of the screw thread 133 on the speaker unit 10 side to the flanks 2131 of the screw thread 213 of the inner wall part 21 side, which are in contact with the flanks 1331. At this time, due to the fact that the flanks 2131 of the screw thread 213 of the inner wall part 21 side are inclined toward a surface (that is, a surface that is perpendicular to the inner wall part 21) that is perpendicular to the screwing direction, the stress that has a direction component perpendicular to the inner wall part 21 (a direction component that presses the inner wall part 21 against the outer side). Accordingly, it is possible to effectively limit wraparound vibrations.

[0147]

Additionally, even in a case in which the neck part 212 (the stepped part) is provided in the speaker 1H (refer to FIG. 24) of the above-mentioned eighth example in the same manner as the speaker 1I of the present example, it is possible to effectively reduce wraparound vibrations in the same manner as the speaker 1I of the present example.

[0148]

<Manufacturing Method>

Next, an example of a manufacturing method of a speaker housing according to an embodiment of the present invention will be described with reference to the drawings. FIGS. 26 to 28 are perspective views that show an example of a manufacturing method of a speaker housing according to an embodiment of the present invention. In addition, FIG. 29 is a cross-sectional view of a speaker housing that is manufactured using the manufacturing method that is shown in FIGS. 26 to 28. Additionally, FIGS. 26 to 28 are drawings that show a process in which a housing is manufactured in the order of FIG.

26, FIG. 27 and FIG. 28. In addition, FIG. 29 is a drawing that shows a cross-section that corresponds to the cross-section (the A-A cross-section, refer to FIG. 1) that is shown in FIG. 2.

[0149]

5 In the manufacturing method of the present example, firstly, as shown in FIG. 26, an inner wall part body part 21X and an inner wall part bottom part 21Y are prepared. The inner wall part body part 21X can, for example, be prepared by joining seams using welding, soldering or the like after configuring a tube by carrying out a curving process on a plate material. In addition, the inner wall part bottom part 21Y can, for example,
10 be prepared by carrying out a drawing process on a plate material.

[0150]

At this time, the shape of at least one end part of the inner wall part body part 21X, which is open, and the shape of the end part of the inner wall part bottom part 21Y, which is open, are configured so as to be equivalent. Further, the inner wall part 21 is
15 prepared by joining the end parts of the inner wall part body part 21X and the inner wall part bottom part 21Y, the shapes of which were respectively configured to be equivalent, using welding, soldering or the like.

[0151]

Next, as shown in FIG. 27, an outer wall part body part 22X is prepared. The
20 outer wall part body part 22X can, for example, be prepared by joining seams using welding, soldering or the like after configuring a tube by carrying out a curving process on a plate material in the same manner as the inner wall part body part 21X, and further carrying out a drawing process on one end part thereof.

[0152]

25 Further, the inner wall part 21 is inserted into the space on an inner side of the

outer wall part body part 22X so as to form nested state where the end part of the outer wall part body part 22X, the opening of which is narrow, and the end part of the inner wall part 21 which is open are aligned. Further, the end part of the outer wall part body part 22X, the opening of which is narrow, and the end part of the inner wall part 21 which is open are integrated and joined using welding, soldering or the like. As a result of this, the rim part 23 is formed. Additionally, the rim part 23 that is formed in the manufacturing method of the present example forms the same shape as the rim part 231 of the above-mentioned fourth example (refer to FIG. 7).

[0153]

10 Next, as shown in FIG. 28, the outer wall part bottom part 22Y is prepared. For example, the outer wall part bottom part 22Y can be prepared by carrying out a drawing process and an inverted drawing process in order on a plate material. Further, a folded back portion of the external circumference of the outer wall part bottom part 22Y is joined to an inner side of the outer wall part body part 22X using welding, soldering or
15 the like after the end part of the outer wall part bottom part 22Y which is open, has been inserted from an end part side on which the rim part 23 of the outer wall part body part 22X is not formed. A housing 20 such as that shown in FIG. 29 is prepared by the above-mentioned process.

[0154]

20 Additionally, the manufacturing method of the housing 20, which is shown in FIGS. 26 to 28 is merely an example, and it is possible to manufacture the housing 20 using methods other than this method.

[0155]

<Modification Examples>

25 In the descriptions of the above-mentioned speakers 1 and 1A to 1I and the

manufacturing method of the housing, housings 20 in which cross-sections of the inner wall part 21 and the outer wall part 22 are circular bottomed tubes, and the axial centre of the inner wall part 21 passes through the opening surface 24 are shown as examples.

However, the shape of the inner wall part 21 and the outer wall part 22 is not limited to this example. For example, a housing 20 in which the axial centre of the inner wall part 21 does not pass through the opening surface 24 may also be used. More specifically, for example, a bottomed tube housing 20 in which the internal diameter of the opening surface 24 (the rim part 23) is smaller than the internal diameter of the body part of the inner wall part 21, and the opening surface 24 (the rim part 23) is in an eccentric position, which is shifted from the axial centre of the inner wall part 21, may also be used.

Furthermore, the shape of the inner wall part 21 and the outer wall part 22 is not limited to a bottomed tube in which a cross-section is circular, and any shape may also be used. More specifically, for example, a bottomed tube in which a cross-section is elliptical, polygonal or the like, may be used, and a shape such as a bombshell type in which the bottom is not flat, may also be used.

[0156]

In addition, in the above-mentioned speakers 1 and 1A to 1I, the outer side surface of the unit support part 13 is formed into a shape that does not come into contact with the rim part 23 (a shape in which the external diameter in the vicinity of the rim part 23 becomes partially smaller) in order to limit direct vibrations. However, the shape of the outer side surface of the unit support part 13 is not limited to this example, and may adopt a shape that comes into contact with the rim part 23.

[0157]

In addition, in the above-mentioned speakers 1 and 1A to 1I, a description in which the rim parts 23 and 231 are formed by joining and integrating the inner wall part

21 and the outer wall part 22 using welding, soldering or the like, was given, but the joining method thereof may be any joining method. More specifically, for example, the rim parts 23 and 231 may be formed by curving and overlapping the respective end parts of the inner wall part 21 and the outer wall part 22 face-to-face or with the same orientation, and joining the overlapping portions using welding, soldering or the like. In addition, for example, the rim parts 23 and 231 may be formed by curving one of the end parts of the inner wall part 21 and the outer wall part 22, causing the above-mentioned end part to abut against the other end part or a side surface, and joining the abutting portions using welding, soldering or the like. In addition, for example, the rim parts 23 and 231 may be formed by overlapping either one or both of the inner wall part 21 and the outer wall part 22 with an end part through curving in a crank form, and joining the overlapping portions using welding, soldering or the like. In addition, for example, the rim parts 23 and 231 may be formed by disposing a material for cross-linking at respectively separate end parts of the inner wall part 21 and the outer wall part 22, and joining using welding, soldering or the like.

[0158]

Furthermore, it is also possible to form the rim parts 23 and 231 are without joining the inner wall part 21 and the outer wall part 22. For example, the rim parts 23 and 231 may be formed without joining being necessary by performing a drawing process and a curving process on a single plate material, which is originally integral. In this case, a site other than the rim parts 23 and 231 may be joined using welding, soldering or the like according to necessity.

[0159]

In addition, in the above-mentioned speakers 1 and 1A to 1I, the speaker unit 10 has a structure that only comes into contact with the inner wall part 21 and does not come

into contact with the outer wall part 22, but the present invention is not rule out a structure in which the speaker unit 10 comes into contact with the outer wall part 22.

For example, a structure in which a part of the speaker unit 10 comes into contact with the outer wall part 22 when the speaker unit 10 comes into contact with and is supported
5 by the inner wall part 21, may also be used. Even in such a structure, as long as the speaker unit 10 mainly comes into contact with and is supported by the inner wall part 21, it is possible to sufficiently limit direct vibrations since it is possible to keep contact between the speaker unit 10 and the outer wall part 22 to a minimum.

[0160]

10 In addition, if necessary, for example, elastic bodies for limiting vibrations may be provided between the speaker unit 10 and the housing 20. However, since the speaker 1 in an embodiment of the present invention is a structure that is capable of limiting the propagation of sound waves through the housing, a small quantity of elastic bodies is sufficient as the elastic bodies that should be provided. For example, in the
15 above-mentioned manner, in a case of a speaker in which contact between the speaker unit 10 and the outer wall part 22 is permitted, elastic bodies may be provided between the speaker unit 10 and the outer wall part 22. In this case, it is possible to further limit direct vibrations.

[0161]

20 In addition, the speaker unit 10 may have a configuration that is provided with a baffle plate. For example, the speaker unit 10 may have a configuration in which a baffle plate is provided at an end part of a forward side thereof, and in the periphery of the vibration plate 11. In this case, the baffle plate forms a part of the speaker unit 10. In addition, in this case, the baffle plate may be integral with the unit support part 13, and
25 may come into contact with and be supported by the inner wall part 21.

Industrial Applicability

[0162]

Although the speakers and the speaker housings of the present invention are provided with a simple configuration, it is possible to limit both wraparound vibrations and direct vibrations. Therefore, it is possible to limit the propagation of sound waves through the housing.

Reference Signs List

[0163]

- | | |
|----|---|
| 10 | 1, 1A TO 1I SPEAKER |
| | 10 SPEAKER UNIT |
| | 11 VIBRATION PLATE |
| | 111 CENTER CAP |
| | 12 DRIVING PART |
| 15 | 13 UNIT SUPPORT PART |
| | 131 CONCAVE PART |
| | 132 TAPERED SURFACE |
| | 133, 134 SCREW THREAD (SPEAKER UNIT SIDE) |
| | 1331, 1341 FLANKS |
| 20 | 14 EDGE PART |
| | 20 HOUSING |
| | 21 INNER WALL PART |
| | 211 CONVEX PART |
| | 212 NECK PART (STEPPED PART) |
| 25 | 213, 214 SCREW THREAD (INNER WALL PART SIDE) |

	2131, 2141	FLANKS
	21X	INNER WALL PART BODY PART
	21Y	INNER WALL PART BOTTOM PART
	22	OUTER WALL PART
5	221	VENTILATION OPENING
	22X	OUTER WALL PART BODY PART
	22Y	OUTER WALL PART BOTTOM PART
	23, 231	RIM PART
	24	OPENING SURFACE
10	25	SEALING MATERIAL
	26	PROTECTIVE PLATE
	27	PENETRATION HOLE
	28	BASS-REFLEX PORT

CLAIMS

1. A speaker comprising:

a speaker unit; and

a housing,

wherein the housing is a double-walled structure that is provided with an inner wall part, a part of which is open, and which has a space on an inner side thereof, and an outer wall part, a part of which is open, and in which the inner wall part is disposed in a space on an inner side of the outer wall part,

wherein respective open end parts of the inner wall part and the outer wall part are integrated to form a rim part,

wherein an airtight space is formed between the inner wall part and the outer wall part,

wherein an air pressure of the airtight space is lower than atmospheric pressure, and

wherein at least a part of the speaker unit comes into contact with and is supported by only the inner wall part in the space on the inner side of the inner wall part, and at a position spaced apart from the rim part, in a direction parallel to an opening surface, which has an outer circumference formed by the rim part.

2. The speaker according to Claim 1,

wherein a shape of the rim part in a cross-section perpendicular to the opening surface is a V-shape.

3. The speaker according to Claim 2,

wherein the shape of the rim part in a cross-section perpendicular to the opening

surface is a V-shape folded back by protruding outside the airtight space surrounded by the inner wall part and the outer wall part.

4. The speaker according to Claim 2 or 3,

wherein the shape of the rim part in a cross-section perpendicular to the opening surface is a V-shape folded once only.

5. The speaker according to any one of Claims 2 to 4,

wherein the shape of the rim part in a cross-section perpendicular to the opening surface is a V-shape folded at an angle smaller than 70°.

6. The speaker according to any one of Claims 1 to 5,

wherein the speaker unit comprises a vibration plate, a driving part that causes the vibration plate to vibrate by driving the vibration plate depending on an input electrical signal, and a unit support part that supports at least the driving part, and

wherein the unit support part comes into contact with and is supported by the inner wall part.

7. The speaker according to Claim 6,

wherein when a direction that runs from the opening surface toward the space on the inner side of the inner wall part is set as a rearward direction, and a direction opposite to the rearward direction is set as a forward direction, at least a part of the unit support part comes into contact with and is supported by the inner wall part at a position further rearward than an end part of the front section of the vibration plate.

8. The speaker according to any one of Claims 1 to 7,

wherein when a direction that runs from the opening surface toward the space on the inner side of the inner wall part is set as a rearward direction, and a direction opposite to the rearward direction is set as a forward direction, an end part of a front section of the speaker unit is positioned further forward than the rim part.

9. The speaker according to 8,

wherein an outer edge of the speaker unit extends up to the front section of the rim part, and is spaced apart from the rim part.

10. The speaker according to any one of Claims 1 to 9,

wherein at least a part of the speaker unit comes into contact with and is supported in the space on the inner side of the inner wall part in a state of being pressed against the inner wall part along a direction parallel to the opening surface.

11. The speaker according to any one of Claims 1 to 10,

wherein at least a part of an outer side surface of the speaker unit inserted into the space on the inner side of the inner wall part comes into contact with and is supported by the inner wall part opposed thereto.

12. The speaker according to any one of Claims 1 to 11,

wherein a shape of a cross-section of a portion of the speaker unit inserted into the space on the inner side of the inner wall part, which is parallel to the opening surface, gradually becomes larger from the space on the inner side of the inner wall part toward the opening surface.

13. The speaker according to any one of Claims 1 to 12,

wherein the inner wall part is a bottomed tube, and an axial center of the inner wall part passes through the opening surface.

14. The speaker according to any one of Claims 1 to 13,

wherein the inner wall part comprises a stepped part which protrudes toward the inside of the inner wall part, and

the speaker unit is supported by the inner wall part in a state where an end part of the speaker unit inserted in the space on the inner side of the inner wall part, abuts against the stepped part.

15. The speaker according to any one of Claims 1 to 14,

wherein at least a part of the speaker unit is screwed together with and is supported by the inner wall part.

16. The speaker according to Claim 15,

wherein an external diameter of a screw thread, which is provided in the speaker unit and screws together with the inner wall part, gradually becomes larger from the space on the inner side of the inner wall part toward the opening surface.

17. The speaker according to Claim 15 or 16,

wherein the inner wall part comprises a stepped part which protrudes toward the inside of the space on the inner side,

a screw thread, which is provided in the speaker unit and screws together with the

inner wall part, and a screw thread, which is provided in the inner wall part and screws together with the speaker unit, respectively include flanks, inclined with respect to a surface perpendicular to a screwing direction, and

the speaker unit is supported by the inner wall part in a state where an end part of the speaker unit which is inserted in the space on the inner side of the inner wall part, abuts against the stepped part.