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(54) **Gasification reactor**

(57) The present invention relates to a gasification reactor comprising a gas injection grid and means for the continuous extraction of ashes that build up on the grid, comprising a scraping arm, assembled such that it rotates about an axis of rotation (X) normal to the grid and extending a certain distance over the grid; and an ash collection container with a bottom arranged at a level below the grid and sides laterally enveloping the grid, the scraping arm having a leading section configured in the shape of a spiral with the center in the axis of rotation (X) generating, as it moves with respect to the grid, radial movement of the ash built up on the grid beyond the contour thereof to be emptied into the bottom of the container by gravity.

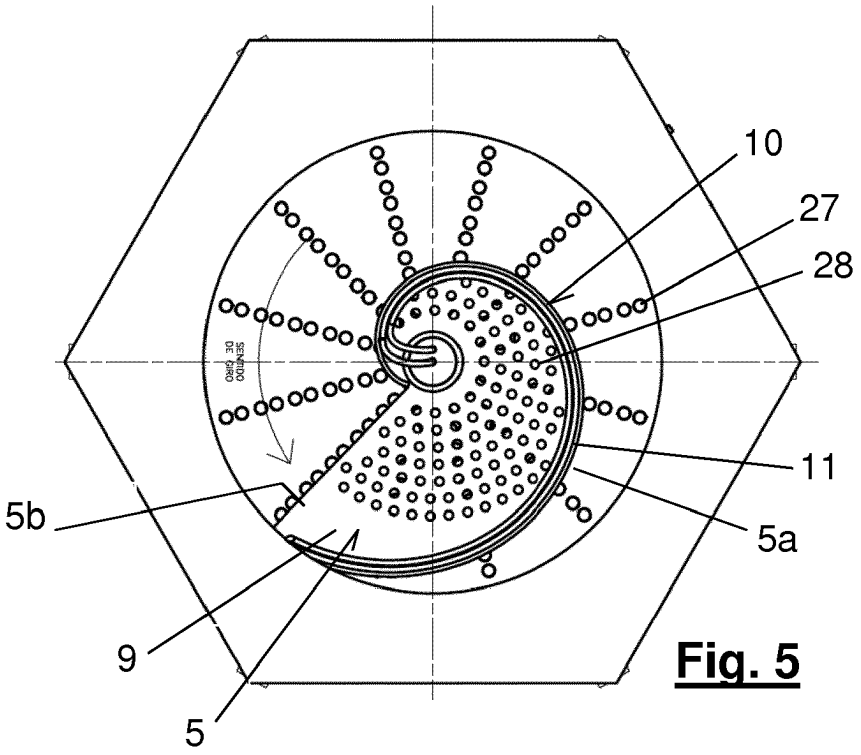

Fig. 5

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Description

Technical Field of the Invention

[0001] The invention relates to a gasification reactor of the type comprising a gasification chamber with a gas injection system arranged in its lower part for injecting gas into the gasification chamber, said gas injection system comprising a gas injection grid and means for the continuous extraction of ashes that build up in the gasification chamber on the grid.

Background of the Invention

[0002] Patent document US 2381200 discloses a gasification reactor that uses a water-cooled metal gasification chamber with a gas injection system arranged in its lower part for injecting gas into the gasification chamber.

[0003] This system comprises a conduit through which gas circulates and said conduit determining a concentric circumference with respect to the gasification chamber, the gas being injected through perforations made on the upper face of the conduit.

[0004] There are arranged on this conduit means for extracting ashes generated during the combustion of the fuel used, comprising a rotary annular plate forming, together with a central disc and an outer annular plate, annular passages for the passage of ashes to the bottom of a container. The moving parts have a type of blades for pushing the ashes towards these annular passages.

[0005] One drawback associated with this system is that the conduit through which gas circulates must be located in the vertical projection of one of the annular passages to assure that the gas reaches the gasification chamber in an upward direction. This causes the discharged ashes to fall precisely onto the conduit.

[0006] A gasification reactor for solid fuels also using a water-cooled metal gasification chamber with an alternative gas injection system arranged in its lower part for injecting gas into the gasification chamber was disclosed at the beginning of the 1980s.

[0007] This system comprises a grid for controlled injection of a gas, specifically gasification air, having a general frustoconical shape but with a stepped contour, a type of shelves being determined at a different height with passages for injecting the gas.

[0008] Patent document EP 2657321 describe means for extracting ashes generated inside the gasification chamber for use with a grid such as the one described above. These means comprise three overlapping, rotating discs eccentric with respect to the axis of the grid. The discs have a different diameter, the lower disc having the largest diameter and the upper disc having the smallest diameter, and passages are determined between the discs. The relative movement between the discs with the aid of a central blower and peripheral blowers, the latter being oriented essentially tangential to the discs, favor pulling up the ashes and redistributing them towards the periphery of the lower disc.

[0009] Generally the described systems have the drawback of not allowing the reactor to operate continuously when working with fuels that generate ash with a low melting point. Since these ashes melt in the high temperature area of the gasification chamber, they deposit on the conduit through which gas circulates in the first case, or on the grid in the second case, where they are cooled with the injected gas and solidify to form a slag which ultimately blocks the ash extraction passages or even affects gas injection in an unwanted manner.

[0010] An objective of the invention is to disclose a reactor with a gas injection system comprising a grid and means for extracting ash that provide an alternative to the known systems, allowing the reactor to operate continuously even when using fuels with ash with a low melting point, such as, for example, household waste, industrial waste and agricultural waste, such as corncob.

[0011] Another objective of the invention is a reactor with a gas injection system having a simple construction that is easy to inspect and repair.

[0012] Another secondary objective of the invention is a reactor the means for extracting ash of which are prepared for working in a high temperature environment without degrading or deteriorating.

[0013] Another secondary objective of the invention is a reactor suitable for reducing the temperature in the gasification chamber in the combustion area close to the grid, thus successfully reducing the effect of melting ash.

Disclosure of the Invention

[0014] The gasification reactor of the invention comprises a gasification chamber with a gas injection system arranged in its lower part for injecting gas into the gasification chamber, said gas injection system comprising a gas injection grid and means for the continuous extraction of ashes that build up in the gasification chamber on the grid.

[0015] The reactor is essentially characterized in that these means for extracting ash comprise a scraping arm assembled such that it rotates about an axis of rotation (X) normal to the grid and extending a certain distance over the grid; operating means for operating the scraping arm according to a direction of rotation; and an ash collection container with a bottom arranged at a level below the grid and sides laterally enveloping the grid, a passage being determined between the contour of said grid and the sides of the container for driving the ashes that are emptied from the grid to the bottom of the container, the scraping arm having a leading section configured in the shape of a spiral with the center in the axis of rotation (X) generating, as it moves with respect to the grid, a radial movement of the ash built up on the grid beyond the contour thereof to be emptied into the bottom of the container by gravity.

[0016] In one embodiment, the scraping arm is formed by a perforated plate for the passage of the gas injected

from the grid, with a curved edge emerging from a portion close to the axis of rotation (X) and determining the leading section of the scraping arm, which follows the shape of an Archimedean spiral making a single turn about the axis of rotation (X), and with a straight edge which, following a radial direction, links the ends of the curved edge and determines the trailing section of the scraping arm.

[0017] According to one variant of the invention, the scraping arm is provided with first cooling means comprising a circuit through which a coolant circulates.

[0018] The invention envisages that the grid forms the upper lid of a gas supply chamber for supplying gas which is injected through the grid, and that an operating shaft of the scraping arm goes through said supply chamber.

[0019] According to one embodiment, the operating shaft of the scraping arm is hollow and the coolant circulating through the circuit of the first cooling means is introduced in and extracted from said circuit through the mentioned operating shaft.

[0020] In one variant, a conduit the upper end of which connects with one of the inlet or outlet of the circuit of the first cooling means extends internally through the operating shaft, concentrically to the axis of rotation (X), the operating shaft comprising an upper hole hydraulically communicating the cavity of the operating shaft with the other one of the inlet or outlet of the circuit.

[0021] A variant is contemplated in which the operating shaft comprises a lower hole communicating the cavity of the operating shaft with the outside by means of a first swivel joint and in which a pipe communicating with the conduit by means of a second swivel joint is introduced into the operating shaft through this lower hole.

[0022] The operating means for operating the scraping arm can comprise a ring integral with the lower end of the operating shaft of the scraping arm meshing with a pinion driven by a drive mechanism.

[0023] Confining the ring within the vertical projection of the grid is of interest.

[0024] In one variant of the invention, the grid is formed by a metal base provided with second cooling means, a series of nozzles or diffusers communicating the gas supply chamber with the gasification chamber going through said metal base.

[0025] As the scraping arm is formed by a perforated plate, the number of holes in the plate per unit area is preferably greater than the number of nozzles going through the grid per unit area.

[0026] The clearance area of the nozzles is preferably greater than the clearance area of the holes of the perforated plate forming the scraping arm.

[0027] In one embodiment, the gasification chamber has a hexagonal cross-section.

[0028] The gasification chamber can be closed in the upper portion by an inclined lid provided with a fuel feeding device (30) comprising a rotary valve communicating with a feed conduit that prolongs into the gasification chamber.

[0029] According to another aspect of a variant of the invention, the gasification chamber comprises a first outlet for the synthesis gas obtained during normal operation of the reactor, being arranged on one side of the mentioned gasification chamber; and a second outlet for the synthesis gas for the sudden expulsion of the synthesis gas in an emergency, being arranged in the lid of the gasification chamber and provided with valve means arranging it such that it is normally closed.

Brief Description of the Drawings

[0030]

Figure 1 is a schematic view according to a longitudinal section plane of a reactor according to the invention;

Figure 2 is a view of the gas injection system of the reactor of Figure 1;

Figure 3 is a detailed view of the part of the gas injection system of the reactor indicated by means of a square with a dashed line in Figure 2 according to another longitudinal section plane; and

Figures 4 and 5 are respective views of the reactor of Figure 1 according to section planes BB and AA.

Detailed Description of the Drawings

[0031] Figure 1 shows an embodiment of a gasification reactor 1 according to the invention. This reactor 1 comprises a steel gasification chamber 2 cooled by means of a series of parallel tubes through which water circulates, said tubes being attached to one another by means of a metal membrane thus forming a leak-tight cooled wall.

[0032] A gas injection system 3 for injecting gas, which can be air, a vapor and air mixture or another mixture of gases, into the gasification chamber 2 is arranged in the lower part of the reactor 1.

[0033] The gas injection system 3 comprises a gas injection grid 4 formed in the example by a disc-shaped metal base having a planar upper area, and means for the continuous extraction of ashes that build up in the gasification chamber 2 on the grid 4.

[0034] The mentioned means for extracting ashes comprise in the example a scraping arm 5 assembled such that it rotates about an axis of rotation (X) normal to the grid 4 and extending a certain distance over the upper area of the grid 4. In the example, the axis of rotation (X) is concentric to the grid 4.

[0035] The scraping arm 5 is formed by a perforated plate 9 (see Figure 5) for the purpose of allowing the passage therethrough of the gas injected from the grid 4 even when the plate 9 covers part of said grid 4.

[0036] The plate 9 has a curved edge emerging from a portion close to the axis of rotation (X) and determining the leading section 5a of the scraping arm 5. This leading section follows a spiral curve with the center in the axis of rotation (X) generating, as the scraping arm rotates

with respect to the grid 4 in the direction indicated by the arrow in Figure 5, radial movement of the ash built up on the grid 4 beyond the contour thereof to be emptied into the bottom of a container 7 by gravity.

[0037] In the illustrated embodiment, the spiral curve is an Archimedean spiral making a single turn about the axis of rotation (X) such that the plate 9 has a straight edge which, following a radial direction, links the ends of the spiral curved edge and determines the trailing section 5b of the scraping arm 5.

[0038] As will be described in more detail below, the scraping arm 5 is provided with first cooling means 10 comprising a circuit 11 through which a coolant circulates to prevent possible problems in the scraping arm 5 due to the high operating temperatures reachable inside the reactor 1. These first cooling means 10 further contribute to lowering the temperature in this area of the gasification chamber 2.

[0039] Figure 2 shows that the grid 4 forms the upper lid of a gas supply chamber 12 for supplying gas which is injected through the grid 4. In turn, the metal base forming the grid 4 is double-walled and has a series of partitions forming passages or a maze for water circulation, which provides the grid 4 with second cooling means 26 contributing to preventing the ashes from melting.

[0040] This enables continuous gasification of fuels generating ashes with a low melting point.

[0041] A series of nozzles 27 or diffusers communicating the gas supply chamber 12 with the gasification chamber 2 goes through the metal base.

[0042] Figure 5 shows that the number of holes 28 in the plate 9 forming the scraping arm 5 per unit area is greater than the number of nozzles 27 going through the grid 4 per unit area. Likewise, the clearance area of the nozzles 27 is greater than the clearance area of the holes 28 of the perforated plate 9.

[0043] The reactor 1 is provided with operating means 6 for operating the scraping arm 5 according to the direction of rotation indicated by the arrow in Figure 5.

[0044] The operating means illustrated in Figure 3 comprise a hollow operating shaft 13 that goes through the gas supply chamber 12. The cavity 21 of the operating shaft 13 is used for supplying the coolant, preferably water, to and extracting it from the circuit 11 of the first cooling means 10 associated with the scraping arm 5.

[0045] In fact, Figure 3 shows that this coolant circulating through the circuit 11 is introduced in and extracted from said circuit through the operating shaft 13. Specifically, Figure 3 illustrates a cross-section of this part of the reactor 1, where it can be seen that a conduit 17, the upper end of which connects with one of the inlet 18 or outlet 19 of the circuit 11 of the first cooling means 10, extends internally through the operating shaft 13, concentrically to the axis of rotation (X), the operating shaft comprising 13 an upper hole 20 hydraulically communicating the cavity 21 of the operating shaft 13 with the other one of the inlet or outlet of the circuit 11.

[0046] In turn, the lower end 13b of the operating shaft 13 is prepared for the hydraulic connection of the circuit 11 with the coolant feeding and return circuits fixed to the frame of the reactor 1.

[0047] For such purpose, the operating shaft 13 has been provided with a lower hole 22 communicating the cavity 21 of the operating shaft 13 with one of the feeding circuit or return circuit by means of a first swivel joint 23. A pipe 24 communicating the conduit 17, by means of a second swivel joint 25, with the other of the coolant feeding circuit or coolant return circuit is introduced into the operating shaft 13 through this lower hole 22.

[0048] Figure 2 also shows that the ash collection container 7 comprises a bottom 7a arranged at a level below the gas supply chamber 12 and sides 7b laterally enveloping the grid 4, an annular passage 8 being determined between the contour of said grid 4 and the sides 7b of the container 7 for driving the ashes that are emptied from the grid to the bottom 7a of the container 7.

[0049] It must be pointed out that the operating means 6 for operating the scraping arm 5 comprise a ring 14 integral with the lower end 13b of the operating shaft 13 of the scraping arm 5 meshing with a pinion 15 driven by a drive mechanism 16, with the particularity that this ring 14 is confined within the vertical projection of the grid 4, i.e., without reaching the vertical projection of the passage 8 determined between the contour of the grid 4 and the sides 7b of the container 7 for the passage of the ashes that are emptied from the grid 4 to the bottom 7a of the container 7. Advantageously, the passage of the ashes emptied from the grid 4 is not blocked.

[0050] The drive mechanism 16 can be hydraulic or electric with the corresponding reduction in speed and transmission of mechanical power that is transmitted to the operating shaft 13. The torque transmitted to the scraping arm 5 is suitable for cutting and removing any possible solidified ash portion (in the event that it has previously melted).

[0051] The reactor 1 comprises at the bottom 7a of the container 7 a set of rotary blades 37 integral with a motorized rotating shaft 38. Figure 4 shows the shape and distribution of these rotary blades 37 that stirs up the ashes in detail.

[0052] The bottom 7a of the container is flat and the existence of an inspection hatch 39 is also envisaged.

[0053] As regards the gasification chamber 2, it has a hexagonal cross-section which reduces manufacturing costs compared to costs associated with a cylindrical gasification chamber, while at the same time it allows systems with a more reliable construction and better final quality.

[0054] The gasification chamber 2 is closed in the upper portion by an inclined lid 29 provided with a fuel feeding device 30 comprising a rotary valve 31 which, by means of lugs rotating inside a casing, allows introducing solid fuel into the gasification chamber 2 without losing the hydraulic seal of the reactor 1.

[0055] A feed conduit 32 that prolongs into the gasification chamber 2 is placed in the discharge opening of

the rotary valve 31, preventing the fuel from being entrained by the gas stream leaving the gasification chamber 2 through the first outlet 33 during normal operation of the reactor, without said fuel having first reacted in a desired manner.

[0056] The mentioned first outlet 33 is arranged on one side of the gasification chamber 2 and the exit of synthesis gases is controlled with a hydraulically or pneumatically actuated guillotine gate 36.

[0057] There is also envisaged in the lid 29 of the reactor 1 a second outlet 34 communicating with an exhaust duct for the gas produced inside the gasification chamber 2 acting as an auxiliary outlet for emergency situations, from where the gas is driven by means of metal conduits to a flare which in turn is responsible for burning the gases released during these emergency periods. The second outlet 34 is provided with valve means 35 arranging it such that it is normally closed.

Claims

1. A gasification reactor (1) comprising a gasification chamber (2) with a gas injection system (3) arranged in its lower part for injecting gas into the gasification chamber, said gas injection system comprising a gas injection grid (4) and means for the continuous extraction of ashes that build up in the gasification chamber on the grid, **characterized in that** these means for extracting ashes comprise

   - a scraping arm (5) assembled such that it rotates about an axis of rotation (X) normal to the grid (4) and extending a certain distance over the grid;
   - operating means (6) for operating the scraping arm (5) according to a direction of rotation; and
   - an ash collection container (7) with a bottom (7a) arranged at a level below the grid (4) and sides (7b) laterally enveloping the grid, a passage (8) being determined between the contour of said grid and the sides of the container for driving the ashes that are emptied from the grid to the bottom of the container,

   the scraping arm (5) having a leading section (5a) configured in the shape of a spiral with the center in the axis of rotation (X) generating, as it moves with respect to the grid, lateral movement of the ash built up on the grid beyond the contour thereof to be emptied into the bottom of the container by gravity.

2. The gasification reactor (1) according to claim 1, **characterized in that** the scraping arm (5) is formed by a perforated plate (9) for the passage of gas injected from the grid (4), with a curved edge emerging from a portion close to the axis of rotation (X) and determining the leading section (5a) of the scraping arm, which follows the shape of an Archimedean spiral making a single turn about the axis of rotation (X), and with a straight edge which, following a radial direction, links the ends of the curved edge and determines the trailing section (5b) of the scraping arm.

3. The reactor (1) according to any one of the preceding claims, **characterized in that** the scraping arm (5) is provided with first cooling means (10) comprising a circuit (11) through which a coolant circulates.

4. The reactor (1) according to any one of the preceding claims, **characterized in that** the grid (4) forms the upper lid of a gas supply chamber (12) for supplying the gas which is injected through the grid, and **in that** an operating shaft (13) of the scraping arm (5) goes through said supply chamber.

5. The reactor (1) according to claims 3 and 4, **characterized in that** the operating shaft (13) of the scraping arm is hollow, and **in that** the coolant circulating through the circuit (11) of the first cooling means (10) is introduced in and extracted from said circuit through the mentioned operating shaft (13).

6. The reactor (1) according to the preceding claim, **characterized in that** a conduit (17) the upper end of which connects with one of the inlet (18) or outlet (19) of the circuit (11) of the first cooling means (10) extends internally through the operating shaft (13), concentrically to the axis of rotation (X), the operating shaft (13) comprising an upper hole (20) hydraulically communicating the cavity (21) of the operating shaft (13) with the other one of the inlet or outlet of the circuit.

7. The reactor (1) according to the preceding claim, **characterized in that** the operating shaft (13) comprises a lower hole (22) communicating the cavity (21) of the operating shaft with the outside by means of a first swivel joint (23), and **in that** a pipe (24) communicating with the conduit (17) by means of a second swivel joint (25) is introduced into the operating shaft (13) through this lower hole (22).

8. The reactor (1) according to any one of claims 4 to 7, **characterized in that** the operating means (6) for operating the scraping arm (5) comprise a ring (14) integral with the lower end (13b) of the operating shaft (13) of the scraping arm (5) meshing with a pinion (15) driven by a drive mechanism (16).

9. The reactor (1) according to the preceding claim, **characterized in that** the ring (15) is confined within the vertical projection of the grid (4).

10. The reactor (1) according to any one of claims 4 to 9, **characterized in that** the grid (4) is formed by a

metal base provided with second cooling means (26), a series of nozzles (27) or diffusers communicating the gas supply chamber (12) with the gasification chamber (2) going through said metal base.

11. The reactor (1) according to the preceding claim, **characterized in that** as the scraping arm (5) is formed by a perforated plate (9), the number of holes (28) in the plate per unit area is greater than the number of nozzles (27) going through the grid (4) per unit area.

12. The reactor (1) according to claim 10 or 11, **characterized in that** the clearance area of the nozzles (27) is greater than the clearance area of the holes (28) of the perforated plate (9) forming the scraping arm (5).

13. The reactor (1) according to any one of the preceding claims, **characterized in that** the gasification chamber (2) has a hexagonal cross-section.

14. The reactor (1) according to any one of the preceding claims, **characterized in that** the gasification chamber (2) is closed in the upper portion by an inclined lid (29) provided with a fuel feeding device (30) comprising a rotary valve (31) communicating with a feed conduit (32) that prolongs into the gasification chamber.

15. The reactor (1) according to any one of the preceding claims, **characterized in that** the gasification chamber (2) comprises

- a first outlet (33) for the synthesis gas obtained during normal operation of the reactor, being arranged on one side of the mentioned gasification chamber (2), and
- a second outlet (34) for the synthesis gas for the sudden expulsion of the synthesis gas in an emergency, being arranged in the lid (29) of the gasification chamber (2) and provided with valve means (35) arranging it such that it is normally closed.

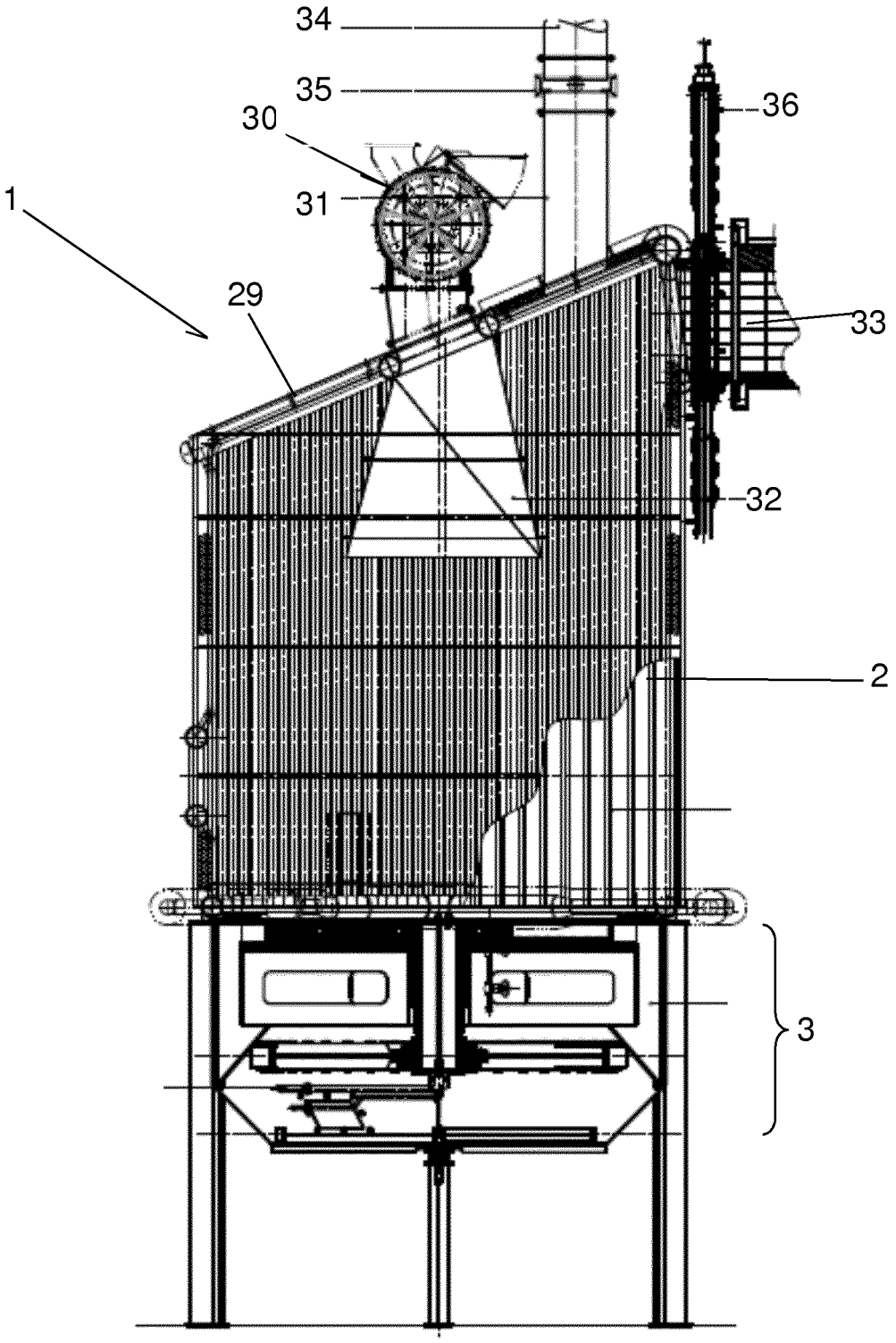

Fig. 1

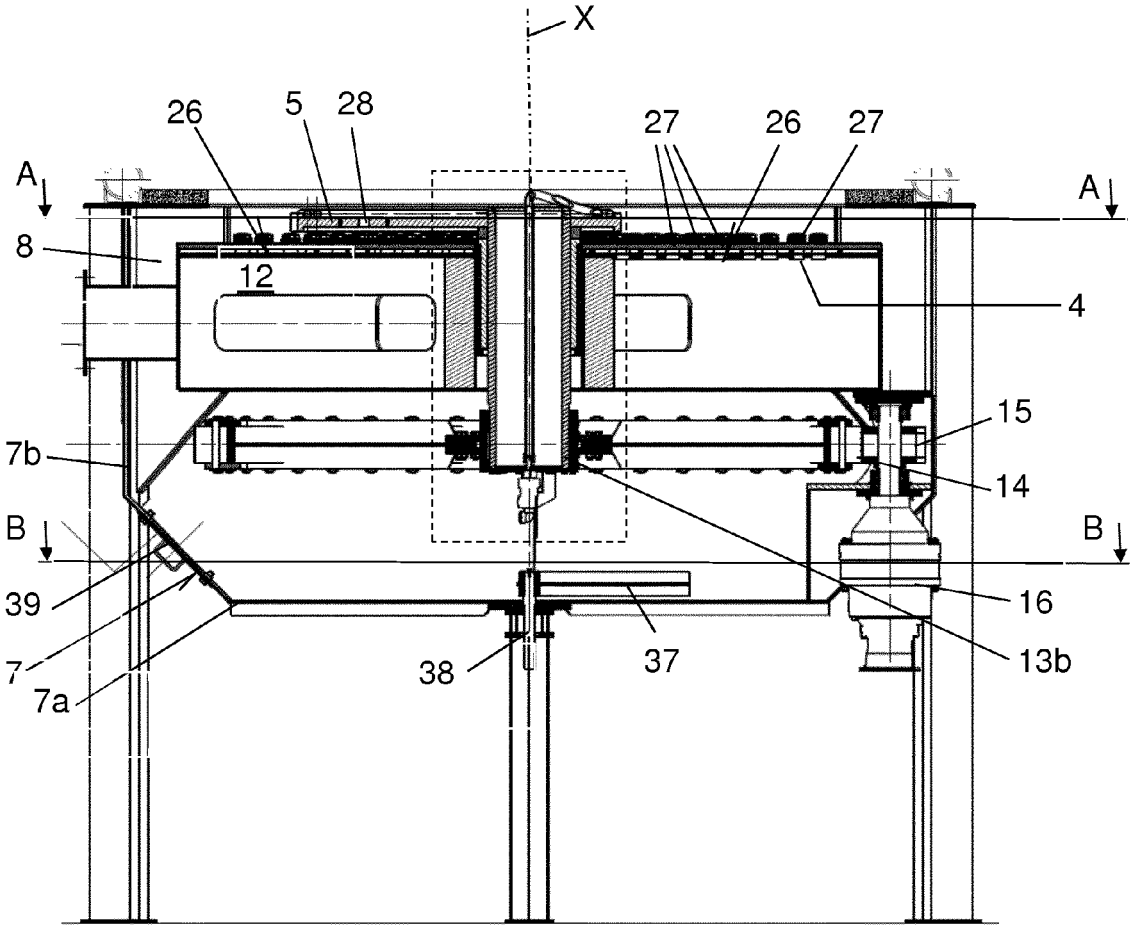

Fig. 2

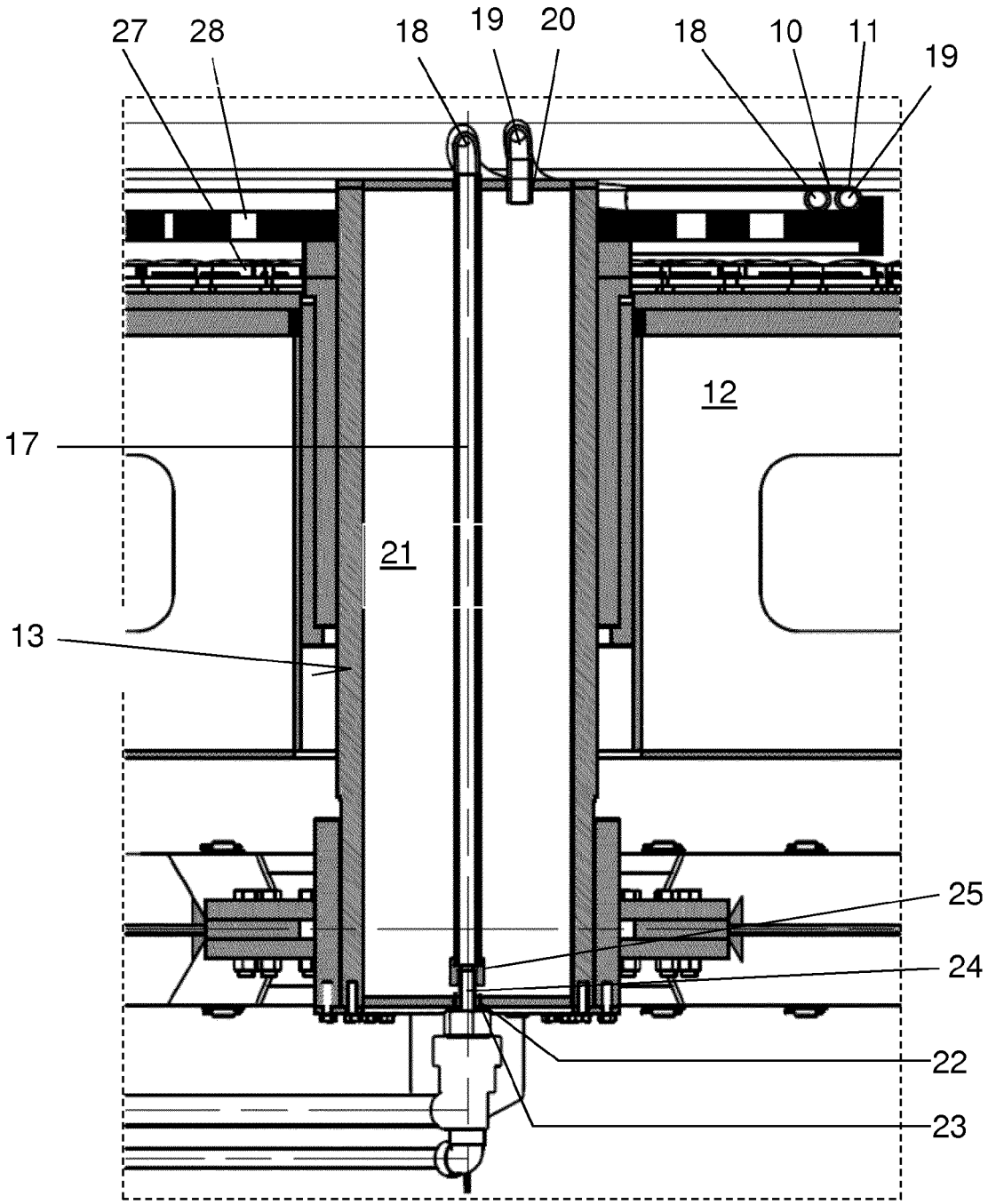

Fig. 3

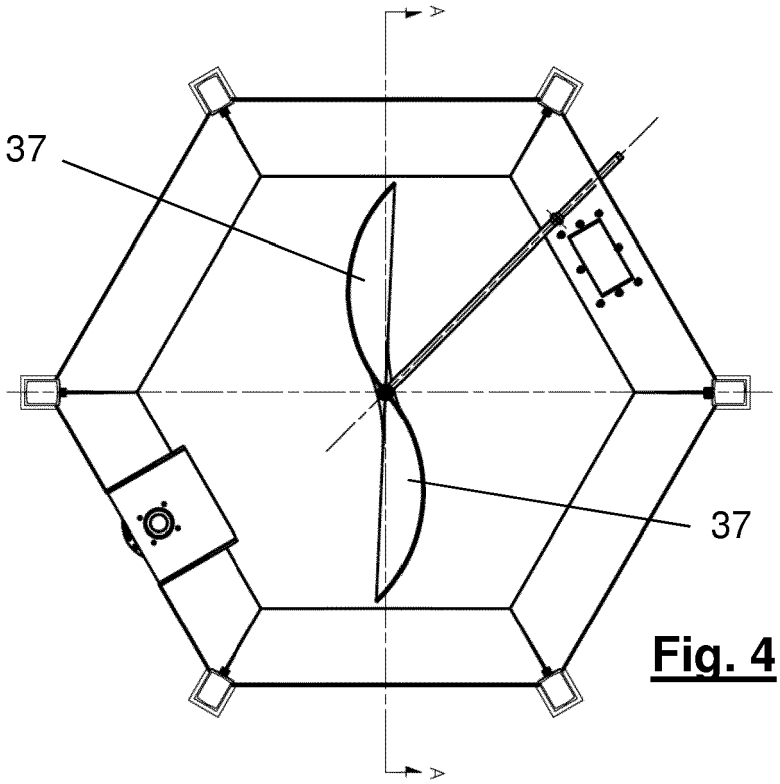

Fig. 4

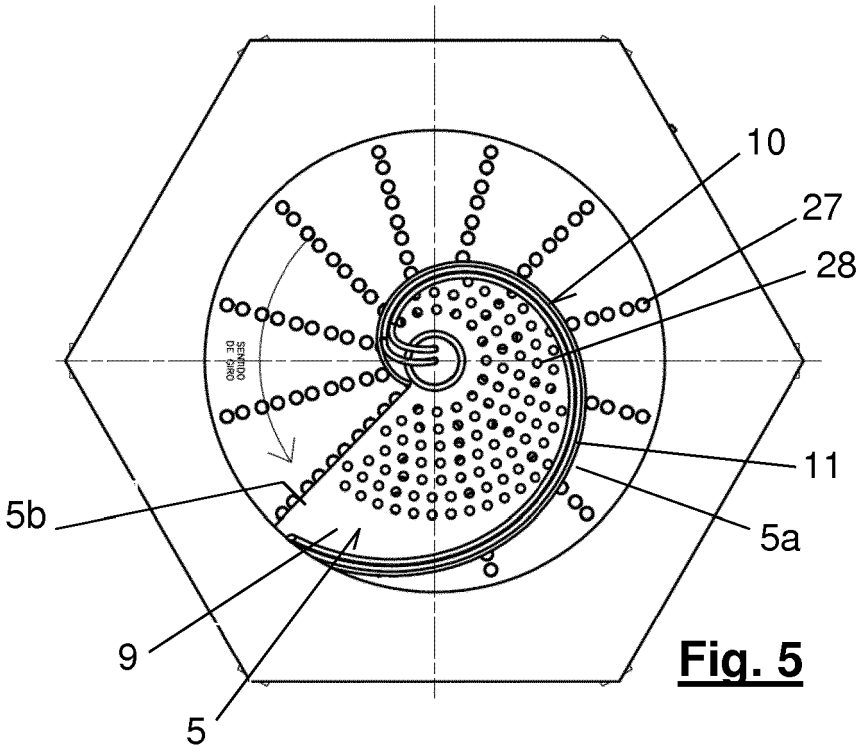

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 14 16 8348

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,D	US 2 381 200 A (BLAKE ALFRED E) 7 August 1945 (1945-08-07)	1,4, 7-10, 12-15	INV. C10J3/42 F23H15/00
Y	* page 1, line 32 - page 2, line 25; figures 1, 2 *	2,3,5,6, 11	

Y	US 2 080 410 A (CRUIKSHANK VIRGINIUS M) 18 May 1937 (1937-05-18) * figure 2 *	2,11	

Y	EP 2 476 953 A2 (METSO POWER OY [FI]) 18 July 2012 (2012-07-18) * paragraph [0009] - paragraph [0017]; figures 1, 4 *	3,5,6	

A	BE 404 558 A (C.A. FELL) 3 August 1934 (1934-08-03) * the whole document *	1-15	

A	US 3 902 872 A (RUDOLPH PAUL) 2 September 1975 (1975-09-02) * the whole document *	1-15	

TECHNICAL FIELDS SEARCHED (IPC)

C10J
F23H
F23B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	24 June 2014	Iyer-Baldew, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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24-06-2014

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2381200 A	07-08-1945	NONE	
US 2080410 A	18-05-1937	NONE	
EP 2476953 A2	18-07-2012	BR 102012001037 A2	29-10-2013
		CA 2764199 A1	18-07-2012
		CN 102607020 A	25-07-2012
		EP 2476953 A2	18-07-2012
		FI 20115049 A	19-07-2012
		RU 2012101608 A	27-07-2013
		US 2012180708 A1	19-07-2012
BE 404558 A	03-08-1934	NONE	
US 3902872 A	02-09-1975	DE 2352900 B1	03-04-1975
		GB 1443293 A	21-07-1976
		US 3902872 A	02-09-1975
		ZA 7404541 A	30-07-1975

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 2381200 A **[0002]**
- EP 2657321 A **[0008]**