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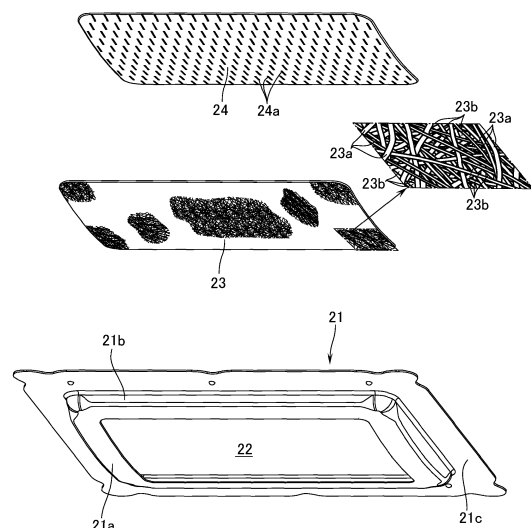
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(54) **HYDROGEN COMBUSTION BURNER**

(57) A hydrogen combustion burner utilizing hydrogen gas as a fuel gas includes a burner body 1 with an air-fuel mixture chamber 11 into which an air-fuel mixture of hydrogen gas and primary air is supplied and a combustion plate portion 2 covering an opening surface 12, which faces the air-fuel mixture chamber, of the burner body. In the hydrogen combustion burner, the air-fuel mixture ejects from the combustion plate portion and undergoes combustion. The hydrogen combustion burner is configured to effectively suppress backfire. The combustion plate portion includes a sintered sheet by sintering an aggregate of metallic fibers, and the aggregate is not formed by weaving or knitting the metallic fibers.

FIG.3



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Description

Technical Field

[0001] The invention relates to a hydrogen combustion burner utilizing an air-fuel mixture of hydrogen gas and air as a fuel gas.

Background Art

[0002] The hydrogen combustion burner, specifically, a surface combustion burner, as mentioned above has been known in Patent Document No. 1, for example. The burner includes a burner body with an air-fuel mixture chamber into which an air-fuel mixture of hydrogen and primary air is supplied, and a combustion plate portion covering an opening surface, which faces the air-fuel mixture chamber, of the burner body. The air-fuel mixture ejects from the combustion plate portion and undergoes combustion. In the combustion plate portion, a cloth-like sheet material formed by weaving or knitting metallic fibers of high-temperature-resistant material is utilized.

[0003] However, in the conventional sheet material, there are many contact portions of the fibers with one another, and areas of the contact portions are large. Therefore, when a surface side of the combustion plate portion reaches high temperatures due to combustion of the air-fuel mixture of hydrogen and primary air, of which a combustion speed is extremely fast, near the surface of the combustion plate portion, heat from the surface side of the combustion plate portion easily transmits to a rear side of the sheet material facing the air-fuel mixture chamber. When the rear side of the sheet material also reaches high temperatures, there is a problem that backfire, specifically, propagation of flames into the air-fuel mixture chamber, occurs easily.

Reference

[0004] Patent Document No. 1: JP2000-18525 A

Summary of Invention

Technical Problem

[0005] In the light of the aforementioned problem, the invention provides a hydrogen combustion burner which can effectively suppress the backfire.

Solution to Problem

[0006] In order to solve the aforementioned problem, the invention presupposes a hydrogen combustion burner utilizing hydrogen gas as a fuel gas, which includes a burner body with an air-fuel mixture chamber into which an air-fuel mixture of the hydrogen gas and primary air is supplied; and a combustion plate portion covering an opening surface, which faces the air-fuel mixture cham-

ber, of the burner body, wherein the air-fuel mixture ejects from the combustion plate portion and undergoes combustion. In the hydrogen combustion burner, the combustion plate portion includes a sintered sheet by sintering an aggregate of metallic fibers and the aggregate is not made by weaving or knitting the metallic fibers.

[0007] According to the invention, in the sintered sheet, numerous micro-porosities which are complex and smaller than a hole diameter of so-called a backfire limit are formed due to random intertwining and combination (welding) of the metallic fibers during sintering. In addition, contact portions of the metallic fibers with one another are less as compared with the aforementioned conventional sheet material and areas of the contact portions are also reduced. Therefore, even if a surface (combustion surface) side of the combustion plate portion reaches high temperatures due to combustion of the air-fuel mixture near the surface of the combustion plate portion, heat from the surface side cannot easily transmit to a rear side of the sintered sheet facing the air-fuel mixture chamber. Furthermore, when the air-fuel mixture at normal temperature passes through the numerous micro-porosities and is ejected, temperature rise of the sintered sheet itself can be suppressed by larger contact areas with the air-fuel mixture. Thus, in the invention, presence of only the micro-porosities in the first sintered sheet, combined with difficulty in achieving high temperatures on the rear surface side of the first sintered sheet, helps effectively suppress backfire. Incidentally, the metallic fibers in the invention contain a semimetal as a constituent element.

[0008] In the invention, it is preferable that the metallic fibers are composed of Fe (iron) and at least one element selected from the group consisting of Al (aluminum), Cr (chromium), Mn (manganese), and Si (silicon), or a carbide(s) thereof and that weight per unit area during sintering the sintered sheet is set within a range of 1,200g/m² to 1,800g/m². If the weight per unit area is less than 1,200g/m², each of the micro-porosities may become excessively large, resulting in a risk that the backfire cannot be effectively suppressed. On the other hand, if the weight per unit area is more than 1,800g/m², passing resistance of the air-fuel mixture will increase.

[0009] In addition, in the invention, it is preferable that a diameter of each metallic fiber ranges from 50μm to 100μm. If the diameter is less than 50μm, areas where the metallic fibers intertwine during sintering increase, leading to easier transmission of the aforementioned heat to the rear side of the sintered sheet. On the other hand, if the diameter is larger than 100μm, each micro-porosity may become excessively large, resulting in a risk that the backfire cannot be suppressed.

[0010] Moreover, in the invention, it is preferable that porosity of the sintered sheet ranges from 60% to 80%. This helps suppress pressure loss when the air-fuel mixture passes through the sintered sheet.

[0011] In addition, in the invention, it is preferable that the sintered sheet is formed into a convex bending shape

towards a downstream side in a flow direction of the air-fuel mixture. This helps prevent the sintered sheet itself from bending easily and can suppress the backfire due to local high temperatures of the sintered sheet.

Brief Description of the Drawings

[0012]

FIG. 1 is a cross-section of an embodiment of a hydrogen combustion burner according to the invention in an installed state of the hydrogen combustion burner on a combustion box.

FIG. 2 is a perspective view of the hydrogen combustion burner shown in FIG. 1.

FIG. 3 is a perspective view showing a combustion plate portion in a disassembled state.

FIG. 4 is a cross-section along a IV-IV line shown in FIG. 1

Description of Embodiments

[0013] Now, referring to figures, an embodiment of a hydrogen combustion burner CB utilizing hydrogen gas as a fuel gas will be described. Incidentally, the term 'hydrogen' as defined by the invention is not limited to pure hydrogen, but encompasses hydrogen mixtures with small amounts of a foul-smelling agent added for flavoring purposes, for example.

[0014] As shown in FIGS. 1-2, the hydrogen combustion burner CB is a total primary combustion burner and includes a burner body 1 with an air-fuel mixture chamber 11 into which an air-fuel mixture of a fuel gas and primary air is supplied, and a combustion plate portion 2 covering an opening surface 12, which faces the air-fuel mixture chamber 11, of the burner body 1. The hydrogen combustion burner CB is fastened to a peripheral edge portion of the opening surface 12 of the burner body 1, specifically to a flange portion Fb1 of a combustion box Fb, within which a heat exchanger for supplying hot water is housed, not shown, at a lower surface peripheral portion 13 by screws (not shown), and is used to heat the heat exchanger. In the burner body 1, an inlet port 14 is provided, into which the air-fuel mixture is supplied by a fan, not shown.

[0015] Referring also to FIG. 3, the combustion plate portion 2 is configured by a burner frame 21 which has a longitudinal picture frame shape in one direction and is made of sheet metal, a first sintered sheet 23 which is provided to cover a first opening 22 surrounded by the burner frame 21 from a side of the burner body 1 (from above), and a distribution plate 24 in which numerous distribution holes 24a are formed and which is disposed to be overlapped on a rear surface (upper surface) that is a surface positioned at an upstream side in a flow direction of the air-fuel mixture within the first sintered sheet 23. The burner frame 21 has an opening peripheral edge portion 21a located on the same plane as the first opening

22, a side plate portion 21b which bends from an upper end of the opening peripheral edge portion 21a towards the side of the burner body 1 (upward), and a frame flange portion 21c which extends outwards from an upper end of the side plate portion 21b. At a state where the distribution plate 24 is overlapped on the rear surface of the first sintered sheet 23, the peripheral edge portions of both the distribution plate 24 and the first sintered sheet 23 are spot-welded to the opening peripheral edge portion 21a of the burner frame 21 at a constant distance. The combustion plate portion 2 is assembled in this manner and is attached to the lower surface peripheral portion 13 of the burner body 1 through the frame flange portion 21c. Incidentally, a sectional shape of the first opening 22 along a front-rear direction bends arcuately. Similarly, sectional shapes of both the first sintered sheet 23 and the distribution plate 24 along the front-rear direction also bend arcuately. In other words, the sectional shapes of both the first sintered sheet 23 and the distribution plate 24 are formed into a convex bending shape towards a downstream side in the flow direction of the air-fuel mixture.

[0016] The first sintered sheet 23 is formed by sintering an aggregate of metallic fibers 23a and the aggregate is not made by weaving or knitting the metallic fibers 23a. The aggregate could be a laminate, for example. A material composed of Fe (iron) and at least one element selected from the group consisting of Al (aluminum), Cr (chromium), Mn (manganese), and Si (silicon), or a carbide(s) thereof, e.g. stainless steel of which main component is Fe, is utilized for the metallic fibers 23a. In addition, the metallic fibers with diameters ranging from 50 μ m to 100 μ m are used for the metallic fibers 23a. Well-known methods such as hot pressing (hot press working) in which pressure molding and sintering are simultaneously performed, and HIP (Hot Isostatic Pressing), can be utilized for making the first sintered sheet 23. For example, when the first sintered sheet 23 is made by the hot pressing, without referring to any of the figures, the aggregate is formed by stacking or laminating the metallic fibers 23a in a cavity of a metallic mold without weaving or knitting. At this time of the formation of the aggregate through stacking or lamination, weight per unit area is set within a range of 1,200g/m² to 1,800g/m². Subsequently, the aggregate is pressurized by a punch from one axial direction, and then the aggregate is heated and held at a prescribed temperature through the metallic mold. Thus, the first sintered sheet 23 is formed into the convex bending shape towards the downstream side in the flow direction of the air-fuel mixture.

[0017] In the first sintered sheet 23 made by the aforementioned manner, as shown in FIG. 3 with partial enlargement, numerous micro-porosities 23b which are complex and smaller than a hole diameter of so-called a backfire limit are formed due to random intertwining and combination (welding) of the metallic fibers 23a during sintering. In the first sintered sheet 23, contact portions of metallic fibers 23a with one another are fewer, and areas

of the contact portions are small compared with the conventional sheet material mentioned above. In this case, porosity of the first sintered sheet 23 ranges from 60% to 80%, and thickness of the first sintered sheet 23 ranges from 0.5 mm to 3.0 mm. Incidentally, if the diameter of each metallic fiber 23a is less than 50 μm , areas where the metallic fibers intertwine (come into contact) during sintering increase, leading to easier transmission of heat to the rear side of the first sintered sheet 23. On the other hand, if the diameter is larger than 100 μm , each micro-porosity 23b may become excessively large, resulting in a risk that backfire cannot be suppressed. If the weight per unit area is less than 1,200g/m², each micro-porosity 23b may become excessively large, resulting in a risk that the backfire cannot be effectively suppressed. On the other hand, if the weight per unit area is more than 1,800g/m², the porosity within the aforementioned range cannot be achieved, and passing resistance of the air-fuel mixture will increase. In addition, if the porosity is out of the aforementioned range, pressure loss when the air-fuel mixture passes through the first sintered sheet 23 will become large.

[0018] Referring also to FIG. 4, a backfire suppressing plate portion 3 is disposed inside the air-fuel mixture chamber 11. The backfire suppressing plate portion 3 includes a supporting frame 31 which is shaped like a longitudinal picture frame in one direction and is made of a metal sheet, and a second sintered sheet 33 which is provided to cover a second opening 32 similar in shape to the first opening 22 from an opposite side (from above). A product similar to the first sintered sheet 23 can be utilized as the second sintered sheet 33. A symbol 33a represents a metallic fiber similar to each of the metallic fibers 23a in the first sintered sheet 23. The supporting frame 31 is interfered, and the backfire suppressing plate portion 3 is fastened on a seat surface 15, which is shaped like a picture frame and formed inside the air-fuel mixture chamber 11, by screws (not-shown). In a fastened state of the backfire suppressing plate portion 3, the second sintered sheet 33 is positioned opposite the first sintered sheet 23 with a gap Gp. The gap Gp between the first sintered sheet 23 and the second sintered sheet 33 is set within a range of 5 mm to 30 mm. If the gap Gp is shorter than 5 mm, there may be a risk of overheating the backfire suppressing plate portion 2 due to excessive radiant heat from the combustion plate portion 2 when the combustion plate portion 2 is heated by the flames. On the other hand, if the gap Gp is longer than 30 mm, a larger amount of the air-fuel mixture may accumulate within the gap Gp between the combustion plate portion 2 and the backfire suppressing plate portion 3. This accumulation results in the occurrence of loud noises when flames propagate within the gap Gp.

[0019] In the aforementioned hydrogen combustion burner CB, the air-fuel mixture supplied from the inlet port 14 of the burner body 1 into the air-fuel mixture chamber 11 is supplied to the combustion plate portion 2 after passing through numerous micro-porosities 33b in

the second sintered sheet 33. Subsequently, the air-fuel mixture, passing through the second sintered sheet 33 of the backfire suppressing plate portion 3, flows through the gap Gp between the combustion plate portion 2 and the backfire suppressing plate portion 3, ejects from each of the numerous micro-porosities 23b in the first sintered sheet 23 of the combustion plate portion 2, and undergoes combustion (combustion without secondary air). Therefore, if a temperature of the surface side of the first sintered sheet 23 rises due to combustion of the air-fuel mixture near the surface of the combustion plate portion 2, heat accompanying the combustion cannot easily propagate to the rear side of the first sintered sheet 23 facing the air-fuel mixture chamber 11. Furthermore, when the air-fuel mixture at normal temperature passes through and ejects from each of the numerous micro-porosities 23b, temperature rise of the first sintered sheet 23 itself can be suppressed due to large contact areas with the air-fuel mixture. As a result, presence of only the micro-porosities 23b in the first sintered sheet 23, combined with difficulty in achieving high temperatures on the rear surface side of the first sintered sheet 23, effectively helps suppress backfire. In addition, shaping the first sintered sheet 23 into a convex bending shape towards the downstream side in the flow direction of the air-fuel mixture makes it difficult for the first sintered sheet 23 itself to distort when the combustion surface side of the first sintered sheet 23 is heated. This helps suppress backfire caused by localized high temperatures on the first sintered sheet 23.

[0020] In addition, when the air-fuel mixture at normal temperature passes through the second sintered sheet 33, similarly, large contact areas with the air-fuel mixture help suppress temperature rise of the second sintered sheet 33, i.e., the backfire suppressing plate portion 3 itself. Furthermore, the numerous micro-porosities 33b formed in the second sintered sheet 33 help suppress pressure loss. Therefore, if flames propagate to the gap Gp between the combustion plate portion 2 and the backfire suppressing plate portion 3, the temperature rise of the backfire suppressing plate portion 3 is so suppressed that the flames can be extinguished. Moreover, in a case where the flames having propagated to the gap Gp are not extinguished and persist, presence of only the micro-porosities 33b in the backfire suppressing plate portion 3 helps suppress propagation of the flames towards the upstream side of the backfire suppressing plate portion 3. As a result, when the backfire suppressing plate portion 3 is in place, the backfire can be certainly suppressed.

[0021] Furthermore, in the hydrogen combustion burner CB, a temperature sensor 4 is disposed at a portion of the air-fuel mixture chamber 11, which is positioned between the combustion plate portion 2 and the backfire suppressing plate portion 3. Well-known detecting devices, such as a thermocouple or a bimetal switch, are utilized as the temperature sensor 4. Thus, in the case where the flames having propagated within the gap Gp

are not extinguished and combustion occurs on the surface (lower surface) of the second sintered sheet 33 facing the gap Gp, temperature rise accompanying the combustion can be detected by the temperature sensor 4. This enables swift action, such as halting the air-fuel mixture supply, for example, thereby rapidly stopping combustion that could cause damage to the hydrogen combustion burner CB.

[0022] Although the embodiment of the invention is described above, various modifications are possible as long as the modifications adhere to the technical concept of the invention. The aforementioned embodiment includes the backfire suppressing plate portion 3 and the sensor 4. However, in a case where flame temperature is reduced by adding a small amount of a reducing agent to the air-fuel mixture, for example, components such as the backfire suppressing plate portion 3 and the sensor 4 may be omitted.

Explanation of symbols

[0023]

CB	Hydrogen combustion burner	
1	Burner body	25
11	Air-fuel mixture chamber	
12	Opening surface	
2	Combustion plate portion	
23	Sintered sheet	
23a	Metallic fibers	30

Claims

1. A hydrogen combustion burner utilizing hydrogen gas as a fuel gas, comprising, 35
 - a burner body with an air-fuel mixture chamber into which an air-fuel mixture of the hydrogen gas and primary air is supplied; and
 - a combustion plate portion covering an opening surface, which faces the air-fuel mixture chamber, of the burner body, 40
 - wherein the air-fuel mixture ejects from the combustion plate portion and undergoes combustion, 45
 - wherein:
 - the combustion plate portion comprises a sintered sheet by sintering an aggregate of metallic fibers and the aggregate is not made by weaving or knitting the metallic fibers. 50
2. The hydrogen combustion burner as claimed in claim 1, wherein the metallic fibers are composed of Fe (iron) and at least one element selected from the group consisting of Al (aluminum), Cr (chromium), Mn (manganese), and Si (silicon), or a carbide(s) thereof, and weight per unit area during sintering the sintered sheet is set within a range of 1,200g/m² to

1,800g/m².

3. The hydrogen combustion burner as claimed in claim 2, wherein a diameter of each metallic fiber ranges from 50μm to 100μm.
4. The hydrogen combustion burner as claimed in claim 1, wherein porosity of the sintered sheet ranges from 60% to 80%.
5. The hydrogen combustion burner as claimed in claim 1, wherein the sintered sheet is formed into a convex bending shape towards a downstream side in a flow direction of the air-fuel mixture.

FIG. 1

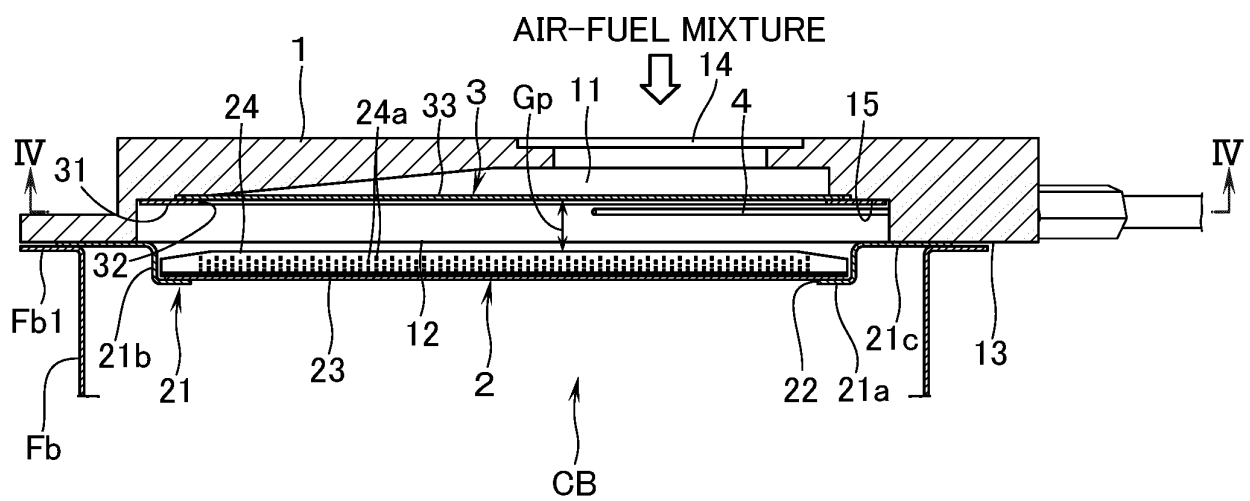


FIG.2

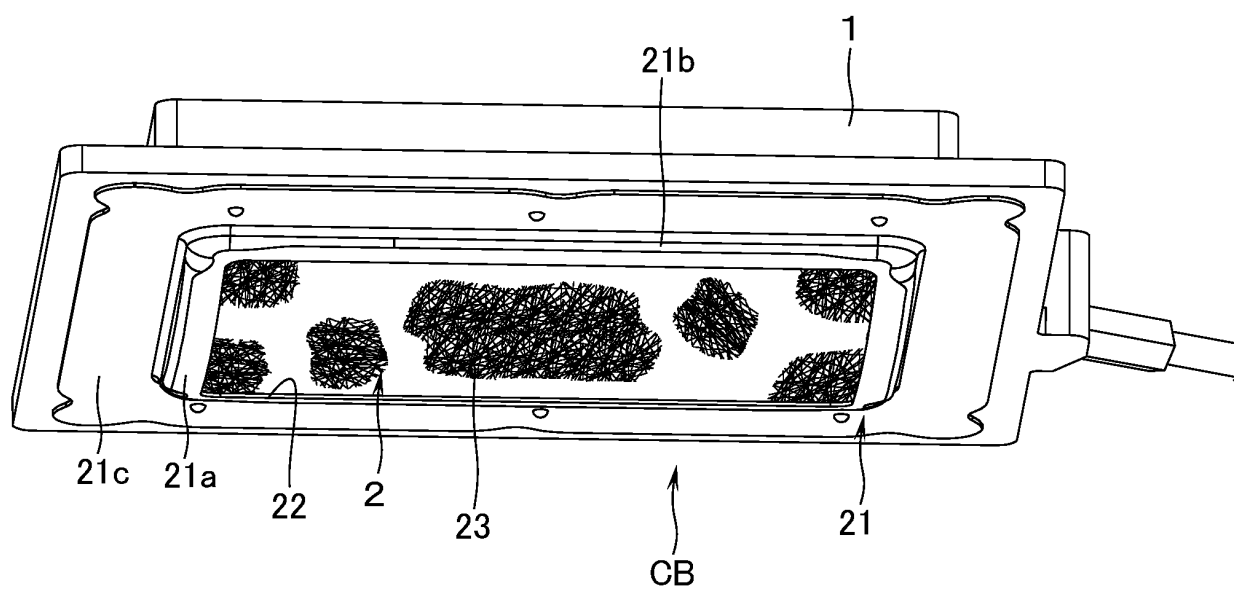


FIG.3

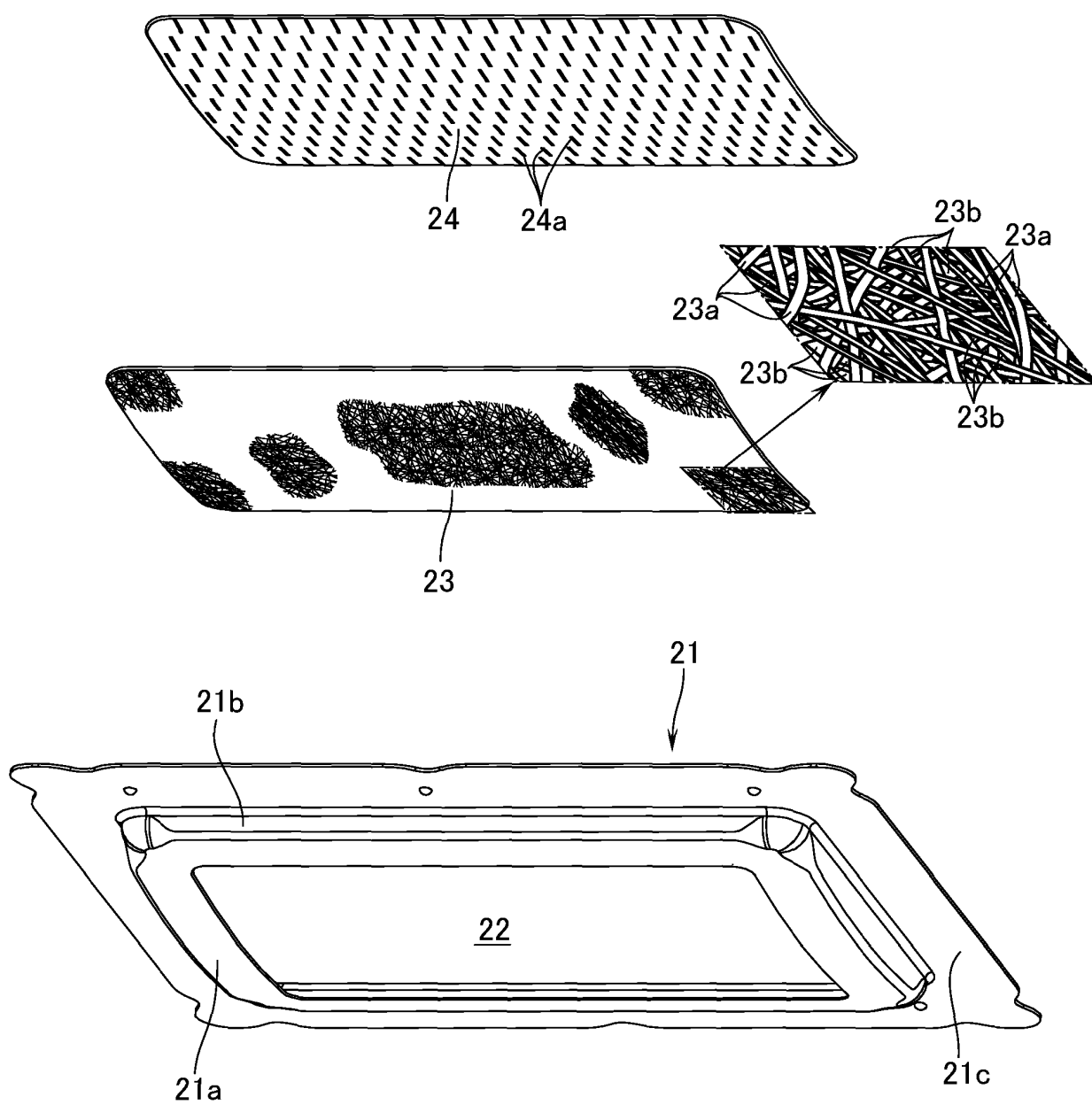
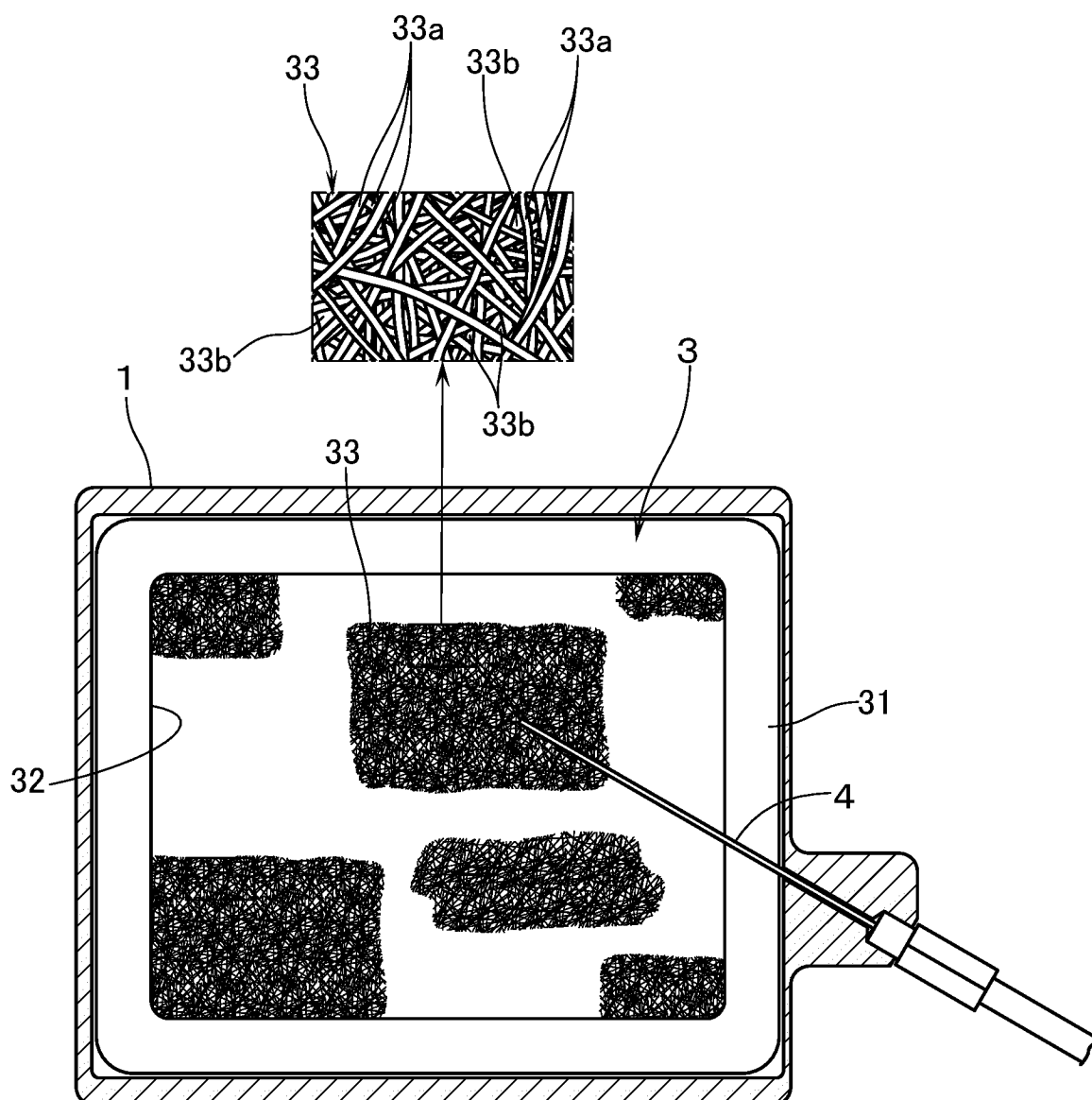


FIG.4



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/042076

A. CLASSIFICATION OF SUBJECT MATTER**F23D 14/16**(2006.01)i; **F23D 14/82**(2006.01)i

FI: F23D14/16 A; F23D14/82 B

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F23D14/16; F23D14/82

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan 1922-1996
 Published unexamined utility model applications of Japan 1971-2022
 Registered utility model specifications of Japan 1996-2022
 Published registered utility model applications of Japan 1994-2022

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2000-18525 A (IWATANI INTERNATL CORP) 18 January 2000 (2000-01-18) paragraphs [0001]-[0015], fig. 1	1-5
Y	JP 2000-283409 A (NIPPON MITSUBISHI OIL CORP) 13 October 2000 (2000-10-13) paragraphs [0015]-[0054], fig. 1	1-5
Y	JP 2003-73711 A (NHK SPRING CO LTD) 12 March 2003 (2003-03-12) paragraphs [0001], [0006], [0012]	2-3
Y	JP 2020-134086 A (RINNAI CORPORATION) 31 August 2020 (2020-08-31) paragraphs [0001]-[0021], fig. 3-6	5

☐ Further documents are listed in the continuation of Box C.
 ☒ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2022/042076

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 2000-18525 A	18 January 2000	(Family: none)	
JP 2000-283409 A	13 October 2000	(Family: none)	
JP 2003-73711 A	12 March 2003	(Family: none)	
JP 2020-134086 A	31 August 2020	US 2020/0271353 A1 paragraphs [0001]-[0026], fig. 3-6	
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Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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