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(54) **A RETRACTABLE THRUSTER, A SWIMMING VESSEL AND A METHOD FOR RETRACTING AND EJECTING A PROPELLER OF THE RETRACTABLE THRUSTER**

(57) A retractable thruster for a swimming vessel, wherein the retractable thruster comprises a propeller (3) and a lifting and lowering arrangement (4). The lifting and lowering arrangement (4) is configured to vertically move the propeller between a retracted position and an ejected position. In the retracted position the propeller is substantially inside a bottom well (5) of the swimming vessel and in the ejected position the propeller is substantially outside the bottom well. The retractable thruster comprises a water-permeable protective element (7) configured to be located inside the bottom well above the propeller and configured to vertically move with the propeller. In the ejected position the water-permeable protective element is configured to substantially prevent loose ice from drifting inside the bottom well through the water-permeable protective element and when the propeller is moved from the retracted position to the ejected position, the water-permeable protective element is configured to push ice out of the bottom well.

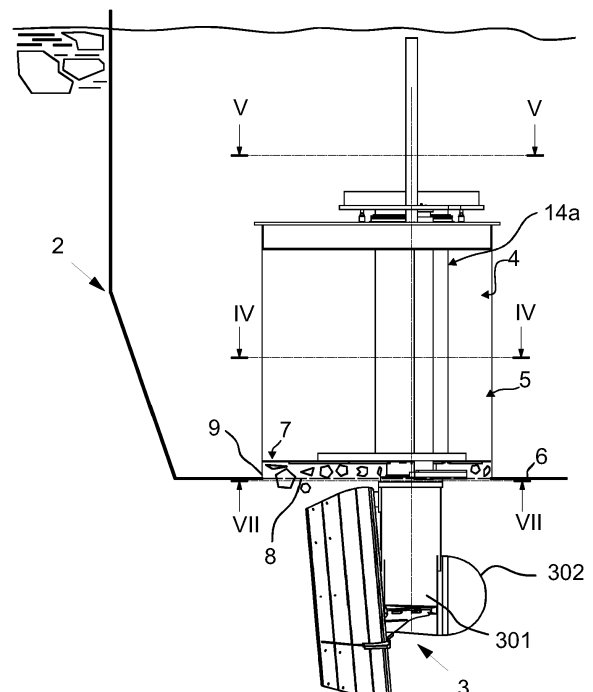


FIG. 1A

Description

FIELD

[0001] A retractable thruster is provided that may be used in swimming vessels, for example in a ship, an off-shore vessel, a fishing vessel, a naval vessel, a luxury liner, an oil tanker, a tug, a ferry or similar applications.

BACKGROUND

[0002] Retractable thrusters are usually used as auxiliary propulsion for swimming vessels. For example, in naval vessels retractable thrusters may be used to provide additional thrust or a so called take-home feature.

[0003] A retractable thruster enables a propeller to retract into a bottom well of a hull of the swimming vessel. When the propeller is not in use and is retracted, the drag of the swimming vessel is reduced. Further, the retractable thruster may be retracted when the swimming vessel enters shallow waters.

[0004] In ice conditions, when the propeller of the retractable thruster is in its lowest position, there is a risk that loose ice fills the bottom well in such a way that the retracting of the propeller is not possible because the ice jams the lifting operation.

SUMMARY

[0005] According to a first aspect, there is provided a retractable thruster for a swimming vessel. The retractable thruster comprises a propeller and a lifting and lowering arrangement. The lifting and lowering arrangement is configured to move the propeller in the vertical direction between a retracted position and an ejected position. In the retracted position the propeller is substantially inside a bottom well of the swimming vessel and in the ejected position the propeller is substantially outside the bottom well. Further, the retractable thruster comprises a water-permeable protective element configured to be located inside the bottom well above the propeller and configured to vertically move with the propeller. In the ejected position the water-permeable protective element is configured to substantially prevent loose ice passing through the water-permeable protective element to the inside of the bottom well and when the propeller is moved from the retracted position to the ejected position, the water-permeable protective element is configured to push ice out of the bottom well. Thus, the water-permeable protective element prevents jamming of the lifting and lowering arrangement caused by loose ice and possibly freezing of the ice inside the bottom well. "Substantially inside a bottom well" means that a larger portion of the propeller is inside the bottom well than outside the bottom well when the propeller is in its retracted position. "Substantially outside the bottom well" means that a larger portion of the propeller is outside the bottom well or the propeller is fully outside when the propeller is in its ejected

position. "Substantially prevent loose ice from drifting inside the bottom well" means that only a minor portion of ice or substantially small ice blocks are permitted to go into the bottom well past or through the water-permeable protective element.

[0006] According to a second aspect, there is provided a retractable thruster for a swimming vessel. The retractable thruster comprises a propeller and a lifting and lowering arrangement. The lifting and lowering arrangement is configured to move the propeller in the vertical direction between a retracted position and an ejected position. In the retracted position the propeller is substantially inside a bottom well of the swimming vessel and in the ejected position the propeller is substantially outside the bottom well. Further, the retractable thruster comprises a water-permeable protective element configured to be located inside the bottom well above the propeller and configured to vertically move with the propeller. In the ejected position the water-permeable protective element is configured to substantially cover a waterside opening of the bottom well and when the propeller is moved from the retracted position to the ejected position, the water-permeable protective element is configured to push ice out of the bottom well. Thus, the water-permeable protective element prevents loose ice from drifting inside the bottom well through the water-permeable protective element and prevents jamming of the lifting and lowering arrangement caused by loose ice.

[0007] According to a third aspect, there is provided a retractable thruster for a swimming vessel. The retractable thruster comprises a propeller and a lifting and lowering arrangement. The lifting and lowering arrangement is configured to move the propeller in the vertical direction between a retracted position and an ejected position. In the retracted position the propeller is substantially inside a bottom well of the swimming vessel and in the ejected position the propeller is substantially outside the bottom well. Further, the retractable thruster comprises a water-permeable protective element configured to be located inside the bottom well above the propeller and configured to vertically move with the propeller. In the ejected position the water-permeable protective element is configured to prevent ice from entering the bottom well through the water-permeable protective element. Thus, the water-permeable protective element prevents jamming of the lifting and lowering arrangement caused by loose ice.

[0008] According to a fourth aspect, there is provided a retractable thruster for a swimming vessel. The retractable thruster comprises a moving support structure, a propeller below the moving support structure and a lifting and lowering arrangement. The lifting and lowering arrangement is configured to move the propeller with the moving support structure in the vertical direction between a retracted position and an ejected position. In the retracted position the propeller is substantially inside a bottom well of the swimming vessel and in the ejected position the propeller is substantially outside the bottom well. Further, the retractable thruster comprises a water-

permeable protective element configured to be located inside the bottom well between the propeller and the moving support structure and configured to vertically move with the propeller. In the ejected position the water-permeable protective element is configured to substantially prevent loose ice from drifting inside the bottom well through the water-permeable protective element and when the propeller is moved from the retracted position to the ejected position, the water-permeable protective element is configured to push ice out of the bottom well. Thus, the water-permeable protective element prevents jamming of the lifting and lowering arrangement caused by loose ice.

[0009] In one embodiment, in the ejected position, the water-permeable protective element is at a lower end of the bottom well. In one embodiment, in the ejected position, the water-permeable protective element is in proximity to a lower end of the bottom well. The technical effect is that the water-permeable protective element prevents loose ice or ice blocks from entering the bottom well through the water-permeable protective element. "In proximity to a lower end" may mean a location of the water-permeable protective element being at a maximum distance of approximately 200mm from the waterside opening towards the bottom well.

[0010] In one embodiment, in the ejected position, the water-permeable protective element substantially covers a waterside opening of the bottom well. In one embodiment, in the ejected position, the entry of ice into the bottom well is prevented in a portion of the area of the waterside opening which is at least 95% of the area of the waterside opening of the bottom well. The technical effect is that the water-permeable protective element limits the possible area of the opening in a way that no or only a minor portion of ice or substantially small ice blocks are permitted to go into the bottom well past or through the water-permeable protective element. "Substantially covers a waterside opening" may mean that, together with the structures of the lifting and lowering arrangement, the water-permeable protective element covers at least around 95% of the area of the waterside opening.

[0011] In one embodiment, the water-permeable protective element comprises at least one perforated plate. The technical effect is that the water is permitted to go through holes in the perforated plate when the propeller is retracted or ejected, thereby lowering the resistance of the water and lowering the force needed to move the propeller in the vertical direction.

[0012] In one embodiment, the water-permeable protective element comprises at least one detachable plate part. In one embodiment, the water-permeable protective element comprises at least two detachable plate parts. The technical effect is that assembling of the retractable thruster and servicing the retractable thruster is easier because at least one of the plate parts may be detached and the detachable plate part, bottom well and the part of the retractable thruster inside the bottom well can be inspected.

[0013] In one embodiment, the water-permeable protective element comprises mesh. The technical effect is that the water is permitted to go through the mesh when the propeller is retracted or ejected, thereby lowering the resistance of the water and lowering the force needed to move the propeller in the vertical direction.

[0014] In one embodiment, the water-permeable protective element comprises a combination of a perforated plate and mesh. The technical effect is that when mesh is installed into larger holes of the perforated plate, smaller holes are less needed, thus improving the manufacturability, and the mesh also permits only very small ice blocks to go through the water-permeable protective element. Further, when the water-permeable protective element comprises a larger portion of the plate than mesh, the stiffness of the structure may be improved comparing to a water-permeable protective element made completely from mesh.

[0015] In one embodiment, the water-permeable protective element comprises a combination of a pipe structure and mesh. The technical effect is that the structure of the water-permeable protective element may be lighter compared to a metal plate when it is made of a hollow pipe.

[0016] In one embodiment, the water-permeable protective element comprises a combination of a support structure and mesh. The technical effect is that the support structure improves the stiffness of the water-permeable protective element.

[0017] In one embodiment, the lifting and lowering arrangement comprises a stationary support structure comprising a guiding element and a lead-through hole. Further, the lifting and lowering arrangement comprises a non-pivoting tube configured through the lead-through hole, wherein a lower end of the non-pivoting tube is configured to be connected to the propeller enabling to slidably connect the propeller to the guiding element and enabling the propeller to be moved vertically. Further, the lifting and lowering arrangement comprises an actuator arrangement configured to be connected between the non-pivoting tube and the bottom well in such a way that when the propeller is moved to the retracted position, the actuator arrangement is configured to lift the propeller substantially inside the bottom well by sliding the non-pivoting tube inside the guiding element and correspondingly when the propeller is moved to the ejected position, the actuator arrangement is configured to lower the propeller substantially outside the bottom well by sliding the non-pivoting tube inside the guiding element. In one embodiment, the guiding element is a bearing. In one embodiment, the non-pivoting tube is a guide bar. The technical effect is that the retractable thruster may be mounted in place with the stationary support structure and the propeller may be lifted or lowered with the lifting and lowering arrangement in a controlled and reliable manner.

[0018] In one embodiment, the lifting and lowering arrangement comprises at least two hydraulic cylinders. In one embodiment, the actuator arrangement comprises

at least two hydraulic cylinders. In one embodiment, each hydraulic cylinder comprises a piston which is hollow allowing a hydraulic fluid connection line connected to the at least two hydraulic cylinders to be placed to a location inside the bottom well, which is out of the reach of water. The technical effect is that, by means of the hydraulic cylinders, the lifting and lowering of the propeller may be done reliably as the hydraulic cylinders share the load of the propeller, thereby balancing the lifting and lowering manoeuvre. Further, the hydraulic cylinder usually performs reliable linear movement even in hard environmental conditions.

[0019] In one embodiment, the lifting and lowering arrangement comprises a manual lifting and lowering mechanism.

[0020] In one embodiment, the lifting and lowering arrangement comprises a moving support structure fixed to the non-pivoting tube, wherein a piston of each hydraulic cylinder is configured to be connected to the non-pivoting tube via the moving support structure and a cylinder housing of each hydraulic cylinder is configured to be connected to the bottom well. The technical effect is that the propeller may be steadily moved by the pistons which are connected to the moving support structure, and the cylinder housing of each hydraulic cylinder may be secured in place to the bottom well, enabling reliable push force of the pistons.

[0021] In one embodiment, the retractable thruster comprises at least one stopper configured to stop the movement of the propeller to the ejected position. In one embodiment, the at least one stopper is connected to the stationary support structure between the stationary support structure and the moving support structure. The technical effect is that the propeller may be smoothly stopped in the ejected position and the stopper prevents the moving support structure from strongly colliding against the stationary support structure.

[0022] In one embodiment, the water-permeable protective element is configured to prevent jamming of the lifting and lowering arrangement caused by freezing of loose ice. The technical effect is that it is possible to move the propeller in the vertical direction even in ice conditions.

[0023] In one embodiment, the propeller is configured to be pivotable for 360 degrees around a vertical axis of the retractable thruster. In one embodiment, the retractable thruster is an azimuth thruster. The technical effect of the pivotable feature of the azimuth thruster is that it makes a rudder unnecessary and gives the retractable thruster better maneuverability than a fixed propeller and rudder system.

[0024] According to a fifth aspect, there is provided a method for retracting and ejecting a propeller of a retractable thruster for a swimming vessel, wherein the propeller is retracted and ejected by:

- connecting a water-permeable protective element to the retractable thruster above the propeller inside a

bottom well of the swimming vessel;

- preventing, with the water-permeable protective element, loose ice from passing through the water-permeable protective element to the inside of the bottom well when the propeller is in an ejected position;
- pushing ice out of the bottom well when the propeller is moved from a retracted position to the ejected position.

[0025] According to a sixth aspect, there is provided a swimming vessel comprising a bottom well, a retractable thruster, and a power pack for supplying power for moving a propeller of the retractable thruster in the vertical direction. The retractable thruster comprises the propeller, a lifting and lowering arrangement configured to move the propeller in the vertical direction between a retracted position and an ejected position, wherein in the retracted position the propeller is substantially inside the bottom well and in the ejected position the propeller is substantially outside the bottom well. Further, the retractable thruster comprises a water-permeable protective element located inside the bottom well above the propeller and configured to vertically move with the propeller. In the ejected position the water-permeable protective element is configured to substantially prevent loose ice from drifting inside the bottom well through the water-permeable protective element and when the retractable thruster is moved from the retracted position to the ejected position, the water-permeable protective element is configured to push ice out of the bottom well.

[0026] According to a seventh aspect, there is provided a swimming vessel comprising a bottom well, a retractable thruster according to the first aspect, and a power pack for supplying power for moving a propeller of the retractable thruster in the vertical direction.

[0027] In one embodiment of the swimming vessel, the propeller is configured to be pivotable for 360 degrees around a vertical axis of the retractable thruster. In one embodiment of the swimming vessel, the retractable thruster is an azimuth thruster. The technical effect of the pivotable feature of the azimuth thruster is that it makes a rudder unnecessary and gives the swimming vessel better maneuverability than a fixed propeller and rudder system.

[0028] The retractable thruster described herein has many advantages. The water-permeable protective element enables shipping in ice or arctic conditions. The structure of the water-permeable protective element enables the prevention of jamming of the movement of the retractable thruster by substantially preventing loose ice from entering the bottom well through the water-permeable protective element when the propeller is in the ejected position. This may also enable preventing of unexpected shutdowns of the retractable thruster caused by ice jamming the lifting and lowering arrangement. The water-permeable protective element also enables the blocking of many other types of objects in the water such

as sunken logs and other waste material that could damage the structures of the retractable thruster inside the bottom well.

[0029] The simple and robust construction of the retractable thruster provides high operational reliability even in ice conditions. The mechanism of the retractable thruster is simple, which may bring savings in maintenance costs. The construction is strong-built and can push large blocks of ice out of the bottom well. In one embodiment of the retractable thruster, hydraulics provides the needed amount of force in order to lift the propeller reliably and safely. In the hydraulic solution of the lifting and lowering arrangement it is possible to equip the hydraulic system with suitable valves for securing the system of the lifting and lowering arrangement against a possible overload or malfunction incident. As the propeller is very heavy, hydraulic valves provide safe lowering of the propeller to the ejected position.

[0030] In an azimuth thruster the propeller pivots 360° around the vertical axis, so the unit provides propulsion, steering and positioning thrust even in ice conditions. The design of the retractable thruster has been developed in response to market requirements, whereby the design of the thruster may be adapted to suit many types of applications. The simple and robust construction provides high operational reliability together with simple maintenance.

[0031] In one embodiment, the structure of the retractable thruster enables the retractable thruster to be inspected by detaching at least one part of the water-permeable protective element. This feature is advantageous because it makes the maintenance of the retractable thruster easier, which may provide cost savings.

[0032] The retractable thrusters do not have any parts that can be external to the bottom well except the propeller, whereby there are no parts outside the bottom well except the propeller that in course of time may break or wear and may have to be replaced by new parts. For example, external structures outside the bottom well for limiting the ice blocks require space under the hull of the swimming vessel and increase the draft of the hull and are sensitive to impacts. These external structures have a risk of colliding against underwater obstacles at the bottom of the body of water such as rocks. These external structures may reduce the minimum depth of water that a ship or boat requires to safely navigate. Further, these types of external structures may collect extensive amounts of waste material or other obstacles from the passing water and may have to be cleaned on a regular basis.

[0033] The embodiments described herein may be used in any combination with each other. Several or at least two of the embodiments may be combined together to form a further embodiment. A method or a device may comprise at least one of the embodiments described hereinbefore.

[0034] It is to be understood that any of the above embodiments or modifications can be applied singly or in

combination to the respective aspects to which they refer, unless they are explicitly stated as excluding alternatives.

BRIEF DESCRIPTION OF THE DRAWINGS

[0035] The accompanying drawings, which are included to provide a further understanding and constitute a part of this specification, illustrate various embodiments and together with the description help to explain the principles of the embodiments. In the drawings:

Figure 1A is a side illustration of an embodiment of a retractable thruster in an ejected position;

Figure 1B is a front side illustration of an embodiment of a retractable thruster in an ejected position;

Figure 2 is an illustration of an embodiment of a water-permeable protective element;

Figure 3A is a sectional view V-V of the embodiment of the retractable thruster of Figure 1A;

Figure 3B is a sectional view VI-VI of the embodiment of the retractable thruster of Figure 3A, where the retractable thruster is in the ejected position;

Figure 3C is a sectional view of the embodiment of the retractable thruster of Figure 3B, where the retractable thruster is in a retracted position;

Figure 4A is an illustration of an embodiment of a retractable thruster in an ejected position; and

Figure 4B is an illustration of an embodiment of a retractable thruster as seen obliquely from below in an ejected position.

Figure 4C is a simplified sectional view of the embodiment of the retractable thruster of Figure 4A in an ejected position.

Figure 4D is a detail view of the retractable thruster of Figure 4A.

Figure 4E is another detail view of the retractable thruster of Figure 4A.

Figure 5 is a sectional view IV-IV of the embodiment of the retractable thruster of Figure 1A;

Figure 6 is a sectional view VII-VII of the embodiment of the retractable thruster of Figure 1A;

Figure 7A is a partial section view of an embodiment of a retractable thruster in an ejected position;

Figure 7B is a partial section view of the embodiment

of the retractable thruster of Fig. 7A in a retracted position;

Figure 8 is another illustration of a water-permeable protective element;

Figure 9 is another illustration of a water-permeable protective element;

Figure 10 is another illustration of a water-permeable protective element; and

Figure 11 is another illustration of a water-permeable protective element.

DETAILED DESCRIPTION

[0036] Reference will now be made in detail to the embodiments, examples of which are illustrated in the accompanying drawings.

[0037] A retractable thruster is a thruster where a propeller of the thruster can be retracted substantially inside a hull of a swimming vessel. In one embodiment, the retractable thruster may be adapted for horizontal drive with an automatic drive shaft disconnection system or for vertical drive. In one embodiment, lifting and lowering of the propeller can be activated by a remote control system, for example with a push button on the bridge of the swimming vessel. In one embodiment, engagement of a drive shaft coupling for the retractable thruster can be automatic.

[0038] Figure 1A is a side illustration of an embodiment of a retractable thruster in an ejected position. Figure 1B is a front side illustration of an embodiment of the retractable thruster in the ejected position. The retractable thruster comprises a propeller 3 comprising a lower gear 301 inside a lower gear housing 302. The detailed operation of the propeller 3 is not described in detail herein as it is well known to a man skilled in the art.

[0039] The retractable thruster comprises a lifting and lowering arrangement 4 configured to move the propeller 3 in the vertical direction between a retracted position and an ejected position. The retracted position is described in more detail below, for example with reference to Figure 3C. In the ejected position the propeller 3 is substantially outside a bottom well 5, for example fully outside the bottom well 5 as illustrated in Figs. 1A and 1B. The bottom well 5 is located at the bottom of the hull 6 of the swimming vessel 2.

[0040] A water-permeable protective element 7 is connected to the retractable thruster above the propeller 3 and its lower gear housing 302. In the embodiment of Figs. 1A and 1B the water-permeable protective element 7 comprises at least one perforated plate. The water-permeable protective element 7 in Figs. 1A and 1B is formed of two sections, which are a first and a second perforated plate 71, 72. The perforated plates 71, 72 are lifted and lowered with the propeller 3 when the propeller

3 is moved vertically. In the ejected position, the water-permeable protective element 7 is in proximity to a lower end 9 of the bottom well 5. For example, in the ejected position, the water-permeable protective element 7 may be at a maximum distance of approximately 200mm from the lower end 9 towards the inside of the bottom well 5 or exactly at the level of the lower end 9. When the retractable thruster is in the ejected position, the perforated plates 71, 72 are in proximity to the lower end 9, in which case loose ice cannot drift inside the bottom well 5 through the water-permeable protective element 7. Thus, the water-permeable protective element 7 substantially prevents ice from getting into the bottom well 5 through the water-permeable protective element 7 when the propeller 3 is in the ejected position. This can be accomplished by the structure of the perforated plates 71, 72 and the location of the perforated plates 71, 72 in the retractable thruster.

[0041] Figure 2 is an illustration of an embodiment of the water-permeable protective element 7. Figure 2 illustrates the water-permeable protective element 7 from the top. Figure 2 shows that most of the area A1 of a water-side opening 8 of the bottom well 5 is substantially covered by the water-permeable perforated plate 7. The water-permeable protective element 7 is split in the middle into sections, which are the perforated plates 71, 72. The perforated plates 71, 72 may be made out of metal. The first perforated plate 71 comprises a first opening 25a and the second perforated plate 72 comprises a second opening 25b designed to leave space for an actuator arrangement of the lifting and lowering arrangement, which actuator arrangement supplies the force for the linear movement of the retractable thruster. Because of the shape of the openings 25a, 25b, the surface of the perforated plates 71, 72 resembles a shell-like shape. The actuator arrangement may comprise, for example, cylinders and structures or brackets that are needed in order to mount the cylinders. The cylinders are explained below with reference to Figures 3B, 3C, 4A and 4B.

[0042] The water-permeable protective element 7 comprises a plurality of holes 23, the size and amount of which are determined according to the size of the retractable thruster. The size of the bottom well 5 and the amount of water in the bottom well 5 affect the size and amount of the holes 23. The size and amount of the holes also have an effect on the force that is needed when the propeller 3 is retracted, and on the ejecting speed of the propeller 3. The purpose of the holes 23 is to permit water to penetrate through the holes 23 when the propeller is retracted. A minor amount of water is also pushed through a clearance 30 between the water-permeable protective element 7 and the bottom well 5 when the propeller is retracted.

[0043] When the propeller 3 is in the ejected position, the openings 25a, 25b are substantially covered by the actuator arrangement, such as cylinders and structures or brackets that are needed in order to mount the cylinders. While retracting and ejecting the propeller, the cyl-

inders are inside the openings 25a, 25b. One cylinder and its mounting part are fitted inside each opening 25a, 25b when the propeller 3 is in the ejected position. Because the water-permeable protective element 7 substantially covers the waterside opening 8 in the ejected position, ice blocks that are larger than the largest hole 32 are prevented from entering the bottom well 5 through the water-permeable protective element 7 and are forced to stay below the water-permeable protective element 7. The diameter D2 of the water-permeable protective element 7 may be so large that the water permeable protective element 7 covers at least 95% of the area A1 of the waterside opening 8.

[0044] A hole pattern of an attachment interface 31 of the water-permeable protective element 7 is illustrated with dash-dot lines around a lead-through opening 26 of the water permeable protective element 7. The attachment interface 31 is used to connect the water-permeable protective element 7 to the rest of the structure of the retractable thruster. Because the perforated plates 71, 72 are detachable, they improve the maintenance of the retractable thruster as one or both of the perforated plates 71, 72 may be detached at the time of maintenance or inspection. The mounting of the water-permeable protective element 7 is also easier as the mounting of the heavy water-permeable protective element 7 can be made in two phases.

[0045] Figure 3A is a sectional view V-V of the embodiment of the retractable thruster of Figure 1A. Figure 3A illustrates the retractable thruster from the top and the position of the cut-out VI-VI which is illustrated in Figure 3B. Figure 3B is a sectional view VI-VI of the embodiment of the retractable thruster of Figure 3A, where the retractable thruster is in the ejected position. Figure 3C is a sectional view of the embodiment of the retractable thruster of Figure 3B, where the retractable thruster is in a retracted position.

Figures 3B and 3C illustrate that the water-permeable protective element 7 substantially prevents loose ice from passing inside the bottom well 5 through the water-permeable protective element 7, when the propeller 3 is in the ejected position and when the propeller 3 is moved from the retracted position to the ejected position, the water-permeable protective element 7 pushes ice out of the bottom well 5.

[0046] The structure of the retractable thruster enables the possibility to use the retractable thruster in ice conditions. The water-permeable protective element 7 protects the bottom well 5 from the ice, whereby it is possible to retract the propeller 3 without the ice interfering or preventing the retracting maneuver. The solution prevents loose ice from permanently accumulating inside the bottom well 5 in such a way that the vertical movement of the propeller 3 will be jammed. In ice conditions when the propeller 3 is in the ejected position, there is a risk that loose ice permanently fills the bottom well 5, whereby the retraction of the propeller 3 is not possible because the ice jams the retracting/lifting operation.

[0047] The lifting and lowering arrangement 4 comprises a stationary support structure 11 located, for example, at least partially inside the bottom well 5 and comprising a guiding element 12. Further, the lifting and lowering arrangement 4 comprises a non-pivoting tube 13 for slidably connecting the propeller 3 to the guiding element 12 and an actuator arrangement 17 connected between the non-pivoting tube 13 and the bottom well 5. The non-pivoting tube 13 goes through a lead-through hole in the stationary support structure 11. This lead-through hole 35 is illustrated in Figure 4B. The non-pivoting tube 13 is connected to the propeller 3 enabling the propeller 3 to be moved vertically. When the propeller 3 is moved to the retracted position, the actuator arrangement 17 lifts the propeller 3 substantially inside the bottom well 5 by sliding the non-pivoting tube 13 inside the guiding element 12. Correspondingly, when the propeller 3 is moved to the ejected position, the actuator arrangement 17 is configured to lower the propeller 3 substantially outside the bottom well 5 by sliding the non-pivoting tube 13 inside the guiding element 12.

[0048] The actuator arrangement 17 may be, for example, two hydraulic cylinders 14a, 14b. By means of the hydraulic cylinders 14a, 14b the lifting and lowering of the propeller 3 may be done reliably as the hydraulic cylinders 14a, 14b share the load of the propeller 3, thereby balancing the lifting and lowering manoeuvre. As the propeller 3 is very heavy, the hydraulic cylinders 14a, 14b enable keeping of the propeller 3 and parts connected to the propeller 3 steady in such a way that, during normal operation of the retractable thruster, there is no possibility of jamming of the lifting operation caused by the heavy load. The first hydraulic cylinder 14a is illustrated in Figures 3B and 3C and the second hydraulic cylinder may be located on the opposite side of the first hydraulic cylinder 14a. The position of the hydraulic cylinders 14a, 14b in relation to each other is also illustrated in Figure 1B. Each hydraulic cylinder 14a, 14b comprises a cylinder housing 16a, 16b and a piston 19a, 19b as illustrated in Figure 1B. The pistons 16a, 16b may be hollow as illustrated in Figure 3B and 3C.

[0049] The lifting and lowering arrangement 4 comprises a moving support structure 15 fixed to the non-pivoting tube 13. The moving support structure 15 can be, for example, welded to the non-pivoting tube 13 or detachably attached to the non-pivoting tube 13 with screws or similar types of accessories. The piston 19a, 19b of each hydraulic cylinder 14a, 14b is connected to the non-pivoting tube 13 via the moving support structure 15. Each piston 14a, 14b may comprise a fixing flange 36 which is used to connect the piston 14a, 14b to the moving support structure 15. There is one piston 19a, 19b on both sides of the moving support structure 15 for enabling a steady and reliable lifting maneuver. The cylinder housings 16a, 16b are attached to the bottom well 5 and thereby remain stationary.

[0050] The swimming vessel may comprise a power pack 20 for supplying power for moving the propeller 3

in the vertical direction. The power pack 20 is used to supply hydraulic fluid to the hydraulic cylinders 14a, 14b. Two hydraulic fluid connection lines may be needed to connect the power pack 20 to the hydraulic cylinders 14a, 14b, or one main hydraulic connection line may be used, which is divided into two hydraulic fluid connection lines near inlets 40a, 40b of the hydraulic cylinders 14a, 14b. One hydraulic fluid connection line 54 may be arranged for each cylinder 14a, 14b. A hydraulic fluid connection line 54 connected to a chamber 21 inside a first cylinder housing 16a of the first hydraulic cylinder 14a via the hollow interior of the piston 19a is illustrated with a dashed line in Figure 3B. The hydraulic fluid connection line 54 may be connected to an inlet 40a, 40b, which is structured into the moving support structure 15. One inlet 40a, 40b may be arranged for each of the hydraulic cylinder 14a, 14b. The inlet 40a, 40b is arranged through the moving support structure 15 to the inside of the piston 14a, 14b. The inlet 40a, 40b may be connected to the hydraulic fluid connection line 54 with a suitable fitting. The inlet 40a, 40b is used to supply the hydraulic fluid inside the hydraulic cylinders 14a, 14b.

[0051] When the retractable thruster is assembled, air may be trapped in the hydraulic circuit. After the startup, it may be important to remove the air from the hydraulic circuit. If the trapped air is not removed, it will be mixed to the hydraulic fluid which may lead to malfunction as the air is compressible. This may be prevented by arranging an air venting connection 53, which is connected to the chamber 21. This air venting connection 53 may be, during normal operation, sealed, for example, with a plug. When the venting of air is needed to be done, the plug is removed or untightened so that the air is removed from the cylinders 14a, 14b. The air venting connection 53 may be arranged into the moving support structure 15 where it is connected to the chamber 21 via the hollow interior of the piston 19a, 19b. Each hydraulic cylinder 14a, 14b may be connected to one air venting connection 53. As the air venting connection 53 may be connected to the highest point in the hydraulic cylinder 14a, 14b, the air may be removed efficiently.

[0052] The hydraulic fluid is pumped from the power pack 20 inside the hydraulic cylinders 14a, 14b. The hydraulic fluid is pumped inside the first piston 19a and from there into the chamber 21. Simultaneously, the hydraulic fluid is supplied inside the second piston 19b. When the pistons 19a, 19b are ejected, the pistons 19a, 19b together with the moving support structure 15 lift the propeller 3 upwards by sliding the non-pivoting tube 13 inside the guiding element 12. The water inside the bottom well 5 flows through the holes in the water-permeable protective element 7. Thus, lifting of the propeller 3 with a lifting force F to the retracted position is enabled. A stroke L of the retractable thruster is illustrated in Figure 3C.

[0053] In the retracted position, loose ice is permitted to enter the bottom well 5. When the propeller 3 is moved from the retracted position to the ejected position, the water-permeable protective element 7 pushes ice out of

the bottom well 5. In the embodiment of the retractable thruster in Figures 3B and 3C, the hydraulic cylinders 14a, 14b are single acting cylinders. The propeller 3 is ejected/lowered by its own weight. The ejecting speed is determined by the size of the propeller 3, the size of the bottom well 5, the amount and size of the holes 23 in the perforated plates 71, 72 and by whether valves are used to throttle the flow of the hydraulic fluid out from the hydraulic cylinders 14a, 14b.

[0054] Finally, the movement of the propeller 3 may be stopped by stoppers 18. In the embodiment of the retractable thruster in Figures 3B and 3C there are four stoppers 18 connected to the upper surface 37 of the stationary support structure 11. One stopper 18 is not visible in Figures 3B and 3C because it is opposite the stopper 18 in the middle of the stationary support structure 11. These stoppers 18 are located between the stationary support structure 11 and the moving support structure 15, thereby stopping the movement of the moving support structure 15 when the propeller 3 is ejected to the ejected position. The propeller 3 is intended to be moved slowly in the vertical direction, thereby avoiding possible bumps or collision caused by the heavy load tending to continue its movement after the stop. The stoppers 18 can be, for example, adjustable rods which have a thread and can be threaded onto threads in the stationary support structure 11. The thread enables the adjustable rods to be lifted or lowered in order to find the right stop position, for example in a start-up phase of the retractable thruster. At the end of the adjustable rods there may be a rubber, plastic or other type of elastic part. The height to which the adjustable rods are threaded determines the stop position of the propeller 3. The adjustable rods may be made out of metal. Another solution for the stoppers 18 may be to use correct length shock absorbers comprising gas springs instead of the adjustable rods (not illustrated). In this solution, there may be possible to arrange only one a larger shock absorber into the stationary support structure 11 instead of four adjustable thread rods (not illustrated).

[0055] The hydraulic fluid exiting from the inside of each hydraulic cylinder 14a, 14b may be restricted by using hydraulic valves. Depending on the size of the retractable thruster and the propeller 3, the hydraulic valves may be, for example, throttle valves or counterbalance valves. The purpose of these above-mentioned valves is to ensure that the propeller 3 will not fall down in an uncontrolled manner, colliding strongly against the stoppers 18. Also, the amount of hydraulic fluid supplied from a pump in the power pack 20 to the hydraulic cylinders 14a, 14b may be adjusted with a hydraulic valve in order to set the correct lifting/retracting speed. Summarizing, the purpose of the hydraulic valves is to control the flow out from and possibly also the flow into the hydraulic cylinders 14a, 14b, thereby improving the reliability and control of the hydraulic system.

[0056] It is also possible to equip the hydraulic cylinders 14a, 14b with an integrated end dampening struc-

ture which will smoothly slow down the speed of the pistons 19a, 19b when the pistons 19a, 19b are retracted. Another solution is to use conventional double-acting hydraulic cylinders with a separate piston inside the cylinder housing and a piston rod connected to the separate piston instead of the single-acting hydraulic cylinders 14a, 14b. In this solution the double-acting cylinder is used as a single-acting cylinder. In this solution, air must be exhausted from a piston rod side chamber, for example with suitable breathers.

[0057] The location of the hydraulic valves may preferably be in the power pack 20. In this way the hydraulic valves are protected from the corrosive conditions inside the bottom well 5. Another solution is to locate the hydraulic valves inside a manifold connected to the inlet 40a, 40b of each hydraulic cylinder 14a, 14b. In this solution the manifold may have to be protected from corrosion. It may also be possible to connect the manifold comprising the hydraulic valves outside the bottom well 5 between the hydraulic cylinders 14a, 14b and the power pack 20 in the hydraulic fluid connection line 54 by using suitable connectors and piping.

[0058] Another solution may be to arrange mechanically actuated cylinders to provide the linear movement (not illustrated) instead of hydraulic cylinders 14a, 14b. These mechanically actuated cylinders would have a gearbox and an electric motor, and rotational movement would be transformed into linear movement by the gearbox (not illustrated). Suitable protection for the electric motor and for other electric parts may have to be provided in order to have reliable operation in sea conditions.

[0059] The propeller 3 of the retractable thruster in Figure 3C is in the retracted position. In the retracted position, the propeller 3 is substantially inside the bottom well 5. In the embodiment of the retractable thruster, the propeller may be, for example, approximately for 85% inside the bottom well 5. Only a portion 34 of a conical housing 33 of the propeller 3 is outside the bottom well 5.

Another solution is to fully retract the propeller 3 inside the bottom well 5, thereby enabling full removal of the drag of the propeller (not illustrated). In this solution the stroke L of the retractable thruster and the stroke of the hydraulic cylinders 14a, 14b may have to be longer than in Figures 3B and 3C, and also the bottom well 5 may have to be deeper.

[0060] A method for retracting and ejecting the propeller 3 of the retractable thruster for the swimming vessel 2 may be performed in Figures 3B and 3C by the following steps:

- connecting a water-permeable protective element 7 to the retractable thruster above the propeller 3 inside the bottom well 5 of the swimming vessel 2;
- preventing, with the water-permeable protective element 7, loose ice from passing through the water-permeable protective element 7 to the inside of the bottom well 5 when the propeller is in the ejected position according to Figure 3B;

- pushing, with the water-permeable protective element 7 ice out of the bottom well 5 when the propeller 3 is moved from the retracted position according to Figure 3C to the ejected position according to Figure 3B.

[0061] Figure 4A is an illustration of an embodiment of a retractable thruster in an ejected position. Figure 4B illustrates the retractable thruster obliquely from below. Figures 4A and 4B illustrate that one hydraulic cylinder 14a, 14b goes through each opening 25a, 25b in the perforated plates 71, 72. Thus, a first cylinder housing 16a of the first hydraulic cylinder 14a goes through the first opening 25a of the first perforated plate 71 and a second cylinder housing 16b of the second hydraulic cylinder 14b goes through the second opening 25b of the second perforated plate 72. The first cylinder housing 16a is connected to a first connection element 39a and the second cylinder housing 16b is connected to a second connection element 39b. These connection elements 39a, 39b are used to connect the lower end of the cylinder housings 16a, 16b to the inner surface of the bottom well. In fact, the shape of the openings 25a, 25b may be designed according to the connection elements 39a, 39b. As seen from Figures 3C, 3B and 4B, the housings 16a, 16b of the hydraulic cylinders 14a, 14b go through the stationary support structure 11. The upper ends of the hydraulic cylinders 14a, 14b may be secured to the stationary support structure 11 in order to improve the stability of the hydraulic cylinders 14a, 14b.

[0062] For example, the non-pivoting tube 13 can be a stem tube, which functions as a guide bar having a sliding surface in an outer surface of the stem tube. The guiding element 12 may comprise a suitable bearing and/or a sliding surface and a seal fitted around the stem tube. The guiding element 12 may comprise, for example, a mechanical seal, which enables the sliding of the outer surface of stem tube inside the guiding element 12. Figure 4B illustrates that the non-pivoting tube 13 goes through a lead-through hole 35 in the stationary support structure 11. The guiding element 12 is connected around the lead-through hole 35 of the stationary support structure 11 and thereby remains stationary. The moving support structure 15 is connected to the upper end of the non-pivoting tube 13. The connection between the upper end of the non-pivoting tube 13 and the moving support structure 15 may be done, for example, by welding or with a tight fit in order to firmly connect them together. The non-pivoting tube 13 is fitted inside the guiding element 12. The non-pivoting tube 13 moves vertically inside the guiding element 12 when the pistons 19a, 19b move the moving support structure 15 in a reciprocating manner, thus retracting or ejecting the propeller 3. Figure 4A also illustrates the position of the inlet 40a, 40b of each hydraulic cylinder 14a, 14b, which may be located near the upper end of the piston 19a, 19b.

[0063] The retractable thruster may comprise guide bars 38a, 38b. One guide bar 38a may be for each hy-

hydraulic cylinder 14a, 14b. The purpose of the guide bars 38a, 38b is to support the retractable thruster into a wall and/or to ceiling structures inside an engine room of the swimming vessel. One example of additional attachment structures 41 to the wall(s) and/or to the ceiling are illustrated with dashed lines in Figure 4A. These guide bars 38a, 38b may be configured through the moving support structure 15 with similar type of structure as the guiding element 12. Each guide bar 38a, 38b may be configured inside a guiding element 381a, 381b of the moving support structure 15. Each guiding element 381a, 381b may comprise a mechanical seal enabling the sliding of the outer surface of the guide bar 38a, 38b inside the guiding element 381a, 381b. The guide bars 38a, 38b may be hollow pipes, which are attached into the stationary support structure 11 from a lower end of the guide bar 38a, 38b.

[0064] An upper end of the guide bar 38a, 38b is attached to the wall(s) and/or ceiling of the engine room with the additional support structures 41. The moving support structure 15 slides up and down along the guide bars 38a, 38b, when the pistons 19a, 19b reciprocate. At the upper end of the guide bars 38a, 38b, the retractable thruster may comprise a locking device 52, which locks the retractable thruster to the retracted position. This locking device 52 may be needed because there may be internal leaks in the hydraulic cylinders 14a, 14b or in the hydraulic system, whereby it may be possible that over time, the propeller 3 is unwantedly lowered/ejected. This unwanted movement may be marginal, but in the long term, it may have an unwanted impact on the operation of the retractable thruster and particularly when the retractable thruster is in the retracted position where it has been unused for some time.

[0065] The retractable thruster may comprise a drive lead-through channel 42. The drive from the engine or motor is led to the lower gear 301 through this drive lead-through channel 42.

[0066] The propeller 3 may be pivotable for 360 degrees around a vertical axis 43 of the retractable thruster. This movement is illustrated with arrows 28 in Figure 4A. Figure 4B illustrates that the retractable thruster may comprise a bearing 29 which enables the rotation of the propeller 3 around its vertical axis 43. Figure 4B also illustrates that a lower end 24 of the non-pivoting tube 13 is connected to the propeller 3. A second attachment interface 49 of the retractable thruster between a pivoting tube 50, which is inside the non-pivoting tube 13, and the propeller 3 is illustrated in Figure 4B. The pivoting tube 50 is pivotable connected to the lower end bearing 29 enabling the propeller 3 to be pivoted for 360 degrees around the vertical axis 43 of the retractable thruster. A third attachment interface 51 of the retractable thruster may be between a support 27 of the lifting and lowering arrangement 4 and the non-pivoting tube 13. This third attachment interface 51 is described in more detail below, for example with reference to Figures 4C, 4D and 6.

[0067] Figure 4C is a simplified sectional view of the

embodiment of the retractable thruster of Fig. 4A in an ejected position. Figure 4C illustrates that the non-pivoting tube 13 is outside the pivoting tube 50 and therefore functions as a stem tube. The bearing 29 is configured between the non-pivoting tube 13 and the pivoting tube 50 enabling the pivoting of the propeller 3 around the vertical axis 43. The bearing 29 is represented with two rectangles filled with mesh-like hatch. The bearing 29 allows the pivoting of the pivoting tube 50 without the pivoting of the non-pivoting tube 13. A drive element (not illustrated) may be led to the lower gear 301 of the propeller 3 via the lead-through channel 42 of the pivoting tube 50. The drive element is used to drive/rotate the propeller 3 to achieve the thrust of the retractable thruster.

[0068] Figure 4D is a detail view of the retractable thruster of Figure 4A. Figure 4D discloses how the support 27 is connected to the lower end 24 of the non-pivoting tube 13 with the third attachment interface 51. The third attachment interface 51 is described in more detail below, for example with reference to Figure 6. The support 27 is described in more detail below, for example with reference to Figure 5.

[0069] An azimuth thruster is an embodiment of a marine propeller that can be pivoted to any horizontal angle (azimuth), making a rudder unnecessary. Azimuth thrusters give swimming vessels better maneuverability than a fixed propeller and rudder system.

[0070] By pivoting the propeller of the azimuth thruster for 360°, the full propulsive power may be used for manoeuvring of the swimming vessel. The retractable thruster can be adapted for different types of drives, for example a diesel or an electric drive.

[0071] Figure 4E is another detail view of the retractable thruster of Figure 4A. Figure 4E describes one suitable installation point for the inlets 40a, 40b of the hydraulic cylinders 14a, 14b. Also the location of the air venting connection 53 is illustrated in Figure 4E. As seen from Figure 4E, the inlet 40a leads the hydraulic fluid from the hydraulic fluid connection line 54 to the inside of the piston 19a of the hydraulic cylinder 14a. This feature is advantageous, because the hydraulic connection line 54, such as hydraulic hoses, pipes and/or fittings, may be connected to the moving support structure 15 so there may be no need to arrange any hydraulic hoses, pipes and/or fittings on the water side opening portion of the well. This feature may prevent corrosion of the hoses, pipes or fittings connected to the inlets 40a, 40b, because the hoses, pipes and/or fittings may be kept out of reach of the water inside the well.

[0072] Figure 5 is a sectional view IV-IV of the embodiment of the retractable thruster of Figure 1A. Figure 5 illustrates a sectional view of the retractable thruster from the top of the retractable thruster. The area A1 of the cross-section of the bottom well 5 is referenced with an indication A1 and has a diameter D1. An area A2 of the water-permeable protective element 7 including the area of the connection elements 39a, 39b is referenced with

an indication A2 and has a diameter D2. The Area A2 may cover 95% of the area A1, or even 98-99%. The suitable percentage may be determined according to the clearance 30 needed for the retracting/ejecting to work properly in such a way that the water-permeable protective element 7 does not collide against the inner surface of the bottom well 5 at any position along its movement. Some clearance 30 must be left between the inner surface of the bottom well 5 and an outer edge of the water-permeable protective element 7 in order to reliably move the water-permeable protective element 7.

[0073] The connection elements 39a, 39b may be welding brackets as illustrated in Figure 5. The welding brackets are welded to the inner surface of the bottom well 5. These welds are referenced with an indication 22 in Figure 5. The welds are not too sensitive to corrosion as they can be painted over. Another attachment solution would naturally be to use bolts to connect the connection elements 39a, 39b to suitable threads in the bottom well 5. In this case, adequate protection must be provided for this bolt type attachment in order to prevent corrosion.

[0074] The lifting and lowering arrangement 4 may comprise a support 27. The support 27 may be, for example, a plate. The purpose of the support 27 is to connect the cylinder housings 16a, 16b to each other and to an outer surface of a lower end of the non-pivoting tube 13 in order to provide extra support. As the propeller is very heavy, this feature improves stability in a lower portion of the lifting and lowering arrangement 4. With the support 27 it is also possible to connect the first perforated plate 71 and the second perforated plate 72 together to form the water-permeable protective element 7. The water-permeable protective element 7 is connected to the support 27 from the attachment interface 31. In Figure 5 the attachment interface 31 is under the support 27 and thereby only partially illustrated with dashed lines. The support 27 may be a thick triangular-like plate. Each cylinder housing 16a, 16b goes through a hole 44 in the support 27 located in proximity to two of the tips of the triangular-like shape. The support 27 is connected to the lower end of the non-pivoting tube 13 and thereby moves with the non-pivoting tube 13. When the water-permeable protective element 7 moves in the vertical direction with the propeller 3, the cylinder housings 16a, 16b function as bearing surfaces enabling the support 27 to move along the outer surface of the cylinder housings 16a, 16b.

[0075] Figure 6 is a sectional view VII-VII of the embodiment of the retractable thruster of Figure 1A. Figure 6 illustrates how the water-permeable protective element 7 is connected to the rest of the structure in the retractable thruster. The support 27 may be connected to the lower end 24 of the non-pivoting tube 13 with the third attachment interface 51. As seen also from Figure 4D, the lead-through opening 26 of the water-permeable protective element 7 may have a larger diameter than a lead-trough opening 55 of the support 27. This feature enables the support 27 to be connected to the lower end 24 of the non-pivoting tube 13 with the third attachment interface

51, for example, by bolting. The water-permeable protective element 7 is on the other hand connected to the support 27 from the attachment interface 31.

[0076] Figure 7A is a partial section view of an embodiment of a retractable thruster in an ejected position. Figure 7B is a partial section view of the embodiment of the retractable thruster of Fig. 7A in a retracted position. The retractable thruster may comprise a water-permeable protective element 7a according to

Figures 7A and 7B. The water-permeable protective element 7a comprises mesh 73a with a suitable mesh size. The mesh 73a may be made out of two parts: a lower mesh 71a and an upper mesh 72a. The meshes 71a, 72a may be designed to have a curved shape. When the meshes 71a, 72a are brought together, the shape may bring more strength for the water-permeable protective element 7a. The water-permeable protective element 7a may be connected to the lower end 24 of the non-pivoting tube 13. The operation of the retractable thruster in Figures 7A and 7B is similar to the retractable thruster in Figures 1-6 and is not explained again herein.

[0077] Figure 8 is another illustration of a water-permeable protective element 7b. The water-permeable protective element 7b comprises a combination of a perforated plate 71b, 72b and mesh 73b. Each perforated plate 71b, 72b comprises three mesh structures. The water permeable protective element 7b comprises several cut-out openings 23b that are manufactured into the perforated plates 71b, 72b. The meshes 73b are connected on top of or inside the cut-out openings, for example by welding or with screws or other suitable accessories. In this solution there may be less drilling to do, and thereby costs may be reduced in the manufacturing phase of the water-permeable protective element 7. The water permeable protective element 7b is similarly connected to the support as the water-permeable protective element 7 in Figures 1-6.

[0078] Figure 9 is another illustration of a water-permeable protective element 7c. The water-permeable protective element 7c comprises a combination of a pipe structure 10 and mesh 73c. The pipe structure 10 may be made out of several pipe parts. A frame of the water-permeable protective element 7c may be made out of bent pipes 101, 102, 103, 104, 105 which are, for example, welded together. The frame may be welded together with a lead-through part 46c with welds 45. The structure of the water-permeable protective element 7c may be strengthened with straight pipes 106, 107, 108, 109, 110, 111 which are connected between the frame and the lead-through part 46c. The straight pipes 106, 107, 108, 109, 110, 111 may be connected inside holes 47 in the frame and in the lead-through part 46c. The straight pipes 106, 107, 108, 109, 110, 111 may also be welded to the frame and to the lead-through part 46c. The non-pivoting tube is arranged through the lead-through part 46c. The water-permeable protective element 7c may be connected to the lower end of the non-pivoting tube with the support. The structure of the water-permeable protective el-

ement 7c may enable the making of the retractable thruster lighter as the pipes are hollow and most of the area of the water-permeable protective element is mesh 73c.

[0079] Figure 10 is another illustration of a water-permeable protective element 7d. The water-permeable protective element 7d comprises mesh 73d. The water-permeable protective element 7d comprises a combination of a support structure 48d and mesh 73d. The support structure 48d comprises support arms 111d, 112d, 113d, 114d, 115d, 116d, 117d, 118d and a lead through part 46d. The structure of the water-permeable protective element 7d may be strengthened with the support arms 111d, 112d, 113d, 114d, 115d, 116d, 117d, 118d. The support arms 111d, 112d, 113d, 114d, 115d, 116d, 117d, 118d are connected between an outer edge 47d of the mesh 73d and the lead-through part 46d, for example by welding. The support arms may be, for example, made out of a metal plate. They can also be standard steel parts such as metal profiles or beams. The non-pivoting tube is arranged through the lead-through part 46d. The water-permeable protective element 7d may be connected to the lower end of the non-pivoting tube with the support.

[0080] Figure 11 is another illustration of a water-permeable protective element 7e. The water-permeable protective element 7e is arranged inside a square-shaped bottom well 5e. Thus, also the water-permeable protective element 7e is designed square-shaped. Another difference between the water-permeable protective element 7e in Figure 11 and the water-permeable protective element 7 in Figure 2 is that a perforated plate 71e of the water-permeable protective element 7e is made out of a single part. Otherwise, the water-permeable protective element 7e is similar to the water-permeable protective element 7 in Figure 2.

[0081] Although in the embodiments the water-permeable protective element 7, 7a, 7b, 7c, 7d, 7e is disclosed as a substantially circular or a square-like structure, the water-permeable protective element may also be another type of a shape, for example oval, triangular, or any type of a shape which is made according to the bottom well. The water-permeable protective element can be implemented in various types of shapes, and the number, shape and amount of holes or the mesh size may vary.

[0082] The water-permeable protective element 7, 7a, 7b, 7c, 7d, 7e substantially prevents loose ice from drifting inside the bottom well 5, 5e when the propeller 3 is in the ejected position. This enables prevention or at least reduction of the possibility that the lifting and lowering arrangement 4 is jammed because of the loose ice jamming the linear movement and possibly even freezing inside the bottom well 5, 5e. Thus, it is possible to use the retractable thruster in ice conditions.

[0083] Although Figures 1A to 11 describe the retractable thruster with the water-permeable protective element 7, 7a, 7b, 7c, 7d, 7e to be used in ice conditions, the water-permeable protective element 7, 7a, 7b, 7c, 7d, 7e may be adapted to block many different types of

objects in the water. For example, with the structure of the retractable thruster disclosed above it is possible to gain protection against other solid material that may damage the structures of the retractable thruster, for example sunken logs and other waste material.

[0084] It is obvious to a person skilled in the art that with the advancement of technology, the basic idea may be implemented in various ways. The solution and its embodiments are thus not limited to the examples described above; instead they may vary within the scope of the claims.

[0085] The embodiments described herein may be used in any combination with each other. Several or at least two of the embodiments may be combined together to form a further embodiment. A method or a device may comprise at least one of the embodiments described hereinbefore.

[0086] It is to be understood that any of the above embodiments or modifications can be applied singly or in combination to the respective aspects to which they refer, unless they are explicitly stated as excluding alternatives.

Claims

1. A retractable thruster for a swimming vessel (2), the retractable thruster comprising:
 - a propeller (3);
 - a lifting and lowering arrangement (4) configured to move the propeller (3) in the vertical direction between a retracted position and an ejected position, wherein in the retracted position the propeller (3) is substantially inside a bottom well (5, 5e) of the swimming vessel (2) and in the ejected position the propeller (3) is substantially outside the bottom well (5, 5e); and
 - a water-permeable protective element (7, 7a, 7b, 7c, 7d, 7e) configured to be located inside the bottom well (5, 5e) above the propeller (3) and configured to vertically move with the propeller (3), wherein in the ejected position the water-permeable protective element (7, 7a, 7b, 7c, 7d, 7e) is configured to substantially prevent loose ice from passing through the water-permeable protective element (7, 7a, 7b, 7c, 7d, 7e) to the inside of the bottom well (5, 5e) and when the propeller (3) is moved from the retracted position to the ejected position, the water-permeable protective element (7, 7a, 7b, 7c, 7d, 7e) is configured to push ice out of the bottom well (5, 5e).
2. The retractable thruster according to claim 1, wherein in the ejected position, the water-permeable protective element (7, 7a, 7b, 7c, 7d, 7e) is in proximity to a lower end (9) of the bottom well (5, 5e).

3. The retractable thruster according to claim 1 or 2, wherein in the ejected position, the water-permeable protective element (7, 7e) substantially covers a waterside opening (8) of the bottom well (5, 5e).
4. The retractable thruster according to any of the claims 1-3, wherein the water-permeable protective element (7, 7e) comprises at least one perforated plate (71e, 71, 72).
5. The retractable thruster according to any of the claims 1-3, wherein the water-permeable protective element (7a, 7b, 7c, 7d) comprises mesh (73a, 73b, 73c, 73d).
6. The retractable thruster according to any of the claims 1-5, wherein the water-permeable protective element (7b) comprises a combination of a perforated plate (71b, 72b) and mesh (73b).
7. The retractable thruster according to any of the claims 1-3, wherein the water-permeable protective element (7c) comprises a combination of a pipe structure (10) and mesh (73c).
8. The retractable thruster according to any of the claims 1-3, wherein the water-permeable protective element (7d) comprises a combination of a support structure (48d) and mesh (73d).
9. The retractable thruster according to any of the claims 1-8, wherein the lifting and lowering arrangement (4) comprises:

a stationary support structure (11) comprising a guiding element (12) and a lead-through hole (35);
 a non-pivoting tube (13) configured through the lead-through hole (35), wherein a lower end (24) of the non-pivoting tube (13) is configured to be connected to the propeller (3) enabling to slidably connect the propeller (3) to the guiding element (12) and enabling the propeller (3) to be moved vertically; and
 an actuator arrangement (17) configured to be connected between the non-pivoting tube (13) and the bottom well (5, 5e) in such a way that when the propeller (3) is moved to the retracted position, the actuator arrangement (17) is configured to lift the propeller (3) substantially inside the bottom well (5, 5e) by sliding the non-pivoting tube (13) inside the guiding element (12) and correspondingly when the propeller (3) is moved to the ejected position, the actuator arrangement (17) is configured to lower the propeller (3) substantially outside the bottom well (5, 5e) by sliding the non-pivoting tube (13) inside the guiding element (12).

10. The retractable thruster according to any of the claims 1-9, wherein the lifting and lowering arrangement (4) comprises at least two hydraulic cylinders (14a, 14b).

11. The retractable thruster according to claim 9, wherein the actuator arrangement (17) comprises at least two hydraulic cylinders (14a, 14b).

12. The retractable thruster according to claim 10 or 11, wherein each hydraulic cylinder (14a, 14b) comprises a piston which is hollow allowing a hydraulic fluid connection line (54) connected to the at least two hydraulic cylinders (14a, 14b) to be placed to a location inside the bottom well (5, 5e), which is out of the reach of water.

13. The retractable thruster according to any of the claims 10-12, wherein the lifting and lowering arrangement (4) comprises:

a moving support structure (15) fixed to the non-pivoting tube (13), wherein a piston (19a, 19b) of each hydraulic cylinder (14a, 14b) is configured to be connected to the non-pivoting tube (13) via the moving support structure (15) and cylinder housings (16a, 16b) of the hydraulic cylinders (14a, 14b) are configured to be connected to the bottom well (5, 5e).

14. The retractable thruster according to any of the claims 1-13 comprising:

at least one stopper (18) configured to stop the movement of the propeller (3) to the ejected position.

15. The retractable thruster according to any of the claims 1-14, wherein the water-permeable protective element (7, 7a, 7b, 7c, 7d, 7e) is configured to prevent jamming of the lifting and lowering arrangement (4) caused by freezing of loose ice.

16. The retractable thruster according to any of the claims 1-15, wherein the propeller (3) is configured to be pivotable for 360 degrees around a vertical axis (43) of the retractable thruster.

17. The retractable thruster according to any of the claims 1-16, wherein the retractable thruster is an azimuth thruster.

18. A method for retracting and ejecting a propeller (3) of a retractable thruster for a swimming vessel (2), wherein the method comprises:

- connecting a water-permeable protective element (7, 7a, 7b, 7c, 7d, 7e) to the retractable

thruster above the propeller (3) inside a bottom well (5, 5e) of the swimming vessel (2);

- preventing, with the water-permeable protective element (7, 7a, 7b, 7c, 7d, 7e), loose ice from passing through the water-permeable protective element (7, 7a, 7b, 7c, 7d, 7e) to the inside of the bottom well (5, 5e) when the propeller is in an ejected position; 5
- pushing, with the water-permeable protective element (7, 7a, 7b, 7c, 7d, 7e), ice out of the bottom well (5, 5e) when the propeller (3) is moved from a retracted position to the ejected position. 10

19. A swimming vessel (2) comprising: 15

- a bottom well (5, 5e);
- a retractable thruster according to any of claims 1 - 17; and
- a power pack (20) for supplying power for moving a propeller (3) of the retractable thruster in the vertical direction. 20

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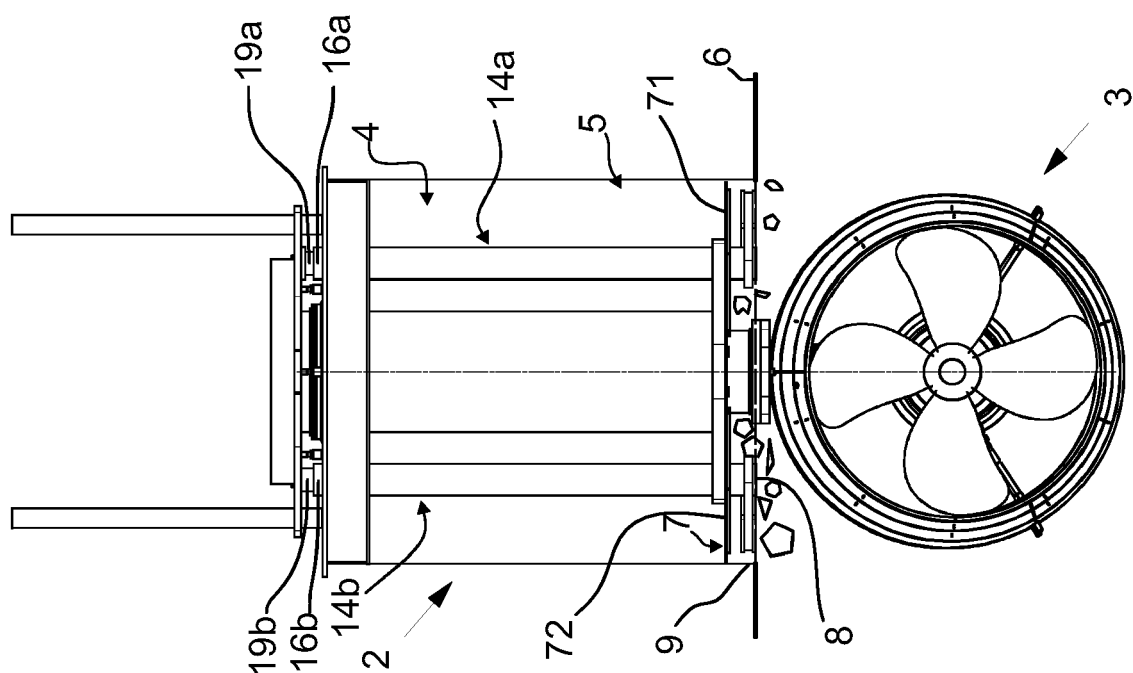
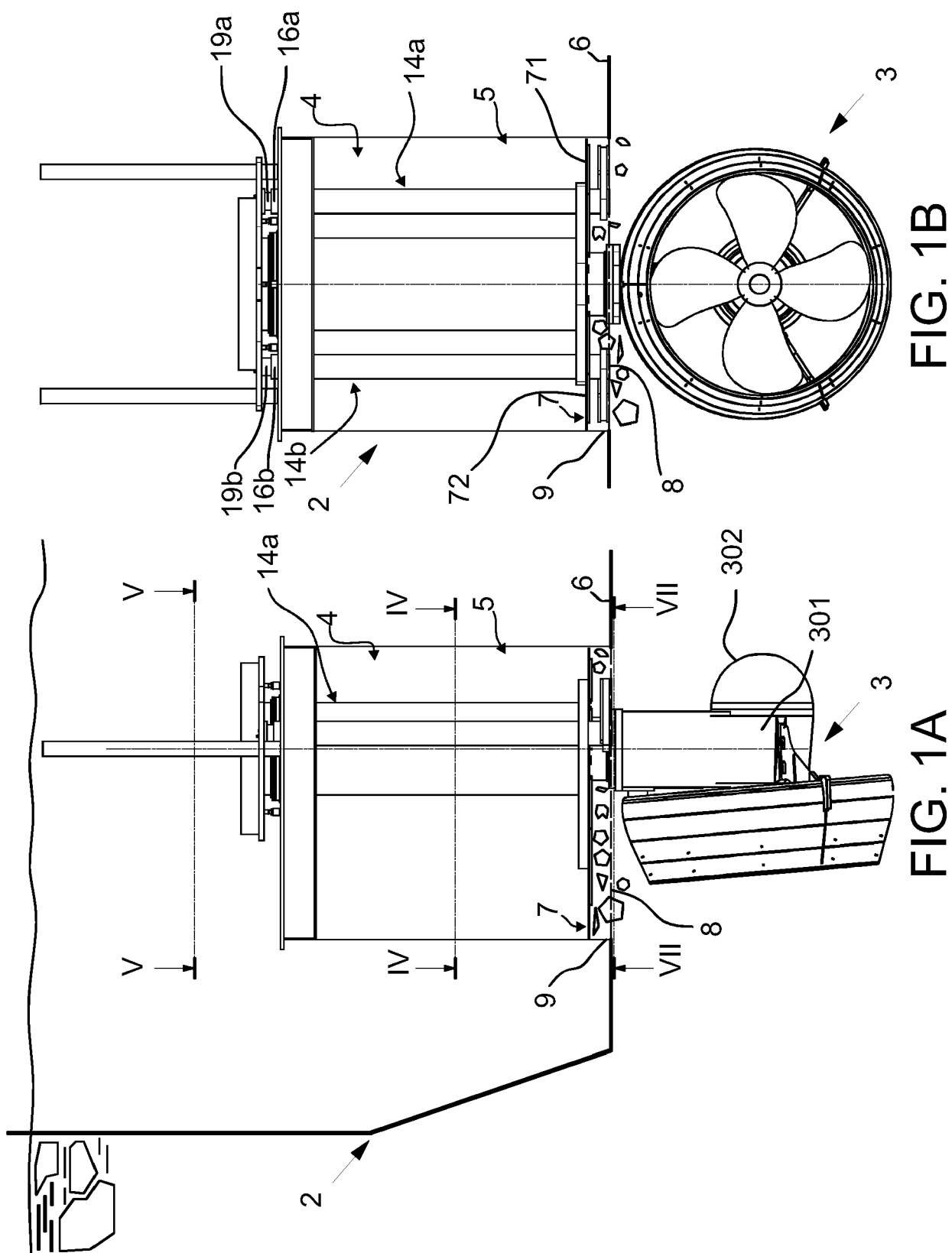
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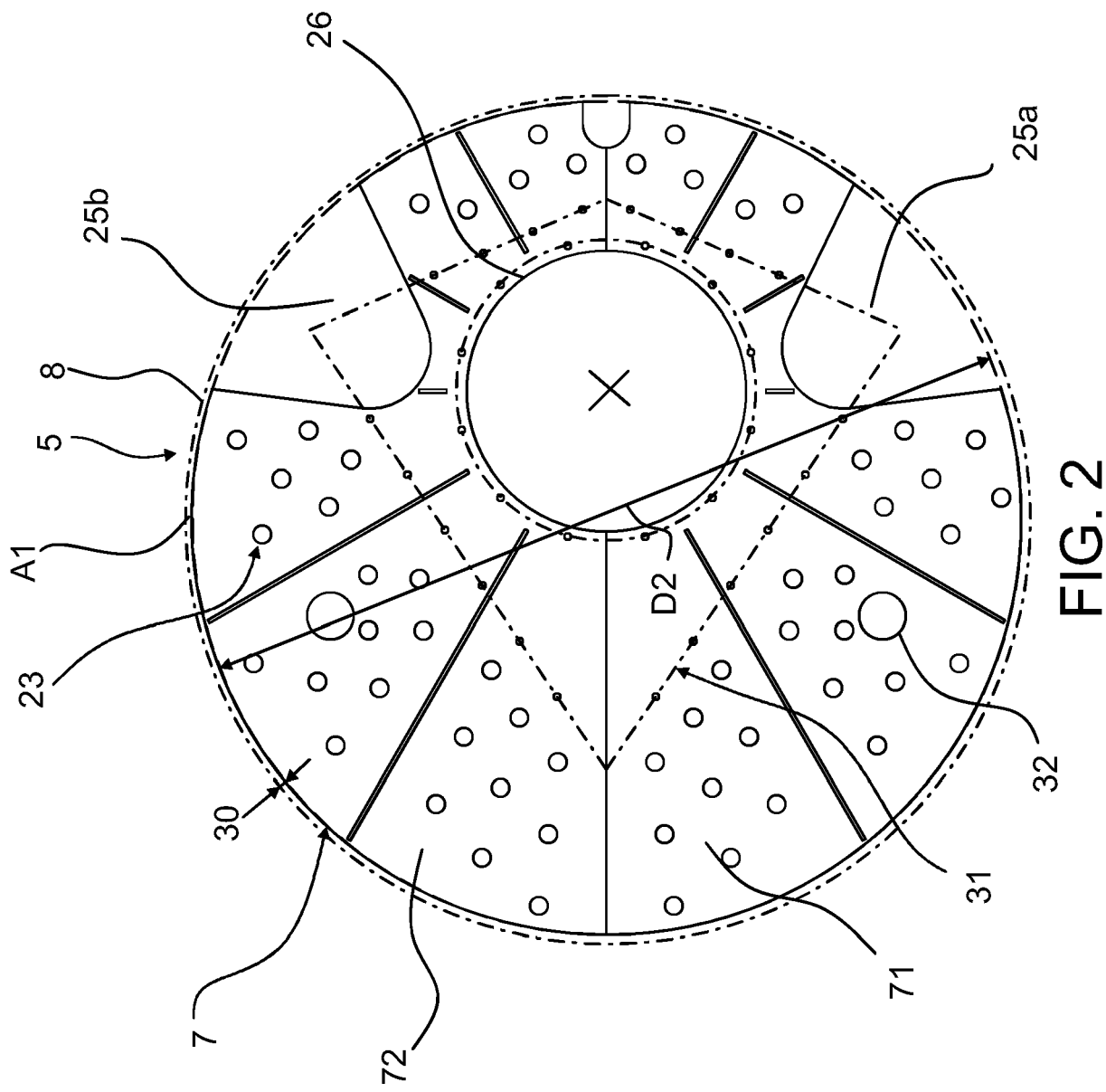
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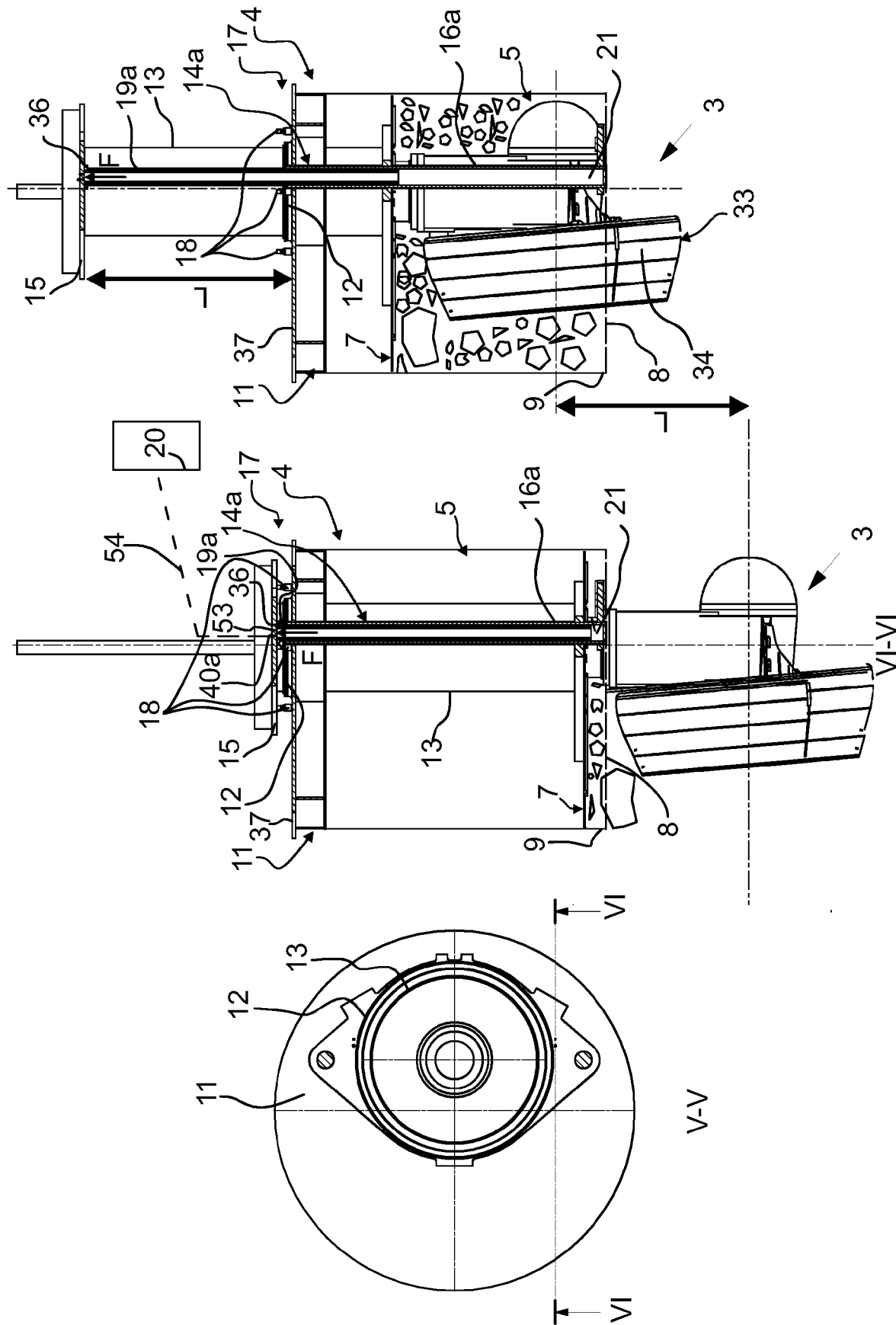


FIG. 3C

FIG. 3B

FIG. 3A

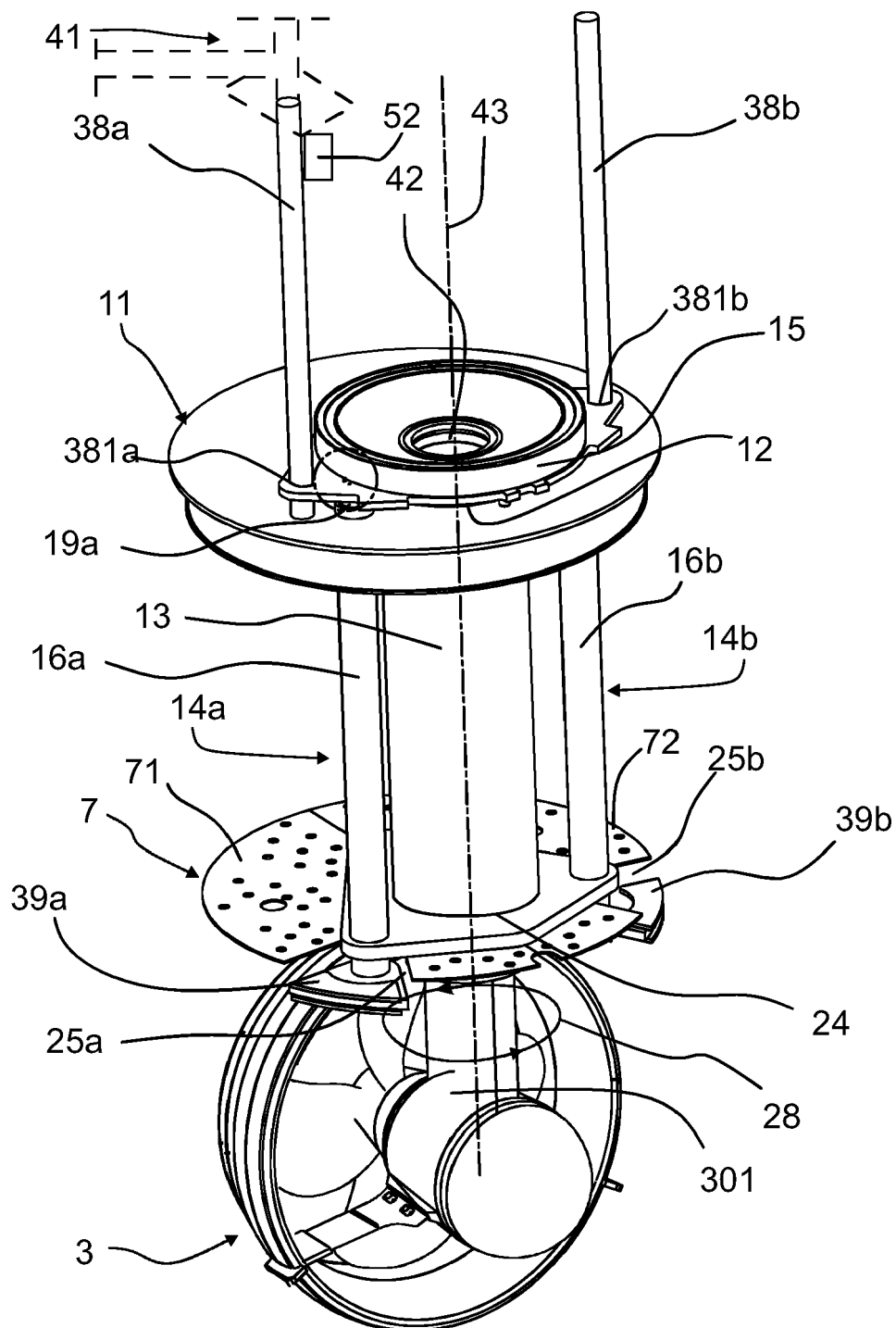


FIG. 4A

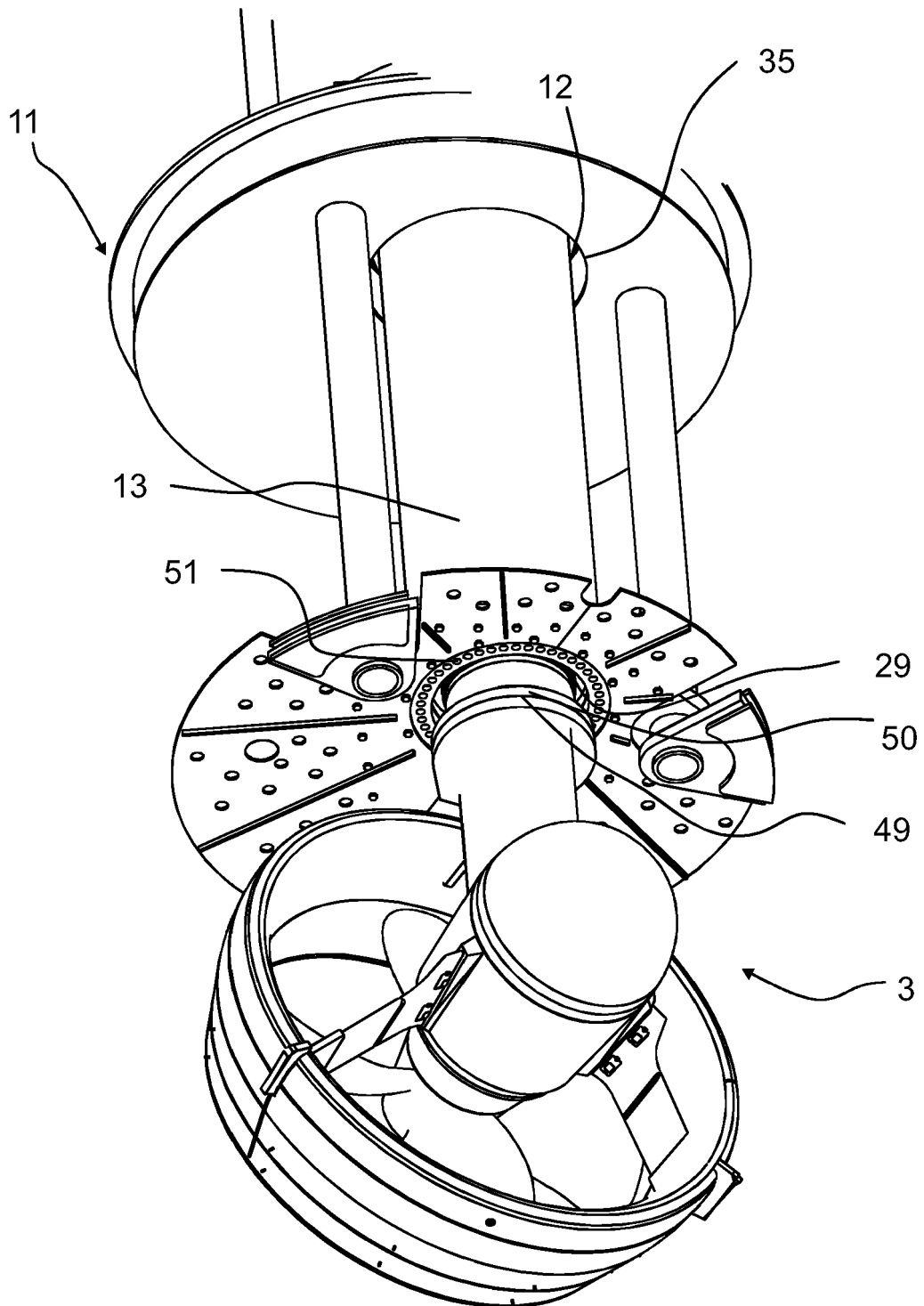


FIG. 4B

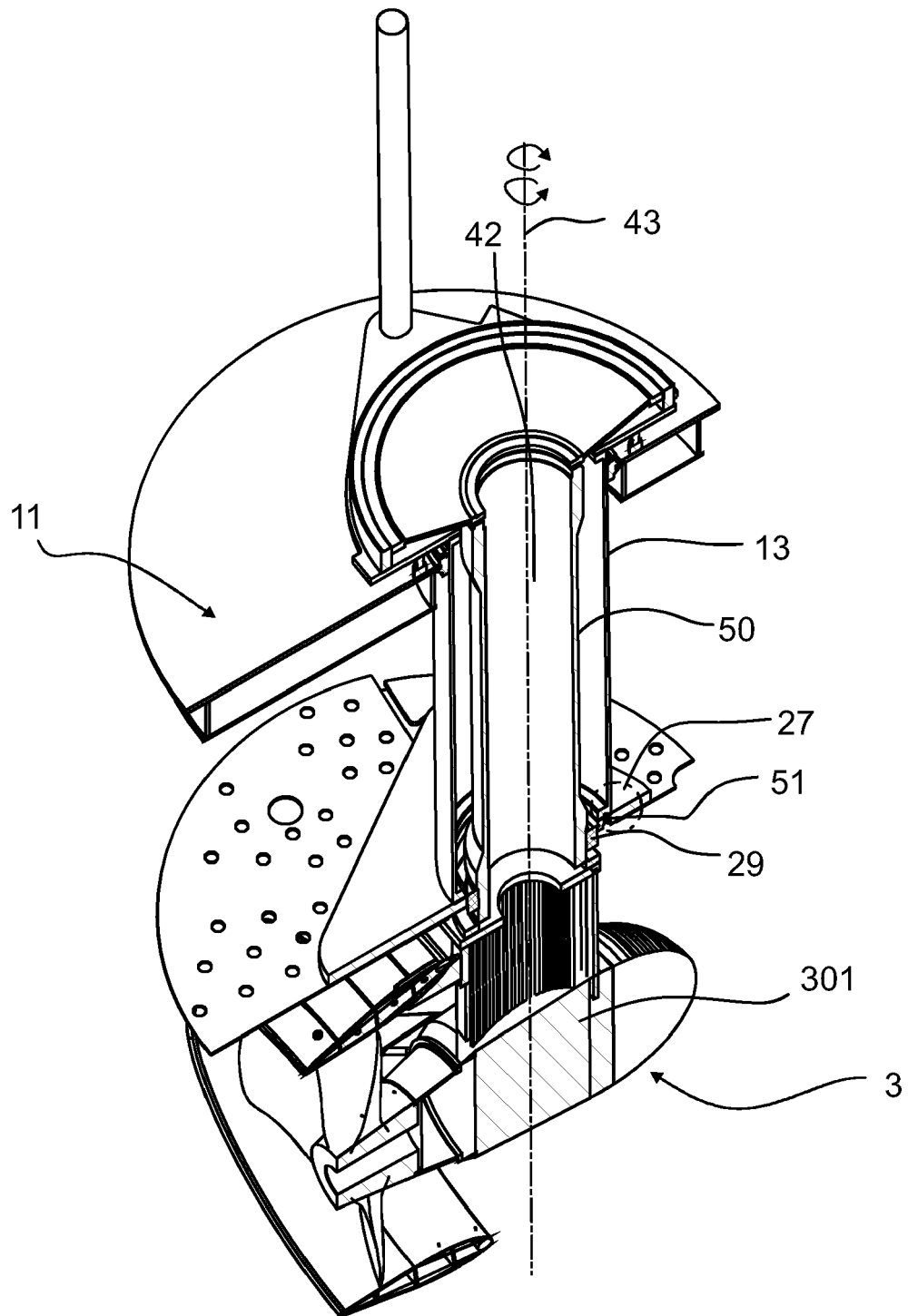


FIG. 4C

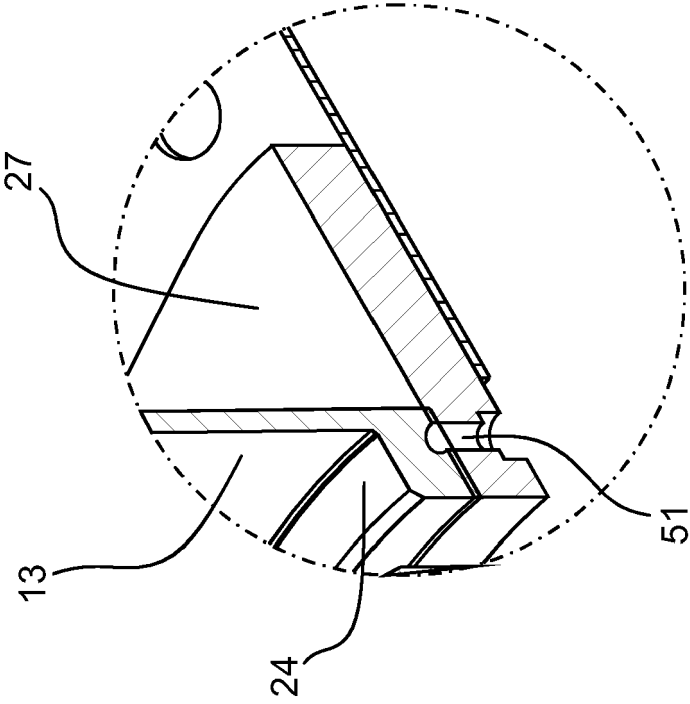


FIG. 4D

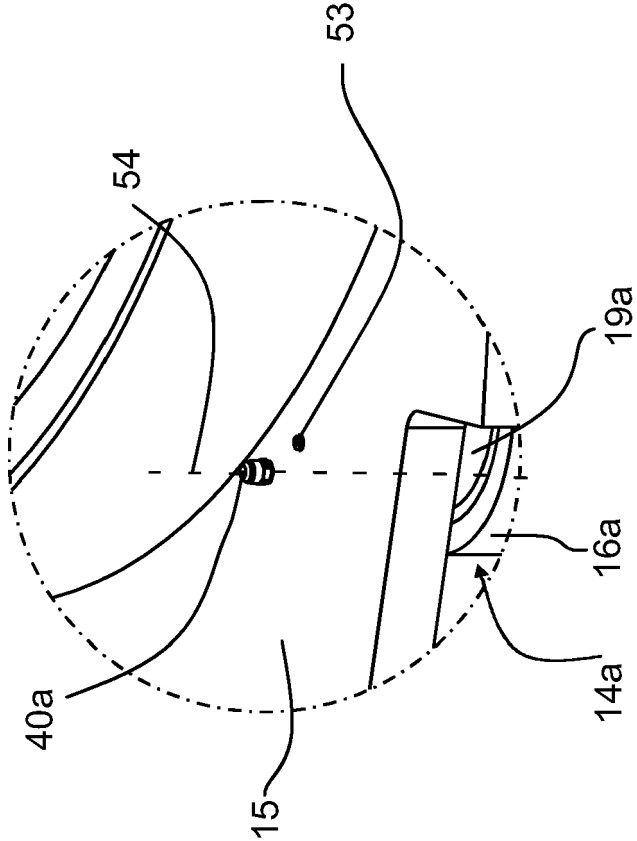


FIG. 4E

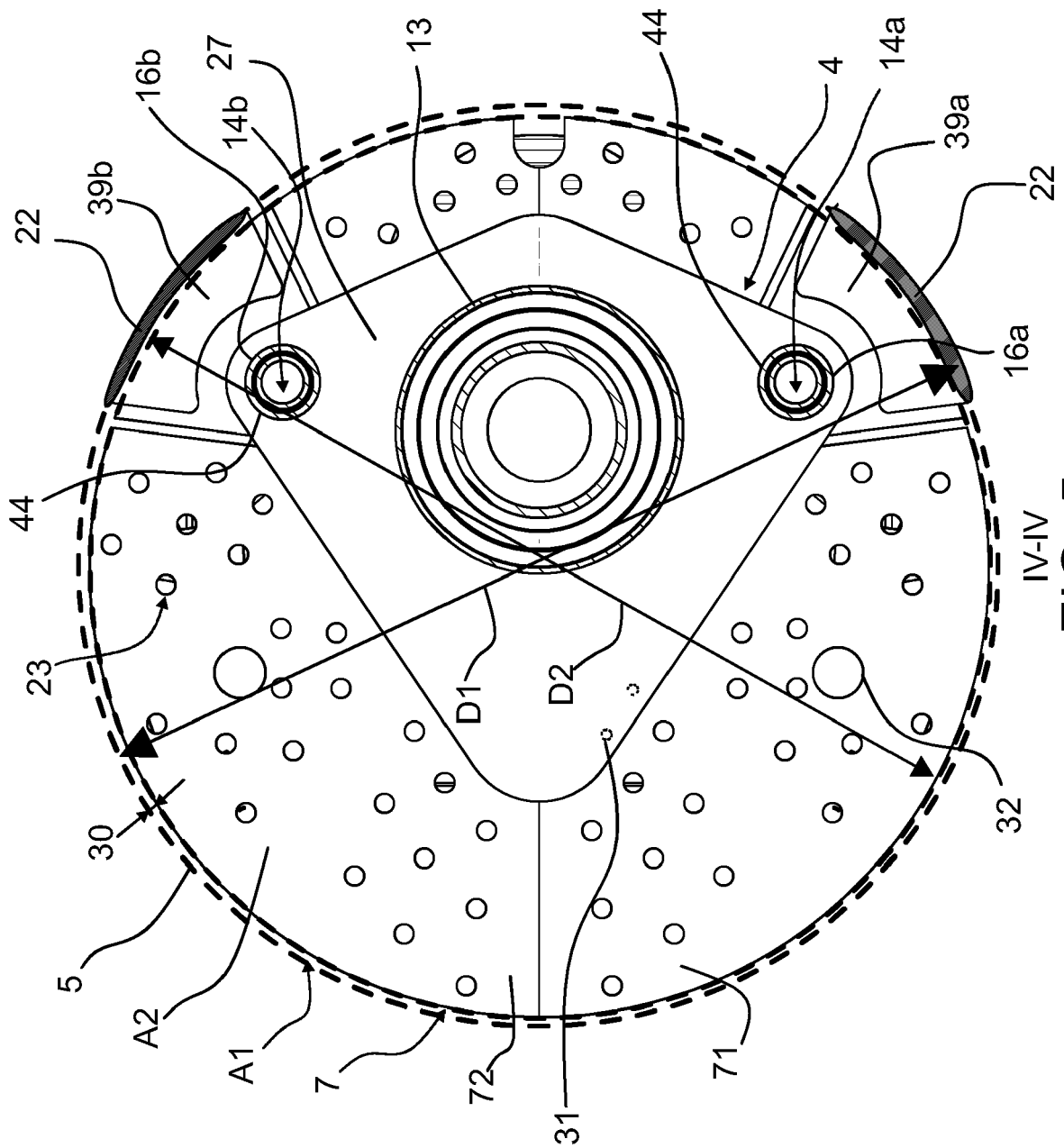
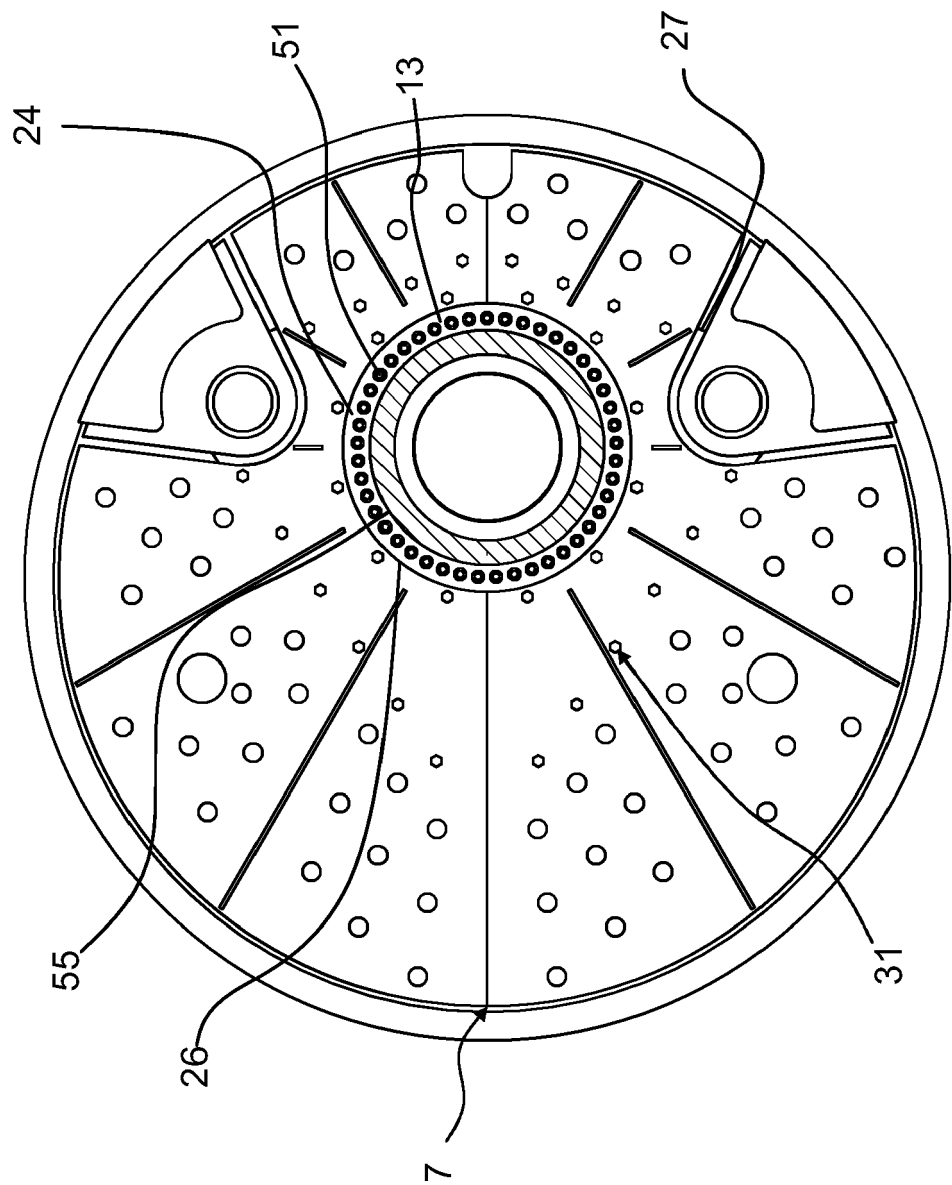


FIG. 5



VII-VII

FIG. 6

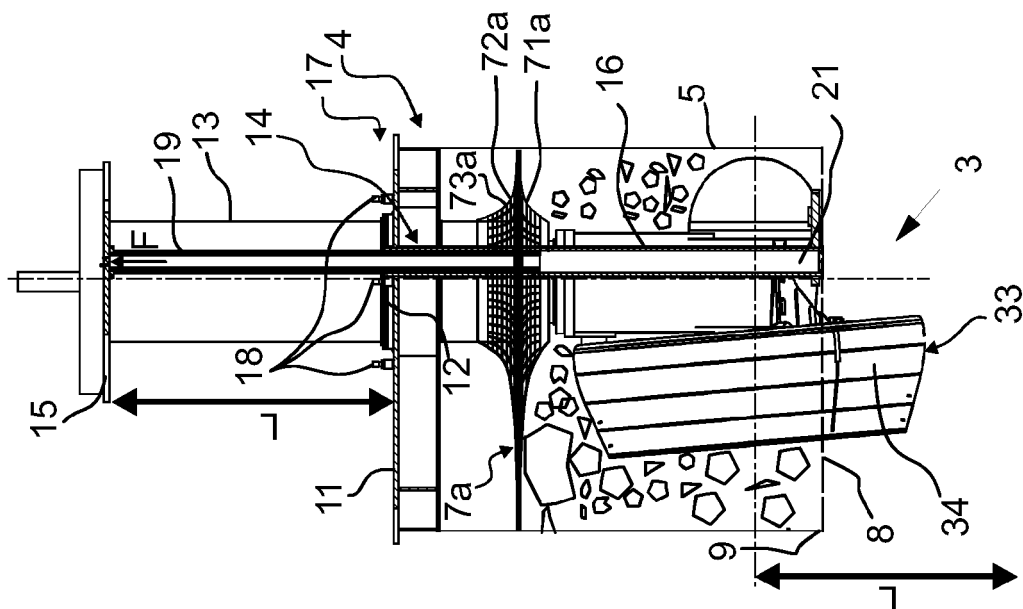


FIG. 7B

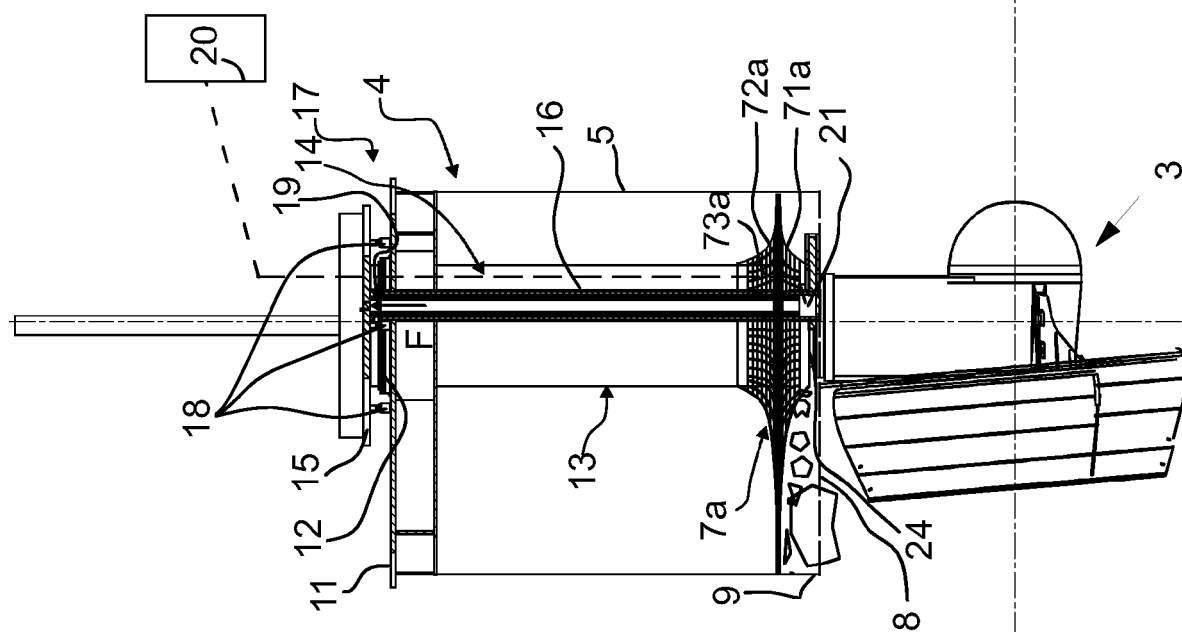
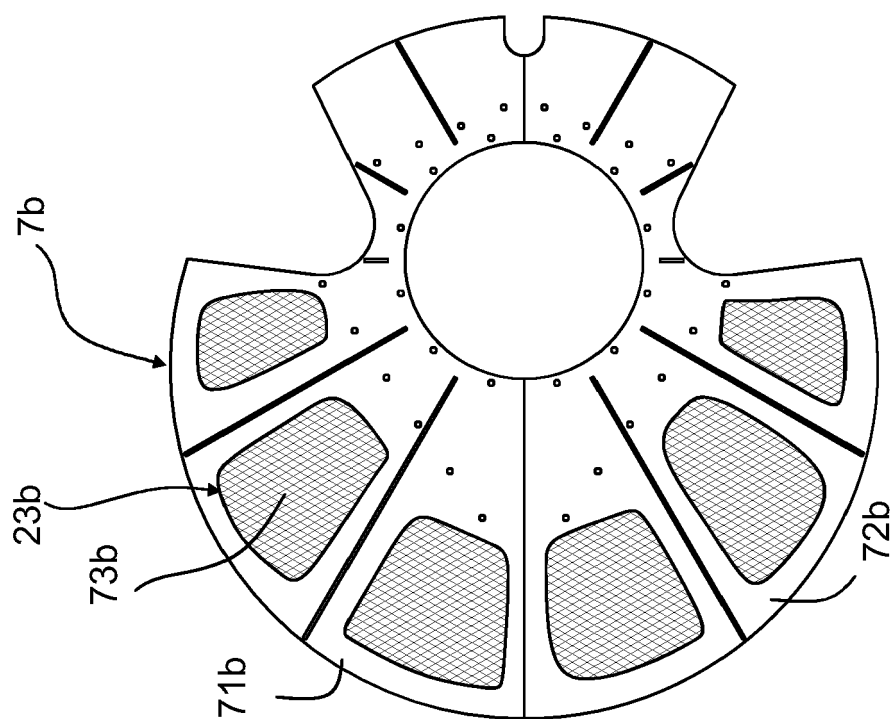
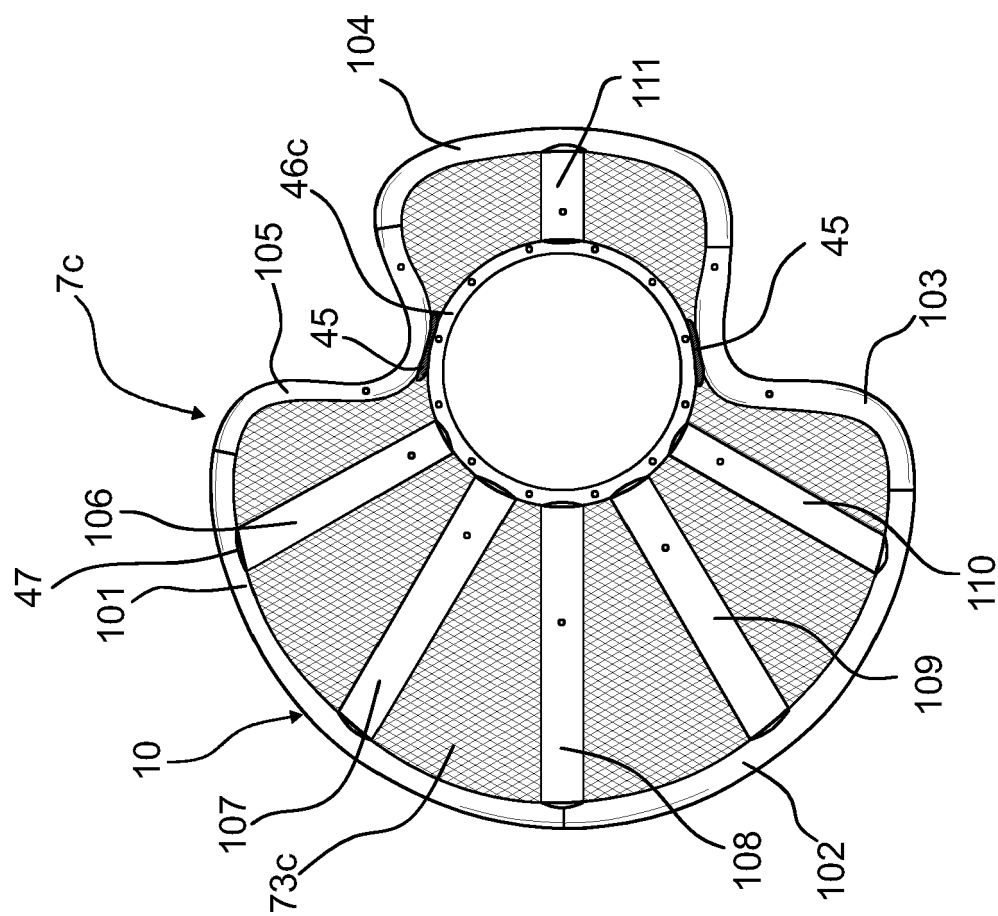


FIG. 7A



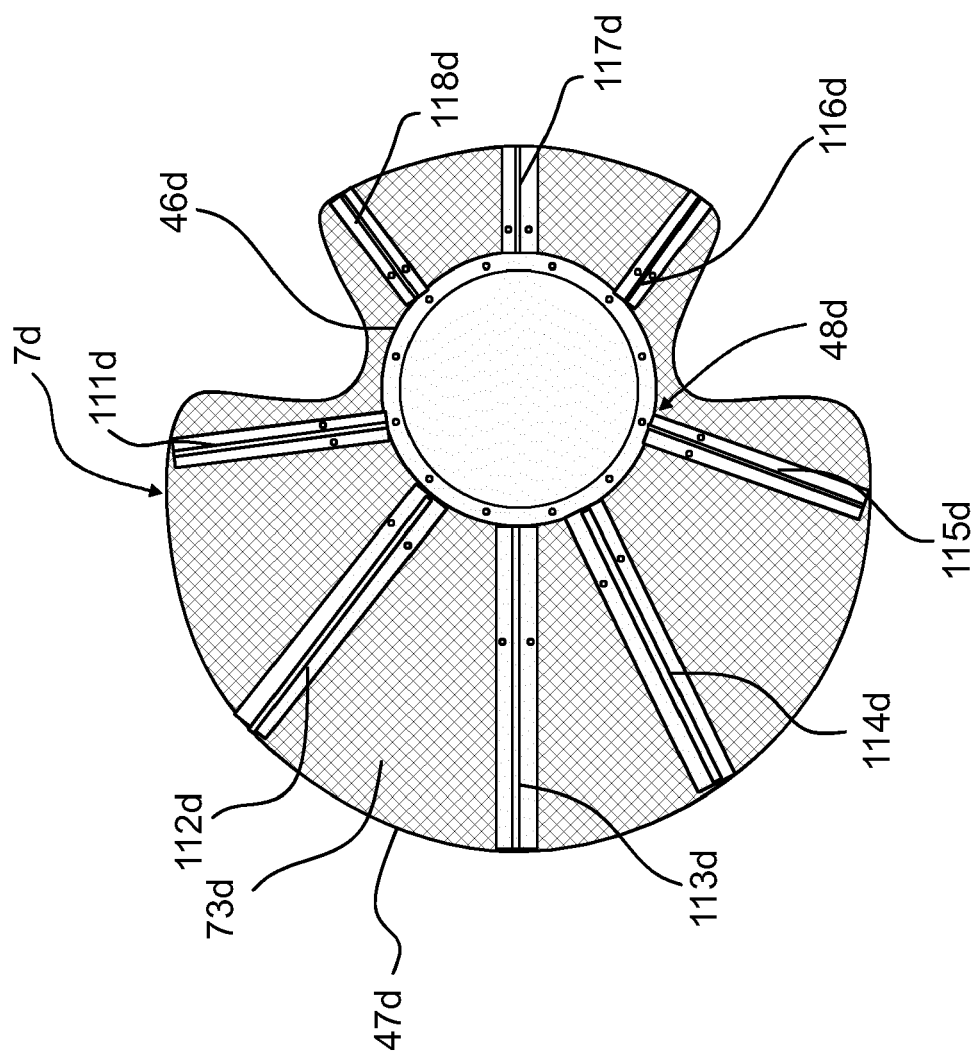


FIG. 10

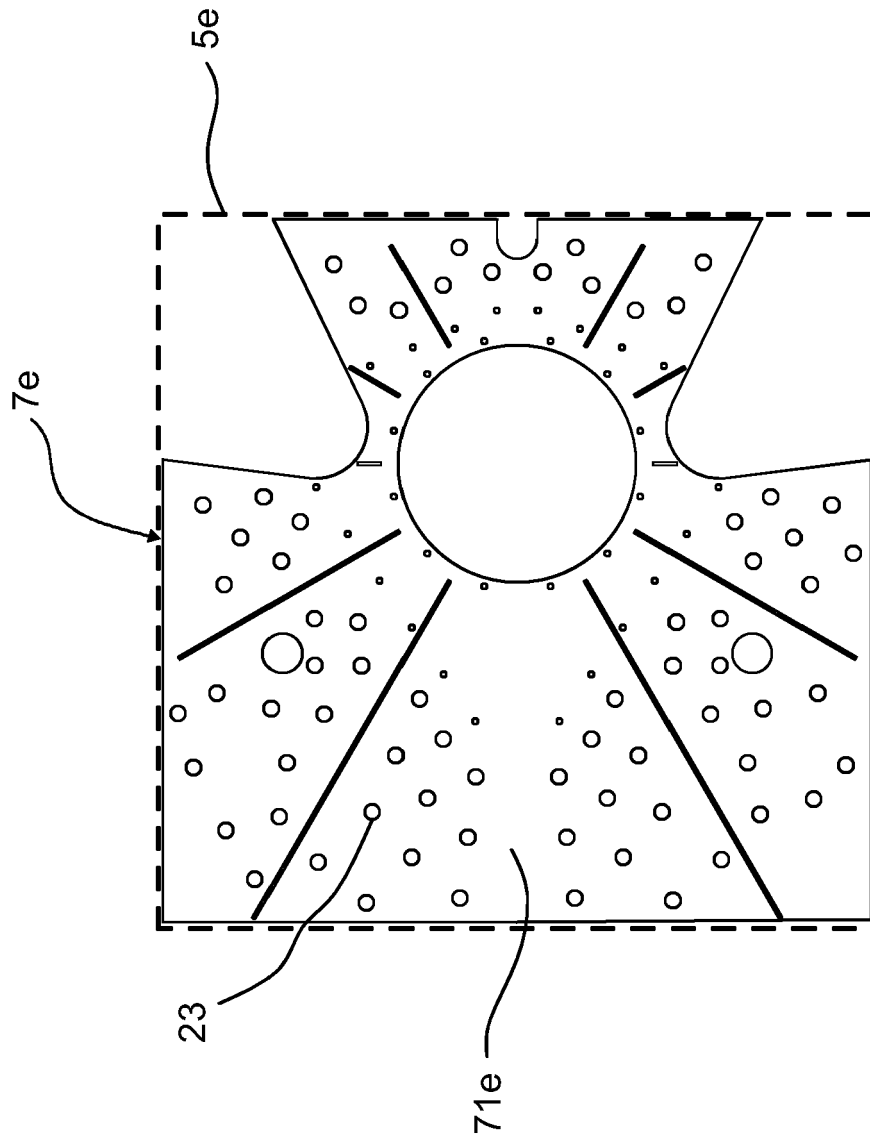


FIG. 11



EUROPEAN SEARCH REPORT

Application Number
EP 16 19 9089

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X	US 3 483 843 A (HAWTHORNE JAMES M) 16 December 1969 (1969-12-16) * column 3, line 70 - column 4, line 23 * * figures *	1-19	
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			TECHNICAL FIELDS SEARCHED (IPC)
			B63H B63B
The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 23 February 2017	Examiner Gardel, Antony
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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23-02-2017

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82