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(54) BOTTOM-BLOWING PLUG

SPÜLSTEIN

BOUCHON À SOUFFLAGE INFÉRIEUR

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Description

Technical Field

[0001] The present invention relates to a bottom blowing plug to be attached to a bottom of a combined blowing converter capable of processing 150 t or more of molten iron at a time and to blow gas into molten iron.

Background Art

[0002] Conventionally, a bottom blowing plug for blowing gas having a plurality of through holes which gas passes through is placed at a bottom portion of a vessel such as a converter, and inert gas (e.g., argon gas) is supplied from the bottom portion of the vessel through the bottom blowing plug and made to stir molten metal. Owing to this stirring, the molten metal in the vessel is equalized in temperature and component and purified. An example of such a bottom blowing plug is a bottom blowing plug having thorough holes whose openings in an upper surface of the plug to contact molten metal are located at vertices of regular triangles (for example, see Patent Document 1).

Citation List

Patent Literature

[0003] [PTL 1] Japanese Unexamined Patent Application Publication No. S61-207505

Summary of Invention

Technical Problem

[0004] In recent years, large combined blowing converters capable of processing 150 t or more of molten iron at a time have been demanded in order to obtain high quality steel at a high productivity.

[0005] It is an object of the present invention to provide a bottom blowing plug which is suitable for such a large combined blowing converter.

[0006] In the abovementioned conventional bottom blowing plug, the through holes are placed at a higher density by locating openings of the through holes at vertices of triangles than a density of through holes placed by locating openings at vertices of squares. However, the number of through holes which one conventional bottom blowing plug has is not many.

[0007] The inventors have focused on durability enhancement of a bottom blowing plug caused by an increase in number of through holes in one bottom blowing plug while the amount of gas from each one of the openings is kept at an appropriate level, and thus sought to provide a bottom blowing plug having a higher durability.

Solution to Problem

[0008] A bottom blowing plug of the present invention as a solution to this problem is a bottom blowing plug to be attached to a combined blowing converter capable of processing 150 t or more of molten iron at a time, and comprising a plug body having an upper surface to contact the molten iron, the upper surface having a group of openings comprising openings of at least 30 through holes and inert gas being injected at 20 to 60 Nl/min from each one of the openings, wherein
the group of openings is located at a central portion of the upper surface of the plug body, and when S_u cm^2 is area of the upper surface and S_o cm^2 is area of an opening group portion where the group of openings is located, $S_o/S_u \leq 0.25$ and $S_u \geq 400$ cm^2, and density of the openings constituting the group of openings, which is expressed by the number of openings divided by the area S_o of the opening group portion, is 0.6 to 3.9 opening/cm^2.

[0009] The bottom blowing plug of the present invention is to be attached to a large combined blowing converter capable of processing 150 t or more of molten iron at a time. The converter is shaped of a barrel or a pear, and has a shaft around which the converter can be freely tilted back and forth. When molten pig iron is poured in or steel is taken out, the converter is tilted. In fining (reacting), the converter is kept upright and pure oxygen under high pressure is blown in from the top and at the same time such gas for stirring as argon gas and nitrogen gas is blown in.

[0010] A large combined blowing converter to be used is a converter capable of processing 150 t or more of molten iron, generally about 250 to 350 t of molten iron at a time from the bottom.

[0011] A first feature of the bottom blowing plug of the present invention is that the area S_u cm^2 of an upper surface of the plug body to contact molten metal is as large as 400 cm^2 or more. Durability of the bottom blowing plug enhances as the area S_u cm^2 of the upper surface gets larger. The area S_u cm^2 of the upper surface is at least 400 cm^2, but as the area S_u cm^2 of the upper surface increases to 800 cm^2 or more or 1200 cm^2 or more, durability further enhances. It should be noted that shape of the upper surface of the bottom blowing plug can be shapes of upper surfaces of conventional bottom blowing plugs as they are, such as circles, squares, rectangles, trapezoids, and fan shapes.

[0012] A second feature is that the upper surface of the bottom blowing plug of the present invention has a great number of openings. The number of openings is at least 30 and preferably 70 or more or 110 or more.

[0013] When S_u cm^2 is area of the upper surface and S_o cm^2 is area of an opening group portion where the group of openings is located, a formula $S_o/S_u \leq 0.25$ needs to be satisfied. The area S_o cm^2 of the opening group portion herein means an area surrounded by a polygon or a polygon-like shape formed by connecting centers of adjacent openings on an outermost contour of the group of openings. The area S_o cm^2 of the opening group portion is 25 % or less of the area S_u cm^2 of the upper surface and the opening group portion is located at a central portion of the upper surface. These two mean that the opening group portion is located at a considerable distance from the periphery of the upper surface and that an area between the periphery of the upper surface and the opening group portion is as extremely large as 75 % or more of the area S_u cm^2 of the upper surface.

[0014] Density of the openings constituting the group of openings, which is expressed by the number of openings divided by the area S_o cm^2 of the opening group portion, is 0.6 to 3.9 opening/cm^2. Size of the openings is about 1 to 3 mm in diameter. When density of the openings is low, that is, the number of openings per unit area is small, openings each having a large opening area are employed. When density of the openings is high, openings each having a small opening area are employed.

[0015] Relative arrangement of the openings constituting the group of openings can be that the openings are formed in the upper surface of the plug body so as to be respectively located at vertices of regular triangles with sides of P mm. More specifically, a central opening at a center of the group of openings is located at a center of a regular hexagon having vertices at six openings at a distance of P mm from the central opening, and all the other openings are located at vertices or on sides of regular hexagons which are concentric around the central opening.

[0016] Moreover, relative arrangement of the openings constituting the group of openings can be that the openings are formed in the upper surface of the plug body so as to be respectively located at vertices of squares with sides of P mm.

[0017] Furthermore, relative arrangement of the openings constituting the group of openings can be that the openings are formed in the upper surface of the plug body so as to be respectively located on circumferences of concentric circles whose radiuses are different by P mm. Note that it is preferred that the openings are located on the same circumferences and distance between adjacent openings is P mm, which is the same as the difference in radius, but it is acceptable that distances between some adjacent openings are not P mm.

[0018] Although it is preferred that relative arrangement of the openings is regular arrangement with a pitch P as mentioned before, arrangement which lacks regularity is acceptable.

[0019] Herein, the value of P can be 6 to 12 mm.

[0020] Note that it is also preferred that the openings are concentrated at a central portion of the upper surface of the bottom blowing plug. In order to concentrate the openings, it is preferred to employ most concentrated arrangement in which all three adjacent openings are located at vertices of a regular triangle.

[0021] More specifically, a first regular hexagon is formed which have vertices at six openings located at a distance of P mm in centrifugal directions from an opening at a center of a group of openings (hereinafter referred to as a central opening) in an upper surface of one bottom blowing plug. The first regular hexagon has openings one at each of the six vertices; the first regular hexagon has six openings in total. A second regular hexagon is formed at a distance of P mm in the centrifugal direction from the first regular hexagon, and has openings one at each of six vertices and one at each center of six sides; the second regular hexagon has 12 openings in total. The second regular hexagon is distant from the central opening by 2 × P mm, and is a regular hexagon which is concentric with the first regular hexagon about the central opening. Similarly, a third regular concentric hexagon at an additional distance of P mm in the centrifugal direction has 18 openings, a fourth regular concentric hexagon has 24 openings, a fifth regular concentric hexagon has 30 openings, a sixth regular concentric hexagon has 36 openings, a seventh regular concentric hexagon has 42 openings, and an eighth regular concentric hexagon has 48 openings.

[0022] The total number of openings within the second regular concentric hexagon in the upper surface of the plug body is the total of one central opening, six openings on the first regular concentric hexagon, and 12 openings on the second regular concentric hexagon, which is 19. The total number of openings within the third regular concentric hexagon is 37. The total number of openings within the fourth regular concentric hexagon is 61. The total number of openings within the fifth regular concentric hexagon is 91. The total number of openings within the sixth regular concentric hexagon is 127. The total number of openings within the seventh regular concentric hexagon is 169. The total number of openings within the eighth regular concentric hexagon is 217.

[0023] Since the opening group portion is located at a considerable distance from the periphery of the upper surface, the bottom blowing plug of the present invention attains good spalling resistance, which makes a great contribution to durability enhancement.

[0024] Openings located at vertices of polygons of the opening group portion are the closest ones to the periphery of the upper surface of the bottom blowing plug. In order to locate all the openings at positions as distant from the periphery of the upper surface as possible, it is possible to provide no opening at a position closest to the periphery on an outermost contour of the opening group portion. Similarly, it is possible to provide no opening at a position second closest to the periphery on the outermost contour of the opening group portion, and it is also possible to provide no openings at positions third, fourth, etc. closest to the periphery on the outermost contour of the opening group portion.

[0025] When shape of the upper surface of the bottom blowing plug is a rectangle or a trapezoid, there is a possibility that an opening at a certain vertex on the outermost contour or an opening on a side adjacent to the opening at the certain vertex is inevitably closer to the periphery of the upper surface than openings located around other vertices. In such a case, it is possible not to provide the opening at the certain vertex or the opening on the side adjacent to the opening at the certain vertex. Upon not providing an opening which is close to the periphery, a necessary distance from the periphery to an opening closest to the periphery can be secured and at the same time a larger number of openings can be provided. Thus a higher spalling resistance can be secured.

[0026] Moreover, preferably distance from the periphery of the upper surface of the plug body to a closest opening located at a shortest distance from the periphery is longer than distance from the closest opening to the central opening. Owing to this, the distance from the periphery of the upper surface to the closest opening to the periphery can be secured long and a high spalling resistance can be obtained.

[0027] It should be noted that the amount of inert gas injected from each one of the openings of the bottom blowing plug of the present invention is 20 to 60 Nl/min. Controlling the amount of inert gas injected in this range keeps a wear rate of the bottom blowing plug due to processing of molten iron low and thus allows an increase in number of processing times of a converter.

Advantageous Effects of Invention

[0028] In the bottom blowing plug of the present invention, the upper surface of the plug body to contact molten metal has a large area, and the number of openings in the upper surface is large. Moreover, the group of openings in the upper surface of the plug body is concentrated in the central portion of the upper surface, and the area S_o cm^2 of the opening group portion where the group of openings is formed is 25% or less of the area S_u cm^2 of the upper surface, and the distance from the opening group portion to the periphery of the upper surface is long. Therefore, this plug body has a good spalling resistance and thus has a high durability. Furthermore, since inert gas is injected at 20 to 60 Nl/min from each one of the openings, wear of the plug body is suppressed and thus durability is enhanced.

[0029] In addition, the area S_o cm^2 of the opening group portion of the plug body is 25 % or less of the area S_u cm^2 of the upper surface and the distance from the periphery of the upper surface to the closest opening at the shortest distance from the periphery is longer than the distance from the closest opening to the central opening. These two ensure that all the openings are distant from the periphery of the upper surface and thus a more reliable, higher spalling resistance can be expected.

[0030] Furthermore, the bottom blowing plug of the present invention is to be used for a large combined blowing converter, and allows the converter to produce high quality steel at a high productivity.

Brief Description of Drawings

[0031]

[Fig. 1] Fig. 1 is a longitudinal cross sectional view of a bottom blowing plug of Example 1.

[Fig. 2] Fig. 2 is a top view of the bottom blowing plug of Example 1.

[Fig. 3] Fig. 3 is a top view of a bottom blowing plug of a modification of Example 1.

[Fig. 4] Fig. 4 is a top view of a bottom blowing plug of Example 2.

Description of Embodiments

[0032] Embodiments of the present invention will be described in detail with reference to the drawings.

Example 1

[0033] Structure of a bottom blowing plug of the present example will be described with reference to Figs. 1 and 2. The bottom blowing plug of the present example has a plug body 2 having an upper surface 2a which intersects with a gas blow-in direction (the direction of the arrow A1), and pipes 1 each having a through hole 1a regularly embedded in the plug body 2.

[0034] The pipes 1 are placed at a pitch P on a number n (= 6) of regular hexagons H_n which are concentric around a center O of the upper surface 2a of the plug body 2. Sides of a most inner hexagon H1 has a length approximating the pitch P. The term "approximating" herein means not being exactly P mm but falling within a certain range.

[0035] In the present example, P is 12 mm and an inner diameter of each of the pipes 1 is 2 mm. A group of openings constituted by all openings comprises a central opening of a pipe at a center, and 127 openings at vertices or on sides of six regular concentric hexagons. The opening group portion is a hexagonal portion formed by connecting centers of openings of six pipes A, B, C, D, E and F located at vertices of the outermost regular concentric hexagon H6 . Area S_o cm^2 of this opening group portion is 135 cm^2. The upper surface of this bottom blowing plug is a trapezoid having an upper base W1 mm of 250 mm in length, a lower base W2 mm of 350 mm in length, a height L mm of 300 mm in length. Area S_u cm^2 of the upper surface is 900 cm^2. Therefore, the area S_o cm^2 of the opening group portion of the bottom blowing plug of the present example is 15 % of the area S_u cm^2 of the upper surface, and distance from an opening on an outermost contour of the opening group portion to the periphery of the upper surface is long. Therefore, the bottom blowing plug of the present example has a good spalling resistance and thus has a good durability.

[0036] Moreover, since the number of openings is 127 and the area S_o cm^2 of the opening group portion is 135 cm^2, density of the openings constituting the opening group portion is 0.94 opening/cm^2.

Modification of Example 1

[0037] A top view of a bottom blowing plug of a modification of Example 1 is shown in Fig. 3. The bottom blowing plug of this modification is the same as that of Example 1, except that six pipes are removed from the pipes located at the vertices and on the sides of the outermost regular concentric hexagon of the bottom blowing plug of Example 1. The removed pipes are four pipes marked with the reference characters A, C, D and E in Fig. 2, one pipe next to the pipe with the reference character C to the right and one pipe next to the pipe with the reference character E to the right, that is, six pipes in total.

[0038] As apparent from Fig. 3, since six pipes at corners of the regular hexagon are not present, a shape connecting pipes on an outermost contour resembles a rounded trapezoid. In the bottom blowing plug of this modification, pipes constituting closest openings, which are closest to the periphery of the upper surface, are two pipes marked with the reference character J and the reference character K in Fig. 3. Distance from the closest openings to the periphery of the upper surface is 84 mm, and distance from the closest openings to a central opening is 66 mm. Therefore, in the bottom blowing plug of this modification, distance from the periphery of the upper surface to the closest openings at a shortest distance from the periphery is longer than distance from the closest openings to the central opening. Owing to this, all the openings can be distant from the periphery of the upper surface and a more reliable, higher spalling resistance can be expected.

[0039] Since the number of openings is 121 and the area S_o cm^2 of the opening group portion is 131 cm^2, density of the openings constituting the group of openings is 0.92 opening/cm^2.

Example 2

[0040] Structure of a bottom blowing plug of the present example will be described with reference to Fig. 4. The bottom blowing plug of the present example is obtained by changing the shape of the upper surface 2a of the plug body 2 of the bottom blowing plug of Example 1 shown in Fig. 1 to a rectangle. Like the bottom blowing plug of Example 1, the bottom blowing plug of the present example has an upper surface 2a which intersects with a gas blow- in direction, and pipes 1 each having a through hole 1a regularly embedded in a central portion of the plug body 2.

[0041] A group of pipes comprises 100 pipes 1 and the pipes are located at four corners of squares with sides of 8 mm formed by 10 vertical lines and 10 horizontal lines at a pitch P of 8 mm. A center O of an upper surface 2a of the plug body 2 is located at a center of the group of pipes.

[0042] In the present example, P is 8 mm and an inner diameter of each of the pipes 1 is 2 mm. Area S_o cm^2 of an opening group portion is 52 cm^2. The upper surface 2a of the bottom blowing plug is a rectangle of 280 mm in length (W3) and 300 mm in width (W4) and has an area S_u of 840 cm^2. Therefore, the area S_o cm^2 of the opening group portion of the bottom blowing plug of the present example is 6.2 % of the area S_u cm^2 of the upper surface. Distance from a periphery of the upper surface to a closest opening located at a shortest distance from the periphery is 104 mm. Distance from the closest opening to a central opening located at a center of the group of openings is 51 mm. Therefore, the distance from the periphery of the upper surface to the closest opening is longer than the distance from the closest opening to the central opening. Therefore, the bottom blowing plug of the present example has a good spalling resistance and thus has a good durability.

[0043] Since the number of openings is 100 and the area S_o cm^2 of the opening group portion is 52 cm^2, density of the openings constituting the group of openings is 1.92 opening/cm^2.

[0044] The group of openings of Example 1 has openings at the vertices and on the sides of regular concentric hexagons, while the group of openings of Example 2 has openings at the vertices and on the sides of squares. However, arrangement of the openings does not need to have strong regularity. Besides, although the description of the present invention says that the group of openings is located at the central portion of the upper surface, the term "central" is not used in a strict meaning and the central portion can be a portion close to a center.

Reference Signs List

[0045]

- 1a Through hole
- 2 Plug body
- 2a Upper surface
- P Pitch

Claims

1. A bottom blowing plug to be attached to a combined blowing converter capable of processing 150 t or more of molten iron at a time, and comprising a plug body having an upper surface to contact the molten iron, the upper surface having a group of openings comprising openings of at least 30 through holes and inert gas being injected at 20 to 60 Nl/min from each one of the openings, wherein
the group of openings is located at a central portion of the upper surface of the plug body, and when S_u cm^2 is area of the upper surface and S_o cm^2 is area of an opening group portion where the group of openings is located, $S_o/S_u \leq 0.25$ and S_u cm$^2 \geq 400$ cm^2, and
density of the openings constituting the group of openings, which is expressed by the number of

openings divided by the area S_o of the opening group portion, is 0.6 to 3.9 opening/cm^2.

2. The bottom blowing plug according to claim 1, wherein a pitch P of adjacent ones of the openings is 6 to 12 mm.

3. The bottom blowing plug according to claim 1 or 2, wherein relative arrangement of the openings constituting the group of openings is that the openings are formed in the upper surface of the plug body so as to be respectively located at vertices of regular triangles or squares having sides of P mm.

4. The bottom blowing plug according to claim 1, 2 or 3, wherein distance from a periphery of the upper surface to a closest one of the openings located at a shortest distance from the periphery is longer than distance from the closest one of the openings to a central opening located at a center of the group of openings.

Patentansprüche

1. Bodenblasstopfen, der an einem kombinierten Blaskonverter befestigbar ist, der 150 t oder mehr von geschmolzenem Eisen auf einmal verarbeiten kann, und einen Stopfenkörper umfasst, der eine obere Fläche zum Berühren des geschmolzenen Eisens hat, wobei die obere Fläche eine Gruppe von Öffnungen hat, die Öffnungen von mindestens 30 Durchgangslöchern aufweist, und wobei ein Inertgas bei 20 bis 60 Nl/min aus jeder einzelnen der Öffnungen eingespeist wird, wobei
die Gruppe von Öffnungen an einem Mittelabschnitt der oberen Fläche des Stopfenkörpers angeordnet ist, und wenn S_u cm^2 ein Flächeninhalt der oberen Fläche ist und S_o cm^2 ein Flächeninhalt eines Öffnungsgruppenabschnitts ist, in dem die Gruppe von Öffnungen angeordnet ist, dann gilt $S_o/S_u \leq 0{,}25$ und S_u $cm^2 \geq 400$ cm^2, und
eine Dichte der die Gruppe von Öffnungen darstellenden Öffnungen, die durch die Anzahl von Öffnungen geteilt durch den Flächeninhalt S_o des Öffnungsgruppenabschnitts ausgedrückt wird, 0,6 bis 3,9 Öffnung/cm^2 ist.

2. Bodenblasstopfen nach Anspruch 1, wobei ein Abstand P von benachbarten Öffnungen 6 bis 12 mm ist.

3. Bodenblasstopfen nach Anspruch 1 oder 2, wobei eine relative Anordnung der Öffnungen, die die Gruppe von Öffnungen darstellen, eine solche ist, dass die Öffnungen in der oberen Fläche des Stopfenkörpers ausgebildet sind, um jeweils an Eckpunkten von gleichseitigen Dreiecken oder Quadraten mit Seiten von P mm angeordnet zu sein.

4. Bodenblasstopfen nach Anspruch 1, 2 oder 3, wobei eine Entfernung von einem Rand der oberen Fläche zu einer nächsten derjenigen Öffnungen, die mit einer kürzesten Entfernung von dem Rand angeordnet sind, größer ist als eine Entfernung von der nächsten der Öffnungen zu einer Mittelöffnung, die an einer Mitte der Gruppe von Öffnungen angeordnet ist.

Revendications

1. Bouchon à soufflage inférieur destiné à être fixé à un convertisseur à soufflage combiné capable de traiter 150 t ou plus de fer fondu à la fois, et comprenant un corps de bouchon ayant une face supérieure pour venir au contact du fer fondu, la face supérieure ayant un groupe d'ouvertures comprenant des ouvertures d'au moins 30 trous traversants et du gaz inerte étant injecté à 20 à 60 Nl/min par chacune des ouvertures, dans lequel
le groupe d'ouvertures est situé à une partie centrale de la face supérieure du corps de bouchon, et lorsque l'aire de la face supérieure est définie comme étant S_u cm^2 et l'aire d'une partie du groupe d'ouvertures est définie comme étant S_o cm^2 où le groupe d'ouvertures est situé, $S_o/S_u \leq 0{,}25$ et S_u $cm^2 \geq 400$ cm^2, et
la densité des ouvertures constituant le groupe d'ouvertures, qui est exprimée par le nombre d'ouvertures divisé par l'aire S_o de la partie du groupe d'ouvertures, est de 0,6 à 3,9 ouvertures/cm^2.

2. Bouchon à soufflage inférieur selon la revendication 1, dans lequel un pas P d'ouvertures adjacentes des ouvertures est de 6 à 12 mm.

3. Bouchon à soufflage inférieur selon la revendication 1 ou 2, dans lequel l'agencement relatif des ouvertures constituant le groupe d'ouvertures consiste en des ouvertures qui sont formées dans la face supérieure du corps de bouchon de façon à être situées respectivement à des sommets de triangles ou carrés réguliers ayant des côtés de P mm.

4. Bouchon à soufflage inférieur selon la revendication 1, 2 ou 3, dans lequel la distance d'une périphérie de la face supérieure à la plus proche des ouvertures située à la plus courte distance de la périphérie est plus longue que la distance de la plus proche des ouvertures à une ouverture centrale située au centre du groupe d'ouvertures.

Fig. 1

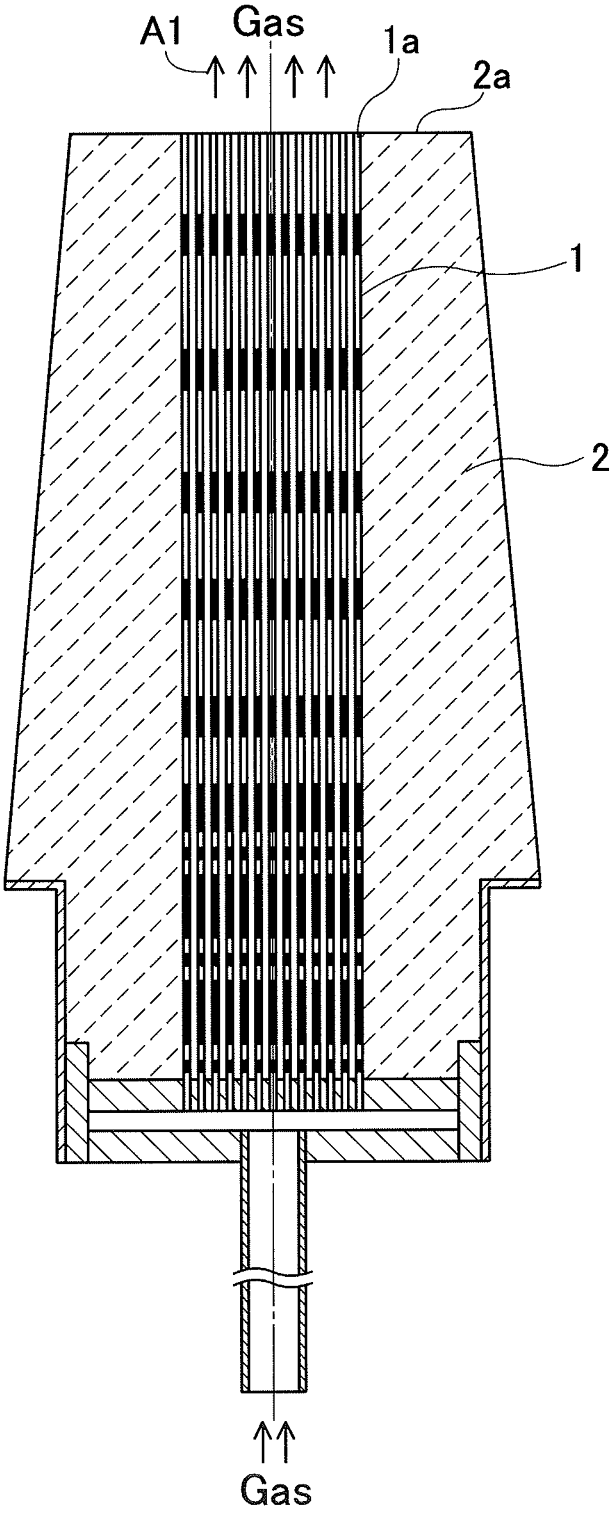


Fig. 2

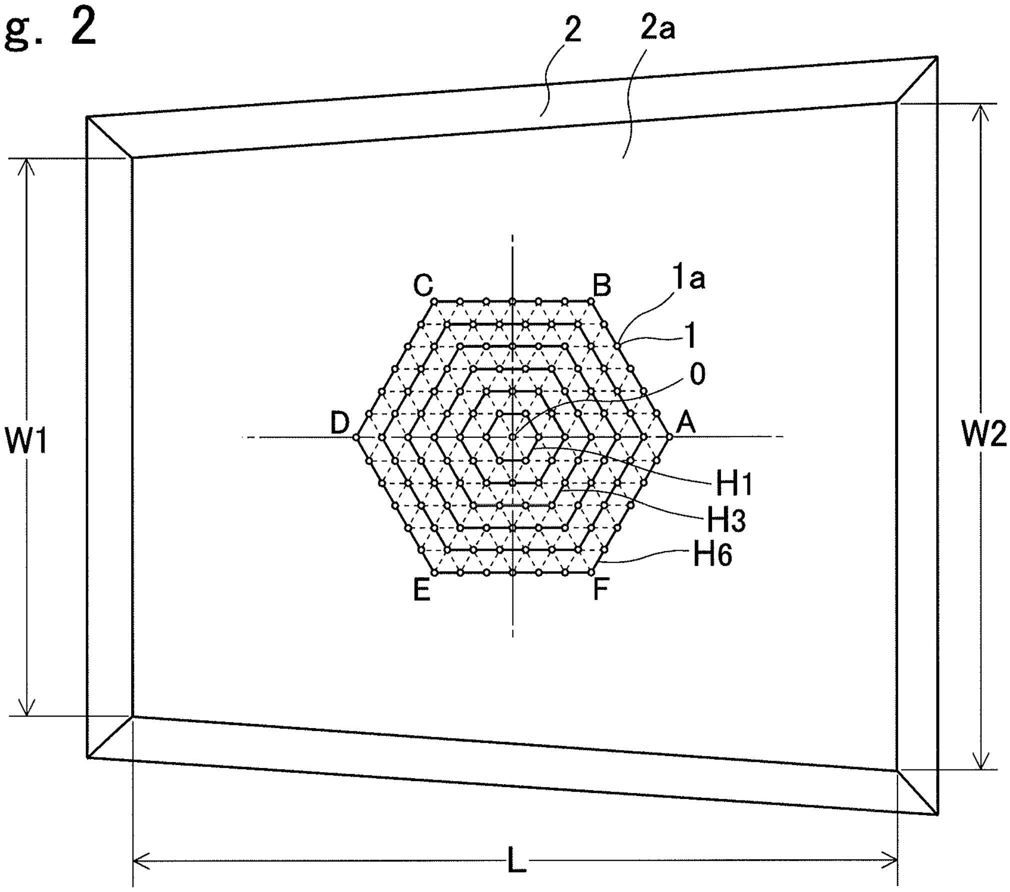


Fig. 3

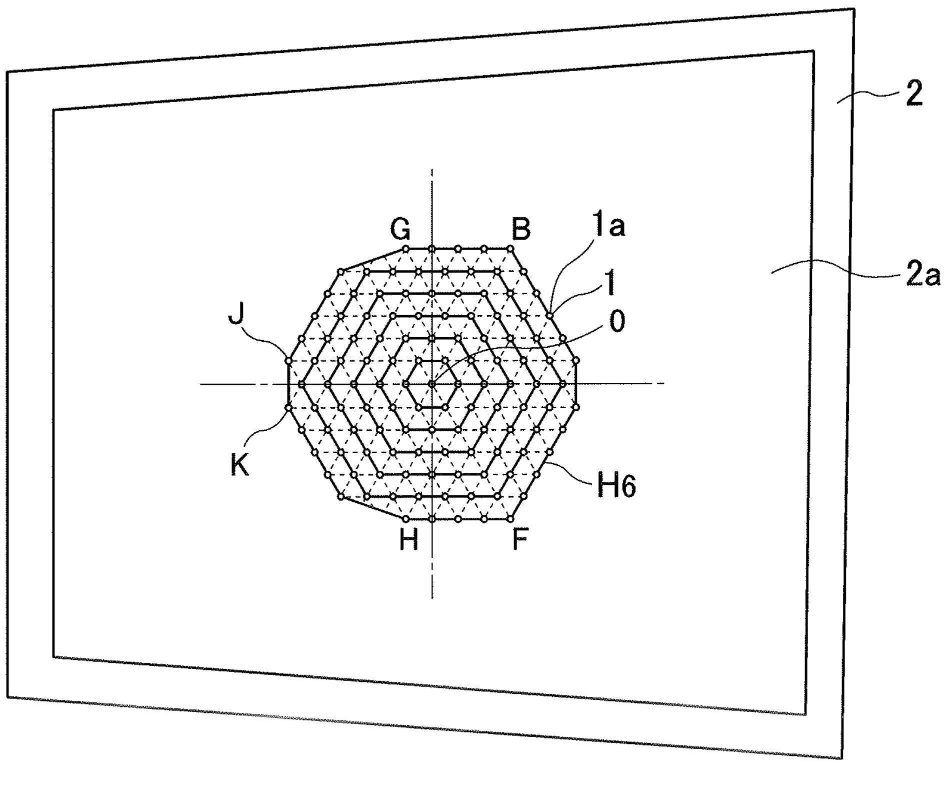
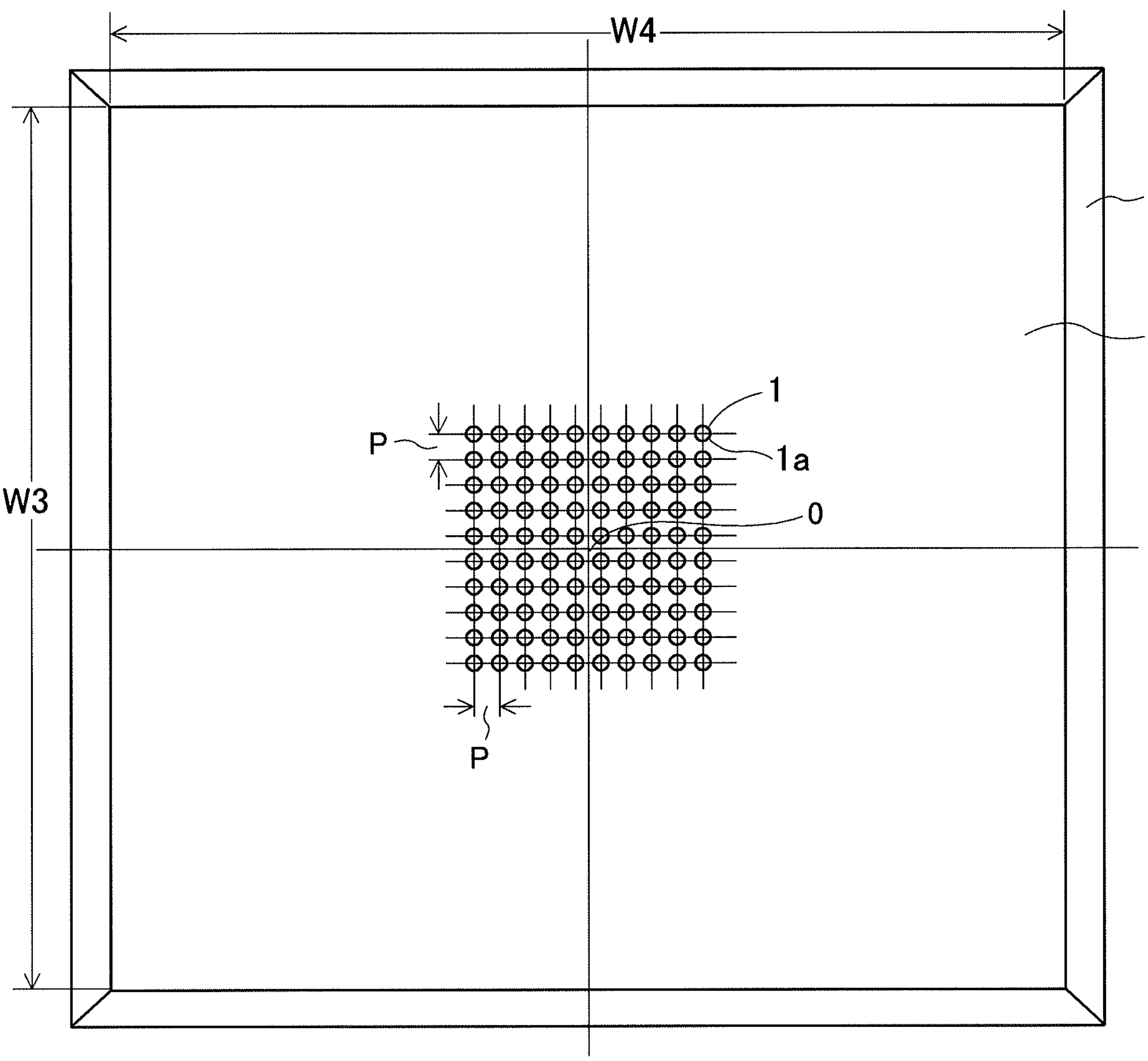


Fig. 4



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