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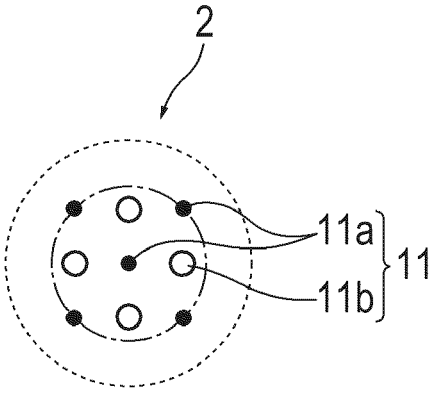
(54) SLIDE PLATE AND FIXED PLATE OF MOLTEN METAL DISCHARGING APPARATUS AND METHODS OF RECYCLING ASSOCIATED

(57) To provide a slide plate that can be reused even if a gas supply hole is clogged.

A slide plate (2) is provided with a pouring hole (2a) configured to be capable of communicating with a molten metal pouring hole (3a) of a fixed plate (3), and a gas supply hole (11) configured to be capable of communicating with the pouring hole (3a) of the fixed plate (3) for blowing gas into molten metal. The gas supply hole (11) of the slide plate (2) includes a secondary supply hole (11b) at a position of an initial supply hole (11a) clogged by solidification of the molten metal, or made anew at a position different from the position of the initial supply hole (11a).

FIG. 3B



EP 3 825 034 A1

Description

Technical Field

[0001] The present invention relates to a slide plate or fixed plate of a molten metal discharging apparatus where the slide plate slides with respect to the fixed plate.

Background Art

[0002] A molten metal discharging apparatus that is attached to the bottom of a vessel such as a ladle, a tundish, or an electric furnace is conventionally known (refer to Patent Literature 1). The molten metal discharging apparatus includes a fixed plate that is fixed to the vessel, and a slide plate that is slidable with respect to the fixed plate. The fixed plate has a pouring hole that communicates with a nozzle hole of an insert nozzle of the vessel. The slide plate has a pouring hole that can communicate with the pouring hole of the fixed plate. When the slide plate is slid with respect to the fixed plate and the pouring holes of the fixed plate and the slide plate are caused to communicate with each other, the molten metal discharging apparatus is opened, and molten metal pours. On the other hand, when the slide plate is slid in the opposite direction with respect to the fixed plate, and the pouring hole of the fixed plate is blocked by the slide plate, the molten metal discharging apparatus is closed, and the molten metal stops pouring.

[0003] If the molten metal discharging apparatus is used for, for example, continuous casting, filler (for example, sand) filled in the insert nozzle of the vessel needs to be floated by gas at the start of a casting operation. Moreover, in the top and bottom pouring method of ingot casting, it is necessary to prevent molten metal from solidifying in the insert nozzle while the vessel moves between ingot (that is, while the molten metal discharging apparatus is closed).

[0004] Hence, the slide plate is provided with gas supply holes that communicate with the pouring hole of the fixed plate to blow gas into the insert nozzle when the molten metal discharging apparatus is closed. Moreover, the fixed plate is provided with gas supply holes that communicate with the pouring hole of the fixed plate to blow gas into the insert nozzle. Gas is blown through the gas supply holes of the slide or fixed plate; accordingly, it is possible to agitate the molten metal in the insert nozzle with gas and to prevent the molten metal from solidifying in the insert nozzle.

Citation List

Patent Literature

[0005] Patent Literature 1: JP 4-33772 A

Summary of Invention

Technical Problem

[0006] However, in terms of the known molten metal discharging apparatus, after, for example, a casting operation for one heat is finished, the molten metal discharging apparatus is closed and the gas is stopped being blown through the gas supply holes of the slide or fixed plate, upon which the molten metal may enter the gas supply holes of the slide or fixed plate, the molten metal in the gas supply holes may solidify, and at least one gas supply hole may be clogged. If the gas supply hole is clogged, a predetermined airflow volume cannot be obtained, and it becomes impossible to blow gas therethrough. Hence, it is necessary to discard the slide or fixed plate and replace it with a new one after, for example, a casting operation for one heat is finished even if the slide or fixed plate has no problem except for the clogging.

[0007] The present invention has been made considering the above problems, and an object thereof is to provide a slide plate or fixed plate that can be reused even if a gas supply hole is clogged.

Solution to Problem

[0008] In order to solve the above problems, an aspect of the present invention is a slide plate of a molten metal discharging apparatus where the slide plate slides with respect to a fixed plate, the slide plate including: a pouring hole configured to be capable of communicating with a molten metal pouring hole of the fixed plate; and a gas supply hole configured to be capable of communicating with the pouring hole of the fixed plate for blowing gas into molten metal, characterized in that the gas supply hole includes a secondary supply hole made at a position of an initial supply hole clogged by solidification of the molten metal, or made anew at a position different from the position of the initial supply hole.

[0009] Another aspect of the present invention is a fixed plate of a molten metal discharging apparatus where a slide plate slides with respect to the fixed plate, the fixed plate including: a molten metal pouring hole; and a gas supply hole communicating with the pouring hole for blowing gas into molten metal, characterized in that the gas supply hole includes a secondary supply hole made at a position of an initial supply hole clogged by solidification of the molten metal, or made anew at a position different from the position of the initial supply hole.

Advantageous Effects of Invention

[0010] According to the aspect of the present invention, the slide plate having no problem except for the clogging of the gas supply hole can be reused. The slide plate can be supplied inexpensively as compared to a new one,

and there is no need to discard the slide plate. Accordingly, it is possible to contribute to reducing resources.

[0011] According to the other aspect of the present invention, the fixed plate having no problem except for the clogging of the gas supply hole can be reused. The fixed plate can be supplied inexpensively as compared to a new one, and there is no need to discard the fixed plate. Accordingly, it is possible to contribute to reducing resources.

Brief Description of Drawings

[0012]

Fig. 1 is a vertical cross-sectional view of a molten metal discharging apparatus where a slide plate of one embodiment of the present invention is incorporated.

Figs. 2A and 2B are detail views of the slide plate of the embodiment (Fig. 2A is a plan view of the slide plate, and Fig. 2B is a cross-sectional view taken along line b-b in Fig. 2A) .

Figs. 3A and 3B are enlarged views of a part III in Fig. 2A (Fig. 3A illustrates initial supply holes, and Fig. 3B illustrates the initial supply holes and secondary supply holes).

Fig. 4 is a vertical cross-sectional view of a molten metal discharging apparatus where a fixed plate of one embodiment of the present invention is incorporated.

Figs. 5A and 5B are detail views of the fixed plate of the embodiment (Fig. 5A is a plan view of the fixed plate, and Fig. 5B is a cross-sectional view taken along line b-b in Fig. 5A) .

Fig. 6 is a diagram illustrating initial supply holes and secondary supply holes for a gas blowing member of the fixed plate of the embodiment.

Description of Embodiments

[0013] A slide plate or fixed plate of a molten metal discharging apparatus of embodiments of the present invention is described in detail hereinafter on the basis of the accompanying drawings. However, the slide plate or fixed plate of the molten metal discharging apparatus of the present invention can be embodied in various forms, and is not limited to the embodiments described in the description. The embodiments are provided with the intention of enabling those skilled in the art to fully understand the invention by fully disclosing the description.

(Slide Plate of the Embodiment)

[0014] Fig. 1 is a vertical cross-sectional view of a molten metal discharging apparatus 1 where a slide plate 2 of one embodiment of the present invention is incorporated. The molten metal discharging apparatus 1 is attached to the bottom of a vessel 4 such as a ladle, a tundish, or an electric furnace. An example where the molten metal discharging apparatus 1 is attached to a ladle for continuous casting is described below. Naturally, the use of the molten metal discharging apparatus 1 is not limited to this example.

[0015] The vessel 4 includes a vessel body 4a made of an iron plate, and a refractory material 4b such as well blocks placed on an inner side of the vessel body 4a. Molten metal (hereinafter referred to as the molten steel) for continuous casting is stored in the vessel 4.

[0016] An insert nozzle 5 is attached to the bottom of the vessel 4. The molten metal discharging apparatus 1 opens and closes a nozzle hole 5a of the insert nozzle 5, and controls the discharge of the molten steel through the nozzle hole 5a.

[0017] The molten metal discharging apparatus 1 includes a fixed plate 3 and the slide plate 2. The fixed plate 3 is formed into a plate shape. The fixed plate 3 is detachably attached to the vessel 4 via a mounting plate 6. The fixed plate 3 includes a pouring hole 3a through which the molten steel pours. The diameter of the pouring hole 3a is substantially the same as the diameter of the nozzle hole 5a of the insert nozzle 5. A ring-shaped convex portion 3b of the fixed plate 3 is fitted in a ring-shaped concave depression 5b of the insert nozzle 5; accordingly, the position of the fixed plate 3 is determined with respect to the insert nozzle 5, and the nozzle hole 5a of the insert nozzle 5 and the pouring hole 3a of the fixed plate 3 communicate with each other. The material of the fixed plate 3 is not particularly limited and is, for example, an alumina-carbon refractory.

[0018] The slide plate 2 is formed into a plate shape. The slide plate 2 is slidably placed on the underside of the fixed plate 3. The slide plate 2 is also detachably attached to the vessel 4 via the mounting plate 6. The slide plate 2 includes a pouring hole 2a through which the molten steel pours. The diameter of the pouring hole 2a of the slide plate 2 is substantially the same as the diameter of the pouring hole 3a of the fixed plate 3. Moreover, the slide plate 2 has gas supply holes 11 (refer to Figs. 2A and 2B) for blowing gas into the molten steel. The diameter of the gas supply hole 11 is much smaller than the diameter of the pouring hole 3a of the fixed plate 3. The portion where the pouring hole 2a of the slide plate 2 is formed and the portion where the gas supply holes 11 of the slide plate 2 are formed are integrated. The material of the slide plate 2 is not particularly limited and is, for example, an alumina-carbon refractory. A pouring nozzle 7 is fixed to the slide plate 2. The diameter of a pouring hole 7a of the pouring nozzle 7 is substantially the same as the diameter of the pouring hole 2a of the slide plate 2.

[0019] A sliding apparatus 8 includes drive sources such as a hydraulic cylinder and a motor, and slides the slide plate 2 with respect to the fixed plate 3. The sliding apparatus 8 may cause the slide plate 2 to move linearly or rotate. Fig. 1 illustrates an example where the sliding

apparatus 8 moves the slide plate 2 linearly.

[0020] Figs. 2A and 2B are detail views of the slide plate 2. As illustrated in Fig. 2A, the gas supply holes 11 of the slide plate 2 are arranged on a pitch circle 20, which is smaller than the diameter of the pouring hole 3a (refer to Fig. 1) of the fixed plate 3, at equal intervals, and at the center of the pitch circle 20. The number of the gas supply holes 11, and their arrangement and diameter are not limited.

[0021] As illustrated in Fig. 2B, a circular recess 12 connected to the gas supply holes 11 is formed in the undersurface of the slide plate 2. A gas introduction portion 13 made of a porous refractory is fitted in the recess 12. A space (an air pool 14) is formed between the gas introduction portion 13 and the gas supply holes 11. The gas introduction portion 13 is connected to a gas source that stores, for example, inactive gas via a pipe 15. The gas introduced into the gas introduction portion 13 is supplied to the gas supply holes 11 via the air pool 14. The gas introduction portion 13 has a role in supplying gas to the gas supply holes 11 and a role in stopping the molten steel if the molten steel passes through the gas supply holes 11.

[0022] As illustrated in Fig. 1, upon pouring, the sliding apparatus 8 slides the slide plate 2 with respect to the fixed plate 3, and causes the pouring hole 3a of the fixed plate 3 and the pouring hole 2a of the slide plate 2 to communicate with each other. The molten steel is poured through the insert nozzle 5 of the vessel 4, the pouring hole 3a of the fixed plate 3, and the pouring hole 2a of the slide plate 2, and is discharged into a tundish. On the other hand, upon stopping pouring, the sliding apparatus 8 slides the slide plate 2 in the opposite direction with respect to the fixed plate 3, and causes the pouring hole 3a of the fixed plate 3 and the gas supply holes 11 of the slide plate 2 to communicate with each other. When the gas is blown into the molten steel through the gas supply holes 11 of the slide plate 2 in this state, gas agitation occurs in the insert nozzle 5. Hence, it is possible to prevent the molten steel in the insert nozzle 5 from solidifying upon stopping pouring. Fig. 1 illustrates a state where the pouring hole 3a of the fixed plate 3 and the gas supply holes 11 of the slide plate 2 have been caused to communicate with each other.

[0023] Fig. 3A illustrates initial supply holes 11a of the gas supply holes 11 of the slide plate 2. The initial supply holes 11a are through-holes that are open at the start of a casting operation. After, for example, a casting operation for one heat is finished, the molten metal discharging apparatus 1 is closed, and the gas is stopped being blown through the initial supply holes 11a, upon which the molten steel may enter the initial supply holes 11a, and solidify therein, and clog at least one initial supply hole 11a. The clogged initial supply holes 11a are indicated by • in Fig. 3A. When the initial supply hole 11a is clogged, a predetermined airflow volume cannot be obtained, and it becomes impossible to blow gas therethrough.

[0024] Hence, the used slide plate 2 with the clogged initial supply holes 11a illustrated in Fig. 3A is collected, and secondary supply holes 11b being through-holes are made anew in the slide plate 2 as illustrated in Fig. 3B. The secondary supply holes 11b are indicated by **o.** The secondary supply holes 11b are made at the positions of the initial supply holes 11a, or at positions different from the positions of the initial supply holes 11a. If the secondary supply holes 11b are made at the same positions as the initial supply holes 11a, the steel solidified in the initial supply holes 11a is melted by, for example, a laser, to restore airflow. If the secondary supply holes 11b are made at positions different from the initial supply holes 11a, the secondary supply holes 11b are made by, for example, a laser or a thin drill at positions away from the initial supply holes 11a. Fig. 3B illustrates an example where the secondary supply holes 11b are open at positions away from the initial supply holes 11a. The secondary supply holes 11b are made at positions different from the positions of the initial supply holes 11a, which allows ensuring a predetermined airflow volume even if some of the initial supply holes 11a are clogged.

[0025] The diameter of the secondary supply hole 11b may be made equal to or different from the diameter of the initial supply hole 11a. If the secondary supply holes 11b are less in number than the initial supply holes 11a, it is desirable to increase the diameter of the secondary supply hole 11b as compared to the diameter of the initial supply hole 11a. Moreover, when the secondary supply holes 11b are made, the gas introduction portion 13 (refer to Fig. 2B) does not necessarily have to be removed. If the gas introduction portion 13 is removed, the gas introduction portion 13 is placed again in the slide plate 2 after the secondary supply holes 11b are made.

[0026] Up to this point, the configuration of the slide plate 2 of the embodiment has been described. The slide plate 2 of the embodiment has the following effects:

[0027] The secondary supply holes 11b are made at the positions of the initial supply holes 11a clogged by the solidification of the molten steel, or made anew at positions different from the positions of the initial supply holes 11a. Accordingly, the slide plate 2 having no problem except for the clogging can be reused. The slide plate 2 can be supplied inexpensively as compared to a new one, and there is no need to discard the slide plate 2. Accordingly, it is possible to contribute to reducing resources.

[0028] The portion where the pouring hole 2a of the slide plate 2 is formed and the portion where the gas supply holes 11 of the slide plate 2 are formed are integrated. Accordingly, the surface accuracy of the surface of the slide plate 2 can be ensured. In contrast, if the portion where the pouring hole 2a of the slide plate 2 is formed and the portion where the gas supply holes 11 of the slide plate 2 are formed are separated (for example, if the gas supply holes are formed in a plug, and the plug is attached to the slide plate body, using mortar or the like), it is difficult to ensure the surface accuracy of the surface of the slide plate 2, and a polishing process is

required to ensure the surface accuracy. If the polishing process is carried out, polishing sludge may enter and block the gas supply holes 11, and the airflow volume may become unstable.

[0029] The secondary supply holes 11b are away from the initial supply holes 11a; accordingly, it is possible to prevent the initial supply holes 11a from having an adverse effect on the shape of the secondary supply holes 11b when the secondary supply holes 11b are made.

[0030] The slide plate of the molten metal discharging apparatus of the present invention is not limited to the materialization of the embodiment, and can be materialized in other embodiments within the scope that does not change the gist of the present invention.

[0031] For example, in the above embodiment, the portion where the pouring hole of the slide plate is formed and the portion where the gas supply holes of the slide plate are formed are integrated, but may be separated.

(Fixed Plate of the Embodiment)

[0032] Fig. 4 is a vertical cross-sectional view of a molten metal discharging apparatus 21 where a fixed plate 22 of one embodiment of the present invention is incorporated. A reference sign 4 denotes a vessel, 5 an insert nozzle, 22 the fixed plate, 2 a slide plate, 7 a pouring nozzle, and 8 a sliding apparatus. The configurations of the vessel 4, the insert nozzle 5, the pouring nozzle 7, and the sliding apparatus 8 are the same as those of the molten metal discharging apparatus 1 illustrated in Fig. 1. Accordingly, the same reference signs are assigned thereto, and descriptions thereof are omitted. The slide plate 2 is the same as the one illustrated in Fig. 1 except the point that the gas supply holes 11 are not provided. Accordingly, the same reference sign is assigned thereto, and a description thereof is omitted.

[0033] The fixed plate 22 includes a fixed plate body 17 and a ring-shaped gas blowing member 16. The gas blowing member 16 is detachably attached to the fixed plate body 17, using mortar or the like. An inner surface of the gas blowing member 16 forms a pouring hole 22a of the fixed plate 22.

[0034] Figs. 5A and 5B illustrate detail views of the fixed plate 22. Gas supply holes 18 communicating with the pouring hole 22a of the fixed plate 22 are formed in the gas blowing member 16. The gas supply holes 18 are arranged at equal intervals in the circumferential direction of the gas blowing member 16 as illustrated in Fig. 5A, and placed in multiple stages in the vertical direction of the gas blowing member 16 as illustrated in Fig. 5B. A circumferential groove 16a functioning as an air pool is formed on an outer surface of the gas blowing member 16. A gas pipe 19 is connected to the air pool. The number of the gas supply holes 18, and their arrangement and diameter are not limited.

[0035] When gas is blown into the pouring hole 22a through the gas supply holes 18 of the gas blowing member 16, gas agitation occurs in the insert nozzle 5 as illustrated in Fig. 4. Hence, it is possible to prevent the molten steel in the insert nozzle 5 from solidifying upon stopping pouring.

[0036] Fig. 6 illustrates initial supply holes 18a and secondary supply holes 18b, which are formed in the gas blowing member 16. The initial supply holes 18a are through-holes that are open at the start of a casting operation. After, for example, a casting operation for one heat is finished, the molten metal discharging apparatus 21 is closed, and the gas is stopped being blown through the initial supply holes 18a, upon which the molten steel may enter the initial supply holes 18a, solidify therein, and clog at least one initial supply hole 18a. The clogged initial supply holes 18a are hatched in Fig. 6. When the initial supply hole 18a is clogged, a predetermined airflow volume cannot be obtained, and it becomes impossible to blow gas therethrough.

[0037] Hence, the used fixed plate 22 with the clogged initial supply holes 18a is collected, and the secondary supply holes 18b are made anew in the fixed plate 22. The secondary supply holes 18b are made at the positions of the initial supply holes 18a, or at positions different from the positions of the initial supply holes 18a. If the secondary supply holes 18b are made at the same positions as the initial supply holes 18a, the steel solidified in the initial supply holes 18a is melted by, for example, a laser, to restore airflow. If the secondary supply holes 18b are made at positions different from the initial supply holes 18a, the secondary supply holes 18b are made anew by, for example, a laser or a thin drill at positions away from the initial supply holes 18a. Fig. 6 illustrates an example where the secondary supply holes 18b are open at positions different from the initial supply holes 18a.

[0038] In this manner, the secondary supply holes 18b are made anew at the positions of the initial supply holes 18a clogged by the solidification of the molten steel, or made anew at positions different from the positions of the initial supply holes 18a. Accordingly, the fixed plate 22 having no problem except for the clogging can be reused.

Reference Signs List

[0039]

1	Molten metal discharging apparatus
2	Slide plate
2a	Pouring hole of the slide plate
3	Fixed plate
3a	Pouring hole of the fixed plate
11	Gas supply hole of the slide plate
11a	Initial supply hole
11b	Secondary supply hole
16	Gas blowing member (fixed plate)
18	Gas supply hole of the fixed plate
18a	Initial supply hole
18b	Secondary supply hole

21 Molten metal discharging apparatus
22 Fixed plate
22a Pouring hole of the fixed plate

Claims

1. A slide plate (2) of a molten metal discharging apparatus (1) where the slide plate (2) slides with respect to a fixed plate (3), the slide plate (2) comprising:

   a pouring hole (2a) configured to be capable of communicating with a molten metal pouring hole (3a) of the fixed plate (3); and a gas supply hole (11) configured to be capable of communicating with the pouring hole (3a) of the fixed plate (3) for blowing gas into molten metal,
   characterized in that
   the gas supply hole (11) includes a secondary supply hole (11b) made at a position of an initial supply hole (11a) clogged by solidification of the molten metal, or made anew at a position different from the position of the initial supply hole (11a).

2. The slide plate (2) of the molten metal discharging apparatus (1) according to claim 1, **characterized in that** a portion where the pouring hole (2a) of the slide plate (2) is formed and a portion where the gas supply hole (11) of the slide plate (2) is formed are integrated.

3. The slide plate (2) of the molten metal discharging apparatus (1) according to claim 1 or 2, **characterized in that** the secondary supply hole (11b) is away from the initial supply hole (11a).

4. A fixed plate (22) of a molten metal discharging apparatus (21) where a slide plate (2) slides with respect to the fixed plate (22), the fixed plate (22) comprising:

   a molten metal pouring hole (22a); and a gas supply hole (18) communicating with the pouring hole (22a) for blowing gas into molten metal,
   characterized in that
   the gas supply hole (18) includes a secondary supply hole (18b) made at a position of an initial supply hole (18a) clogged by solidification of the molten metal, or made anew at a position different from the position of the initial supply hole (18a).

5. A method for recycling a slide plate (2) of a molten metal discharging apparatus (1) where the slide plate (2) slides with respect to a fixed plate (3), the method being **characterized by** comprising the steps of:

   collecting the used slide plate (2) comprising a pouring hole (2a) configured to be capable of communicating with a molten metal pouring hole (3a) of the fixed plate (3) and an initial supply hole (11a) configured to be capable of communicating with the pouring hole (3a) of the fixed plate (3) for blowing gas into molten metal; and making a secondary supply hole (11b) for blowing gas into the molten metal at a position of the initial supply hole (11a) clogged by solidification of the molten metal, or anew at a position different from the position of the initial supply hole (11a).

6. A method for recycling a fixed plate (22) of a molten metal discharging apparatus (21) where a slide plate (2) slides with respect to the fixed plate (22), the method being **characterized by** comprising the steps of:

   collecting the used fixed plate (22) comprising a molten metal pouring hole (22a), and an initial supply hole (18a) communicating with the pouring hole (22a) for blowing gas into molten metal; and
   making a secondary supply hole (18b) for blowing gas into the molten metal at a position of the initial supply hole (18a) clogged by solidification of the molten metal, or anew at a position different from the position of the initial supply hole (18a).

FIG. 1

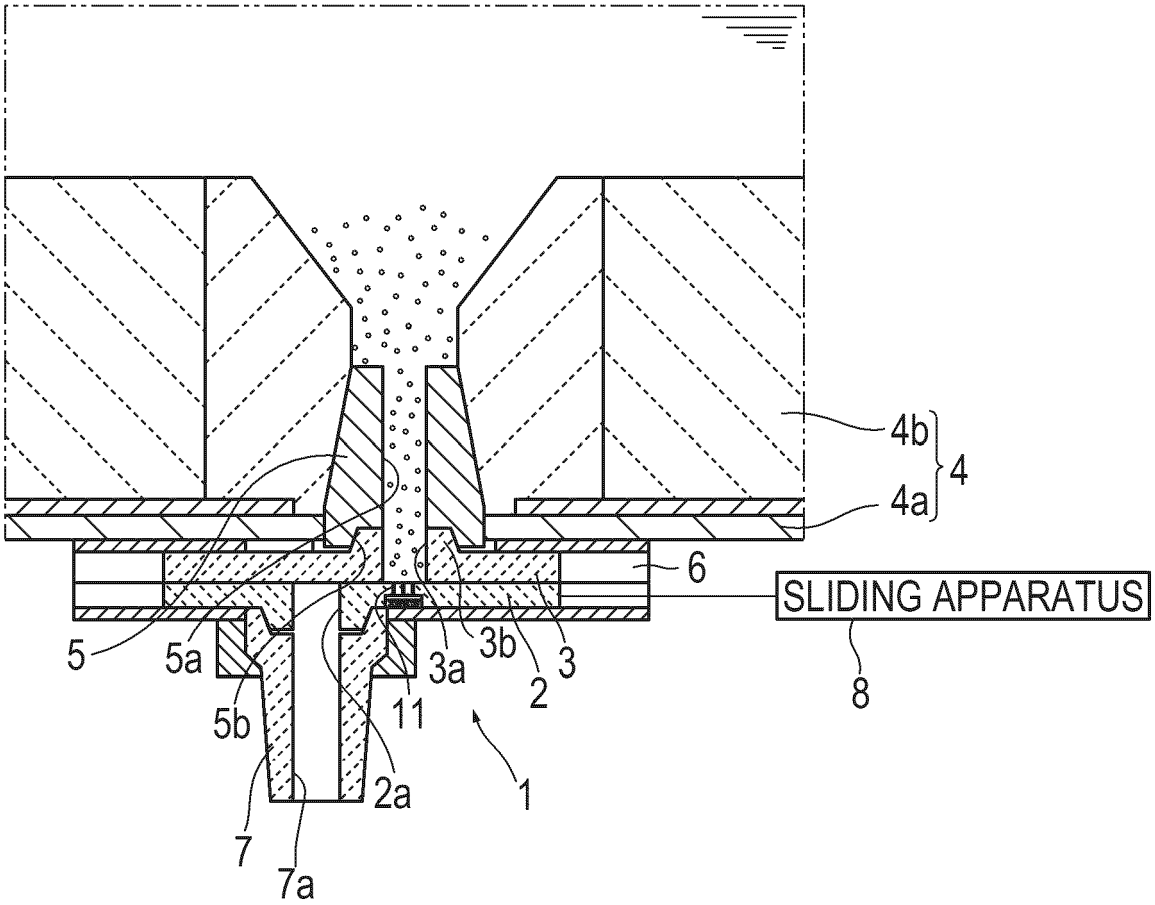


FIG. 2A

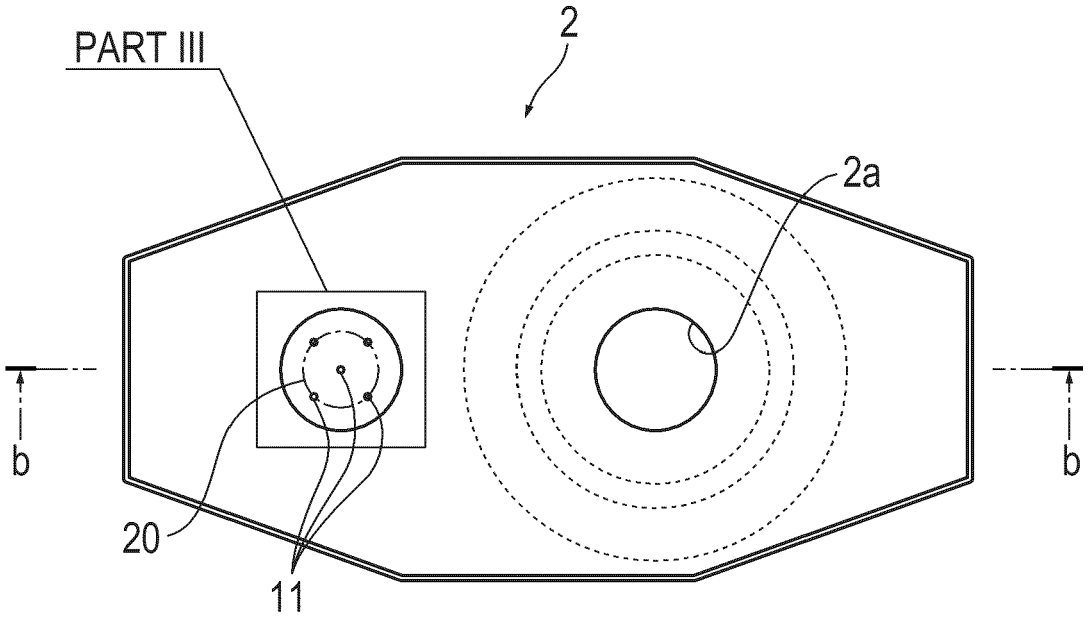


FIG. 2B

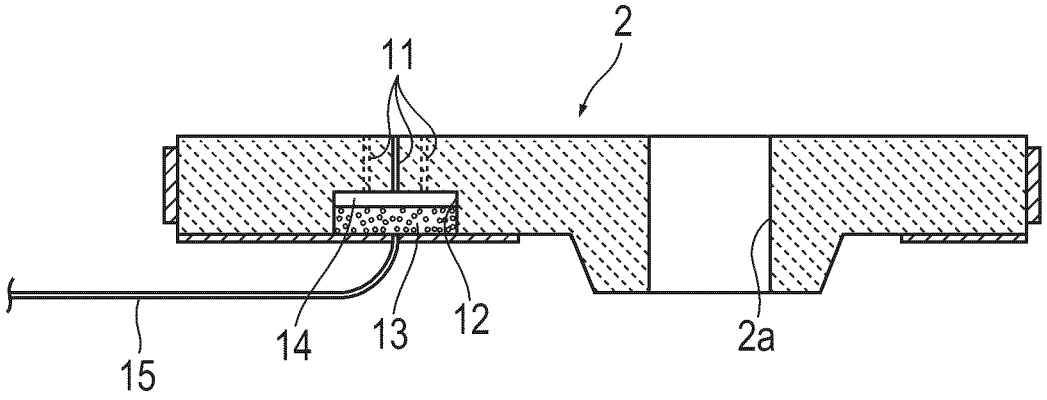


FIG. 3A

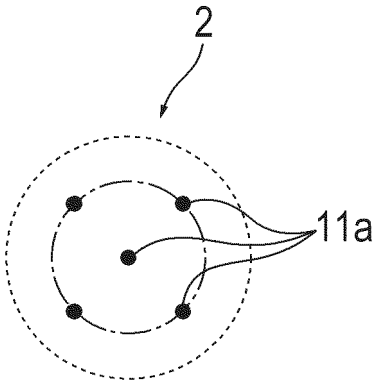


FIG. 3B

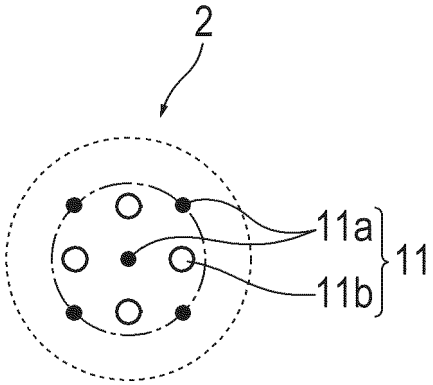


FIG. 4

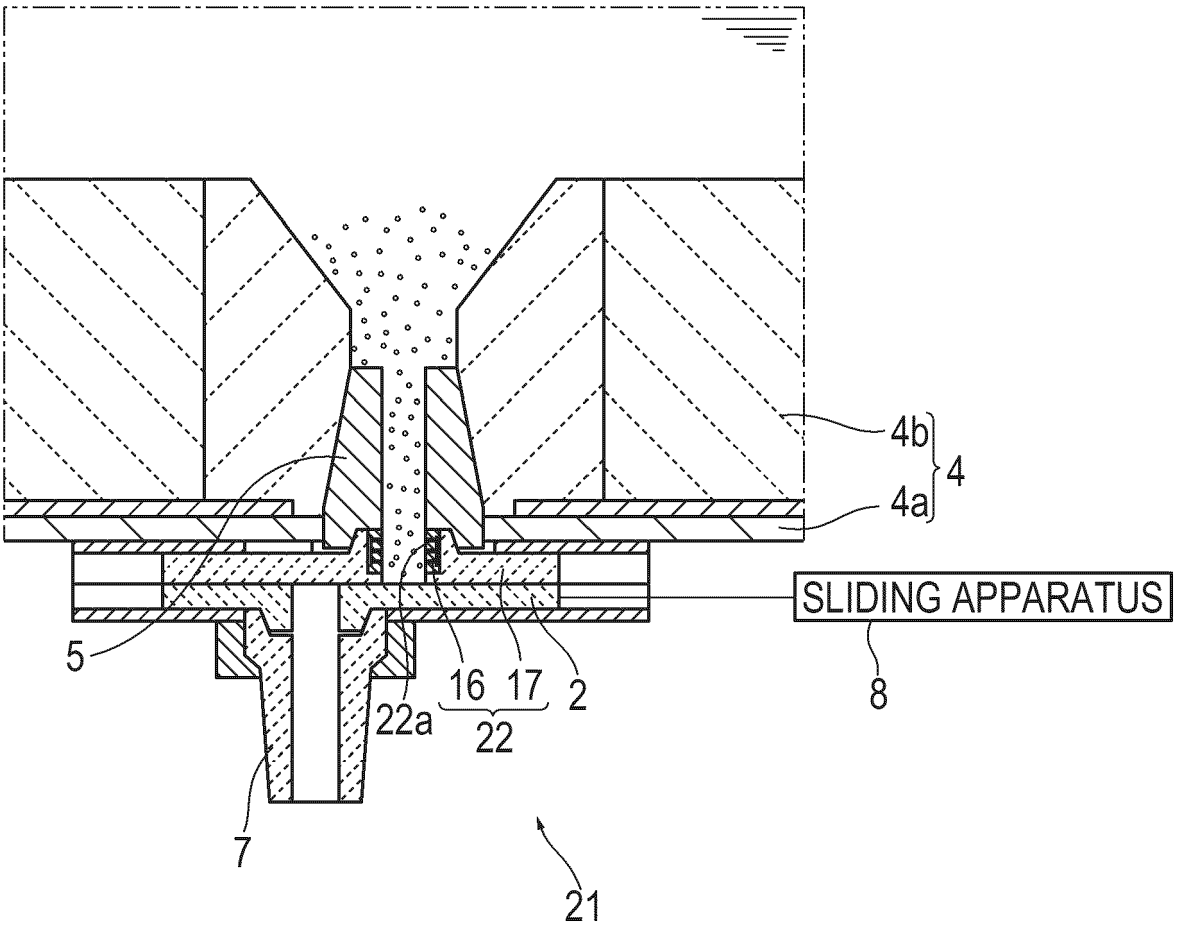


FIG. 5A

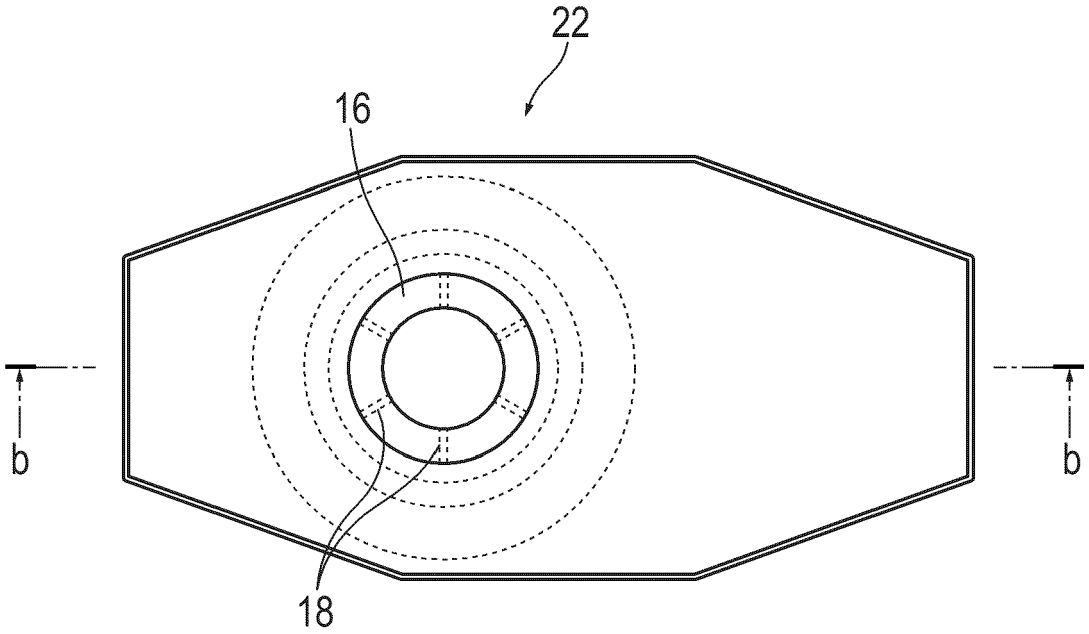


FIG. 5B

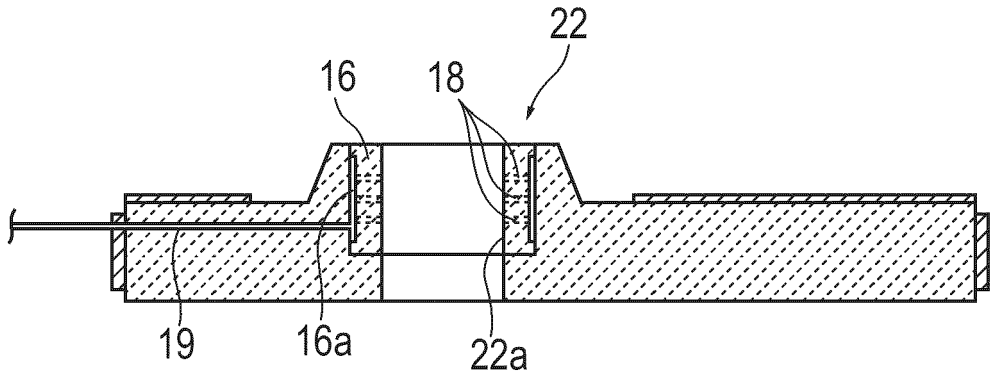
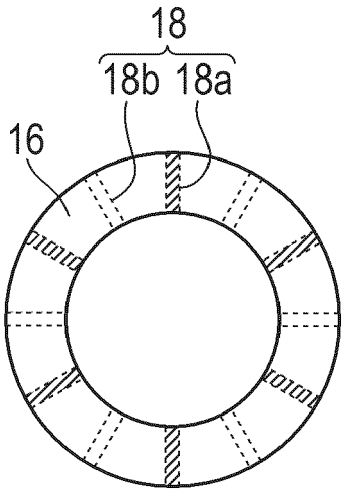


FIG. 6



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EUROPEAN SEARCH REPORT

Application Number
EP 20 20 3558

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	JP H11 138244 A (NIPPON KOKAN KK; TOKYO YOGYO KK) 25 May 1999 (1999-05-25) * figure 1 * * claim 4 * * paragraph [0001] *	1-3,5	INV. B22D11/117 B22D11/16 B22D11/18 B22D41/24 B22D41/28 B22D41/42 B22D41/58
X	JP 2000 158126 A (TOSHIBA CERAMICS CO) 13 June 2000 (2000-06-13) * figure 10 * * paragraph [0002] - paragraph [0006] *	4,6	
X	US 4 632 283 A (ARAKAWA KAZUMI [JP] ET AL) 30 December 1986 (1986-12-30) * figures 1, 6 *	4	
A	US 5 730 892 A (NIWA SHIGEKI [JP] ET AL) 24 March 1998 (1998-03-24) * figures 3, 5 * * claim 2 *	6	

TECHNICAL FIELDS SEARCHED (IPC)

B22D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	4 December 2020	Porté, Olivier

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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