



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
18.01.2012 Bulletin 2012/03

(51) Int Cl.:
B63H 1/04 (2006.01) **B63H 11/08 (2006.01)**
B63H 21/17 (2006.01) **B63H 25/42 (2006.01)**

(21) Application number: **11173954.6**

(22) Date of filing: **14.07.2011**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

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(30) Priority: **14.07.2010 NL 2005079**

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(54) **Steering device**

(57) The invention concerns a steering device for a ship comprising a channel for guiding a water flow from an inlet opening in a bottom plane near a bow to an outlet opening wherein the channel has perpendicular to a flow direction a constant cross section area. For generating the water flow through the channel there is near the inlet opening in the channel a propeller with propeller blades and in the downstream direction immediately after the

propeller blades, the channel makes a bend over an angle of approximately 90 degrees.

In accordance with the invention, the propeller blades are mounted in a ring shaped rotor with a rotation axis in line with the flow direction, the outer circumference of the ring shaped rotor is provided with magnets and a stator surrounds the magnets and generates a rotating magnetic field.

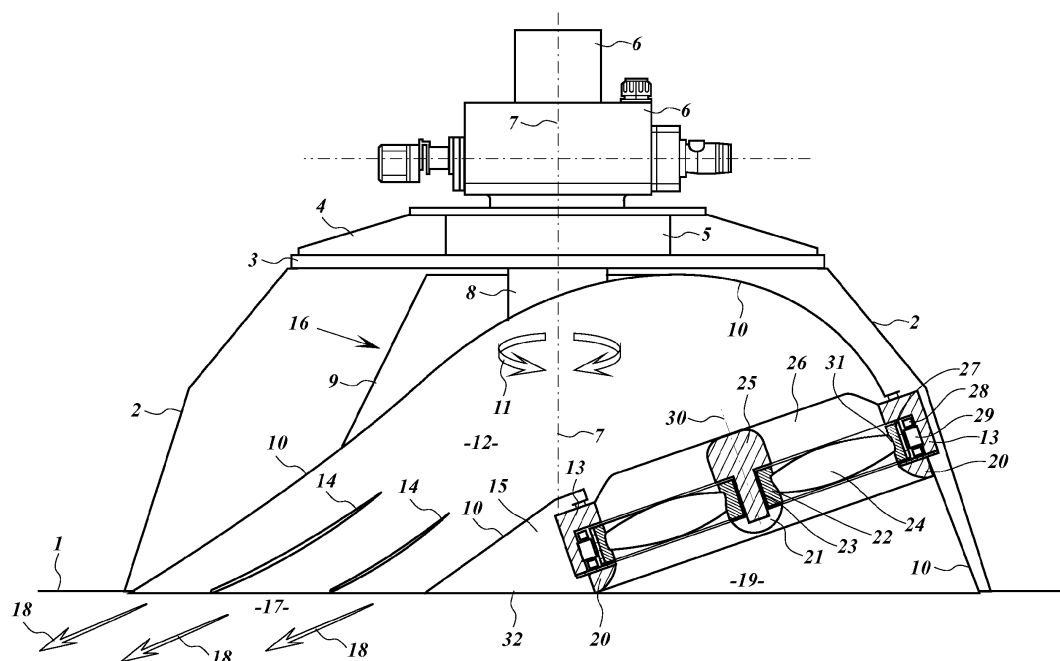


Fig. 1

Description

[0001] The invention concerns a device in accordance with the preamble of claim 1. Such a device is known from document NL1020119. The known device provides a water flow that exerts a more or less horizontal force on the bow for steering the ship. The disadvantage of the known device is that the drive of the propeller blades comprises a shaft supported by bearings and this shaft and the bearings disturb the water flow generated by the propeller blades. The disadvantage of this disturbance is even more as the disturbance is in the 90 degrees bend of the channel immediately behind the propeller so that there is no stable flow in the channel and there are many flow losses. A further disadvantage is that the drive of the propeller blades requires complicated and expensive gearboxes with an angular drive for a square or a sharp angle.

[0002] In order to avoid the disadvantages, the device is in accordance with the characterising part of claim 1. As the channel now is free from obstacles such as drive shafts, bearings, and the like up to after the 90 degrees bend in the channel there can be a balanced flow with limited flow losses and the height of the channel in the bow of the ship can be lower. In addition, the drive of the propeller blades does not require gearboxes. The use of permanent magnets makes the design of the rotor easier as there is no need for feeding electricity to the rotor to feed the electromagnets.

[0003] Document US 5476401 discloses a water jet propulsion system. The system disclosed in this document has an inlet opening in the bottom plane of a ship and an outlet opening at the rear. In the channel, there is a pump with an impeller and the water flows in axial direction from the inlet opening to the center of the impeller. The impeller accelerates the water to a high speed in radial direction and the volute shaped flow chamber 49 downstream of the impeller transforms this high speed of the water to a water flow of pressurized water to create a jet stream through the outlet opening. In this design, the channel has no constant cross section area so that the water speed through the channel is not constant and there is a lot of turbulence in the flow; this leads to flow losses. The device according to the invention is completely different.

[0004] In accordance with an embodiment, the steering device is according to claim 2. In this way, the ring shaped rotor is accurately centred in the stator and the permanent magnets may remain free of the stator during assembly of the ring shaped rotor in the stator.

[0005] In accordance with an embodiment, the steering device is according to claim 3. In this way, the drive creates a higher thrust as the flow losses are reduced as the second set of propeller blades reduces and/or cancels out the rotation of the first set of propeller blades.

[0006] In accordance with an embodiment, the steering device is according to claim 4. In this way, each counter rotating rotor has a rotating speed that is suitable for

the speed and direction of the water flow through the rotating rotor.

[0007] Hereafter several embodiments explain the invention with the aid of a drawing. In the drawing

Figure 1 shows a schematic section of a first embodiment of the steering device,

Figure 2 shows a schematic section of a second embodiment of the steering device, and

Figure 3 shows a schematic section of a third embodiment of the steering device.

[0008] In the different figures, the same reference numbers indicate similar parts.

[0009] Figure 1 schematically shows a steering device mounted in the bow of a ship. This steering device sucks water in from a ship's bottom plane 1 at an underside of the bow and thrusts water out in a set direction along the underside of the bow. For this a closed housing 2 is mounted in the ship's bottom plane 1 and a channel 16 can rotate around a channel rotation axis 7 in the closed housing 2. A shaft 8 mounted in a bearing house 5 supports the channel 16; the bearing house 5 is mounted on a cover 3 with supports 4. The cover 3 closes the top of the housing 2. A drive 6 can position the shaft 8 in a channel rotation direction 11 and this sets the direction of a water flow 18. The water flow 18 exerts a force on the bow and this force can steer the ship or it generates additional propulsion or braking force on the ship.

[0010] A channel wall 10 is connected to the shaft 8 and supports 9 reinforce the channel wall 10. The channel wall 10 forms a channel 12 that extends from an inlet opening 19 to an outlet opening 17 and the surface area of the cross section perpendicular on the direction of the channel 12 is approximately constant. Near the rotation axis 7 at the underside of the channel wall 10 is a central support 15, the central support 15 has a bottom plane 32 that extends over the complete underside of the housing 2 except that it is open at the inlet opening 19 and the outlet opening 17. The supports 9 also strengthen the bottom plane 32. The inlet opening 19 can have a grid (not shown) for stopping large parts entering the channel 12. In the channel 12 near the outlet opening 17 are guide plates 14 for directing a water flow 18 in approximately horizontal direction so that the out-flowing water exerts a sideways force on the bow.

[0011] A circular shaped frame 13 is mounted perpendicular to the direction of channel 12 in the channel wall 10 near the inlet opening 19. This means that the frame 13 makes an angle with the ship's bottom plane 1 and the lowest part of the frame 13 is approximately in the ship's bottom plane 1 near the central support 15. Supports 26 connect a bearing support 25 to the frame 13. A bearing 23 supports a hub 22 on the bearing support 25. A ring shaped rotor 27 is mounted around the central hub 22 and between the ring shaped rotor 27 and the hub 22 are propeller blades 24. The propeller blades 24 rotate with the hub 22 and the ring shaped rotor 27 around

the bearing 23 with a propeller axis 30 on the bearing support 25. The rotating propeller blades 24 generate the water flow 18 through the channel 12 from the inlet opening 19 to the outlet opening 17. A hubcap 21 and an entrance guide 21 guide the water flow to the propeller blades 24. At the side past the propeller blades 24, the bearing support 25 can have a shape that reduces the flow resistance.

[0012] On the outer circumference of the ring shaped rotor 27 are permanent magnets 31, these permanent magnets 31 rotate accurately with a narrow gap in the stator 29. The stator 29 has stator coils 28 that generate in the stator 29 a rotating magnetic field that causes the ring shaped rotor 27 to rotate around the propeller axis 30. The combination of the rotating magnetic field and the rotor with magnets 31 form a so called direct drive motor that drives the propeller blades 24, this means a drive without gear boxes or other transmissions between the direct drive motor and the propeller blades 24. Between the frame 13 and the ring shaped rotor 27 are labyrinth seals (not shown) that prevent dirt to reach the stator 29. In a further embodiment, a core surrounded by coils fed by direct current (DC) can replace the permanent magnets 31.

[0013] The bearing 23 and the bearing support 25 are designed such, that during mounting the ring shaped rotor 27 in the stator 29, the bearing 23 guides the ring shaped rotor 27. This prevents that the permanent magnets 31 get stuck to the stator 29 and hinder further mounting of the ring shaped rotor 27 in the center of the stator 29.

[0014] The channel 12 with the channel wall 10 starts at the inlet opening 19 as a tube shaped channel with a circular cross section perpendicular to the direction of the channel 12. At a distance that is less than the diameter of the propeller blades 24 after and/or above the propeller blades 24 the channel wall 10 forms a bend that changes the direction of the channel 12 over approximately ninety degrees and the channel 12 then continues in an approximately straight line to the outlet opening 17. In the direction of the flow, the cross section of the channel 12 can change to elliptical and near the outlet opening 17 possibly to rectangular. In the channel 12 the cross section area perpendicular to the direction of the water flow 18 remains more or less constant so that the average speed of the water when passing through the channel 12 is more or less constant. As the drive of the propeller blades 24 is more or less in the plane and aside of the propeller blades, the drive is no obstacle for the strongly curved water flow 18 and after the water flow 18 has passed the propeller blades 24 it can bear back to the ships bottom plane 1. In this way, there is less energy loss and the same drive power generates an increased thrust force.

[0015] Figure 2 schematically shows a second embodiment of the steering device with a ring shaped rotor 27 with propeller blades 24 rotatably mounted in a frame 13 and driven by a direct drive for rotation around a propeller axis 30 in a similar way as described in figure 1. The ring

shaped rotor 27 has permanent magnets 31 on its outer circumference; the rotating magnet field of the stator 29 exerts a torque on the ring shaped rotor 27. In this embodiment, propeller blades 24 rotate around the propeller axis 30 that is approximately perpendicular to the ships bottom plane 1. The frame 13 is mounted on the ships bottom plane 1 and the inlet opening 19 is in the ships bottom plane 1. The inlet opening 19 might have a grid (not shown). A cylindrical house 43 is mounted on the frame 13 and a cover 3 closes the top of the cylindrical house 43.

[0016] In the sidewall of the cylindrical house 43 are four openings to which a first channel 34, a second channel 38, a third channel 40 and a fourth channel (not shown) with channel walls 33 are connected. The channel walls 33 of the first channel 34 and the third channel 38 connect to an opening in the sidewall of the ship and water flowing out off the opening in the sidewall exerts a sideways force on the bow of the ship. The channel walls of the second channel 38 and the fourth channel each connect to an opening in the ships bottom plane 1 and the water flowing out off these openings exerts a force on the ship either in forward direction or to the rear. Separation ridges 35, 39 are between the openings in the sidewall of the cylindrical house 43.

[0017] The bearing house 5, in which the shaft 8 can rotate around the rotation axis 7, is on top of the cover 3. A rotating drum 36 with a channel wall 41 rotates with the shaft 8 and the channel wall 41 forms a channel 37 between the propeller blades 24 and the outlet opening 17 that connects to the openings in the cylindrical house 43. The surface area of the cross section perpendicular on the direction of the channel 37 and the first channel 34, the second channel 38, the third channel 40 and the fourth channel to which it connects is approximately constant. In the channel 37 can be a guide plate 42. The water flowing from the propeller blades 24 flows in vertical direction upwards and bends in a bend of the channel 37 over approximately 90 degrees to the horizontal direction, thereby a highest part of the channel 37 has a distance to the propeller blades 24 that is smaller than the diameter of the propeller blades 24. Because of the direct drive of the ring shaped rotor 27, there is no obstruction in the water flow immediately above the propeller blades 24. By rotating the rotating drum 36 around the vertical rotation axis 7 the outlet opening 17 of the rotating drum 36 is brought in front of one or possibly two of the openings in the sidewall of the cylindrical house 43 and the water flow 18 that is generated by the propeller blades 24 exerts a force on the bow in the desired direction.

[0018] Figure 3 shows schematically a third embodiment of the steering device that exerts a force on the bow of the ship. In this embodiment, propeller blades 24 are similarly mounted in the housing 13 as described in figure 1 powered by the direct drive for rotation around the propeller axis 30. Permanent magnets 31 are mounted on the outer circumference of the ring shaped rotor 27 and the rotating magnetic field of stator 29 exerts a torque on

the permanent magnets 31. The housing is mounted immediately on the ships bottom plane 1 and the inlet opening 19 is in the ships bottom plane 1. Possibly a grid (not shown) is mounted in the inlet opening 19. A housing 44 is mounted on the frame 13 and the housing 44 forms a U-shaped channel 47 to the outlet opening 17 that is also in the ships bottom plane 1. The surface area of the cross section perpendicular on the direction of the U-shaped channel 47 is approximately constant.

[0019] In the embodiment of figure 3, the outlet opening 17 has a circular shape and in the outlet opening 17 is a ring 48 with guide plates 50. Coupling plates 49 couple the ring 48 with the guide plates 50 to a shaft 53 that can rotate in a bearing housing 46 around the rotation axis 7 in rotation directions 11. The bearing housing 46 is mounted on the cover 3 that is located above the outlet opening 17 and the drive 6 rotates the shaft 53 with the guide plates 50 so that the water flow 18 can be directed to any desired direction so that the direction of the force on the bow is fully adjustable. The ring 48 rotates with a small clearance 52 in the housing 44 where it commands support.

[0020] Directly above the propeller blades 24 the channel 47 bends over approximately 90 degrees to a horizontal direction and the water propelled by the propeller blades 24 flows over the center piece 51 and guided by the guide plates 45 to the outlet opening 17. Thereby the water flow bends again approximately 90 degrees. As the house 44 can support the ring 48, the bearing house 46 and the shaft 53 can be relatively small and hardly obstructs the water flow.

[0021] In addition to the earlier discussed embodiments with a single ring shaped rotor 27 there can be an embodiment with two counter rotating rotors with propeller blades 24 that are located right after each other. Such an embodiment reduces flow losses as the water flow through the channel 12, 37, 47 hardly rotates anymore around an axis in the flow direction. By the use of the direct driven rotor 27, the building height remains low so that the space that the steering device requires in the bow of the ship hardly increases.

[0022] Each of the counter rotating rotors 27 has a separate direct drive motor that can rotate the rotor 27 at a different rotation speed by changing the rotation speed of the rotating magnetic field in the stator 29. This makes it possible that the rotating rotor 27A nearest to the inlet opening 19 has a higher speed than the rotating rotor 27B immediately after it. This leads to better efficiency of the second rotor 27B as the incoming flow of the second rotor 27B differs from the incoming flow of the first rotor 27A. The ratio of the rotation speeds of the first rotor 27A and the second rotor 27B depends on the rotation speed of the first rotor 27A.

37;47) for guiding a water flow (18) from an inlet opening (19) in a bottom plane near a bow to an outlet opening (17) wherein the channel has perpendicular to a flow direction a constant cross section area, for generating the water flow through the channel there is near the inlet opening in the channel a propeller with propeller blades (24) and in the downstream direction immediately after the propeller blades the channel makes a bend over an angle of approximately 90 degrees **characterized in that** the propeller blades are mounted in a ring shaped rotor (27) with a rotation axis in line with the flow direction, the outer circumference of the ring shaped rotor is provided with magnets (31) and a stator (29) surrounds the magnets and generates a rotating magnetic field and the magnets may be permanent magnets .

2. Steering device according to claim 1 wherein the ring shaped rotor (27) has a hub (22) with a bearing (23) that is mounted on a central hub support (25) and the bearing guides the ring shaped rotor during centrally assembling the ring shaped rotor in the stator.
3. Steering device according to claim 1 or 2 wherein there are two ring shaped rotors (27A, 27B) that are counter rotating and driven by separate rotating magnetic fields.
4. Steering device according to claim 3 wherein the rotation speed of the counter rotating rotors (27A, 27B) can be set independently and preferably, their ratio varies for different rotation speeds.

Claims

1. Steering device for a ship comprising a channel (12;

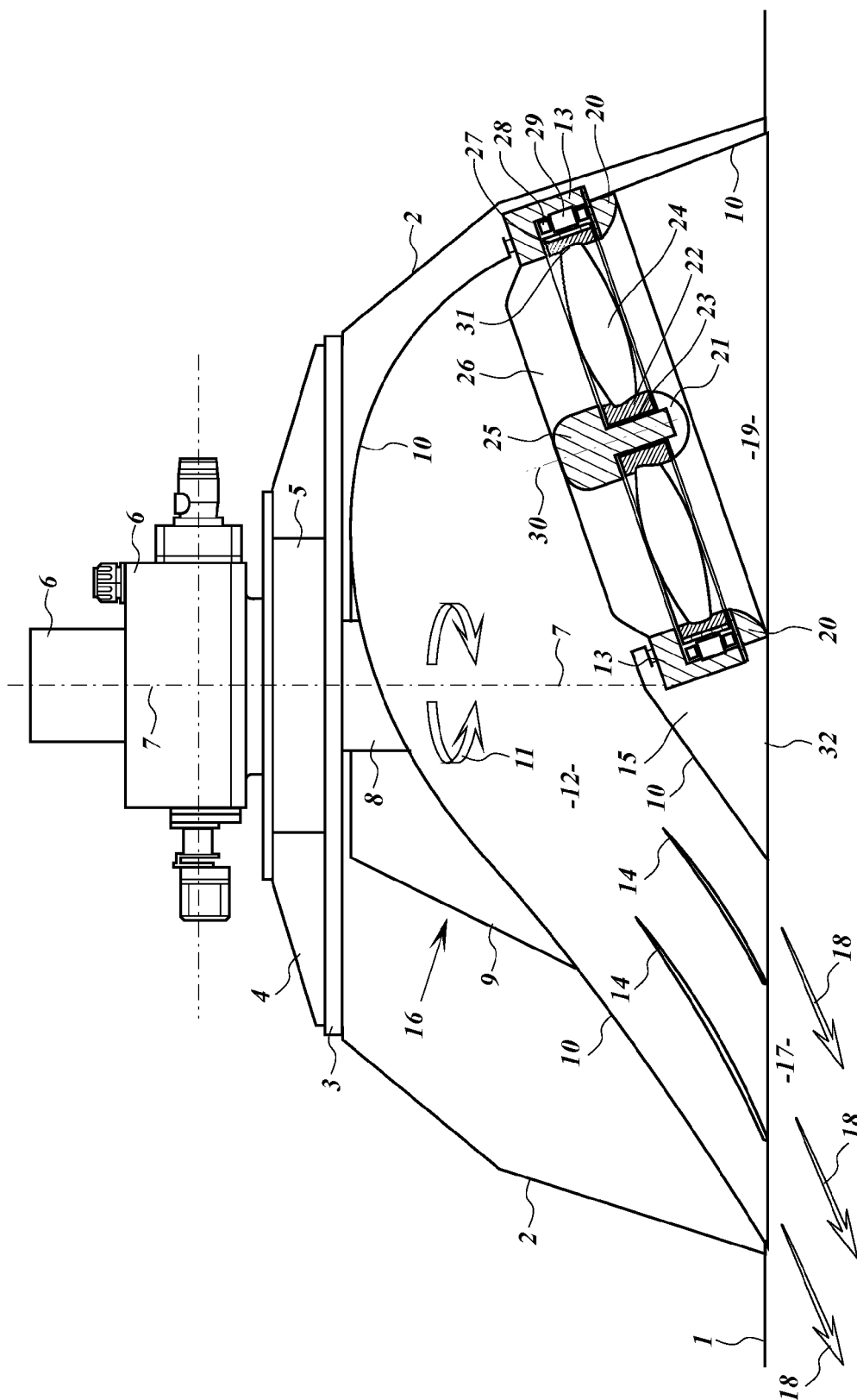


Fig. 1

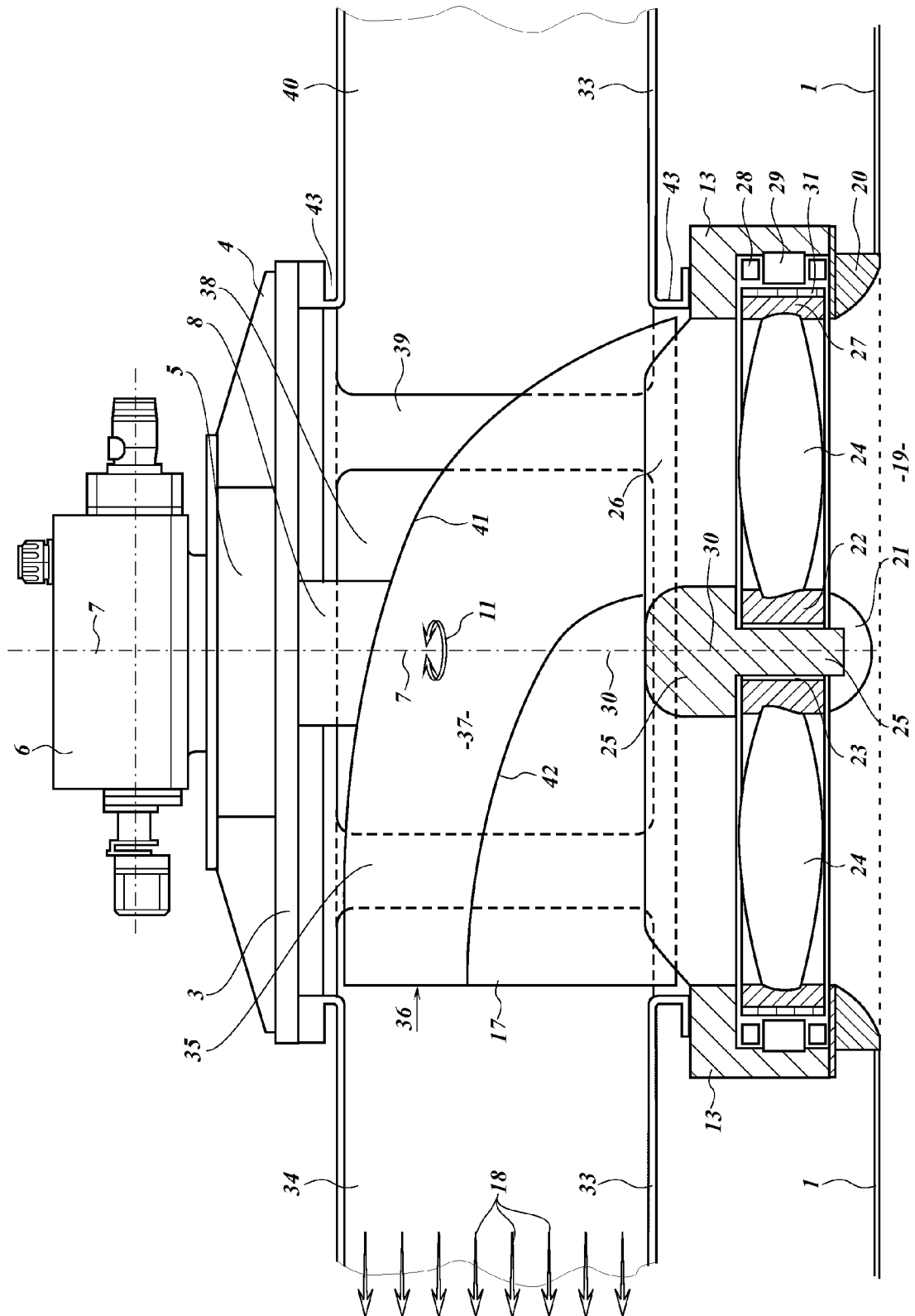


Fig. 2

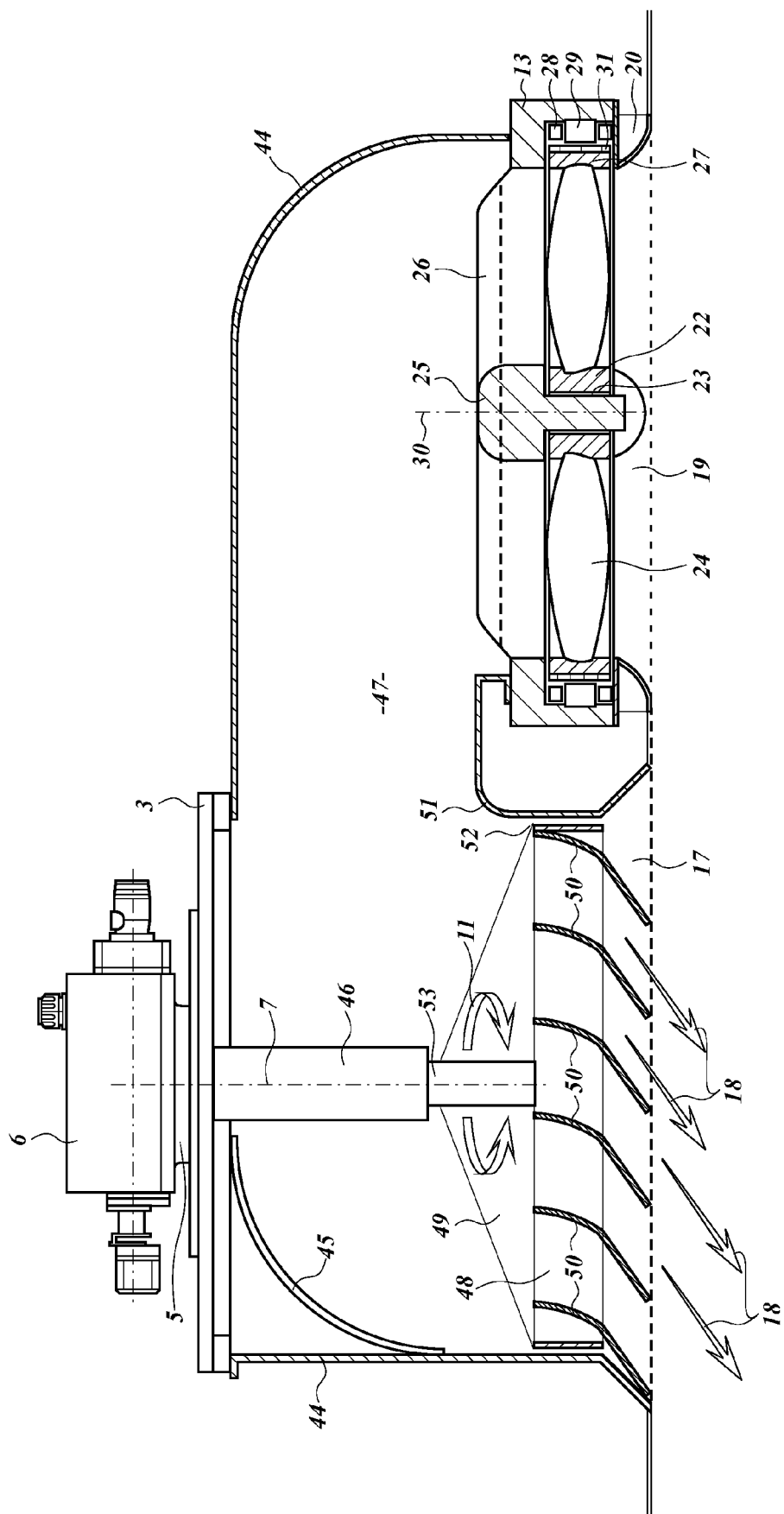


Fig. 3



EUROPEAN SEARCH REPORT

 Application Number
 EP 11 17 3954

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Place of search The Hague		Date of completion of the search 21 November 2011	Examiner van Rooij, Michael
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**ANNEX TO THE EUROPEAN SEARCH REPORT
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