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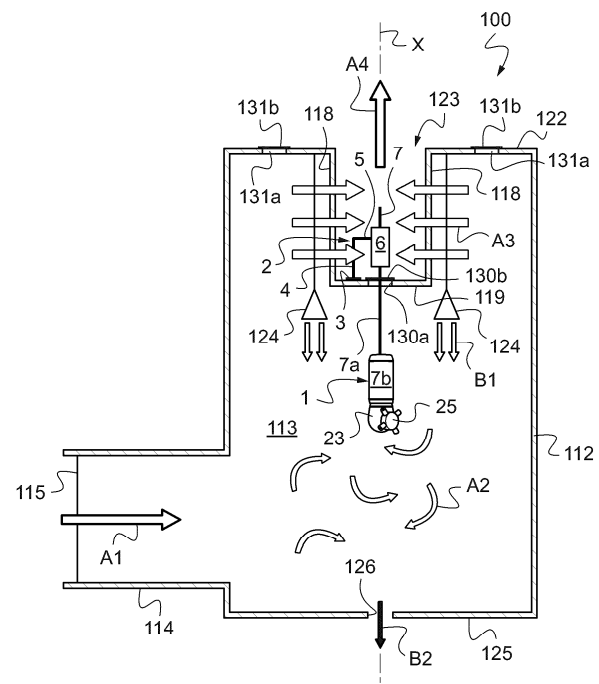
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(54) CLEANING DEVICE FOR COOLING TOWER

(57) This automatic cleaning device (1) for cleaning a part (112, 118, 119, 122, 125) of a cooling tower (100) comprises a fixed basis (2) attached to an upper wall (119, 122) of the cooling tower (100, 100'), a main body (7) mechanically connected to the fixed basis (2) and movable, relative to the fixed basis (2), in translation along a first direction (X) substantially perpendicular to the upper surface (119, 122), and a nozzle arrangement (25) fluidly connected to the fixed basis (2), including at least one nozzle (29, 30, 32, 32) adapted to spray a cleaning fluid toward the part (112, 118, 119, 122, 125) to be cleaned, wherein the main body (7) may be moved between a stowed position and a cleaning position. The nozzle arrangement (25) is pivotable, relative to the main body (7), around a first axis (22) and a second axis (27).

Fig.2

Description

Technical Field

[0001] . The present disclosure relates to an automatic cleaning device, more particularly an automatic cleaning device for cleaning a part of a cooling tower, a cooling tower, an automatic cleaning method and a method of cooling a liquid in a cooling tower.

Background

[0002] . Cooling towers are widely used in industry for cooling fluids. Some cooling towers are essentially passive, in which airflow in the atmosphere around the cooling tower acts to draw air in near a bottom or base of the cooling tower which is then heated inside the cooling tower. The warmed air rises up through the cooling tower and out from the top. There are "wet" cooling towers, where the air comes into contact directly with a fluid to be cooled. There are "dry" cooling towers where the air passes over a heat exchanger through which the liquid to be cooled is flowing.

[0003] . In the field of hydrometallurgy, electrolytes or acidic solutions containing slurries, gypsum or metals need to be cooled. For example, it is known to separate zinc from an electrolytic solution containing zinc ions and sulfuric acid. In the separation process, the temperature of the electrolyte generally rises and this then needs to be cooled.

[0004] . WO 2007/096457 A2 discloses a cooling tower wherein cooling air is passed via a fan into the cooling tower near the base of the cooling tower. The cooling air enters the cooling tower generally horizontally and swirls around inside the cooling tower. Nozzles are provided near an upper end of the cooling tower and these spray a liquid to be cooled into the cooling tower so that the droplets of liquid mix with the air and are cooled by evaporation.

[0005] . Eight demisters are arranged near a top end of the cooling tower, arranged such that fluid passing through the demisters is moving horizontally out from the top of the cooling tower. The demisters remove water droplets suspended in the air, along with any impurities contained in said droplets. The demisters therefore substantially purify the fluid passing therethrough, such that there are limited overall emissions of impurities (which may be toxic in some cases) from the cooling tower. The word "fluid" is to be understood according to its general definition, namely a substance such as a liquid or a gas. The word "fluid" may refer to a mixture of one or more liquids with one or more gases, such as a gas fluid mix. An example of a gas fluid mix is gas and/or air which contains moisture and droplets.

[0006] . During use, impurities from the liquid can build up on the wall of the chamber and can build up in the demisters. The impurities may lead to a loss of efficiency in the cooling process.

[0007] . The building up of impurities on the wall or in the demisters causes a need for relatively frequent cleaning. This results in cooling towers being labour intense products, with a cleaning frequency being typically about 1 cleaning operation per month. To perform this maintenance cleaning, the demisters must be sprayed with a pressure hose to wash off the buildup of impurities. The wall and floor of the chamber must also be sprayed with a pressure hose, which typically requires removal of the demisters in order to allow a maintenance worker to access the inside of the chamber. Accordingly, during cleaning time, the equipment needs to be shut down, drained and cleaned for maintenance to enter.

[0008] . Also, it is known to add a cloth usually made from PVC on the radially inner face of the peripheral wall or hanging radially inward from the wall. This cloth prevents solids to form on the wall surface, due to the cloth smooth surface. The cloth is usually a replaceable item, made of a material that is more resistant to corrosion by the liquid compared to a material of the wall. Even if this arrangement provides the general advantage that the wall is better protected from the impurities and from the further consequences such as corrosion, it involves a need to replace the cloth periodically, for example at each maintenance cycle. The cloth is thus difficult to install and has a high operation cost.

[0009] . The actions of removing the demisters, accessing the inside of the chamber, spraying the demister, spraying the walls of the chamber, and replacing the cloth are arduous and dangerous for the maintenance worker. They also involve a long interruption of the cooling process. All this negatively impact the overall efficiency and complexity of the cooling process by a cooling tower.

[0010] . The problem of cleaning the cooling tower has been the subject of much research in the past. For example, CN 220387257U discloses a cleaning rod with arranged high-pressure nozzles for cleaning the inside of a cooling tower. The cleaning rod is controlled to move up and down inside the cooling tower to achieve cleaning effect. Although this device made the cleaning easier, it was not fully satisfactory, especially as it still requires an operator to closely handle the cleaning rod in order to move the nozzles at the right altitude and, even with such a control, some parts of the cooling tower remain difficult to clean.

Summary

[0011] . According to a first aspect, there is provided an automatic cleaning device for cleaning a part of a cooling tower, comprising:

- a fixed basis intended to be attached to an upper wall of the cooling tower,
- a main body mechanically connected to the fixed basis and movable, relative to the fixed basis, in translation along a first direction substantially per-

pendicular to the upper surface, and

- a nozzle arrangement fluidly connected to the fixed basis, including at least one nozzle adapted to spray a cleaning fluid toward the part to be cleaned, wherein the main body may be moved between a stowed position in which the nozzle arrangement is above the upper wall and a cleaning position in which the nozzle arrangement is below the upper wall, wherein the nozzle arrangement is pivotable, relative to the main body, around a first axis parallel to the first direction and around a second axis perpendicular to the first direction.

[0012] . This device allows automatically lowering down an arrangement which directly sprays the part to be cleaned, with all the part being reached by the sprayed cleaning fluid and without it being necessary for a maintenance cleaner to enter the cooling chamber or to dismount a demister. As a result, the cleaning process is made much easier, less dangerous, minimizes labour intensity in maintenance and minimize downtime for equipment. It is then possible to perform the cleaning process more frequently. This makes the amount of impurities less important, and results in turn in the cleaning cycle being much shorter and in the cloth being no longer necessary.

[0013] . It should be understood that the upper wall may be any substantially horizontal wall forming an upper boundary of the cooling chamber. For example, in a cooling tower not including demisters or including demisters located radially outside a peripheral wall, like in WO 2007/096457 A2, the upper wall may be an upper cover of the cooling tower. In another example, in a cooling tower including demisters vertically inserted between an upper cover and a platform placed under the upper cover, the upper wall may be a peripheral ring forming a part of the upper cover. In this other example, the upper wall may also be the platform placed under the upper cover.

[0014] . It should be understood that the cleaning fluid may be any fluid which may be sprayed, that is dispersed or applied at a certain pressure. The cleaning fluid may particularly be a cleaning liquid, for example a mixture of water and a cleaning agent.

[0015] . The main body may include an elongated rod extending along the first direction and having a first longitudinal end and a second longitudinal end. The nozzle arrangement may be adjacent to the second longitudinal end. The elongated rod may be configured to be passed through a hole of the upper wall so that the second longitudinal end is relatively close to the fixed basis in the stowed position and the second longitudinal end is relatively far away below the fixed basis in the cleaning position.

[0016] . Such an arrangement provides a simple mechanism for moving the nozzle arrangement between the stowed position and the cleaning position. One also takes advantage of a geometry with demisters vertically ar-

ranged or arranged with an angle, and/or with the demisters located radially inside the peripheral wall of the cooling tower.

[0017] . The elongated rod may be a telescopic rod. The elongated rod may have a fixed length. The fixed length may be within a range 500-4000 mm, preferably 1000-2000 mm. With a nozzle arrangement pivotable around a first axis parallel to the first direction and around a second axis perpendicular to the first direction, the length within this range is particularly well adapted in order for the cleaning fluid to reach any location of the walls of the cooling chamber, for a cooling chamber with the usual dimensions.

[0018] . The automatic cleaning device may include a first proximity sensor able to detect that the first longitudinal end is close to the fixed basis. The automatic cleaning device may include a second proximity sensor able to detect that the second longitudinal end is close to the fixed basis. These sensors may render a control of the automatic cleaning device more accurate, in order to further improve the efficiency of the cleaning process.

[0019] . The pressure of the cleaning fluid is another factor which may impact the efficiency of the cleaning process. The pressure, combined with the usual dimensions of a cooling tower, will impact the speed at which the sprayed cleaning fluid will reach the part to be cleaned. The at least one nozzle may be adapted to be fed with the cleaning fluid at a pressure within a range 2-15 bars, preferably 3-10 bars, more preferably 4-6 bars, even more preferably 4,5-5,5 bars.

[0020] . The flow rate is another important parameter, as a cleaning fluid colliding with a surface to be cleaned at a certain speed is more effectively cleaned if the flow rate is higher, but it is more complicated to maintain a high flow rate with a high cleaning fluid pressure, without excessively increasing the size of the device. For that reason, it is necessary to strike a careful balance between the high flow rate and high pressure. Given the usual dimensions of a cooling tower, it is particularly preferable when the at least one nozzle is adapted to be fed with the cleaning fluid at an overall flow rate within a range 10-175 L/minute, preferably 20-120 L/minute.

[0021] . It should be understood that the overall flow rate is the sum of the individual flow rate(s) of each of the at least one nozzle(s). That is, when one nozzle only is provided, the overall flow rate equals the individual flow rate of this one nozzle. When two nozzles, namely a first nozzle and a second nozzle, are provided, then the overall flow rate equals the sum of the individual flow rate of the first nozzle and of the individual flow rate of the second nozzle.

[0022] . Said at least one nozzle may include a first nozzle oriented along a second direction perpendicular to the second axis. Said at least one nozzle may include a second nozzle oriented along a third direction perpendicular to the second direction and to the second axis. Said at least one nozzle may include a third nozzle oriented along a fourth direction perpendicular to the third direc-

tion and opposite to the second direction. Said at least one nozzle may include a fourth nozzle oriented along a fifth direction perpendicular to the fourth direction and opposite to the third direction.

[0023] . Such a construction, together with the feature that the nozzle arrangement is pivotable, relative to the main body, around a first axis parallel to the first direction and around a second axis perpendicular to the first direction, makes it particularly adapted to the internal shape of a cooling tower. It is thus particularly easy to access automatically each portion of a part to be cleaned, in particular of a peripheral wall, a bottom or an upper boundary of the cooling chamber or a surface of a demister.

[0024] . The automatic cleaning device can further include an intermediate body mechanically connected to the main body and to the nozzle arrangement. The intermediate body can be pivotable around the first axis, relative to the main body. The nozzle arrangement can be pivotable around the second axis, relative to the intermediate body.

[0025] . It is then provided a particularly simple and not cumbersome way to provide the nozzle arrangement having the function mentioned above.

[0026] . The main body can further include a hose fluidly connected to the fixed basis and fluidly connected to the nozzle. The hose can be indirectly fluidly connected to the nozzle via at least the main body and/or the intermediate body.

[0027] . This arrangement provides a convenient way of feeding the nozzle with the cleaning fluid to be sprayed.

[0028] . According to a second aspect, a cooling tower comprises a bottom, a peripheral wall, and an upper wall, wherein the bottom, the peripheral wall, and the upper wall define together a cooling chamber of the cooling tower, and an automatic cleaning device according to the first aspect, wherein the fixed basis of the automatic cleaning device is attached to the upper wall, and the main body of the automatic cleaning device is movable between the stowed position in which the main body is out of the cooling chamber and a cleaning position in which the main body is in the cooling chamber.

[0029] . It should be understood that the upper wall may, like in the first aspect, be any substantially horizontal wall forming an upper boundary of the cooling chamber. According to the precited examples, the upper wall may be an upper cover forming a horizontal plate placed over all the cooling chamber, or an upper cover forming a ring radially located between demisters of the cooling tower and the peripheral wall of the cooling tower, or an upper platform placed under the upper cover, attached to the upper cover and placed radially inside the demisters of the cooling tower and vertically supporting the demisters. The demisters may also be radially inside the peripheral wall.

[0030] . According to a third aspect, it is provided an automatic cleaning method for cleaning a part of a cooling tower, wherein the part is preferably a wall of the cooling

tower or a demister of the cooling tower. The method comprises:

- moving, relative to the fixed basis, the main body of an automatic cleaning device according to the first aspect, the motion being a translation along a first direction substantially perpendicular to an upper wall of the cooling tower, the motion being between a stowed position in which the nozzle arrangement of the automatic cleaning device is above the upper wall and a cleaning position in which the nozzle arrangement is below the upper wall,
- spraying a cleaning fluid toward the part to be cleaned, by the at least one nozzle of the nozzle arrangement, and it further includes, when spraying, pivoting the nozzle arrangement, relative to the main body, around the first axis and around the second axis.

[0031] . With such a method, the operator of the cooling tower has at their disposal a off the shelf product that is protected from the environment inside the cooling tower. Further to the precited effects of making it easier to reach all the part with the sprayed cleaning fluid, the cleaning with the step of moving between the stowed and the cleaning position is made more efficient and more reliable.

[0032] . According to a fourth aspect, a method of cooling a liquid in a cooling tower comprises:

passing gas, optionally air, through a gas inlet of the cooling tower into a cooling chamber,

spraying liquid to be cooled from one or more spray nozzles into the chamber, such that gas from the gas inlet cools the liquid and mixes with the liquid to form a mixed fluid,

passing the mixed fluid through one or more demisters to reduce or eliminate liquid from the mixed fluid,

wherein the method of cooling includes periodically performing the automatic cleaning method according to the third aspect.

Brief Description of the Drawings

[0033]

. Figure 1 shows a perspective view of a cooling tower according to a first embodiment;

. Figure 2 shows a cross-sectional schematic view of the cooling tower of Figure 1;

. Figure 3 shows a cutaway perspective view of the cooling tower of Figures 1 and 2;

. Figure 4 shows a perspective view of an elongated rod of the automatic cleaning device equipping the cooling tower of Figures 1 to 3;

. Figure 5 shows a front view of the rod depicted in Figure 4;

. Figure 6 shows a side view of the rod depicted in Figures 4 and 5;

. Figure 7 shows a perspective view of a lower section of the automatic cleaning device equipping the cooling tower of Figures 1 to 3;

. Figure 8 shows a front view of the lower section of figure 7 in a first state in the cleaning position;

. Figure 9 shows the front view of the lower section of figures 7 and 8, in a second state in the cleaning position shortly after the first state;

. Figure 10 shows the front view of the lower section of figures 7 to 8, in a third state in the cleaning position shortly after the second state;

. Figure 11 shows a front view of an inner surface of the peripheral wall of the cooling tower of Figures 1 to 3 in the process of being cleaned;

. Figure 12 shows a cutaway perspective view of an upper section of a cooling tower according to a second embodiment;

. Figure 13 shows a schematic cross-section view of the upper section of Figure 12, with the automatic cleaning device in stowed position; and

. Figure 14 shows a schematic cross-section view of the upper section of Figure 12 and 13, with the automatic cleaning device in cleaning position.

Detailed Description

[0034] . Figures 1 to 3 show a cooling tower 100. The cooling tower 100 comprises a wall 112 that defines a chamber 113. The wall 112 typically defines a generally cylindrical chamber 113, for example a generally cylindrical chamber 113 with a circular basis. Other shapes are envisaged such as chambers having a square, rectangular, hexagonal, or oval cross-sectional shape. A pipe 120 (visible in Figure 2) is provided to convey liquid to be cooled to an upper section of the cooling tower 100 and thence to a plurality of spray nozzles 124 (schematically depicted in Figures 2 and 3) located inside the chamber 113. The nozzles 124 will be described more in detail later.

[0035] . An upper cover 122 of the chamber 113 defines a top of the cooling tower 100. The upper cover 122 is an

example of an upper wall according to the present description. The upper cover 122 may have a flat, substantially horizontal surface. The upper cover 122 has an outlet 123 therein for allowing fluid to flow out of the chamber 113. The outlet 123 may be any shape, including, for example, circular, hexagonal, or square. With the depicted circular central outlet 123, the upper cover 122 is shaped like a ring radially surrounding the outlet 123. A bottom 125 of the chamber 113 defines a bottom of the chamber 113. The bottom 125 of the chamber 113 comprises a liquid outlet 126 for allowing liquid to flow out of the chamber 113. The bottom 125 may be part of the cooling tower 100. Alternatively, the cooling tower peripheral wall 112 and the upper cover 122 may be built upon an already-existing space (e.g. a concrete platform) onsite such that the pre-existing space thereby closes the bottom side of the cooling tower and consequently acts as the bottom of the cooling tower 100 once constructed. When assembled, the cooling tower 100 is arranged vertically such that a centreline X of the cooling tower that extends from the bottom 125 to the upper cover 122 is vertical, i.e., with respect to gravity. The centreline X is an example of a first direction or of a first axis according to the present description.

[0036] . The peripheral wall 112 may be made from any suitable material. The upper cover 122 may be a wall made of any suitable material. Some suitable materials include fiberglass, reinforced fiberglass, aluminium, (stainless) steel, and combinations thereof. The bottom 125 may be a separate material and may, for example, be concrete that the peripheral wall 112 of the cooling tower 100 is installed upon. Alternatively, the bottom 125 may be made of the same material as the peripheral wall 112.

[0037] . A gas inlet 114 is provided through the peripheral wall 112, near the bottom 125 of the cooling tower 100 and a fan 115 is provided for drawing gas, typically air, into the chamber 113. The air is used to cool a liquid to be cooled, as described below. While only one gas inlet 114 is shown, more than one gas inlet may be provided near the bottom of the cooling tower 100.

[0038] . An upper platform 119 is provided inside the cooling tower 100 towards an upper end of the cooling tower 100. That is, the platform 119 is at a vertical position within the peripheral wall 112 that is between the bottom 125 and the upper cover 122, and is typically located closer to the upper cover 122 than to the bottom 125. Put another way, the platform is located in the upper half of the cooling tower 100. The platform 119 may have a flat, substantially horizontal surface. The platform 119 is an example of an upper wall according to the present description.

[0039] . The platform 119 is spaced apart from the peripheral wall 112, but may be connected thereto, e.g., via struts and/or beams. Alternatively or additionally, the platform 119 may be connected to the upper cover 122, e.g. via struts and/or beams 121. One or more demisters 118 are provided around the platform 119, generally extending between the platform 119 and the

upper cover 122. In one example, eight demisters 118 are provided circumferentially around the platform 119. In one example, each pair of adjacent demisters 118 may be delimited by a strut 121 extending vertically between the platform 119 and the upper cover 122. In other examples, more than two, preferably anywhere from two to ten demisters 118 are provided. The number of demisters 118 may in particular depend on the size of the cooling tower. Preferably, an even number of demisters 118 is provided, so that the demisters 118 may be grouped by pairs. It may also be contemplated that a demister located within an angular range around a centreline of the cooling tower is further coupled to a second demister. In such an arrangement, the fluid passes through both demisters, which are then arranged in series. In the above ranges, a demister is to be understood as possibly covering a set of demisters arranged in series. These exemplary demisters 118 extend substantially the whole distance between the platform 119 to the upper cover 122. If present, the struts that connect the platform 118 to the upper cover 122 may also provide mounting points for the demisters 118. That is, the struts/beams may generally define a frame for each demister to be mounted in. The platform 119 is solid such that fluid cannot pass through the platform 119 itself. The cooling chamber 113 is to be understood as the space downstream the inlet 114 and upstream the demisters 118. Accordingly, the cooling chamber 113 is delimited by the bottom 125, the peripheral wall 112, and an upper boundary of the cooling chamber is delimited by the upper cover 122, by the demisters 118 and by the platform 119. As a consequence, the space vertically located between the plane of the upper cover 122 and the platform 119 does not form part of the cooling chamber 113.

[0040] . The one or more demisters 118 are located radially inward from the peripheral wall 112 of the cooling tower 100. The one or more demisters 118 are arranged such that fluid exiting the outlet 123 must first pass through the one or more demisters 118. That is, each demister is arranged within the chamber such that fluid moving from within the chamber 113 to the outlet 123 passes through the demister substantially radially inwardly, towards the centreline X of the cooling tower, before it reaches the outlet 123.

[0041] . Demisters 118 typically comprise a plurality of spaced-apart corrugated sheets, where the corrugations on adjacent sheets are aligned with one another. This forces a fluid passing through the demister to take a serpentine path which substantially drops the velocity of the fluid. This drop in velocity causes the suspended droplets to separate from the fluid flow and to form on the sheets. The droplets may then flow out of the demister.

[0042] . The one or more spray nozzles 124 are provided inside the chamber 113. The nozzles 124 are oriented generally downwards at an angle, such that liquid is broadly sprayed towards a middle of the chamber 113. The nozzles 124 are arranged at or below a level of the platform 119, but may be located higher provided their

spray does not directly impinge upon the one or more demisters 118. The spray nozzles 124 are configured to spray a liquid to be cooled into the chamber 113. The liquid to be cooled is not particularly limited and may be any liquid, including, for example, water, acids, acidic solutions, electrolyte, or neutral solution. The liquid may be provided at any temperature. Typically, the cooling tower 100 may be for cooling a liquid having a temperature of between 25°C and 95°C. The temperature of cooled liquid exiting via the liquid outlet 123 may be between 15°C and 75°C. The temperature of gas entering the gas inlet 114 may be at ambient atmospheric temperature and so may typically be between -35°C and 45°C. The temperature of gas exiting the outlet 123 may be between 0°C and 65°C.

[0043] . In use, a flow of gas A1 is drawn into the chamber 113 via the inlet 114 near the bottom 125 of the chamber 113. This flow of gas is typically air taken from the atmosphere surrounding the cooling tower 100, but in principle may be any gas including gas, for example, from a compressed source such as a compressed-gas tank or compressor.

[0044] . The flow of gas A1 is generally horizontal when it enters the chamber 113. The gas inlet 114 may be arranged such that a horizontally extending centreline of the gas inlet does not intersect the vertical centreline X of the cooling tower. That is, the inlet may not point directly towards a centreline of the cooling tower 100. In this manner, the gas inlet 114 may inject gas into the chamber 113 such that the gas is moving circumferentially within the chamber 113. A flow of liquid to be cooled B1 is pumped through the liquid pipe 120 and is sprayed into the chamber 113 from the nozzles 124. The downward-falling flow of liquid to be cooled B1 mixes with the flow of gas A1 to form a turbulent flow of mixed fluid A2 inside the chamber 113. Where the mixed fluid flow becomes turbulent, its velocity in the horizontal direction (i.e., in a plane perpendicular to the centreline X) increases.

[0045] . In the turbulent flow A2, the liquid to be cooled is cooled by the gas, primarily by evaporation but also by conduction and convection. The intense airflow and turbulence help break up water droplets emitted from the nozzles 124 into yet-smaller droplets, which further enhances the cooling efficiency of the cooling tower. The cooled liquid eventually drops off the bottom 125 of the cooling tower 100 and the flow of cooled liquid B2 exits the cooling tower 100 via the liquid outlet 126. In Figure 3, the liquid outlet 126 is shown as a vertically-oriented outlet formed in the bottom 125 of the chamber 113. In alternative designs, the liquid outlet 126 may be generally horizontally oriented and formed in the peripheral wall 112 of the cooling tower 100, at a location near the bottom 125 of the cooling tower 100, i.e. arranged as an overflow outlet.

[0046] . The liquid exiting the outlet 126 may be recycled through the cooling tower 100 again, if desired. That is, this portion of liquid may be run through the

cooling tower again by being directly sent to one of the nozzles 124, or the liquid may be mixed with the (hotter) flow of liquid to be cooled that is being delivered generally to the nozzles 124.

[0047] . The turbulent flow A2 rises up towards the one or more demisters 118. As stated, the turbulence of the flow leads to increase the velocity in the horizontal direction. The fluid, which is a mixture of the gas (e.g., air), evaporated liquid, and liquid droplets forms a fluid flow A3 that passes through the demisters in a generally horizontal direction, radially inwards towards the centreline X of the cooling tower 100. Thus, the particular orientation of the demisters 118 allows them to make use of the high horizontal velocity of the turbulent flow as it moves to exit the cooling tower 100.

[0048] . Where there are multiple demisters 118, any given portion of fluid will typically only pass through one of the demisters 118 before exiting the cooling tower 100, but the demisters 118 are arranged such that all or substantially all of the fluid exiting the chamber 113 must pass through at least one of the demisters 118.

[0049] . Demisters 118 comprise a plurality of spaced-apart corrugated sheets, where the corrugations on adjacent sheets are aligned with one another. This shape forces the fluid passing through the demister to take a serpentine path which substantially drops the velocity of the fluid. This drop in velocity causes the suspended droplets to separate from the fluid flow and to form on the sheets. The droplets may then flow out of the demister 118.

[0050] . Each of the demisters 118 is arranged such that fluid flowing through the demister is flowing generally horizontally. When droplets drop out of the airflow in a demister that is oriented in this way, the droplets drop under the action of gravity generally perpendicular to the flow direction. This helps avoid the droplets from slowing the flow of further fluid entering the demister. By contrast, in vertically-oriented demisters, where the fluid is flowing generally vertically upwards through the demister, droplets that drop out of the airflow are falling down under the action of gravity in the opposite direction to the airflow. This can undesirably reduce the fluid velocity of fluid coming in behind said droplets and also increases the chance of droplets becoming re-entrained in the airflow. Horizontally-oriented demisters may have double the efficiency compared to an equivalent vertically-oriented demister. That is, it may demist twice as much mixed fluid per unit time compared to a vertically-oriented demister.

[0051] . After having passed through the one or more demisters 118, the fluid flow A4 changes direction and moves vertically upward and exits the cooling tower 100 via the outlet 123. At this stage, having passed through the one or more demisters 118, the fluid is almost-entirely or entirely in gas form or mixture of gas and liquid that has been warmed via contact with the liquid to be cooled. The gas exits to the atmosphere.

[0052] . With the cooling tower 100 of Figures 1 to 3, compared to a cooling tower in which the demisters are

located radially outward compared to the peripheral wall of the cooling tower, it is avoided a first defect in which the effective-footprint of the cooling tower is larger than the footprint measured at the ground, around the circumference of the peripheral wall. It is also avoided a second defect in which fluid exits the cooling tower in a generally horizontal direction. In the cooling tower 100 of Figures 1 to 3, fluid exits the cooling tower 100 in a generally vertical direction, but nonetheless passes the demisters 118 generally in the horizontal direction, thus retaining the aforementioned higher-efficiency of horizontal demisters compared to vertical demisters.

[0053] . Regarding the first defect, the cooling tower 100 may have an effective footprint that is defined entirely by the wall (plus a small amount to accommodate the gas inlet). As such, multiple cooling towers 100 may be placed closer together than in the cooling tower in which the demisters are located radially outward compared to the peripheral wall of the cooling tower.

[0054] . As one example, four cooling towers in which the demisters are located radially outward compared to the peripheral wall of the cooling tower arranged in a square, each having a 6m diameter cylindrical chamber 13, require 22m x 22m ground space at the installation site, in order to accommodate a larger upper part comprising the demisters and to provide sufficient spacing therebetween. By contrast, four cooling towers 100 according to Figures 1 to 3 arranged in a square, each having 6m diameter chamber, may require only 12m x 12m ground space at the installation site. Thus, this design may offer significant space savings for a given cooling capacity, both for individual cooling towers and for multi-tower installations.

[0055] . The smaller overall size of the cooling tower 100 (due to the lack of the aforesaid large upper part) may also offer reduced material costs and simpler construction for equivalent cooling capacity.

[0056] . The precited second defect, that is the generally-horizontal outflow of warm gas exiting from the cooling tower, can lead to a circulation of air outside the cooling tower such that the air drawn in at the inlet is warmer than it would otherwise be. This reduces the efficiency of the cooling provided by the cooling tower.

[0057] . As the fluid flow A4 from the cooling tower 100 depicted in Figures 1 to 3 is ejected in the vertical direction, there may be significantly less of the aforesaid undesirable circulation of air outside the cooling tower, and consequently significantly less warming of the gas (air) entering the inlet 114 in the cooling tower 100.

[0058] . As shown on Figures 1 to 3, the platform 119 includes a central hole 130a. The central hole 130a is for passing an automatic cleaning device, which will be described later. The central hole 130a is a through hole extending through the platform 119. The central hole 130a may be any shape, including, for example, circular, hexagonal, or square. In the depicted embodiment, the centreline of the central hole 130a coincides with the centreline X of the cooling tower. The central hole

130a is an example of a hole of the upper wall according to the present description. The central hole 130a cooperates with a cover 130b of a corresponding shape. The cover 130b may be open or closed. In the open state, it does not obstruct the central hole 130a. In the closed state, it obstructs the central hole 130a.

[0059] . The upper cover 122 includes one or more, preferably a plurality of secondary holes 131a. Like the central hole 130a, the one or more secondary holes 131a are for passing the automatic cleaning device. Each secondary hole 131a is a through hole extending through the upper cover 122. Accordingly, each secondary hole is located radially outside of the outlet 123, of the demisters 118 and of the platform 119. The secondary holes 131a may be any shape, including, for example, circular, hexagonal, or square. The secondary holes 131a cooperate with a respective cover 131b of a corresponding shape. The covers 131b may be open or closed. In the open state, the covers 131b do not obstruct the secondary holes 131a. In the closed state, they obstruct the secondary holes 131a. It is also possible to have a cover able to obstruct several secondary holes or to have a single cover for all the secondary holes. In the depicted embodiment, a plurality of secondary holes is provided circumferentially, evenly, around the centreline X of the cooling tower. Preferably, one secondary hole 131a is provided for each demister 118. The secondary holes 131a are each an example of a hole of the upper wall according to the present description.

[0060] . As shown on Figures 2 and 3, the cooling tower 100 includes an automatic cleaning device 1. The automatic cleaning device 1 may be provided separately from the cooling tower 100. In particular, it is possible to remove the automatic cleaning device 1 from the cooling tower 100 depicted in Figures 1 to 3, for example in order to use it on another cooling tower 100 or for replacing it with another, for example a new automatic cleaning device. Also, several automatic cleaning devices 1 may be provided on a single cooling tower 100. In the present description, for a better clarity of the figures, only one automatic cleaning device 1 is depicted and is adjacent to the central hole 130a. Nevertheless, it is possible to provide another automatic cleaning device 1 adjacent to one of the secondary holes 131a. It is also possible to provide one automatic cleaning device 1 adjacent to each one of the central and secondary holes 130a and 131a.

[0061] . The automatic cleaning device 1 is for cleaning a part of a cooling tower, for example an inner surface delimiting the cooling chamber. In particular, the inner surface may be one of a peripheral wall 112, of the bottom 125, of the upper cover 122, of the platform 119 and of the demisters 118. In practice, the automatic cleaning device 1 provided adjacent to the central hole 130a will be more adapted for cleaning an inner surface of the bottom 125, of the peripheral wall 112 and of the platform 119. The automatic cleaning device 1 provided adjacent to a secondary hole 131a will be more adapted for cleaning an

inner surface of the cover 122, of the peripheral wall 112 in the upper section of the cooling tower 100 and of the demister(s) 118 adjacent to the secondary hole 131a.

[0062] . The automatic cleaning device 1 includes a fixed basis 2. The fixed basis is attached to the upper surface of the upper wall formed, in the depicted embodiment, by the platform 119. If the automatic cleaning device 1 was adjacent to a secondary hole 131a, then the fixed basis 2 can be attached to the upper surface of the upper wall formed by the cover 122. In both cases, it is not necessary that the fixed basis 2 is attached to the upper surface. The fixed basis 2 may be attached on a radial inner surface of the central hole 130a or of the secondary hole 131a, or to the lower surface of the platform 119 of the cover 122.

[0063] . In the present description, the word "attached" is to be understood as a permanent or temporary attachment at least the time necessary to make use of the automatic cleaning device 1, that is during a cleaning cycle. That is, the fixed basis 2 may be fully permanently attached and remain secured to the platform 119 or cover 122 during the lifetime of the cooling tower 100. In another example, the fixed basis 2 may be permanently attached and remain secured to the platform 119 or cover 122, except for some operations unrelated to the cleaning of the cooling tower 100. Examples of operations unrelated to the cleaning may include, for example, a maintenance of the automatic cleaning device 1 or a cleaning of the automatic cleaning device 1. In a further example, the fixed basis may be temporarily attached to the platform 119 or cover 122, so that it remains fixedly attached to the platform or cover 122 when the cleaning operation is performed, and is then detached in order to be attached near another hole among the central hole 130a and secondary holed 131a.

[0064] . The fixed basis 2 may be shaped as any part suitable for being permanently or temporarily attached to the upper surface of the platform 119 or cover 122. The fixed basis 2 may be, as schematically depicted in figures 2 and 3, by a plate 3, a first strut 4, a second strut 5 and a sleeve 6. The plate 3 is intended to be attached, for example with bolts or screws, to the platform 119 or cover 122. The first strut 4 extends perpendicularly to the plate 3, the second strut 5 extends perpendicularly to the first strut 4 and the sleeve 6 extends parallel to the first strut 4. By doing so, the sleeve 6 is fixedly held above the central hole 130a (or, if fixed to the cover 122, above a secondary hole 131a). In the depicted embodiment, in which the platform 119 is substantially perpendicular, the plate 3 and the second strut 5 are substantially horizontal and the first strut 4 and the sleeve 6 are substantially vertical. Also, the first strut 4 is radially offset from the centreline X and the sleeve 6 is coaxial with the centreline X. Another example of a shape for the fixed basis 2 may be a flange, for example a flanging having a cylindrical shape or a shape of a cylinder of revolution, which may be coaxial with the centreline X or with a vertical centreline of a secondary hole 131a.

[0065] . The fixed basis 2 may include a cleaning fluid circuit. In this regard, the fixed basis 2 may include a cleaning fluid feeding conduit which is connected to a cleaning fluid reservoir. The cleaning fluid conduit may extend next to the pipe 120. The cleaning fluid circuit may also include a closing valve. The cleaning fluid circuit is not shown in the first embodiment but is identical to that of the second embodiment, which will be described later. The cleaning fluid may be a cleaning liquid, for example water mixed with a cleaning agent.

[0066] . The fixed basis 2 may include a pneumatic circuit and a pneumatic actuator. For example, the sleeve 6 may be or include a pneumatic cylinder. The pneumatic cylinder may be fed with a compressed gas or compressed air in order to drive a part around the centreline X.

[0067] . The automatic cleaning device 1 includes a main body 7. The main body 7 includes an elongated rod 7a and a main housing 7b. The rod 7a and the housing 7b form two mechanical parts fixedly attached to each other. The rod 7a and the housing 7b may be fixedly attached by means of bolts, by welding, or may be formed integral with each other.

[0068] . The rod 7a is schematically depicted in the views of the cooling tower of Figures 2 and 3 and is further shown in detail on Figures 4 to 6. As visible on Figures 2 and 3, the rod 7a is passed through the sleeve 6. As a result, the elongated rod 7a extends along the centreline X.

[0069] . By virtue of this arrangement, the rod 7a is mechanically connected to the fixed basis 2, namely to the sleeve 6. The rod 7a may be or may be fixedly connected to a piston (not shown) of the pneumatic cylinder formed by or included in the sleeve 6. The rod 7a is movable, relative to the fixed basis 2, in translation along a direction of the centreline X, e.g. the vertical direction.

[0070] . The rod 7a includes an upper longitudinal end 8 and a lower longitudinal end 9 (shown in figures 4 to 6). With the rod 7a passed through the sleeve 6 and the fixed body 2 attached adjacent to the hole 130a (respectively 131a), the rod 7a is able to be passed through the hole 130a (respectively 131a) with the upper longitudinal end 8 being above the platform 119 (respectively the cover 122) and the lower longitudinal end 9 being below the platform 119 (respectively the cover 122).

[0071] . By virtue of this arrangement, the rod 7a may be moved between a stowed upper position and a cleaning lower position. The lower longitudinal end 9 is relatively close to the fixed basis 2 in the stowed position. In other words, the rod 7a is lifted up in order to reach the stowed position. In the stowed position, both longitudinal ends 8 and 9 are above the platform 119 (or the cover 122). The upper longitudinal end 8 is far above the fixed basis 2 in the stowed position. The upper longitudinal end 8 is relatively close to the fixed basis 2 in the cleaning position. In other words, the rod 7a is lowered down in order to reach the cleaning position. In the cleaning

position, one longitudinal end 8 remains above the platform 119 (or the cover 122) and the other longitudinal end 9 is below the platform 119 (or the cover 122). The lower longitudinal end is far below the fixed basis 2 in the cleaning position.

[0072] . In the depicted embodiment, the rod 7a has a fixed length. The length can be calculated as a distance between the longitudinal ends 8 and 9. The fixed length may be within a range 500-4000 mm, preferably 1000-2000 mm. The fixed length may be outside of these ranges. Especially, the fixed length depends on the dimensions, for example, the height of the cooling tower 100. Such a construction with such dimensions allows, together with the other features of the automatic cleaning device 1, efficiently reaching each area of the parts to be cleaned in the cooling chamber 113, and without complicating the automatic cleaning device 1. In a variant, the rod 7a is telescopic. That is, the distance between the longitudinal ends 8 and 9 is able to vary in such a variant.

[0073] . The rod 7a includes an upper proximity sensor 10 and a lower proximity sensor 11. The proximity sensors 10 and 11 may be located at the respective longitudinal ends 8 and 9. The proximity sensors 10 and 11 may include any suitable means for detecting that they are located near a certain part, which may be a receiver on the fixed basis 2. For example, a beam emitter-receiver (not shown) may be provided on the fixed basis 2 and the sensor 10 may be a light reflector. With this arrangement, the proximity sensor 10 is able to detect that the longitudinal end 8 is close to the fixed basis 2. A further beam emitter-receiver (not shown) may be provided on the fixed basis 2 and the sensor 11 may be a light reflector like the sensor 10. With this arrangement, the proximity sensor 11 is able to detect that the longitudinal end 9 is close to the fixed basis 2. Alternatively, the same beam emitter-receiver may be used for both sensors, and the information may be coupled with an information of a pneumatic pressure in the cylinder. As a further alternative, the proximity sensor 10 may be a reflector of a type different from the type of the proximity sensor 11, and this difference may be detected by the beam emitter-receiver.

[0074] . At the lower longitudinal end 9, the rod 7a includes a fixing flange 12. The fixing flange 12 may be attached to the rod 7a by a plate 13 and a cylinder 14. This arrangement allows for a solid attachment between the fixing flange 12 and the rod 7a. The fixing flange 12 may include a plurality of holes 15 distributed evenly circumferentially for cooperating with bolts attached with the main body 7b.

[0075] . For example, the length of the cylinder 14 in the longitudinal direction of the rod 7a is within a range 100-250 mm. For example, the length of the flange 12 in the longitudinal direction of the rod 7a is no more than 20 mm. For example, the length of the plate 13 in the longitudinal direction is no more than 20 mm.

[0076] . The rod 7a includes a hose 16. The hose 16 is fluidly connected to the cleaning fluid circuit of the fixed basis 2. The hose 16 may be formed by a rigid or flexible

pipe. The hose 16 may be held by an upper plate 17 and by a hole 18 in the plate 13.

[0077] . The main housing 7b is schematically depicted in the views of the cooling tower of Figures 2 and 3 and is further shown in detail on Figures 7 to 10.

[0078] . The main housing 7b is rotationally symmetric around the centreline X. The main housing 7b includes a central portion 19, an upper portion 20 and a lower portion 21. The central portion 19 may be cylindrical, forms preferably a cylinder of revolution, around a first axis 22 parallel to the centreline X. The upper portion 20 and the lower portion 21 may be frustoconical, with the larger end on the side of the central portion 19.

[0079] . The upper portion 20 is attached to the lower longitudinal end 9 of the rod 7a. By virtue of this arrangement, the rod 7a and the housing 7b form together a mechanical part, namely the main body 7. The upper portion 20 may be fixed to the flange 12 by bolts (not shown) received in the holes 15.

[0080] . The automatic cleaning device 1 further includes an intermediate body 23. Like the housing 7b, the body 23 is schematically depicted in the views of the cooling tower of Figures 2 and 3 and is further shown in detail on Figures 7 to 10. The body 23 is located just below the main body 7, for example just below the housing 7b. The body 23 is mechanically connected to the main body 7. In the present embodiment, the body 23 may be mechanically connected by its upper end to the lower portion 21 of the main housing 7b. For example, a bearing, more particularly a slide bearing, may be provided between a cylindrical or frustoconical shape of the lower portion 21 and a corresponding shape of an upper end of the body 23. With such an arrangement, the body 23 is pivotable around the first axis 22, relative to the main body 7, as shown by the double arrow 24 on figures 7 and 8.

[0081] . The automatic cleaning device 1 further includes a nozzle arrangement 25. Like the housing 7b and the body 23, the arrangement 25 is schematically depicted in the views of the cooling tower of Figures 2 and 3 and is further shown in detail on Figures 7 to 10. The nozzle arrangement 25 is located at the same position, along the first axis 22, as the intermediate body 23. That is, when the automatic cleaning device 1 is positioned with the fixed basis 2 attached to the platform 119 and when the platform 119 is horizontal, the nozzle arrangement is at the same vertical level as the intermediate body 23. The nozzle arrangement 25 is then arranged below the main body 7, in particular below the main housing 7b, and horizontally offset away from the first axis 22.

[0082] . With such a disposition, the nozzle arrangement 25 is relatively closer to the lower longitudinal end 9 of the rod 7a, in particular compared to the upper longitudinal end 8. With such a disposition, the nozzle arrangement 25 is lowered down or lifted up together with the main body 7. As a result, when the main body 7 is lifted up in the stowed position, the nozzle arrangement 25 is above the platform 119 (or the cover 122). Thus, when the

main body 7 is in the stowed position, the nozzle arrangement 25 is out of the cooling chamber 113. When the main body 7 is lowered down in the cleaning position, the nozzle arrangement 25 is below the platform 119 (or the cover 122). Thus, when the main body 7 is in the cleaning position, the nozzle arrangement 25 is in the cooling chamber 113. The position depicted in figures 2 and 3 is the cleaning position.

[0083] . With respect to the direction of the first axis 22, the nozzle arrangement 25 is provided on a side of the intermediate body 23. In this regard, a side surface of the intermediate body 23 may include a side cylinder of revolution 26 (partly visible on figures 9 and 10). The cylinder of revolution may be formed around a second axis 27 perpendicular to the first axis 22. The nozzle arrangement 25 is mechanically connected to the intermediate body 23. In the present embodiment, the nozzle arrangement 25 is mounted on the cylinder of revolution 26. For example, the nozzle arrangement 25 forms together with the cylinder of revolution 26 a bearing, more particularly a slide bearing. With such an arrangement, the nozzle arrangement 27 is pivotable around the second axis 27, relative to the body 23, as shown by the double arrow 28 on figures 7 and 8.

[0084] . Because the second axis 27 is defined with respect to a portion of the intermediate body 23, which is movable with respect to the main body 7, the second axis 27 also moves with respect to the main body 7. That is, when the automatic cleaning device 1 is positioned with the fixed basis 2 attached to the platform 119 and when the platform 119 is horizontal, the second axis 27 is a horizontal axis pivoting around the vertical axis 22.

[0085] . With such a mechanical connection, the nozzle arrangement 25 is pivotable, relative to the main body 7, around the first axis 22 and around the second axis 27. That is, the nozzle arrangement 25 has two degrees of freedom in rotation with respect to the main body 7. The actuation of the rotation along the two degrees of freedom may be using the pressure of the cleaning fluid provided by the hose 16, or with a pneumatic actuator linked to the pneumatic circuit of the fixed basis, or with any other actuator such as, but not limited to, an electromotor.

[0086] . The nozzle arrangement 25 includes one or more nozzles, in the present embodiment four nozzles. Namely, the nozzle arrangement includes a first nozzle 29, a second nozzle 30, a third nozzle 31 and a fourth nozzle 32. The nozzles 29 to 32 are evenly distributed along a circumference of the nozzle arrangement 25, with respect to the second axis 27. Each of the nozzles 29 to 32 is formed as a cylinder of revolution including a port 37. The cylinder of revolution and the port 37 may be coaxial around a same direction. Namely, as referenced in Figure 8, the first nozzle 29 is oriented along a direction 33 perpendicular to the axis 27. The second nozzle 30 is oriented along a direction 34 perpendicular to the direction 33 and to the axis 27. The third nozzle 31 is oriented along a direction 35 perpendicular to the direction 34 and to the axis 27. The fourth nozzle 32 is oriented along a

direction 36 perpendicular to the directions 35, 33 and 27. As a result, the direction 35 is opposite to the direction 33, and the direction 36 is opposite to the direction 34.

[0087] . The nozzles 29 to 32 are fluidly connected to the fixed basis via the hose 16. The nozzles 29 to 32 are indirectly connected to the hose 16 via the main body 7, more precisely the main housing 7b, and the intermediate body 23. The hose 16 may communicate with the ports 37 so that the cleaning fluid provided by the hose 16 is provided to the ports 37 and sprayed from the ports 37. As a result, the cleaning fluid is sprayed from the port 37, substantially in the direction of the respective directions 33 to 36. Then, the nozzles 29 to 32 may spray the cleaning fluid towards the parts of the cooling tower 100 which are to be cleaned.

[0088] . The nozzles 29 to 32 may be adapted so that the sprayed cleaning fluid is at a pressure within a range 2-15 bars, preferably 3-10 bars, more preferably 4-6 bars, even more preferably 4,5-5,5 bars. The pressure may also be beyond these ranges, especially beyond the upper value. The need for a certain pressure may vary depending on the fluid used, on the type of the cooling tower, or on an environment of the cooling tower, or on the dimensions of the cooling tower or of the material being cooled.

[0089] . The nozzles 29 to 32 may be adapted so that the sprayed cleaning fluid is ejected at an overall flow rate within a range 10-175 L/minute, preferably 20-120 L/minute. More particularly, each of the nozzles 29 to 32 may be adapted so that the sprayed cleaning fluid is ejected at an individual flow rate, for each of the nozzles 29 to 32, within 2.5-44 L/minute, preferably 5-30 L/minute. As well as the pressure, the flow rate may also be beyond these ranges, especially beyond the upper value. The need for a certain flow rate may vary mainly depending on the fluid used, or on an environment of the cooling tower, or on the type of the cooling tower or of the material being cooled.

[0090] . As aforementioned, the nozzle arrangement 25 has two degrees of freedom in rotation with respect to the main body 7. Accordingly, when operating in the cleaning position, the directions 33 to 36 move in rotation around both direction 22 and 27. Figures 8 to 10 show three exemplary successive states of the automatic cleaning device 1 during cleaning operation. As shown on these figures, the nozzles 29 to 32 pivot both around the direction 22 and around the direction 27. This results in a flow of cleaning fluid covering all the volume, in three dimensions, around the nozzle arrangement 25.

[0091] . Referring now to Figure 11, it is shown a portion of the inner surface of the peripheral wall 112 of the cooling tower 100. The peripheral wall 112 is shown in the process of being cleaned by the automatic cleaning device 1. As a result, the inner surface of the peripheral wall 112 includes a dirty area 133 and five cleaned areas 134 to 138. The cleaned areas 134 to 138 form curved lines which follow the course of the projection of the directions 33 to 36 on the inner surface, when the nozzle arrangement 25 pivots around the axes 22 and 27. In

particular, the cleaned area 138 was captured at a moment at which the corresponding direction 33 to 36 projects on the inner surface. When the cleaning process is further performed, the cleaned areas are further extended and more cleaned areas will extend between the areas 134 to 138. The dirty area 133 will then progressively disappear and the inner surface is then cleaned.

[0092] . Namely, the automatic cleaning device 1 and the cooling tower 100 make it possible to implement the following cooling process.

[0093] . In the cooling process according to the invention, gas, preferably air, is passed through the gas inlet 115 into the cooling chamber 113. At the same time, a liquid to be cooled is sprayed from the spray nozzles 124 into the cooling chamber 113. As a result, the passed gas cools the sprayed liquid and mixes with the liquid to form a mixed fluid. As a following step, the mixed fluid is passed through the demisters 118 to reduce or eliminate liquid from the mixed fluid.

[0094] . At regular intervals, the method of cooling is stopped. Namely, the flow of liquid to be cooled in the pipe 120 is interrupted and the fan 115 is stopped. As a result, the flows A1, B1, A2, B2, A3 and A4 are interrupted and the cooling is no longer performed. In other words, this corresponds to a downtime of the cooling tower 100. At this moment, the covers 130b and 131b are opened and the automatic cleaning device 1 is passed through the holes 130a and 131a. Then a cleaning process is performed by the automatic cleaning device.

[0095] . This cleaning may be done successively, with one automatic cleaning device 1, or simultaneously, with the same number of automatic cleaning devices 1 as the number of holes 130a and 131a. Also, this may be done either successively and simultaneously for some of the holes, with a number of automatic cleaning devices 1 strictly more than one and strictly below the number of holes 130a and 131a. For example, the cleaning may be done simultaneously for the hole 130a and at least one of the holes 131a, with one automatic cleaning device 1 whose fixed basis 2 is permanently attached to the platform 119 and one automatic cleaning device 1 whose fixed basis 2 is temporarily attached to the cover 122, and is successively moved to be adjacent to each respective hole 131a.

[0096] . The regular intervals may be any time between one hour and ten hours. It is to be understood that an interval varying by less than 10% of the average interval is a regular interval.

[0097] . The cleaning concerns particularly a wall of the cooling tower 100 such as the peripheral wall 112, the bottom 125, the cover 122 and the platform 119. The cleaning includes moving, relative to the fixed basis 2, the main body 7. The motion is a translation along the direction X. The motion is between a stowed position in which the nozzle arrangement 25 is above the upper wall 119 or 122 and a cleaning position in which the nozzle arrangement 25 is below the upper wall 119 or 122. The cleaning

further includes spraying a cleaning fluid toward the part to be cleaned, by the nozzles 29 to 32. Also, when spraying, the nozzle arrangement 25 is pivoted, relative to the main body 7, around the axes 22 and 27.

[0098] . In addition to or instead of the covers 130b and 131b, the automatic cleaning mechanism 1 may be provided with an automatic valve. The automatic valve is above the hole 130a or 131a and, in the stowed position, under flange 12. In the stowed position, the automatic valve covers the nozzle from fluid such as cooled liquid, gas or fluid flowing above the platform 119. Such an automatic valve protects the nozzles 29 to 32 from getting dirt or from scaling.

[0099] . Figure 12 shows an alternative design of an upper section of the cooling tower 100' in which the demisters 118 are arranged at an angle to the vertical direction. Identical components include the same reference numerals. In this design, the demisters 118 cumulatively define a frustoconical shape, where the narrower end of the frustocone is closer to the bottom 125 and the wider end of the frustocone is closer to (or directly adjacent to) the cover 122. Put another way, each demister 118 may be said to be "leaning out" from the platform 119. The fluid flow A3 may still flow through these demisters substantially in the horizontal plane. Thus, this design also makes use of the higher horizontal velocity of the fluid flow in the chamber 113.

[0100] . As visible in figures 12 to 14, the cooling tower 100' is provided with the same automatic cleaning device 1 as the cooling tower 100. Namely, an automatic cleaning device 1 is schematically depicted on the platform 119 in the cutaway perspective view of Figure 12 and in the schematic cross-sections of Figures 13 and 14, and an automatic cleaning device 1 on the cover 122 is shown in the schematic cross-sections of Figures 13 and 14.

[0101] . From the figures 13 and 14, the respective automatic cleaning devices 1 each include a cleaning fluid circuit 140, a cleaning fluid feeding conduit 141, a cleaning fluid reservoir 142 and a closing valve 143.

[0102] . In figure 13, the automatic cleaning device 1 linked to the platform 119 is shown in the stowed position. As a result, the nozzle arrangement 123 is above the platform 119. In figure 14, the automatic cleaning device 1 linked to the platform 119 is shown in the cleaning position. As a result, the nozzle arrangement 123 is below the platform 119. Also, in the cleaning position, the nozzles may spray the cleaning fluid as shown by the arrows 150. In both figures 13 and 14, the automatic cleaning device 1 associated to the cover 122 is shown more schematically than the one associated to the platform 119, and is in both figures shown in the cleaning position.

Claims

1. An automatic cleaning device (1) for cleaning a part (112, 118, 119, 122, 125) of a cooling tower (100, 100'), comprising:

- a fixed basis (2) intended to be attached to an upper wall (119, 122) of the cooling tower (100, 100'),
- a main body (7) mechanically connected to the fixed basis (2) and movable, relative to the fixed basis (2), in translation along a first direction (X) substantially perpendicular to the upper surface (119, 122), and
- a nozzle arrangement (25) fluidly connected to the fixed basis (2), including at least one nozzle (29, 30, 32, 32) adapted to spray a cleaning fluid toward the part (112, 118, 119, 122, 125) to be cleaned,

wherein the main body (7) may be moved between a stowed position in which the nozzle arrangement (25) is above the upper wall (119, 122) and a cleaning position in which the nozzle arrangement (25) is below the upper wall (119, 122), **characterized in that** the nozzle arrangement (25) is pivotable, relative to the main body (7), around a first axis (22) parallel to the first direction (X) and around a second axis (27) perpendicular to the first direction (X).

2. The automatic cleaning device (1) according to claim 1, wherein the main body (7) includes an elongated rod (7a) extending along the first direction (X) and having a first longitudinal end (8) and a second longitudinal end (9), the nozzle arrangement (25) being adjacent to the second longitudinal end (9), the elongated rod (7a) being configured to be passed through a hole (130a, 131a) of the upper wall (119, 122) so that the second longitudinal end (9) is relatively close to the fixed basis (2) in the stowed position and the second longitudinal end (9) is relatively far away below the fixed basis (2) in the cleaning position.
3. The automatic cleaning device (1) according to claim 2, wherein the elongated rod (7a) is a telescopic rod.
4. The automatic cleaning device (1) according to claim 2, wherein the elongated rod (7a) has a fixed length.
5. The automatic cleaning device (1) according to any one of claims 1-4, wherein the fixed length is within a range 500-4000 mm, preferably 1000-2000 mm.
6. The automatic cleaning device (1) according to any one of claims 1-5, including a first proximity sensor (10) able to detect that the first longitudinal end (8) is close to the fixed basis (2).
7. The automatic cleaning device (1) according to any one of claims 1-6, including a second proximity sensor (11) able to detect that the second longitudinal end (9) is close to the fixed basis (2).

8. The automatic cleaning device (1) according to any one of claims 1-7, wherein the at least one nozzle (29, 30, 32, 32) is adapted to be fed with the cleaning fluid at a pressure within a range 2-15 bars, preferably 3-10 bars, more preferably 4-6 bars, even more preferably 4,5-5,5 bars. 5
9. The automatic cleaning device (1) according to any one of claims 1-8, wherein the at least one nozzle (29, 30, 32, 32) is adapted to be fed with the cleaning fluid at an overall flow rate within a range 10-175 L/minute, preferably 20-120 L/minute. 10
10. The automatic cleaning device (1) according to any one of claims 1-9, wherein said at least one nozzle includes a first nozzle (29) oriented along a second direction (33) perpendicular to the second axis (27), a second nozzle (30) oriented along a third direction (34) perpendicular to the second direction (33) and to the second axis (27), a third nozzle (31) oriented along a fourth direction (35) perpendicular to the third direction (34) and opposite to the second direction (33), and a fourth nozzle (32) oriented along a fifth direction (36) perpendicular to the fourth direction (35) and opposite to the third direction (34). 15 20 25
11. The automatic cleaning device (1) according to any one of claims 1-9, further including an intermediate body (23) mechanically connected to the main body (7) and to the nozzle arrangement (25), the intermediate body (23) being pivotable around the first axis (22), relative to the main body (7), the nozzle arrangement (25) being pivotable around the second axis (27), relative to the intermediate body (23). 30 35
12. The automatic cleaning device (1) according to any one of claims 1-11, wherein the main body (7) further includes a hose (16) fluidly connected to the fixed basis (2) and fluidly connected to the nozzle (29, 30, 32, 32), preferably indirectly fluidly connected to the nozzle (29, 30, 32, 32) via at least the main body (7). 40
13. A cooling tower (100, 100') comprising a bottom (125), a peripheral wall (112), and an upper wall (119, 122), wherein the bottom (125), the peripheral wall (112), and the upper wall (119, 122) define together a cooling chamber (113) of the cooling tower (100, 100'), and an automatic cleaning device (1) according to any one of claims 1-12, wherein the fixed basis (2) of the automatic cleaning device (1) is attached to the upper wall (119, 122), and the main body (7) of the automatic cleaning device (1) is movable between the stowed position in which the nozzle arrangement (25) is out of the cooling chamber (113) and the cleaning position in which the nozzle arrangement (25) is in the cooling chamber (113). 45 50 55
14. An automatic cleaning method for cleaning a part (112, 118, 119, 122, 125) of a cooling tower (100, 100'), wherein the part is preferably a wall (112, 119, 122, 125) of the cooling tower (100, 100') or a demister (118) of the cooling tower (100, 100'), the method comprising:
- moving, relative to the fixed basis (2), the main body (7) of an automatic cleaning device (1) according to any one of claims 1-12, the motion being a translation along a first direction (X) substantially perpendicular to an upper wall (119, 122) of the cooling tower (100, 100'), the motion being between a stowed position in which the nozzle arrangement (25) of the automatic cleaning device (1) is above the upper wall (119, 122) and a cleaning position in which the nozzle arrangement (25) is below the upper wall (119, 122),
 - spraying a cleaning fluid toward the part (112, 118, 119, 122, 125) to be cleaned, by the at least one nozzle (29, 30, 32, 32) of the nozzle arrangement (25),
- characterized in that** it further includes, when spraying, pivoting the nozzle arrangement (25), relative to the main body (7), around the first axis (22) and around the second axis (27).
15. A method of cooling a liquid in a cooling tower (100, 100'), the method comprising:
- passing gas, optionally air, through a gas inlet (114) of the cooling tower (100, 100') into a cooling chamber (113),
 - spraying liquid to be cooled from one or more spray nozzles (124) into the chamber (113), such that gas from the gas inlet (114) cools the liquid and mixes with the liquid to form a mixed fluid,
 - passing the mixed fluid through one or more demisters (118) to reduce or eliminate liquid from the mixed fluid,
 - wherein the method of cooling includes periodically performing the automatic cleaning method according to claim 14.

Fig.1

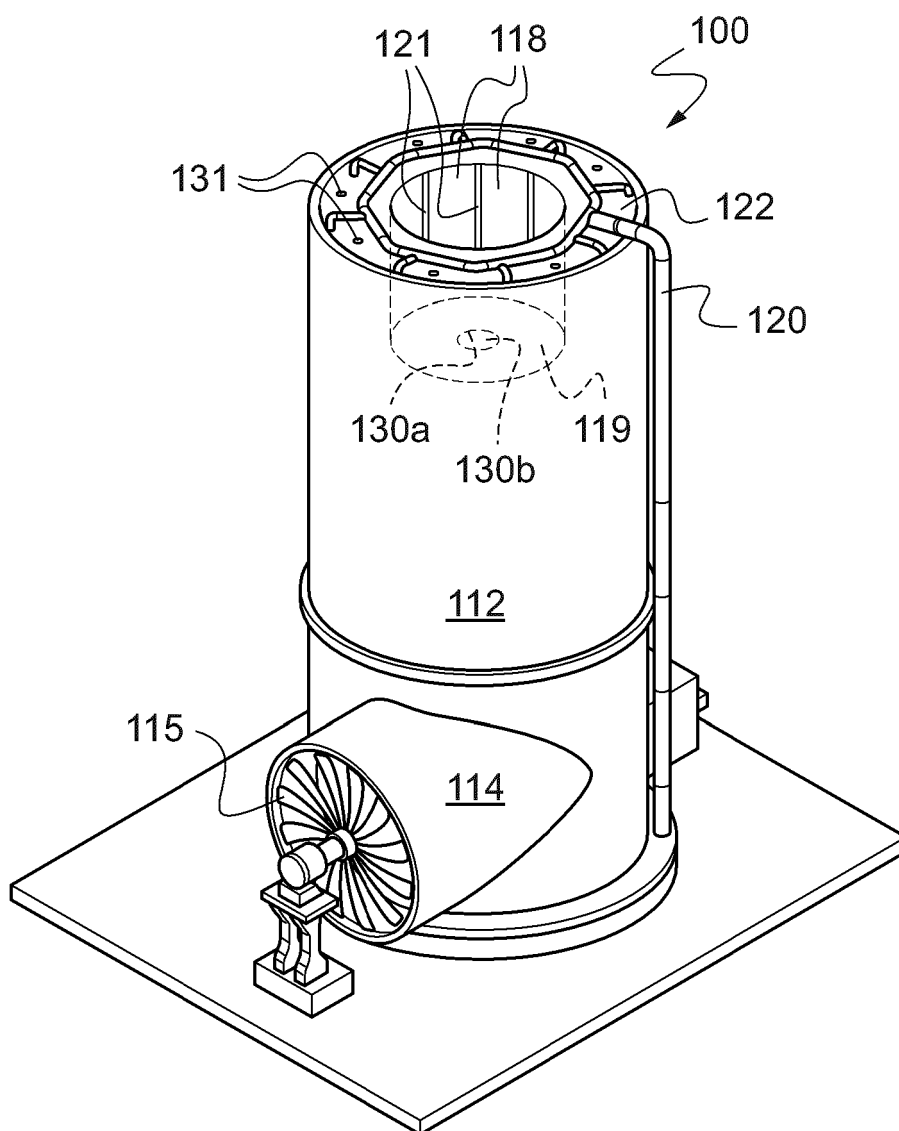


Fig.2

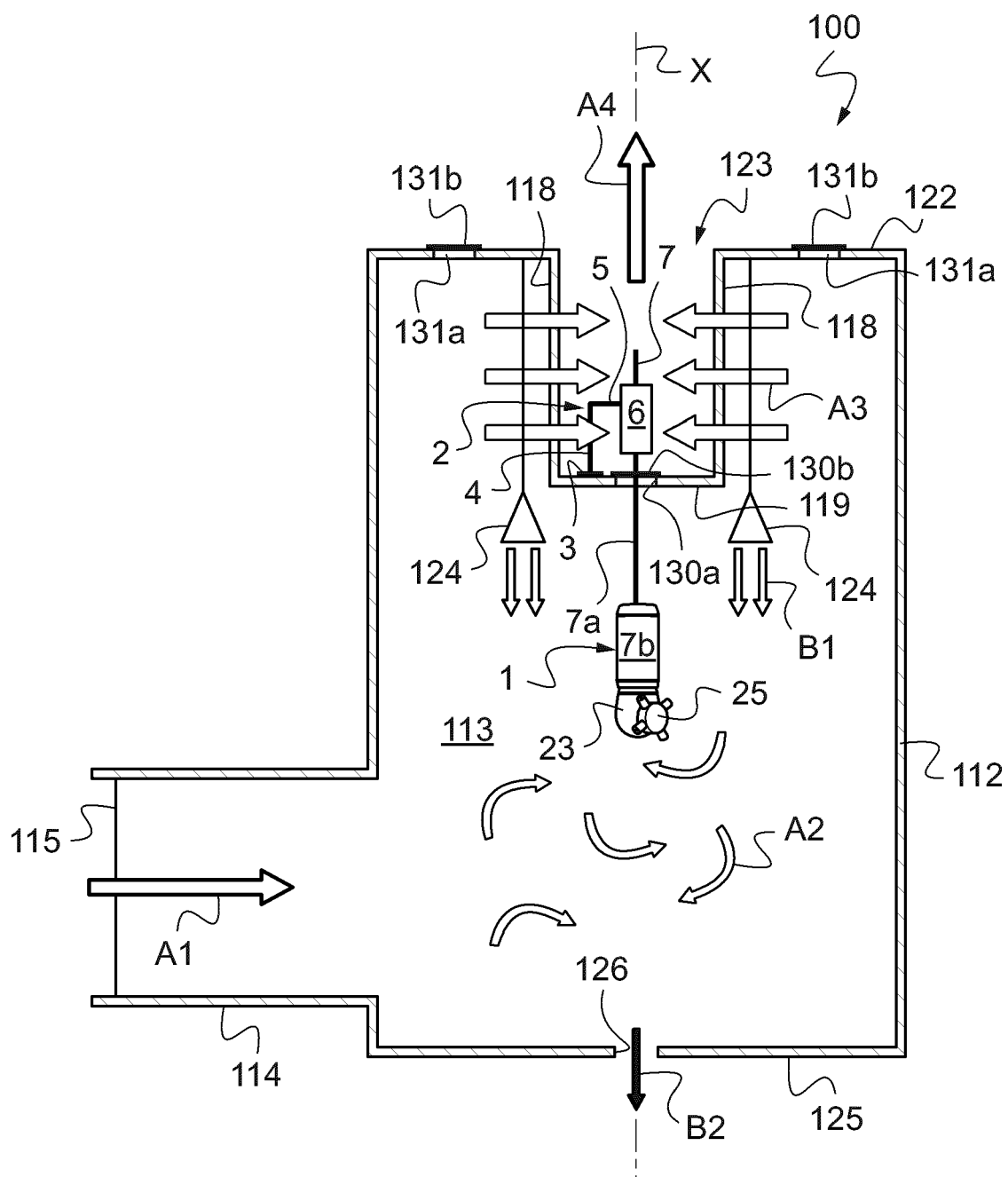


Fig.3

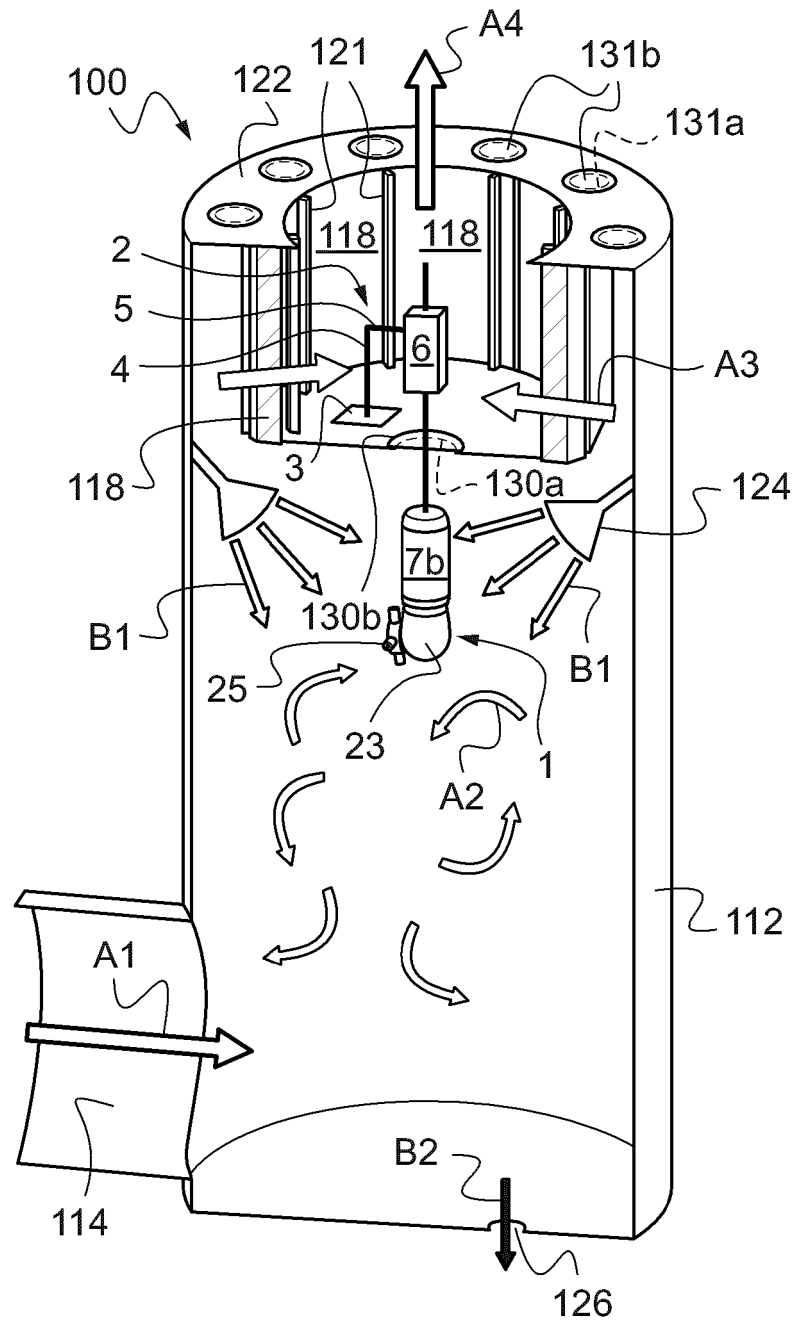


Fig.4

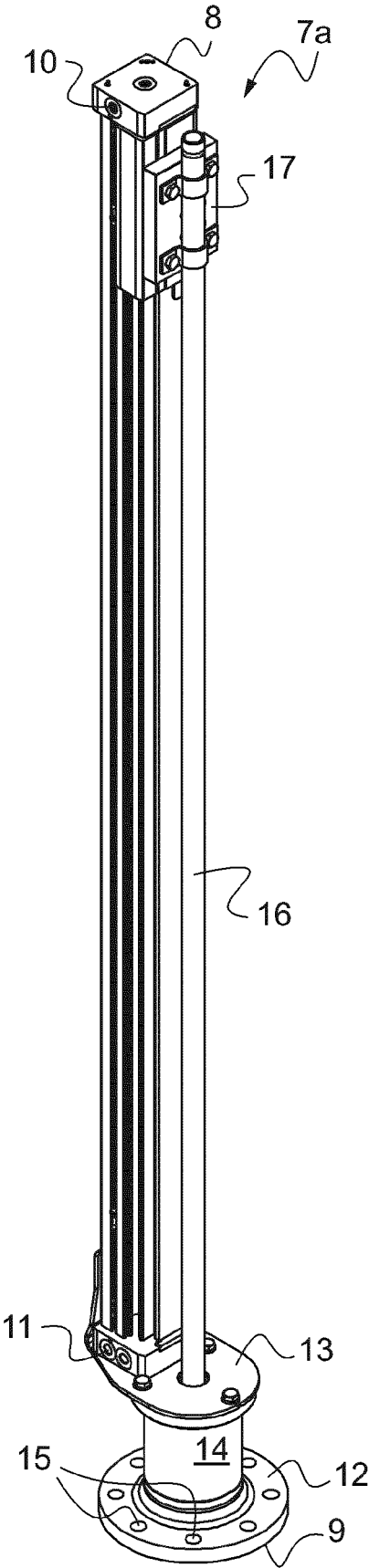


Fig.5

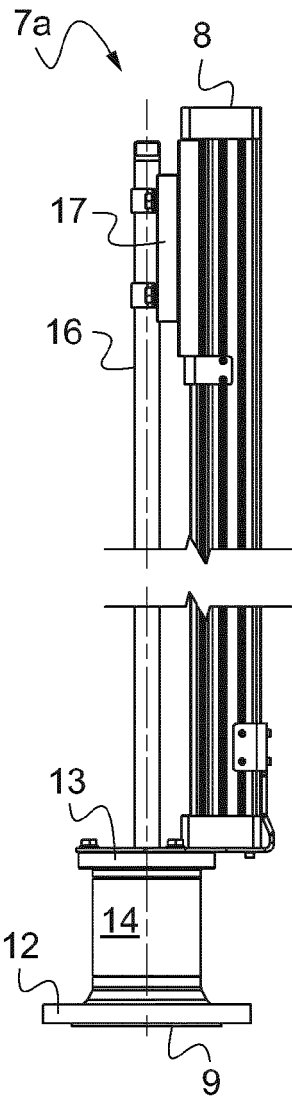


Fig.6

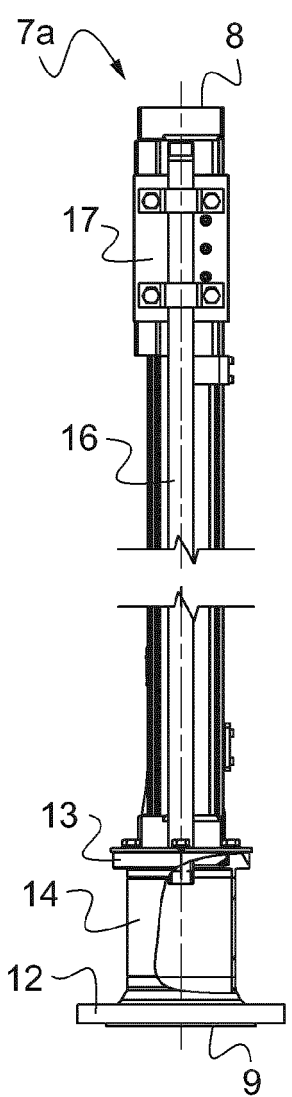


Fig.7

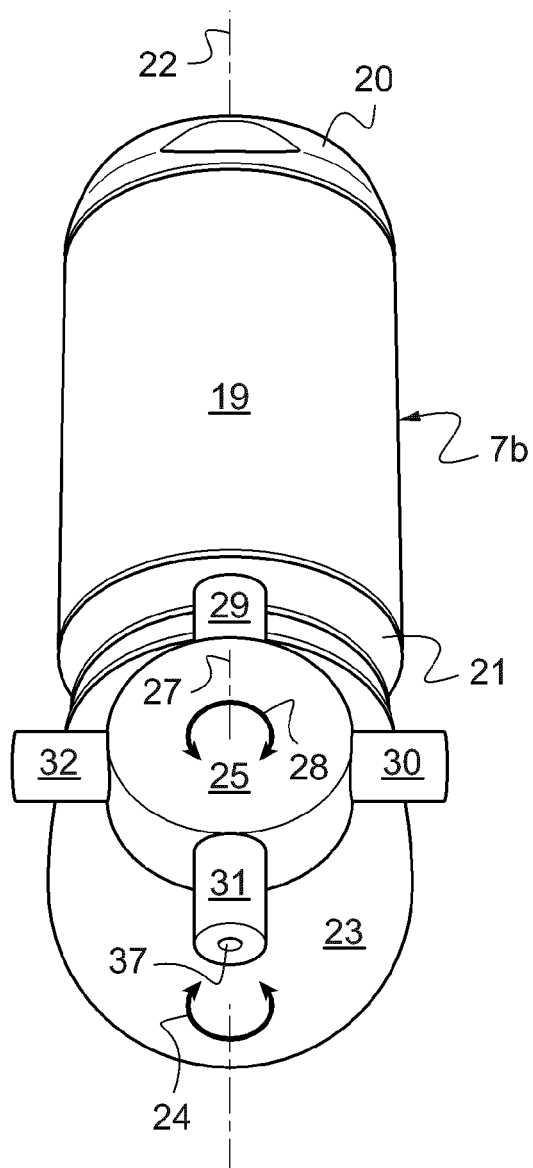
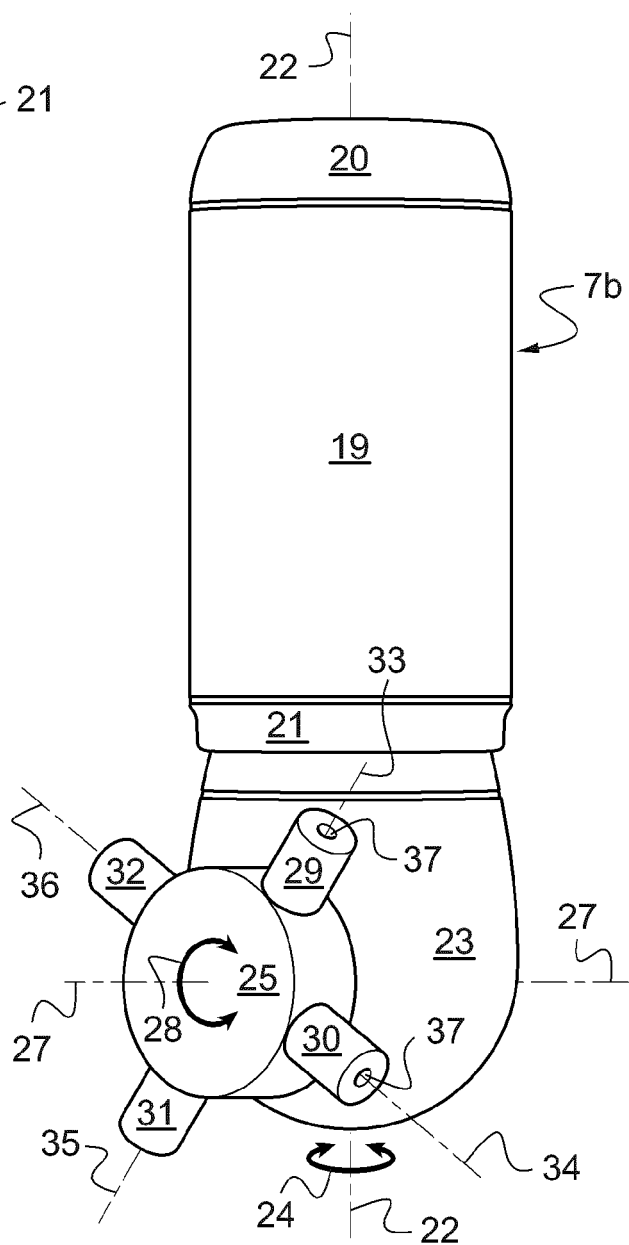


Fig.8



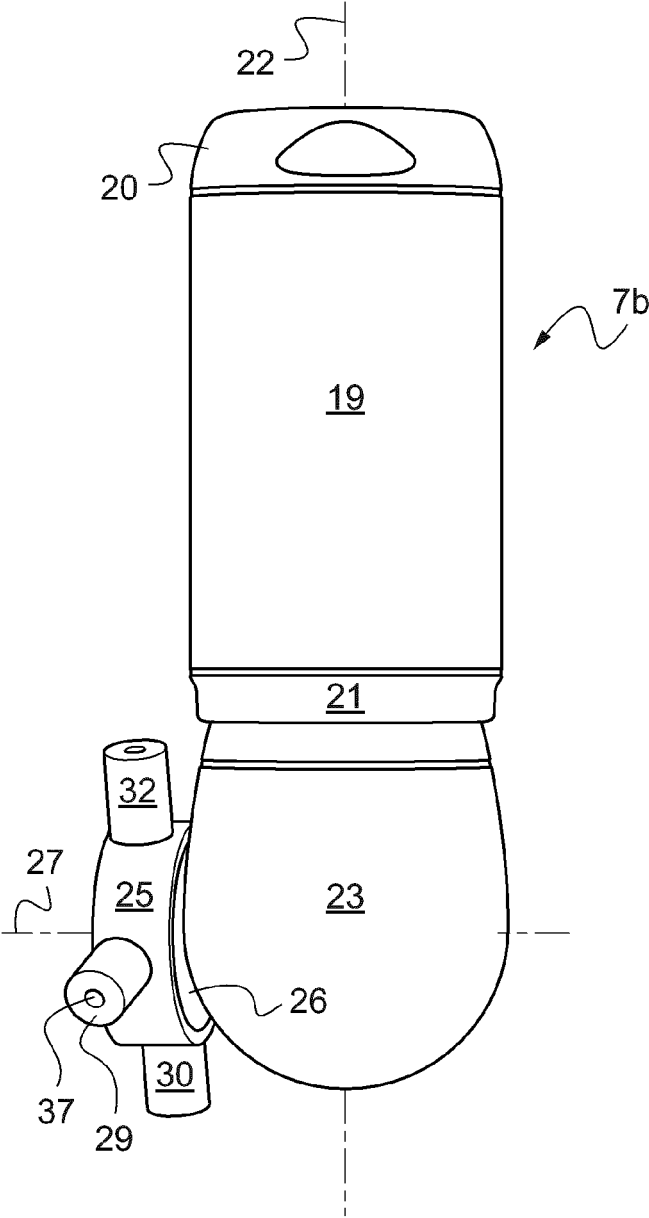


Fig.9

Fig.10

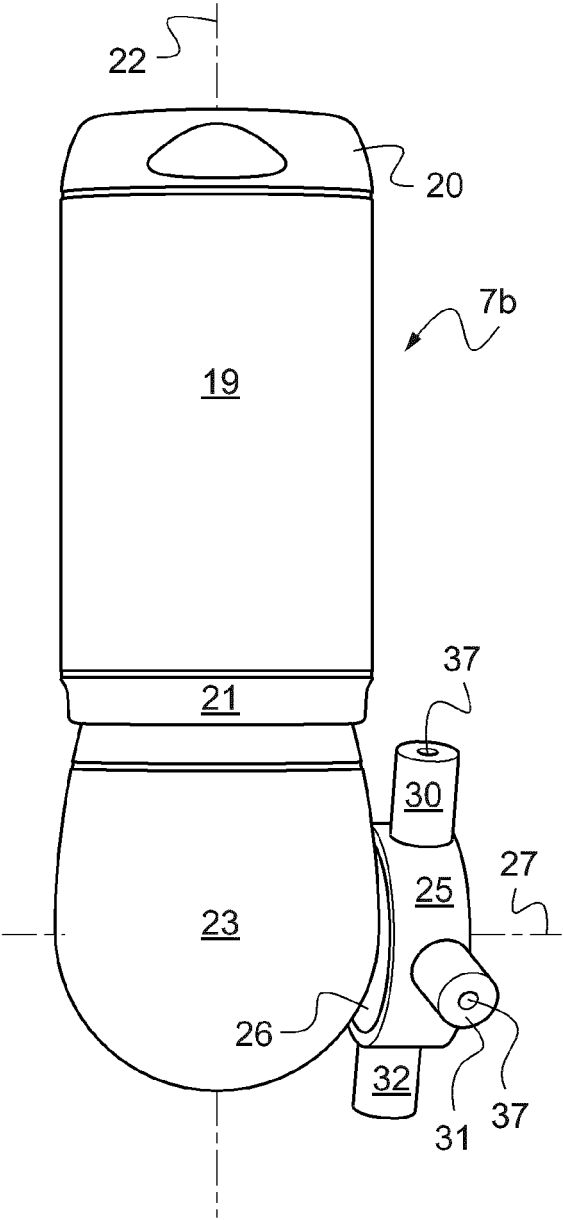


Fig.11

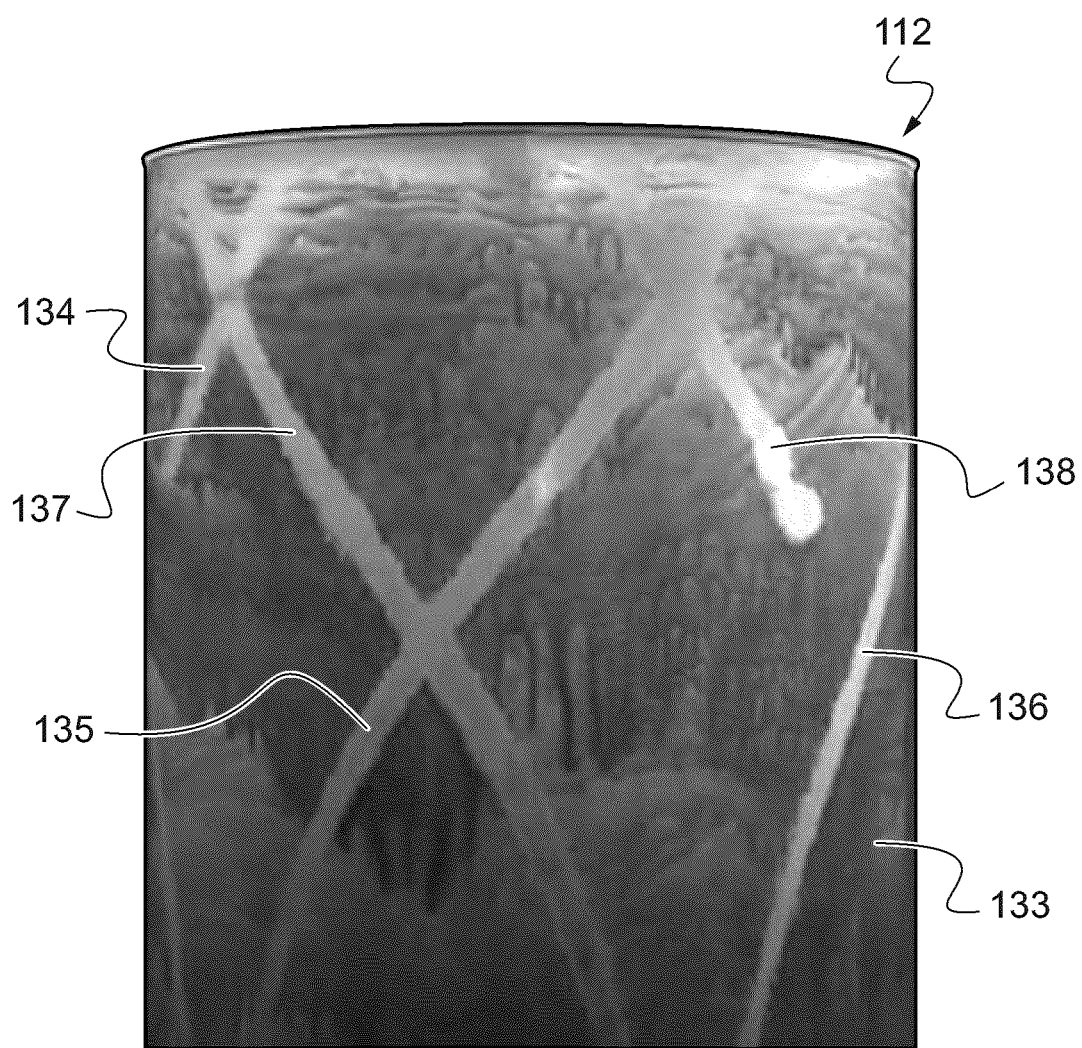


Fig.12

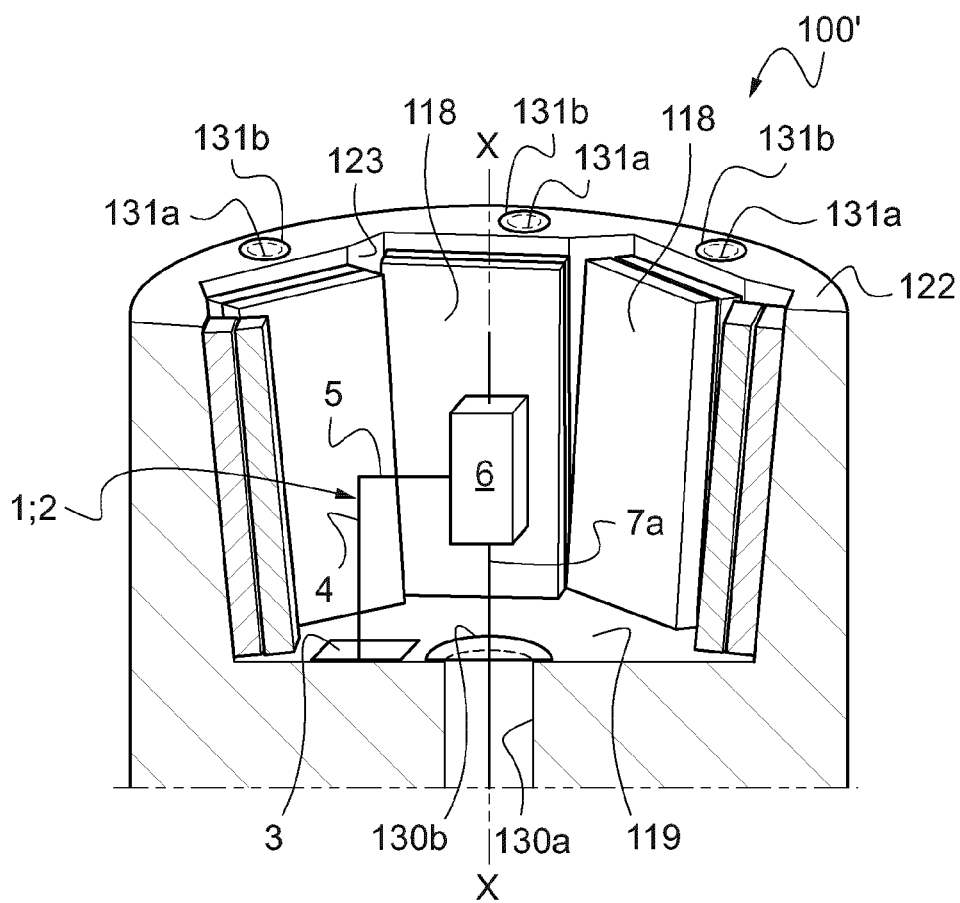


Fig.13

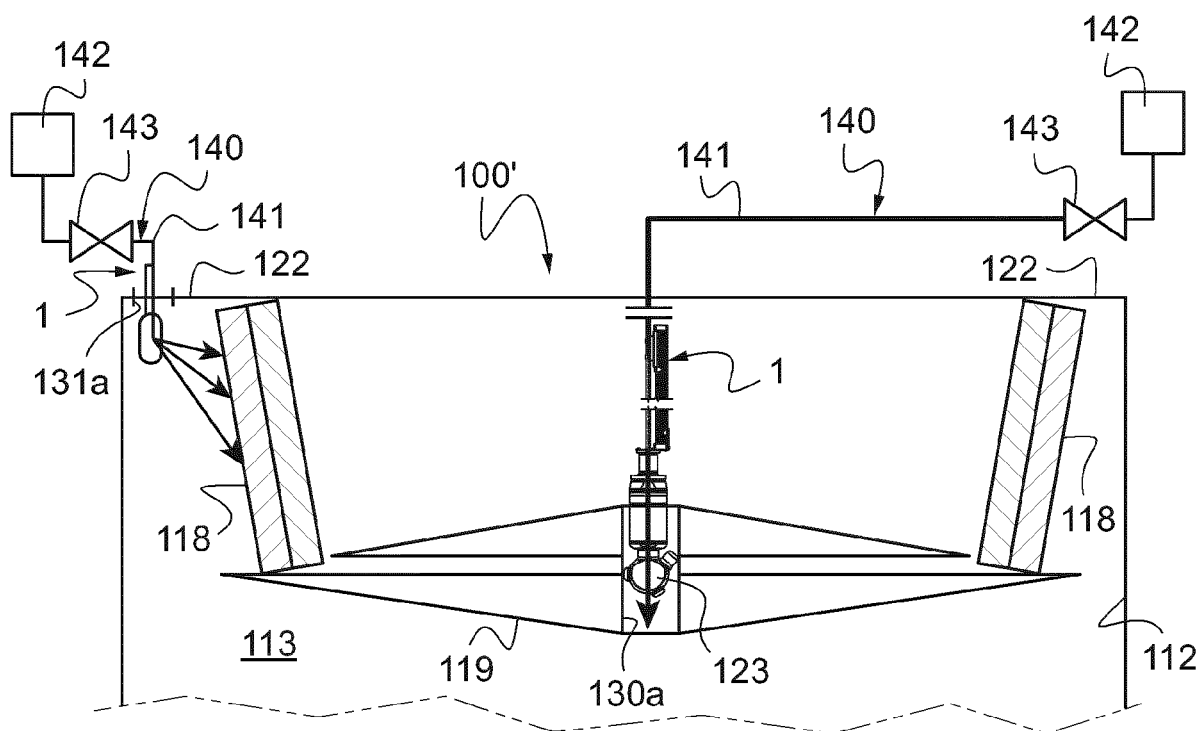
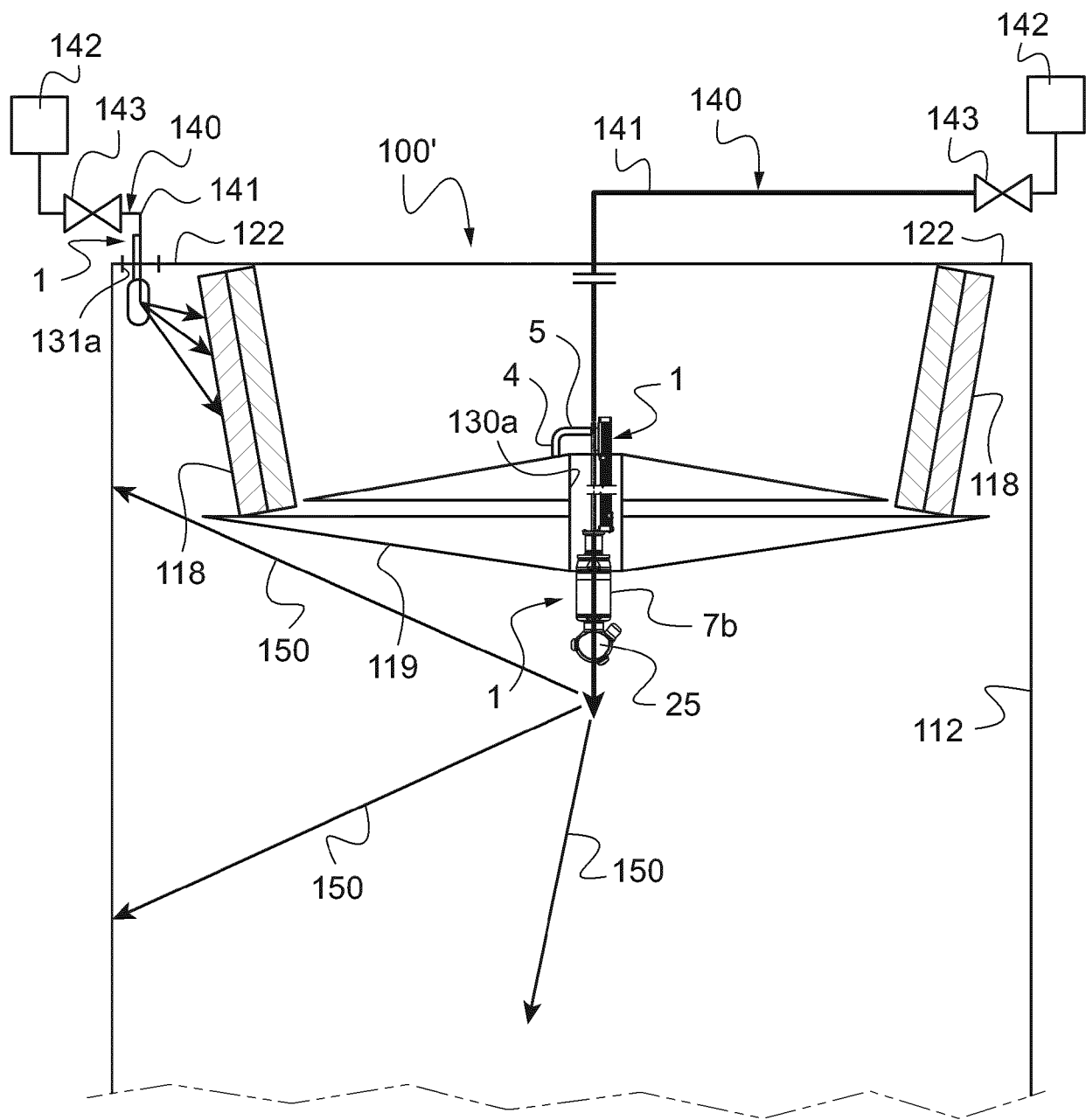


Fig.14





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Place of search Munich		Date of completion of the search 7 August 2025	Examiner Delaitre, Maxime
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