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(54) A CYCLONE AND A FOOD PROCESSING SYSTEM HAVING THE CYCLONE

(57) The invention is a cyclone (1) comprising; a chamber (10) comprising a top wall (12) and a bottom wall (13), an inlet (15) for a fluid mixture entry to the chamber (10), a first outlet (20) for at least one separated substance of the fluid, and a second outlet (21) on the bottom wall (13) for the rest of the fluid, wherein the bottom wall (13) has a conical shape extending towards the top wall (12) of the chamber (10); and a food processing system employing the cyclone (1).

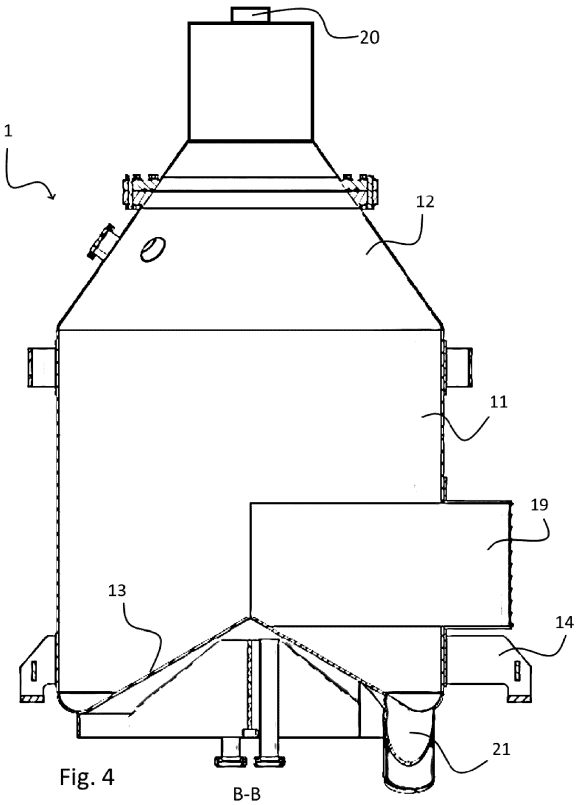

Fig. 4

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Description

Field of Invention

[0001] The invention is related to a cyclone. Particularly, a cyclone that can be used on a processing system like a food processing system.

Prior Art

[0002] Cyclones are separation devices employing the principle of inertia to remove particulate matter from gases.

[0003] In many liquid food processing systems, a flash boiling stage may be included for several reasons. For example, when heat treating a liquid food product by steam injection for killing microorganisms, the product is held at a heat treatment temperature for a few seconds before it is introduced into a vacuum vessel to be flash boiled, or flash cooled. The flash boiling reduces the temperature of the product and removes an amount of vapor that equals the amount of steam that was injected for the heat treatment.

[0004] Flash boiling may also be used when it is desired to increase the concentration of a liquid food product. The product is then introduced in a vacuum vessel that acts as an evaporator, where vapor is removed by virtue of the flash boiling that takes place in the vessel.

[0005] The flash boilers and/or cyclones have vortex breakers preventing the formation of vortices and of a separated portion being drawn into the outlet of the other portion.

[0006] The invention provides an additional improvement, an additional advantage, or an alternative to the prior art.

Purpose of the Invention

[0007] The purpose of the invention is providing an efficient separator for fluids.

[0008] The invention, to achieve the abovementioned purpose, is a cyclone comprising a chamber comprising a top wall and a bottom wall; an inlet for a fluid mixture entry to the chamber; a first outlet for at least one separated portion of the fluid; and a second outlet on the bottom wall for the rest of the fluid; and wherein the bottom wall has a conical shape extending towards the top wall of the chamber. Thus, by the shape of the conical bottom, a strong vortex is created and separation of the fluid into its substances is realized. For example, a liquid food, comprising gas in it, is separated into the liquid food, such as milk, and the gas, such as water vapor. The conical bottom provides a completely or an almost dry surface for the root/center of the vortex. This makes it possible to have a cyclone vessel without a vortex breaker in the bottom and without an internal gas channel and still have a strong separating efficiency. By the solution, it also makes it possible to have a hygienically designed cyclone. Additionally, in contrary to a vortex finder close to the bottom of the chamber, the first outlet on the top wall allows the gas to attain a stable vertical flow upwards, without strong turbulence. This minimizes the risk that droplets at the "splashy" bottom are dragged with the gas flow to the exit. Thus, no product particles (for example food such as milk) carried over to outlet; and efficiency increased. The resulted cyclone is become designed as hygienically. In addition to all, having a first outlet at the top wall provides elimination of any outlet channel located in the chamber as in the prior art; and provides more space in the chamber to clear area between the conical bottom wall and the first outlet. All advantages and results stated are achieved by without compromising separating efficiency, even by having better separating efficiency.

[0009] The chamber may have a cylindrical section as the main section forming side wall of the chamber. The top wall may be in a conical shape as extending away from the main section. The conical bottom wall may have a cone extending from edge of the bottom wall towards inside of the main section of the chamber.

[0010] In this context, the gas may be water vapor that may be formed due to usage of steam to heat the fluid before arriving the inlet of the cyclone.

[0011] In a possible embodiment of the invention, the cyclone may comprise a condenser provided out of the chamber. Thus, it provides more space in the chamber to clear area between the conical bottom and the top outlet.

[0012] In a possible embodiment of the invention, the inlet may be in form of a pipe and has a widening cross section along the flow direction of the fluid. Thus, slowing down the fluid and reducing risk of particle induced erosion is achieved. For example, the fluid may be milk and due to being calcium enriched, the inlet can be harmed. Although the velocity of the fluid is slowed down due to widening cross section, it is still better to have velocity enough to create cyclone. For instance, the velocity may be 8-40 m/s.

[0013] In a possible embodiment of the invention, the widening may be provided by at least one inlet wall having an inclination compared to longitudinal extension direction of the inlet, that is below 20 degrees of angle, particularly 15 degrees of angle or less. Thus, a better flow of the product is achieved that avoids product loss and provides a better cleanability of the inlet due to flowability of the product.

[0014] In a possible embodiment of the invention, each of the two facing walls of the inlet may have an inclination compared to longitudinal extension direction of the inlet, that is below 20 degrees of angle, particularly 15 degrees of angle or less; particularly the two facing walls may have the same angle, thus symmetrically widening the cross section of the inlet. Thus, a shorter inlet is provided, that leads decreased velocity, less erosion and less carry over of the product droplets (avoiding product loss) by the gas vertically moving and being exhaust through the top outlet.

[0015] In a possible embodiment of the invention, the inlet may provide a tangential entry for the fluid to the chamber. Thus, speed of the fluid is maintained, and cyclone effect is supported and enhanced.

[0016] In a possible embodiment of the invention, the inlet may have a linear section and a bending section wherein the widening cross section is provided on the liner section and the bending section is provided between the chamber and the linear section as also providing tangential entry stated before. Thus, a better flow of the product is achieved that avoids product loss and provides a better cleanability of the inlet due to flowability of the product. Moreover, speed of the fluid is maintained, and cyclone effect is supported and enhanced.

[0017] In a possible embodiment of the invention, the fluid may be a liquid food comprising gas, particularly water vapor, wherein the top outlet is for the gas and the bottom outlet is for the liquid food as not comprising gas. Thus, a food product without having excess and/or unnecessary gas in it is achieved. The liquid food may be milk, juice or any other liquid food known.

[0018] In a possible embodiment of the invention, the first outlet may be disposed on the top wall. Thus, no product particles (for example food such as milk) carried over to outlet; and efficiency increased compared to the prior arts having the first outlet inside the chamber. The outlet may be located at the tip of the cone. In a possible embodiment, a further cylindrical outlet chamber may be formed on the tip area of the cone shaped top wall. This outlet chamber may have the first outlet on top of it.

[0019] In a possible embodiment of the invention, the second outlet may be disposed on an area on or close to the periphery of the bottom wall. Thus, whole surface of conical bottom wall may be used to guide the portion of the fluid, particularly liquid portion to the second outlet. Addition to that, the advantages mentioned earlier related to the conical bottom wall may be supported and/or enhanced.

[0020] The other aspect of the invention is a food processing system comprising a direct heating device, a holding cell, and the cyclone according to any one of the alternatives mentioned before. The food processing may mean ultra-high temperature (UHT) treatment, for example to produce UHT dairy product, UHT beverage, or extended shelf life (ESL) milk or any other food product known in the art as having longer shelf life compared to fresh food. The direct heating may mean steam injection or steam infusion processes known in the art. The cyclone of the first aspect of the invention may be used as flash vessel or separator or a deaerator in the food processing system.

[0021] The velocity in the product inlet may be in between 8-40 m/s, the vertical velocity inside the chamber may be in between 0.5-2.7 m/s; on the other hand, velocity in an exhaust pipe to condenser may be 8-46 m/s.

[0022] In addition to their individual advantages, having a cyclone comprising;

- The conical bottom wall,
- The first outlet on the top wall,
- The tangential inlet, and
- The condenser located outside of the chamber

may have all advantages previously mentioned and more or enhanced versions of the stated advantages due to synergistic effect of these features.

Brief Description of the Figures

[0023]

Fig. 1 represents a cyclone according to the invention.

Fig. 2 represents an alternative of the cyclone according to the invention.

Fig. 3 represents a horizontal cross-sectional view (A-A) of the cyclone of Fig. 2.

Fig. 4 represents a vertical cross-sectional view (B-B) of the cyclone of Fig. 2.

Fig. 5 represents a food processing system according to the invention

Detailed Description of the Invention

[0024] All directional or locational references such as front, left, top or bottom are based on reference to the cyclone (1) shown in Fig. 1, in which the visible side is the "front" side of the cyclone (1) and the upper section of the figure showing a conical section of the cyclone (1) is the "top" of the cyclone (1). One or more of possible embodiments of the present invention will be described as examples in detail below.

[0025] In Fig.1, a cyclone (1) having a chamber (10) resting on four legs (14) is presented. The chamber (10) comprises a main section (11) in cylindrical shape and a top wall (12) disposed on the main section (11) and having a conical shape. The cyclone (1) has an inlet (15) guiding a fluid inside the chamber (10). The chamber (10) has also a bottom wall (13) comprising a second outlet (21).

[0026] The fluid fed to the cyclone (1) may be a liquid food (L) that may be heated already by a direct heating device (2) that uses steam (S), like a steam injector and/or a steam infusion device and then passing through a holding cell (3) known in the art as in Fig. 5. The liquid food may have additional water therein due to condensed steam used to heat the liquid food. When the direct heated liquid food is wished to be separated from the excess water caused by the steam (S), the liquid food is fed to cyclone after heating process.

[0027] The inlet (15) for the liquid food comprises two sections, a linear section (16) and a bending section (19). The linear section (16) has a widening cross section, meaning along the direction of fluid flow, the cross-sectional area of the inlet (15) increases. To provide that, at least one of the inlet walls (17) extends with an angle

(18) along the food flow direction compared to the longitudinal direction of the inlet (15). That angle (18) is equal or less than 20-degree, preferably 15-degree. After widening linear section (16), the bending section (19) of the inlet (15) starts. In Fig. 1, a first alternative of the cyclone (1) is presented that has only one inlet wall (17) having the angled extension. In Fig. 2, on the other hand, the inlet (15) has its two inlet walls (17) facing each other as having the angled extension; and having a symmetrical widening cross section.

[0028] The bending section (19) allows the liquid food to enter the cylindrical chamber (10) tangentially as seen on Fig. 3. That supports cyclone effect and prevents the flow from slowing down; and eventually creating a vortex in the cyclone (1).

[0029] The cyclone (1) has a bottom wall (13) in a conical shape. The tip of cone shaping the bottom wall (13) remains in the chamber (10), meaning that the cone is oriented as extending upward direction towards the top wall (12). The conical bottom wall (13) provides a base for vortex to center its root. By having a conical shape, the bottom wall (13) keeps the base of the vortex almost dry, so none or so limited amount of liquid or particles in the liquid food drawn up in the cyclone (1). That avoids product losses through the first outlet (20). The portion forwarded to the first outlet (20) is mainly the water vapor. The liquid food product follows the conical bottom wall (13) to the bottom edge of the cone. There, as in Fig. 3, a second outlet (21) is formed to collect the separated liquid food to transfer a further point, like a processing point, for example to a homogenizer and/or a package filling machine. In summary, the conical bottom wall (13) facilitates an improved and efficient separation.

[0030] As in Fig. 4, the top wall (12) of the cyclone (1) is also a conical wall as extending away from the bottom wall (13) and the chamber (10), meaning that the cone is oriented as extending upward direction as the conical bottom wall (13). The first outlet (20) for the vapor is located on the top wall (12). By having the first outlet (20) on the conical top wall (12) compared to having the first outlet (20) inside the chamber (10) as in the prior art, it is achieved that there is none or at least a very limited amount of product particle leaves the cyclone (1) through the first outlet (20).

[0031] The cyclone does not have any condenser in the chamber (10) to condense the water vapor. The condenser (not shown) is provided out of the cyclone (1), so the space between the top wall (12) and the bottom wall (13) in the chamber (10) is kept clean and empty.

[0032] All features connected to the cyclone (1) shown and explained according to Fig. 1 are also valid for the alternative shown in Fig. 2, or vice versa, except the form of the inlet (15) that is already explained before.

[0033] The cyclone (1) explained above is used on a food processing system (100) as in Fig. 5. The system (100) also comprises a direct heating device (2) that is a steam injector or a steam infusion unit using steam (S) as heating medium and a holding cell (3) before the cyclone (1). A liquid food (L) heated by the direct heating device (2), for example to UHT temperature values, and kept for some time at that temperature by travelling in the holding cell (3). Then, the excess water in the liquid food is separated by the cyclone (1).

Reference Signs

[0034]

1. Cyclone
2. Direct heating device
3. Holding cell
10. Chamber
11. Main section
12. Top wall
13. Bottom wall
14. Leg
15. Inlet
16. Linear section
17. Inlet wall
18. Angle
19. Bending section
20. First outlet
21. Second outlet
100. Food processing system

Claims

1. A cyclone (1) comprising:

- a chamber (10) comprising a top wall (12) and a bottom wall (13),
- an inlet (15) for a fluid mixture entry to the chamber (10),
- a first outlet (20) for at least one separated portion of the fluid, and
- a second outlet (21) on the bottom wall (13) for the rest of the fluid **characterized in that**

the bottom wall (13) has a conical shape extending towards the top wall (12) of the chamber (10).

2. The cyclone (1) according to claim 1; wherein the cyclone (1) comprises a condenser provided out of the chamber (10).

3. The cyclone (1) according to anyone of the preceding claims; wherein the inlet (15) is in form of a pipe and has a widening cross section along the fluid flow direction of the fluid.

4. The cyclone (1) according to claim 3; wherein the widening is provided by at least one inlet wall (17) having an inclination compared to longitudinal extension direction of the inlet (15), that is below 20 degrees of angle, particularly 15 degrees of angle or

less.

5. The cyclone (1) according to claim 4; wherein each of the two facing inlet walls (17) have an inclination compared to longitudinal extension direction of the inlet (15), that is below 20 degrees of angle, particularly 15 degrees of angle or less.

6. The cyclone (1) according to claim 5; wherein the two facing inlet walls (17) have the same inclination, thus symmetrically widening the cross section of the inlet (15).

7. The cyclone (1) according to anyone of claims 3-6; wherein the inlet (15) provides a tangential entry for the fluid to the chamber (10).

8. The cyclone (1) according to anyone claims 3-7; wherein the inlet (15) has a linear section (16) and a bending section (19) wherein the widening cross section is provided on the linear section (16) and the bending section (19) is provided between the chamber (10) and the linear section (16).

9. The cyclone (1) according to anyone of the preceding claims; wherein the first outlet (20) is disposed on the top wall (12).

10. The cyclone (1) according to anyone of the preceding claims; wherein the second outlet (21) is disposed on an area on or close to the periphery of the bottom wall (13).

11. A food processing system comprising a direct heating device (2), a holding cell (3) and the cyclone (1) according to any one of claims 1-10.

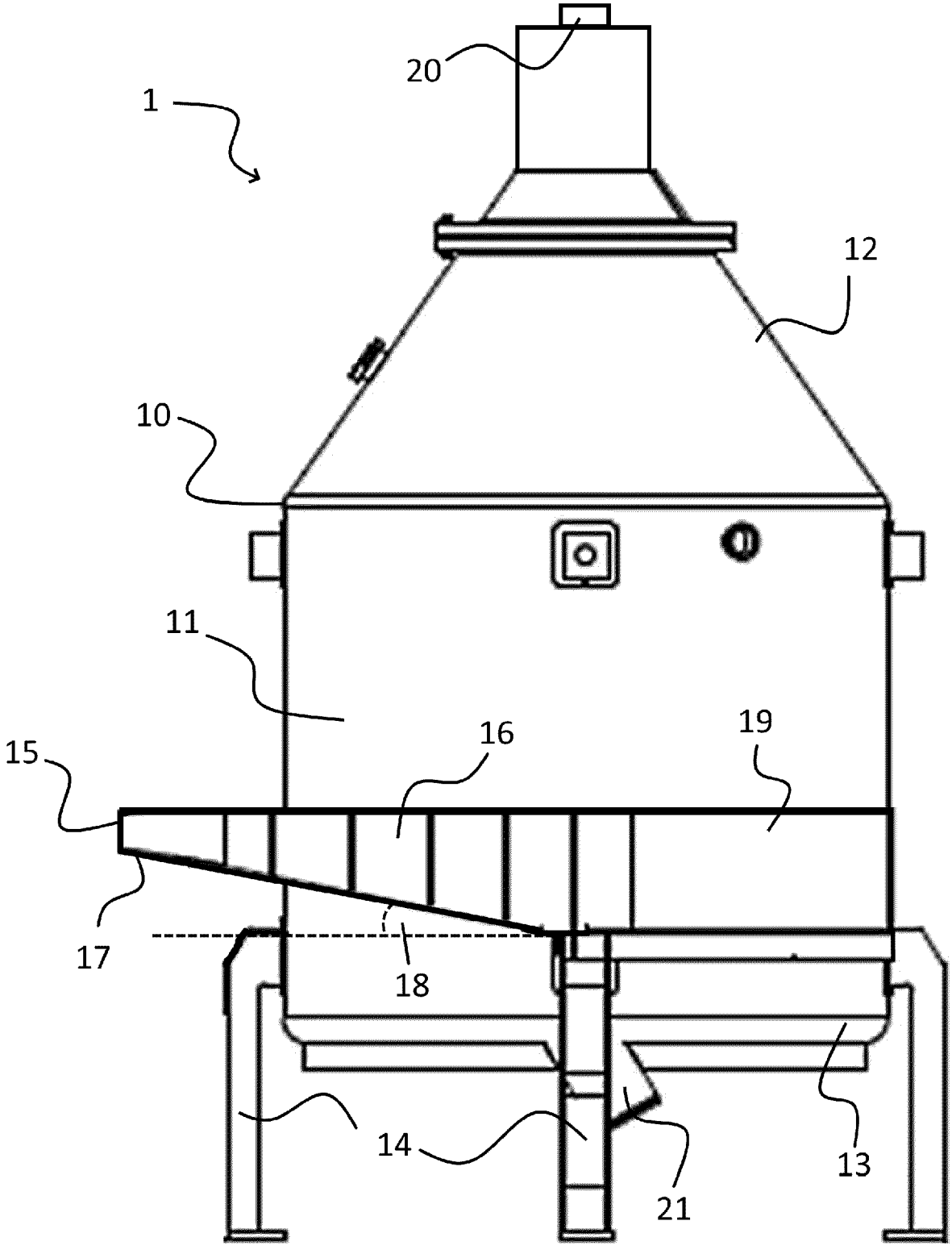

Fig. 1

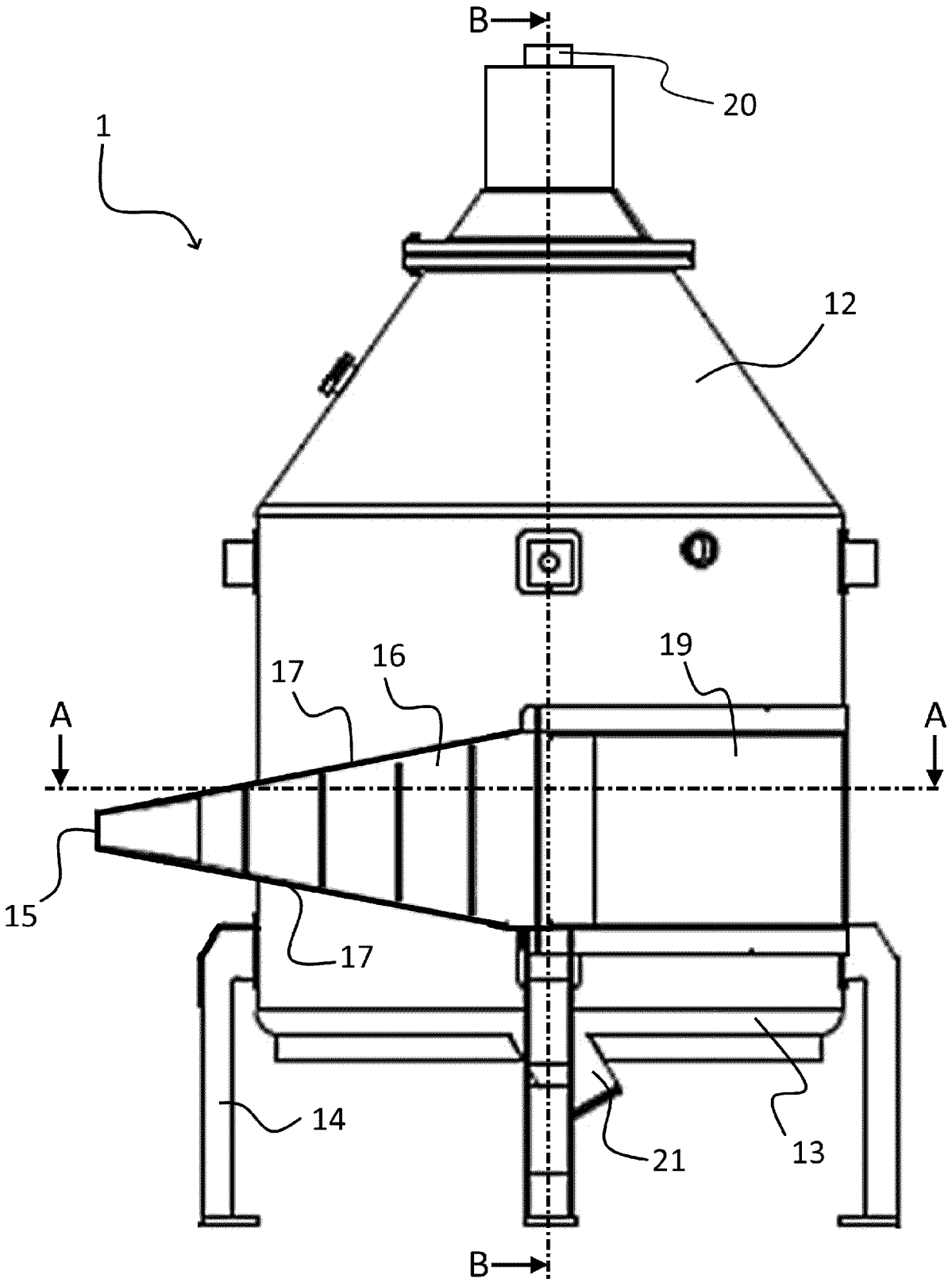

Fig. 2

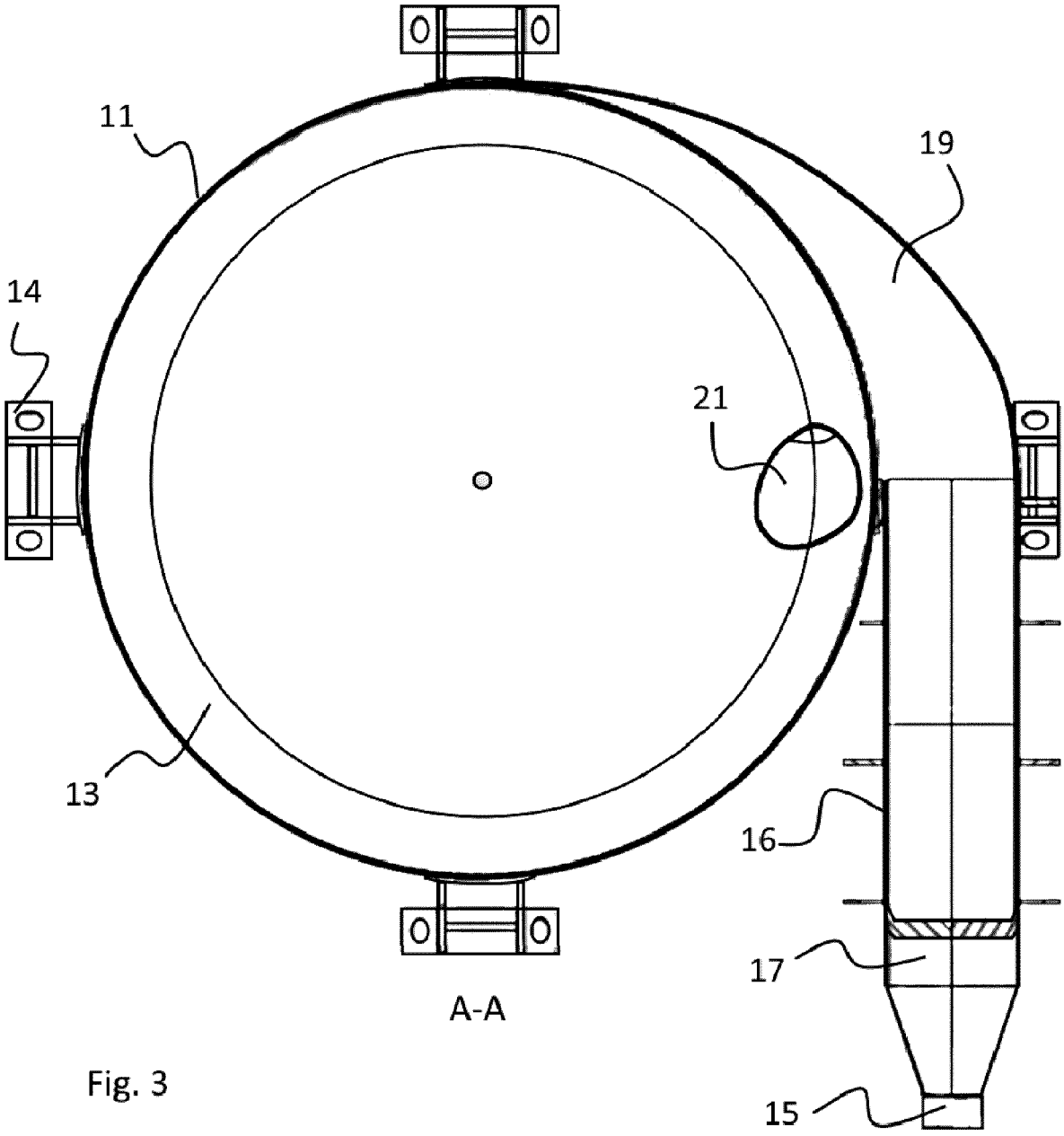

Fig. 3

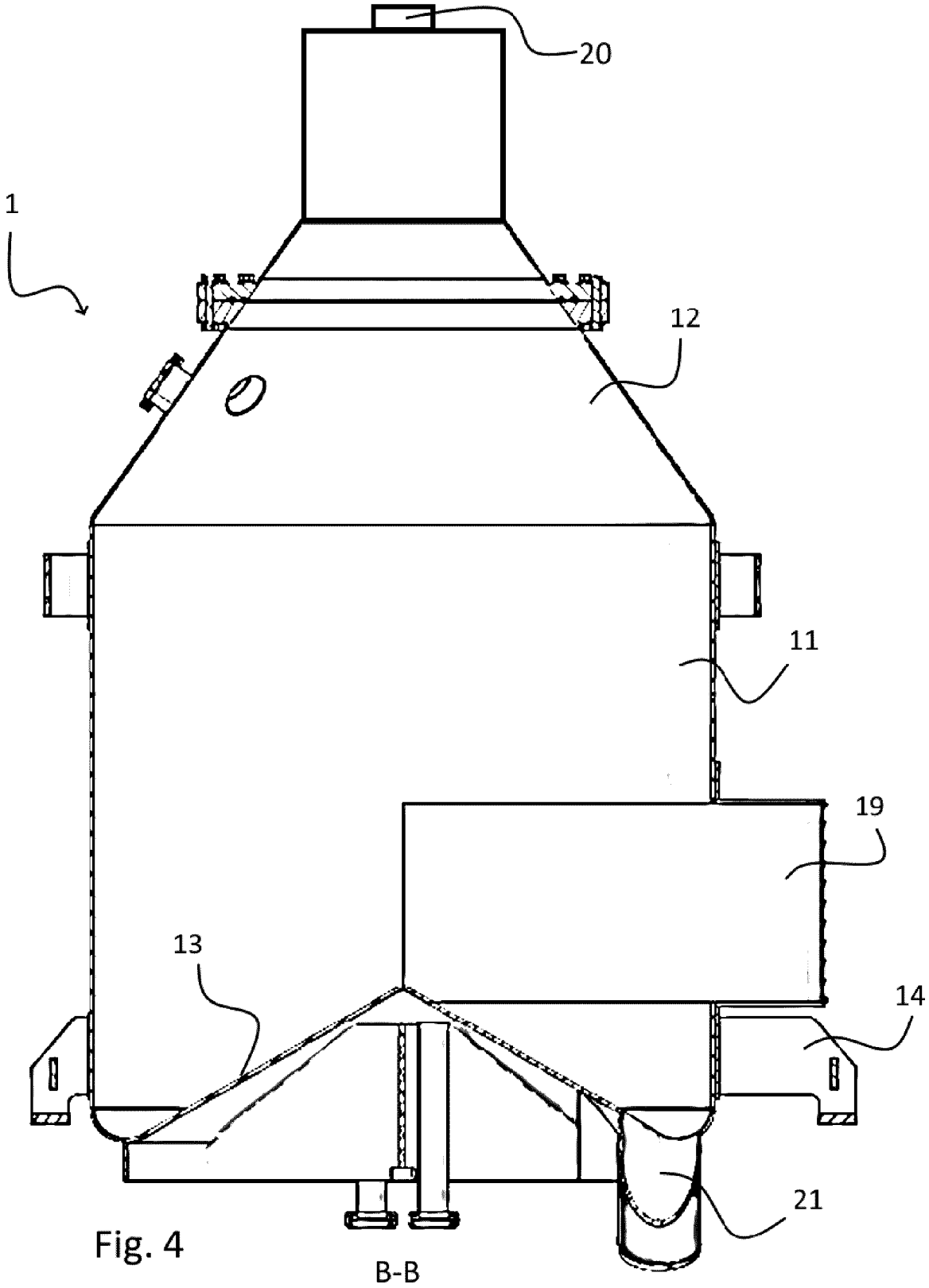

Fig. 4

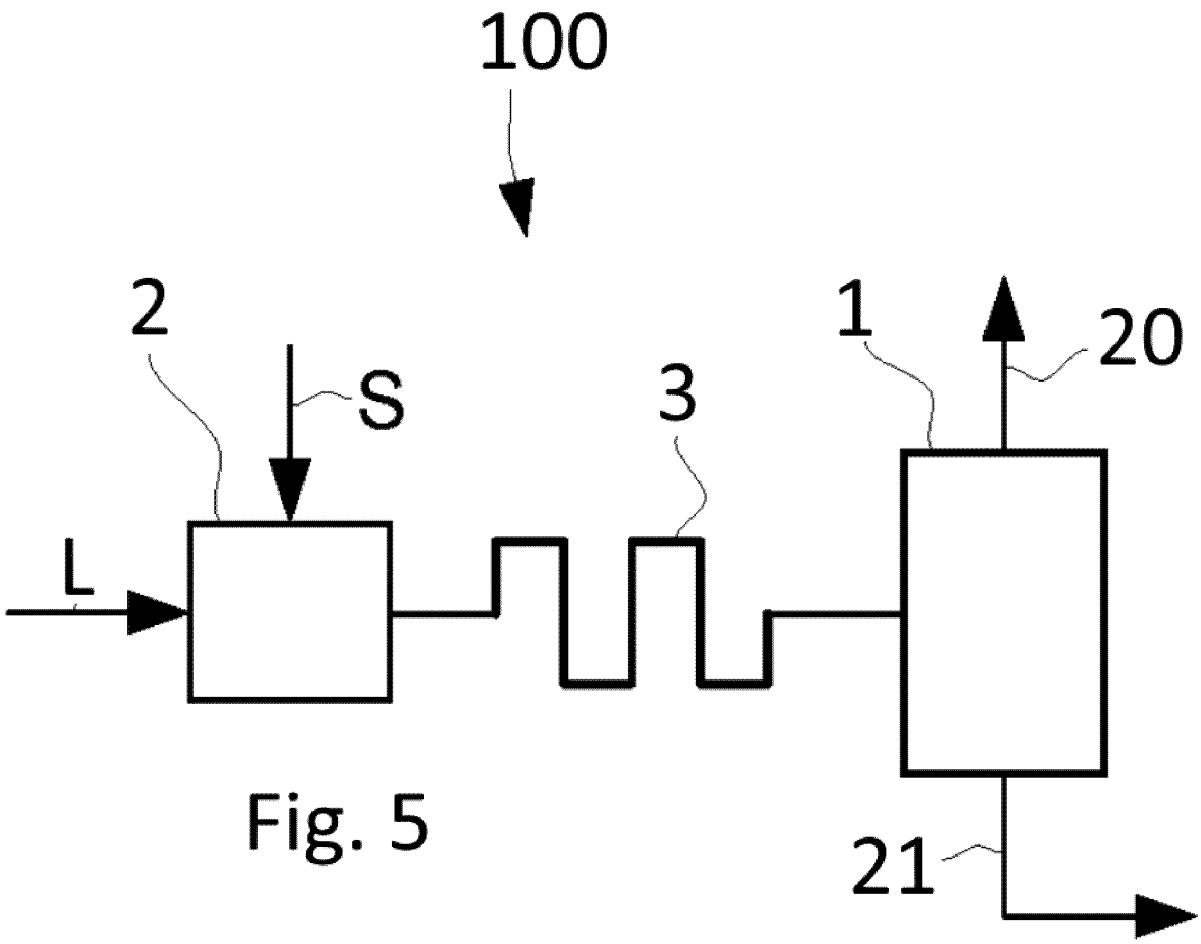

Fig. 5

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EUROPEAN SEARCH REPORT

Application Number
EP 22 16 9514

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			TECHNICAL FIELDS SEARCHED (IPC)
			B04C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 October 2022	Laurim, Jana

CATEGORY OF CITED DOCUMENTS

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