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(54) Title: SOLUBILIZER FOR VARIOUS MIXTURES

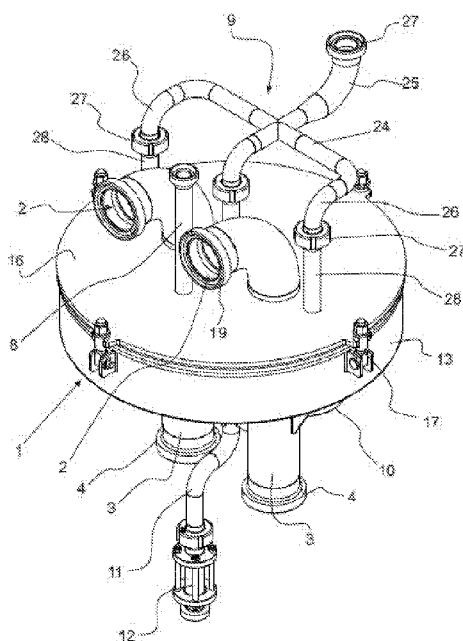


Fig. 1

(57) Abstract: SOLUBILIZER FOR VARIOUS MIXTURES, formed by a hydraulic recirculation device under pressure for any mixture, having at least one solute constituent and at least one solvent, comprising : a dynamic passage chamber (1); at least one solubilizing core (2), at least one collecting tube (3); the lower edge with connection (4) to the collecting tube (3) is coupled to the upper part of a mixture tank (5) inside which the solubilized mixture flow is discharged; an external recirculation pipeline (6) interconnecting the bottom and the upper part of the mixture tank (5), configuring a closed recirculation circuit; a high pressure pump (7) is interleaved to the pipeline (6); the upper part of the dynamic passage chamber (1) includes at least one inlet tube (8) for gas injection; a cleaning set (9); the lower side of the dynamic passage chamber (1) includes at least one vent tube (10) for air/gas inlet and recirculation from inside the mixture tank (5) and inside the dynamic passage chamber (1); and the lower side of the dynamic passage chamber (1) includes a central tubular outlet (11) and its respective line display (12).

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SOLUBILIZER FOR VARIOUS MIXTURES

Field of the Invention

[01] More particularly, the present Invention refers to a hydraulic recirculation device under pressure for any mixture, be it heated or not, such as those which, for any reason, have at least one solute constituent and at least one solvent, including water, and should go through a solubilization process for said solute constituent.

[02] Therefore, the solubilizer at issue is a coadjuvant hydraulic device for the solubilization of different mixtures with various ingredients, such as: grains, grasses, roots and others, which is performed in a wide range of devices processing mixtures to obtain different products, such as e. g. in production plants for food or other products, from mixtures, including those of the "fermentable" kind, obviously for the production of different liquids: alcoholics, food, beverages, chemicals and others.

State of the Art

[03] Currently, there is a considerable variety of devices used for solubilization in a solvent. Said devices, depending on the solubilization to be performed, may be independent or a coadjuvant in a complex facility.

[04] Solubilization occurs in different processing situations for a wide range of constituents, i. e., in organic mixtures, metals, chemical solutions and others. Solubility is the ability of a body or matter to be dissolved or not in a given kind of liquid, including water. It is also known as solubility coefficient and defined as the ability of a given solute to be dissolved

in a solvent. This process is related to chemical dissolution - the formation of a new or homogeneous mixture or solution, responsible for dispersing the solute into the solvent.

[05] Therefore, as stated above, there is currently a wide range of devices for the solubilization of given constituents in any given solvent, as taught e. g. by the documents: BR112019011631, BRPI0700134, CN2335961, CN20125313, CN110627232, CN207627162, JP2003010890, JP2003260448, JP2005137968, JP2005193099, JP2006122875, JP2006130475, JP2016064367, JP2020104026, JP2020203246, JPS6046443, KR101831758, RO130602, US5770062, US7592139, US8426135, US9127233 and US2009215023.

[06] Said devices are specific for each case, and thus, solubilizations obtained cover mixtures, compounds and solutions, but also involve chemically transformable situations. Consequently, each one includes its particularities.

[07] The state of the art does not offer specific solutions as for optimizing time and increasing the solubilization ability of a mixture of constituents, by using a universal solvent, which is water, as in the production of beverages, be them alcoholic or not. In this case, a simple and efficient solubilizing device is desirable, able to optimize solid constituents (solutes) to enable them to be solubilized by means of a simple process under pressure, wherein the solid portion suffers microfragmentation, thus facilitating its chemical dissolution with the formation of a new solution or a

homogeneous mixture, responsible for dispersing the solute into the solvent, which is, in this case, water.

Summary of the Invention

[08] The embodiment of a device which, in this case, is a coadjuvant for operation jointly with an already existing facility or to be built and used for processing different mixtures, wherein at least one of them is a solute. As examples, we can mention the different kinds of beer, which is a drink prepared with various adjuvant solutes, usually characterizing a mixture with barley malt, non-malt grains, water, hop and yeast. In case of beer, the solvent used is water, representing about 90% of the final product resulting from the manufacturing process.

[09] Therefore, the water is usually heated, consisting of the solvent for the solubilization of different constituents added to the must or mixture to produce beer, such as: hop is a solute which should be solubilized and release substances which are responsible for the bitterness and flavor of the beverage, adding specific characteristics, increasing diuresis, caused by the solubilized bitter resins of the hop; and the solubility of magnesium phosphate ($\text{Mg}_3(\text{PO}_4)_2$), which is essential for the operation of a few yeast enzymes.

[10] Therefore, the invention embodies a hydraulic passage device, so that said mixture or must may be moved in a closed circuit, characterizing its "recirculation" inside a processing tank. Recirculation is performed by a tube interconnecting the bottom of the tank to its upper portion. A high pressure and flow pump is interleaved between said tubes, causing the flow of the mixture to be

moved from the bottom of the tank to its upper portion. The flow is continued and passes through the device, wherein said passage suffers different hydrodynamic effects, especially vortexing, compression, expansion, speed reduction and shock between the particles, including solute constituents and their microfragmentation. Everything helps to increase the contact area between the solvent (water) and the solute constituent, and consequently the solubilization rate increases exponentially, reducing the processing time for the mixture, which becomes more efficient.

[11] Other events occur when the flow passes through the device, since it also includes means to inject gases, such as: air, carbon dioxide (CO₂), nitrogen (N₂) and others, which may eventually be a part of the mixture or a constituent cooperating for solubilization.

Brief Description of the Drawings

[12] To better understand the present invention, its detailed description is presented below, with reference to the attached drawings:

- Figure 1 shows an isometric view showing the assembled set in an upper angle;
- Figure 2 shows another isometric view of the assembled set, but in a lower angle;
- Figure 3 shows an upper view of the device with the indications of A-A, B-B and C-C cuts;
- Figure 4 shows a view of the A-A cut as shown by Figure 3;
- Figure 5 shows a schematic view of the device as installed jointly with a processing tank for any given

mixture;

- Figure 6 shows a view of the B-B cut as shown by Figure 3;
- Figure 7 is a view of the C-C cut as shown by Figure 3;
- Figure 8 shows a perspective view in upper angle and a magnified cut detail; highlighting a version in smaller dimensions than the ones as shown by the previous figures; and
- Figure 9 is a perspective view showing the lower version in a lower angle.

Detailed Description of the Invention

[13] According to those figures and their details, more specifically Figures 1 to 4, the present invention, a **SOLUBILIZER FOR VARIOUS MIXTURES**, is characterized by comprising:

- a continued dynamic passage chamber (1) for the mixed flow to be solubilized;
- at least one vertically assembled solubilizing core (2) going through the upper wall of the dynamic passage chamber (1), wherein a part of it or its upper end is externally exposed and configures an inlet for the flow of the mixture to be solubilized, while the other part or lower end is vertically located and hinged inside the dynamic passage chamber (1), configuring an ejection point for the flow of mixture to be solubilized into the dynamic chamber (1);
- at least one vertically assembled collection tube (3) crossing the lower wall of the dynamic passage chamber (1), in a coaxial alignment position with a solubilizer

core (2), wherein the internal upper end of said collector tube (3) is away from the corresponding edge of the solubilizer core (2), while its exposed lower end includes a connection (4);

- the lower end with a connection (4) for the collector tube (3) (please refer to Fig. 5) is coupled to the upper part of a mixing tank (5), inside which the solubilized mixture flow is discharged;
- an external recirculation pipeline (6), interconnecting the lower and the upper part of the mixture tank (5), forming a closed recirculation circuit;
- a high pressure pump (7) is interleaved with the pipeline (6), wherein the mixture flow is moved from the bottom of the mixture tank (5) to the inlet of the solubilizing core (2) and from there to inside the mixture tank (5);
- the upper part of the dynamic passage chamber (1) includes at least one inlet tube (8) for injecting a gas, such as carbon dioxide (CO₂), nitrogen (N₂) and others which, eventually, may be a part of the mixture or a cooperating constituent for solubilization;
- a cleaning set (9) assembled to the upper part of the dynamic passage chamber (1), extending itself to its inner side;
- the lower side of the dynamic passage chamber (1) includes at least one vent tube (10) for inlet and recirculation of air/gas from inside the mixture tank (5) and inside the dynamic passage chamber (1); and
- the lower side of the dynamic passage chamber (1) includes a central tube outlet (11) and the respective

line display (12) as a transparent cup.

[14] As also shown by Figure 6, the dynamic passage chamber (1) is formed by a body, preferably of stainless steel, defined by a cylindrical wall (13), closed on its bottom by a conic path (14), with its acute part turned downside and connected to the central tubular outlet (11) and its respective line display (12), being located in a median position between that point and the cylindrical wall (13), the collector tube (3) and the vent tube (10) for air inlet, while the upper diameter of the cylindrical wall (13) includes trimming (15), over which a circular closing cap (16) is located, coupled to the cylindrical wall (13) by means of fasteners (17), over which cap the solubilizing core (2), the inlet tube (8) for gas injection and the cleaning set (9) are attached.

[15] The solubilizing core (2), seen in detail on Figure 7, is constituted by a tube (18), preferably elbow-shaped, having its upper edge with connection coupling (19) to the pipeline (6), while its lower edge has its internal diameter with a constriction zone (20) defined by a tablet (21) which, on the other hand, ends at a lower position with reduced diameter (22) and, above it, the surface of said tablet is widened into a round shape until meeting the internal diameter of said tube (18), and also, above the constriction zone (20), at least two deflecting wings (23), both equally curved, are located and, when combined, they form a helix-shaped passage for the flow of processing mixture, causing its vortexing.

[16] The reduced diameter (22) of the tablet (21) is between 35 and 65% shorter than the internal diameter of

the collector tube (3).

[17] The distance (d) between the lower end of the tube (18) and the upper end of the collector tube (3) is between one and six times higher than the diameter radius (22).

[18] Referring to Figure 4, the cleaning set (9) is constituted by a manifold (24), with one inlet (25) and outlets (26), having connection couplings (27) to a pipeline to supply cleaning water and connection to the tubes (28), the latter transpassing and being vertically coupled to the circular cap (16) and, inside the dynamic passage chamber (1), its outlets have the form of spheroid sieves (29), which orifices provide means to form water jets, heated or not, to all directions and against the internal walls of the dynamic passage chamber (1), allowing them to be washed by not disassembling the set.

[19] The present solubilizer was developed for manufacturing under different dimensions, depending on the desired productivity/hour. Therefore, Figures 1 to 7 show a version with two solubilizing cores (2), which does not appear on Figures 8 and 9, showing a version with just one solubilizing core (2). In this case, it is assembled in exactly the same way, i. e. by vertically crossing the circular closing cap (16) of the dynamic passage chamber (1), but exactly on its central part. Consequently, its collecting tube (3) is equally aligned to the center of the conic path (14) of the dynamic passage chamber (1), and that centralized tubular outlet (11) and the respective line display (12) were thus eliminated, being this latter set substituted with a display window (30), installed in a hole (31) made on the circular closing cap

(16), wherein the set is formed by a nipple (32), having its base attached to the circular closing cap (16), while its upper end is coupled to a screw (33) with an internal flange enclosing a glass disc (34) between two seals (35) and (36). Said glass disc (34) allows for the internal visualization of the dynamic passage chamber (1) to verify its internal activity.

[20] The embodiment with only one solubilizing core (2) optionally eliminates the cleaning set (9), and may even include a modified cleaning set with smaller dimensions, keeping other necessary details, especially an air or gas inlet.

[21] As we can see, the present device was developed to establish a continued flow in closed circuit, established jointly with the mixing tank (5), which, on the other hand, is loaded with a batch of ingredients to be mixed and solubilized, under heating or not. The established flow enters at least one solubilizer (2) under high pressure and, at that point, suffers a first dynamic effect when passing through the deflecting wings (23), wherein the flow suffers high rotation (vortexing). At that point, a first effect occurs between the flow friction against the tube wall (18) of the solubilizing core (2), i. e. the constituents are homogenized, thus drastically reducing their surfactant effect, allowing the flow to slide with no interference inside the tube (18). Subsequently, the vortexing flows through the constriction zone (20) and the reduced diameter (22). At that point, different effects concur. The first effect is a considerable increase in pressure at the constriction

zone (20) itself and, after the diameter (22), the speed of the flow being injected into the collector tube (3) increases and, shortly after its inlet, the flowing speed and pressure are reduced and the flow is expanded, obviously limited by the larger diameter of said collecting tube (3), wherein the expanded volume works as an impact point for the flow exiting at high speed from the diameter (22) of the constriction zone (20) and the internal region of the collecting tube (3) and, consequently, the particles of the mixture constituents abut themselves, causing their microfragmentation by shearing. At that point, another effect concurs, which is the aspiration and mixture of gases which is injected through the tube (8) or aspiration of the air entering through the vent tube (10). In this case, optionally, gas and air injection may occur simultaneously, or the injection of just one of them.

[22] The solubilization of one or more constituents occurs in higher degree when the flow goes in and out the solubilizer (2), since, during that flow, different effects occur, especially microfragmentation, considerably increasing the contact surface between the solute and the solvent, e. g. water, also making the mixture become more homogeneous, and consequently eliminating the surfactant effect between the particles, everything exponentially speeding up the solubilization process of the solute constituents in the mixture.

[23] Concerning the operation of the cleaning set (9), we can notice that it has an embodiment enabling the water flow, be it heated or not, to be injected under pressure

into the dynamic passage chamber (1), wherein the spheroid sieves (29) produce various jets against their walls, fully removing any sediments which, jointly with the water, are removed by gravitation and flow towards the tank (5) through the central tubular outlet (11) and its respective line display (12) as a transparent cup. Said line display allows to detect not only the internal cleaning stage of the set, but also other irregularities which may eventually occur when the material flows through the solubilizing core (2), i. e. if there is an eventual imbalance in the speed or pressure rank in the recirculation line, the processed material consequently escapes from the collecting tube (3) and flows by gravitation through the line display (12), showing irregular operation of the device.

CLAIMS

1) **SOLUBILIZER FOR VARIOUS MIXTURES**, formed by a hydraulic recirculation device under pressure for any mixture, be it heated or not, having at least one solute constituent and at least one solvent, including water, and should go through a solubilization process for said solute constituent; **characterized** by comprising:

- a continued dynamic passage chamber (1) for the mixed flow to be solubilized;
- at least one vertically assembled solubilizing core (2) going through the upper wall of the dynamic passage chamber (1), wherein a part of it or its upper end is externally exposed and configures an inlet for the flow of mixture to be solubilized, while the other part or lower end is vertically located and hinged inside the dynamic passage chamber (1), configuring an ejection point for the flow of mixture to be solubilized into the dynamic chamber (1);
- at least one vertically assembled collection tube (3) crossing the lower wall of the dynamic passage chamber (1), in a coaxial alignment position with a solubilizer core (2), wherein the internal upper edge of said collector tube (3) is away from the corresponding edge of the solubilizer core (2), while its exposed lower end includes a connection (4);
- the lower end with a connection (4) for the collector tube (3) is coupled to the upper part of a mixing tank (5), inside which the solubilized mixture flow is discharged;
- an external recirculation pipeline (6),

interconnecting the lower and the upper part of the mixture tank (5), forming a closed recirculation circuit;

- a high pressure pump (7) is interleaved with the pipeline (6), wherein the mixture flow is moved from the bottom of the mixture tank (5) to the inlet of the solubilizing core (2) and from there to inside the mixture tank (5);

- the upper part of the dynamic passage chamber (1) includes at least one inlet tube (8) for injecting carbon dioxide (CO₂), nitrogen (N₂) and others which, eventually, may be a part of the mixture or a cooperating constituent for solubilization;

- a cleaning set (9) assembled to the upper part of the dynamic passage chamber (1), extending itself to its inner side;

- the lower side of the dynamic passage chamber (1) includes at least one vent tube (10) for inlet and recirculation of air/gas from inside the mixture tank (5) and inside the dynamic passage chamber (1); and

- the lower side of the dynamic passage chamber (1) includes a central tube outlet (11) and the respective line display (12) as a transparent cup.

2) **SOLUBILIZER FOR VARIOUS MIXTURES**, of claim 1, **characterized** by the dynamic passage chamber (1) being formed by a body defined by a cylindrical wall (13), closed on its bottom by a conic path (14), having its acute part turned downside and connected to the central tubular outlet (11) and respective line display (12), being in a median position between that point and the cylindrical wall (13), the collecting tube (3) and the

vent tube (10) for air inlet, while the upper diameter of the cylindrical wall (13) includes trimming (15) over which a circular closing cap (16) is coupled to the cylindrical wall (13) by means of fasteners (17) and, to that cap, the solubilizing core (2), the inlet tube (8) for gas injection and the cleaning set (9) are attached.

3) **SOLUBILIZER FOR VARIOUS MIXTURES**, of claim 1, **characterized** by the solubilizing core (2) being constituted by an elbow-shaped tube (18), having its upper end coupled (19) for connection to the pipeline (6), while its lower end has its internal diameter with a constriction zone (20) defined by a tablet (21) which, on the other hand, ends in a lower position at reduced diameter (22), and, on its upper side, the surface of said tablet is widened in a rounded shape until meeting the internal diameter of said tube (18), and also, above the constriction zone (20), at least two deflecting wings (23) are located, both equally curved and which, in combination, form a helix vortexing passage for the mixture flow in process.

4) **SOLUBILIZER FOR VARIOUS MIXTURES**, of claim 3, **characterized** by the reduced diameter (22) of the tablet (21) being between 35 and 65% shorter than the internal diameter of the collecting tube (3).

5) **SOLUBILIZER FOR VARIOUS MIXTURES**, of claim 1, characterized by the distance (d) between the lower end of the tube (18) and the upper end of the collecting tube (3) being one to six times longer than the diameter radius (22).

6) **SOLUBILIZER FOR VARIOUS MIXTURES**, of claim 1,

characterized by the cleaning set (9) being constituted by a manifold (24) with one inlet (25) and outlets (26), having couplings (27) for connection to a pipeline to supply cleaning water and connection to tubes (28), the latter crossing and being vertically coupled to the circular cap (16) and, inside the dynamic passage chamber (1), its outlets are in the form of spheroid sieves (29).

7) **SOLUBILIZER FOR VARIOUS MIXTURES**, of claim 1, characterized by, in an embodiment of only one solubilizing core (2), being assembled in a central position, vertically crossing the circular closing cap (16) of the dynamic passage chamber (1), which also happens with its collecting tube (3), which is equally aligned to the center of the conic path (14) of the dynamic passage chamber (1).

8) **SOLUBILIZER FOR VARIOUS MIXTURES**, of claim 7, characterized by including a display window (30), installed in a hole (31) made on the circular closing cap (16), wherein the set is formed by a nipple (32), having its base attached to the circular closing cap (16), while, on its upper end, a screw (33) is coupled, with an internal flange fixing a glass disc (34) between two seals (35) and (36).

9) **SOLUBILIZER FOR VARIOUS MIXTURES**, of claim 1, characterized by the embodiment having only one solubilizing core (2), optionally eliminating the cleaning set (9) or including a modified cleaning set with shorter dimensions.

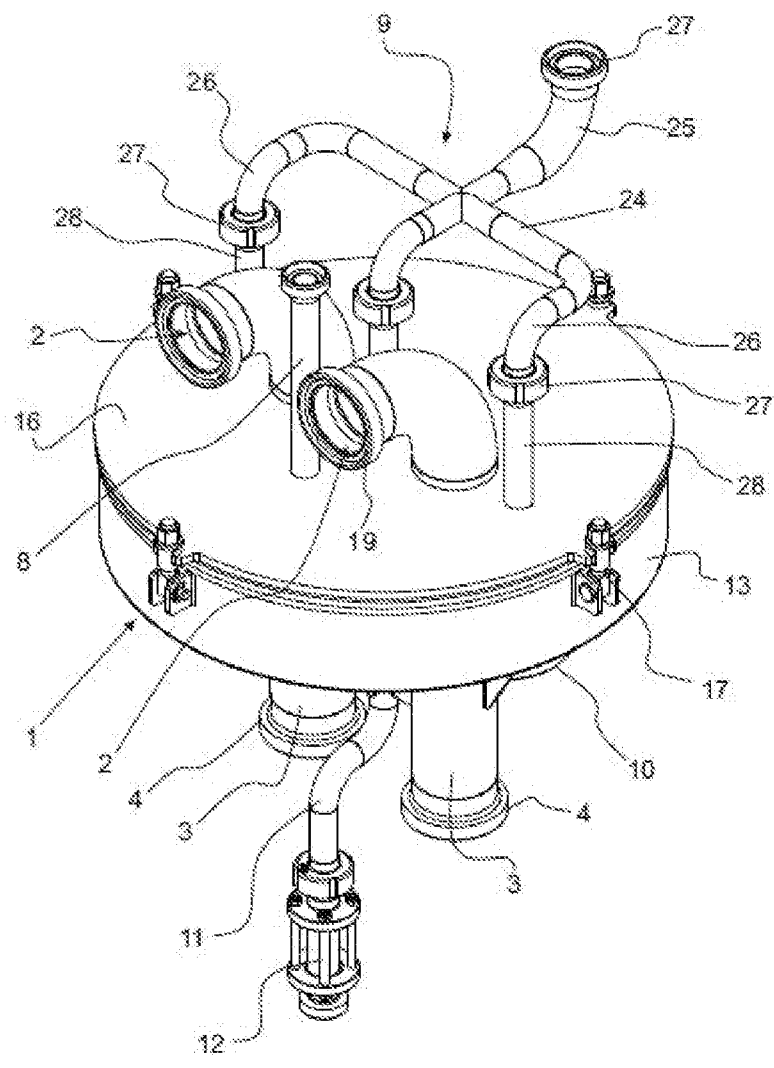


Fig. 1

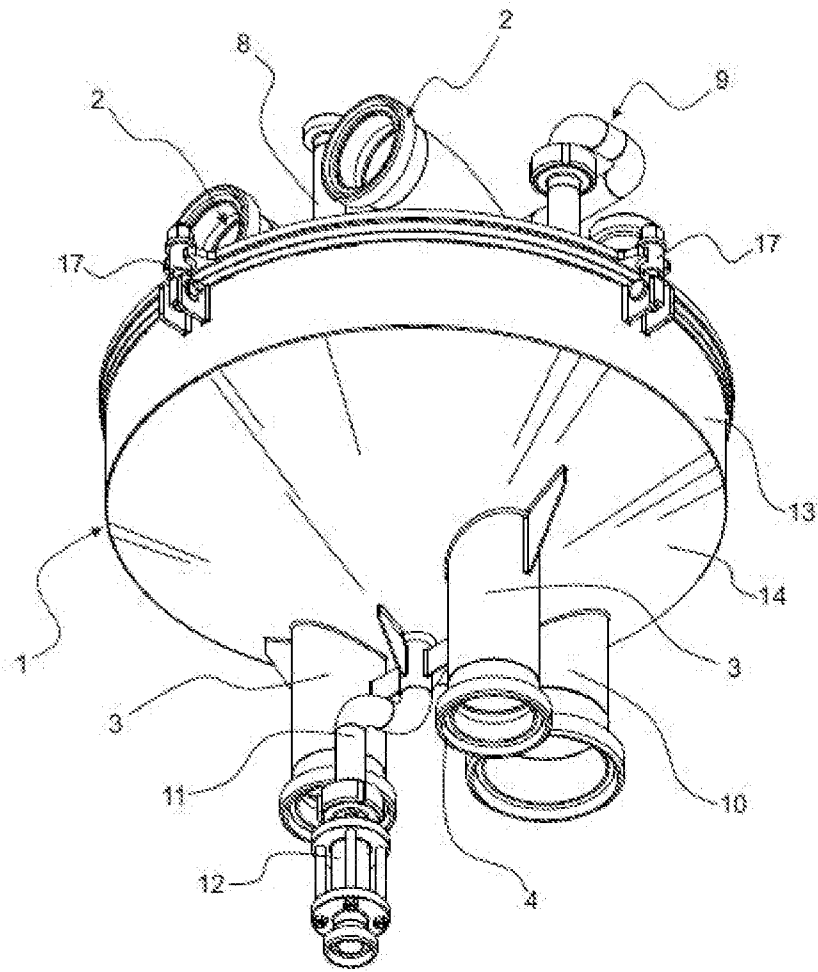


Fig. 2

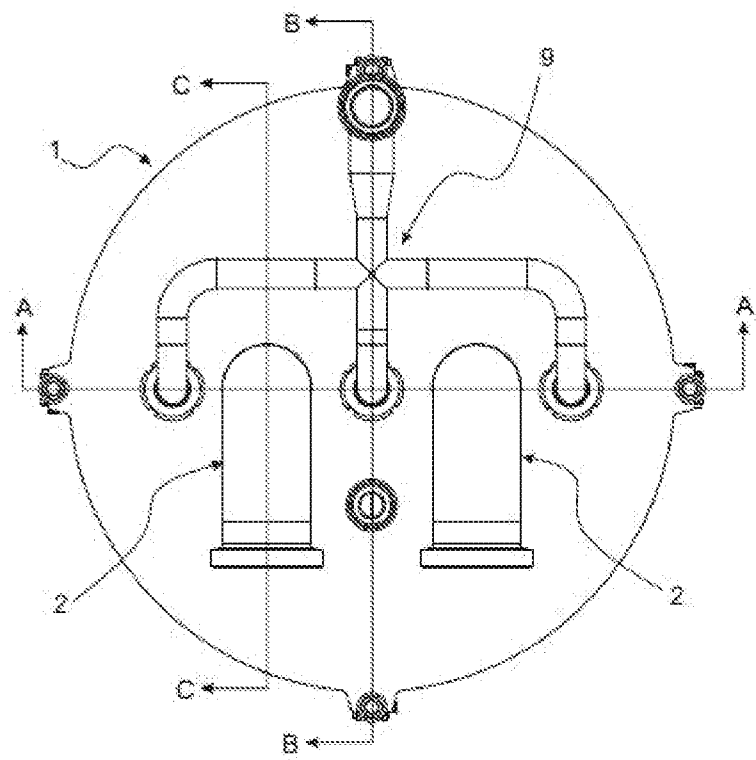


Fig. 3

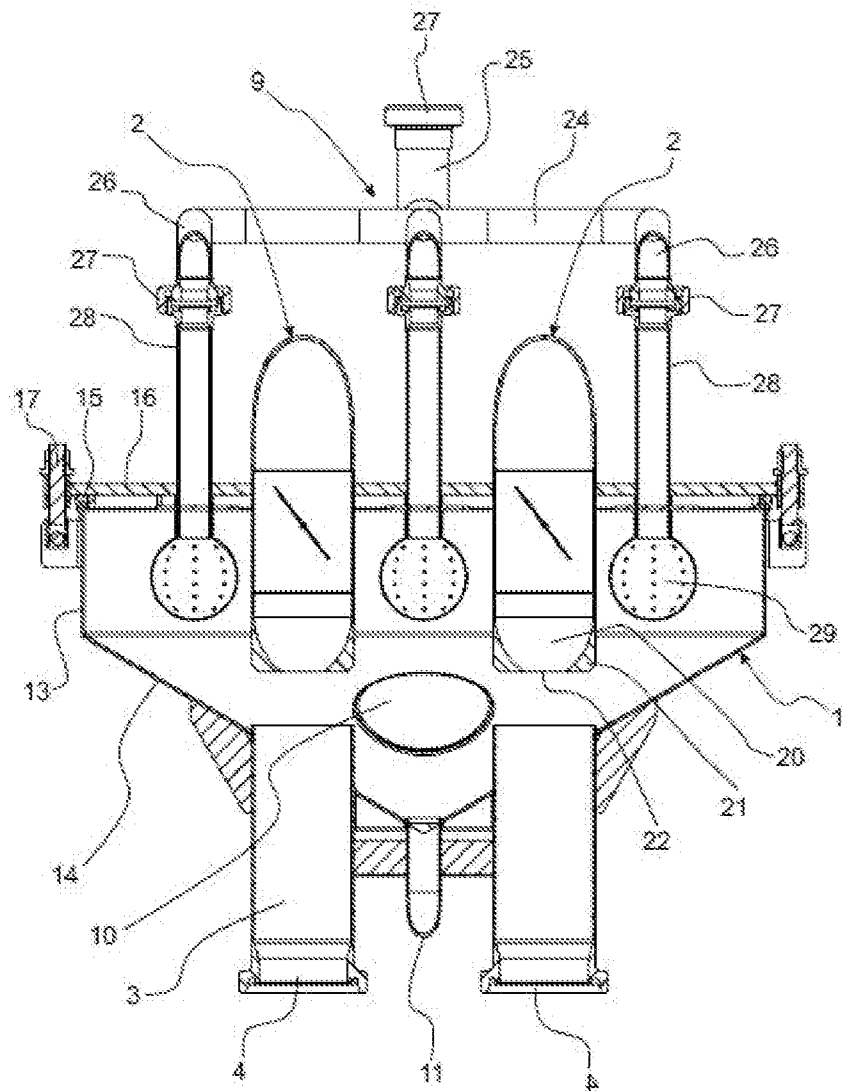


Fig. 4
A-A Cut

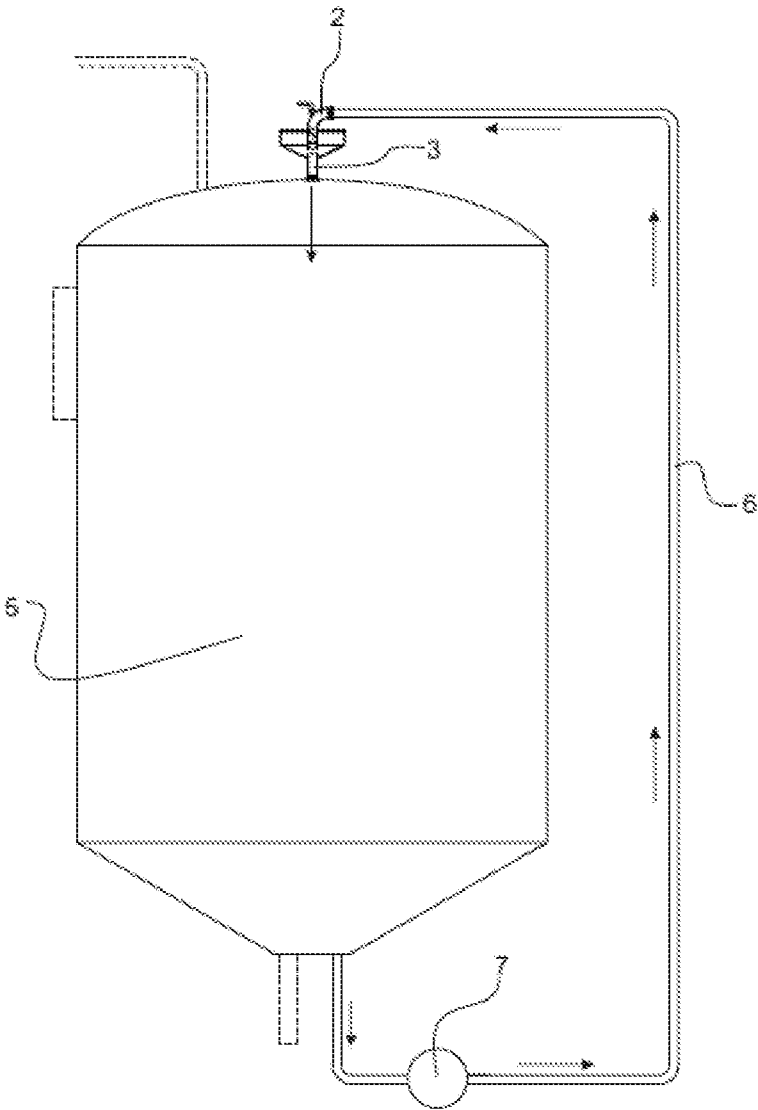


Fig. 5

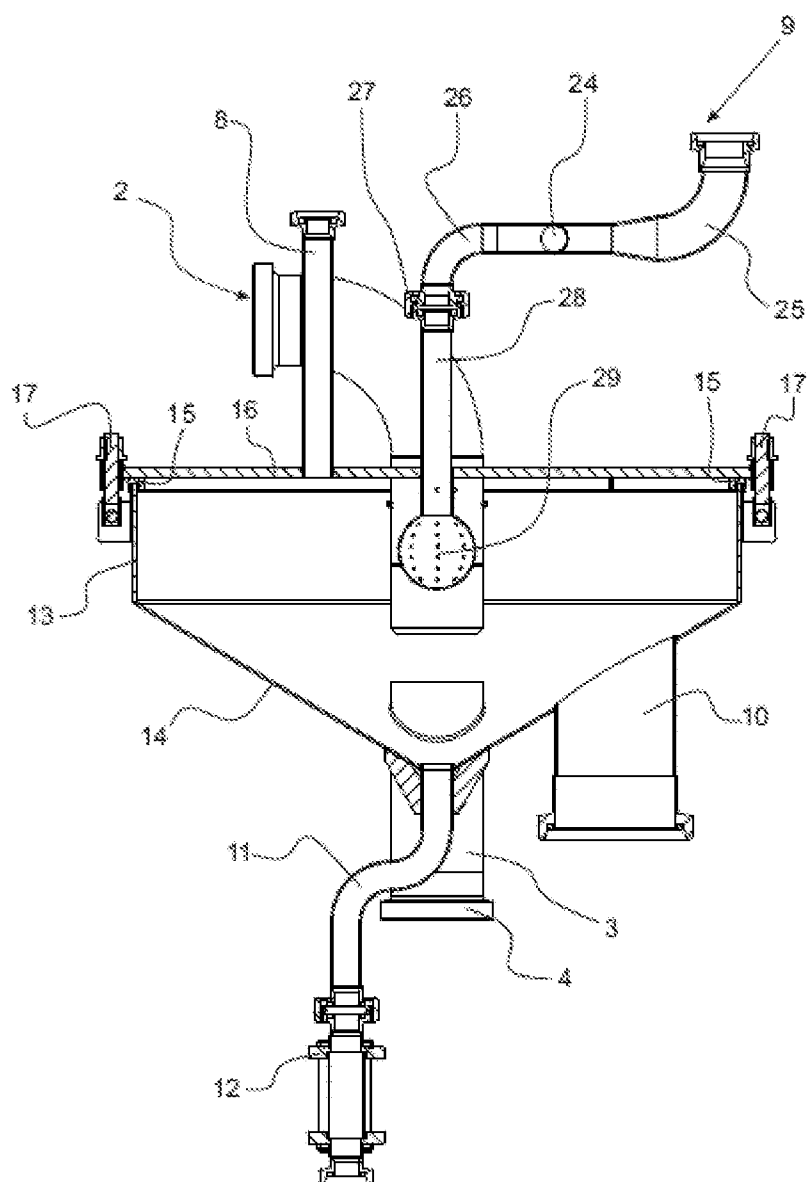


Fig. 6

B-B Cut

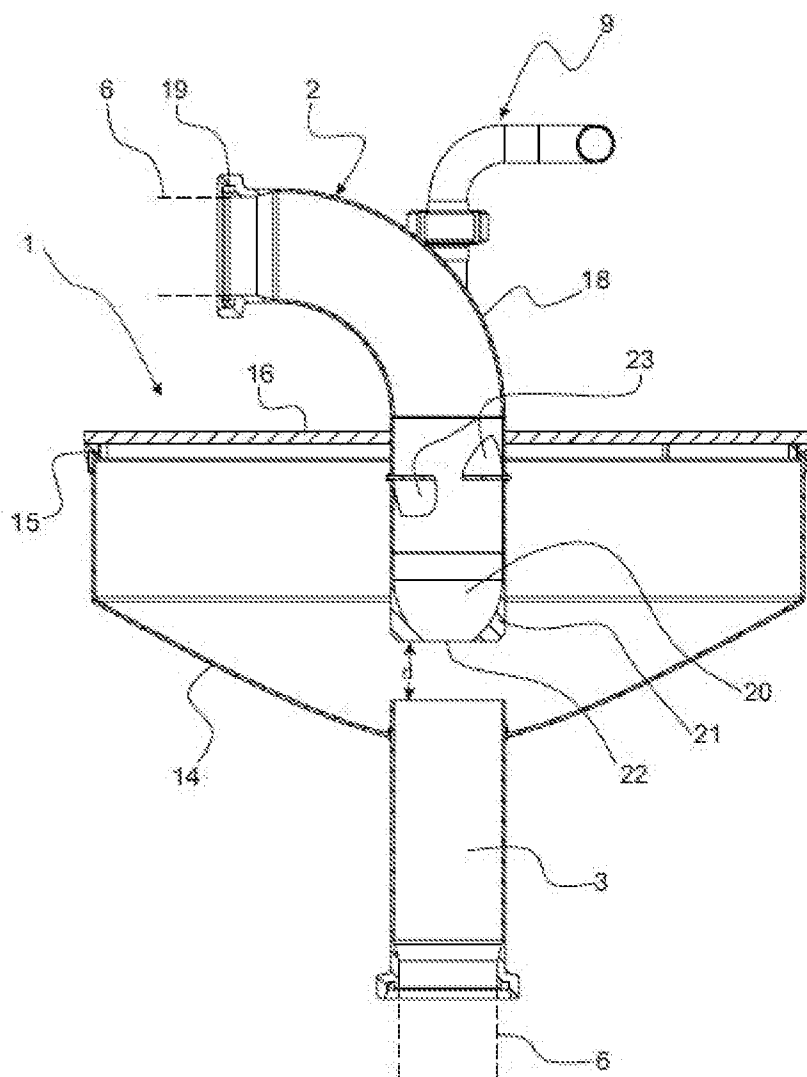


Fig. 7
C-C Cut

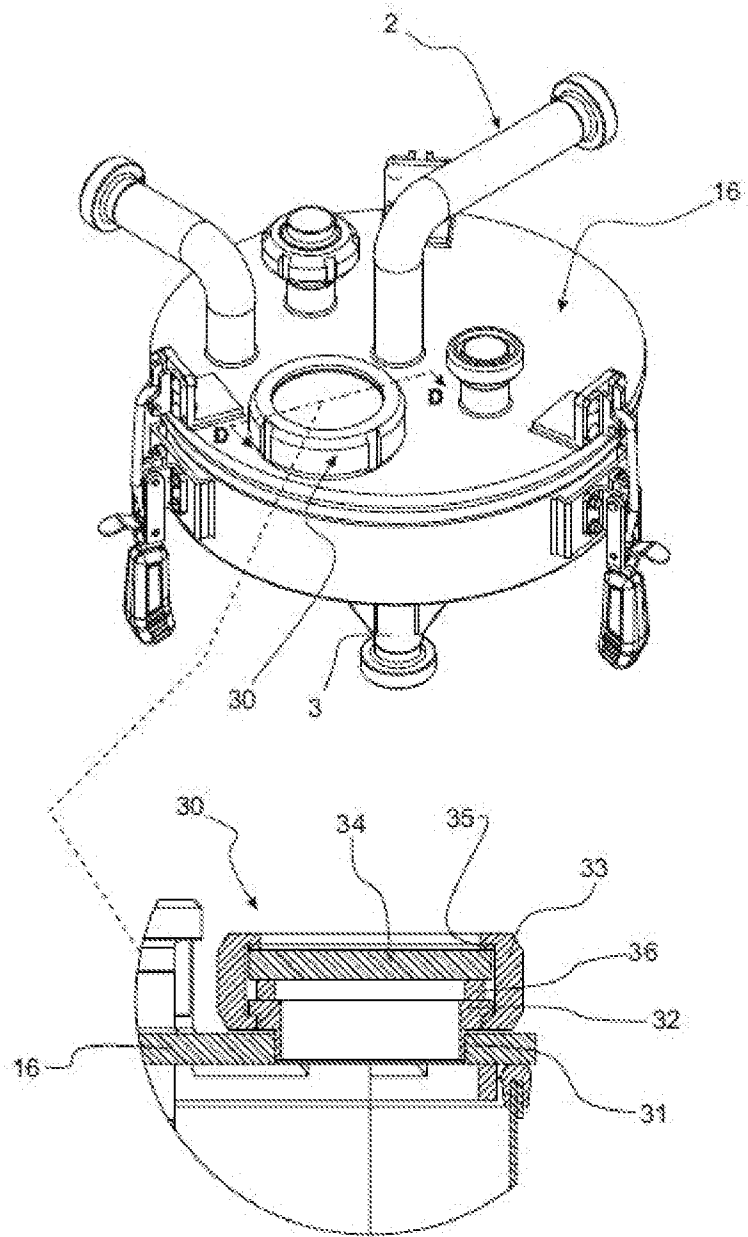


Fig. 8

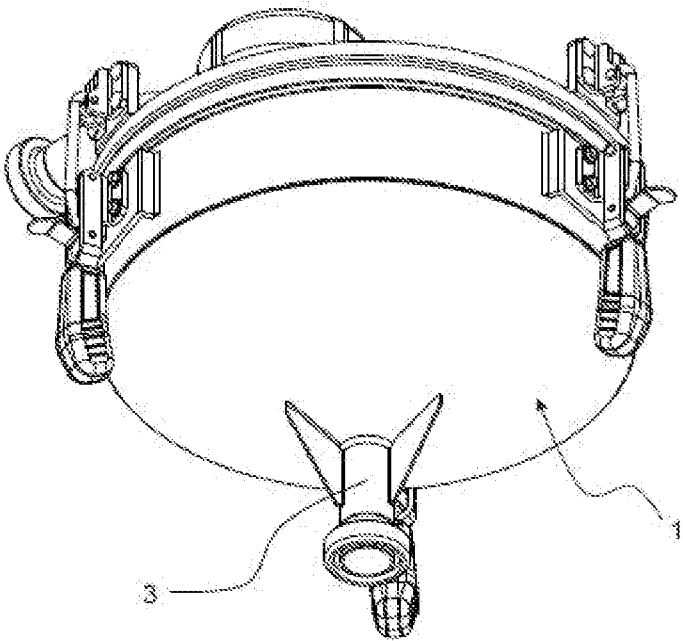


Fig. 9

INTERNATIONAL SEARCH REPORT

International application No.

PCT/BR2023/050098

A. CLASSIFICATION OF SUBJECT MATTER B01F 21/20 (2022.01)i; B01F 25/50 (2022.01)i; B01F 33/40 (2022.01) CPC: B01F21/20, B01F25/50, B01F33/405 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) B01F 21/20; B01F 25/50; B01F 33/40 CPC: B01F21/20, B01F25/50, B01F33/405 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched INPI-BR data base Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Derwent Innovation, Google Patents		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 7281840 B2 (TRES ARK INC [US]) 16 October 2007 (2007-10-16) Whole document	1 - 9
X	WO 2009064878 A1 (ENTEGRIS INC [US]) 22 May 2009 (2009-05-22) Whole document	1-9
X	CA 2808010 A1 (DU PONT [US]) 15 March 2012 (2012-03-15) Whole document	1-9
X	US 6109778 A (UNITED STATES FILTER CORP [US]) 29 August 2000 (2000-08-29) Whole document	1-9
X	CN 105536588 A (ZHUHAI GREE INTELLIGENT EQUIPMENT CO LTD) 04 May 2016 (2016-05-04) Whole document	1-9
A	EP 0710148 B1 (FUCHSBICHLER KEVIN JOHAN [AU]) 13 September 2000 (2000-09-13) Whole document	1-9
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Date of the actual completion of the international search 26 May 2023		Date of mailing of the international search report 05 June 2023
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/BR2023/050098**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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