A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from the fuel cell, comprising an inner pipe having a plurality of sound transmission holes formed in its peripheral wall and allowing the exhaust gases to flow therethrough and an outer shell disposed to surround the inner pipe through a prescribed distance from the peripheral wall and constituting a sound absorbing chamber with a sound absorbing material filled in the clearance thereof from the inner pipe. The sound transmission hole has an inner diameter of 3 mm or greater, and a depth of 1.2 mm or less.
ENLARGED VIEW I

Fig. 12

VIEW ALONG ARROW D

Fig. 13
Fig. 32
NOISE ELIMINATOR FOR FUEL CELL

TECHNICAL FIELD

[0001] The present invention relates to a structure providing countermeasures against condensation of moisture in exhaust gas with respect to a noise eliminator installed in an exhaust system of fuel cell.

BACKGROUND ART

[0002] In fuel cells, a power generating reaction between fuel gas supplied to the anode electrode and oxidizing gas supplied to the cathode electrode occurs in an electrolyte, in conjunction with moisture is produced. The produced moisture is discharged as fuel cell exhaust gas, along with unused fuel gas and oxidizing gas, through an exhaust system connected to the fuel cell. In such an exhaust system, the gas stream may produce a sound of a relatively high frequency, on the order of 500 Hz to 2000 Hz. In order to reduce the noise produced by the gas stream, the exhaust system of a fuel cell vehicle or the like is typically equipped with a sound absorption type noise eliminator whose interior is packed with a sound absorbing material (noise elimination material) such as glass wool.

[0003] One example of a noise eliminator of this type is that having the cross-sectional structure illustrated in FIG. 31. This noise eliminator 100 includes an inner pipe 102 through which the exhaust gas from the fuel cell flows, and an outer shell 104 surrounding the inner pipe 102. A sound absorbing material 106 such as glass wool is filled between the inner pipe 102 and outer shell 104. A plurality of sound transmission holes 108 are formed in the peripheral wall of the inner pipe 102. The sound radiated from the sound transmission holes 108 toward the sound absorbing material 106 is attenuated while subjected to repeated scattering and interference in the sound absorbing material 106, and is consequently absorbed by the sound absorbing material 106.

[0004] Meanwhile, fuel cell exhaust gases contain a large amount of moisture produced by the reaction of hydrogen and oxygen. This moisture may condense in the exhaust system upstream to form liquid water which flows into the noise eliminator, or the moisture may condense in the interior of the noise eliminator. As a result, water may accumulate in the vertical lower part (hereinafter referred to as the bottom part) of the noise eliminator. When this happens, because the sound absorbing material filled in the bottom part of the noise eliminator absorbs and holds the water ("contains water"), a specified sound absorption performance cannot be achieved, and, thus, noise elimination performance is impaired.

[0005] Means of addressing this problem have been proposed in the conventional art, such as, for example, the noise eliminator 120 proposed in Japanese Patent Laid-Open Publication No. 2002-206413. As illustrated in FIG. 32 of that publication, in the noise eliminator 120, the interior of the noise eliminator 120 is vertically partitioned into upper and lower parts by a partition board 124 having a continuous hole 123, whereby a sound absorbing chamber 126 and expansion chamber 128 are formed. An inner pipe 130 having sound transmission holes 136 is arranged inside the sound absorbing chamber 126, and a sound absorbing material is filled to surround the inner pipe 130. With this structure, even when the sound absorbing material 126 in the vertical lower side of the inner pipe 130 contains water, it is possible to cause the water to drip through the continuous hole 123 of a partition board 124 into the expansion chamber 128. The water falling into the expansion chamber 128 is successively discharged through the sound transmission holes 136 of a guiding pipe 134 to the outside of the noise eliminator 120.

[0006] However, in the noise eliminator of Japanese Patent Laid-Open Publication No. 2002-206413, the water flowing from the exhaust system upstream into the noise eliminator or the water, contained in exhaust gas, and condensing in the interior of the noise eliminator can cause a water film to be produced in the inner pipe or sound transmission holes. When a water film is produced in the sound transmission holes, much of the sound energy in the inner pipe or the guiding pipe is not discharged through the sound transmission holes to the sound absorbing chamber and expansion chamber, impairing the noise elimination performance of the noise eliminator. Thus, there has been a need for a tangible approach for suppressing formation of a water film in the sound transmission holes.

DISCLOSURE OF THE INVENTION

[0007] The present invention provides a noise eliminator allowing suppression of formation of a water film in sound transmission holes. A noise eliminator for a fuel cell according to the present invention includes an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough, and an outer shell, arranged to surround the inner pipe through a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe. The shape of the sound transmission holes is configured so that no liquid film is formed in the holes. Also, the shape of the sound transmission hole can be construed to have a function of reducing liquid surface tension in the hole.

[0008] The noise eliminator for a fuel cell according to the present invention has the following configurations.

[0009] (1) In one configuration, a noise eliminator for a fuel cell according to the present invention is characterized by including an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough, and an outer shell, arranged to surround the inner pipe through a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein the sound transmission hole has an inner diameter of 3 mm or longer and a depth of 1.2 mm or shorter.

[0010] Here, the peripheral part of the sound transmission hole in the inner pipe is preferably formed thinner in wall thickness than the other part thereof.

[0011] Also, a rib reinforcing the inner pipe is preferably formed between the sound transmission holes.

[0012] (2) In another configuration, a noise eliminator for a fuel cell according to the present invention is characterized by including an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough, and an outer shell, arranged to surround the inner pipe through a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein the sound transmission hole is formed in the shape of an oval having a longitudinal axis along the axis direction of the inner pipe.
(3) In another configuration, a noise eliminator for a fuel cell according to the present invention is characterized by including an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough, and an outer shell, arranged to surround the inner pipe through a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein there is formed a groove connecting the adjoining sound transmission holes.

(4) In still another configuration, a noise eliminator for a fuel cell according to the present invention is characterized by including an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough, and an outer shell, arranged to surround the inner pipe through a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein the inner wall of the sound transmission hole is formed with a saw-tooth shape.

(5) In yet another configuration, a noise eliminator for a fuel cell according to the present invention is characterized by including an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough, and an outer shell, arranged to surround the inner pipe through a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein a water repellant layer is formed in the inner wall of the sound transmission hole.

(6) In another configuration, a noise eliminator for a fuel cell according to the present invention is characterized by including an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough, and an outer shell, arranged to surround the inner pipe through a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein a sound absorbing material is filled in the inner side of the inner wall of the sound transmission hole.

(7) In another configuration, a noise eliminator for a fuel cell according to the present invention is characterized by including an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough, and an outer shell, arranged to surround the inner pipe through a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein the inner pipe is provided with a drift member drifting an exhaust gas stream so that the exhaust gas stream is prevented from directly impacting the sound transmission hole.

(8) Here, the drift member is preferably a louver protruding in a manner inclined from an upstream end of the sound transmission hole to a downstream direction in the inner-pipe inner wall.

Also, the drift member may be arranged in the inner wall of an upstream portion of the inner pipe, being preferably a stream guide plate which guides exhaust gas to an area where no sound transmission hole is formed.
that all the exhaust gas flowing through the outer shell flows through the interior of the inner case.

In another configuration, a noise eliminator for a fuel cell according to the present invention is characterized by including a shell allowing exhaust gas to flow therethrough, and a plate-shaped member partitioning the interior of the shell by a face thereof orthogonal to the direction of exhaust gas stream and having a plurality of through holes formed therein.

**BRIEF DESCRIPTION OF THE DRAWINGS**

**FIG. 1** is a vertical section of a noise eliminator according to a first embodiment of the present invention;

**FIG. 2** is an expanded sectional view of an inner-pipe peripheral wall in a noise eliminator according to the first embodiment of the present invention, being an expanded sectional view of the portion A in **FIG. 1**;

**FIG. 3** is an expanded sectional view of an inner-pipe peripheral wall in a noise eliminator according to a variation of the first embodiment of the present invention, being an expanded sectional view of the portion A of **FIG. 1**;

**FIG. 4** is a vertical section of a noise eliminator according to another variation of the first embodiment of the present invention;

**FIG. 5** is a view of an inner pipe having a cross section illustrated in **FIG. 4**, as seen from the direction indicated by the arrow D;

**FIG. 6** is a view illustrating a configuration of a sound transmission hole in a noise eliminator according to a second embodiment of the present invention;

**FIG. 7** is a view illustrating a configuration of a sound transmission hole in a noise eliminator according to a variation of the second embodiment of the present invention;

**FIG. 8** is a view illustrating a configuration of a sound transmission hole in a noise eliminator according to another variation of the second embodiment of the present invention;

**FIG. 9** is an expanded sectional view of an inner-pipe peripheral wall in a noise eliminator according to a third embodiment of the present invention, being an expanded sectional view of the portion A in **FIG. 1**;

**FIG. 10** is an expanded sectional view of an inner-pipe peripheral wall in a noise eliminator according to a fourth embodiment of the present invention, being an expanded sectional view of the portion A in **FIG. 1**;

**FIG. 11** is a vertical section of an inner pipe in a noise eliminator according to a fifth embodiment of the present invention;

**FIG. 12** is an expanded sectional view of the inner-pipe peripheral wall portion 1 in **FIG. 11**;

**FIG. 13** is a view of the inner pipe having a cross section illustrated in **FIG. 11**, as seen from the direction indicated by the arrow D;

**FIG. 14** is a vertical section of an inner pipe in a noise eliminator according to a variation of the fifth embodiment of the present invention;

**FIG. 15** is a view schematically illustrating a vertical cross section of a noise eliminator according to a sixth embodiment of the present invention;

**FIG. 16** is a view schematically illustrating a vertical cross section of a noise eliminator according to a seventh embodiment of the present invention;

**FIG. 17** is a view illustrating an exemplary vortex generation member arranged in the noise eliminator according to the seventh embodiment of the present invention;

**FIG. 18** is a vertical section of an inner pipe in a noise eliminator according to a variation of the seventh embodiment of the present invention;

**FIG. 19** is a view of the inner pipe having a cross section illustrated in **FIG. 18**, as seen from the direction indicated by the arrow D;

**FIG. 20** is a view schematically illustrating a vertical cross section of a noise eliminator according to an eighth embodiment of the present invention;

**FIG. 21** is a vertical section of an inner pipe in a noise eliminator according to a variation of the eighth embodiment of the present invention;

**FIG. 22** is a view of the inner pipe having a cross section illustrated in **FIG. 21**, as seen from the direction indicated by the arrow D;

**FIG. 23** is a view schematically illustrating a noise eliminator according to a ninth embodiment of the present invention, and a peripheral device;

**FIG. 24** is a vertical section of a noise eliminator according to a tenth embodiment of the present invention;

**FIG. 25** is a view of the inner pipe having a cross section illustrated in **FIG. 24**, as seen from the direction indicated by the arrow D;

**FIG. 26** is a view schematically illustrating a vertical cross section of a noise eliminator according to an eleventh embodiment of the present invention;

**FIG. 27** is a perspective view of an inner case in a noise eliminator according to the eleventh embodiment of the present invention;

**FIG. 28** is a vertical section of a noise eliminator according to a twelfth embodiment of the present invention;

**FIG. 29** is a view of a plate-shaped member in a noise eliminator according to the twelfth embodiment of the present invention, as seen from a direction indicated by the arrow D of **FIG. 28**;

**FIG. 30** is a view illustrating an exemplary schematic configuration of a fuel cell system;

**FIG. 31** is a transverse sectional view of a sound absorption type noise eliminator and


**BEST MODE FOR CARRYING OUT THE INVENTION**

**FIG. 33** is a block diagram illustrating the configuration of the present invention.

Embellishments of the present invention will be described in detail below with reference to the drawings.

(1) First Embodiment

An exhaust system of a fuel cell system in which a noise eliminator 10 of the present embodiment is used will be schematically described with reference to **FIG. 30**. The fuel cell system 80 includes a fuel cell 82, a hydrogen tank 84 supplying hydrogen gas to the fuel cell 82, a blower 86 supplying oxidizing gas to the fuel cell 82, and an exhaust system 88 (indicated by the two-dot chain line in **FIG. 30**) discharging exhaust gas from the fuel cell 82.

The hydrogen tank 84 is joined through a fuel gas supplying path 85 to the fuel cell 82, and hydrogen gas (fuel gas) stored in the hydrogen tank 84 is supplied, after being
subjected to flow rate adjustment by a regulator 90, through a control valve 92 to the fuel cell 82. The blower 86 is connected through an oxidizing gas supplying path 87 to the fuel cell 82, whereby oxidizing gas (air) is supplied to the fuel cell 82. In the fuel cell 82, the supplied hydrogen gas and air react to produce electric energy and at the same time produce moisture.

[0063] Air unused in the reaction and oxidizing gas containing moisture (water vapor) produced in the fuel cell are discharged from the fuel cell 82 through a given exhaust system. The noise eliminator 10 is disposed at the tail end of this exhaust system; the exhaust gas containing moisture, and water being the result of moisture contained in exhaust gas condensing in the interior of the preceding exhaust system relative to the noise eliminator 10 flow from the upstream end of the exhaust system upstream (the end indicated by the arrow D of FIG. 1) into the noise eliminator 10.

[0064] The noise eliminator according to the present embodiment is arranged in the exhaust system of the above described fuel cell system. More specifically, the noise eliminator is installed as an exhaust sound noise elimination device (muffler) for a fuel cell vehicle in the underbody (not illustrated) towards the rear of the vehicle hung by a bracket or the like.

[0065] The noise eliminator 10 according to the present embodiment will be described with reference to FIGS. 1 to 4. FIG. 1 illustrates a vertical section configuration of the noise eliminator; FIG. 2 illustrates an expanded sectional view of the section of the inner-pipe peripheral wall A in FIG. 1; FIG. 3 illustrates an expanded sectional view of another example inner-pipe peripheral wall; FIG. 4 illustrates a vertical section configuration of another example noise eliminator; and FIG. 5 illustrates a view of an inner pipe having a cross section illustrated in FIG. 4, as seen from the direction indicated by the arrow D.

[0066] The noise eliminator 10 includes, as illustrated in FIG. 1, an outer shell 12 constituting the outer covering of the noise eliminator and an inner pipe 14, arranged within the outer shell 12, and allowing exhaust gas to flow therethrough. A sound absorbing material 16 is filled between the inner pipe 14 and outer shell 12, to thereby form a sound absorbing chamber 17. As indicated by the arrow D, the exhaust gas flowing from the exhaust system upstream side into the noise eliminator passes through the inner pipe 14 and is discharged to the outside of the noise eliminator 10. The sound transmitted along with the exhaust gas from the exhaust system upstream side into the inner pipe 14 is radiated from sound transmission holes 18 arranged in a peripheral wall 13 of the inner pipe 14 toward the sound absorbing material 16, and absorbed by the sound absorbing material 16. In this way, the noise eliminator 10 achieves a given noise elimination performance.

[0067] The inner pipe 14 is, as illustrated in FIG. 2, constituted of an outer pipe section 20 having a plurality of sound transmission holes 18 formed in a peripheral wall 13 thereof, and an inner pipe section 22, installed in the inner side of the peripheral wall 13 of the outer pipe section 20, and reinforcing the outer pipe section 20. The outer pipe section 20 is made of synthetic resin, the wall thickness (indicated by the size B in FIG. 2) thereof being 1.2 mm or smaller. In the outer pipe section 20, there are formed many sound transmission holes 18, the inner diameter of the sound transmission hole 18 (indicated by the size C in FIG. 2) being set to 3 mm or larger.

[0068] Meanwhile, the wall thickness of the inner pipe section 22 is formed larger than the outer pipe section 20. In the inner pipe section 22, there are formed a plurality of through holes 23 in a manner corresponding to that used to form the above described sound transmission holes 18. The configuration of the through hole is designed so as not to seal the sound transmission hole 18 formed in the outer pipe section 20 when the inner pipe section 22 is installed in the outer pipe section 20. When the inner pipe section 22 having a relatively large wall thickness is inserted and welded to the outer pipe section 20, the thin-walled outer pipe section 20 is reinforced.

[0069] With the above arrangement, the inner pipe 14 can be made of synthetic resin and have a desired stiffness, and sound transmission holes 18 having an inner diameter of 3 mm or greater and a depth of 1.2 mm or less can be formed in the peripheral wall of the inner pipe 14. The word “depth” used herein refers to the length of the sound transmission hole 18 in the direction along the center axis of the sound transmission hole 18 indicated by the dashed line E in FIG. 2, and the wall thickness of the part (the outer pipe section 20 in the present embodiment) in which the sound transmission holes are formed.

[0070] While the inner diameter of the sound transmission hole 18 is 3 mm or larger, the depth thereof is set to a sufficiently small value of 1.2 mm or less. While there is formed a water film having a size corresponding to the inner diameter of the sound transmission hole 18, because the area of the inner wall of the sound transmission hole 18 holding the water film is small, it is not possible for the inner wall of the sound transmission hole 18 to retain the water film. Consequently, in the noise eliminator 10 of the present embodiment, even when water flowing in from the exhaust system upstream side or water condensing in the interior of the noise eliminator attaches to the sound transmission holes, formation of a water film in the sound transmission holes can be suppressed.

[0071] In the noise eliminator 10 according to the present embodiment, in order to implement the inner pipe of synthetic resin having the sound transmission holes 18 of an inner diameter of 3 mm or larger and a depth of 1.2 mm or smaller, the inner pipe section 22 reinforcing the outer pipe section 20 was inserted to the interior of the thin-walled outer pipe section 20 in which the sound transmission holes 18 are formed, but the structure of the inner pipe is not limited thereto. The inner pipe can also be implemented by various embodiments described below.

[0072] For example, as with the variation illustrated in FIG. 3, it is also preferable that the wall of the peripheral part 24 of the sound transmission hole 18 in the inner pipe 14 is formed smaller than the other part 25. Here, the peripheral part 24 is a part adjoining to the inner wall of the sound transmission hole 18 in which the thickness closer to the inner wall of the sound transmission hole 18 is less than elsewhere. In the inner wall of the sound transmission hole 18, the wall thickness (indicated by the size B) is 1.2 mm or less. The peripheral part 24 can be formed by cutting or injection molding.

[0073] Meanwhile, “the other part” (indicated by reference numeral 25 in FIG. 3) which is at a longer distance from the sound transmission hole 18 than the peripheral part 24, has a sufficiently larger wall thickness than the part in which the sound transmission hole 18 is formed.

[0074] In this way, when the peripheral part 24 of the sound transmission hole 18 is formed thinner than the other part 25, it is possible to provide in the inner pipe of synthetic resin a
sound transmission hole which ensures the stiffness of the inner pipe and which has the dimensions described above which suppress formation of a water film.

[0075] Also, as with the variation illustrated in FIGS. 4 and 5, it is also preferable that a rib 28 reinforcing the inner pipe 14c is formed between the sound transmission holes 18. In the inner pipe 14c, there is formed a rib 28 protruding from the inner wall 15 toward the axis center (indicated by F in FIG. 4) of the inner pipe 14c. This rib 28 is formed integrally with the inner wall 14c; in the inner wall of the inner pipe 14c are formed an axis-direction rib 28a extending in a direction along the axis center of the inner pipe 14c and a circular shaped rib 28b extending in a circular shape in a direction orthogonal to the axis center of the inner pipe 14c. These ribs 28 are formed between the sound transmission holes 18 so as to avoid interfering with the sound transmission holes formed in the inner pipe 14c.

[0076] Meanwhile, except the part in which the rib 28 is formed, the inner pipe 14c is formed thinner to have a wall thickness of 1.2 mm or less; the sound transmission hole 18 is formed in this part.

[0077] In this way, when the rib 28 is formed in the inner wall 15 of the thin-walled inner pipe, it is possible to provide in the inner pipe 14c of synthetic resin the sound transmission hole 18 of dimensions which suppress formation of a water film, while ensuring the stiffness of the inner pipe 14.

(2) Second Embodiment

[0078] A noise eliminator 10b according to the present embodiment will be described with reference to FIG. 6. FIG. 6 illustrates a configuration of a sound transmission hole in the noise eliminator illustrated in FIG. 1. FIG. 7 and illustrate alternative configurations of a sound transmission hole according to the present invention. In the noise eliminator 10b of the present embodiment, the configuration of the sound transmission hole formed in the inner pipe is differs from the noise eliminator 10 according to the first embodiment, and will be described in detail. The same reference numerals are applied to parts corresponding to the noise eliminator 10 of the first embodiment, and explanation of these parts will not be repeated.

[0079] According to the present embodiment, the sound transmission hole 18b is oval-shaped as indicated by the solid line in FIG. 6. This oval shape is an envelope configuration of a group of circles produced by sliding a circle indicated by the two-dot chain line in FIG. 6 in a given direction (indicated by the arrow G). That is, the configuration of the sound transmission hole 18b is an oval shape having its longitudinal axis in a direction indicated by the arrow G. The distance from the center of the sound transmission hole 18b indicated by the point E to the inner wall 19b in the longitudinal axis direction (longitudinal direction of the sound transmission hole 18) indicated by the arrow G is set longer than the circle indicated by the two-dot chain line in FIG. 6.

[0080] When the configuration of the sound transmission hole 18b is set in this manner, the sound transmission hole 19b cannot retain a water film in the longitudinal axis direction of the sound transmission hole 18b. Even if a water film forms in this sound transmission hole 18b, the film is easily broken in the longitudinal axis direction indicated by the arrow G. Consequently, in the noise eliminator 10b of the present embodiment, even when water flowing in from the exhaust system upstream or water condensing in the interior of the noise eliminator attaches to the sound transmission hole, formation of a water film in the sound transmission hole can be suppressed.

[0081] Also, in the sound transmission hole 18b, the longitudinal axis of the oval shape is set parallel to the axis center F of the inner pipe 14. More specifically, the sound transmission hole 18b is set so that the stream direction of exhaust gas passing through the interior of the inner pipe 14 corresponds with the direction in which the longitudinal axis of the sound transmission hole 18b is set.

[0082] Accordingly, even if a water film forms in the sound transmission hole 18b, the water film is unevenly distributed and deformed in the longitudinal axis direction by the exhaust gas stream passing through the inner pipe 14. Because thin portions of the water film are thus formed, the film tension is easily broken. Consequently, in the noise eliminator 10b of the present embodiment, a water film can be suppressed from forming in the sound transmission hole.

[0083] In the noise eliminator 10b of the present embodiment, in order to suppress a water film from forming in the sound transmission hole, the sound transmission hole was formed to have an oval shape having its longitudinal axis along the axis direction of the inner pipe 14; but the configuration of the sound transmission hole is not limited thereto.

[0084] For example, as with the variation illustrated in FIG. 7, it is also preferable that the inner wall 19c of the sound transmission hole 18c is formed with a saw tooth shape. The expression “saw tooth shape” used herein refers to a configuration different from the circular-shaped sound transmission hole, in which substantially triangle-shaped slits having the apex at a point 31 are successively formed. More specifically, in the sound transmission hole inner wall 19c are alternately arranged a part 30 closer to the center axis of the sound transmission hole 18c indicated by the point E and a part 31 at a longer distance from the center axis.

[0085] When the configuration of the sound transmission hole 18c is set in this manner, it is not possible for the sound transmission hole inner wall 19c to retain a water film in the part 31 at a longer distance from the center E of the sound transmission hole 18c. Thus, even if a water film forms in the sound transmission hole 18c, the surface tension of the film is easily broken at the part 31 farther from the center E, thus enabling suppression of water film formation in the sound transmission hole.

[0086] Also, as with the variation illustrated in FIG. 8, it is also preferable that there is formed a groove 32 connecting adjoining sound transmission holes 18d and 18e. Between the circular-shaped sound transmission holes 18d and 18e is arranged the linear groove 32 connecting these holes through the shortest distance. This groove 32 constitutes a communicating path which causes the sound transmission holes 18d and 18e to communicate with each other.

[0087] When such a groove 32 is provided, even if a water film forms in these sound transmission holes 18, the water constituting a water film in the one sound transmission hole 18 is pushed through the groove 32 to the other sound transmission hole 18 by effect of exhaust gas stream passing through the interior of the inner pipe 14 or of acceleration acting on the noise eliminator 10b. For example, the water constituted a water film formed in the sound transmission hole 18d can pass, as indicated by the arrow H, through the groove 32 to the sound transmission hole 18c. Accordingly, in the one sound transmission hole 18d, the amount of water
 constituting a water film decreases and thus the water film tension becomes easily breakable.

Accordingly, according to the noise eliminator of the present embodiment, each time the sound transmission holes 18d and 18e is subjected to effects of exhaust gas stream inside the inner pipe 14 or of acceleration, the number of sound transmission holes in which a water film forms can be reduced, thus allowing suppression of water film formation in the sound transmission holes.

(3) Third Embodiment

A noise eliminator 10c according to the present embodiment will be described with reference to FIG. 9. FIG. 9 illustrates an expanded sectional view of the portion of the inner-pipe peripheral wall A in FIG. 1. The noise eliminator 10c of the present embodiment differs from the noise eliminator 10 of the first embodiment in that a water repellent finish is applied to sound transmission holes, and will be described in detail below. The same reference numerals are applied to parts corresponding to the noise eliminator 10 of the first embodiment, and an explanation thereof will not be repeated.

According to the present embodiment, in the inner wall 19d of a sound transmission hole 18, as illustrated in FIG. 9, there is formed a water repellent layer 34. In this water repellent layer 34, a water repellent film of fluorine resin or like is formed in the inner wall 19d. In this case, the water repellent layer 34 may be formed not only in the sound transmission hole inner wall 19d but also in the entire inner pipe 14d. When a water repellent finish is applied to the entire inner pipe 14d, the water repellent finish application process can be simplified.

When the above described water repellent finish is applied, the water repellent layer 34 is formed at least in the inner wall 19d of the sound transmission hole 18, the inner wall 19d of the sound transmission hole 18 cannot hold a water film. Accordingly, in the noise eliminator 10c of the present embodiment, even when water flowing in from the exhaust system upstream or water condensing in the interior of the noise eliminator attaches to the sound transmission hole, formation of a water film in the sound transmission hole can be suppressed.

(4) Fourth Embodiment

A noise eliminator 10d according to the present embodiment will be described with reference to FIG. 10. FIG. 10 illustrates an expanded sectional view of the portion of the inner-pipe peripheral wall 13 A in FIG. 1. The noise eliminator 10d of the present embodiment differs from the noise eliminator 10 of the first embodiment in that the sound absorbing material is filled in the inner side of the inner wall of a sound transmission hole, and will be described in detail below. The same reference numerals are applied to parts corresponding to the noise eliminator 10 of the first embodiment, and their explanation will not be repeated.

According to the present embodiment, a sound absorbing material 16b is, as illustrated in FIG. 10, filled in the inner wall 19d of a sound transmission hole 18. In the sound absorbing material 16b, a short projection 36 is integrally formed by press molding or the like. When the sound absorbing material 16b is placed around the inner pipe 14e, the projection 36 of the sound absorbing material 16b fits into the inner side of the inner wall 19 of the sound transmission hole 18 formed in the inner pipe 14e. The configuration of the projection 36 is set according to the configuration of the sound transmission hole 18. In this manner, the sound absorbing material 16b is filled in the inner side of the sound transmission hole 18.

According to this configuration, in the noise eliminator 10d of the present embodiment, when water flowing in from the exhaust system upstream, or water condensing in the interior of the noise eliminator 10d attaches to the sound transmission hole 18, it also naturally attaches to the projection 36 of the sound absorbing material 16b disposed in the inner side of the sound transmission hole 18. The water attaching to the projection 36 disperses to parts other than the projection 36 of the sound absorbing material 16b by the capillary phenomenon. Consequently, the projection 36 of the sound absorbing material 16b does not continue to be all wet.

Accordingly, even if a water film forms in the sound transmission hole 18, the water constituting this water film is made to disperse to another part of the sound absorbing material 16b by the projection 36 of the sound absorbing material 16b and thus the tension of the film forming in the sound transmission hole 18 is easily broken. Consequently, in the noise eliminator 10 of the present embodiment, even when water flowing in from the exhaust system upstream or water condensing in the interior of the noise eliminator attaches to the sound transmission hole, formation of a water film in the sound transmission hole can be suppressed.

(5) Fifth Embodiment

A noise eliminator 10e according to the present embodiment will be described with reference to FIGS. 11, 12 and 13. FIG. 11 illustrates a cross section of an inner pipe; FIG. 12 illustrates an expanded sectional view of the section of the inner-pipe peripheral wall I in FIG. 11; FIG. 13 illustrates a view of the inner pipe having a cross section illustrated in FIG. 11, as seen from the direction indicated by the arrow D; and FIG. 14 illustrates a cross section of an inner pipe in a noise eliminator according to a variation. The noise eliminator 10d of the present embodiment differs from the noise eliminator 10 of the first embodiment in that the inner pipe is provided with a drift member drifting the exhaust gas stream, as will be described in detail below. The same reference numerals are applied to parts corresponding to the noise eliminator 10 of the first embodiment, and their explanation will not be repeated.

The inner pipe 14 is provided with a drift member drifting the exhaust gas stream so that the exhaust gas stream does not impact directly against the sound transmission hole 18. The drift member is arranged inside the inner pipe 14; because the exhaust gas stream containing moisture does not directly impact against the sound transmission hole 18, fixing of the moisture contained in the exhaust gas stream to the sound transmission hole 18 is suppressed to a great extent. In the noise eliminator 10 of the present embodiment, the drift member is arranged inside the inner pipe 14 to prevent the exhaust gas stream from impacting against the sound transmission hole 18; thus, formation of a water film in the sound transmission hole 18 can be suppressed.

According to the present embodiment, a louver 38 as illustrated in FIG. 11, is provided as the drift member in a protruding manner upstream of the sound transmission hole 18 in the inner-pipe inner wall 15. More specifically, the louver 38 protrudes as illustrated in FIG. 12, from the upstream end of the sound transmission hole 18 toward the
inner pipe axis center F and at the same time in a manner inclined toward a downstream direction (direction indicated by the arrow D).

As indicated by the arrow J in FIG. 12, the exhaust gas stream flowing along the inner-pipe inner wall 15 is polarized upstream of the sound transmission hole 18 toward the side having the inner pipe axis center F by the louver 38. Consequently, the exhaust gas stream flowing inside the inner pipe 14 does not directly impact against the sound transmission hole 18 in the downstream of the louver 38, and thus little of the moisture contained in the exhaust gas attaches to the walls of the sound transmission hole 18.

In addition, the louver 38 is as illustrated in FIG. 13, preferably arranged in a circular shape to cover the entire circumference of the inner-pipe inner wall 15. The louver 38 having such a circular configuration not only polarizes the exhaust gas stream inside the inner pipe 14, but also functions as a “rib” reinforcing the inner pipe 14. When the inner pipe 14 is reinforced by the louver 38, the stiffness of the inner pipe 14 can be improved. As a result, the thickness of the peripheral wall 13 of the inner pipe 14 can be set thinner.

In the noise eliminator 10e of the present embodiment, as the drift member drifting the exhaust gas stream to prevent the exhaust gas stream from impacting directly against the sound transmission hole 18, the louver 38 protruding from the upstream end of the sound transmission hole 18 is provided, but the drift member is not limited to this configuration.

For example, as with a variation illustrated in FIG. 14, it is also preferable to provide within the inner pipe 14g a stream guide plate 40 guiding the exhaust gas stream to an area 39 in which no sound transmission hole 18 is formed. The stream guide plate 40 may be a plate-shaped member arranged in the inner wall 15 of an upstream end 41 of the inner pipe 14g, the plate being disposed in a manner inclined relative to the stream direction (indicated by the arrow D) of exhaust gas flowing into the inner pipe 14g. Then, the exhaust gas stream flowing into the upstream end 41 of the inner pipe 14g is as indicated by the arrow K in FIG. 14, polarized by the stream guide plate 40 and guided to the area 39 (area surrounded by the dashed line in FIG. 14) where no sound transmission hole 18 is formed.

The “area 39 where no sound transmission hole 18 is formed” refers to an area, downstream of the upstream end 41 of the inner pipe 14g, and excluding the area 43 (indicated by the dotted line in FIG. 14) where the sound transmission hole 18 is formed. The stream guide plate 40 polarizes the exhaust gas stream flowing into the inner pipe 14g so that the exhaust gas stream avoids this “area 43 where the sound transmission hole 18 is formed”.

In this way, the exhaust gas stream does not directly impact the “area 43 in which the sound transmission hole 18 is formed”. Consequently, very little of the moisture contained in the exhaust gas attaches to the sound transmission hole 18.

As described above, in the noise eliminator 10e of the present embodiment, the louver 38 protruding from the upstream side of the sound transmission hole 18 is arranged inside the inner pipe 14g, or the stream guide plate 40 is arranged in the upstream side end 41, and thus very little moisture attaches to the sound transmission hole 18. Consequently, formation of a water film in the sound transmission hole is suppressed.

(6) Sixth Embodiment

A noise eliminator 10f according to the present embodiment will be described with reference to FIG. 15. FIG. 15 schematically illustrates a cross section of the noise eliminator. The noise eliminator 10f of the present embodiment differs from the noise eliminator 10 of the first embodiment in that a swirling stream (vortex) generation member is provided along the inner pipe inner wall for generating a swirling stream, and will be described in detail below. The same reference numerals are applied to parts corresponding to the noise eliminator 10 of the first embodiment, and their explanation will not be repeated.

According to the present embodiment, the swirling stream generation member 44 is, as illustrated in FIG. 15, a plate-shaped member having a twisted configuration and arranged in the upstream end 41 inside the inner pipe 14f. This twisted plate-shaped member generates a swirling stream swirling along the inner-pipe inner wall 15. As indicated by the arrow b, the exhaust gas stream flowing into the upstream end 41 of the inner pipe 14f swirls around the inner pipe axis center F by the plate-shaped member. This swirling exhaust gas stream (swirling stream) flows, as indicated by the arrow L in FIG. 15, in a downstream direction while swirling along the inner-pipe inner wall 15. Acting on the exhaust gas swirling inside the inner pipe 14f is a centrifugal force working toward the inner-pipe inner wall 15 around the axis center of the inner pipe 14f.

Accordingly, in the noise eliminator 10f of the present embodiment, even if a water film forms in the sound transmission hole, the exhaust gas is pressed against the water film and thus the film tension is easily broken. Consequently, in the noise eliminator 10 of the present embodiment, formation of a water film in the sound transmission hole can be suppressed.

Here, it is also preferable that the sound transmission hole 18f is, as illustrated in FIG. 15, formed to have a configuration along the flow of the generated swirling stream. More specifically, the sound transmission hole 18 is set so that the stream direction (indicated by the arrow L) of the swirling stream agrees with the longitudinal direction of the sound transmission hole 18f.

When the sound transmission hole 18f is configured in this manner, even if a water film forms in the sound transmission hole 18f, the water film is polarized and deformed in the longitudinal direction of the sound transmission hole 18f by the exhaust gas stream (swirling stream) flowing along the inner-pipe inner wall 15, and, because the film includes thin patches, the film tension is easily broken.

(7) Seventh Embodiment

A noise eliminator 10g according to the present embodiment will be described with reference to FIGS. 16 to 19. FIG. 16 schematically illustrates a cross section of the noise eliminator; FIG. 17 illustrates an exemplary vortex generation member arranged in the noise eliminator; FIG. 18 illustrates a cross section of an inner pipe in a noise eliminator according to a variation; and FIG. 19 illustrates a view of the inner pipe having a cross section illustrated in FIG. 18, as seen from the direction indicated by the arrow D. The noise eliminator 10g of the present embodiment differs from the noise eliminator 10 of the first embodiment in being provide with a vortex generation member generating a vortex along the inner-pipe inner wall, and will be described in detail below. The same reference numerals are applied to parts corresponding to the noise eliminator 10 of the first embodiment, and their explanation will not be repeated.
0112] The inner pipe 14i is provided with a vortex generation member generating a vortex in the vicinity of the inner wall 15 of the inner pipe 14i. The vortex generation member produces a vortex 48 upstream of the sound transmission hole 18. The produced vortex 48 flows downstream along the inner wall of the inner pipe 14 towards the sound transmission hole 18. The turbulent flow of the vortex 48 as it reaches the sound transmission hole 18 suppresses formation of water films in the sound transmission hole 18, and, upon impact, acts to break up any films that may have formed. In the noise eliminator 10 of the present embodiment, because the inner pipe 14i is provided with the vortex generation member to produce a vortex in the vicinity of the inner-pipe inner wall 15, formation of a water film in the sound transmission hole can be suppressed.

0113] According to the present embodiment, as the vortex generation member, a Karman vortex generation member 46 is, as illustrated in FIG. 16, arranged in the upstream end 41 of the inner pipe 14i. The Karman vortex generation member 46 can be, as illustrated in FIG. 17, composed of a plate-shaped member having some thickness, for example. The member is disposed inside the inner pipe 14i so that the axis center F of the inner pipe 14i penetrates through the member.

0114] The exhaust gas stream flowing into the inner pipe 14 from the direction indicated by the arrow D is divided into two streams (an upper stream and a lower stream indicated by the arrows M1 and M2, respectively, in FIG. 16) by the Karman vortex generation member 46. The two streams break away at a downstream end 46c of the Karman vortex generation member 46 and alternately produce a vortex 48. This Karman vortex 48 flows to the downstream side and reaches the sound transmission hole 18. The turbulent flow of the vortex 48 suppresses formation of water films in the sound transmission hole 18, and acts to break up any films that do form.

0115] In the noise eliminator 10 of the present embodiment, the Karman vortex generation member 46 produces a vortex in the vicinity of the inner-pipe inner wall 15, but the vortex generation member is not limited to this configuration.

0116] For example, as with the variation illustrated in FIGS. 18 and 19, it is also preferable that there is arranged a protrusion 50 generating a vortex 51 in the vicinity of the inner-pipe inner wall 15. A protrusion 50 may be, as illustrated in FIG. 18, arranged for each sound transmission hole 18 in the upstream side of the hole. Also, the protrusions 50 project, as illustrated in FIG. 19, from the inner-pipe inner wall 15 toward the inner-pipe axis center F. The protrusion 50 is configured so that the flow along the inner wall 15 of the inner pipe 14j can be separated from the boundary layer as much as possible.

0117] Of the exhaust gas stream flowing from a direction indicated by the arrow D into the inner pipe 14j, the flow (indicated by the arrow N in FIG. 18) along the inner-pipe inner wall 15 collides with the protrusion 50 and separates from the inner wall 15, thus generating a vortex 51 (turbulent flow). This vortex 51 reaches the sound transmission hole 18 residing in the upstream side of the protrusion 50. Accordingly, formation of a water film in the sound transmission hole can be further suppressed.

0118] A noise eliminator 10b according to the present embodiment will be described with reference to FIGS. 20 to 22. FIG. 20 schematically illustrates a vertical section of the noise eliminator; FIG. 21 illustrates a vertical section of an inner pipe in a noise eliminator according to a variation; and FIG. 22 illustrates a view of the inner pipe having a cross section illustrated in FIG. 21, as seen from the direction indicated by the arrow D. The noise eliminator 10 of the present embodiment differs from the noise eliminator 10b of the first embodiment in that stream guide means are provided for directing a portion of the exhaust gas flowing into the inner pipe from the upstream sound transmission hole to the sound absorbing chamber. These stream guide means will be described in detail below, but the same reference numerals are applied to parts corresponding to the noise eliminator 10 of the first embodiment, and their explanation will not be repeated.

0119] The stream guide means cause a portion of the exhaust gas flowing inside the inner pipe 14 to flow out from inside the inner pipe 14 through the sound transmission hole 18g in the upstream side to the sound absorbing chamber 17. More specifically, in the sound transmission hole 18g in the upstream side, the stream guide means produce an exhaust gas stream flowing from inside the inner pipe 14 to the sound absorbing chamber 17. The sound absorbing chamber 17 is a hermetically-closed space surrounded by the inner-pipe outer wall and outer-shell inner wall, with the exception of the sound transmission holes 18g and 18h, and the exhaust gas flowing out from the sound transmission hole 18g in the upstream side to the sound absorbing chamber 17 flows back from the sound transmission hole 18h in the downstream side into the inner pipe 14. In the sound transmission hole 18h in the downstream side, there is produced an exhaust gas stream flowing from the sound absorbing chamber 17 into the inner pipe 14.

0120] When the stream guide means are arranged in the noise eliminator 10b, an exhaust gas stream can be produced in such a manner that a portion of the streams flows out from inside the inner pipe 14 through the sound transmission hole 18g in the upstream side to the sound absorbing chamber 17 and flows back through the sound transmission hole 18h in the downstream side into the inner pipe 14. Because the exhaust gas streams flows through both the upstream and downstream sound transmission holes 18g and 18h, formation of water films in the sound transmission holes 18g and 18h is suppressed, and any films that do form tend to be broken by the exhaust gas stream flowing through the sound transmission holes 18g and 18h. Accordingly, in the noise eliminator 10b of the present embodiment, formation of a water film in the sound transmission hole can be further suppressed.

0121] According to the present embodiment, a narrowed section 52 as illustrated in FIG. 20 is formed in the inner pipe 14 as the stream guide means. The narrowed section 52 is a portion in which the cross sectional area (cross section orthogonal to the axis center F of the inner pipe 14) of the stream path formed inside the inner pipe 14 is smaller than elsewhere, and disposed in the path of the inner pipe 14. The sound transmission holes 18g and 18h are formed upstream and downstream relative to this narrowed section 52, respectively.

0122] When exhaust gas flows in from the direction indicated by the arrow D, the pressure in the upstream side relative to the narrowed section 52 in the inner pipe 14 increases. On the other hand, downstream of the narrowed section 52 in the inner pipe 14, the pressure becomes lower than in upstream side relative to the narrowed section 52. In this way, when the narrowed section 52 is formed in the inner pipe 14,
a pressure differential between the flow upstream and downstream of the narrowed section 52 is created, causing a portion of the exhaust gas flowing upstream of the narrowed section 52 in the inner pipe 14± to flow out from the upstream-side sound transmission hole 18 to the sound absorbing chamber 17. Further, the exhaust gas flowing out to the sound absorbing chamber 17 flows, as indicated by the arrow P in FIG. 20, in a downstream direction inside the sound absorbing chamber 17, and then flows through the downstream sound transmission hole 18h into the downstream side relative to the narrowed section 52 in the inner pipe 14±.

In this way, in the noise eliminator 10i of the present embodiment, because the narrowed section 52 is arranged in the inner pipe 14±, exhaust gas streams flowing from inside the inner pipe 14± through the sound transmission hole 18g in the upstream side into the sound absorbing chamber 17, and flowing from the sound absorbing chamber 17 through the sound transmission hole 18h in the downstream side into the inner pipe 14±, are produced. Accordingly, water films rarely form in the upstream and downstream sound transmission holes 18g and 18h, and any films that do form are easily broken by the exhaust gas stream flowing through the sound transmission holes 18g and 18h.

In the noise eliminator 10i of the present embodiment, the formation of the narrowed section 52 in the inner pipe 14± allows a portion of the exhaust gas to flow out through the upstream sound transmission hole 18g into the sound absorbing chamber 17, but the stream guide means are not limited to this configuration.

For example, as with the variation illustrated in FIGS. 21 and 22, it is also preferable that there is arranged a duct 54 corresponding to the upstream sound transmission hole 18g. The duct 54 may be, as illustrated in FIG. 21, arranged in the inner wall 15 of the inner pipe 14± in a manner corresponding to each of the upstream sound transmission holes 18. Also, the duct 54 may protrude, as illustrated in FIG. 22, from the inner wall 15 of the inner pipe 14± toward the axis center Φ of the inner pipe 14±, and have an opening facing the upstream side.

Of the exhaust gas streams flowing from a direction indicated by the arrow D into the inner pipe 14±, the stream indicated by the arrow Q in FIG. 21, which flows along the inner-pipe inner wall 15, flows from the opening of the duct 54 through the sound transmission hole 18 (in the upstream side) and flows out into sound transmission hole 18. Because the exhaust gas flowing out into the sound absorbing chamber 17 raises the pressure inside the sound absorbing chamber 17, the exhaust gas flowing out into the sound absorbing chamber 17 flows back, as indicated by the arrow R in FIG. 21, through the sound transmission hole 18h in the downstream side into the inner pipe 14±.

In this manner, providing for each upstream sound transmission hole 18 a duct 54 having an upstream opening can produce the exhaust gas streams flowing through the upstream and downstream sound transmission holes 18. As a result, formation of a water film in the sound transmission hole can be further suppressed.

(9) Ninth Embodiment

A noise eliminator 10i according to the present embodiment will be described with reference to FIG. 23. FIG. 23 schematically illustrates the noise eliminator and its peripheral device. The noise eliminator 10i of the present embodiment is different from the noise eliminator 10 of the first embodiment in being provided with gas injection means for injecting gas into the sound absorbing chamber, and will be described in detail below. The same reference numerals are applied to parts corresponding to the noise eliminator 10 of the first embodiment, and their explanation will not be repeated.

Separately from the exhaust gas stream flowing from the upstream of the exhaust system into the inner pipe 14, the gas injection means injects gas from the outside of the noise eliminator 10 into the sound absorbing chamber 17. Because the pressure of the injected gas is greater than the pressure inside the inner pipe 14, when gas is injected into the sound absorbing chamber 17, the gas inside the sound absorbing chamber 17 flows through the sound transmission hole 18 into the inner pipe 14. In this way, a stream flowing from inside the sound absorbing chamber 17 through the sound transmission hole 18 and into the inner pipe 14 can be produced.

Consequently, water film rarely form in the sound transmission hole 18, and, even should such a film form, the stream flowing through the sound transmission hole 18 acts to break up the film. As a result, in the noise eliminator 10 according to the present embodiment, formation of water films in the sound transmission hole can be suppressed.

According to the present embodiment, a bypass stream path 60 which bypasses the fuel cell 82 and directly connects the oxidizing gas supplying path 87 and the interior of the sound absorbing chamber 17 as illustrated in FIG. 23 is provided as the gas injection means. One end of the bypass stream path 60 is connected to a gas outlet 57 arranged in the oxidizing gas supplying path 87 connecting a blower 86 and fuel cell body 82a; and the other end thereof is connected to a gas inlet 58 arranged in the outer shell 12c. By connecting the bypass stream path 60 in this manner, the oxidizing gas supplying path 87 is made to communicate with the sound absorbing chamber 17 inside the outer shell 12.

Referring to FIG. 23, when the blower 86 supplies, as indicated by the arrow S, oxidizing gas (air) through the oxidizing gas supplying path 87 to the fuel cell body 82a, the oxidizing gas is simultaneously supplied to the bypass stream path 60 (indicated by the arrow T in FIG. 23). The oxidizing gas supplied to the bypass stream path 60 flows, as indicated by the arrow U, through the gas inlet 58 of the outer shell 12 into the sound absorbing chamber 17. Meanwhile, the oxidizing gas supplied to the fuel cell body 82a is discharged as oxidizing gas from the fuel cell body 82a, and subjected to flow rate adjustment by an adjustment valve 82b, and flows, as indicated by the arrow D, into the inner pipe 14 of the noise eliminator 10i.

Here, the pressure of oxidizing gas flowing in the bypass stream path 60 (the pressure of oxidizing gas injected into the sound absorbing chamber) is set higher than the pressure of exhaust gas flowing in the inner pipe 14, so the oxidizing gas flowing through the gas inlet 58 into the sound absorbing chamber 17 flows from the sound absorbing chamber 17 through the sound transmission hole 18 into the inner pipe 14.

In this way, the bypass stream path 60 directly connecting the oxidizing gas supplying path 87 outside the noise eliminator 10 and the interior of the sound absorbing chamber 17 is provided in the noise eliminator 10 of the present embodiment, such that a gas stream flowing from the sound absorbing chamber 17 through the sound transmission hole
According to the present embodiment, oxidizing gas is removed from the oxidizing gas supplying path to the bypass stream path and injected into the sound absorbing chamber, but the configuration is not limited thereto. For example, it is also preferable that a gas outlet is arranged in an anode purge valve intermittently discharging anode gas (hydrogen) and is connected to the bypass stream path, whereby the anode gas is injected into the sound absorbing chamber. With this configuration, gas is intermittently supplied to the sound absorbing chamber and produces a pressure wave when injected, and any water films forming in the sound transmission hole can be further suppressed.

(0136) It is also preferable that a valve (not illustrated) which can be opened and closed instantaneously be provided in the bypass stream path 60. The instantaneous opening or closing of this valve produces a pressure wave in the oxidizing gas downstream of the valve. When this pressure wave propagates through the sound absorbing chamber 17 to the sound transmission hole 18,

(0137) It is also preferable that the adjustment valve 82b is opened or closed instantaneously. Such instantaneous opening and closing of the adjustment valve 82b produces a pressure wave as indicated by the arrow D in the exhaust gas flowing into the inner pipe 14. This pressure wave propagates from the inner pipe 14 to the sound transmission hole 18, and again acts to break up any water films forming in the sound transmission hole.

(10) Tenth Embodiment

A noise eliminator 10′ according to the present embodiment will be described with reference to FIGS. 24 and 25. FIG. 24 illustrates a vertical section of an inner pipe 14, while FIG. 25 illustrates a view of the inner pipe 14 having the cross section illustrated in FIG. 24, as seen from the direction indicated by the arrow D. The noise eliminator 10′ of the present embodiment differs from the noise eliminator 10 of the first embodiment in that the sound transmission hole and the peripheral part thereof are formed projecting towards the axis center F of the inner pipe, as will be described in detail below. The same reference numerals are applied to parts corresponding to the noise eliminator 10′ of the first embodiment, and their explanation will not be repeated.

(0139) According to the present embodiment, the sound transmission hole 18′ and its peripheral part 62 are, as illustrated in FIGS. 24 and 25, arranged to project from the inner wall 15 of the inner pipe 14m toward the inner-pipe axis center F. The exhaust gas (indicated by the arrow V) flowing along the inner wall 15 of the inner pipe 14 is polarized toward the inner-pipe axis center F by the peripheral part 62 of the sound transmission hole 18′, such that a contracted flow area 64 (surrounded by the two-dot chain line in FIG. 24) having a relatively rapid flow is produced between the sound transmission hole 18′ and the inner-pipe axis center F. That is, the sound transmission hole 18′ is exposed to the rapidly flowing exhaust gas stream.

(0140) In this manner, in the noise eliminator 10′ of the present embodiment, even when a water film forms in the sound transmission hole 18′, because the sound transmission hole 18′ is exposed to a relatively rapid flow, the water film is polarized towards a downstream direction and deformed, such that portions of the film are thinner and the film is, thus, easily broken or dispersed. Consequently, formation of water films in the sound transmission hole can be further suppressed.

(11) Eleventh Embodiment

A noise eliminator 10k according to the present embodiment will be described with reference to FIGS. 26 and 27. FIG. 26 schematically illustrates a vertical cross section of the noise eliminator, while FIG. 27 schematically illustrates a perspective view of an inner case constituting the noise eliminator. The noise eliminator 10k of the present embodiment differs from the noise eliminator 10 of the first embodiment in including an outer shell allowing exhaust gas to flow therethrough and an inner case, having a plurality of through holes formed in a wall surface thereof, with a sound absorbing material filled in the interior thereof, the inner case being disposed over the entire cross section of the outer-shell stream path, and will be described in detail below.

The inner case 66 is illustrated in FIG. 27, a hard case of a substantially rectangular shape having a plurality of through holes 18 formed on the wall surface 68 thereof. In more detail, in the wall surface 68 constituting the inner case 66, the sound transmission hole 18′ is formed in the upstream wall surface 68a and the downstream wall surface 68b facing the wall surface 68a; gas can flow therethrough from the upstream side wall surface 68a to the downstream side wall surface 68b. The sound absorbing material 16 is filled in the inner side of the inner case wall surface 68, i.e., inside the inner case 66, which functions as a sound absorbing chamber 17.

The inner case 66 described above is, as illustrated in FIG. 26, received and held in the inner side of the outer shell 12d. A stream path 70 is formed in the inner side of the outer shell 12d, and the inner case 66 is disposed so as to seal this stream path 70. In more detail, the wall surface 68 (the upstream side wall surface 68a and the downstream side wall surface 68b) of the inner case 66 having the sound transmission hole 18′ is disposed over the entire cross section of the stream path 70 inside the outer shell 12d.

When the noise eliminator 10k is configured in this manner, all the exhaust gas flowing through the outer shell 12d flows, as indicated by the arrow W, through the through hole 18 of the inner-case wall surface 68 and the sound absorbing chamber 17 residing therein. Accordingly, in the noise eliminator 10k of the present embodiment, formation of a water film in the through hole 18′ can be suppressed.

(12) Twelfth Embodiment

A noise eliminator 10m according to the present embodiment will be described with reference to FIGS. 28 and 29. FIG. 28 illustrates a vertical section of the noise eliminator, while FIG. 29 illustrates a view of a plate-shaped member constituting the noise eliminator, as seen from the direction indicated by the arrow D. The noise eliminator 10m of the present embodiment is differs from the noise eliminator 10 of
the first embodiment in that it includes a shell allowing exhaust gas to flow therethrough and a plate-shaped member having a plurality of through holes formed therein, the plate-shaped member partitioning the interior of the shell by a face thereof orthogonal to the direction of exhaust gas stream. The noise eliminator 10m will be described in detail below.

[0147] The plate-shaped member 72 is a hard plate member having a substantially circular shape as illustrated in FIG. 29. A plurality of through holes 18k are formed in a wall surface 73 thereof. Meanwhile, a stream path 75 having a substantially circular-shaped cross section is, as illustrated in FIG. 28, formed inside the shell 74. A plurality of the plate-shaped members 72 are arranged inside the shell 74 so as to divide the stream path 75 inside the shell 74 by a face thereof orthogonal to the stream direction (direction indicated by the arrow D) of exhaust gas. That is, the through hole 18k of the plate-shaped member 72 has the same through direction as the direction of exhaust gas stream.

[0148] The exhaust gas flowing in from the direction indicated by the arrow D flows, as indicated by the arrow D, through the through hole 18k of the plate-shaped member 72. The exhaust gas stream indicated by the arrow D is a turbulent flow produced upstream in the exhaust system, and this turbulent flow is rectified when the exhaust gas flows through the plurality of through holes 18k formed in the plate-shaped member 72. In this way, the turbulent flow is rectified each time it passes through the through holes 18k of each plate-shaped member, whereby the sound propagating from the exhaust system upstream to the interior of the shell 74 is silenced.

[0149] In the noise eliminator 10m of the present embodiment, the flowing — in exhaust gas is reliably directed through the through hole 18k of the plate-shaped member 72, and formation of water films in the through hole 18k is thereby suppressed. As a result, a desired noise elimination performance can be achieved without using a sound absorbing material.

**INDUSTRIAL APPLICABILITY**

[0150] As described above, the noise eliminator for a fuel cell according to the present invention is useful as a noise eliminator in an exhaust system of a fuel cell.

1. A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from a fuel cell, the noise eliminator comprising:
   - an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough; and
   - an outer shell, arranged to surround the inner pipe up to a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein the sound transmission hole has an inner diameter of 3 mm or greater and a depth of 1.2 mm or less.

2. The noise eliminator for a fuel cell according to claim 1, wherein the peripheral part of the sound transmission hole in the inner pipe is formed with a wall thickness thinner than that of other parts of the sound transmission hole.

3. The noise eliminator for a fuel cell according to claim 1, wherein a rib reinforcing the inner pipe is formed between the sound transmission holes.

4. A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from a fuel cell, the noise eliminator comprising:
   - an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough; and
   - an outer shell, arranged to surround the inner pipe up to a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein the sound transmission hole is formed in the shape of an oval having a longitudinal axis along the axis direction of the inner pipe.

5. The noise eliminator for a fuel cell according to claim 4, wherein the direction of the longitudinal axis of the oval being the sound transmission hole is substantially parallel to the axis of the inner pipe.

6. A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from a fuel cell, the noise eliminator comprising:
   - an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough; and
   - an outer shell, arranged to surround the inner pipe up to a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein there is formed a groove connecting the adjoining sound transmission holes.

7. A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from a fuel cell, the noise eliminator comprising:
   - an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough; and
   - an outer shell, arranged to surround the inner pipe up to a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein the inner wall of the sound transmission hole is formed in a saw-tooth shape.

8. A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from a fuel cell, the noise eliminator comprising:
   - an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough; and
   - an outer shell, arranged to surround the inner pipe up to a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein a water repellent layer is formed in the inner wall of the sound transmission hole.

9. A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from a fuel cell, the noise eliminator comprising:
   - an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough; and
an outer shell, arranged to surround the inner pipe up to a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein a sound absorbing material is filled in the inner side of the inner wall of the sound transmission hole.

10. A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from a fuel cell, the noise eliminator comprising:

an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough; and

an outer shell, arranged to surround the inner pipe up to a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein the inner pipe is provided with a steam drift member drifting an exhaust gas stream in such a manner that the exhaust gas stream is prevented from directly impacting the sound transmission hole, and wherein the steam drift member is a louvre in the innerpipe inner wall, protruding in a manner inclined from the upstream side of the sound transmission hole towards a downstream direction.

11. A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from a fuel cell, the noise eliminator comprising:

an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough; and

an outer shell, arranged to surround the inner pipe up to a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein the inner pipe is provided with a stream drift member drifting an exhaust gas stream in such a manner that the exhaust gas stream is prevented from directly impacting the sound transmission hole, and wherein the stream drift member is a stream guide plate, provided at an upstream end of the inner pipe, and guiding the exhaust gas stream to an area where no sound transmission hole is formed.

12. A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from a fuel cell, the noise eliminator comprising:

an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough; and

an outer shell, arranged to surround the inner pipe up to a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein a swirling flow generation member generating a swirling flow along the inner-pipe inner wall is provided in an upstream end of the inner pipe.

13. A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from a fuel cell, the noise eliminator comprising:

an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough; and

an outer shell, arranged to surround the inner pipe up to a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, wherein a vortex generation member generating a vortex in the vicinity of the inner-pipe inner wall is provided in the inner pipe.

14. A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from a fuel cell, the noise eliminator comprising:

an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough; and

an outer shell, arranged to surround the inner pipe up to a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, the noise eliminator further comprising stream guide means for causing a portion of the exhaust gas flowing into the inner pipe to flow out from inside the inner pipe through the upstream-side sound transmission holes to the sound absorbing chamber, wherein the exhaust gas flowing out to the sound absorbing chamber flows through the downstream-side sound transmission holes back into the inner pipe.

15. The noise eliminator for a fuel cell according to claim 14, wherein the stream guide means is a narrowed portion formed in the path of the inner pipe.

16. The noise eliminator for a fuel cell according to claim 14, wherein the stream guide means is a duct arranged in the inner-pipe inner wall in a manner corresponding to the upstream-side sound transmission hole.

17. A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from a fuel cell, the noise eliminator comprising:

an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough; and

an outer shell, arranged to surround the inner pipe up to a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe, the noise eliminator further comprising gas injection means for injecting gas from outside the noise eliminator directly to the sound absorbing chamber so that gas flows from the sound absorbing chamber through the sound transmission holes into the inner pipe.

18. A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from a fuel cell, the noise eliminator comprising:

an inner pipe having a plurality of sound transmission holes formed in a peripheral wall thereof and allowing exhaust gas to flow therethrough; and

an outer shell, arranged to surround the inner pipe up to a prescribed distance from the peripheral wall, and constituting a sound absorbing chamber with a sound absorbing material filled in a space between the outer shell and the inner pipe,
wherein the sound transmission hole and a peripheral part thereof are formed in a manner projecting towards the axis center of the inner pipe.

19. A noise eliminator for a fuel cell installed in an exhaust system discharging exhaust gas from a fuel cell, the noise eliminator comprising:
   an outer shell allowing exhaust gas to flow therethrough; and
   an inner case having a plurality of through holes formed in a peripheral wall thereof and constituting a sound absorbing chamber with a sound absorbing material filled in the interior thereof,
wherein the inner case is arranged over the entire stream path cross section of the outer shell such that all the exhaust gas flowing through the outer shell flows through the interior of the inner case.

20. (canceled)

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