



(11)

EP 4 534 904 A1

(12)

EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
09.04.2025 Bulletin 2025/15

(51) International Patent Classification (IPC):
F23D 14/82 ^(2006.01) **F23D 14/02** ^(2006.01)

(21) Application number: **22943839.5**

(52) Cooperative Patent Classification (CPC):
F23D 14/02; F23D 14/82

(22) Date of filing: **11.11.2022**

(86) International application number:
PCT/JP2022/042075

(87) International publication number:
WO 2023/228440 (30.11.2023 Gazette 2023/48)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

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(30) Priority: **26.05.2022 JP 2022086442**

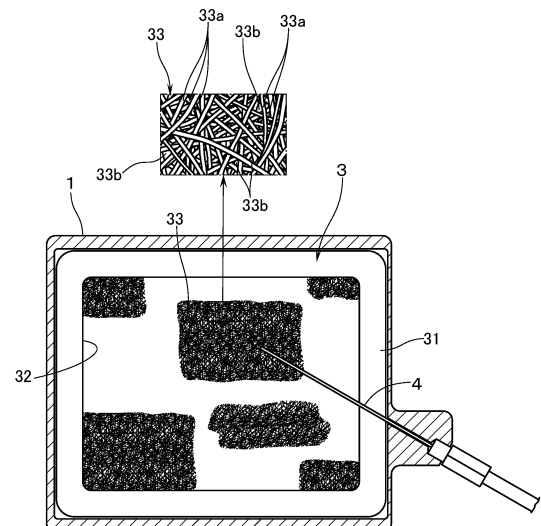
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(54) **TOTALLY AERATED COMBUSTION BURNER**

(57) A total primary combustion burner which 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, a combustion plate portion 2 covering an opening surface 12, which faces the air-fuel mixture chamber, of the burner body, and a backfire suppressing plate portion 3 disposed opposite the combustion plate portion with a gap inside the air-fuel mixture chamber. The air-fuel mixture passing through the backfire suppressing plate portion ejects from the combustion plate portion and undergoes combustion. The total primary combustion burner is configured so that backfire can be suppressed as much as possible while suppressing pressure loss, even when using hydrogen as the fuel gas. The backfire suppressing plate portion has a sintered sheet 33, 5 made by sintering an aggregate of metallic fibers or beads.

FIG.4



Description

Technical Field

[0001] The invention relates to a total primary combustion burner. More specifically, the invention relates to the total primary combustion burner which utilizes hydrogen gas as a fuel gas.

Background Art

[0002] As a total primary combustion burner of the above species, the one utilizing hydrocarbon gas as the fuel gas has been known in Patent Document No. 1, for example. This burner includes a burner body with an air-fuel mixture chamber, into which a mixture of the fuel 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 and in which a plurality of aligned flame holes is provided. Inside the air-fuel mixture chamber, a backfire suppressing plate portion is disposed opposite the combustion plate portion with a gap. In the backfire suppressing portion, a plurality of aligned through-holes, passing through in a direction of plate thickness thereof, is provided. The air-fuel mixture supplied into the air-fuel mixture chamber passes from each of the through-holes and between the backfire suppressing plate portion and the combustion plate portion, and is then supplied into each of the flame holes. Subsequently, the air-fuel mixture ejects from each flame hole and undergoes combustion. In this case, a height of the gap is set within a range between 1 mm or more and 4 mm or less, a diameter of each through-hole ranges from 1 mm to 5 mm, and a diameter of each flame hole ranges from 0.5 mm to 3 mm. Thereby, pressure loss is suppressed as the air-fuel mixture passes through both the combustion plate portion and the backfire suppressing plate portion, suppressing backfire that flames propagate within the air-fuel mixture chamber while forming an approximately equal distributed flames across the surface of the combustion plate chamber portion.

[0003] Incidentally, hydrogen, which does not emit carbon dioxide, has recently garnered attention as an alternative to hydrocarbon gas for mitigating global warming. However, a combustion speed of an air-fuel mixture of hydrogen and primary air is extremely rapid. When the air-fuel mixture of hydrogen and primary air is combusted in the conventional total primary combustion burner mentioned above, the combustion occurs near the surface of the combustion plate portion, making the combustion plate portion to easily reach high temperatures. Furthermore, because the aforementioned gap is relatively narrow, the backfire suppressing plate portion is excessively heated by radiant heat from the combustion plate portion. Therefore, when the flames propagate within the gap in the air-fuel mixture chamber, there are instances where the flames cannot be extinguished. In addition, due to the relatively long diameter of each

through-hole, the flames propagating within the gap become liable to easily extend an upstream side of the air-fuel mixture chamber through the through-hole. As a result, the backfire cannot be effectively suppressed and this may lead to burner breakage. In such a case, it may be considered that the diameter of each through-hole is set to the diameter that is so-called a backfire limit (for example, 0.6 mm). However, this would increase the pressure loss.

Reference

[0004] Patent Document No.1: JP2001-263614 A

Summary of Invention

Technical Problem

[0005] In the light of the aforementioned problem, the invention provides a total primary combustion burner which can suppress the backfire as much as possible while suppressing the pressure loss even when hydrogen gas is utilized as the fuel gas.

Solution to Problem

[0006] In order to solve the aforementioned problem, the invention presupposes a total primary combustion burner which includes a burner body with an air-fuel mixture chamber into which an air-fuel mixture of a fuel 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, wherein a backfire suppressing plate portion is disposed opposite the combustion plate portion with a gap inside the air-fuel mixture chamber, and wherein the air-fuel mixture passing through the backfire suppressing plate portion is configured to eject from the combustion plate portion and undergoes combustion, and wherein hydrogen gas is utilized as the fuel gas. In the total primary combustion burner, the backfire suppressing plate portion has a sintered sheet formed by sintering an aggregate of metallic fibers or beads.

[0007] According to the invention, the air-fuel mixture supplied into the air-fuel mixture chamber passes through numerous micro-porosities of the sintered sheet. These micro-porosities, formed by random intertwining and combination (welding) of the metallic fibers or beads during sintering, are intricate and smaller than a hole diameter of the so-called backfire limit. Subsequently, the air-fuel mixture is supplied to the combustion plate portion. At this time, temperature rise of the sintered sheet, i.e., the backfire suppressing plate portion itself, can be suppressed by large contact areas with the air-fuel mixture at normal temperature. In addition, pressure loss can also be suppressed by the numerous micro-porosities. Furthermore, the air-fuel mixture passing through the sintered sheet of the backfire suppressing plate portion

passes through the gap between the backfire suppressing plate portion and the combustion plate portion, ejects from the combustion plate portion and undergoes combustion. At this time, even if flames propagate within the gap between the combustion plate portion and the backfire suppressing plate portion, the temperature rise of the backfire suppressing plate portion is suppressed, allowing the flames to be extinguished by the backfire suppressing plate portion. Also, if the flames propagating within the gap are not extinguished and persist on a surface of the backfire suppressing plate portion facing the gap, presence of only the micro-porosities helps suppress propagation of the flames to an upstream side of the backfire suppressing plate portion. Thus, in the invention, since the backfire suppressing plate portion has the sintered sheet, even when utilizing hydrogen gas as the fuel gas, the backfire can be suppressed as much as possible while suppressing the pressure loss. Meanwhile, the metallic fibers or beads in the invention contain a semimetal as a constituent element.

[0008] In the invention, it is preferable that the metallic fibers or beads 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. In this case, it is preferable 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 temperature sensor is disposed at a portion of the air-fuel mixture chamber, which is positioned between the combustion plate portion and the backfire suppressing plate portion. Thereby, in the case where the flames propagating within the gap are not extinguished and combustion occurs on the surface of the backfire suppressing portion facing the gap, any temperature rise can be detected by the temperature sensor. This enables swift action such as halting the air-fuel mixture supply, suppressing combustion that could bring about burner damage.

[0010] Furthermore, in the invention, it is preferable that the gap between the combustion plate portion and the backfire suppressing plate portion is set within a range of 5 mm to 30 mm. If the gap is shorter than 5 mm, there may be a risk of overheating the backfire suppressing plate portion due to excessive radiant heat from the combustion plate portion. On the other hand, if the gap is longer than 30 mm, a larger amount of air-fuel mixture may accumulate within the gap between the combustion plate portion and the backfire suppressing portion. This leads to the occurrence of loud noises when flames propagate within the gap.

[0011] In addition, in the invention, it is preferable that the combustion plate portion is configured by a sintered

sheet formed by sintering an aggregate of metallic fibers or beads. This allows for large contact areas with the air-fuel mixture, resulting in suppressed temperature rise of the combustion plate portion itself, which is advantageous.

Brief Description of the Drawings

[0012]

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

FIG. 2 is a perspective view of the total primary 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.

FIG. 5 is a plan view showing a part of a sintered sheet of one of the variations.

Description of Embodiments

[0013] Now, referring to figures, an embodiment of a total primary combustion burner CB utilizing hydrogen gas as a fuel gas will be described. This embodiment includes a backfire suppressing plate portion includes a sintered sheet made by sintering an aggregate of metallic fibers. Meanwhile, 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 total primary combustion burner CB includes a burner body 1 having 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 flange portion Fb1 of a combustion box Fb, within which a heat exchanger, not shown, for supplying hot water is housed, at a peripheral portion of the opening surface 12 of the burner body 1, specifically 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 rectangular main body portion 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 dis-

posed to be overlapped on a rear surface (an upper surface) that is a surface positioned at an upstream side in a flow direction of the air-fuel mixture within the main body 3. 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 the opening peripheral edge portion 21a towards the side of the burner body 1 (upward), and a frame flange portion 21c which extends outward from an upper end of the side plate portion 21b. The main body portion 23, for example, can be configured by a knitted material made of metallic fibers such as heat-resistant steel. The metallic fibers may have a thickness ranging from 35 μm to 100 μm , for example. The distribution plate 24 is overlapped on a rear surface of the knitted material made of the metallic fibers. In this overlapped state, the combustion plate portion 2 is assembled by spot-welding peripheral edge portions of the knitted material and the distribution plate 24 to the opening peripheral edge portion 21a at a constant distance. Hence, the combustion plate portion 2 is attached to the lower surface peripheral portion 13 through the frame flange portion 21c. In addition, a backfire suppressing plate portion 3 is disposed inside the air-fuel mixture chamber 11.

[0016] Referring also to FIG. 4, the backfire suppressing portion 3 includes a supporting frame 31 with a longitudinal picture frame shape in the one direction, and a sintered sheet 33 provided to cover a second opening 32, which is surrounded by the supporting frame 31 and has the same contour as the first opening 22, from an opposite side (from above) to the combustion plate portion 2. The backfire suppressing plate portion 3 is fastened to a picture frame-like seat surface 15 formed in the air-fuel mixture chamber 11 by screws (not shown) through the supporting frame 31. In this fastened state of the backfire suppressing portion 3, the sintered sheet 33 opposes to the knitted material made of metallic fibers of the combustion plate portion 2 with a gap Gp. The gap Gp between the sintered sheet 33 and the knitted material made of metallic fibers 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 3 due to excessive radiant heat from the combustion plate portion 2. On the other hand, if the gap Gp is longer than 30 mm, a larger amount of air-fuel mixture may accumulate within the gap Gp between the combustion plate portion 2 and the backfire suppressing portion 3. This accumulation leads to the occurrence of loud noises when flames propagate within the gap Gp.

[0017] The sintered sheet 33 is made by sintering an aggregate in which metallic fibers 33a are stacked. The aggregate could be a laminate, for example. 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 carbide(s) thereof. For example, stainless steel, which primarily contains Fe as a main component element, may be utilized for the metallic fibers. A diameter of each metallic

fiber falls in a range from 50 μm to 100 μm . 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 sintered sheet 33. For example, in the case of the hot pressing, although there is no specific explanation with any figure, the metallic fibers 33a are stacked or laminated and formed into an aggregate within a cavity in a die, without weaving or knitting. At this time, weight per unit area is set within a range from 1,200g/m² to 1,800g/m². Subsequently, the aggregate is pressurized from one axis direction by a punch, and then the aggregate is heated and held at a predetermined temperature through the die.

[0018] The metallic fibers 33a, made in the aforementioned manner, randomly intertwine and combine (weld) during the sintering. As a result, numerous micro-porosities 33b which are complex and smaller than a hole diameter of so-called a backfire limit are formed in the sintered sheet 33. This is partially enlarged as shown in FIG. 4. In this case, the sintered sheet 33 has a porosity ranging from 60% to 80% and a plate thickness ranging from 0.5 mm to 3.0 mm. Meanwhile, if a diameter of each of the metallic fiber 33a is less than 50 μm , areas where the metallic fibers intertwine during the sintering increase, resulting in easy heat transfer to a rear surface of the sintered sheet 33. On the other hand, if the diameter of each metallic fiber 33a is more than 100 μm , each of the micro-porosities becomes too large, which poses a risk that the backfire cannot be suppressed. In addition, if weight per unit area is less than 1,200g/m², each micro-porosity 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 may not be obtained and therefore passing resistance of the air-fuel mixture increases.

[0019] In the aforementioned total primary 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 sintered sheet 33. At this time, temperature rise of the sintered sheet 33, i.e., the backfire suppressing plate portion 3 itself, can be suppressed by large contact areas with the air-fuel mixture at normal temperature. In addition, pressure loss can also be suppressed by the numerous micro-porosities 33b. Furthermore, the air-fuel mixture passing through the sintered sheet 33 of the backfire suppressing plate portion 3 passes through the gap Gp between the combustion plate portion 2 and the backfire suppressing plate portion 3, ejects from the main body portion 23 of the combustion plate portion 2 and undergoes combustion (combustion without secondary air). At this time, even if flames propagate within 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 sup-

pressed, allowing the flames to be extinguished by the backfire suppressing plate portion 3. Also, if the flames propagating within the gap Gp are not extinguished and persist, presence of only the micro-porosities 33b in the backfire suppressing plate portion 3 helps to suppress propagation of the flames to an upstream side of the backfire suppressing plate portion 3. Thus, in the total primary combustion burner CB, due to disposition of the backfire suppressing plate portion 3 having the sintered sheet 33, even when utilizing hydrogen gas as the fuel gas, the backfire can be suppressed as much as possible while suppressing the pressure loss.

[0020] In addition, in the total primary 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. Thereby, in the case where the flames propagating within the gap Gp are not extinguished and combustion occurs on the surface (lower surface) of the sintered sheet 33 facing the gap Gp, any temperature rise can be detected by the temperature sensor 4. This enables swift action such as halting the air-fuel mixture supply, suppressing combustion that could bring about damage of the total primary combustion burner CB.

[0021] 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. In the aforementioned embodiment, the sintered sheet 33 is configured by the sintered aggregate of the metallic fibers 33a. However, as long as numerous micro-porosities, which are complex and smaller than the hole diameter of the backfire limit, can be formed after the sintering, the sintered sheet is not restricted to the sintered sheet 33. As shown in FIG. 5, for example, a sintered sheet 5 can be made from metallic beads 5a. Each of the metallic beads 5a, with a diameter ranging from 50 μ m to 500 μ m, is 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. The sintered sheet 5 can be made by sintering an aggregate of the metallic beads 5a in the similar manner to the aforementioned process. In the metallic sheet 5, numerous micro-porosities 5b are also formed. In this case, the weight per unit area is set within the range from 1,200g/m² to 1,800g/m².

[0022] In addition, although, in the aforementioned embodiment, the knitted material made from the metallic fibers is described as the main body portion 23 of the combustion plate portion 2, it should be noted that the main body portion 23 is not exclusively limited to the knitted material. Instead of the knitted material, the sintered sheet 33 produced in accordance with the aforementioned manner can be utilized as the main body portion 23 of the combustion plate portion 2. Similarly, due to increase of the contact areas with the air-fuel

mixture, the temperature rise of the combustion plate portion itself is suppressed, which is advantageous.

Explanation of symbols

[0023]

CB	Total primary combustion burner
1	Burner body
11	Air-fuel mixture chamber
12	Opening surface
2	Combustion plate portion
3	Backfire suppressing plate portion
33, 5	Sintered sheet
33a	Metallic fibers
4	Temperature sensor
5a	Metallic beads

Claims

1. A total primary combustion burner, comprising,
 - a burner body with an air-fuel mixture chamber into which an air-fuel mixture of a fuel 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, wherein a backfire suppressing plate portion is disposed opposite the combustion plate portion with a gap inside the air-fuel mixture chamber, and wherein the air-fuel mixture passing through the backfire suppressing plate portion is configured to eject from the combustion plate portion and undergoes combustion, and wherein hydrogen gas is utilized as the fuel gas, wherein: the backfire suppressing plate portion has a sintered sheet formed by sintering an aggregate of metallic fibers or beads.
2. The total primary combustion burner as claimed in claim 1, wherein the metallic fibers or beads 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.
3. The total primary combustion burner as claimed in claim 2, wherein weight per unit area during sintering the sintered sheet is set within a range of 1,200g/m² to 1,800g/m².
4. The total primary combustion burner as claimed in claim 1, wherein a temperature sensor is disposed at a portion of the air-fuel mixture chamber, which is positioned between the combustion plate portion and the backfire suppressing plate portion.

5. The total primary combustion burner as claimed in claim 1 or 4, wherein the gap between the combustion plate portion and the backfire suppressing plate portion is set within a range of 5 mm to 30 mm.

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6. The total primary combustion burner as claimed in claim 1, wherein the combustion plate portion has a sintered sheet formed by sintering an aggregate of metallic fibers or beads.

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FIG. 1

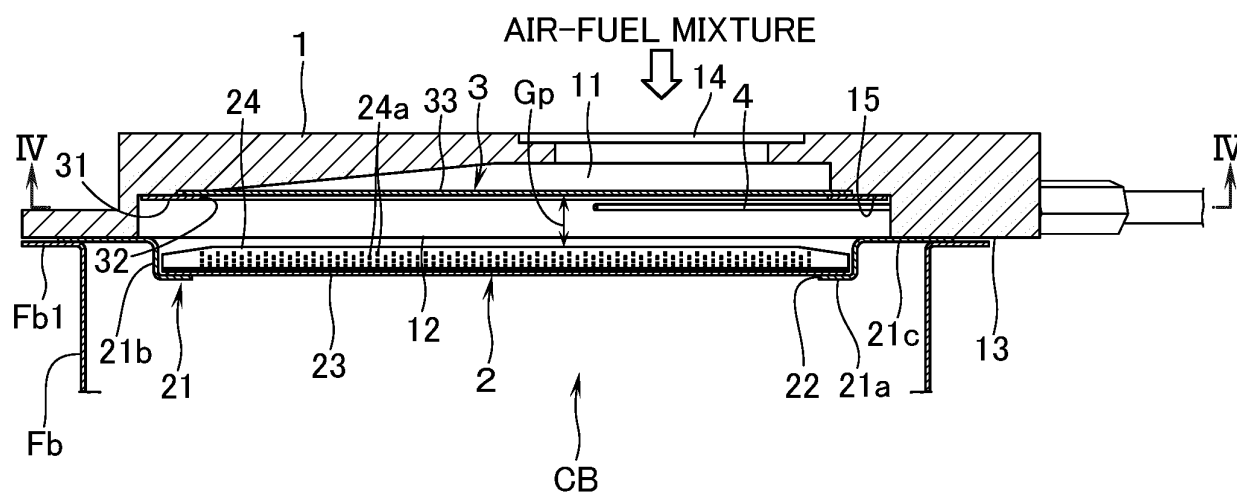


FIG.2

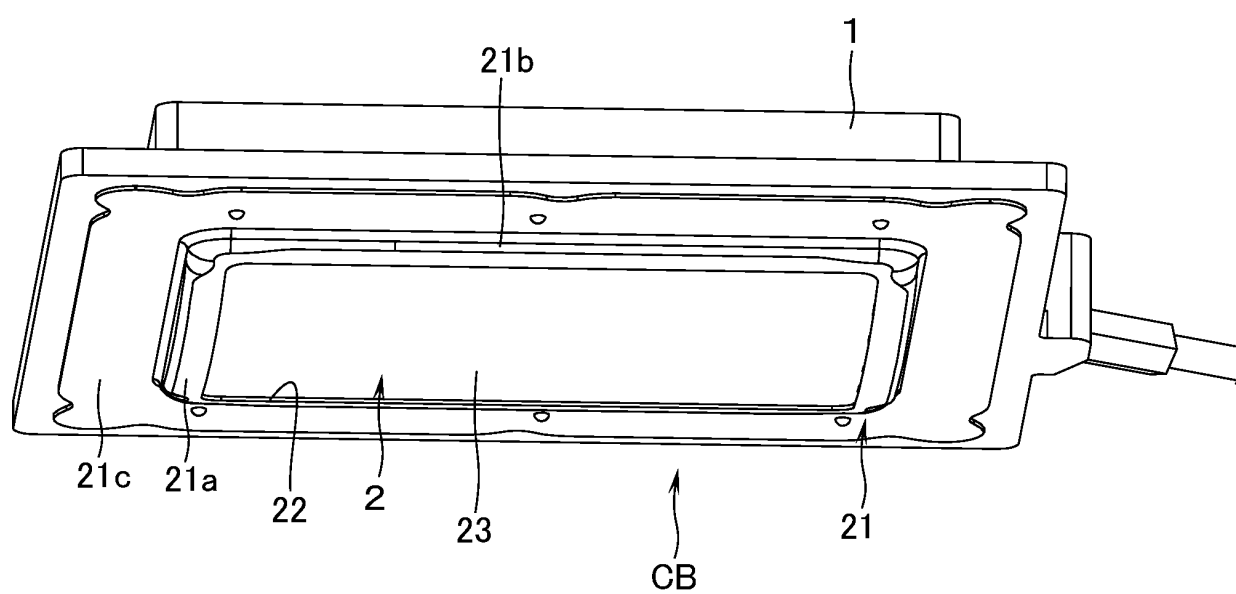


FIG.3

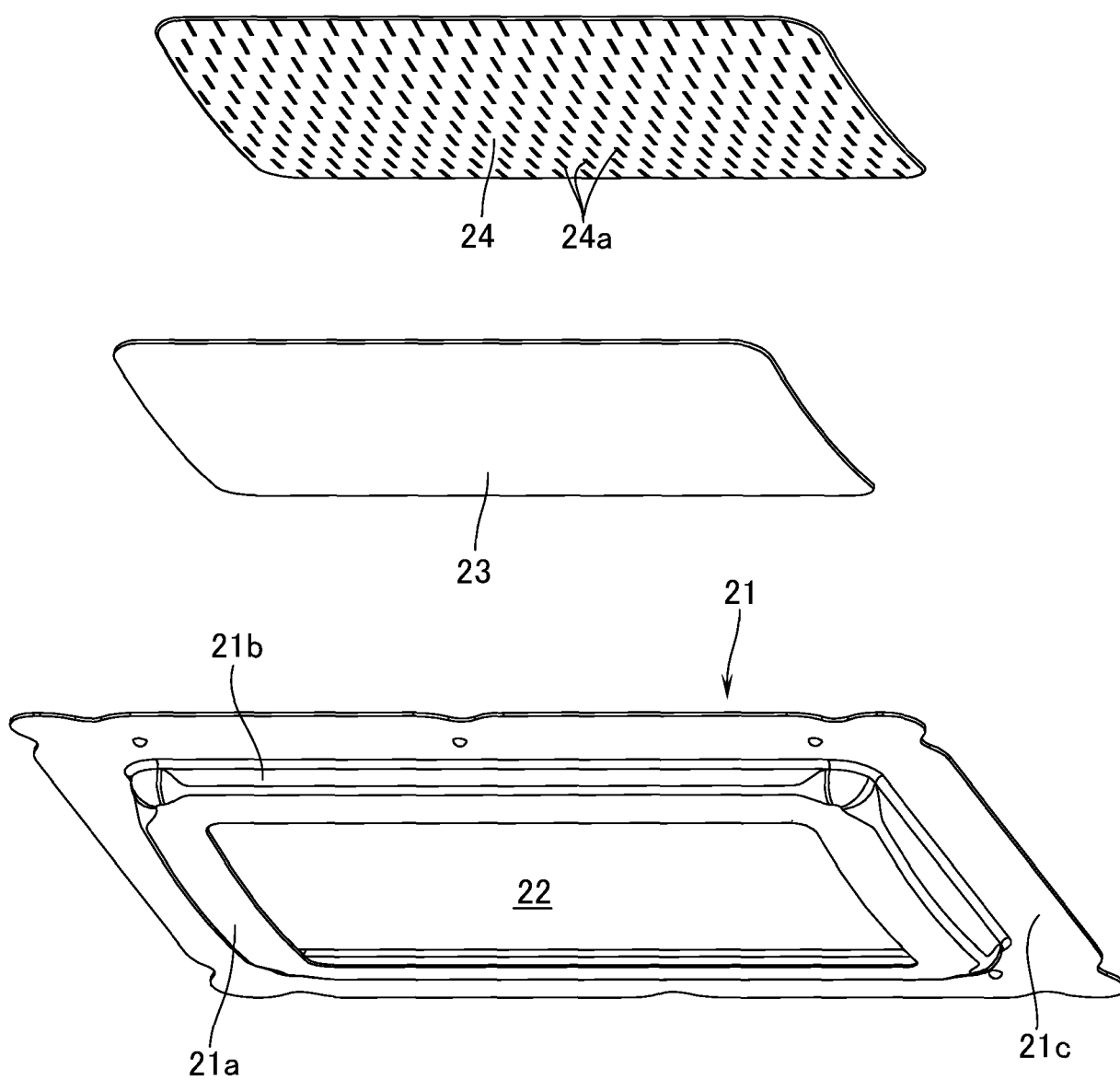


FIG.4

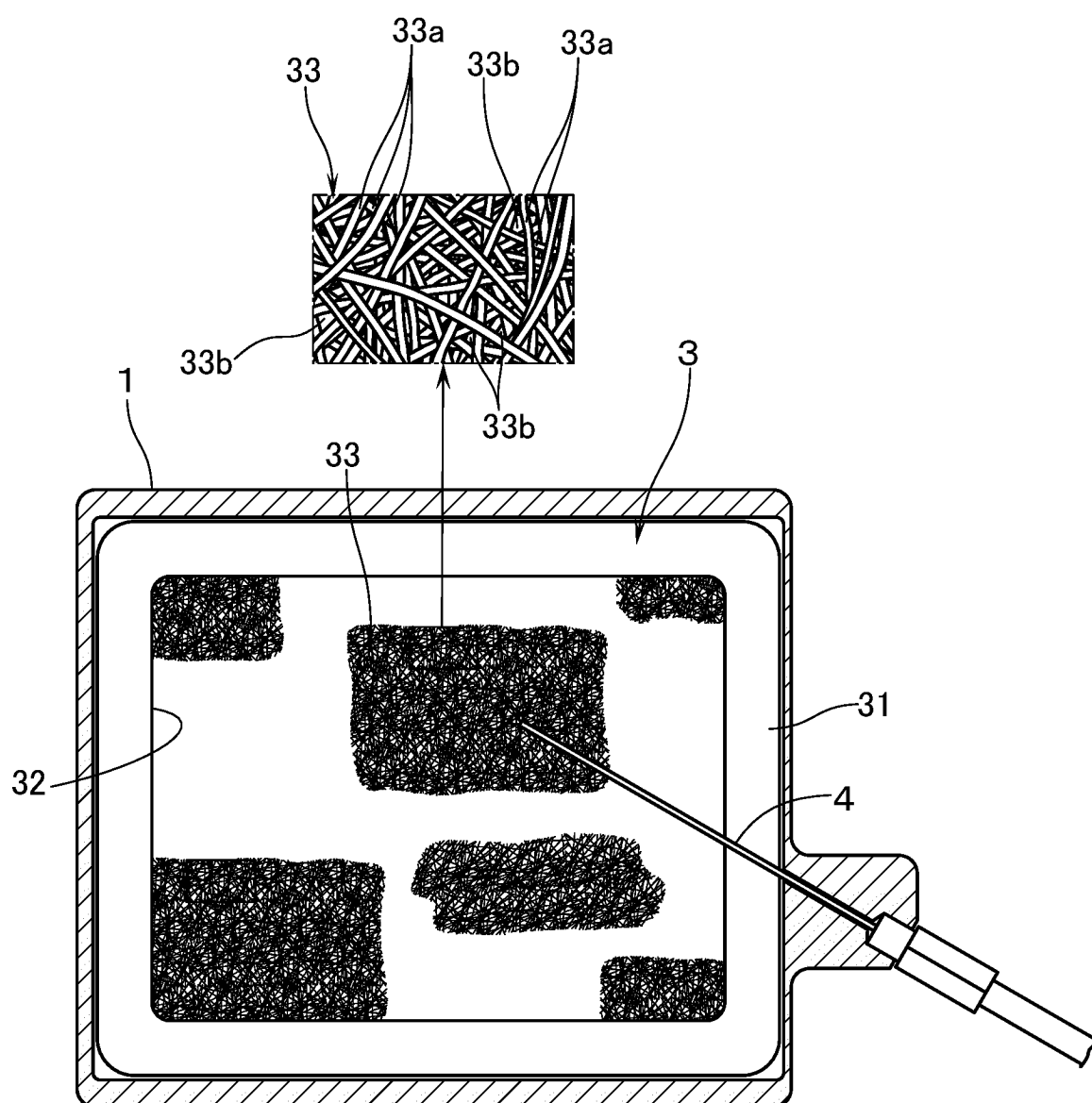
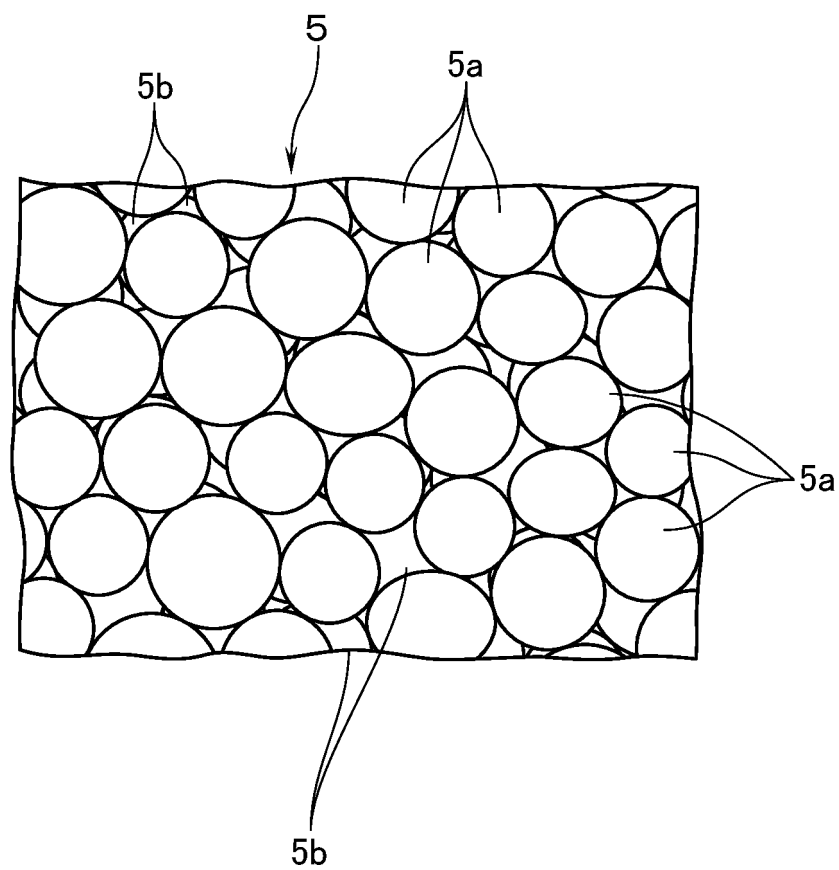


FIG.5



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2022/042075

A. CLASSIFICATION OF SUBJECT MATTER

F23D 14/82(2006.01)i; *F23D 14/02*(2006.01)i

FI: F23D14/82 B; F23D14/02 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)

F23D14/00-14/84

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 1971-2023

Registered utility model specifications of Japan 1996-2023

Published registered utility model applications of Japan 1994-2023

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 2001-263614 A (OSAKA GAS COMPANY, LIMITED) 26 September 2001 (2001-09-26) particularly, paragraphs [0010]-[0013], fig. 1	1-6
Y	JP 2000-18525 A (IWATANI INTERNATL. CORPORATION) 18 January 2000 (2000-01-18) particularly, paragraphs [0003]-[0007]	1-6
Y	JP 3047486 U (SHINWA GAS SOUCHI COMPANY, LIMITED) 14 April 1998 (1998-04-14) particularly, paragraphs [0006]-[0011]	1-6
Y	JP 2003-73711 A (NHK SPRING COMPANY, LIMITED) 12 March 2003 (2003-03-12) particularly, claims 1-4, paragraphs [0001], [0012]	3, 6
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 93225/1986 (Laid-open No. 5230/1988) (NIPPON STEEL CORPORATION) 14 January 1988 (1988-01-14), particularly, specification, page 7, lines 4-8, 14-19, fig. 1	4-5
A	KR 10-2352277 B1 (CHP TECH COMPANY, LIMITED) 18 January 2022 (2022-01-18) particularly, paragraphs [0049]-[0050], fig. 4, 5d	1-6

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

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Date of the actual completion of the international search

10 January 2023

Date of mailing of the international search report

24 January 2023

Name and mailing address of the ISA/JP

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/JP2022/042075

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JP	2000-18525	A	18 January 2000	(Family: none)	
JP	3047486	U	14 April 1998	(Family: none)	
JP	2003-73711	A	12 March 2003	(Family: none)	
JP	63-5230	U1	14 January 1988	(Family: none)	
KR	10-2352277	B1	18 January 2022	(Family: none)	

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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