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(54) **VACUUM COOLING DEVICE FOR FOOD COOLING**

(57) Disclosed vacuum cooling device for food cooling, the device comprising a vacuum chamber that has a cylinder-shaped or bell-shaped upper part (1) with a downside opening, where the upper part (1) is liftable (movable up and down) and can be lowered onto a base/floor (10), thereby enclosing food products in a hermetic volume/chamber (1, 10), where the food products stay placed on said base/floor (10). The hermetic volume (1, 10) is then vacuumed, thereby cooling the food products inside the vacuum chamber (1, 10). This vacuum cooling device is efficient because of its specific construction and the materials required to build it. The invention further discloses a method of operating the vacuum cooling device, thereby cooling the food products placed within the vacuum chamber (1, 10). The operation method, due to the cooling device construction, can be performed automatically.

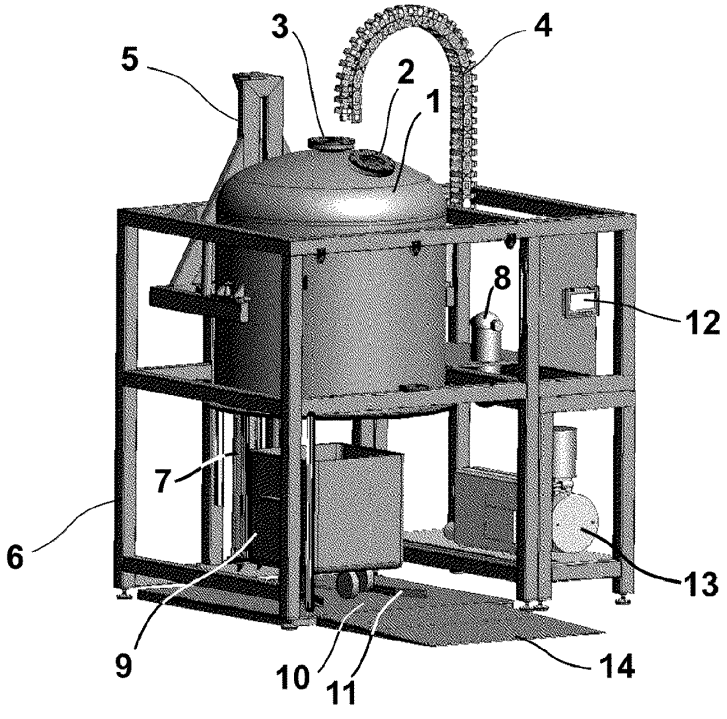

Fig. 1

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Description

FIELD OF INVENTION

[0001] The invention belongs to the field of the food industry. Specifically, the invention discloses a vacuum cooling device for food cooling, comprising an efficient construction thereof, which is employed to cool food products efficiently.

BACKGROUND ART

[0002] To cool food products, vacuum cooling units are often used in the food industry. Vacuum cooling is carried out using the physical laws of thermodynamics. Under normal ambient conditions, when the ambient pressure is 1000 millibars, water boils at +100°C temperature. Meanwhile, in a vacuum, at a pressure of 10 millibars, water boils at 7°C temperature. Water evaporates during boiling, and as it evaporates, it takes heat, thus cooling the food.

[0003] This thermodynamic principle is exploited by food industry equipment manufacturers who produce vacuum cooling equipment. In this equipment, vacuum chambers are used to carry out vacuum cooling. These are devices and systems of massive construction that ensure the rigidity of the walls of the vacuum chamber at low vacuum pressure.

[0004] The European patent application EP3789704A1 by Durrer Spezialmaschinen AG discloses a vacuum chamber comprising aluminum walls and plates. The vacuum chamber (10) for food cooling is delimited by a floor (11), a left side wall (14), a back wall (13), a right side wall (12) and a ceiling (15) as well as a door (17) and having a connection to the outside for supplying a negative pressure. The door is connected to a door frame (16), the three side walls (12, 13, 14) are positioned at right angles to adjacent walls, wherein a connecting vertical post (24, 34) is provided in each corner between and separating adjacent side walls, wherein the three side walls (12, 13, 14) are positioned on an elevated ridge (35, 135) of the floor (11) and are covered by the ceiling (15), and the three side walls (12, 13, 14), the two vertical corner posts (24, 34), the floor (11), the ceiling (15) and the door frame (16) are connected one to the other with a plurality of screws (25). The patentee states that his invention reduces the costs of providing and deploying in service such vacuum chamber. However, the walls of the chamber are thick, presumably, of 40 to 50 milimeters which is not efficient in the aspect of material amounts used to implement the construction.

[0005] Another patent application WO2019141574A1 relates to the use of a cover (2) for installing into a drawer body (9), wherein the cover can be arranged so as to be operatively connectable to a linearly movable drawer (3). The cover (2) is suitable for evacuating at least one drawer interior (R) by means of evacuating means such that the at least one drawer interior (R) is evacuated when the drawer (3) is in the closed position and can be ventilated prior to opening the drawer (3), and the cover (2) is designed to be air-tight and is profiled such that the evacuating means, in the form of a controller (8), a pump (1), and a valve (4), are secured in at least one recess (A) in the cover (2) in an integrated manner. The cover (2) has at least one air channel (11') which leads into the cover interior or into the at least one recess (A), and the air channel (1 1') is operatively connected to the evacuating means such that when the cover (2) is supported on the drawer (3), air can be pumped out of the at least one drawer interior (R), the cover interior, or the at least one recess (A) through the air channel (11'). However, this invention by WO2019141574A1 aims only for home use, and only for evacuating the food storage space but not for cooling the food by evacuation of said storage space, which is a usual cooling technology in industrial vacuum cooling equipment.

[0006] One more European patent EP2295907A1/ EP2295907B1 discloses a vacuum system for cooling food including a vacuum chamber (1) for holding the food. The vacuum chamber (1) is delimited by a floor (6), a side wall (7) and a ceiling and has a connection for supplying vacuum. The bottom (6) of the vacuum chamber (1) contains a depression (9) with a drain (10) for draining water. A pump (3) is advantageously connected to the drain (10) to pump out water that has accumulated in the recess (9). The floor advantageously runs at an angle. The vacuum chamber (1) advantageously has a door (5) without a mechanical locking mechanism. The door (5) has at least one start button (13) to start a cooling process. This document discloses that the interior of vacuum chamber 1 is delimited by a floor 6, a side wall 7, and a ceiling. However, vacuum chamber 1 can have any shape, for example, it is a cuboid. The side wall 7 can be rectangular when viewed from above, but it is preferably round, in particular circular. Fig. 2 in this patent shows the bottom 6 of a vacuum chamber 1 with a circular floor plan and pipe 8 of a ventilation system in supervision. However, this

The present invention aims to improve the construction of a vacuum cooling device, with a purpose for better efficiency in large-scale industrial food processing applications. Furthermore, it is important to improve the operation of the cooling chamber, to provide means to load, cool, and unload the cooled food in automatically performed steps, not requiring human interaction in the process (for example, to open and to close the door of the vacuum chamber, as the door is disclosed in EP3789704A1 and EP2295907A1 / EP2295907B1).

SUMMARY OF INVENTION

[0007] Technical problem. The present invention aims to disclose an efficient vacuum cooling device and construction thereof, suitable for large-scale industrial food processing equipment and processes, and also

by the construction and operation of such vacuum cooling devices.

[0008] **Solution to the problem.** The concept of the present invention is a liftable cylinder-shaped camera with a downside opening (open side from beneath of the lifable camera). The lower opening, while the camera is in the lifted state, allows to put food products under the camera, and when the camera is lowered down to the floor/basis, thus, enclosing the food products in a hermetic volume. Preferably, the camera is bell-shaped. This cylinder-shaped or bell-shaped camera is efficient because of its better resistance to external pressure and internal pressure differences. Therefore, thinner walls of the vacuum camera can be implemented. In some practical embodiments of the vacuum chamber having volume from 0,5 to 2 cubic meters, the camera wall thickness can be as thin as 4 millimeters.

[0009] The aforementioned cylinder-shaped camera comprises side walls, and the upper wall, while the lower side of the camera is open where a wall is absent.

[0010] The bell-shaped upper part (1) of the vacuum chamber comprises its side and upper walls of a bell-shape, while the lower side of the camera is open.

[0011] The upper part (1) of the vacuum chamber is liftable during the operation of the cooling device.

[0012] The bottom ring of the bell-shaped or cylinder-shaped chamber with the lower opening further comprises a rubber gasket that fits tightly onto the stainless steel base/floor and thereby provides a hermetic seal between the camera's lower opening and the base/floor.

[0013] The bell-shaped or cylinder-shaped upper part (1) of the vacuum chamber with the lower opening is moved up and down by a pneumatic cylinder.

[0014] The operation of the vacuum cooling device is operated by the following steps.

- a stroller/cart with food products is brought under the lifted camera with the lower opening:
- the bell-shaped or cylinder-shaped upper part of the camera/chamber with the lower opening is lowered down until its rubber gasket touches the floor/base;
- the vacuum pump draws out the air, thereby creating a vacuum inside the camera, and in this way, the cooling of the product begins;
- After the product cools down, then air is let in into the camera;
- the bell-shaped or cylinder-shaped camera is lifted up,
- the stroller/cart with the cooled food products is pulled out from under the camera.

[0015] **Advantages, effects.** The present invention is efficient because of the optimized shape of the vacuum chamber, and the optimized amount of materials to produce such a vacuum cooling device.

[0016] Furthermore, the disclosed vacuum cooling device construction allows for improved operation of the cooling chamber, to provide automated means to load, cool, and unload the cooled food in automatically performed steps, not requiring human interaction in the process.

BRIEF DESCRIPTION OF DRAWINGS

[0017] The drawings are provided as a reference to possible embodiments but are not intended to limit the scope of the invention. The drawings presented herein are merely as an example of a possible embodiment of the invention.

Fig. 1 depicts the front perspective view of the vacuum cooling device.

Fig. 2 depicts the rear perspective view of the vacuum cooling device.

Fig. 3 depicts a bell-shaped upper part of the vacuum chamber of the vacuum cooling device:

a) front view and top view of the bell-shaped upper part of the vacuum chamber;
b) perspective view of the bell-shaped upper part of the vacuum chamber).

Fig. 4 depicts an implementation of how the bell-shaped upper part of the vacuum chamber is tightly coupled with the flat base/floor of the vacuum cooling device, thereby, forming a sealed hermetic chamber for vacuum cooling of food products placed in said hermetic chamber with the applied vacuum inside it: 1 - side-wall of the bell-shaped upper part of the hermetic/vacuum chamber (1,10); 15 - flat edge of the side-wall of the bell-shaped upper part of the chamber; 16 - the inner ring on the side-wall flat edge; 17 - the outer ring on the side-wall flat edge; 18 - sealing rubber gasket between the inner and outer rings.

Fig. 5 depicts a food cart/stroller and its placement limiters on the flat base/floor in the vacuum chamber;

Fig. 6 depicts the holder of the upper part of the vacuum chamber. The holder embraces the chamber's upper part and is attached to the lifting device, thereby allowing the upper part of the vacuum chamber up and down onto the base/floor of the vacuum cooling device.

Fig. 7 depicts the front and top projections of the cooling device, where the 2 front projections present the upper part of the vacuum chamber in the bottom position and the upper position.

DRAWINGS - description of items

[0018]

1 the upper part of the vacuum chamber, the upper part has the shape of a cylinder or preferably a bell, with an open bottom side;
2 an observation window of the vacuum chamber;
3 port of the vacuum chamber for connecting the vacuum hose;
4 a flexible shell enclosing the vacuum (air evacuation) hose, and cables for temperature and pressure sensors, being connected to the upper part (1) of the vacuum chamber (1, 10);
5 the holder of the upper part (1) of the vacuum chamber (1, 10); the holder embraces the chamber's upper part (1), is attached to the lifting device, and is arranged to move the upper part (1) up and down onto the base/floor (10) of the vacuum cooling device;
6 frame of the vacuum cooling device;
7 pneumatic (or hydraulic) cylinder which ensures lifting and lowering down of the upper part (1) of the vacuum chamber (1, 10);
8 the condenser cooling water;
9 a food cart/stroller;
10 the flat base/floor in the vacuum chamber (1, 10);
11 placement limiters of the food cart/stroller (9) on the flat base/floor (10) in the vacuum chamber (1, 10);
12 control computer and its operator panel;
13 vacuum pump;
14 cooling chamber (1, 10) entrance slope, for the food cart/stroller (9) into the vacuum cooling device (onto the flat base/floor (10) thereof);
15 a bottom flat edge of the side-wall of the bell-shaped upper part (1) of the chamber (1, 10);
16 the inner ring on the side-wall flat edge;
17 the outer ring on the side-wall flat edge;
18 a sealing rubber gasket between the inner and outer rings.

DETAILED DESCRIPTION OF THE INVENTION

[0019] Vacuum cooling device. The device comprises at least:

- a frame (6) for arrangement of components of the device,
- a hermetically closable chamber (1, 10), comprising:
    - a liftable cylinder-shaped upper part (1) of the vacuum chamber, where this upper chamber part (1) is open from the beneath;
    - a flat floor of the device, onto which the upper part (1) of the vacuum chamber can be lowered, thereby forming a sealed hermetic chamber;
- a controllable vacuum pump providing vacuum to the closed chamber (1, 10).

[0020] The type of vacuum pump can be a vane vacuum pump. Another optional implementation can be a dry screw vacuum pump. Also other types of vacuum pumps can be employed within the vacuum cooling device.

[0021] When the upper part (1) is in the lifted (upper) state, its lower opening allows to put food products under the upper part (1), onto the base/floor of the chamber. And, when the the upper part (1) is lowered down to the floor/basis (10), thereby formed hermetic chamber (1, 10) encloses the food products inside a hermetic volume.

[0022] Preferably, the upper part (1) of the chamber is bell-shaped. The cylinder-shaped or bell-shaped upper part (1) is more efficient because of its mechanical resistance to the external and internal pressure differences. Correspondingly, thinner walls of the upper part (1) and the chamber can be selected/implemented.

[0023] In a practical (preferred) embodiment, where the chamber has a volume of nearly 1 cubic meter (100cm x 120cm x 120 cm), the wall thickness of the chamber can selected as thin as 4 millimeters, for vacuum levels as low as 10 millibars. The practical size of the upper part (1) can be in the range, of the diameter from 70cm to 150 cm, and the height from 70 cm to 200 cm.

[0024] The aforementioned cylinder-shaped upper part (1) comprises side walls, and the upper wall, while the lower side of the upper part (1) is open from beneath.

[0025] The bell-shaped upper part (1) of the chamber comprises the side and upper walls together forming a bell shape, and the beneath side of the bell is open.

[0026] The upper part (1) of the vacuum chamber (1, 10) is liftable during the operation of the vacuum cooling device. The mechanism of the lifting/lowering of the upper part (1) is shown in Figures 1 and 2. The upper part (1) is embraced and held by a special holder frame (5) (depicted in Figure 6), which is movable up and down by a pneumatic cylinder (7) implemented in the device's main frame (6), as shown in Figures 1, 2, and 7.

[0027] Further, the upper part (1) of the vacuum chamber (1, 10) has the following arrangements:

- connecting a vacuum (air evacuation) hose (4) from the vacuum pump (13) to the upper part (1) of the vacuum chamber (1, 10);
- a glass window (3) for inspecting the inside of the vacuum chamber (1, 10) being closed;
- an air valve, which is used to let in the air, control the vacuum level during the process, or fill the chamber (1, 10) with the air when the vacuum process is over/completed.

[0028] The bell-shaped or cylinder-shaped upper part (1) at the lower opening further comprises a bottom flat edge (15). This flat edge (15) is coupled with a rubber gasket (18) and fits tightly onto the flat base/floor (10)/ The floor (10) is preferably made from stainless steel, thereby providing a hermetic seal between the upper part (1) of the chamber (1, 10) and the flat base/floor (10) of

the chamber. The floor (10) is more thick than the bell-shaped upper part (1), to withstand the vacuum in the chamber (1, 10). Comparatively, when the bell-shaped upper part has 4 millimeters-thick wall, the floor (10) layer has a thickness of 10 millimeters.

[0029] The bell-shaped or cylinder-shaped upper part (1) with the lower opening is movable (liftable) up and down by a pneumatic cylinder (7) and lifting mechanism/holder (5).

[0030] The sealing between the cylinder-shaped upper part (1) and the flat base/floor is ensured by a 10 mm thick vacuum rubber gasket (18), as presented in Figure 4. The screw attaching the rubber gasket (18) to the upper part edge (15) has its head conical, thus, the screw head hides in the rubber gasket and does not contact with the base/floor (10). The sealing edge (15) and flat base/-floor (10) are also precisely made, to prevent surface irregularities that can occur during welding, to cause spaces between the sealing edge (15)/gasket (18) and the flat floor (10), thereby vacuum could be not achieved.

[0031] **Control of the device.** Control of the vacuum cooling device can be fully ensured by a programmable logic computer and its operator panel (10). For example, such as Siemens KTP-700. The control computer controls the vacuum pump (13), measures the vacuum, and controls the air intake valves. Also, it displays the product temperature variation and the inlet and outlet temperature of the condenser cooling water (8). In addition, different food products are cooled according to different vacuum management curves. The computer (12) provides a user-friendly selection of the food cooling program.

[0032] Furthermore, the control computer (12) of the vacuum cooling device can be connected by a remote data connection link to a central computer, thereby allowing a centralized control of one or more such cooling devices. For example, this feature of the remote control can be useful when implementing an automated control of food processing where the cooling device is operated in a fully automated manner together with other food processing equipment, for example, the automated food transportation cart (9).

[0033] **Operation of the device.** The disclosed vacuum cooling device is operated by the following steps.

- a stroller/cart (9) with food products is brought under the lifted upper part (1) of the vacuum chamber:
- the upper part (1) with its lower opening is lowered until its rubber gasket (18) touches the floor/base (10),
- the vacuum pump (13) draws out the air, thereby creating a vacuum inside the chamber (1, 10), and in this way, cooling of the food product begins;
- After the product cools down, the air is let into the vacuum chamber (1, 10);
- the upper part (1) of the vacuum chamber (1, 10) is lifted;
- the stroller/cart (9) with cooled food products is pulled out from under the upper part (1) of the vacuum chamber (1, 10).

[0034] **Condensate removal.** The water condensate is extracted/removed from the the hermetic/vacuum chamber (1,10) in two ways. In the first way, during evacuation of the hermetic chamber (1,10) the extracted air first passes sequentially through the air part of the plates heat exchanger, then through the inlet of the condensate collecting vessel, then it exits on the opposite side of the condensate collecting vessel and enters the vacuum pump. Ice-cold water (in vessel 8) of temperature +2.....+5 C circulates through the other side of the plates of the heat exchanger. Then the air from the vacuum chamber is warm and moist and drawn through the heat exchanger. Moisture in the air condenses and condensate collects in the condensate container. At the end of the cooling process, the condensate discharge valve opens automatically and the formed condensate is discharged out.

[0035] In another way, some part of condensate also forms on the walls of the vacuum chamber (1, 10) and on the floor of it. However, the condensate amount is small in the chamber (1, 10) as the main amount is extracted with evacuated air and is collected in the condensate collection tank.

[0036] The condensed water which appears on the walls and floor of the vacuum cooling chamber (1, 10) during the cooling period, can be removed from the base/floor (10) in different ways, for example:

- wiping the condensate from the flat base/floor (10) by a special wiper, after the upper part (1) of the chamber (1, 10) has been raised;
- making the base/floor (10) of the chamber (1, 10) inclined, for the condensate to flow down from the flat floor (10) to a collector of the condensate;
- providing the flat floor (10) with a recess in the central part of the flat floor (10), where the water condensate collects into the recess, and afterwards can be leaked out through a controlled valve implemented in the recess.

Claims

1. A vacuum cooling device, comprising at least

- a vacuum chamber (1, 10), for placing and cooling food products inside it,
- means of evacuating air (4, 13) from the chamber to create a vacuum in the chamber (1, 10);
- means for opening and closing the chamber (1, 10), and placing the food products (9) inside,

wherein

- the vacuum chamber (1, 10) comprises a vertically liftable upper part (1) comprising cylindrical side walls and an upper wall, while the lower

opening of said upper part (1) is arranged to fit hermetically onto a base/floor (10) of the device, to form said hermetic chamber (1, 10) when the vacuum cooling device is operating.

2. The device according to claim 1, **wherein** the upper part (10) of the vacuum chamber (1, 10) is bell-shaped.

3. The device according to claim 1, **wherein** the base/-floor (10) of the vacuum cooling device and of the chamber (1, 10) is flat and made of stainless steel.

4. The device according to claim 1, **wherein** the means for placing the food products inside the chamber (1, 10) is a stroller/cart (9) to be brought with food products under the lifted upper part (1) of the vacuum chamber (1, 10) when said upper part (1) is lifted to the upper opening position.

5. The device according to claim 1, **wherein** the means of lifting and lowering the upper part (1) is arranged to be moved up and down by a pneumatic cylinder (7).

6. The device according to claim 1, **wherein** the means (4, 13) of evacuating air from the chamber (1, 10) to create a vacuum in the chamber (1, 10) are connected to the liftable upper part (1) of the vacuum chamber (1, 10).

7. The device according to claim 1, **wherein** the liftable upper part of the vacuum chamber (1, 10) comprises a flat edge (15) on the side walls of the upper part (1) and a sealing rubber gasket (18) along said flat edge (15), arranged to seal hermetically the vacuum chamber (1, 10) when the upper part (1) is lowered down to the base/floor (10) of the vacuum cooling device.

8. The device according to claim 1, **wherein** said sealing rubber gasket (18) along said flat edge (15) is arranged between the inner ring (17) and the outer ring (16), those are arranged on said flat edge (15) on both sides of said sealing rubber gasket (18).

9. The device according to claim 1, **wherein** the upper part (1) and the base/floor (10) of the vacuum chamber (1, 10) are made from stainless steel.

10. The device according to claim 1, **wherein** the device further comprises means to remove water condensate from the flat floor (10), any one of:

- a wiper for wiping the water condensate from the flat floor (10);
- the temporary or permanent inclination of the flat floor (10), for the water condensate to flow down from the flat floor (10) to a condensate collector;
- a recess in the central part of the flat floor (10), for the water condensate to collect into the recess, and a controlled valve implemented in the recess for the condensate to leak out.

11. A method of operating the vacuum cooling device according to any of claims 1 to 10, comprising steps of:

- a stroller/cart (9) with food products is brought under the lifted upper part (1) of the vacuum chamber (1, 10);
- the upper part (1) of the vacuum chamber (1, 10) is lowered until its rubber gasket (18) touches the floor/base (10);
- the vacuum pump (13) draws the air out of the chamber (1, 10), thereby creating a vacuum inside the chamber (1, 10), thereby, cooling of the food product begins;
- After the food product cools down, then air is let into the chamber (1, 10);
- the upper part (1) of the vacuum chamber (1, 10) is lifted,
- the stroller/cart (9) with cooled food products is pulled out from under the upper part (1) of the vacuum chamber (1, 10).

12. The method according to claim 11, **wherein** the method steps are performed by automated and computer-controlled means, such as a control computer (12) of the vacuum cooling device or a central computer, to provide a fully automated process of the food products loading, cooling, and unloading.

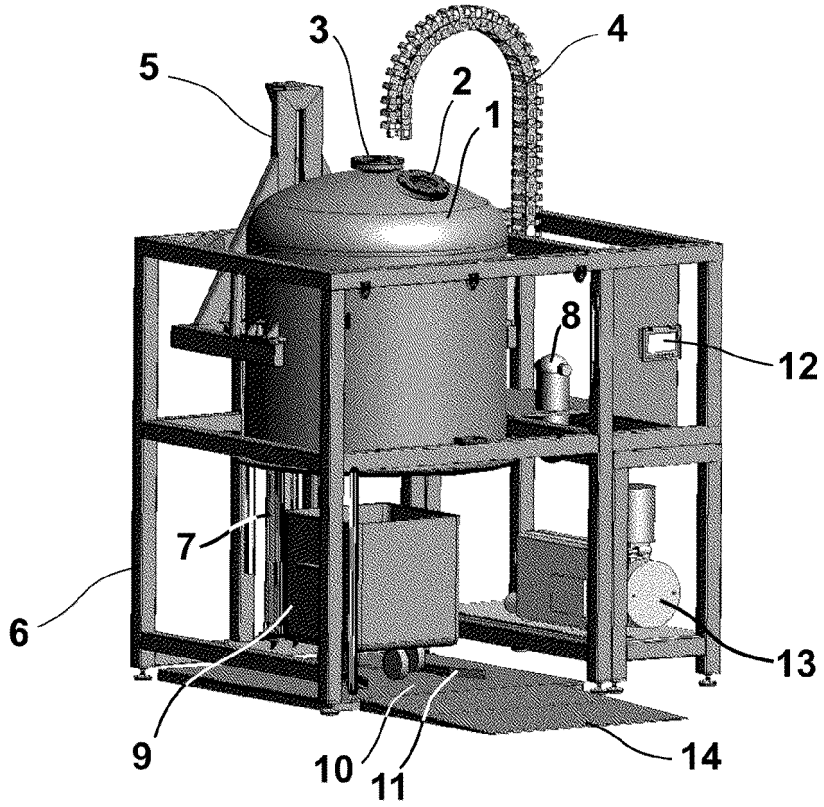


Fig. 1

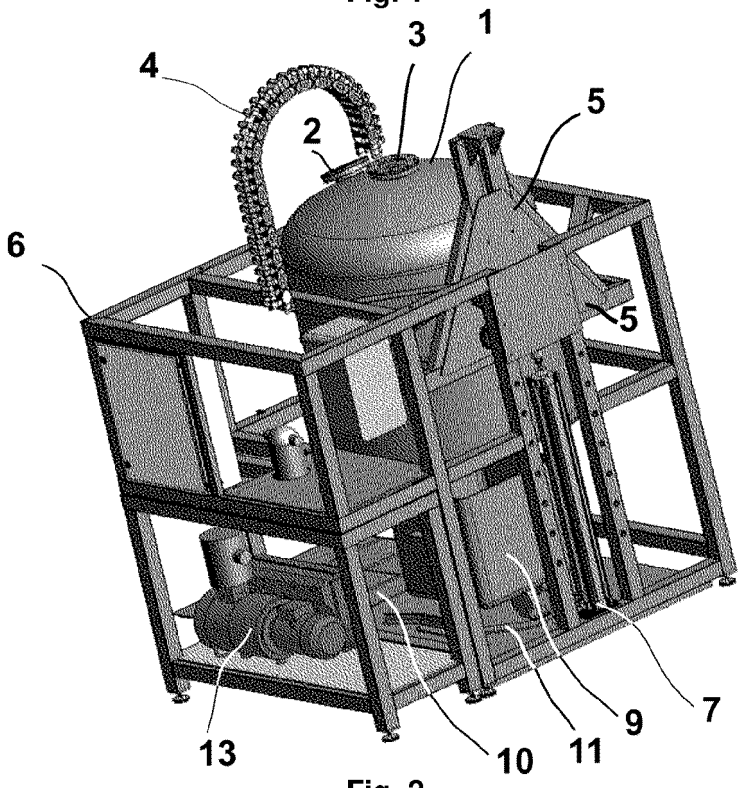


Fig. 2

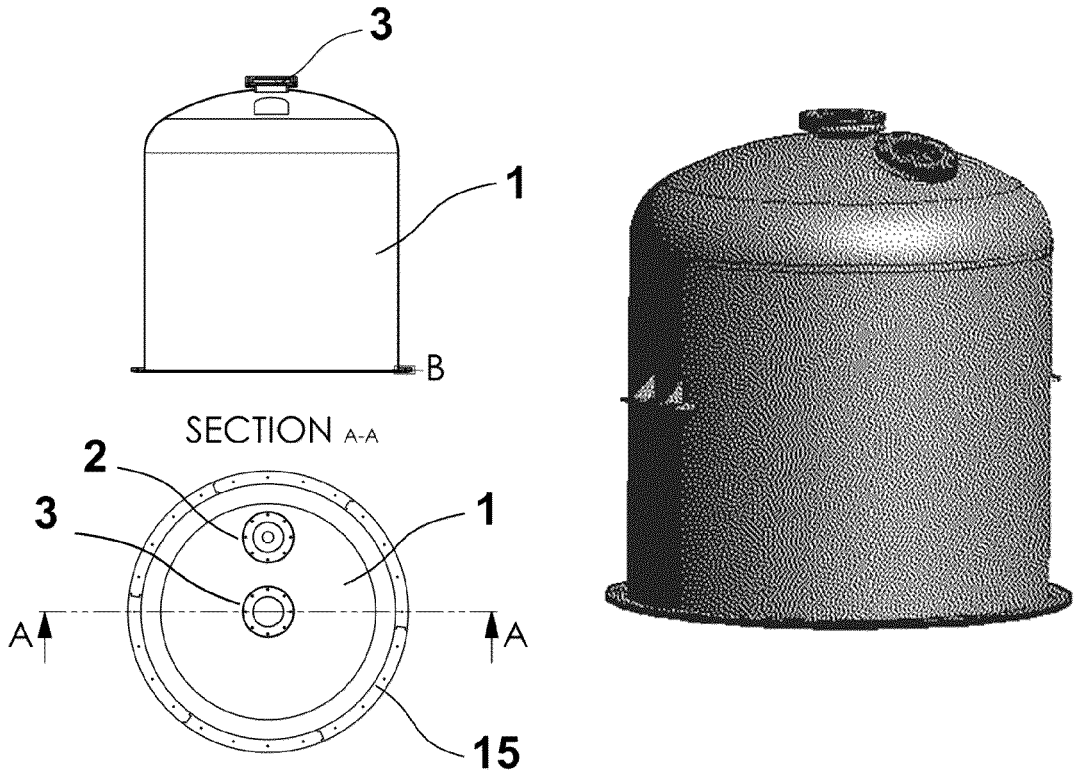


Fig. 3

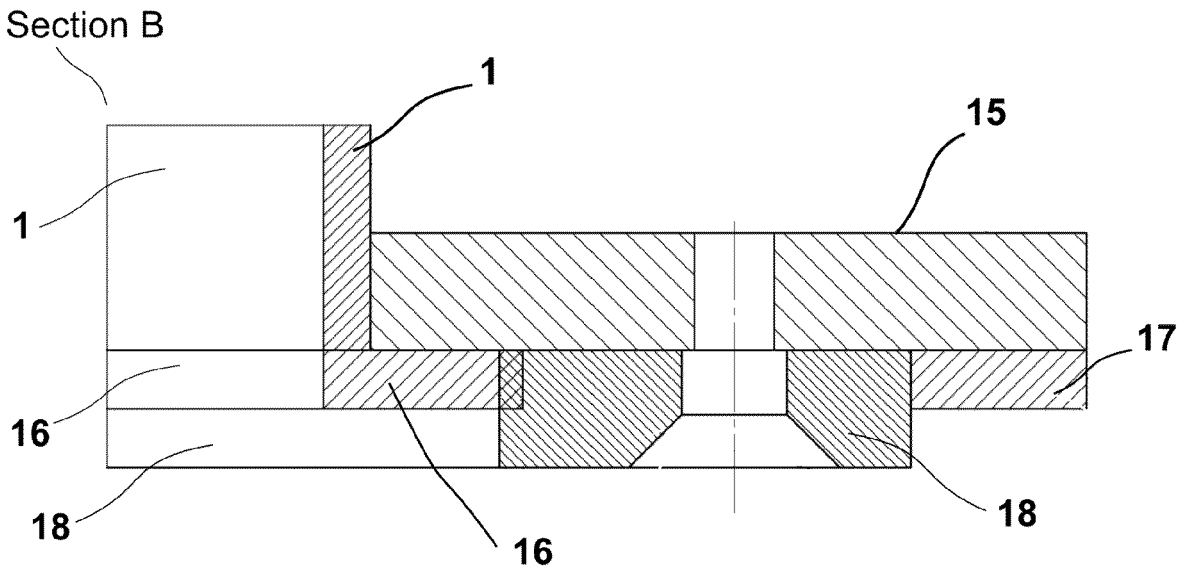


Fig. 4

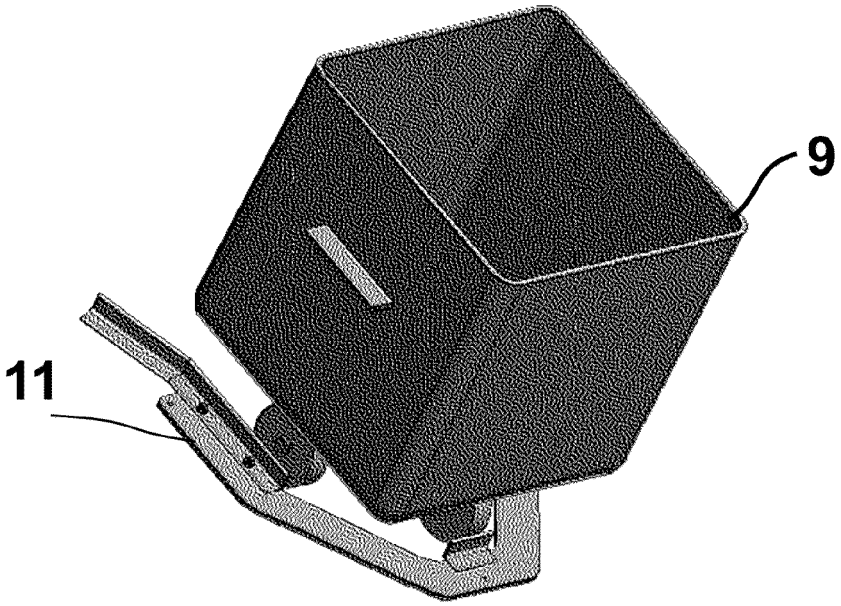
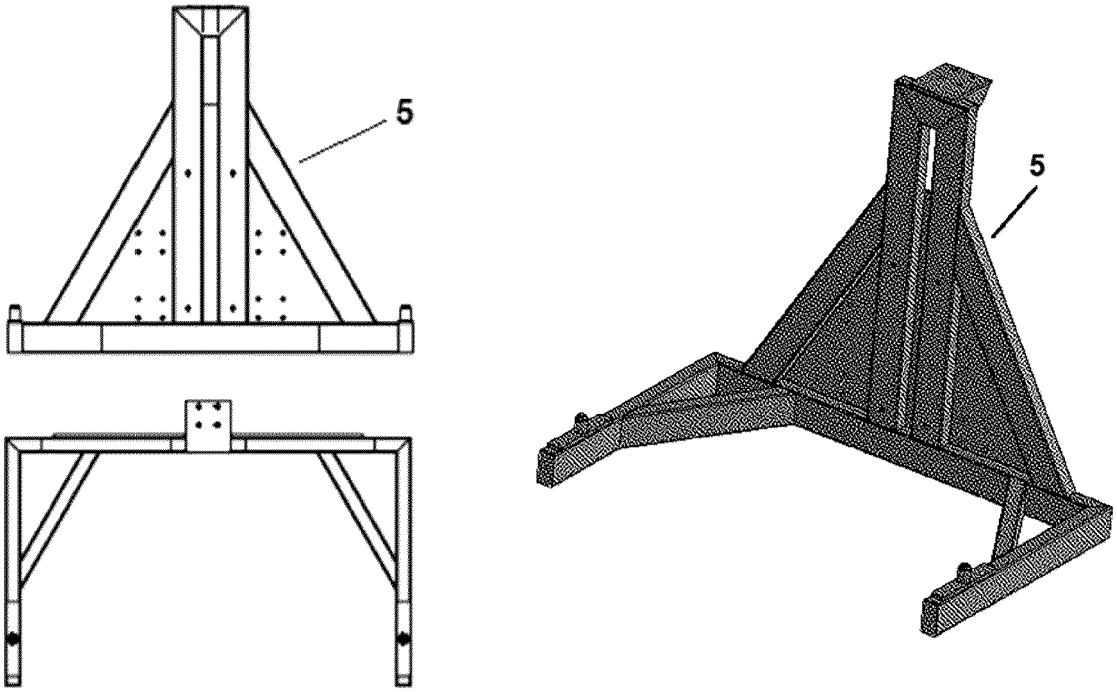


Fig. 5



a) b)

Fig. 6

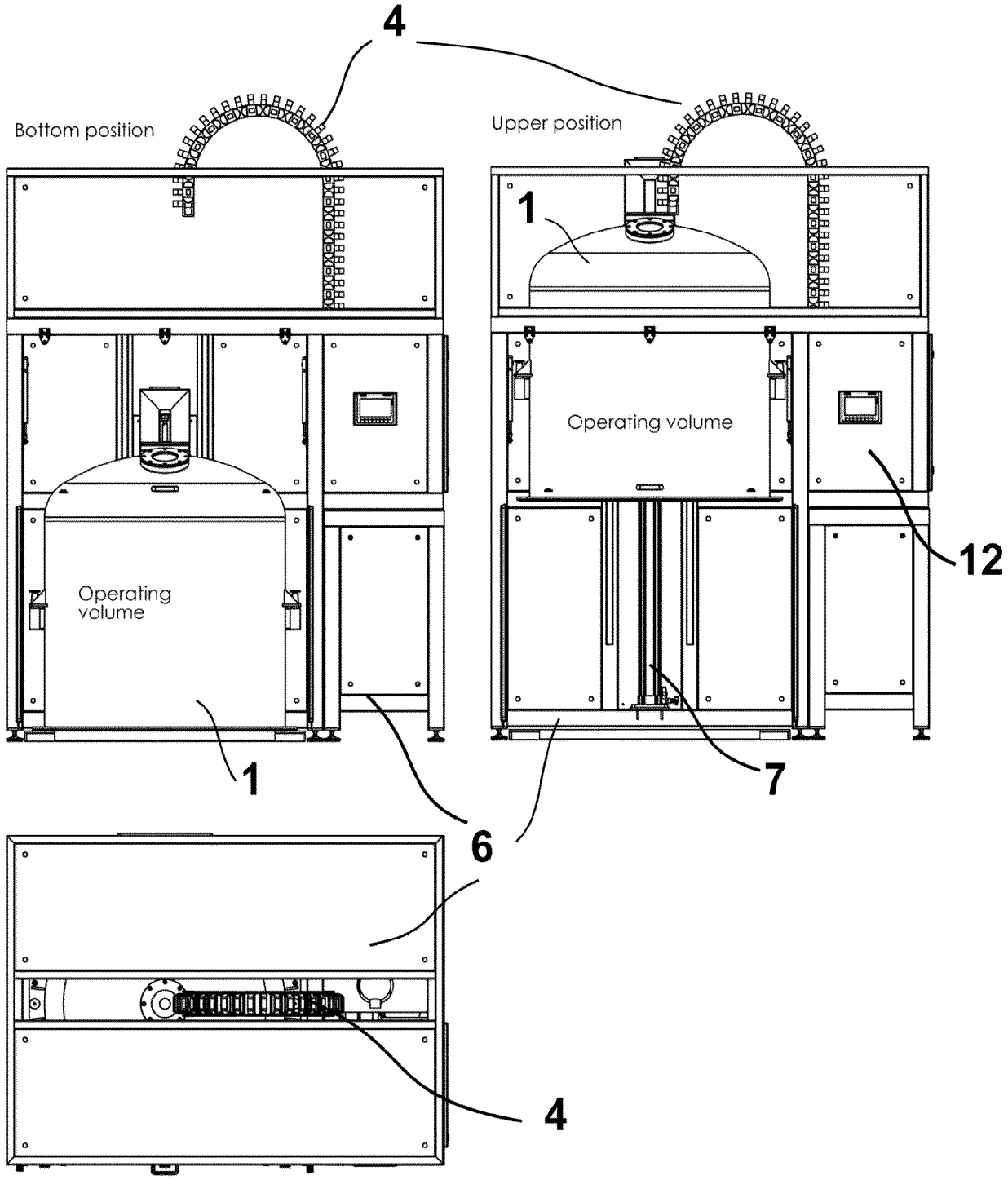

4
Bottom position
Upper position
1
Operating volume
Operating volume
12
1
7
6
4

Fig. 7

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 23 20 6002

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

F25D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	8 April 2024	Bejaoui, Amin

CATEGORY OF CITED DOCUMENTS

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REFERENCES CITED IN THE DESCRIPTION

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