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(54) NOISE ELIMINATOR FOR FUEL CELL

(76) Inventors: **Toshiyuki Kondo**, Aichi-ken (JP); **Kazunori Yanagihara**, Aichi-ken (JP); **Hideaki Taniguchi**, Aichi-ken (JP); **Takashi Kato**, Aichi-ken (JP); **Kiyohiko Nagae**, Gifu-ken (JP)

Correspondence Address:
KENYON & KENYON LLP
1500 K STREET N.W., SUITE 700
WASHINGTON, DC 20005 (US)

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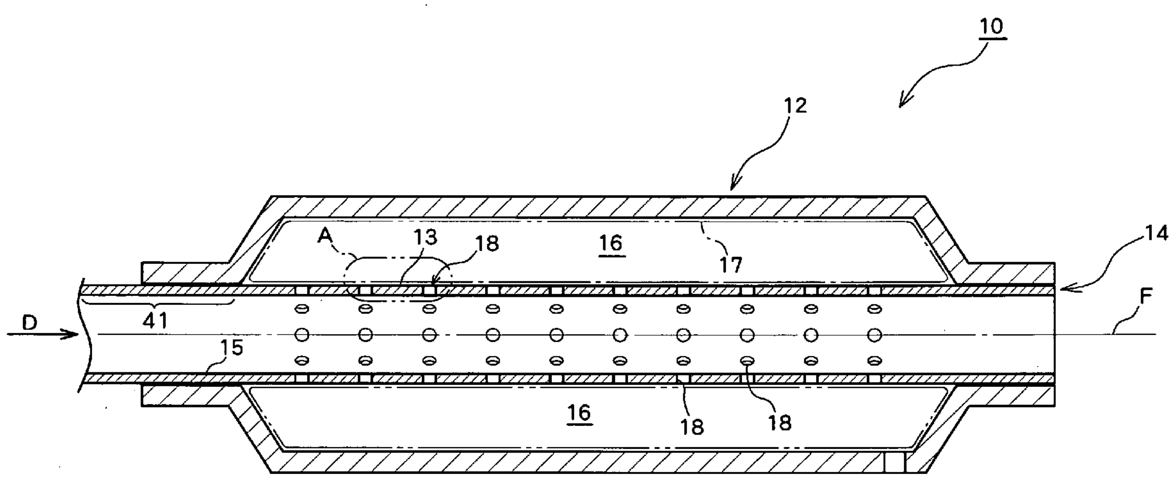
(57) ABSTRACT

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.



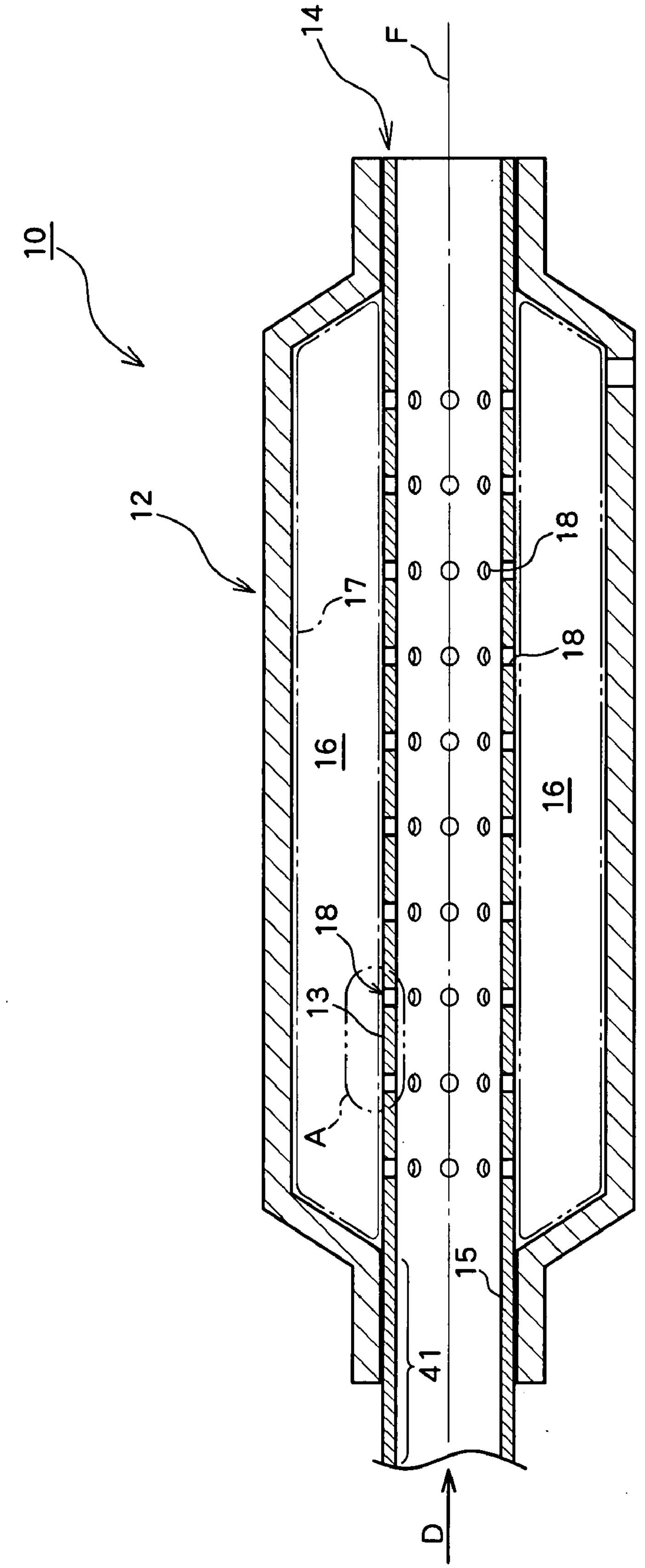


Fig. 1

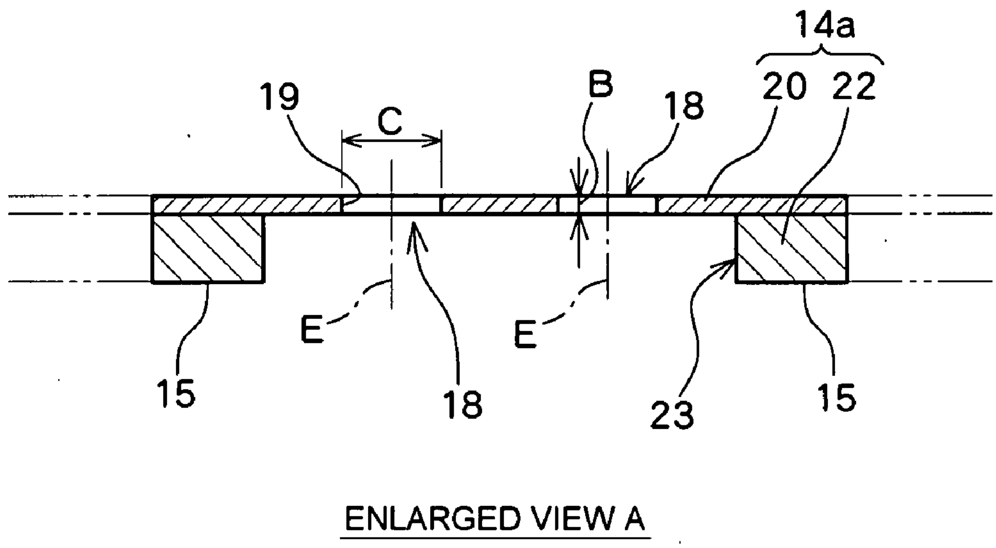

14a
19
C
B
18
20
22
15
E
18
E
23
15
ENLARGED VIEW A

Fig. 2

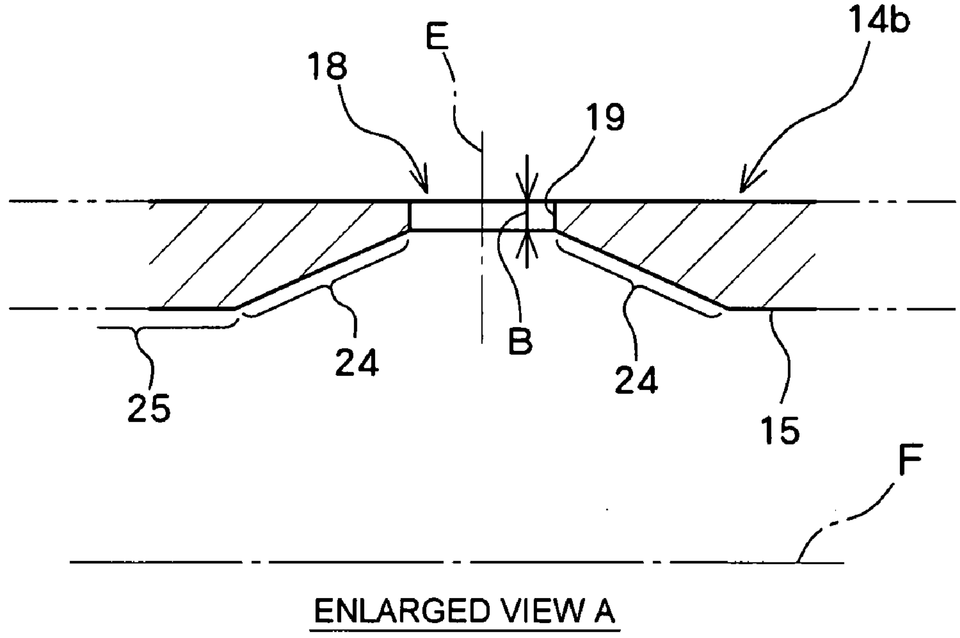
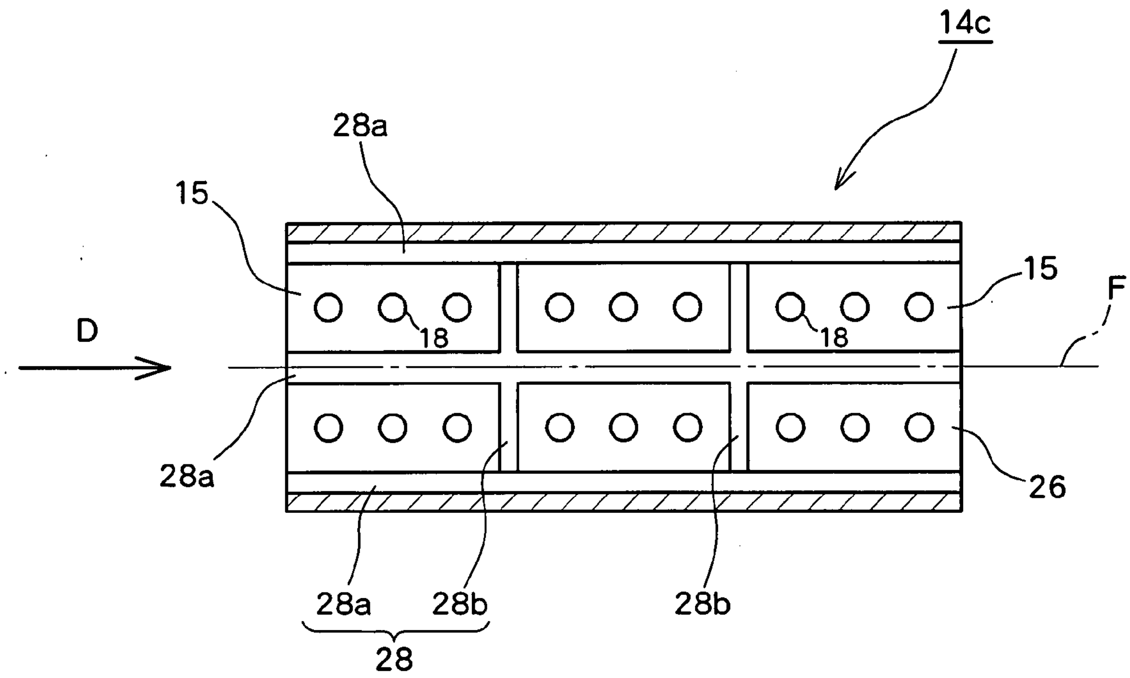
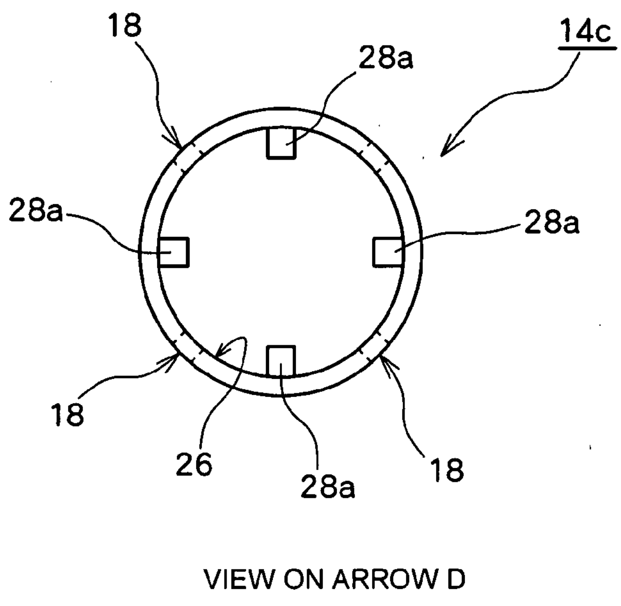

E
18
14b
19
25
24
B
24
15
F
ENLARGED VIEW A

Fig. 3



14c
28a
15
15
F
D
18
18
28a
26
28a
28b
28b
28

Fig. 4



18
14c
28a
28a
28a
18
26
28a
18
VIEW ON ARROW D

Fig. 5

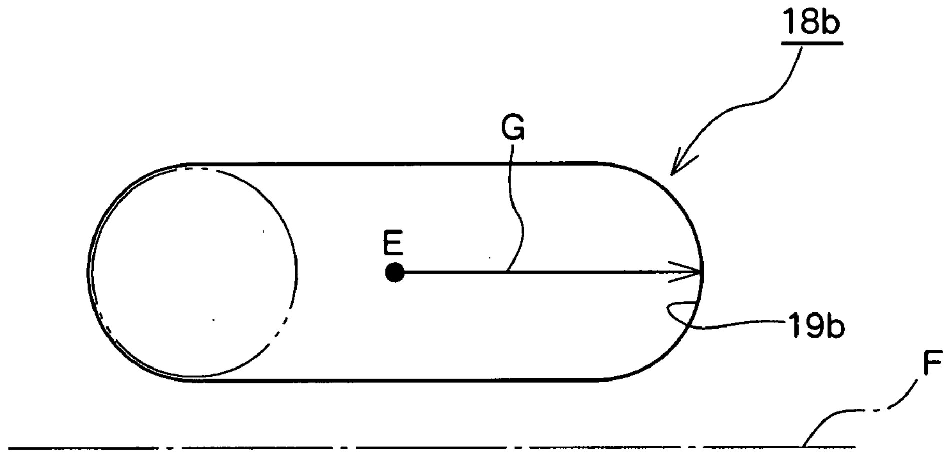


Fig. 6

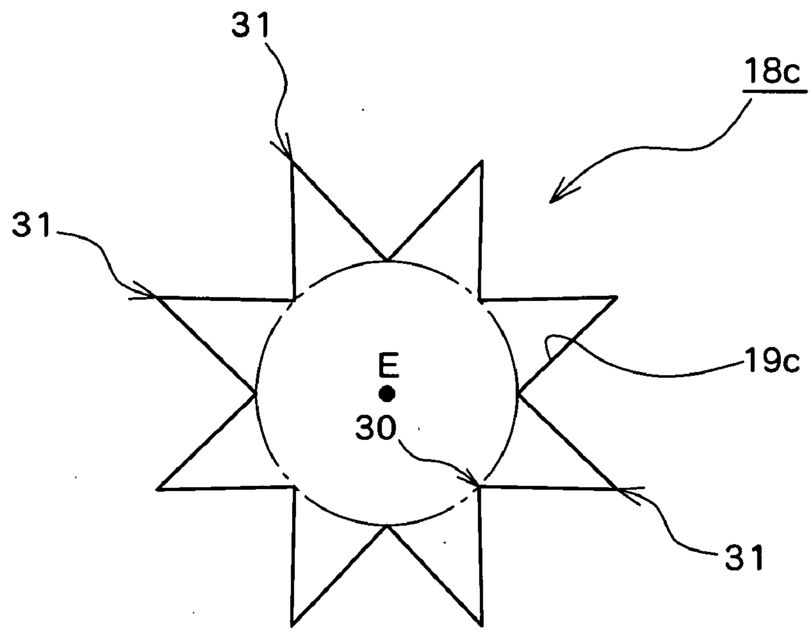


Fig. 7

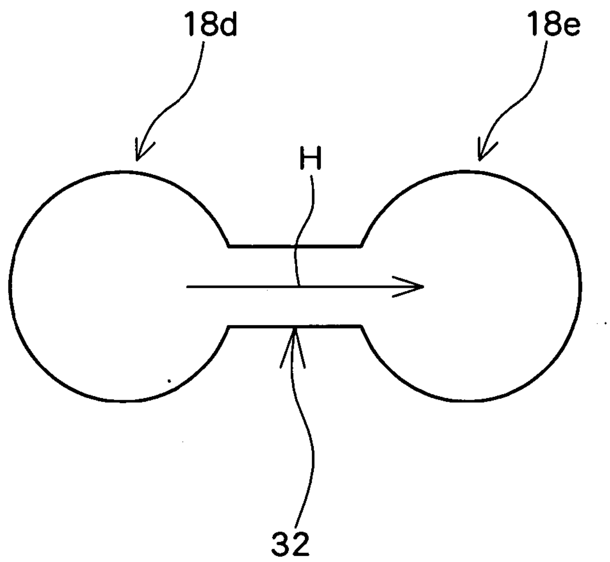


Fig. 8

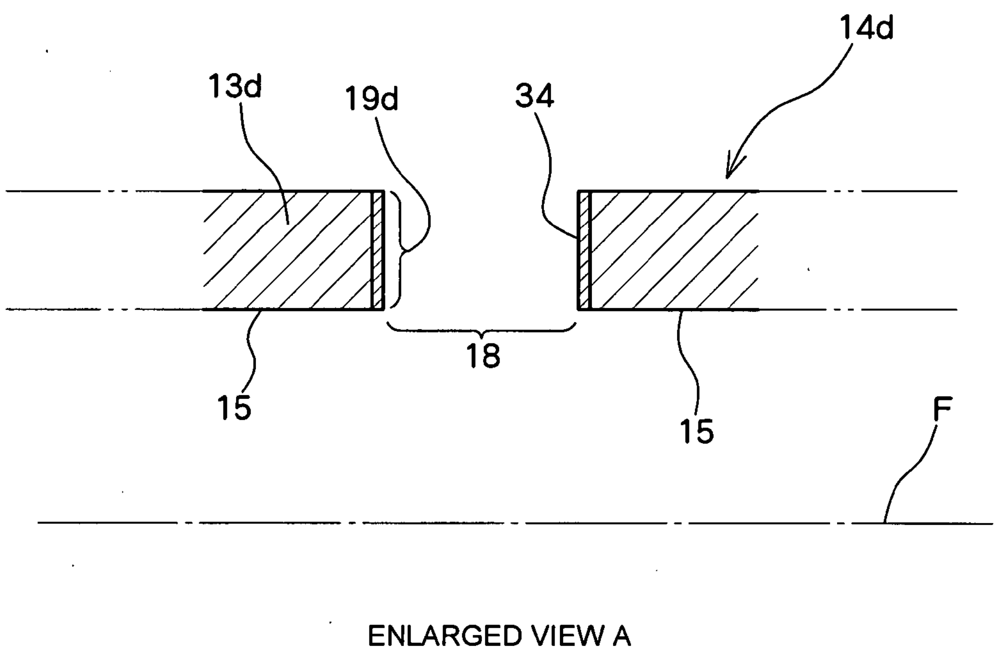


Fig. 9

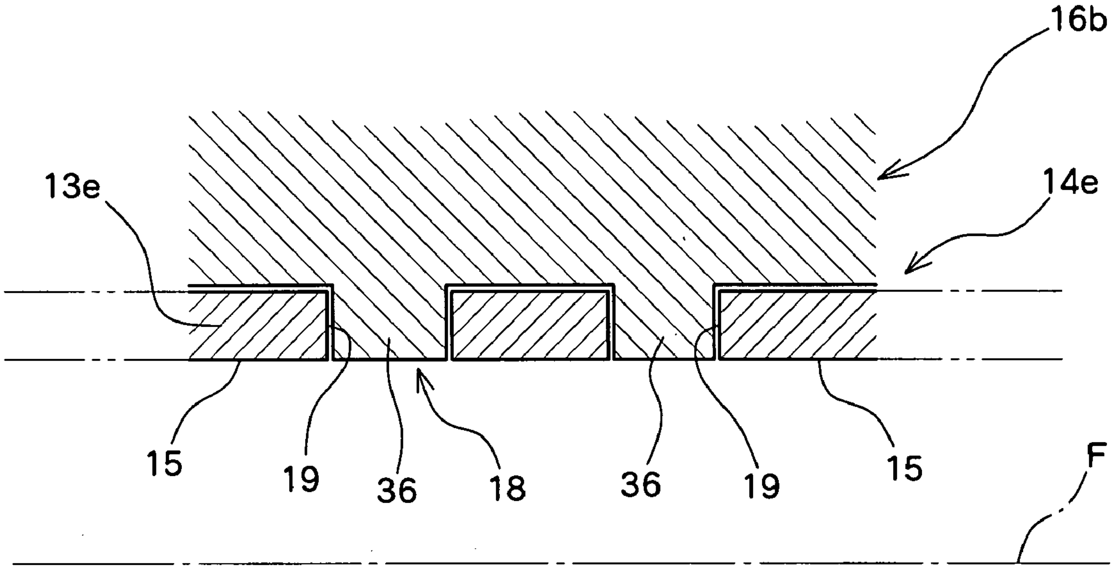


Fig. 10

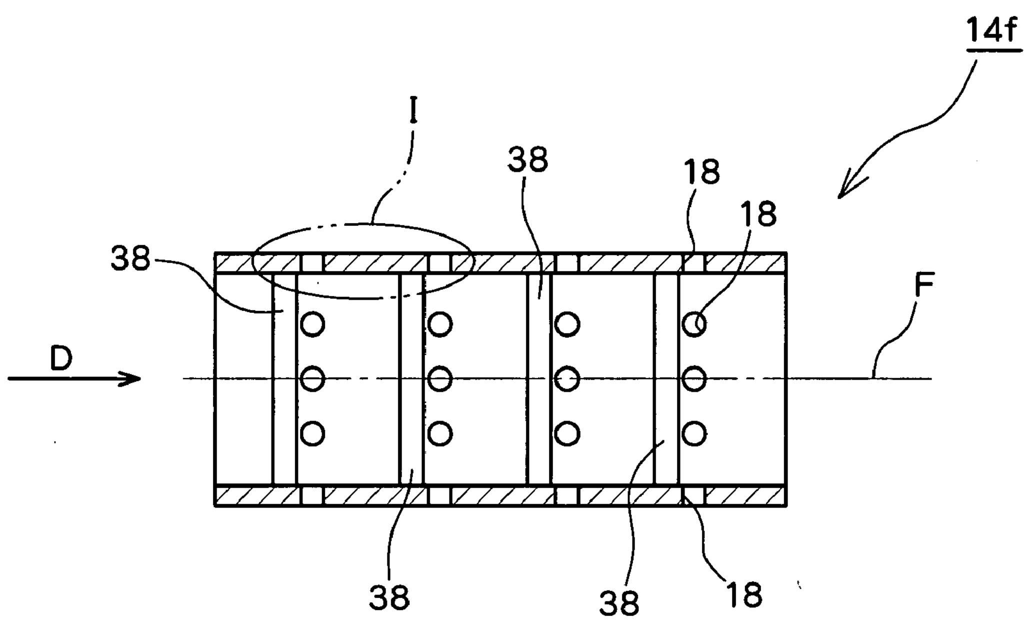


Fig. 11

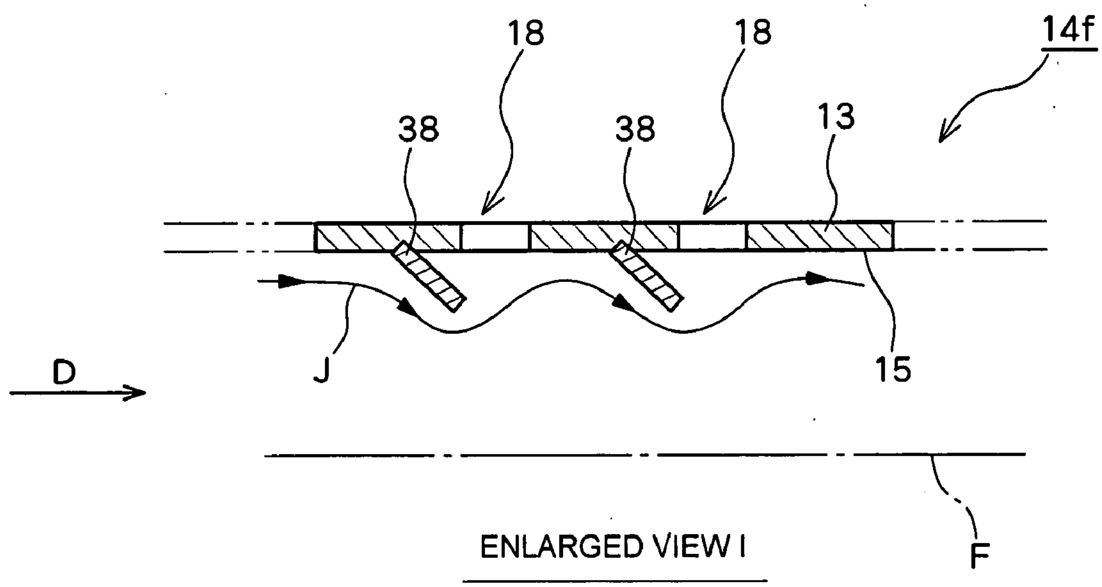

18
18
14f
38
38
13
D
J
15
F
ENLARGED VIEW I

Fig. 12

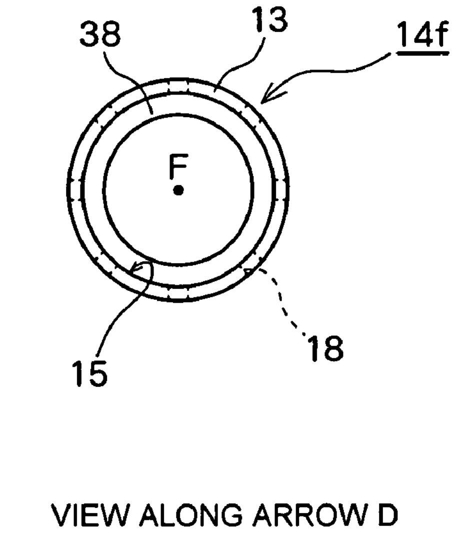

38
13
14f
F
15
18
VIEW ALONG ARROW D

Fig. 13

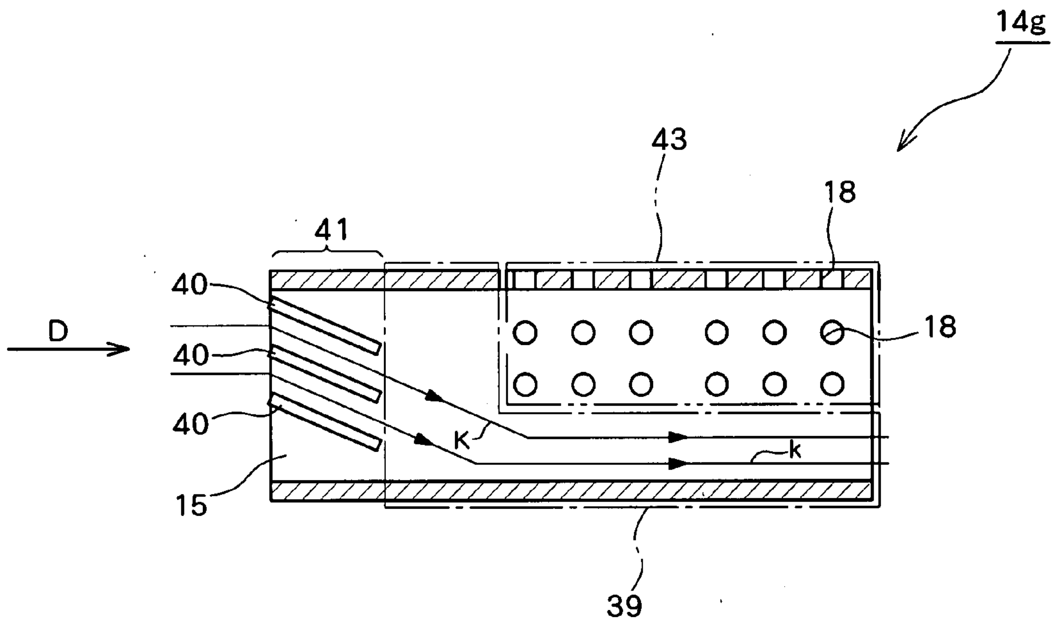
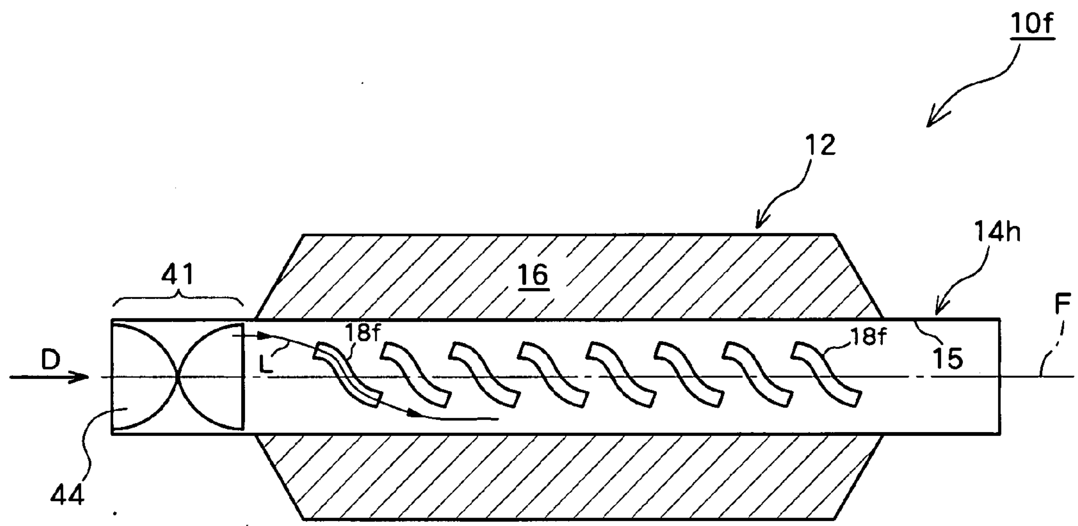


Fig. 14



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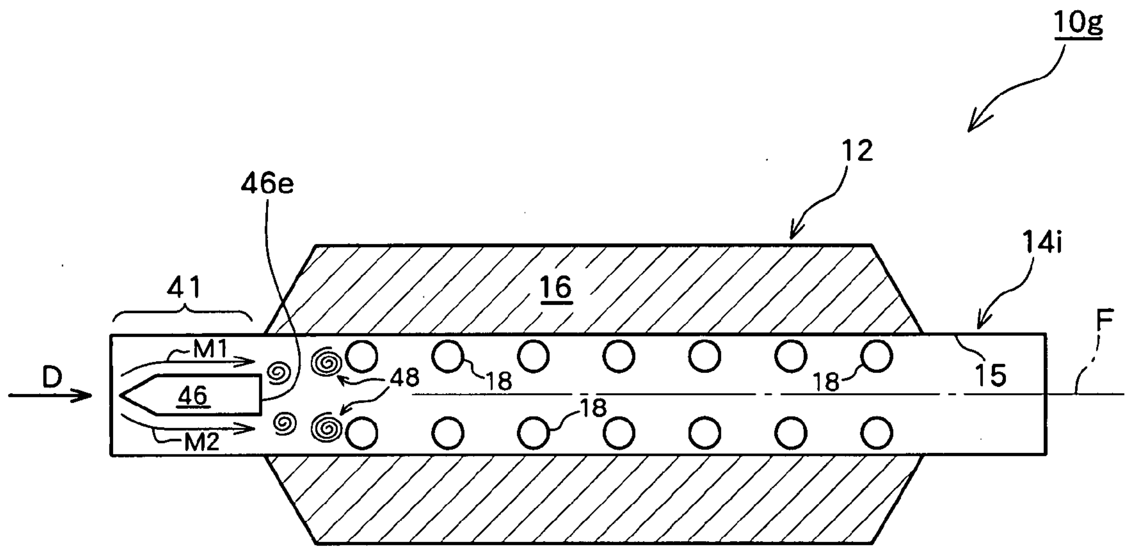

Fig. 16

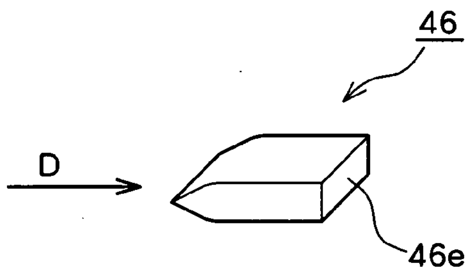

Fig. 17

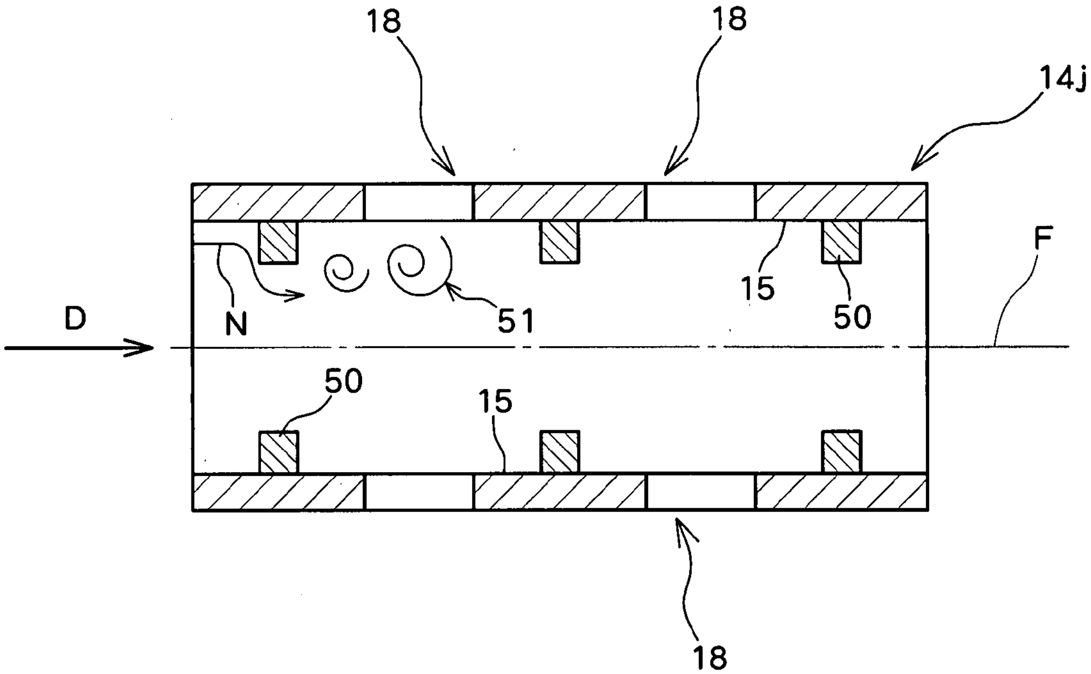

Fig. 18

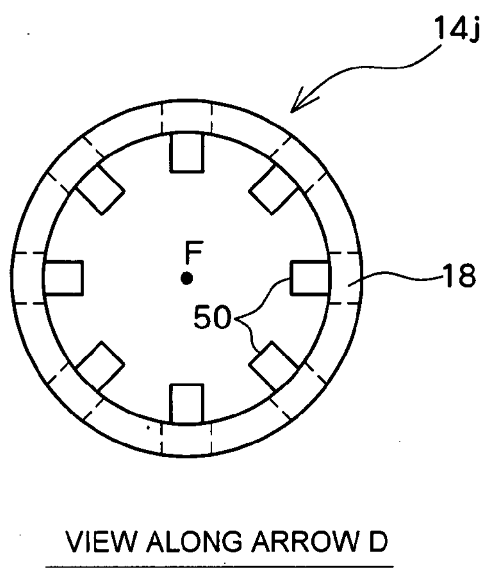

Fig. 19

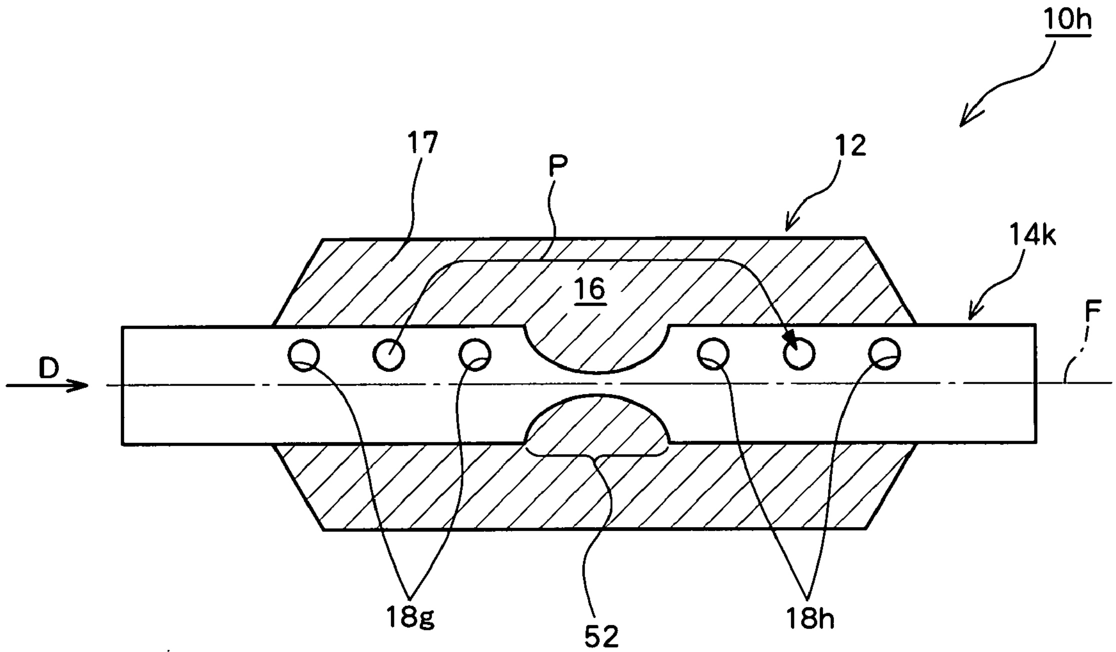
10h
17
P
12
14k
16
F
D
18g
52
18h

Fig. 20

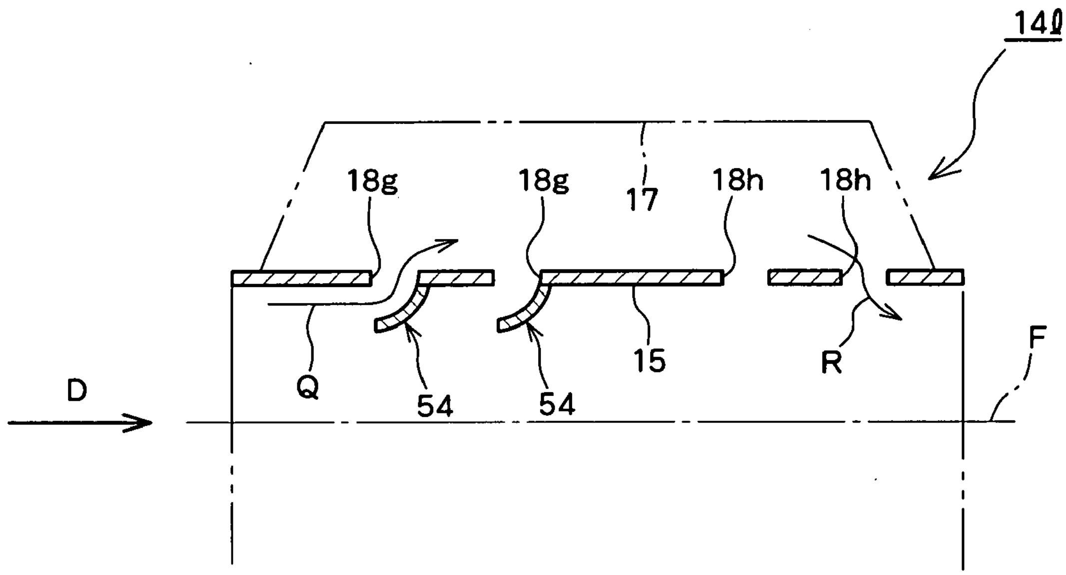
14l
18g
18g
17
18h
18h
Q
54
54
15
R
F
D

Fig. 21

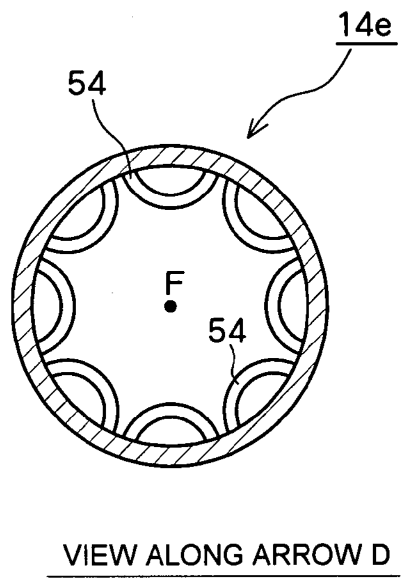
14e
54
F
54
VIEW ALONG ARROW D

Fig. 22

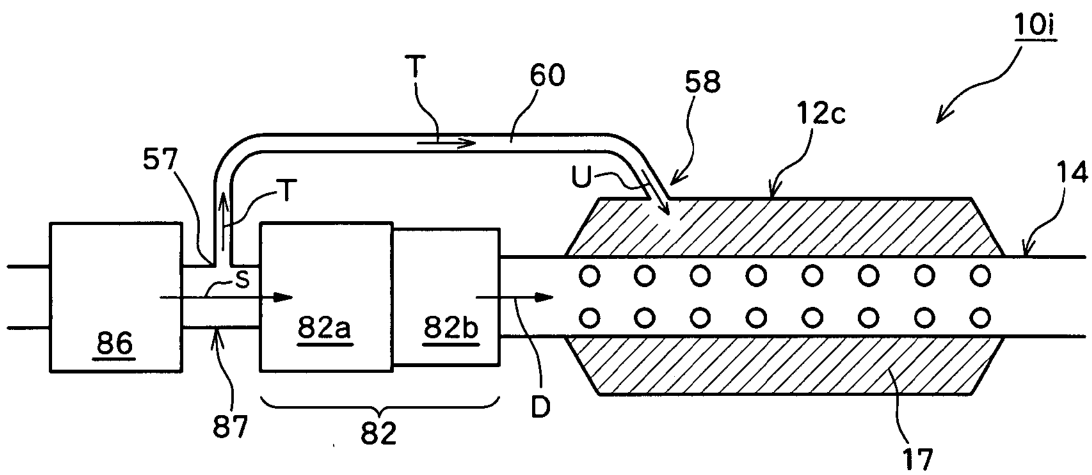
10i
T
60
58
12c
57
U
14
T
S
86
82a
82b
87
82
D
17

Fig. 23

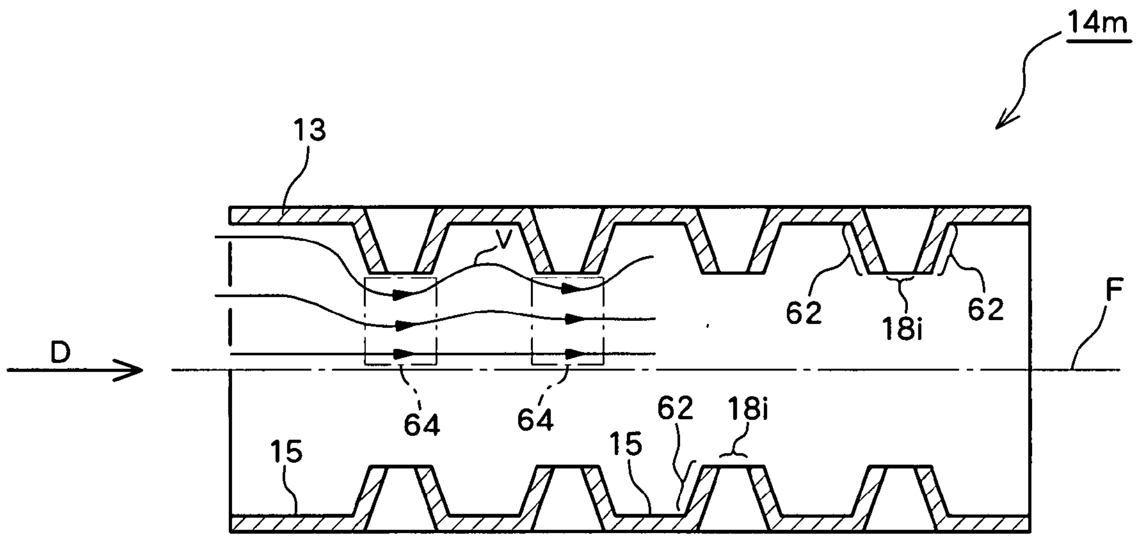
14m
13
V
62
62
18i
F
D
64
64
62
18i
15
15
15

Fig. 24

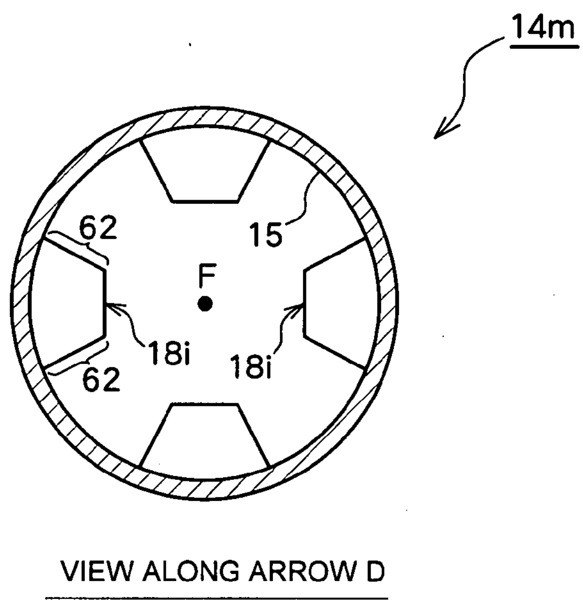
14m
62
15
F
18i
18i
62
VIEW ALONG ARROW D

Fig. 25

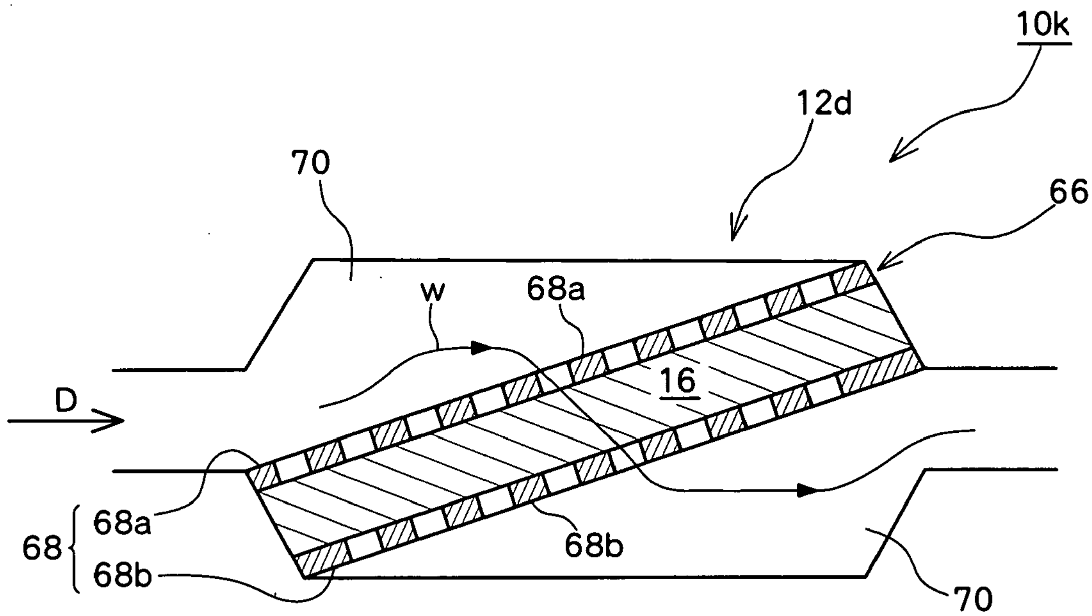

Fig. 26

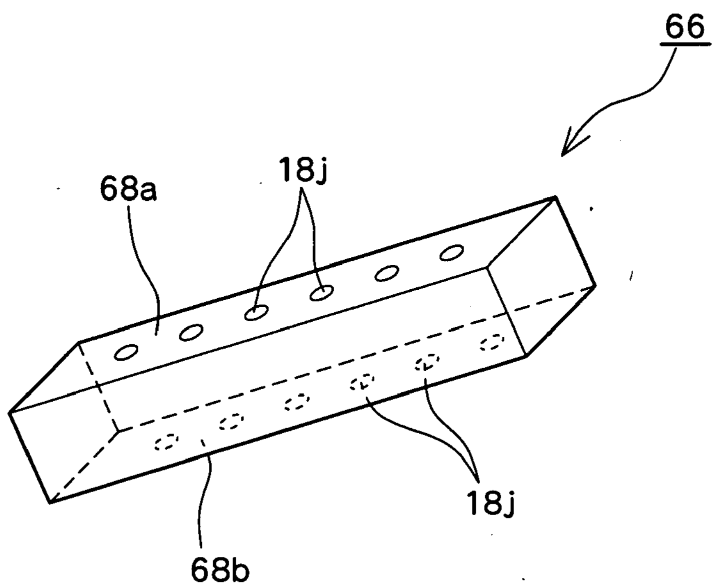

Fig. 27

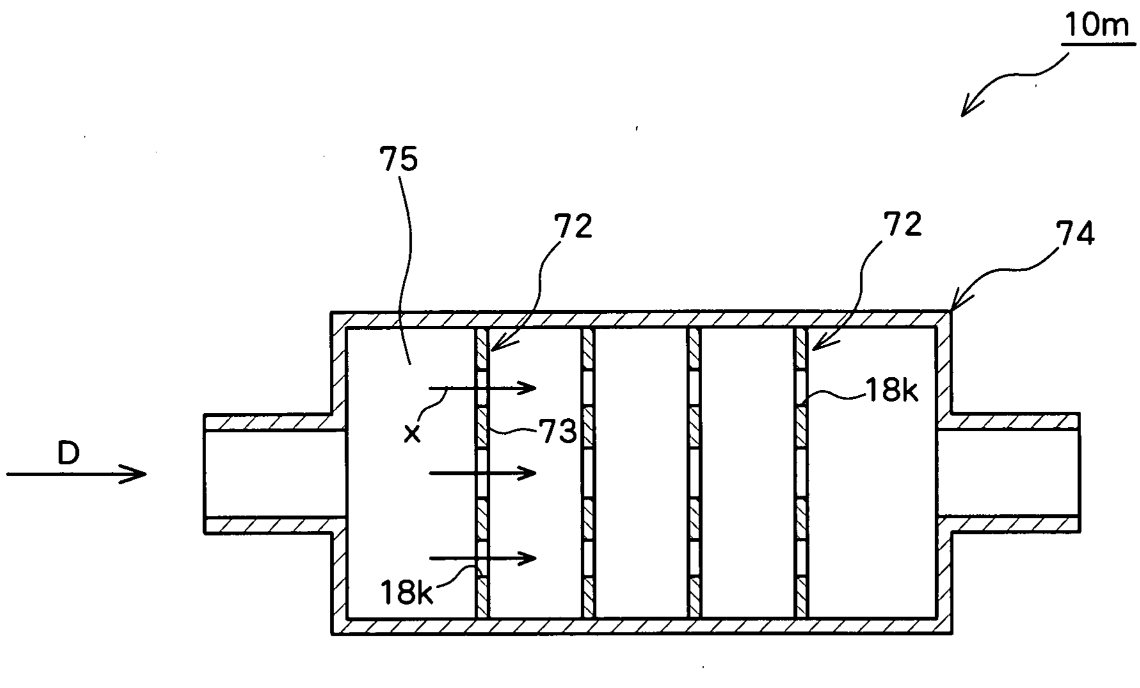

Fig. 28

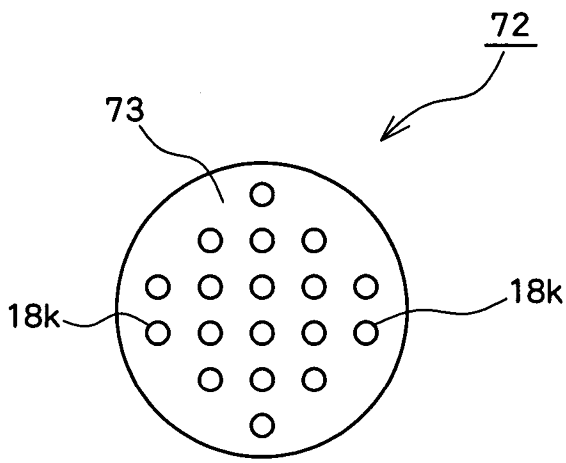

Fig. 29

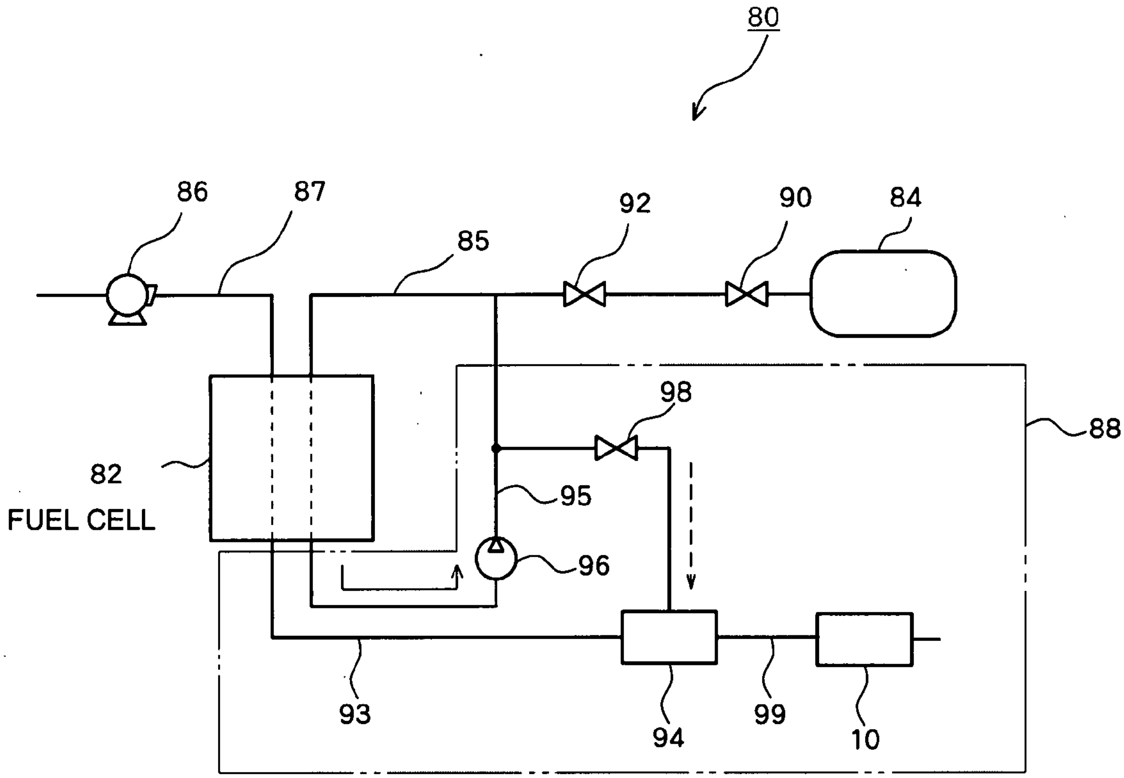
80
86
87
85
92
90
84
98
88
82
FUEL CELL
95
96
93
94
99
10

Fig. 30

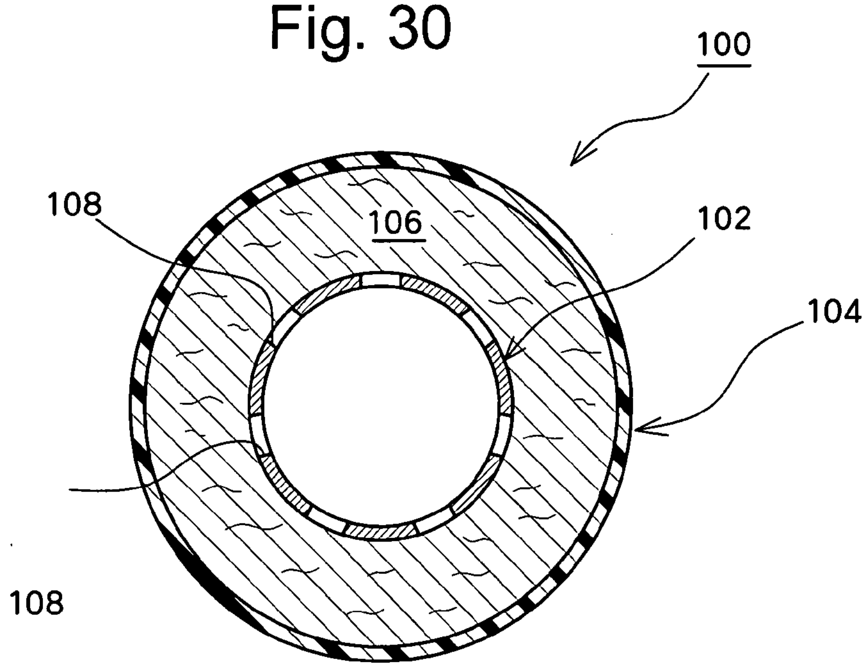
100
108
106
102
104
108

Fig. 31

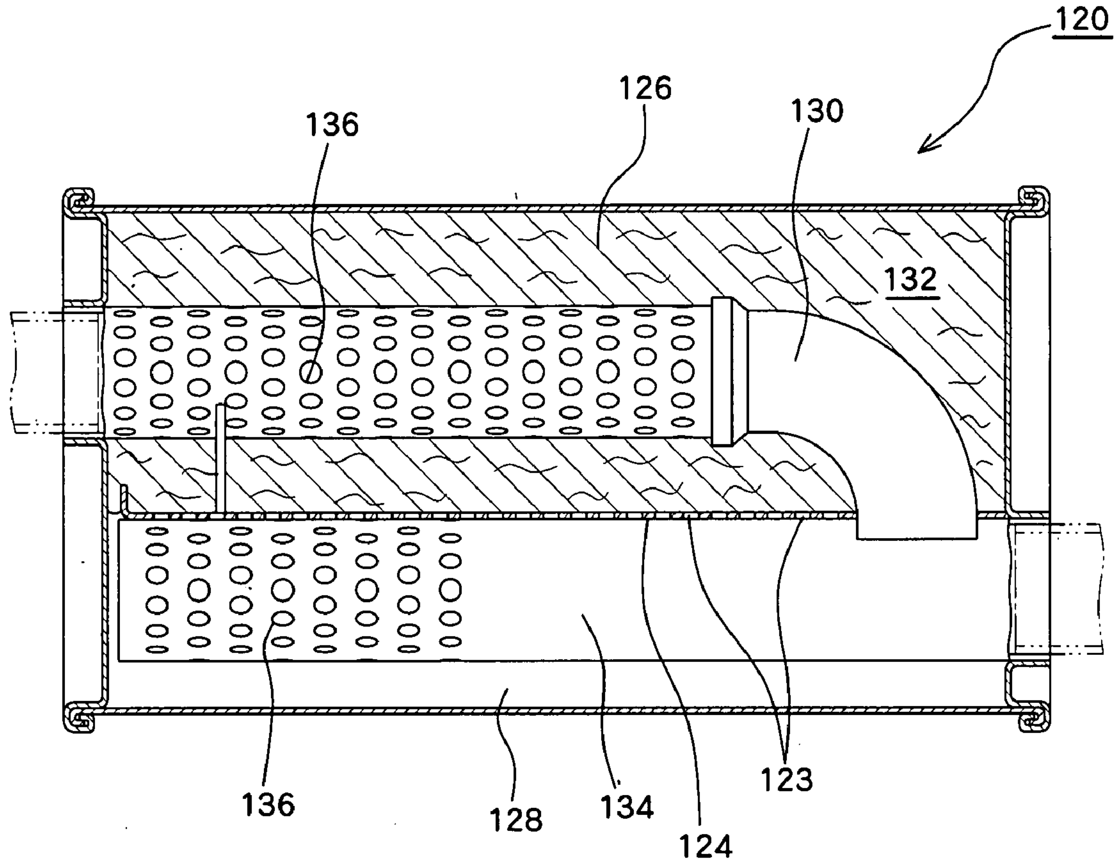

Fig. 32

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.

[0013] (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.

[0014] (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.

[0015] (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.

[0016] (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.

[0017] (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.

[0018] 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.

[0019] 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.

[0020] (8) In another configuration, a noise eliminator for a fuel cell according to the present invention is characterized by including a swirling stream generation member for generating a swirling stream along the inner pipe inner wall, the member being disposed upstream in the inner pipe.

[0021] (9) 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 vortex generation member generating a vortex in the vicinity of the inner-pipe inner wall is arranged in the inner pipe.

[0022] (10) In another configuration, a noise eliminator for a fuel cell according to the present invention is characterized by including stream guide means for causing a part of 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.

[0023] Here, the stream guide means may be a narrowed portion formed in the path of the inner pipe, or the stream guide means may be a duct arranged in the inner-pipe inner wall in a manner corresponding to the upstream-side sound transmission hole.

[0024] (11) 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, the noise eliminator further including 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.

[0025] (12) 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 and a peripheral part thereof are formed in a manner projecting toward the axis center of the inner pipe.

[0026] (13) In another configuration, a noise eliminator for a fuel cell according to the present invention is characterized by including 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 so that all the exhaust gas flowing through the outer shell flows through the interior of the inner case.

[0027] (14) 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

[0028] FIG. **1** is a vertical section of a noise eliminator according to a first embodiment of the present invention;

[0029] FIG. **2** is an expanded sectional view of an inner-pipe peripheral wall in the noise eliminator according to the first embodiment of the present invention, being an expanded sectional view of the portion A in FIG. **1**;

[0030] 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**;

[0031] FIG. **4** is a vertical section of a noise eliminator according to another variation of the first embodiment of the present invention;

[0032] 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;

[0033] 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;

[0034] 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;

[0035] 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;

[0036] 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**;

[0037] 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**;

[0038] FIG. **11** is a vertical section of an inner pipe in a noise eliminator according to a fifth embodiment of the present invention;

[0039] FIG. **12** is an expanded sectional view of the inner-pipe peripheral wall portion I in FIG. **11**;

[0040] 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;

[0041] 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;

[0042] FIG. **15** is a view schematically illustrating a vertical cross section of a noise eliminator according to a sixth embodiment of the present invention;

[0043] FIG. **16** is a view schematically illustrating a vertical cross section of a noise eliminator according to a seventh embodiment of the present invention;

[0044] 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;

[0045] 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;

[0046] 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;

[0047] FIG. **20** is a view schematically illustrating a vertical cross section of a noise eliminator according to an eighth embodiment of the present invention;

[0048] 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;

[0049] 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;

[0050] FIG. **23** is a view schematically illustrating a noise eliminator according to a ninth embodiment of the present invention, and a peripheral device;

[0051] FIG. **24** is a vertical section of a noise eliminator according to a tenth embodiment of the present invention;

[0052] 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;

[0053] FIG. **26** is a view schematically illustrating a vertical cross section of a noise eliminator according to an eleventh embodiment of the present invention;

[0054] FIG. **27** is a perspective view of an inner case in a noise eliminator according to the eleventh embodiment of the present invention;

[0055] FIG. **28** is a vertical section of a noise eliminator according to a twelfth embodiment of the present invention;

[0056] FIG. **29** is a view of a plate-shaped member in the noise eliminator according to the twelfth embodiment of the present invention, as seen from a direction indicated by the arrow D of FIG. **28**;

[0057] FIG. **30** is a view illustrating an exemplary schematic configuration of a fuel cell system;

[0058] FIG. **31** is a transverse sectional view of a sound absorption type noise eliminator; and

[0059] FIG. **32** is a vertical section of a noise eliminator described in Japanese Patent Laid-Open Publication No. 2002-206413.

BEST MODE FOR CARRYING OUT THE INVENTION

[0060] Embodiments of the present invention will be described in detail below with reference to the drawings.

(1) First Embodiment

[0061] 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**.

[0062] 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 a 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***b* 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 **14***c* is formed between the sound transmission holes **18**. In the inner pipe **14***c*, 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 **14***c*. This rib **28** is formed integrally with the inner pipe **14***c*; in the inner wall of the inner pipe **14***c* are formed an axis-direction rib **28***a* extending in a direction along the axis center of the inner pipe **14***c* and a circular shaped rib **28***b* extending in a circular shape in a direction orthogonal to the axis center of the inner pipe **14***c*. 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 **14***c*.

[0076] Meanwhile, except the part in which the rib **28** is formed, the inner pipe **14***c* 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 **14***c* 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 **10***b* 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 **10***b* 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 **18***b* 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 **18***b* 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 **18***b* indicated by the point E to the inner wall **19***b* 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 **18***b* is set in this manner, the sound transmission hole inner wall **19***b* cannot retain a water film in the longitudinal axis direction of the sound transmission hole **18***b*. Even if a water film forms in this sound transmission hole **18***b*, the film is easily broken in the longitudinal axis direction indicated by the arrow G. Consequently, in the noise eliminator **10***b* 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 **18***b*, 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 **18***b* 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 **18***b* is set.

[0082] Accordingly, even if a water film forms in the sound transmission hole **18***b*, 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 **10***b* of the present embodiment, a water film can be suppressed from forming in the sound transmission hole.

[0083] In the noise eliminator **10***b* 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 **19***c* of the sound transmission hole **18***c* 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 part **31** are successively formed. More specifically, in the sound transmission hole inner wall **19***c* are alternately arranged a part **30** closer to the center axis of the sound transmission hole **18***c* 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 **18***c* is set in this manner, it is not possible for the sound transmission hole inner wall **19***c* to retain a water film in the part **31** at a longer distance from the center E of the sound transmission hole **18***c*. Thus, even if a water film forms in the sound transmission hole **18***c*, 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 **18***d* and **18***e*. Between the circular-shaped sound transmission holes **18***d* and **18***e* 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 **18***d* and **18***e* 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 **10***b*. For example, the water constituting a water film formed in the sound transmission hole **18***d* can pass, as indicated by the arrow H, through the groove **32** to the sound transmission hole **18***e*. Accordingly, in the one sound transmission hole **18***d*, the amount of water constituting a water film decreases and thus the water film tension becomes easily breakable.

[0088] Consequently, according to the noise eliminator of the present embodiment, each time the sound transmission holes **18***d* and **18***e* 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

[0089] A noise eliminator **10***c* 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 **10***c* 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.

[0090] According to the present embodiment, in the inner wall **19***d* 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 the like is formed in the inner wall **19***d*. In this case, the water repellent layer **34** may be formed not only in the sound transmission hole inner wall **19***d* but also in the entire inner pipe **14***d*. When a water repellent finish is applied to the entire inner pipe **14***d*, the water repellent finish application process can be simplified.

[0091] When the above described water repellent finish is applied and the water repellent layer **34** is formed at least in the inner wall **19***d* of the sound transmission hole **18**, the inner wall **19***d* of the sound transmission hole **18** cannot hold a water film. Accordingly, in the noise eliminator **10***c* 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

[0092] A noise eliminator **10***d* 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 **10***d* of the present embodiment differs from the noise eliminator **10** of the first embodiment in that a 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.

[0093] According to the present embodiment, a sound absorbing material **16***b* is, as illustrated in FIG. **10**, filled in the inner wall **19***d* of a sound transmission hole **18**. In the sound absorbing material **16***b*, a short projection **36** is integrally formed by press molding or the like. When the sound absorbing material **16***b* is placed around the inner pipe **14***e*, the projection **36** of the sound absorbing material **16***b* fits into the inner side of the inner wall **19** of the sound transmission hole **18** formed in the inner pipe **14***e*. 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 **16***b* is filled in the inner side of the sound transmission hole **18**.

[0094] According to this configuration, in the noise eliminator **10***d* of the present embodiment, when water flowing in from the exhaust system upstream, or water condensing in the interior of the noise eliminator **10***d* attaches to the sound transmission hole **18**, it also naturally attaches to the projection **36** of the sound absorbing material **16***b*, 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 **16***b* by the capillary phenomenon. Consequently, the projection **36** of the sound absorbing material **16***b* does not continue to be all wet.

[0095] 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 **16***b* by the projection **36** of the sound absorbing material **16***b* 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

[0096] A noise eliminator **10***e* 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 **10***d* 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.

[0097] 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.

[0098] 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).

[0099] 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***f* 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**.

[0100] 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***f*, but also functions as a "rib" reinforcing the inner pipe **14***f*. When the inner pipe **14***f* is reinforced by the louver **38**, the stiffness of the inner pipe **14***f* can be improved. As a result, the thickness of the peripheral wall **13** of the inner pipe **14***f* can be set thinner.

[0101] In the noise eliminator **10***e* 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.

[0102] For example, as with a variation illustrated in FIG. **14**, it is also preferable to provide within the inner pipe **14***g* 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 side end **41** of the inner pipe **14***g*, 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 **14***g*. Then, the exhaust gas stream flowing into the upstream side end **41** of the inner pipe **14***g* 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.

[0103] 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 **14***g*, 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 **14***g* so that the exhaust gas stream avoids this "area **43** where the sound transmission hole **18** is formed".

[0104] 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**.

[0105] As described above, in the noise eliminator **10***e* of the present embodiment, the louver **38** protruding from the upstream side of the sound transmission hole **18** is arranged inside the inner pipe **14***g*, 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

[0106] A noise eliminator **10***f* 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 **10***f* 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.

[0107] 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 **14***h*. 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 **14***h* 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 **14***h* is a centrifugal force working toward the inner-pipe inner wall **15** around the axis center of the inner pipe **14***h*.

[0108] Accordingly, in the noise eliminator **10***f* 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.

[0109] Here, it is also preferable that the sound transmission hole **18***f* 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 **18***f*.

[0110] When the sound transmission hole **18***f* is configured in this manner, even if a water film forms in the sound transmission hole **18***f*, the water film is polarized and deformed in the longitudinal direction of the sound transmission hole **18***f* 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

[0111] A noise eliminator **10***g* 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 **10***g* 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 **14***i* is provided with a vortex generation member generating a vortex in the vicinity of the inner wall **15** of the inner pipe **14***i*. 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***g* of the present embodiment, because the inner pipe **14***i* 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 **14***i*. 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 **14***i* so that the axis center F of the inner pipe **14***i* penetrates through the member.

[0114] The exhaust gas stream flowing into the inner pipe **14***i* from the direction indicated by the arrow D is divided into two streams (an upper stream and a lower stream indicated by the arrows M**1** and M**2**, respectively, in FIG. **16**) by the Karman vortex generation member **46**. The two streams break away at a downstream end **46***e* 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***g* of the present embodiment, the Karman vortex generation member **48** 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 **14***j* can be separated away 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 **14***j*, 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.

(8) Eighth Embodiment

[0118] A noise eliminator **10***h* 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 **10** of the first embodiment in that stream guide means are provided for directing a portion of the exhaust gas flowing into the inner pipe out 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 **18***g* in the upstream side to the sound absorbing chamber **17**. More specifically, in the sound transmission hole **18***g* 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 **18***g* and **18***h*, and the exhaust gas flowing out from the sound transmission hole **18***g* in the upstream side to the sound absorbing chamber **17** flows back from the sound transmission hole **18***h* in the downstream side into the inner pipe **14**. In the sound transmission hole **18***h* 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 **10***h*, 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 **18***g* in the upstream side to the sound absorbing chamber **17** and flows back through the sound transmission hole **18***h* in the downstream side into the inner pipe **14**. Because the exhaust gas streams flows through both the upstream and downstream sound transmission holes **18***g* and **18***h*, formation of water films in the sound transmission holes **18***g* and **18***h* is suppressed, and any films that do form tend to be broken by the exhaust gas stream flowing through the sound transmission holes **18***g* and **18***h*. Accordingly, in the noise eliminator **10***h* 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***k* 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***k* is smaller than elsewhere, and disposed in the path of the inner pipe **14***k*. The sound transmission holes **18***g* and **18***h* 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***k* increase. On the other hand, downstream of the narrowed section **52** in the inner pipe **14***k*, 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***k*, 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***k* 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 **18***h* into the downstream side relative to the narrowed section **52** in the inner pipe **14***k*.

[0123] In this way, in the noise eliminator **10***h* of the present embodiment, because the narrowed section **52** is arranged in the inner pipe **14***k*, exhaust gas streams flowing from inside the inner pipe **14***k* through the sound transmission hole **18***g* in the upstream side into the sound absorbing chamber **17**, and flowing from the sound absorbing chamber **17** through the sound transmission hole **18***h* in the downstream side into the inner pipe **14***k*, are produced. Accordingly, water films rarely form in the upstream and downstream sound transmission holes **18***g* and **18***h*, and any films that do form are easily broken by the exhaust gas stream flowing through the sound transmission holes **18***g* and **18***h*.

[0124] In the noise eliminator **10***h* of the present embodiment, the formation of the narrowed section **52** in the inner pipe **14***k* allows a portion of the exhaust gas to flow out through the upstream sound transmission hole **18***g* into the sound absorbing chamber **17**, but the stream guide means are not limited to this configuration.

[0125] 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 **18***g*. The duct **54** may be, as illustrated in FIG. **21**, arranged in the inner wall **15** of the inner pipe **141** 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 **141** toward the axis center F of the inner pipe **141**, and have an opening facing the upstream side.

[0126] Of the exhaust gas streams flowing from a direction indicated by the arrow D into the inner pipe **141**, 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 the sound absorbing chamber **17**. 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 **18***h* in the downstream side into the inner pipe **141**.

[0127] 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***i*. As a result, formation of a water film in the sound transmission hole can be further suppressed.

(9) Ninth Embodiment

[0128] A noise eliminator **10***i* 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 **10***i* 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.

[0129] 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***i* 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.

[0130] 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.

[0131] 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 **82***a*; and the other end thereof is connected to a gas inlet **58** arranged in the outer shell **12***c*. 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**.

[0132] 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 **82***a*, 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 **82***a* is discharged as oxidizing gas from the fuel cell body **82***a*, and subjected to flow rate adjustment by an adjustment valve **82***b*, and flows, as indicated by the arrow D, into the inner pipe **14** of the noise eliminator **10***i*.

[0133] 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**.

[0134] 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

18 into the inner pipe **14** can be formed. Accordingly, formation of a water film in the sound transmission hole can be further suppressed.

[0135] 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 **18** can be broken up by this pressure wave.

[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 **82**b is opened or closed instantaneously. Such instantaneous opening and closing of the adjustment valve **82**b 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

[0138] A noise eliminator **10**j 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**j 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**i 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 **14**m 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**i, 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**i and the inner-pipe axis center F. That is, the sound transmission hole **18**i is exposed to the rapidly flowing exhaust gas stream.

[0140] In this manner, in the noise eliminator **10**i of the present embodiment, even when a water film forms in the sound transmission hole **18**i, because the sound transmission hole **18**i 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

[0141] A noise eliminator **10**k 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 **10**k 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.

[0142] The inner case **66** is as illustrated in FIG. **27**, a hard case of a substantially rectangular shape having a plurality of through holes **18**j 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**j is formed in the upstream wall surface **68**a and the downstream wall surface **68**b facing the wall surface **68**a; gas can flow therethrough from the upstream side wall surface **68**a to the downstream side wall surface **68**b. 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**.

[0143] The inner case **66** described above is, as illustrated in FIG. **26**, received and held in the inner side of the outer shell **12**d. A stream path **70** is formed in the inner side of the outer shell **12**d, 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 **68**a and the downstream side wall surface **68**b) of the inner case **66** having the sound transmission hole **18**j is disposed over the entire cross section of the stream path **70** inside the outer shell **12**d.

[0144] When the noise eliminator **10**k is configured in this manner, all the exhaust gas flowing through the outer shell **12**d flows, as indicated by the arrow W, through the through hole **18**j of the inner-case wall surface **68** and the sound absorbing chamber **17** residing therein. Accordingly, in the noise eliminator **10**k of the present embodiment, formation of a water film in the through hole **18**j can be suppressed.

[0145] It is preferable that the configuration of the inner case **66** and outer shell **12**d is set so that the area of the wall surface **68** having the through hole **18**j of the inner case **66** is maximized. When the area of the wall surface **68** having the through hole **18**j of the inner case **66** is maximized and the number of the through holes **18**j is set accordingly, the pressure loss caused by exhaust gas flowing through the inner case **66** can be reduced.

(12) Twelfth Embodiment

[0146] A noise eliminator **10**m 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 **10**m 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 **10***m* 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 **18***k* 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 **18***k* 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 **18***k* 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 **18***k* formed in the plate-shaped member **72**. In this way, the turbulent flow is rectified each time it passes through the through holes **18***k* 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 **10***m* of the present embodiment, the flowing—in exhaust gas is reliably directed through the through hole **18***k* of the plate-shaped member **72**, and formation of water films in the through hole **18***k* 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 repellant 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 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 louver in the inner-pipe 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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