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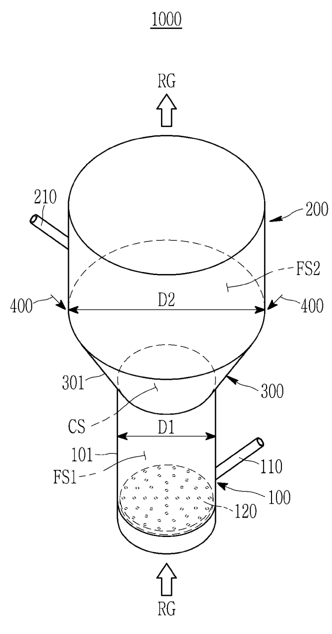
(54) **FLUIDIZED BED FURNACE**

(57) A fluidized bed furnace includes: a lower reactor which forms a first fluidized bed space having a first diameter, and which includes a discharge port through which reduced iron fines are discharged; an upper reactor which forms a second fluidized bed space having a second diameter greater than the first diameter, and which includes a charging port through which iron ore fines are charged; and a tapered part which forms a connecting space that allows communication between the first fluidized bed space and the second fluidized bed space, and which directly connects the lower reactor and the upper reactor.

FIG. 1



EP 3 889 532 A1

Description

[Technical Field]

[0001] The present disclosure relates to a fluidized bed furnace.

[Background Art]

[0002] In general, in the case of a melt reduction iron manufacturing facility that produces molten iron by using fine iron ore directly, it includes a plurality of fluidized bed furnaces for fluidized reduction treatment of fine iron ore.

[0003] The fluidized bed furnace reduces fine iron ore in powder form to fine reduced iron by using high temperature reducing gas supplied from a melting gas furnace.

[0004] A conventional fluidized bed furnace used fine iron ore with a particle size of substantially less than 8 mm, but recently, the use of ultra-fine iron ore iron with a smaller particle size is required.

[0005] However, when a large amount of ultra-fine iron ore is charged into the conventional fluidized bed furnace, problems that a stagnant layer is formed inside the fluidized bed furnace due to interaction between the ultra-fine iron ores, or large particles are formed due to fusion and agglomeration of the ultra-fine iron ore on an inner wall of the fluidized bed furnace, may occur.

[0006] In addition, in the conventional fluidized bed furnaces, extremely fine iron ore with a terminal velocity that is lower than an operating flow rate scattered inside the fluidized bed furnace must be recovered and re-injected by a cyclone inside the fluidized bed furnace, but since the efficiency of the cyclone decreases as the particle size of extremely fine iron ore, which is a scattered particle, decreases, there is a problem that scattering loss increases.

[Disclosure]

[Technical Problem]

[0007] An embodiment provides a fluidized bed furnace that can minimize scattering loss while minimizing fusion problems even though fine iron ores are charged.

[0008] In addition, a fluidized bed furnace that can use 100 % of ultra-fine iron ore as a raw material can be provided.

[Technical Solution]

[0009] One aspect of the present invention is to provide a fluidized bed furnace that includes: a lower reactor that forms a first fluidized bed space having a first diameter, and includes a discharge port through which fine reduced iron is discharged; an upper reactor that forms a second fluidized bed space having a second diameter that is greater than the first diameter, and includes a charging port through which fine iron ore is charged; and a tapered portion that forms a connection space that allows communication between the first fluidized bed space and the second fluidized bed space, and directly connects the lower reactor and the upper reactor.

[0010] The second diameter may be 3 to 4 times the first diameter.

[0011] An outer wall of the tapered portion may have an angle of 45 degrees to 75 degrees with a second diameter D2 direction.

[0012] The charging port may be higher than half the height of an outer wall of the upper reactor.

[0013] The discharge port may be lower than half the height of an outer wall 201 of the upper reactor 200 and may extend upward.

[0014] The fluidized bed furnace may further include a porous plate that is disposed between the second fluidized bed space and the connection space, and includes a plurality of through-holes.

[0015] The fluidized bed furnace may further include a stand pipe that extends from the second fluidized bed space through the porous plate to the first fluidized bed space, and is supported by the porous plate.

[0016] The fluidized bed furnace may further include a plurality of nitrogen purge supply pipes disposed along a circumferential direction of an outer wall of the upper reactor.

[0017] The fluidized bed furnace may further include a dispersion plate through which reduced gas supplied to the first fluidized bed space passes.

[Advantageous Effects]

[0018] According to the embodiment, a fluidized bed furnace that can minimize scattering loss while minimizing fusion problems even though fine iron ores are charged can be provided.

[0019] In addition, a fluidized bed furnace that can use 100 % of ultra-fine iron ore as a raw material can be provided.

[Description of the Drawings]

[0020]

FIG. 1 is a perspective view of a fluidized bed furnace according to a first embodiment.

FIG. 2 shows the nitrogen purge supply pipes illustrated in FIG. 1.

FIG. 3 shows the interior of the fluidized bed furnace according to the first embodiment.

FIG. 4 is a perspective view of a fluidized bed furnace according to a second embodiment.

FIG. 5 shows the interior of the fluidized bed furnace according to the second embodiment.

FIG. 6 is a perspective view of a fluidized bed furnace according to a third embodiment.

FIG. 7 shows the interior of the fluidized bed furnace according to the third embodiment.

[Mode for Invention]

[0021] The present invention will be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. As those skilled in the art would realize, the described embodiments may be modified in various different ways, all without departing from the spirit or scope of the present invention.

[0022] Accordingly, the drawings and description are to be regarded as illustrative in nature and not restrictive. Like reference numerals designate like elements throughout the specification.

[0023] In addition, unless explicitly described to the contrary, the word "comprise", and variations such as "comprises" or "comprising", will be understood to imply the inclusion of stated elements but not the exclusion of any other elements.

[0024] Hereinafter, referring to FIG. 1 to FIG. 3, a fluidized bed furnace according to a first embodiment will be described. A fluidized bed furnace may be included in a melt reduction iron-manufacturing facility, but is not limited thereto.

[0025] For example, the melt reduction iron-manufacturing facility may include at least one fluidized bed furnace for reducing fine iron ore to fine reduced iron, a compacting device for producing compacted material by pressing fine reduced iron, and a molten gas furnace, but are not limited thereto, and may further include various configurations. Fine reduced iron is charged into fluidized bed furnaces, and fine reduced iron reduced from the fluidized bed furnaces can be made into molten iron by being manufactured as compacted material in a compacting device and supplied to a melting gas furnace with coal briquettes. In addition, the reducing gas generated from the molten gas furnace can be supplied to fluidized bed furnaces.

[0026] FIG. 1 is a perspective view of a fluidized bed furnace according to a first embodiment.

[0027] Referring to FIG. 1, a fluidized bed furnace 1000 according to a first embodiment includes a lower reactor 100, an upper reactor 200, a tapered portion 300, and a plurality of nitrogen purge supply pipes 400.

[0028] The lower reactor 100 has a circular cylinder shape, and forms a first fluidized bed space FS1 with a first diameter D1 as a flat area.

[0029] In the first fluidized bed space FS1 of the lower reactor 100, a turbulent fluidized bed (or fast fluidized bed) is formed such that vigorous gas solid mixing may occur.

[0030] The lower reactor 100 includes a discharge port 110 through which fine reduced iron is discharged.

[0031] The fine reduced iron reduced from the fine reduced iron in the first fluidized bed space FS1 of the lower reactor 100 is discharged through the discharge port 110.

[0032] The lower reactor 100 includes a lower reactor 120 that passes reducing gas RG supplied to the first fluidized bed space FS1.

[0033] The lower reactor 100 includes a dispersion plate 120 for passing the reducing gas RG supplied to the first fluidized bed space FS1.

[0034] The dispersion plate 120 includes a plurality of through-holes through which the reducing gas RG passes. Reduced gas RG is supplied from a lower portion of the dispersion plate 120, and the reduced gas RG passes through the first fluidized bed space FS1 of the lower reactor 100 and the second fluidized bed space FS2 of the upper reactor 200, and is discharged to the upper portion of the upper reactor 200. The reduced gas RG can be generated from the molten gas furnace of the melt reduction iron-manufacturing facility, and the reduced gas RG discharged to the upper portion of the upper reactor 200 can be supplied to the lower portion of another fluidized bed furnace.

[0035] The upper reactor 200 has a circular cylinder shape that has a larger volume compared to the lower reactor 100. The upper reactor 200 forms a second fluidized bed space FS2 with a larger second diameter D2 compared to the first diameter D1 as a flat area.

[0036] The second diameter D2 may be 3 to 4 times the first diameter D1.

[0037] In the second fluidized bed space FS2 of the upper reactor 200, a minimum fluidized bed (or a bubbling fluidized bed) is formed due to the lower gas flow rate compared to the gas flow rate of the first fluidized bed space FS1.

[0038] The upper reactor 200 includes a charging port 210 into which fine iron ore is charged.

[0039] Fine iron ore is charged through the charging port 210 in the second fluidized bed space FS2 of the upper reactor 200.

[0040] The charging port 210 is disposed higher than half the height of an outer wall 201 of the upper reactor 200 and extends upward.

[0041] The tapered portion 300 directly connects between the lower reactor 100 and the upper reactor 200. The tapered portion 300 forms a connection space CS that communicates between the first fluidized bed space FS1 and the second fluidized bed space FS2.

[0042] An outer wall 301 of the tapered portion 300 may have an angle of 45 degrees to 75 degrees with a second diameter D2 direction.

[0043] The tapered portion 300, the lower reactor 100, and the upper reactor 200 may be integrally formed, but are not limited thereto.

[0044] A plurality of nitrogen purge supply pipes 400 are disposed along the circumferential direction of the outer wall 201 of the upper reactor 200.

[0045] FIG. 2 shows the nitrogen purge supply pipes illustrated in FIG. 1. In FIG. 2, (A) shows an example of the nitrogen purge supply pipe 400 connected to the upper reactor 200.

[0046] Referring to (A) of FIG. 2, the nitrogen purge supply pipe 400 is disposed on the lower portion of the outer wall 201 of the upper reactor 200, and is adjacent to the outer wall 301 of the tapered portion 300.

[0047] The nitrogen purge supply pipe 400 may extend in the same direction as the extension direction of the outer wall 301 of the tapered portion 300 in order to smooth the flow of the charged material from the upper reactor 200 to the tapered portion 300.

[0048] In FIG. 2, (B) shows an example of alignment of the plurality of nitrogen purge supply pipes 400 connected to the upper reactor 200.

[0049] Referring to (B) of FIG. 2, each of the plurality of nitrogen purge supply pipes 400 may be disposed to have an angle of 45 degrees with the center of the second fluidized bed space FS2 along the circumference of the outer wall 201 of the upper reactor 200.

[0050] In FIG. 2, (C) shows another example of alignment of the plurality of nitrogen purge supply pipes 400 connected to the upper reactor 200.

[0051] Referring to (C) of FIG. 2, each of the plurality of nitrogen purge supply pipes 400 may be disposed to have an angle of 30 degrees with the center of the second fluidized bed space FS2 along the circumference of the outer wall 201 of the upper reactor 200.

[0052] FIG. 3 shows the interior of the fluidized bed furnace according to the first embodiment. In FIG. 3, the solid flow can mean the flow of fine iron ore and fine reduced iron, and the solid presence region can mean the presence of fine iron ore and fine reduced iron.

[0053] Referring to FIG. 3, when fine iron ore IO1 is charged at the charging port 210 of the upper reactor 200 of the fluidized bed furnace 1000 where reduced gas RG is injected through the dispersion plate 120, a calm fluidized bed FB1 is formed in the second fluidized bed space FS2 due to the low gas flow rate.

[0054] The calm fluidized bed FB1 formed in the second fluidized bed space FS2 of the upper reactor 200 passes through the connection space CS of the tapered portion 300 and moves to the first fluidized bed space FS1 of the lower reactor 100, which is a turbulent region.

[0055] In the first fluidized bed space FS1 of the lower reactor 100, a turbulent fluidized bed FB2 is formed, thereby causing vigorous gas solid mixing. Accordingly, the occurrence of a fusion phenomenon in which fine reduced iron 102 reduced in the turbulent fluidized bed FB2 aggregates with each other is minimized.

[0056] The fine reduced iron 102 reduced in the lower reactor 100 is discharged to the outside of the lower reactor 100 through the discharge port 110 due to a pressure difference.

[0057] In the narrow first fluidized bed space FS1 of the lower reactor 100, the charge, which is the fine iron ore IO1, is reduced in the turbulent fluidized bed condition of the turbulent fluidized bed FB2.

[0058] Since the reduced gas RG and the fine iron ore IO1 are violently mixed by the rapid gas flow in the first fluidized bed space FS1 of the lower reactor 100, agglomeration of fine reduced iron IO2 reduced on the inner wall of lower reactor 100 or agglomeration of reduced particles by fusion between reduced particles is suppressed.

[0059] In the first fluidized bed space FS1 of the lower reactor 100, the reduction occurs rapidly due to a high gas/ore ratio. The fine reduced iron 102 reduced in the first fluidized bed space FS1 is discharged through the discharge port 110 due to the pressure difference.

[0060] The fine reduced iron IO2 reduced by vigorous mixing in the first fluidized bed space FS1 of the lower reactor 100 can be scattered to the second fluidized bed space FS2 of the upper reactor 200 together with the reduced gas RG moving to the upper reactor 200. However, since the gas flow rate is reduced by the second fluidized bed space FS2 of the upper reactor 200, which is significantly wider than the first fluidized bed space FS1 of the lower reactor 100, the fine reduced iron IO2 scattered into the second fluidized bed space FS2 falls directly by gravity into the first fluidized bed space FS1 in the lower reactor 100.

[0061] In the second fluidized bed space FS2 of the upper reactor 200, heat exchange with fine iron ore IO1 of the room temperature charged from the charging port 210 results in a lower temperature and gas/ore ratio compared to the first fluidized bed space FS1 of the lower reactor 100 such that a low reduction reaction occurs.

[0062] Thus, a problem of fusion of fine reduced iron IO2 does not occur due to a bubble fluidized bed atmosphere, which is the calm fluidized bed FB1, in the second fluidized bed space FS2 of the upper reactor 200, and in the first fluidized bed space FS1 of the lower reactor 100, the reduction of fine reduced iron IO2 is accelerated to a turbulent fluidized bed atmosphere, which is the turbulent fluidized bed FB2, and is discharged through the discharge port 110 to minimize the problem of fusion of fine reduced iron IO2.

[0063] That is, since the upper reactor 200, the lower reactor 100, and the tapered portion 300 are included, even though extremely fine iron ore is charged, the fluidized bed furnace 1000 that minimizes scattering loss and minimizes fusion problems is provided.

[0064] In addition, since the upper reactor 200, the lower reactor 100, and the tapered portion 300 are included, the fluidized bed furnace 1000 that can use 100 % of fine iron ore as a raw material is provided.

[0065] Hereinafter, referring to FIG. 4 and FIG. 5, a fluidized bed furnace according to a second embodiment will be described. Hereinafter, parts different from the fluidized bed furnace according to the first embodiment will be described.

[0066] FIG. 4 is a perspective view of a fluidized bed furnace according to a second embodiment.

[0067] Referring to FIG. 4, a fluidized bed furnace 1002 according to a second embodiment includes a lower reactor 100, an upper reactor 200, a tapered portion 300, a plurality of nitrogen purge supply pipes 400, and a porous plate 500.

[0068] The porous plate 500 is disposed between a second fluidized bed space FS2 of the upper reactor 200 and a connection space CS of the tapered portion 300, and includes a plurality of through-holes.

[0069] The porous plate 500 is disposed between the second fluidized bed space FS2 and the connection space CS, and serves as a partitioning wall between the second fluidized bed space FS2 and the first fluidized bed space FS1.

[0070] The porous plate 500 may physically separate the upper reactor 200 and the lower reactor 100.

[0071] FIG. 5 shows the interior of the fluidized bed furnace according to the second embodiment.

[0072] Referring to FIG. 5, when fine iron ore IO1 is charged at a charging port 210 of the upper reactor 200 of the fluidized bed furnace 1002 where reduced gas RG is injected through a dispersion plate 120, a calm fluidized bed FB1 is formed in the second fluidized bed space FS2 due to the low gas flow rate. The fine iron ore IO1 is partially reduced in the calm fluidized bed FB1 by the porous plate 500.

[0073] After that, when the fine reduced iron IO2 and fine iron ore IO1 that are partially reduced in the second fluidized bed space FS2 pass through the through-holes of the porous plate 500 and move to the lower reactor 100, a turbulent fluidized bed FB2 is formed in a first fluidized bed space FS1 of the lower reactor 100 due to the fast flow rate, resulting in vigorous gas solid mixing. Accordingly, the occurrence of a fusion phenomenon in which the fine reduced iron IO2 reduced in the turbulent fluidized bed FB2 aggregates is minimized.

[0074] The fine reduced iron IO2 reduced in the lower reactor 100 is discharged to the outside of the lower reactor 100 through the discharge port 110 due to a pressure difference.

[0075] That is, since the upper reactor 200, the lower reactor 100, the tapered portion 300, and the porous plate 500 are included, even though extremely fine iron ore is charged, the fluidized bed furnace 1002 that minimizes scattering loss and minimizes fusion problems is provided.

[0076] Since the upper reactor 200, the lower reactor 100, the tapered portion 300, and the porous plate 500 are included, the fluidized bed furnace 1002 that can use 100 % of fine iron ore as a raw material is provided.

[0077] Hereinafter, referring to FIG. 6 and FIG. 7, a fluidized bed furnace according to a third embodiment will be described. Hereinafter, parts different from the fluidized bed furnace according to the first embodiment will be described.

[0078] FIG. 6 is a perspective view of a fluidized bed furnace according to a third embodiment.

[0079] Referring to FIG. 6, a fluidized bed furnace 1003 according to a third embodiment includes a lower reactor 100, an upper reactor 200, a tapered portion 300, a plurality of nitrogen purge supply pipes 400, a porous plate 500, and a stand pipe 600.

[0080] The porous plate 500 is disposed between a second fluidized bed space FS2 of the upper reactor 200 and a connection space CS of the tapered portion 300, and includes a plurality of through-holes.

[0081] The porous plate 500 is disposed between the second fluidized bed space FS2 and the connection space CS, and serves as a partitioning wall between the second fluidized bed space FS2 and the first fluidized bed space FS1.

[0082] The porous plate 500 may physically separate the upper reactor 200 and the lower reactor 100.

[0083] The stand pipe 600 extends from the second fluidized bed space FS2 through the porous plate 500 to the first fluidized bed space FS1. The stand pipe 600 is supported on the porous plate 500 corresponding to the first fluidized bed space FS1 of the lower reactor 100.

[0084] The stand pipe 600 facilitates the flow of fine iron ore from the upper reactor 200 to the lower reactor 100.

[0085] FIG. 7 shows the interior of the fluidized bed furnace according to the third embodiment.

[0086] Referring to FIG. 7, when fine iron ore IO1 is charged at a charging port 210 of the upper reactor 200 of the fluidized bed furnace 1003 where reduced gas RG is injected through a dispersion plate 120, a calm fluidized bed FB1 is formed in the second fluidized bed space FS2 due to the low gas flow rate. The fine iron ore IO1 is partially reduced in the calm fluidized bed FB1 by the porous plate 500.

[0087] In this case, a part of the fine iron ore IO1 disposed in the second fluidized bed space FS2 smoothly moves from the second fluidized bed space FS2 of the upper reactor 200, which has a low pressure, to the first fluidized bed space FS1 of the lower reactor 100, which has a high pressure, through the stand pipe 600.

[0088] After that, when the fine reduced iron IO2 and fine iron ore IO1 that are partially reduced in the second fluidized bed space FS2 pass through the through-holes of the porous plate 500 and move to the lower reactor 100, a turbulent fluidized bed FB2 is formed in a first fluidized bed space FS1 of the lower reactor 100 due to the fast flow rate, resulting in vigorous gas solid mixing. Accordingly, the occurrence of a fusion phenomenon in which the fine reduced iron IO2 reduced in the turbulent fluidized bed FB2 aggregates with each other is minimized.

[0089] The fine reduced iron IO2 reduced in the lower reactor 100 is discharged to the outside of the lower reactor 100 through the discharge port 110 due to a pressure difference.

[0090] That is, since the upper reactor 200, the lower reactor 100, the tapered portion 300, the porous plate 500, and the stand pipe 600 are included, even though extremely fine iron ore is charged, the fluidized bed furnace 1003 that minimizes scattering loss and minimizes fusion problems is provided.

[0091] In addition, since the upper reactor 200, the lower reactor 100, the tapered portion 300, the porous plate 500, and the stand pipe 600 are included, the fluidized bed furnace 1003 that can use 100 % of fine iron ore as a raw material is provided.

[0092] While this invention has been described in connection with what is presently considered to be practical embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. On the contrary, it is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the appended claims.

- Description of symbols -

[0093] first fluidized bed space FS1, lower reactor 100, second fluidized bed space FS2, upper reactor 200, connection space CS, tapered portion 300

Claims

1. A fluidized bed furnace comprising:

a lower reactor that forms a first fluidized bed space having a first diameter, and includes a discharge port through which fine reduced iron is discharged;
an upper reactor that forms a second fluidized bed space having a second diameter that is greater than the first diameter, and includes a charging port through which fine iron ore is charged; and
a tapered portion that forms a connection space that allows communication between the first fluidized bed space and the second fluidized bed space, and directly connects the lower reactor and the upper reactor,
wherein a turbulent fluidized bed is formed in the first fluidized bed space, and a calm fluidized bed having lower a gas flow rate compared to a gas flow rate of the turbulent fluidized bed is formed in the second fluidized bed space.

2. The fluidized bed furnace of claim 1, wherein the second diameter is 3 to 4 times the first diameter.

3. The fluidized bed furnace of claim 1, wherein an outer wall of the tapered portion has an angle of 45 degrees to 75 degrees with a second diameter D2 direction.

4. The fluidized bed furnace of claim 1, wherein the charging port is higher than half the height of an outer wall of the upper reactor.

5. The fluidized bed furnace of claim 1, wherein the discharge port is lower than half the height of an outer wall 201 of the upper reactor 200 and extends upward.

6. The fluidized bed furnace of claim 1, further comprising a porous plate that is disposed between the second fluidized bed space and the connection space, and includes a plurality of through-holes.

7. The fluidized bed furnace of claim 6, further comprising a stand pipe that extends from the second fluidized bed space through the porous plate to the first fluidized bed space, and is supported by the porous plate.

8. The fluidized bed furnace of claim 1, further comprising a plurality of nitrogen purge supply pipes disposed along a circumferential direction of an outer wall of the upper reactor.

9. The fluidized bed furnace of claim 1, further comprising a dispersion plate through which reduced gas supplied to the first fluidized bed space passes.

FIG. 1

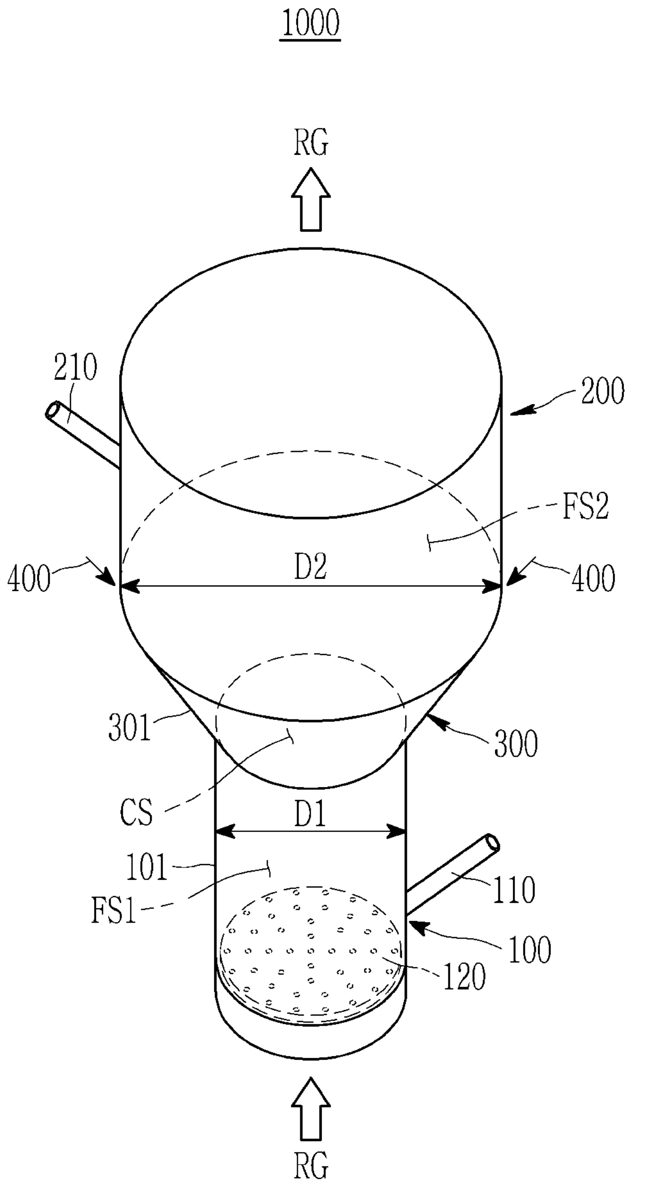
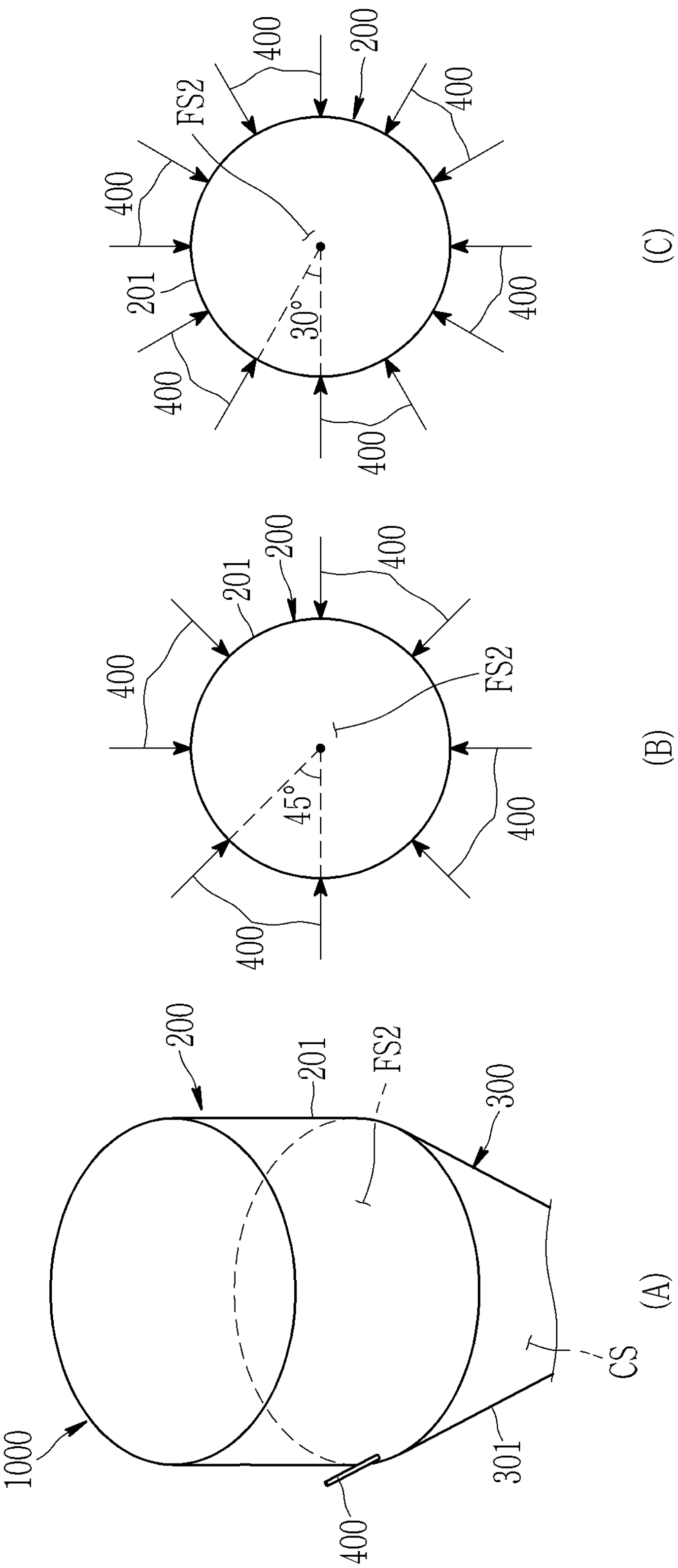

1000
RG
210
200
FS2
400
D2
400
301
300
CS
D1
101
110
FS1
100
120
RG

FIG. 2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FS2
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30°
(C)

FIG. 3

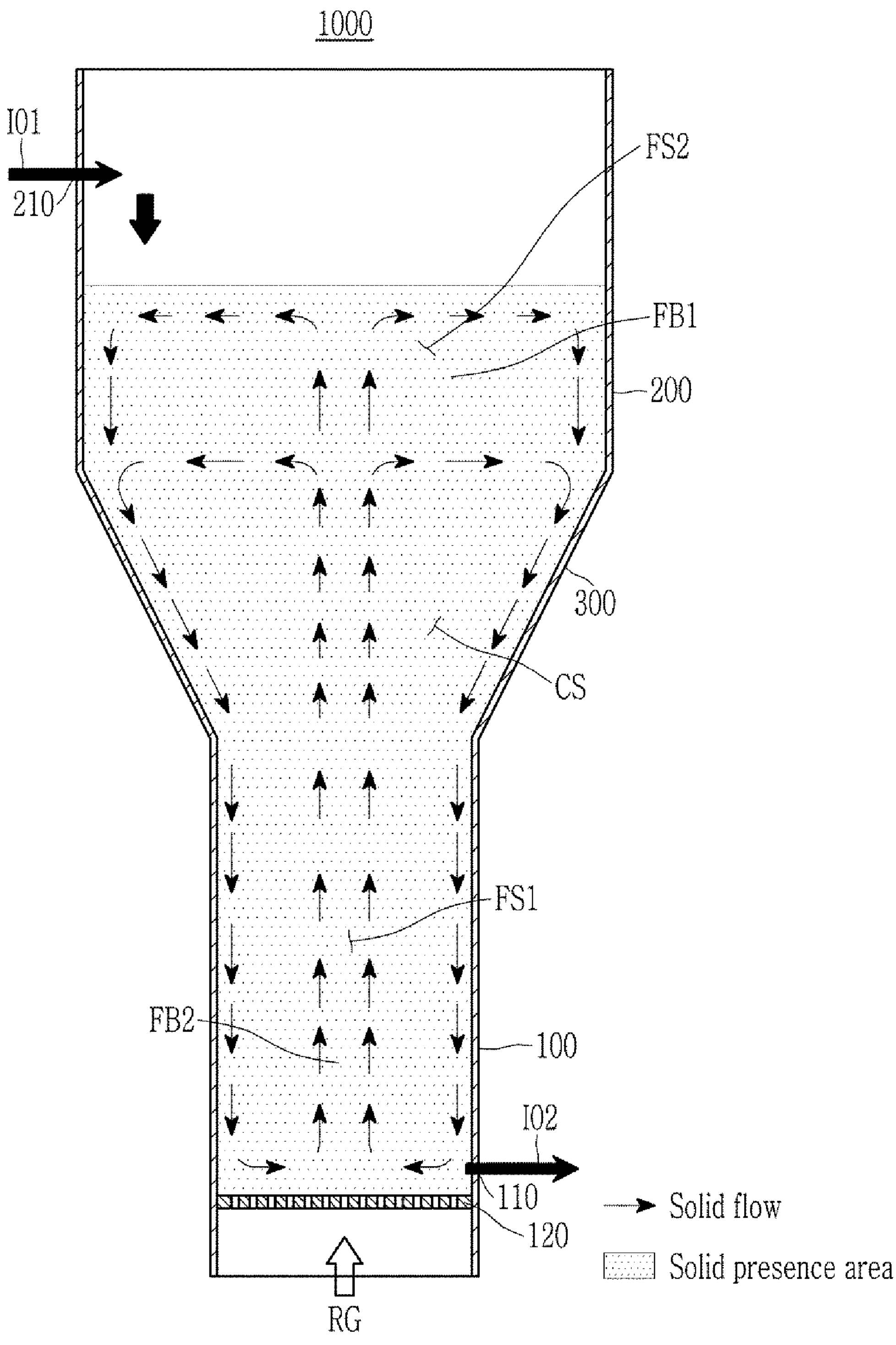
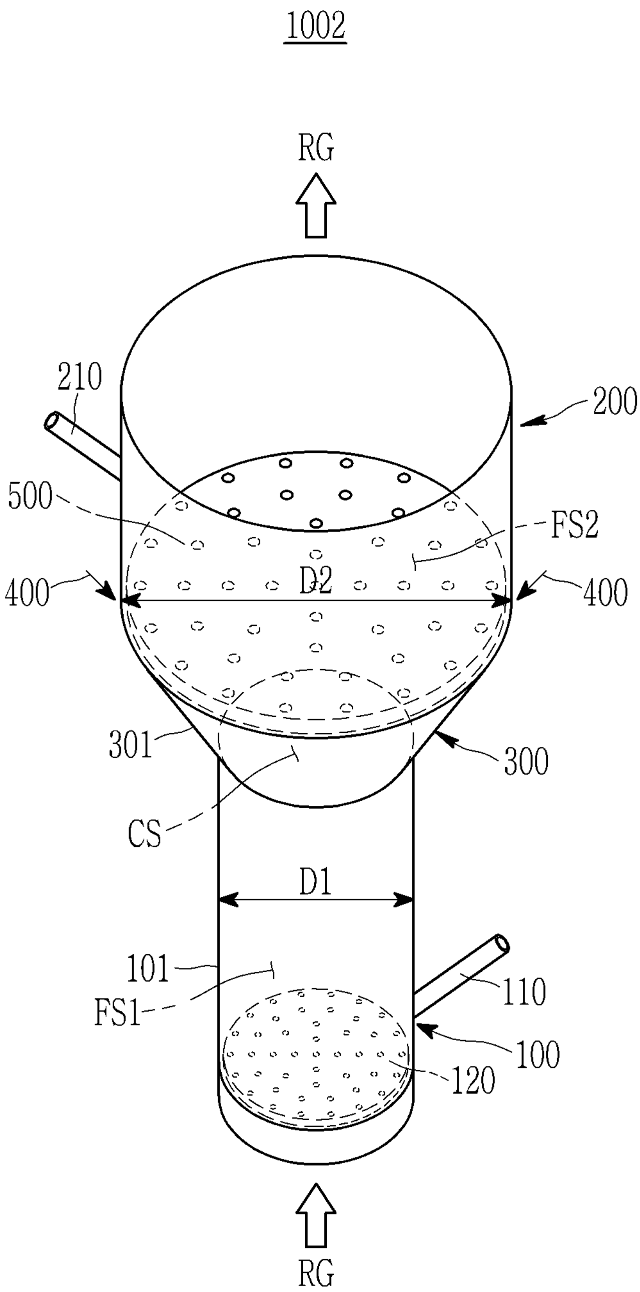

1000
I01
210
FS2
FB1
200
300
CS
FS1
FB2
100
I02
110
120
RG
Solid flow
Solid presence area

FIG. 4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RG
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FS2
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D2
400
301
300
CS
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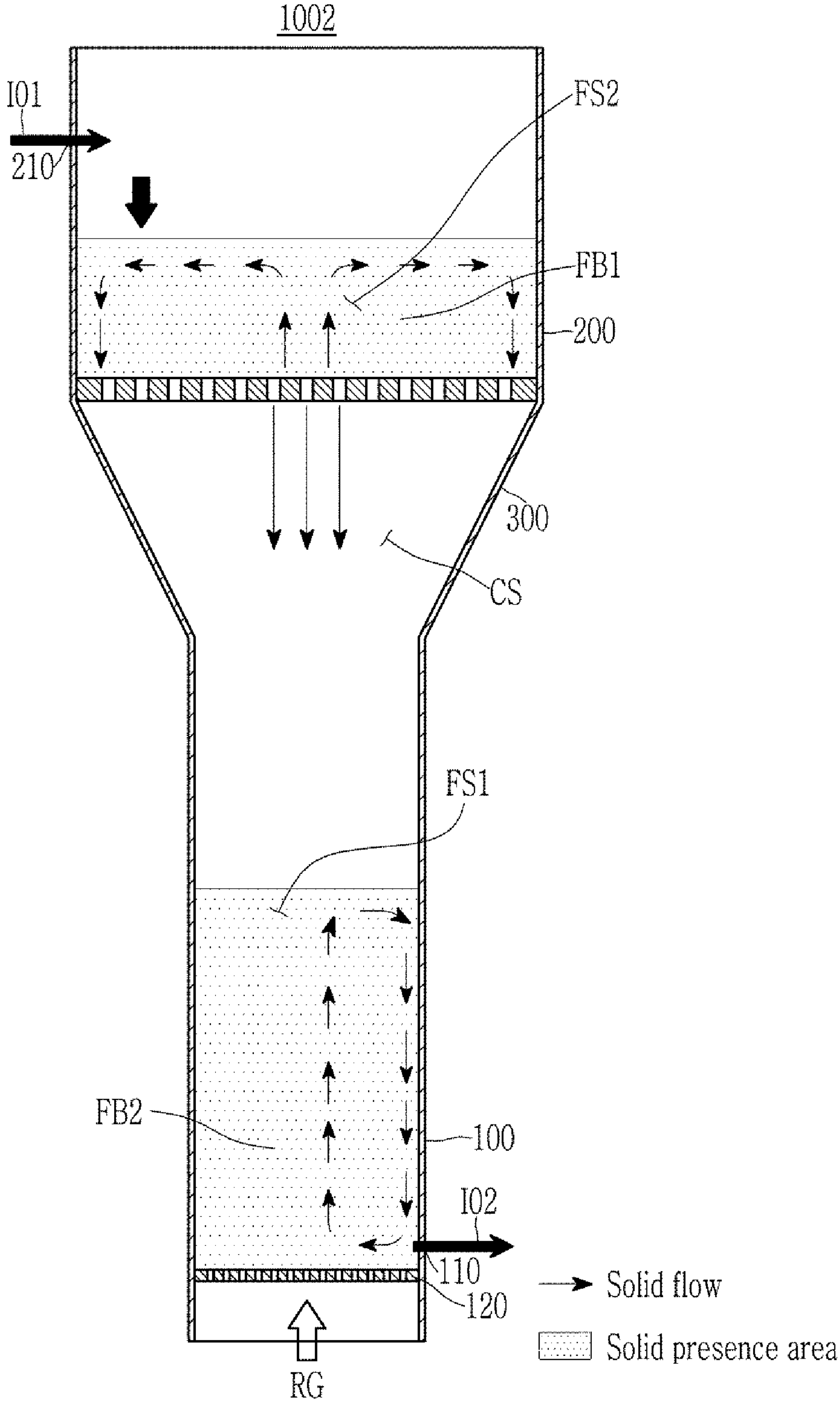
FS1
100
120
RG

FIG. 5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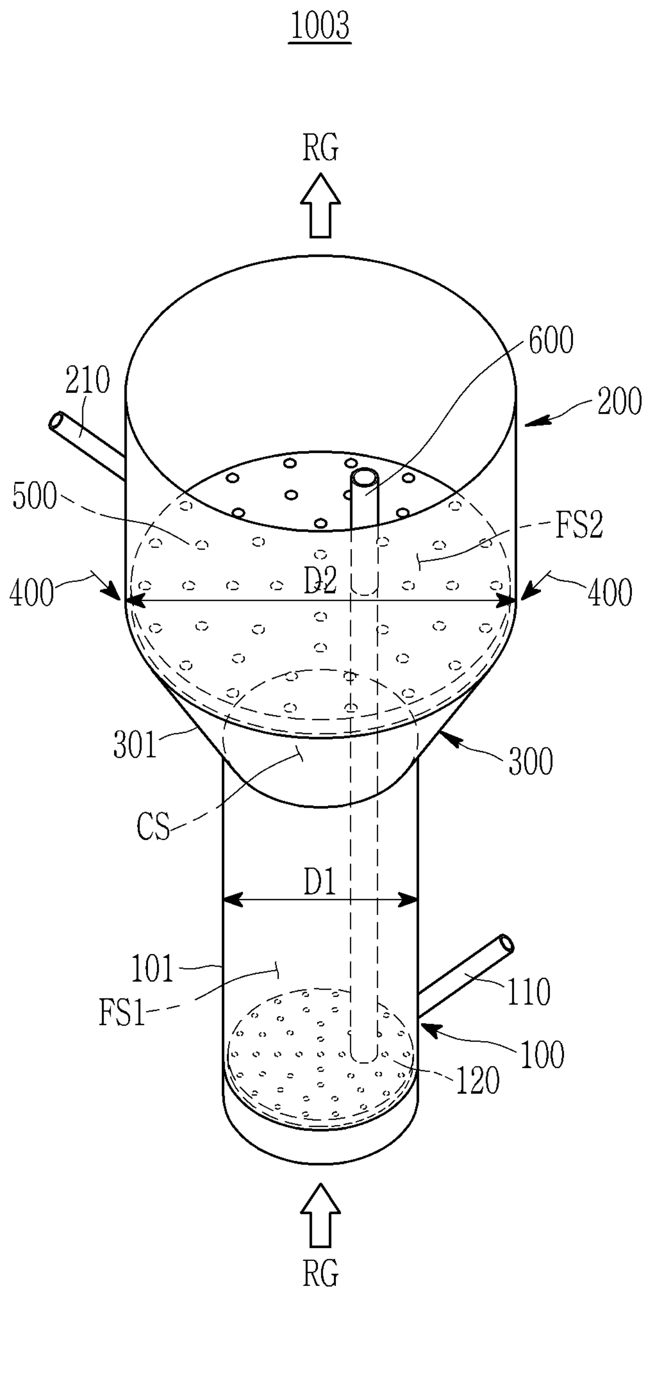
Solid flow
Solid presence area

FIG. 6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RG
600
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FS2
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D2
400
301
300
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D1
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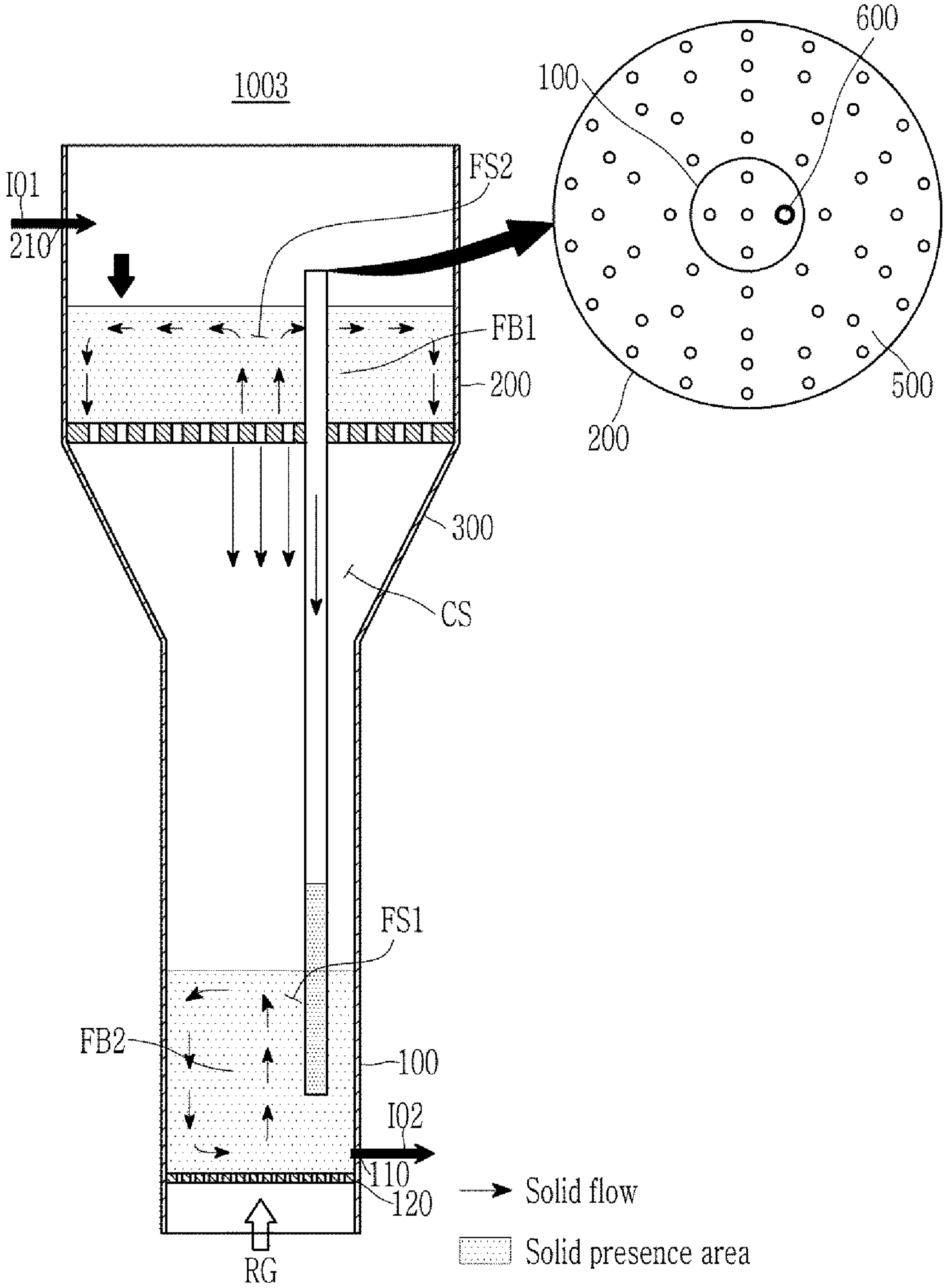
110
FS1
100
120
RG

FIG. 7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FB1
200
300
CS
FS1
FB2
100
I02
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120
RG
Solid flow
Solid presence area
600
100
500
200

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2019/016101

A. CLASSIFICATION OF SUBJECT MATTER

F27B 15/00(2006.01)i, F27B 15/08(2006.01)i, F27B 15/09(2006.01)i, F27B 15/10(2006.01)i, C21B 13/00(2006.01)i

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)
F27B 15/00; C21B 11/00; C21B 11/02; C21B 13/00; F27B 15/08; F27B 15/10; F27B 15/09

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models: IPC as above
Japanese utility models and applications for utility models: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS (KIPO internal) & Keywords: diameter, fluidized bed, outlet, reactor, iron ore, taper, flow rate, flow path

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 11-181510 A (KAWASAKI HEAVY IND., LTD.) 06 July 1999 See paragraphs [0026]-[0027]; and figure 1.	1-9
A	KR 10-2007-0068222 A (POSCO) 29 June 2007 See paragraphs [0041]-[0053]; and figure 2.	1-9
A	KR 10-1998-0702767 A (POHANG IRON AND STEEL CO., LTD. et al.) 05 August 1998 See claims 1-12; and figures 1-2.	1-9
A	JP 06-049520 A (KAWASAKI HEAVY IND., LTD.) 22 February 1994 See claim 1.	1-9
A	JP 11-504989 A (POHANG IRON & STEEL CO., LTD. et al.) 11 May 1999 See claims 1-3; and figures 1-4.	1-9

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

* Special categories of cited documents:
- "A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search	Date of mailing of the international search report
24 FEBRUARY 2020 (24.02.2020)	**26 FEBRUARY 2020 (26.02.2020)**

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