

(19) **DANMARK**

(10) **DK/EP 2997307 T3**



(12)

Oversættelse af europæisk patentskrift

Patent- og
Varemærkestyrelsen

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- (51) Int.Cl.: **F 23 C 10/00 (2006.01)** **F 23 G 5/30 (2006.01)**
- (45) Oversættelsen bekendtgjort den: **2017-08-28**
- (80) Dato for Den Europæiske Patentmyndigheds bekendtgørelse om meddelelse af patentet: **2017-07-05**
- (86) Europæisk ansøgning nr.: **14728236.2**
- (86) Europæisk indleveringsdag: **2014-05-13**
- (87) Den europæiske ansøgnings publiceringsdag: **2016-03-23**
- (86) International ansøgning nr.: **FI2014050356**
- (87) Internationalt publikationsnr.: **WO2014184437**
- (30) Prioritet: **2013-05-14 FI 20135507**
- (84) Designerede stater: **AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR**
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- (54) Benævnelse: **ANORDNING OG FREMGANGSMÅDE I KEDEL MED FLUIDISERET LEJE-TEKNOLOGI**
- (56) Fremdragne publikationer:
EP-A1- 1 030 150
GB-A- 2 297 608
US-A1- 2007 012 230
STEINRUCK P: "EIN NEUES WIRBELSCHICHT-VERBRENNUNGS- VERFAHREN ZUR THERMISCHEN VERWERTUNG VON ABFALLSTOFFEN", CHEMIE INGENIEUR TECHNIK, WILEY VCH. VERLAG, WEINHEIM; DE, vol. 61, no. 11, 1 November 1989 (1989-11-01), pages 889-891, XP000133546, ISSN: 0009-286X, DOI: 10.1002/CITE.330611109

DESCRIPTION

Background

[0001] The invention relates to an arrangement comprising a boiler using fluidized-bed technology.

[0002] The invention further relates to a method for a boiler using fluidized-bed technology.

[0003] In boilers using fluidized-bed technology, such as bubbling fluidized bed boilers (BFB), the temperature of the bed is adjusted to a required level by grate dimensioning, primary air volume and circulation gas. When using certain fuels, such as dry agro fuels, the volume of circulation gas may become very large, because the temperature of the fluidized bed typically needs to be kept at 600 to 750°C to prevent sintering.

[0004] The problem is that a large circulation gas volume decreases efficiency and increases the size of the convection part of the boiler and the internal consumption. Further, even though sintering is prevented in the fluidized bed, there is often also the problem of extensive fouling of the walls of the furnace by ash compounds melting in low temperature. Large ash layers may then fall into the fluidized bed and cause disruptions in the process, especially in the floating of the bed, in the removal of bottom ash and in emissions. The result is that the proportion of the agro fuels, for instance, need to be limited in the fuel and the degree of use of the plant may be poor. Document "Ein neues Wirbelschicht-Verbrennungs- verfahren zur thermischen verwertung von Abfallstoffen" by Steinruck P, in Chemie Ingenieur Technik, Wiley Vhc. Verlag, Weinheim; DE, vol. 61, no. 11, 1 Nov. 1989 (1989-11-01), pgs. 889-891, WP000133546, ISSN: 0009-286X, DOI: 10.1.1002/CITE.330611109 discloses an arrangement in a boiler using fluidized-bed technology. The disclosed boiler comprises two zones in its furnace and a partition wall therebetween.

Brief description

[0005] The arrangement and method of the invention are characterised by what is disclosed in the characterising parts of the independent claims. Other embodiments of the invention are characterised by what is disclosed in the other claims.

[0006] Inventive embodiments are also disclosed in the specification and drawings of this application.

[0007] The idea of the invention is that the boiler is divided by a partition wall and roof structure into two sections or spaces, in the first of which fuel is gasified and in the second of which the fuel is burned.

[0008] The advantage is that it is possible to use, even without limitations, fuels, the ash of which melts in low temperatures. Another advantage may be the flexibility of the boiler in relation to the fuels that can be burned in it. Yet another advantage may be a better efficiency and reduced internal consumption due to the fact, among other things, that less high-pressure air is required to maintain a smaller fluidized bed and that less sand mass is required, which means that the bed weighs less and the structure of the boiler can be correspondingly lightened.

[0009] The idea of an embodiment is that the arrangement comprises at least two first spaces that are arranged on different sides of a second space of a furnace. The advantage is that the arrangement can be efficiently applied to large-scale boilers.

[0010] The idea of an embodiment is that it comprises nozzles arranged at the bottom or in the bottom part of the second space of the furnace for feeding bottom air. The advantage is that any fuel that ends up at the bottom of the second space can be burned.

[0011] The idea of an embodiment is that the partition wall and/or roof structure is at least partly made of a membrane wall connected to the water/vapour circulation of the boiler. The advantage is that the recovery of thermal energy can be improved and the thermal expansions of the partition wall and/or roof structure can be controlled.

[0012] The idea of an embodiment is that the partition wall comprises a bend that increases the rigidity of the partition wall.

[0013] The idea of an embodiment is that the partition wall extends to a distance from the roof structure, whereby the gap between them forms a flow path. The advantage is that a flow path is achieved that has a low flow resistance.

[0014] The idea of an embodiment is that the partition wall and/or roof structure is at least partly made of a membrane wall connected to the water/vapour circulation of the boiler and that the membrane walls are connected to each other through a lattice pipe system, and the gaps in the lattice pipe system form the flow path. The advantage is that the recovery of thermal energy is boosted and a partition wall - roof structure having good strength is formed.

[0015] The idea of an embodiment is that the roof structure comprises a bottom surface that is arranged to ascend to the end of the roof structure, and a top surface that is arranged to descend to the end of the roof structure.

[0016] The advantage is that the bottom surface guides gases toward the second space and the top surface guides the residue falling from the walls of the second space to the bottom of the second space.

Brief description of the drawings

[0017] Some embodiments of the invention are explained in more detail in the accompanying drawings, in which

Figure 1 is a schematic sectional side view of an arrangement of the invention,

Figure 2 is a schematic view of an embodiment of a detail of the arrangement according to the invention in cross-section,

Figure 3a is a schematic sectional side view of a second arrangement of the invention,

Figure 3b is a schematic view of the cross-section of the detail of the arrangement shown in Figure 3a, and

Figure 4 is a schematic sectional side view of a third arrangement of the invention.

[0018] For the sake of clarity, the figures show some embodiments of the invention in a simplified manner. In the figures, like reference numerals identify like elements.

Detailed description

[0019] Figure 1 is a schematic sectional side view of an arrangement and method of the invention.

[0020] In this embodiment, the boiler 10 is a bubbling fluidized bed boiler (BFB). The boiler 10 may be supported from below and/or the top.

[0021] A BFB boiler, like other boiler types based on fluidization, is especially well suited for burning so-called poor-grade fuels, such as wet biomasses, sludges, recycled fuels, and waste coals; naturally other fuels can also be used. According to an idea, the boiler is used in burning so-called agro fuels. An agro fuel refers to straw, straw pellets, palm oil waste or any other waste produced in agricultural production, for example. Agro fuels typically originate from fast-growing plants and, thus, contain lots of alkalis, chlorine and phosphor.

[0022] The boiler 10 comprises a furnace that is divided into two spaces: a first space 1 and a second space 2. The boiler also has, among other things, a flue gas channel and channels for feeding combustion air, fuel, reagents and other additives possibly needed in burning into the furnace 2. Thermal energy generated in the thermal process taking place in the boiler 10 can be recovered by means of walls formed of water pipes and other heat delivery surfaces. However, it should be noted that the figures do not show all details of the boiler 10 to simplify the presentation.

[0023] The path of the gas is shown by arrows G.

[0024] The first space 1 of the furnace comprises means known per se for forming 21 a fluidized bed, and from the second space 2, they are missing.

[0025] Fuel F is fed to the first space of the furnace with appropriate means that comprise, among other things, one or more feed channels 4. The feed channel 4 is preferably directed to the middle of the bottom 15 of the first space, whereby the entire surface area of the bottom 15 is utilized as well as possible.

[0026] The boiler 10 may be a front wall-fed furnace as shown in Figure 1 or a side wall-fed furnace.

[0027] The boiler 10 comprises nozzles 22 for feeding primary air and/or circulation gas into the first space 1 of the furnace. According to an idea, only an amount of air required for the fluidization and the gasification of the fuel is fed into the first space 1. The amount of necessary circulation gas is also rather small due to the small surface area of the grate in the first space. If necessary, the temperature of the first space 1 is adjusted with circulation gas in such a manner that it is below the sintering temperature, that is, typically below 750°C. Circulation gas comprises flue gases generated during the process in the boiler 10. According to an idea, a sub-stoichiometric state prevails in the first space 1 and its air coefficient may be 0.2 to 0.5, for instance, depending on the used fuel.

[0028] A partition wall 3 and roof structure 5 are arranged between the first space 1 and the second space 2. The partition wall 3 is at least mainly vertical, whereas the roof structure 5 arranged above the first space 1 forms a horizontally extending obstacle or space divider between the first space 1 and part of the second space 2 above it.

[0029] The partition wall 3 extends to a distance from the roof structure 5, whereby the gap between them forms a flow path 18. Gases rising from the fluidized bed can flow through the flow path 18 from the first part 1 to the second part 2 as shown by arrow G.

[0030] The partition wall 3 may have additional functional features, for instance in the partition wall shown in Figure 1, there is a bend 17 that increases the rigidity of the wall 3. The location, direction, shape, depth, and number of the bend may differ from the example shown in the figure.

[0031] According to an idea, the partition wall 3 is bent at its top toward the first part 1. It is then possible to use a shorter roof structure 5, which in turn increases the effective volume of the boiler.

[0032] The partition wall 3 may also naturally be straight without any specific functional shapes.

[0033] According to an idea, the height of the partition wall 3 is selected to only just prevent the fuel from flying over to the second space 2. In an embodiment, the height of the partition wall is approximately 5 m, when the height of the boiler is approximately 20 m. The wall surfaces of the first space 1 and thus also the partition wall 3 may comprise brickwork that extends to a height of 2.5 m, for instance.

[0034] According to another idea, the wall 3 is at least partly formed of a membrane wall 16 connected to the water/vapour circulation of the boiler 10. An example of the structure of the membrane wall is shown in Figure 2.

[0035] The roof structure 5 can also be at least partly formed of the membrane wall 16 connected to the water/vapour circulation of the boiler 10.

[0036] The wall 3 and roof structure 5 that comprise a membrane wall 16 provide the advantage that they boost the recovery of thermal energy in the boiler 10.

[0037] The partition wall 3 and/or roof structure 5 can naturally be implemented using different solutions, such as a plate structure or a combination of a plate structure and brickwork.

[0038] The roof structure 5 is preferably shaped to improve the natural flow of the gases G. Thus, the bottom surface 6 of the roof structure may be arranged to ascend toward the end 20 of the roof structure and, on the other hand, the top surface 7 of the roof structure may be arranged to descend toward the end 20 of the roof structure.

[0039] According to an idea, the roof structure 5 covers the first space 1 of the furnace entirely; most preferably the roof structure 5 extends to some extent past the partition wall 3. When it is dimensioned in this way, the roof structure 5 prevents the fall of detaching ash layers and other layers into the fluidized bed from the top part of the furnace in the second space 2. According to an idea, the roof structure extends approximately 0.5 m or more past the partition wall 3.

[0040] The layers may detach by themselves or be detached by sweepers 11, such as hydraulic guns, vapour sweepers, and audio sweepers.

[0041] Designing the top surface 7 of the roof structure to slant downward toward the end 20 guides the detached layers to the bottom of the second space 2.

[0042] The roof structure 5 also prevents thermal radiation from the top part of the second space 2 to the fluidized bed, thanks to which the temperature of the fluidized bed or first space 1 is easier to keep sufficiently low. Further, the roof structure 5 may cause turbulence in the flow of the gas G, which boosts the mixing of the fuel and air and, therefore, burning.

[0043] The second space 2 of the furnace is the combustion section, into which the remaining combustion air is fed to burn the fuel. Air nozzles 9 for feeding secondary, tertiary and possible

other higher airs are arranged in the second space 2; the second space may also have nozzles for feeding circulation gas, among other things. In the second space 2, the temperature may rise substantially higher than in the first space 1, to 1100° to 1400°, for instance. The air coefficient of the top part of the second space 2 may be over one, and the fuel is burned out there.

[0044] It should be noted that the fuel gasifies and may also partly burn already in the first space 1.

[0045] The walls of the second space 2 may scorify and/or foul due to melted ash. However, this does not cause problems, because the walls can be cleaned with above-mentioned sweepers 11.

[0046] The second space 2 may have a nose 8 guiding the flow of the flue gases.

[0047] A slag and ash removal system 12 to remove the fallen matter from the boiler 10 has been arranged at the bottom of the second space 2. The slag and ash removal system 12 may also be extended to the first part 1, as shown in Figure 1. According to another idea, the first space 1 has its own bottom ash removal system.

[0048] In addition, bottom air-feeding nozzles 24 can be arranged in the second space 2, at its bottom 23 or in its bottom part. With the bottom air fed through them, it is possible to burn any fuel particles that may fly there from the first space 1.

[0049] Flue gases are led from the second space 2 of the furnace away from the furnace to a so-called empty pass and on to thermal surfaces. The second space 2 of the furnace may have thermal surfaces, but this is not necessary.

[0050] **Figure 2** is a schematic cross-sectional view of an embodiment of the partition wall and/or roof structure of the arrangement according to the invention.

[0051] As already stated earlier, the partition wall 3 and roof structure 5 may be at least partly formed of a membrane wall 16 connected to the water/vapour circulation of the boiler 10.

[0052] The membrane wall 16 typically comprises cooling pipes 13 arranged side by side and in the same direction and fastened to each other by fins 14. This type of gas-tight structure is known from furnace walls. The membrane wall 16 may be made by welding, for example. The structure of the membrane wall 16 can naturally also be made in some other way, for instance by directly joining adjacent cooling pipes 13 or by doing the opposite, that is, by increasing the width of the fin 14 in view of the embodiment shown in Figure 2.

[0053] Figure 3 is a schematic sectional side view of another arrangement and method of the invention, and Figure 3b is a schematic view of the cross-section of a detail of the arrangement.

[0054] In this arrangement, the partition wall 3 extends to the roof structure 5. Gas G flows from the first part 1 to the second part 2 through one or more openings 19 arranged in the partition wall 3. In other words, the flow path 18 is formed of one or more openings 19.

[0055] The openings 19 are formed of the cooling pipes 13 of the membrane wall 16, from the gaps of which the fins 14 are left out along a suitable length and which are grouped in a lattice form. The membrane walls of the partition wall 3 and roof structure 5 are then connected to each other. Figure 3b shows a possible lattice 25. The lattice 25 can naturally be of some other kind, as long as the cooling pipes 13 are arranged loosely so that the gases G can flow through them via the openings 19.

[0056] The cooling pipes 13 of the lattice 25 can be connected to the cooling pipes 13 of the partition wall 3 and/or roof structure 5 through collector chambers 26. By means of the collector chambers 26, the lattice 25 may be formed of cooling pipes 13, the diameter of which differs from that of the cooling pipes 13 of the membrane wall 16. In addition, the number of cooling pipes 13 forming the lattice 25 may differ from the number of cooling pipes 13 of the membrane wall 16 connected to the collector chambers 26.

[0057] In the solution shown in Figure 3a, the lattice 25 is directed obliquely downward by dimensioning the partition wall 3 and roof structure 5. The roof structure 5 forms a lid over the lattice 25 to prevent matter detached from the second space 2 from falling into the first space 1. A bend 17 toward the first space 1 in the wall below the lattice 25 stiffens the structure, increases the effective volume of the second space 2 and guides the matter detached from the second space 2 to the bottom 23 of the second space. The direction of the bend 17 is selected to be the most advantageous for the entity.

[0058] Figure 4 is a schematic sectional side view of a third arrangement and method of the invention.

[0059] The arrangement may comprise at least two first spaces 1 that are arranged on different sides of the second space 2 of the furnace. In the solution of Figure 4, there are two first spaces 1. The features of both first spaces 1 may be as already described above: both may have a fuel feed channel 4 connected to them, for example. This type of solution is especially advantageous for use in large boilers 10. The shapes and structure of the partition wall 3 and roof structure 5 may also be implemented in some other manner, for instance as in Figure 3a.

[0060] In some cases, features disclosed in this application may be used as such, regardless of other features. On the other hand, when necessary, features disclosed in this application may be combined in order to provide different combinations.

[0061] In summary, it can be noted that the arrangement of the invention is as defined in claim 1.

[0062] Further, it can be noted that the method of the invention is as defined in claim 16.

[0063] The drawings and the related description are only intended to illustrate the idea of the invention. It is apparent to a person skilled in the art that the invention is not restricted to the embodiments described above, in which the invention is described by means of some examples, but many modifications and different embodiments of the invention are possible within the scope of the inventive idea defined in the following claims.

Reference markings

[0064]

- 1 First space of furnace
- 2 Second space of furnace
- 3 Partition wall
- 4 Feed channel
- 5 Roof structure
- 6 Bottom surface
- 7 Top surface
- 8 Nose
- 9 Air nozzle
- 10 Boiler
- 11 Sweeper
- 12 Slag and ash removal system
- 13 Cooling pipe
- 14 Fin
- 15 Bottom of first space
- 16

17	Membrane wall
18	Bend of wall
19	Flow path
20	Opening
21	End of roof structure
22	Means for forming fluidized bed
23	Nozzles for primary air and/or circulation gas
24	Bottom of second space
25	Nozzles feeding bottom air
26	Lattice
F	Collector chamber
G	Fuel
	Gas

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Non-patent literature cited in the description

- Ein neues Wirbelschicht-Verbrennungs- verfahren zur thermischen verwertung von Abfallstoffen **STEINRUCK P** Chemie Ingenieur Technik Wiley Vhc. Verlag 1989 1101 vol. 61, 889-891 [0004]

Patentkrav

- 1.** Anordning omfattende en kedel med fluidiseret leje-teknologi, der omfatter et første rum (1) af en ovn, der omfatter organ til at danne et fluidiseret leje (21),
 5 et andet rum af ovnen, der ikke har organ til at danne et fluidiseret leje, organer til at tilføre brændstof til ovnen, en skillevæg (3), der er i det mindste hovedsageligt vertikal og anbragt mellem rummene (1, 2) af ovnen for at separere dem fra hinanden, hvor anordningen yderligere omfatter
- 10 en tagstruktur (5) anbragt over det første rum af ovnen for at separere det første rum (1) af ovnen fra dele af det andet rum (2) af ovnen over den, hvor det første rum (1) af ovnen er forbundet til det andet rum (2) af ovnen igennem en strømningsvej (18), hvor strømningsvejen (18) er anbragt på siden af det første rum (1) af ovnen til at lede gasser (G), der stiger fra det fluidiserede
- 15 leje til det andet rum (2) af ovnen, **kendetegnet ved at** brændstof er anbragt til at blive fødet af en brændstoftilløbskanal (4) forbundet til det første rum (1) af ovnen.
- 2.** Anordning ifølge krav 1, **kendetegnet ved at** organerne til at tilføre brændstof
- 20 omfatter en tilløbskanal (4), der åbner til det første rum (1) af ovnen og er rettet mod midten af bunden (15) af det første rum (1).
- 3.** Anordning ifølge krav 1 eller 2, **kendetegnet ved at** den omfatter dyser til at tilføre primærluft og/eller cirkulationsgas til det første rum (1) af ovnen.
- 25
- 4.** Anordning ifølge et hvilket som helst af de foregående krav, **kendetegnet ved at** den omfatter mindst to første rum (1) anbragt på forskellige sides af det andet rum (2) af ovnen.

5. Anordning ifølge et hvilket som helst af de foregående krav, **kendetegnet ved at** den omfatter dyser til at tilføre sekundær- og eventuelt højere luft og/eller cirkulationsgas til det andet rum (2) af ovnen.
- 5 6. Anordning ifølge et hvilket som helst af de foregående krav, **kendetegnet ved at** den omfatter dyser anbragt ved bunden eller i bunddelen af det andet rum (2) af ovnen til at tilføre bundluft.
7. Anordning ifølge et hvilket som helst af de foregående krav, **kendetegnet ved**
- 10 **at** skillevæggen (3) er mindst delvist dannet af en membranvæg (16) forbundet til vand-/dampcirkulationen af kedlen (10).
8. Anordning ifølge et hvilket som helst af de foregående krav, **kendetegnet ved at** skillevæggen (3) omfatter en krumning (17), der øger stivheden af væggen
- 15 (3).
9. Anordning ifølge et hvilket som helst af de foregående krav, **kendetegnet ved at** skillevæggen (3) strækker sig til en afstand fra tagstrukturen (5), hvorved mellemrummet mellem dem danner strømningsvejen (18).
- 20
10. Anordning ifølge et hvilket som helst af kravene 1 til 8, **kendetegnet ved at** skillevæggen (3) strækker sig til tagstrukturen (5), og at strømningsvejen (18) er dannet af et eller flere mellemrum (19) i skillevæggen (3).
11. Anordning ifølge et hvilket som helst af de foregående krav, **kendetegnet ved at** tagstrukturen (5) dækker det første rum (1) af ovnen fuldkomment.
12. Anordning ifølge et hvilket som helst af de foregående krav, **kendetegnet ved at** tagstrukturen (5) er mindst delvist dannet af membranvæggen (16)
- 30 forbundet til vand-/dampcirkulationen af kedlen (10).

13. Anordning ifølge krav 12, **kendetegnet ved at** skillevæggen (3) er mindst delvist dannet af membranvæggen (16) forbundet til vand-/dampcirkulationen af kedlen (10), at membranvæggen (16) af tagstrukturen (5) er forbundet til membranvæggen (16) af skillevæggen (3) igennem et gitter (25), og at mellemrum mellem kølerør (13) af gitteret (25) danner strømningsvejen (18).

14. Anordning ifølge et hvilket som helst af de foregående krav, **kendetegnet ved at** tagstrukturen (5) omfatter en bundflade (6), der er anbragt til at stige op til enden (20) af tagstrukturen, og en topflade (7), der er anbragt til stige ned til enden (20) af tagstrukturen.

15. Anordning ifølge et hvilket som helst af de foregående krav, **kendetegnet ved at** kedlen (10) er en boblende fluidiseret leje-kedel (BFB).

16. Fremgangsmåde til en kedel med fluidiseret leje teknologi, hvilken inkluderer:

at tilføre brændstof direkte til et første rum (1) af en ovn, der omfatter organ (21) til at danne et fluidiseret leje,

at tillade gasser der stiger fra det fluidiserede leje at bevæge sig til et andet rum (2) af en ovn forbi en skillevæg (3) og under en tagstruktur (5) anbragt over det første rum (1) af ovnen, hvor skillevæggen (3) er mindst hovedsageligt vertikal og anbragt mellem rummene (1, 2) af ovnen for at separere dem fra hinanden, og hvor tagstrukturen (5) er anbragt til at separere det første rum (1) af ovnen fra dele af det andet rum (2) af ovnen over den.

17. Fremgangsmåde ifølge krav 16, **kendetegnet ved at** kun en mængde af luft krævet til fluidiseringen og forgasningen af brændstoffet fødes ind i det første rum (1) af ovnen.

18. Fremgangsmåde ifølge krav 16 eller 17, **kendetegnet ved** ikke at danne et fluidiseret leje i det andet rum (2) af ovnen.

19. Fremgangsmåde ifølge krav 16 eller 18, **kendetegnet ved at** brændstof, der
5 omfatter agrobrændstof, fødes ind i det første rum (1).

DRAWINGS

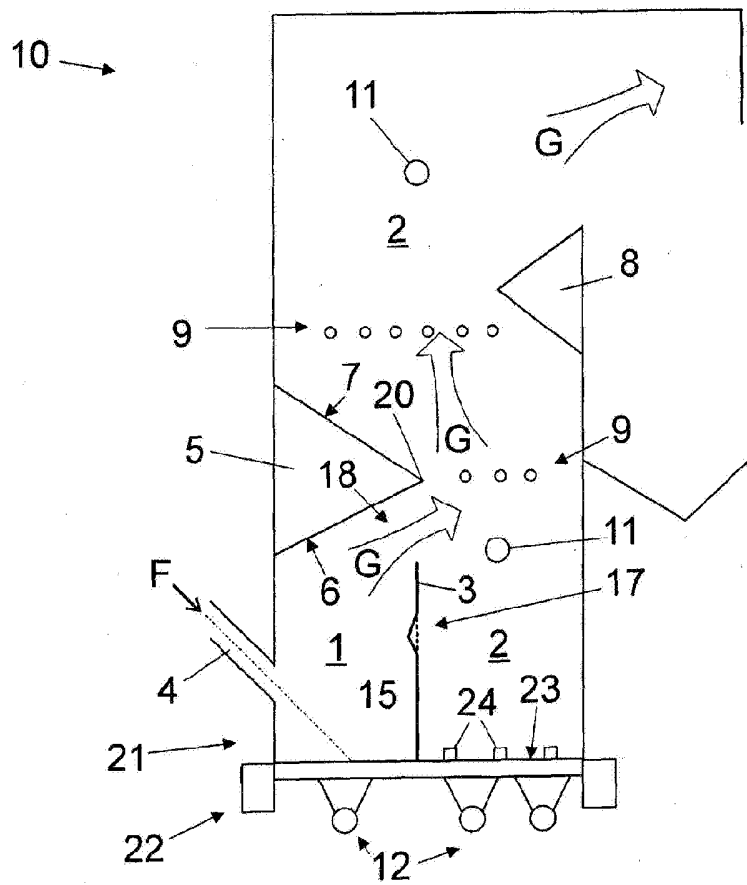


Fig. 1

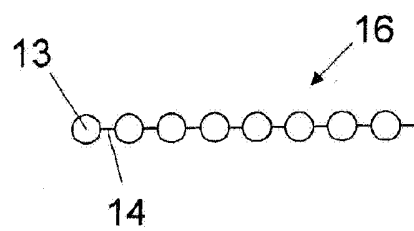


Fig. 2

