(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 2 133 262 A2

(12) # EUROPEAN PATENT APPLICATION

(43) Date of publication:
16.12.2009 Bulletin 2009/51

(51) Int Cl.:
B63H 11/10 *(2006.01)*

(21) Application number: **09161896.7**

(22) Date of filing: **04.06.2009**

(84) Designated Contracting States:
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 SE SI SK TR

(30) Priority: **10.06.2008 JP 2008151345**

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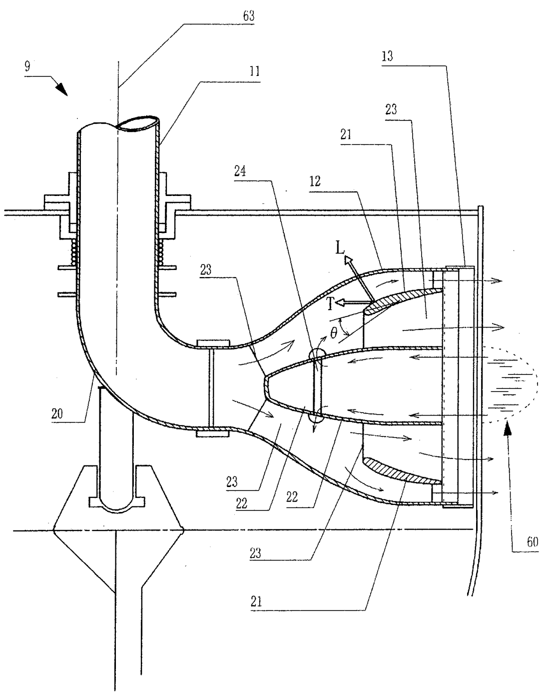
(54) **Thrust generating apparatus**

(57) A thrust generating apparatus is provided that can transform a spouting water flow having a small diameter into a water flow having a large diameter, and that can be provided at the bow or the stern end. A bell-shaped nozzle is coupled to an ejection port of a pump water flow, a ring having a blade-shaped cross section is disposed inside the nozzle, and a shell-shaped cone is disposed inside the ring on the center line of a water flow. Thereby, an ejection flow is straightened, and a thrust is generated. In addition, the bottom of the cone is open, a slit is further provided at a shoulder portion of the cone forward of the ring, and the water flow inside the cone is in communication with a water flow outside the cone. Furthermore, a rotating door is provided that enables the nozzle to pivot toward a shell plating opening on a port side or a starboard side, and that closes or opens the shell plating opening in accordance with the position of the nozzle.

Fig. 4



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a thrust generating apparatus for a side thruster that can be installed at the bow end or the stern end of displacement ships, and a rotating door that automatically opens and closes the opening of shell plating in response to the movement of such a thrust generating apparatus.

2. Description of Related Art

[0002] A side thruster refers to an apparatus installed at the bow or the stern of ships for maneuvering the ships sideways. Such a side thruster is often provided in large ships, especially, ferries or the like that are docked and undocked a large number of times. On the other hand, it is rare that small ships are provided with a side thruster since they are relatively easy to maneuver, and can be moved with less labor.

[0003] However, with the recent labor shortage and aging of crew members, there is an increasing necessity also for small ships to have a side thruster function. For this reason, JP H05-016594U proposes a side thruster that generates a thrust force by jetting seawater from a seawater pump that is used for a clear water cooling apparatus.

SUMMARY OF THE INVENTION

[0004] With the development of the declining of the birthrate and the aging of the population, environment preservation and energy savings are serious challenges that are inevitable when operating various ships. In the course of the aging of crew members, labor saving, and globalization, simplification and safety ensuring for various operations performed inside ships are becoming increasingly important. In particular, energy saving and enhanced performance for ships themselves based mainly on motorization of the main engine are becoming important challenges. Under such circumstances, the apparatus of the present invention provides a side thruster that technically facilitates the simplification and the streamlining of docking and undocking operations.

[0005] In view of the above-described challenges, a method is provided in which a thrust is achieved by using jets of an on-board seawater pump, which puts little pressure on the ship price. However, a large-capacity pump generally has a high pump head. Therefore, randomly releasing high-speed jets into the sea would result in a vortex, and a desired thrust as a reaction force cannot be achieved. The water column of the pump has a viscosity higher than that of the surrounding seawater and will only be diffused and annihilated, while sliding, into infinite seawater under hydrostatic pressure, so that it is not possible to provide an effective thrust.

[0006] Under this phenomenon, the difficulty of the initial motion for turning increases with an increase in resistance of drainage water that is to be moved. Therefore, the proposed method has not been put to practical use.

[0007] Furthermore, a side thruster for displacement ships is required to achieve a slow-speed thrust with high effectiveness, rather than a high-speed thrust. One problem solved by the present invention is to convert a small-diameter spouting water flow of a seawater pump into a larger-diameter water flow. That is, it is an object of the invention to efficiently discharge a water flow having a practical diameter that is similar to a water flow discharged by a commonly used thruster, under a constant output.

[0008] An ordinary side thruster generates a thrust using a propeller having a reversible thrust generating function and disposed within a duct penetrating through the port side and the starboard side, and it is essentially advantageous to provide a side thruster at the tip of a bow where possible in order to achieve thrust for turning the bow and the stern.

[0009] However, due to the overall size of the apparatus, or in other words, the constraints on the arrangement in a ship, such as the complexity of shafting for rotating a propeller, a side thruster is inevitably disposed at a location near a parallel portion of the hull. Consequently, the duct length is increased more than necessary, which leads to a reduction in thrust. If the opening position of the duct entrance of the side thruster is moved forward to a portion having an incidence angle with the waterline for this reason, the hull resistance increases, which will also lead to inflow of foreign objects. Providing a guard at the openings at both ends of the entrance for this reason will lead to an increase in the resistance of the duct itself. The stern portion is no exception for this, and these constraints make it difficult to install a side thruster at an optimum position.

[0010] Furthermore, a thrust that is equal in both the positive and negative directions for the thrust generating direction can only be achieved by rotating the propeller body, and performing this will result in a complex mechanism.

[0011] It should be noted that wakes of a propeller-type thruster provide a rotational flow, which is less efficient than a straight water flow provided by jets of a general-purpose pump.

[0012] Therefore, the present invention was made in order to solve the above-described various problems. The underlying idea of the invention is to provide a thrust generating mechanism inside a nozzle having a bell-shaped outer casing to achieve a thrust while increasing a spouting water column of a seawater pump and performs flow straightening, thereby achieving a strait flow having a thrust comparative to that achieved by a thruster of an equivalent output, or a Kort nozzle thruster, in a similar diameter

[0013] Furthermore, it is an object of the invention to achieve a more effective thrust for turning the bow and the stern by installing the thrust generating apparatus at the tip of the bow or the stern such that the apparatus is pivotable toward the port side and the starboard side, making use of the compactness of the apparatus, and to realize a side thruster that prevents the increase of the hull resistance and the inflow of foreign objects such as driftwood and drift ice during navigation by disposing, at a shell plating opening at the operative position, a door that automatically opens and closes in response to the movement of the nozzle position

[0014] It is another object of the invention to provide an omnidirectional thrust generating apparatus having excellent maneuverability at a harbor or the like.

[0015] In order to solve the above-described problems, a thrust generating apparatus according to the present invention is configured as follows.

[0016] According to a first aspect of the present invention, a bell-shaped nozzle is coupled to an ejection port of a pump water flow, a ring having a blade-shaped cross section is disposed inside the nozzle, and an artillery shell-shaped (referred to as "shell-shaped" in the following) cone is disposed inside the ring on the center line of a water flow.

[0017] A thrust generating apparatus according to a second aspect of the invention is the thrust generating apparatus of the first aspect, wherein the bottom of the cone is open, and a slit is further provided at a shoulder portion of the cone upstream from the ring.

[0018] According to a third aspect of the invention, a rotating door is further provided that enables the nozzle located in a bow tip or a stern tip to pivot toward a shell plating opening on a port side or a starboard side, and that closes or opens the shell plating opening in accordance with the position of the nozzle.

According to a fourth aspect of the invention, an illuminant is provided above the rotating door, and near the waterline at a hull end.

[0019] According to a fifth aspect of the invention, in an omnidirectional thrust generating apparatus, a bell-shaped nozzle is coupled to an ejection port of a pump water flow, a ring having a blade-shaped cross section is disposed inside the nozzle, and a shell-shaped cone is disposed inside the ring on the center line of a water flow, the nozzle is further provided inside a half spindle-shaped housing suspended from the bottom of a ship, and the housing and the nozzle located inside the housing are pivotable in the horizontal direction in accordance with pivoting of the ejection pipe of the pump water flow.

[0020] An omnidirectional thrust generating apparatus according to a sixth aspect of the invention is the omnidirectional thrust generating apparatus of the fifth aspect, wherein the bottom of the cone is open, and a slit is further provided at a shoulder portion of the cone upstream from the ring.

[0021] Since the present invention utilizes jets of a seawater pump, it is not necessary to provide a side thruster apparatus itself with a motor unlike a propeller-type side thruster. The present invention therefore makes it possible to realize the size reduction of a side thruster and its related apparatuses. Accordingly, it is possible to house the side thruster within a hold at the bow or the stern, or within the engine room, and to select an optimum position of the side thruster. That is, due to its compactness, the side thruster can be installed near the bow end or the stern end, making it possible to perform turning efficiently.

[0022] The side thruster of the invention has a simple structure, and therefore can be made of high performance plastics instead of steel, thereby facilitating the size reduction and the standardization of its products.

[0023] With the thrust generating apparatus according to the first aspect, an exhaust flow from the nozzle is changed to a straight flow that has been leveled in the radial direction, so that it is possible to achieve a thrust efficiently. That is, a bell-shaped nozzle is coupled to an ejection port of a pump water flow, a ring having a blade-shaped cross section is disposed inside the nozzle, and a shell-shaped cone is disposed inside the ring on the center line of a water flow, and therefore, it is possible to expand and straighten the ejection flow. That is to say, the exhaust flow is changed to a straight flow that has been leveled in the radial direction. Accordingly, it is possible to achieve an exhaust flow having a thrust comparable to that achieved by a thruster of an equivalent output or a Kort nozzle thruster, in a similar diameter.

[0024] The thrust generating apparatus according to the second aspect has a configuration in which a slit is provided at a shoulder portion of the cone, and backwater in a wake region that is produced at the rear end of the cone is in communication with the interior of the nozzle through the interior of the cone. The water flow that is in communication with the interior of the nozzle exerts the effect of suppressing the turbulence of flow generating from this area due to the change in the internal structure of the nozzle.

[0025] With the thrust generating apparatus according to the third aspect, the increase in resistance of the duct opening and the entry of foreign objects such as driftwood and drift ice can be prevented using the rotating door that automatically opens and closes.

[0026] Since the side thruster room is a non-watertight compartment, it is possible to perform maintenance work on a light load waterline.

[0027] With the thrust generating apparatus according to the fourth aspect, an illuminant is provided above the rotating door and near the waterline at the end of the ship, and therefore, it is possible to increase the safety in the area near the bow end or the stern end that includes a side thruster where it is difficult to distinguish between the rotating door and the shell plating.

[0028] According to the fifth and sixth aspects of the present invention, the nozzle, ring, cone or the like according to the first and second aspects is provided inside a half spindle-shaped housing pivotably suspended from the bottom of a ship. Since the housing is pivotable, it is possible to discharge a water flow from the nozzle in any direction, thereby improving the maneuverability at a harbor or the like.

[0029] The structure according to the second aspect, or in other words, a flow straightening structure, can be also used for a propeller thruster. More specifically, as shown in FIG. 20, a cylindrical outer casing 56 (low-strength member) is fixed to a blade stump portion 74 with a spacing provided between the outer cylinder 56 and the outer surface of a propeller hub 55, the rear end surface 57 of the outer casing 56 is opened, and a slit 58 is formed forward of the blade stump portion 74 of the propeller. That is, with the structure according to the second aspect, backwater in a wake region that is produced at the rear end of the outer casing 56 is in communication with the forward portion of the blade 75 through the interior of the outer casing 56. Accordingly, the water flow that is in communication with the forward portion of the blade 75 exerts the effect of suppressing a vortex that could have been produced near the blade 75.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030]

FIG. 1 is a longitudinal cross-sectional view of a bow portion in which an apparatus according to the present invention is provided.
FIG. 2 is a plan view on a floor surface on which the apparatus is installed.
FIG. 3 is a transverse sectional view at the bow end where the apparatus is located.
FIG. 4 is a longitudinal cross-sectional view of a nozzle of a thrust generating apparatus of the apparatus of the present invention.
FIG. 5 is a front view showing a configuration of the nozzle.
FIG. 6 is a plan view showing operating positions of the nozzle and a rotating door inside a thrust generating apparatus room.
FIG. 7 is a plan view showing operating positions of the nozzle and a rotating door inside a thrust generating apparatus room.
FIG. 8 is a plan view showing operating positions of the nozzle and a rotating door inside a thrust generating apparatus room.
FIG. 9 is a detail view of a pivot center of the rotating door.
FIG. 10 is a detail view of a pivot center of the rotating door.
FIG. 11 is a view taken along the arrow A-A in FIG. 6.
FIG. 12 is a view taken along the arrow C-C in FIG. 11.
FIG. 13 is a view taken along the arrow D-D in FIG. 11.
FIG. 14 is a view taken along the arrow B-B in FIG. 6.
FIG. 15 is a detail view of a rotating door closing mechanism of the thrust generating apparatus.
FIG. 16 is a diagram showing the arrangement at a lower end portion of the nozzle and a locking device for the rotating door.
FIG. 17 is a detail view of the same apparatus at a locked position.
FIG. 18 is a detail view of the same apparatus at a released position.
FIG. 19 is a simplified illustration showing rotating door supports and elbow plates.
FIG. 20 is an illustration in the case where a part of a nozzle configuration of the present invention is applied to a general-purpose propeller thruster.
FIG. 21 is a configuration diagram of the case where a nozzle of the present invention is applied to a flat bottom of a ship.
FIG. 22 is a simplified configuration diagram of the case where a nozzle of the present invention is installed at a stern end.

DETAILED DESCRIPTION OF THE INVENTION

[0031] Hereinafter, the configuration of the present invention will be described by way of examples with reference to the accompanying drawings.

FIG. 1 is a longitudinal cross-sectional view of a bow portion in which an apparatus according to the present invention is provided; FIG. 2 is a plan view on a floor surface on which the apparatus is installed; FIG. 3 is a transverse sectional view at the bow end where the apparatus is located; FIG. 4 is a longitudinal cross-sectional view of a nozzle of a thrust generating apparatus of the apparatus of the present invention; FIG. 5 is a front view showing a configuration of the nozzle; FIGS. 6, 7 and 8 are plan views showing operating positions of the nozzle and a rotating door inside a thrust generating apparatus room; FIGS. 9 and 10 are detail views of a pivot center of the rotating door; FIG. 11 is a view taken along the arrow A-A in FIG. 6; FIG. 12 is a view taken along the arrow C-C in FIG. 11; FIG. 13 is a view taken along the arrow D-D in FIG. 11; FIG. 14 is a view taken along the arrow B-B in FIG. 6 (for convenience in drawing the figures the rotating door and the nozzle are assumed to be located on the hull center line); FIG. 15 is a detail view of a rotating door closing mechanism of the thrust generating apparatus; FIG. 16 is a diagram showing the arrangement at a lower end portion of the nozzle and a locking device for the rotating door; FIG. 17 is a detail view of the same apparatus at a locked position; FIG. 18 is a detail view of the same apparatus at a released position; FIG. 19 is a simplified illustration showing rotating door supports and elbow plates; FIG. 20 is an illustration of the case where a part of a nozzle configuration of the present invention is applied to a general-purpose propeller thruster; FIG. 21 is a configuration diagram of the case where a nozzle of the present invention is applied to a flat bottom of a ship; and FIG. 22 is a simplified configuration diagram of the case where a nozzle of the present invention is installed at the stern.

[0032] While the present invention can be applied to ships of various sizes, ranging from small ships to large ships, the maximum hull form is restricted by the ability of available seawater pumps and the cost efficiency. The following embodiment corresponds to a thrust of approximately two tons, which is required for a side thruster used for a ship having a gross tonnage of less than 500 tons.

[0033] In this case, the required side thruster output is usually 180 to 200 PS (132 to 147 kilowatts), which corresponds to 1.0 ton to 1.1 tons for a bollard pull of 100 PS (73 kilowatts) of a commonly used tugboat. The diameter of a duct that contains the propeller as a thrust generating apparatus is approximately 750 millimeters.

[0034] Therefore, the following embodiment is also aimed at achieving a low-speed, direct ejection flow having a diameter of 750 millimeters and whose speed is leveled in the radial direction with a seawater pump having an output of 180 PS (132 kilowatts). In this case, the corresponding seawater pump ordinarily has an output of 180 PS (132 kilowatts) and the ejection pipe has a diameter of approximately 250 millimeters. Therefore, with a configuration according to this embodiment, the diameter of an ejection flow of the seawater pump is increased by three times to reduce the speed so that an exhaust flow similar to that of a commonly used thruster having a duct diameter of 750 millimeters can be used as a low-speed thrust for turning.

[0035] First, a configuration of the present invention will be described.

[0036] A side thruster according to the present invention includes a thrust generating apparatus, an apparatus for opening and closing a shell plating opening, and operating devices for these apparatuses. A side thruster 1 as shown in FIGS. 1 to 3 is simple and compact, and therefore can be installed in a side thruster room 3 in a watertight compartment at a tip portion of a bow hold 2.

[0037] A seawater pump 4, which powers the thrust generating apparatus, is installed inside a pump room 7 in a watertight compartment accessible from an upper deck 6 located approximately below a chain locker 5 at the back of the bow hold 2. The seawater sucked through a suction pipe 8 passes through an ejection pipe 9, as well as a vertical upper pipe portion 10 and a rotatable vertical lower pipe portion 11 of the ejection pipe 9, and is ejected into a nozzle 12 having a bell-shaped outer casing, and thereby, the water flow is expanded and straightened. Thereafter, the water flow passes through an extension ring 13 at the end of the nozzle, and is discharged from a shell plating opening 14.

[0038] A non-watertight rotating door 15 that pivots about a vertical stationary pipe portion 10 of the ejection pipe 9 and a rotatable pipe portion 11 of the ejection pipe 9 is provided at the opening 14. Accordingly, the side thruster room 3 is configured to be non-watertight to the outside.

[0039] At a mooring deck 16, a handle 19 for operating a side thruster operation rod 18 that is guided via a gear 17 attached to the vertical portions 10 and 11 of the ejection pipe 9. Accordingly, the vertical portion 11 can be rotated by rotating the handle 19. Since the vertical portion 11 is connected to the nozzle 12 via an elbow pipe 20, rotating the handle 19 causes the nozzle 12 to rotate about a center line 63 (see FIG. 4) of the vertical portion 11.

[0040] Next, the internal configuration and the action of a thrust generating apparatus of a side thruster according to the present invention will be described.

[0041] In FIG. 4, the nozzle 12 having a bell-shaped outer casing is coupled to the end of the elbow pipe 20 connected to the vertical portion 11 of the ejection pipe 9. Inside the nozzle 12, a ring 21 having a blade-shaped cross section is fixed as an inner casing via flow straightening plates 23 along with a shell-shaped cone 22 located on the center line, as shown in FIGS. 4 and 5. The interior of the cone 22 is hollow, and the bottom of the cone 22 is open. The ring 21 and the cone 22 are fixed to each other with the flow straightening plates 23, and are also fixed to the nozzle outer casing (FIG. 5 shows a state of the nozzle 12 as viewed from the ejection side).

[0042] It should be noted that "bell-shaped" as used herein refers to a shape whose diameter gradually increases in the form of an arc, and takes the form of a linear cylinder at its peripheral portion after the maximum diameter is reached. "Blade-shaped cross section" refers to a form that has a round leading edge, a maximum thickness at a portion located approximately at one third from the leading edge, a trailing edge with an elongated teardrop shape, wherein the line connecting the top, bottom and middle of the cross section is in an arch shape. "Shell-shaped" refers to a form whose diameter increases more gradually than that of the bell shape.

[0043] Accordingly, jets ejected from the elbow pipe 20 are expanded in the radial direction by the cone 22 at the position where the internal cross-sectional area of the nozzle 12 starts to increase, thereby equalizing the flow velocity in the radial direction within the nozzle 12. At the same time, the jets flow into the ring 21 with an angle of attack (θ) to generate a lift (L), thereby achieving a component of force in the thrust direction (T). Furthermore, the cross-sectional area between the nozzle 12 serving as the outer casing and the ring 21 serving as the inner casing is set such that the outlet of water flow is smaller than the inlet, thereby making the flow velocity higher than on the inner surface of the ring 21 and achieving a lift. However, it is also possible to achieve a larger effect by applying a coating for reducing the frictional resistance or a lining of metal-clad steel such as titanium onto the outer surface ring 21 and the inner surface of the nozzle 12.

[0044] Further, a slit 24 is formed in a shoulder portion of the cone 22, and backwater 60 in a wake region that is generated at the rear end of the cone 22 is in communication with the interior of the nozzle 12 through the interior of the cone 22, thereby providing an effect of suppressing the turbulence of flow generated at this area due to the change in the internal structure of the nozzle 12 (the arrow in FIG. 4 indicates the water flow).

[0045] It should be noted that for the apparatus for suppressing a vortex generated on the outer surface of the cone 22 it is also possible to apply the flow straightening of a hub vortex of a commonly used propeller. That is, in FIG. 20, by fixing a cylindrical outer casing 56 (low-strength member) to a blade stump portion with a spacing between the outer casing 56 and the outer surface of the propeller hub 55, opening the rear end surface 57 of the outer casing 56, and forming a slit 58 forward of the propeller blade stump portion, it is possible to realize the same function as described above, and to achieve the effect of slowing a rotational flow at the blade stump portion on the outer surface of the outer casing so that the flow becomes similar to a straight flow, thereby further reducing the hum vortex.

[0046] Next, the configuration of the rotating door 15, which is a feature of the side thruster according to the present invention, at the shell plating opening will be described.

[0047] As shown in FIGS. 1, 6, 7, 8, 9, 11, 12 and 13, the non-watertight rotating doors 15 are made up of an outer plate 27 and an inner plate 28. For the outer plate 27, a "cut-out plate" from the shell plating at the relevant portion is used to ensure precision, and the outer plate 27 is configured so as to be rotatable. In addition, an internal space 29 is secured between the outer plate 27 and the inner plate 28 to reduce the apparent weight in water by the buoyancy of the inner space so that the sliding of the rotating doors 15 can be performed easily.

[0048] The pivot center of the rotating doors 15 at the port side and the starboard side is located on the center line 63 of the vertical portions 10 and 11 of the ejection pipe. Supports 30 that are part of the rotating doors 15 are attached via elbow plates 45a and 45b to freely movable plate rings 25 and 26 surrounding the vertical portion 11 of the ejection pipe 9 (see FIG. 19). Here, the elbow plates 45a and 45b are L-shaped plates. One side of the L-shaped plates is fixed to the support, and an aperture 50 and a cut-out portion 51 are formed in the other side. Further, the elbow plates 45a and 45b are cut out to form arc-shaped portions, where the elbow plates 45a and 45b are fixed to the freely movable rings 25 and 26.

[0049] The elbow plate 45a is fixed to an upper portion of the support 30 of the rotating door 15 located at one of the port side and the starboard side, and the elbow plate 45a is fixed to the freely movable plate ring 25. The elbow plate 45b is fixed to a lower portion of the support 30 of the rotating door 15 located at the other of the port side and the starboard side, and the elbow plate 45b is fixed to the freely movable plate ring 26. Thus, the pivoting and sliding of each of the supports 30 of the right rotating door and the left rotating door can be performed on the same plane.

[0050] It should be noted that the supports 30 have a box-shaped cross section as shown in FIG. 13, and enclose a space for achieving buoyancy that is balanced with the rotating doors 15.

[0051] At the lower end of the rotating door 15, a skid 31 is provided to facilitate sliding, and a skid 32 is further provided at the top in order to suppress floating in water. A guide plate 64 that comes into slide contact with the skid 32 is provided inside the thruster room 3.

[0052] Furthermore, for the purpose of suppressing floating or sinking of the plate rings 25 and 26, as well as the elbow plates 45a and 45b fixed to the plate rings 25 and 26, plate rings 33 fixed to the vertical pipe 11 are also attached above and below the plate rings 25 and 26.

[0053] Although the length of the supports 30 is set so that the outer plates 27 are contained inside the hull in order to prevent the outer plate 27 from becoming flush with the shell plating of the hull, there will be an area 34 where the front end of the outer plate slightly protrudes from the shell plating when the rotating door 15 is opened or closed (see FIG. 6). However, this happens only for a short time when the rotating door 15 is being pivoted, and therefore, will not cause a problem. In the case of shell plating on the ship side where the incident angle of the waterline is large, the size of such a protruding area 34 is small.

[0054] Next, operating devices and fixing devices of the side thruster will be described.

[0055] To generate a thrust toward either the port side or the starboard side, it is required for a side thruster of the present invention to pivot the nozzle 12 itself, and the rotating door 15 is moved in response to that pivoting. Therefore, the following mechanism is provided.

[0056] As shown in FIG. 14, the vertical portion 11 of the ejection pipe can be pivoted by means of a watertight washer 35 and a bearing 36 at the lower end of its vertical axis, and supports the thrust generated in the nozzle 12 as well as its own weight. The pivoting force of the vertical portion 11 is conducted by means of the gear 17 via the vertical rod 18 using the handle 19 on the mooring deck 16. The vertical portion 11 at the end of the fixed ejection pipe retains water tightness with a seal 37 on the inner side of the gear 17.

[0057] Next, the nozzle 12 and the opening and closing operations of the rotating door 15, which moves in response to the movement of the nozzle 12, using the above-described devices will be described.

[0058] FIG. 6 shows the situation when the rotating door 15 is in a closing position for the opening 14 on the port side when the nozzle 12 is in an operating position on the starboard side, that is, in a mooring operation, i.e., in a state in which an ejection flow is discharged from the nozzle 12. FIG. 7 shows the situation when the rotating door 15 is in a closing position for the opening 14 on the starboard side when the nozzle 12 is in an operating position on the port side, that is, in a mooring operation, i.e., in a state in which an ejection flow is discharged from the nozzle 12. FIG. 8 shows that when the nozzle 12 is not in operation (during navigation), i.e., is in a state in which no ejection flow is discharged from the nozzle 12, the nozzle 12 is fixed at a position 38 on the hull center line, and the rotating door 15 is at the closing position on both the port side and the starboard side. That is to say, when the nozzle 12 is pivoted from the navigation position to the mooring operation position, the rotating door 15 is pushed by the nozzle 12, and stopped by a stopper 39.

[0059] Furthermore, when the nozzle 12 moves from the operating position to the fixed position or to the opposite side of the ship, the rotating door 15 is automatically restored to the closing position by a torsion coil spring 42 that surrounds the vertical portion 11 of the ejection pipe and is disposed between a round bar 40 attached to its support 30 and a round bar 41 attached to the undersurface of the top plating of the thruster room, and then is stopped at the fixed position by a stopper 44, as shown in FIGS. 9 and 10. The motive energy is given via the gear 17 by the rotating operation of the handle 19 when the nozzle 12 moves to the operative position. Here, the stopper 39 and the stopper 44 are provided on the floor surface of the side thruster room 3.

[0060] The range of movement of the supports 30 of the rotating doors is limited to an area between the stopper 39 and the stopper 44 of each of the port and starboard sides. On the other hand, the nozzle 12 moves via a position 38 on the hull center, and the supports 30 are stopped by the stoppers 39, and therefore, the range of movement of the nozzle 12 is limited between the stoppers 39 of the port and starboard sides.

[0061] In addition, the fixing devices will be now described. In FIGS. 1, 6, 9, 14 and 16, the operation rod 18 is located on the hull center line forward of the vertical portion 11 of the ejection pipe, and is configured to be vertically slidable together with the gear 17. The rotating doors 15 on the port side and the starboard side are attached to the freely movable plate rings 25 and 26 via the elbow plates 45a and 45b. An elbow plate 46 is fixed to the vertical portion 11. The elbow plate 45a, elbow plate 45b, and elbow plate 46 are penetrated by the rod 18. In the drawings, the rod 18 is located at a position 47 that is pressed most downward (see FIG. 17), and each of the elbow plates 45a, 45b and 46 is pierced by the rod 18, and thereby, the rotating doors 15 are fixed at the closing positions, and the nozzle 12 is fixed to the storage position 38 on the hull center line.

[0062] When a mooring operation is performed from such a condition (in the navigation position), the rod 18 is lifted up to a position 48 shown in FIG. 18. Then, the elbow plate 46 fixed to the vertical portion 11 of the ejection pipe becomes laterally pivotable, while the elbow plates 45a and 45b located at the position of a small diameter portion 49 provided in the rod 18 becomes pivotable in the direction opposite to the opening side of the cut-out portion 51 formed at its aperture 50. Consequently, the rotating doors 15 become rotatable toward their respective sides of the ship. Therefore, the rotating door 15 at either the port or the starboard side on which the nozzle 12 rotates is pushed by that nozzle 12, and is thereby pivoted. By depressing the rod 18 after the pivoting, the rotating door 15 at the opposite side of the ship can be fixed with a large diameter portion 52 of the rod.

[0063] It should be noted that the relationship between the large diameter portion 52 and the small diameter portion 49 of the rod 18, and the aperture 50 and the cut-out portion 51 of the elbow plates 45a and 45b is as follows. That is, the diameter of the large diameter portion 52 is smaller than the diameter of the aperture 50, but is larger than a width H of the cut-out portion 51 (FIG. 10). The diameter of the small diameter portion 49 is smaller than the width H.

[0064] Furthermore, since the rotating doors 15 are integrated via the elbow plates 45a and 45b and the rod 18 by the above-described operation, the simultaneous fixation of the nozzle 12 and the rotating doors 15 at both the port side and the starboard side is completed by stopping lateral pivoting of the rotating doors 15 at both the port side and the starboard side by the respective stoppers 44. However, it is also possible to provide a safeguard by performing the above-described fixation, for example, by using a barrel bolt (not shown) at the handle 19 on a worker's deck.

[0065] For large ships having a size larger than the ship in the above-described embodiment, it is necessary to realize a light pivoting maneuver. In this respect, since the nozzle has no movable parts, the nozzle can be easily made partly or entirely of plastic. Furthermore, the realization of a light pivoting maneuver can be facilitated, for example, by forming the rotating doors in the shape of a regular square and arranging seawater resistant casters facing upward and downward at the four corners of the rotating doors, or by injecting foamed plastics into the buoyancy tank of the rotating doors in order to increase the rigidity of the rotating doors.

[0066] In order to realize a larger apparatus, it is necessary to increase the pump capacity, which leads to an increase in the ship price. However, as shown in FIG. 1, by using stop valves as the check valve 53a on the suction pipe side and the check valve 53b on the ejection pipe side, and cleaning the seawater pump 4 by connecting the clear water pipe 54 to the pump side of these valves, the ship service life will not be reduced by the use of a general purpose clear water pump, making it possible to keep the cost low.

[0067] The width of the thruster room increases with an increase in the size of a hull form. Such a situation can be addressed, for example, by extending the extension ring 13 of the nozzle 12, and extending the length of the nozzle 12 itself. In the case of a hull form whose bow cross section has a U shape 61 or a V shape 62 as shown in FIG. 3, the above-described situation can also be addressed in the same manner.

[0068] In order to avoid contact with the area near the rotating door of small crafts that handle a mooring line at the bow and the stern in a mooring operation or the like, in particular, in order to visually recognize the area near the waterline in clouded water at night, for example, it is possible to increase the safety in the area near the bow end or the stern end that includes a side thruster where it is difficult to distinguish between the rotating door and the shell plating, by attaching a white colored hemisphere-type, tempered glass reflection sphere that uses a lamplight as the light source, such as a working light on the worker's deck near the bow end or the stern end, or covering an illuminant 59 that requires no power wiring with a watertight cover made of tempered glass, and attaching the illuminant directly above the rotating door and near the waterline at the hull end.

[0069] Although the embodiment of the present invention has been described mainly as a bow thruster, the invention can often be directly applied to a stern portion 72 by utilizing the seawater pump in an engine room 73 as shown in FIG. 22.

[0070] In the case of a ship with a flat bottom, such as a shallow draft ship or a wide width ship, it is also possible to suspend the nozzle 12 from the bottom of the ship by applying the fifth and sixth aspects of the present invention.

[0071] In the following, this will be described in detail. In FIG. 21, a half spindle-shaped housing 65 is provided for the purpose of straightening the water flow outside the bell-shaped nozzle 12 and the ejection pipe 11 used as a pintle. A fin 66 having a streamlined horizontal cross section and serving as a control surface is provided at above and below the housing 65, and the area proportions are set such that the whole structure functions as a balance rudder.

[0072] The vertical portion 11 of the ejection pipe is adapted to a horizontal thrust and heaving, by using a bearing 68 at the bottom of a steering gear room 67. Furthermore, a steering engine 69 capable of pivoting 360 degrees is installed above the bearing 68. It should be noted that existing techniques that have been put into practical use can be used for these devices.

[0073] Furthermore, an ejection pipe 10, which forms fixed piping together with the seawater pump 4, is provided above the vertical portion 11 of the ejection pipe used as a pintle, and their connection portion is kept watertight by a seal case 70.

[0074] As shown in FIG. 22, the apparatus of the present invention can function as a side thruster at the stern portion. Alternatively, the apparatus can be used as a propeller. In that case, in order to achieve a further thrust by expanding the exhaust flow and utilizing a wake gain resulting from the forward movement of the hull, a ring 71 having a blade-shaped cross section is additionally provided at the rear end.

[0075] It should be noted that depending on the hull form, a thrust can be easily increased, for example, by providing a plurality of the apparatus including a seawater pump, and further increasing the pumping capability by driving an inverter-controlled electric motor.

Claims

1. A thrust generating apparatus that expands and straightens an ejection flow, and generates thrust, comprising:

a bell-shaped nozzle (12) that can be coupled to an ejection port for ejecting a pump water flow,
a ring (21) having a blade-shaped cross section that is disposed inside the nozzle, and
a shell-shaped cone (22) that is disposed inside the ring on the center line of a water flow.

2. The thrust generating apparatus according to claim 1,
wherein the bottom of the cone (22) is open, a slit (24) is further provided at a shoulder portion of the cone upstream from the ring (21), and the water flow inside the cone (22) is in communication with a water flow outside the cone (22).

3. The thrust generating apparatus according to claim 1 or 2,
further comprising a rotating door (15) that enables the nozzle (12) located in a bow tip or a stern tip to pivot toward a shell plating opening (14) on a port side or a starboard side, and that closes or opens the shell plating opening (14) in accordance with the position of the nozzle (12).

4. The thrust generating apparatus according to claim 3,
wherein an illuminant (59) is provided above the rotating door (15), and near the waterline at a hull end.

5. The thrust generating apparatus according to any of claims 1 to 4,
wherein the thrust generating apparatus is omnidirectional, and
wherein the nozzle (12) is further provided inside a half spindle-shaped housing (65) that can be suspended from the bottom of a ship, the housing (65) and the nozzle (12) located inside the housing (65) being pivotable in the horizontal direction in accordance with pivoting of an ejection pipe (11) of the pump water flow.

Fig. 1

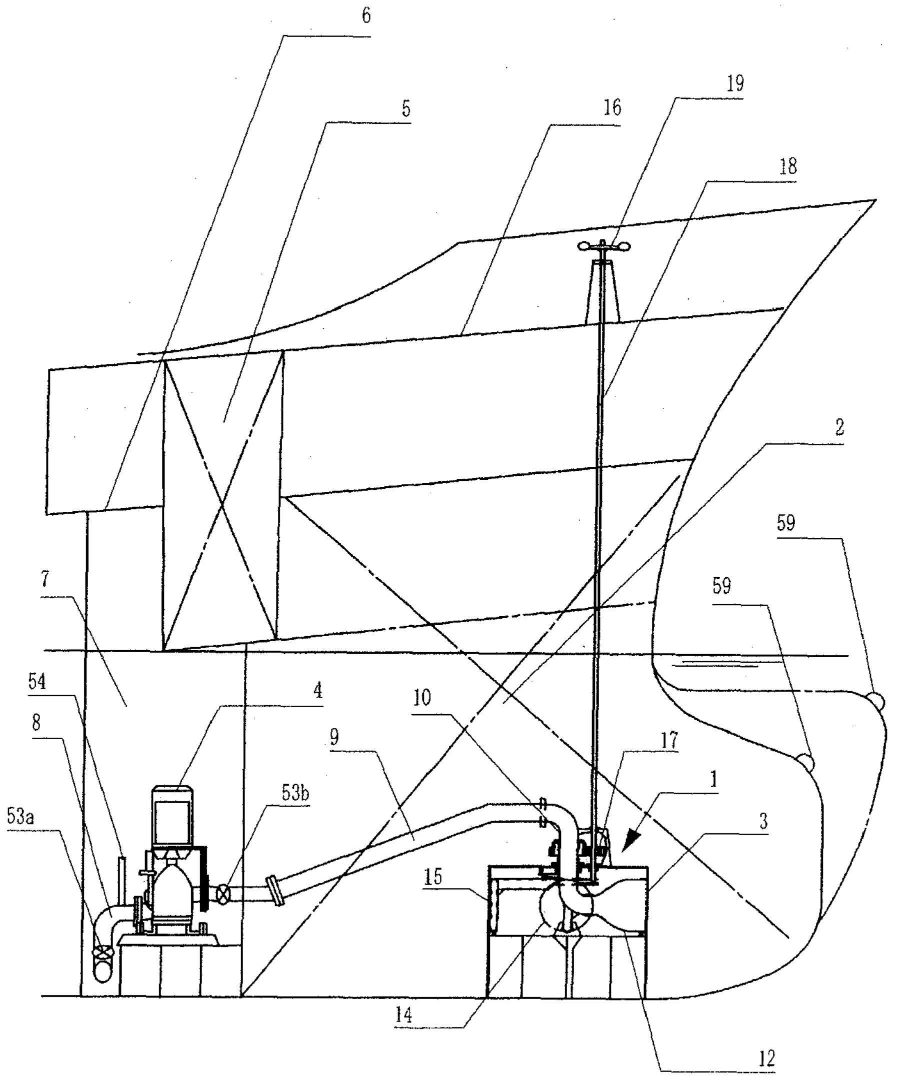


Fig. 2

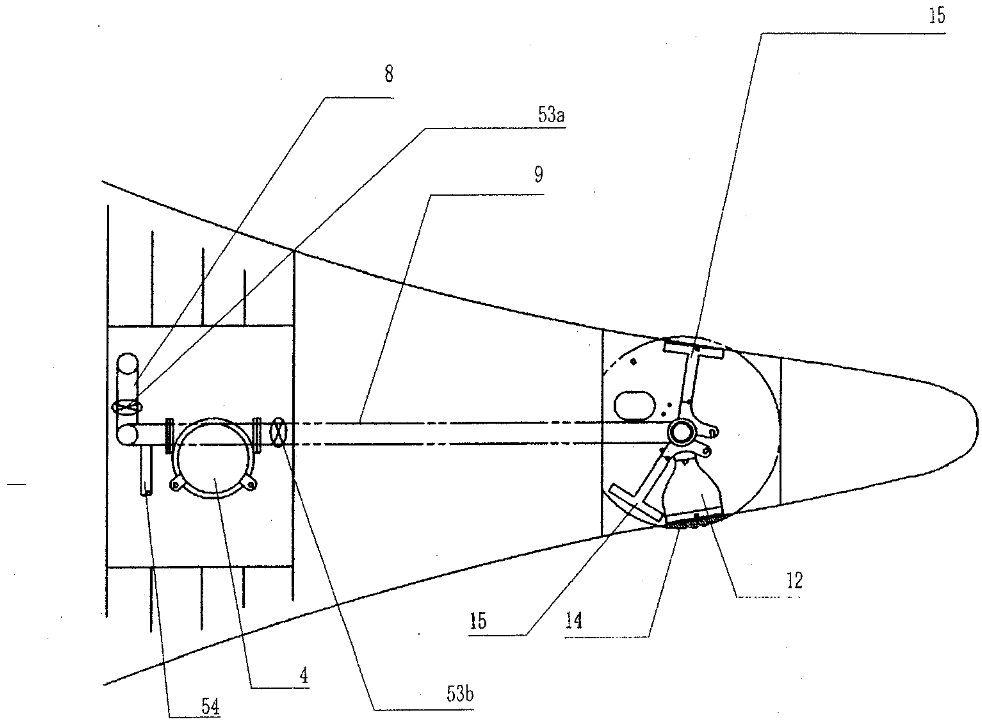


Fig. 3

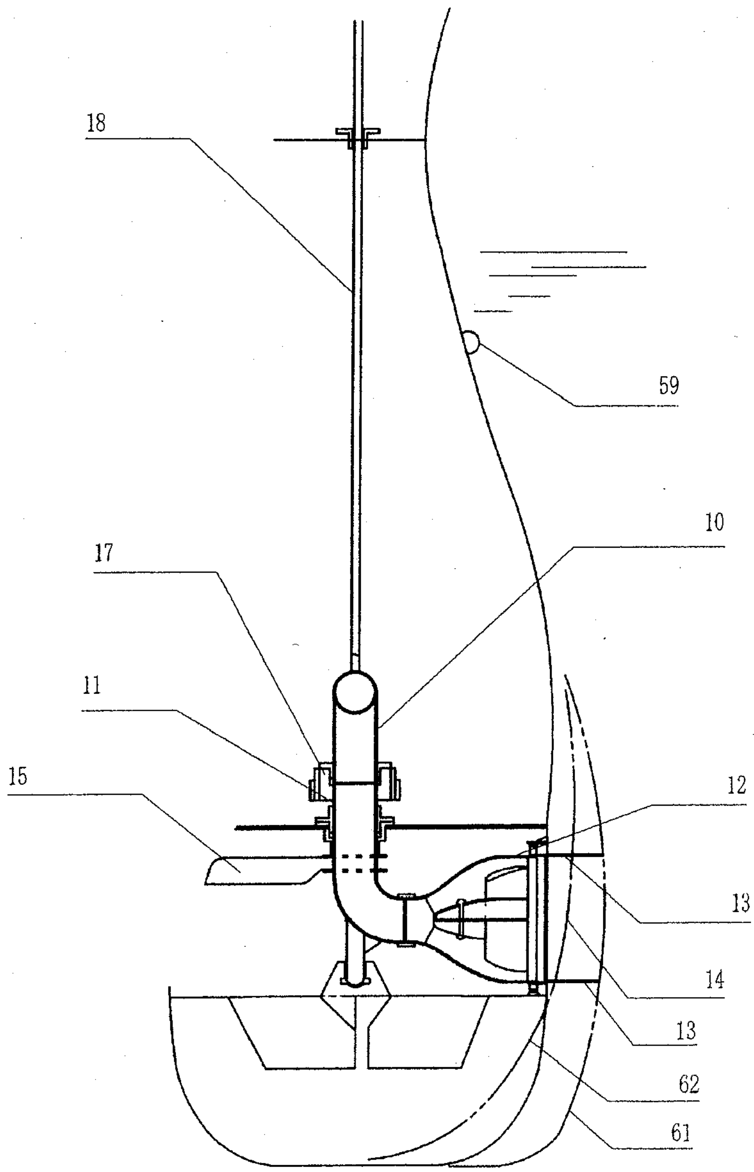


Fig. 4

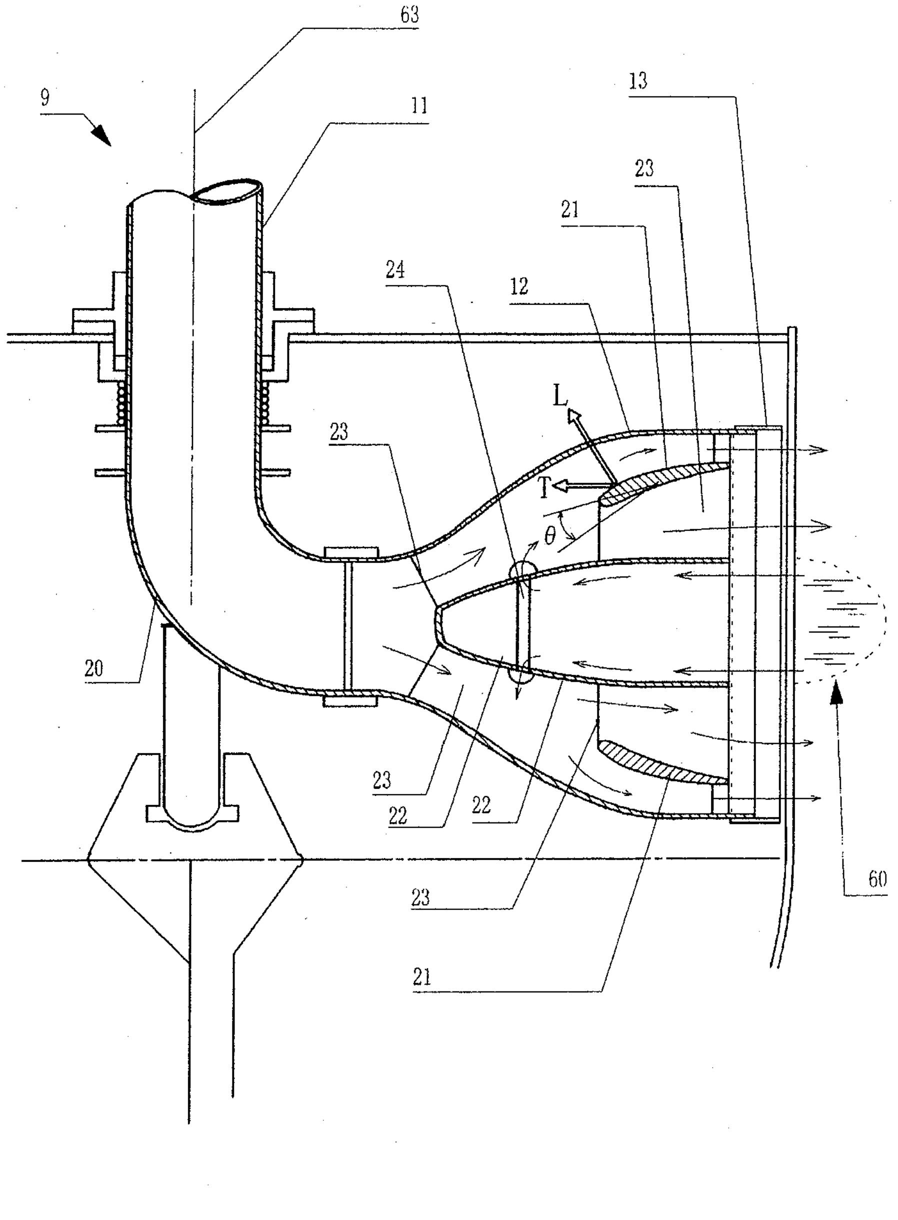


Fig. 5

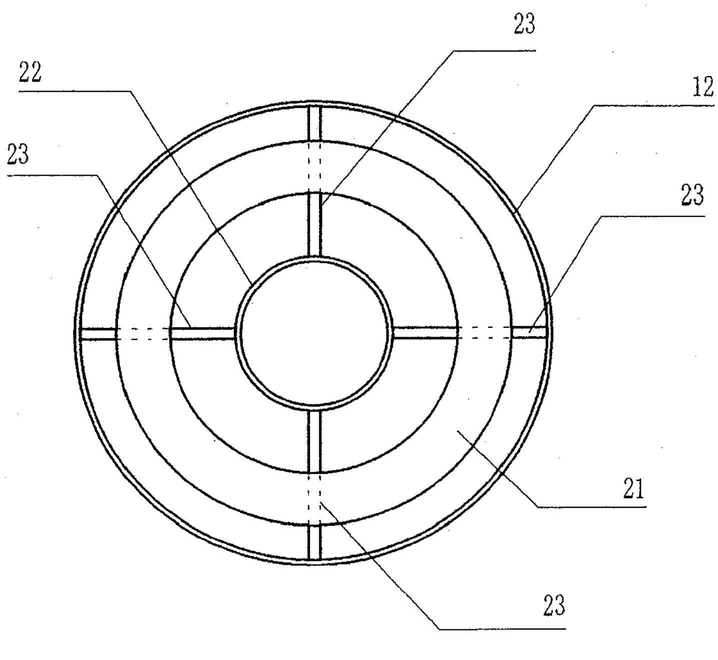


Fig. 6

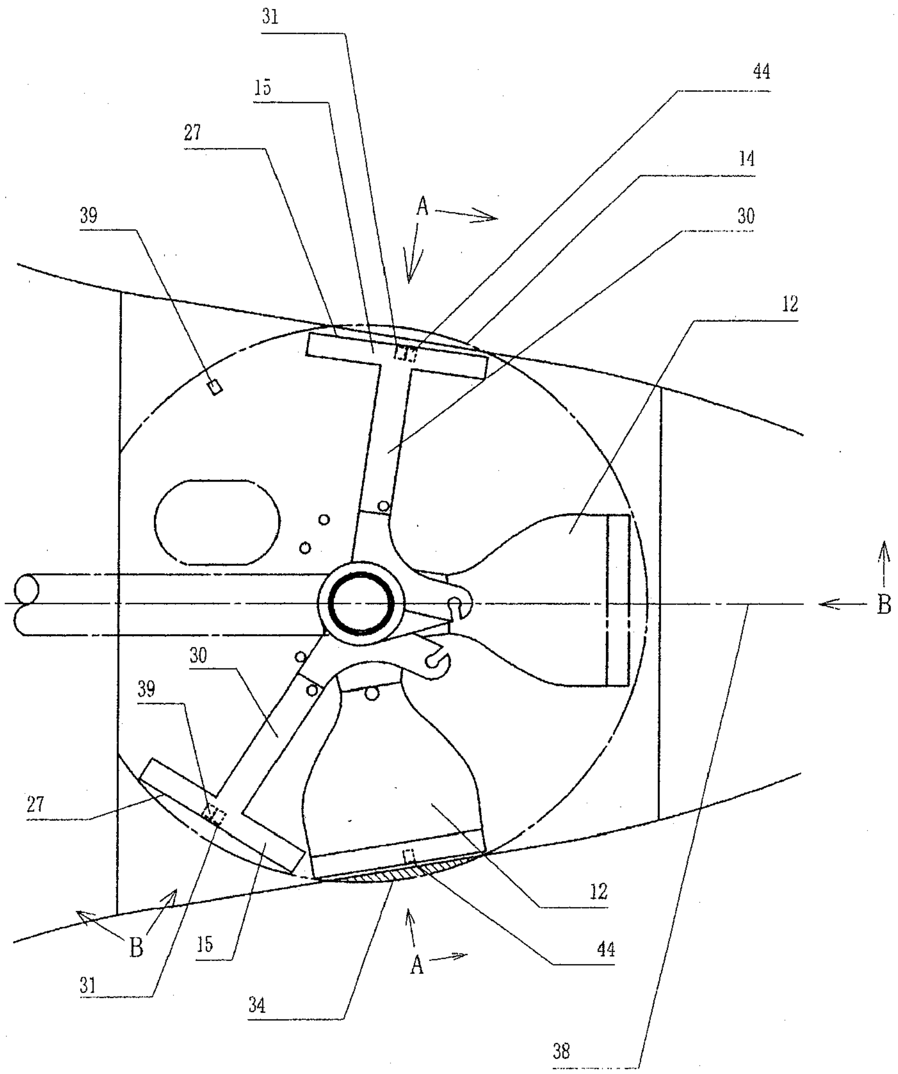


Fig. 7

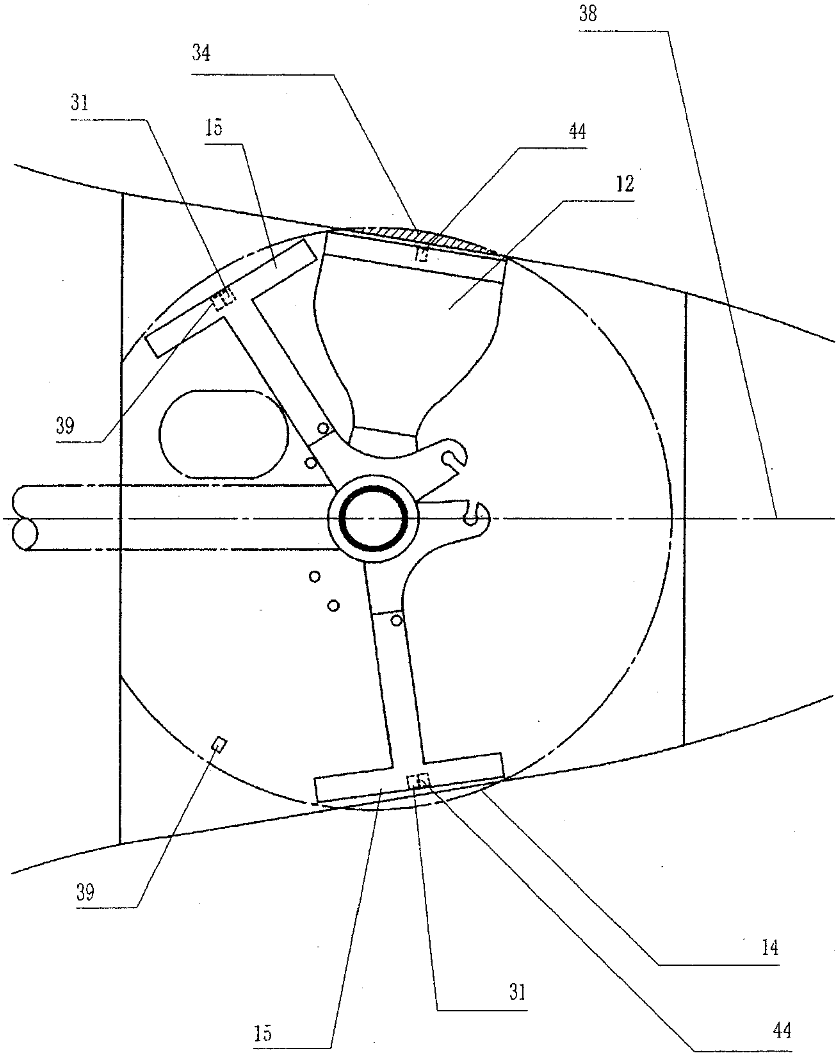


Fig. 8

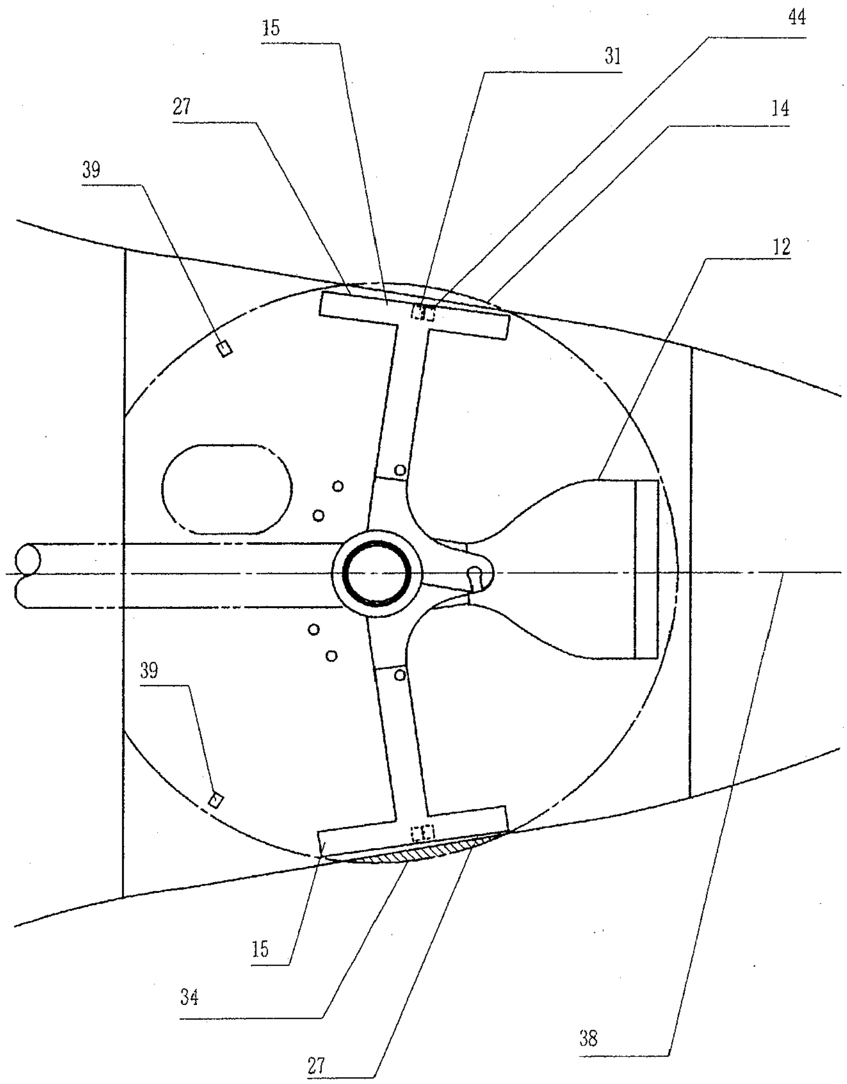


Fig. 9

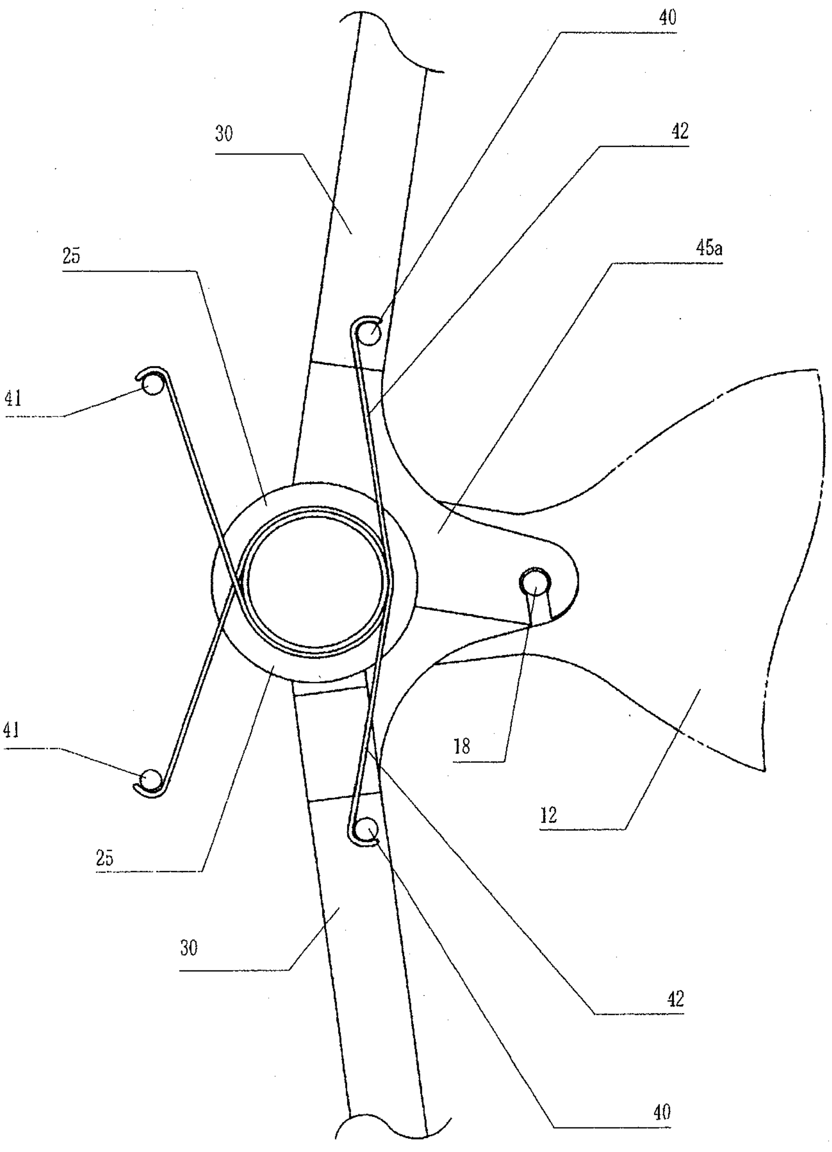


Fig. 10

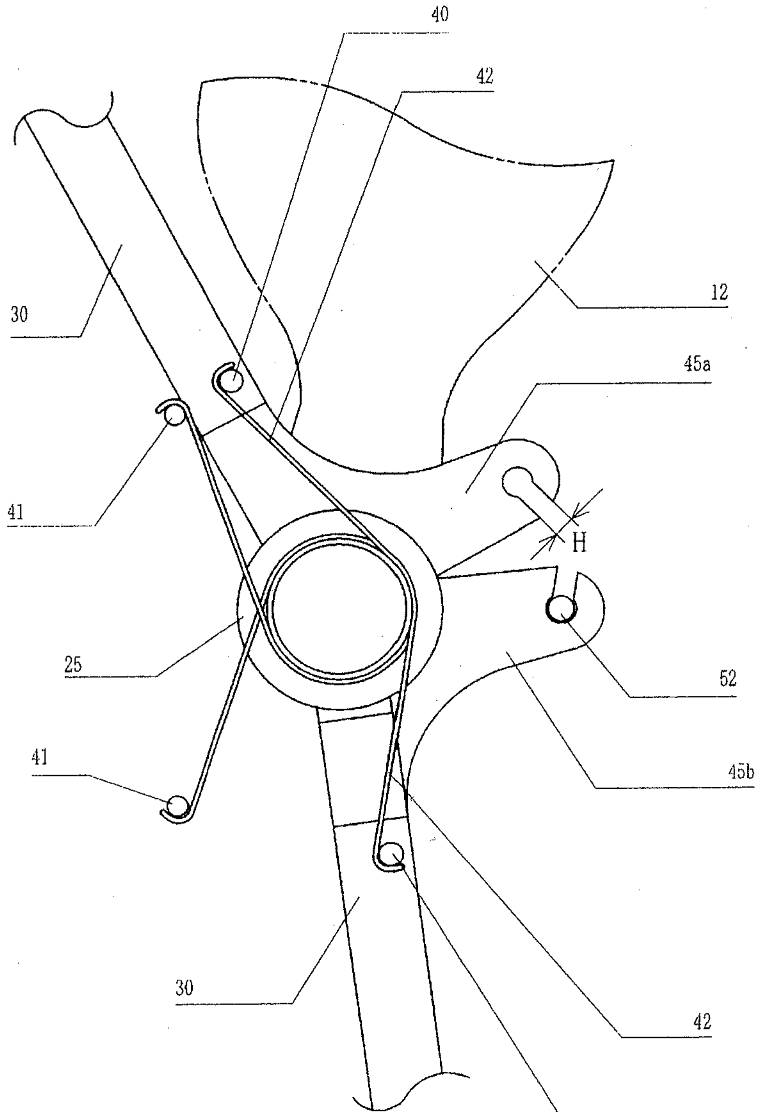
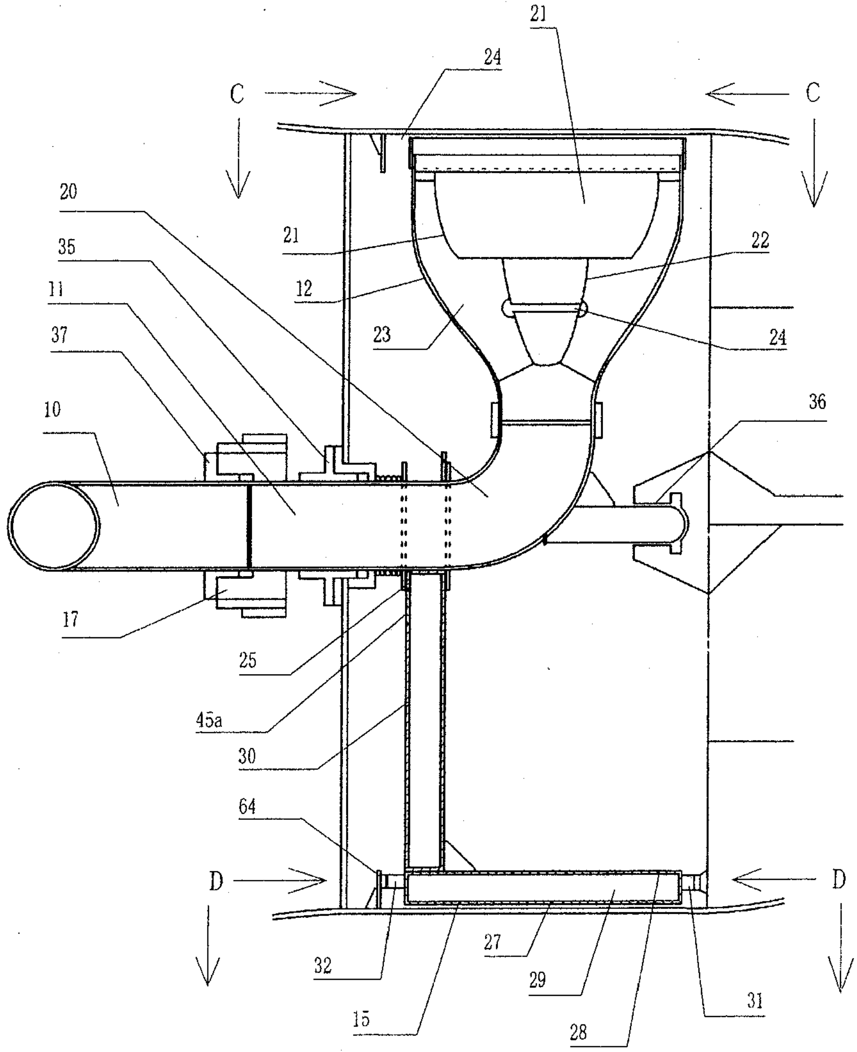


Fig. 11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45a
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Fig. 12

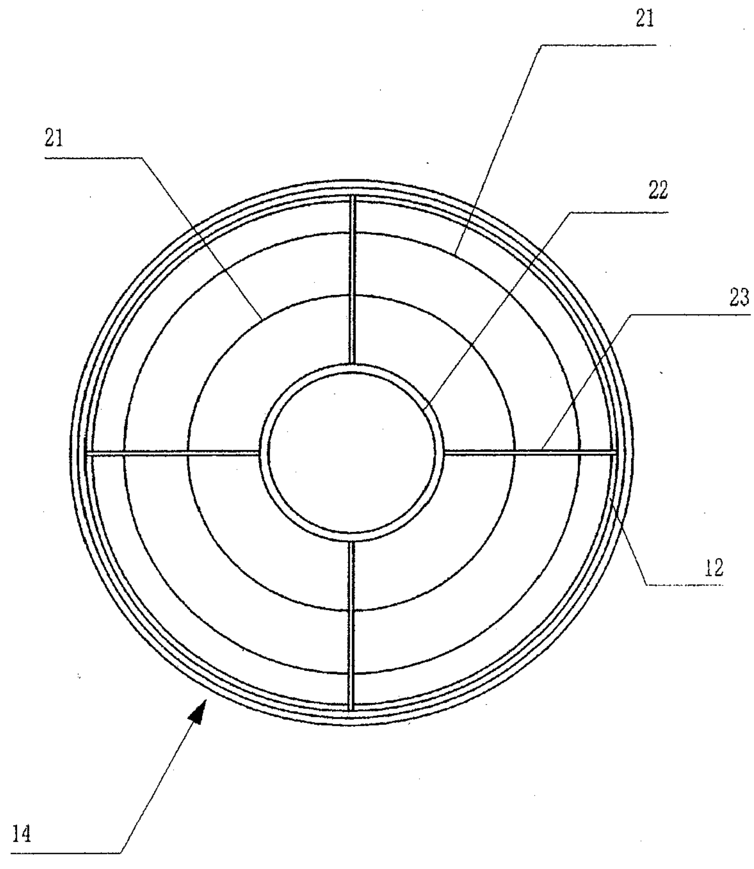


Fig. 13

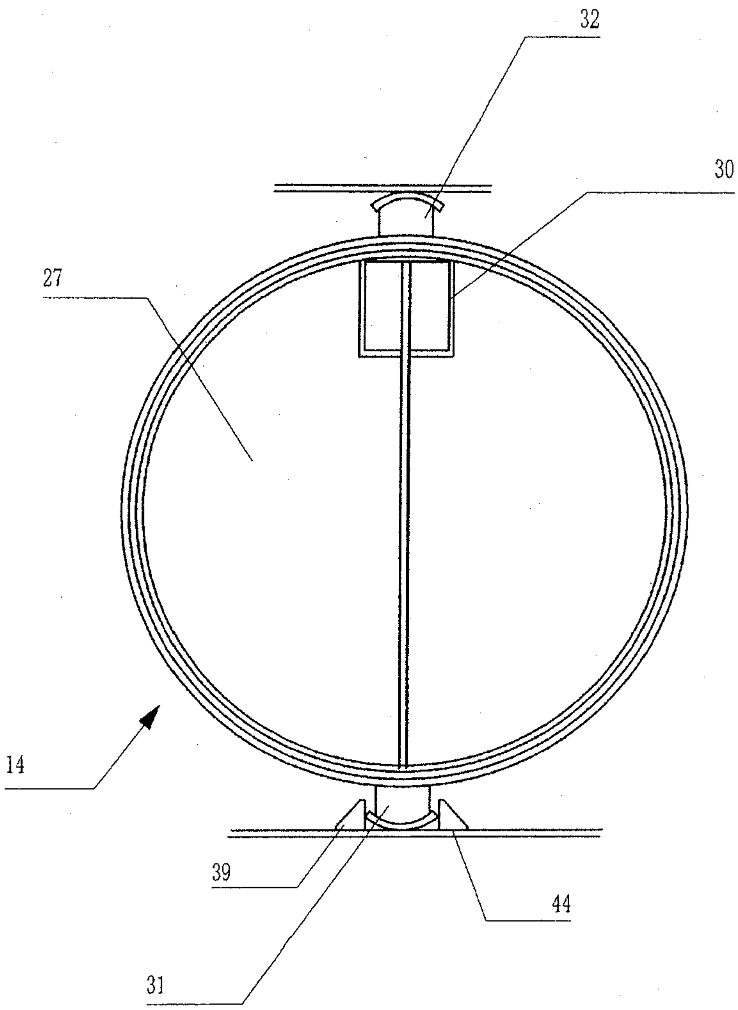


Fig. 14

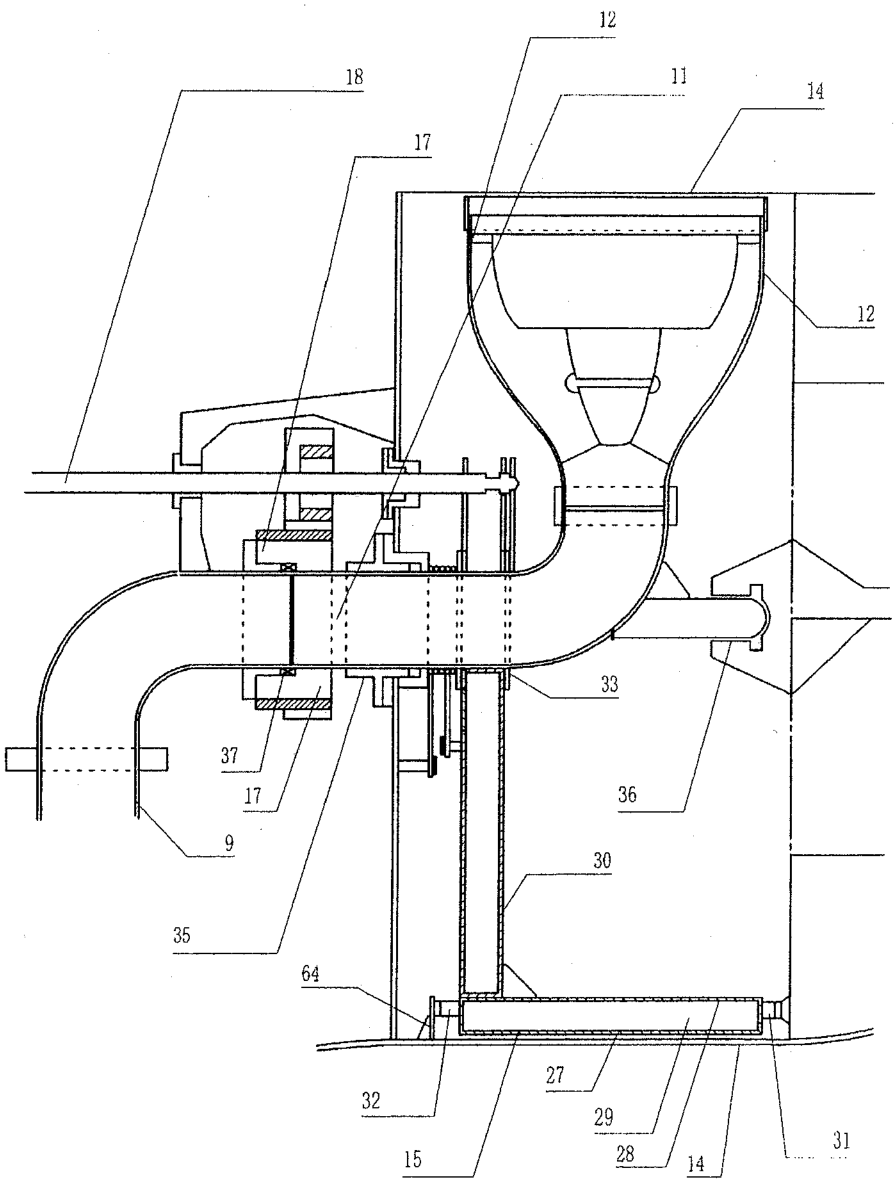


Fig. 15

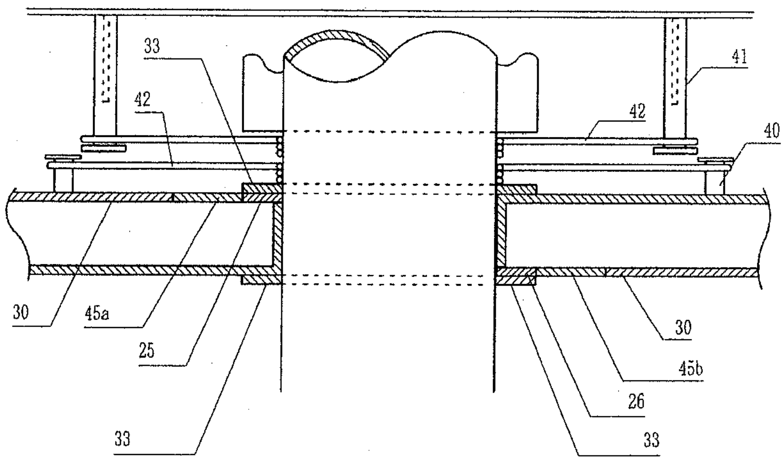


Fig. 16

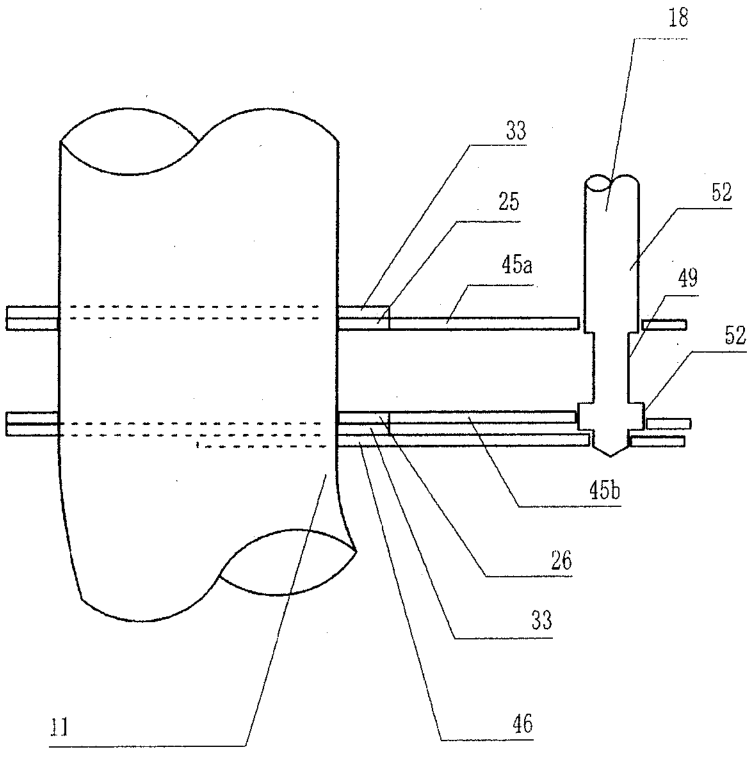


Fig. 17

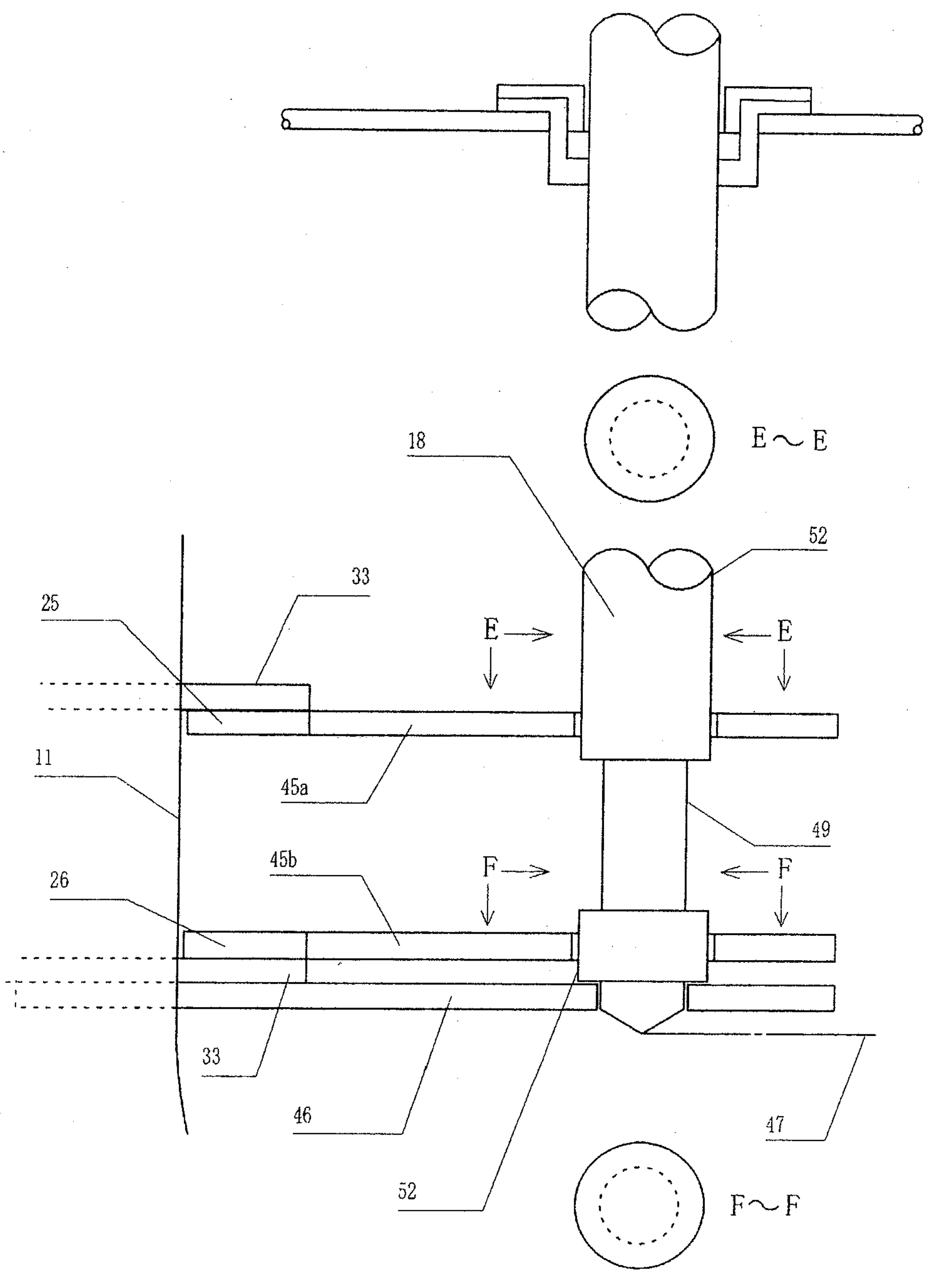


Fig. 18

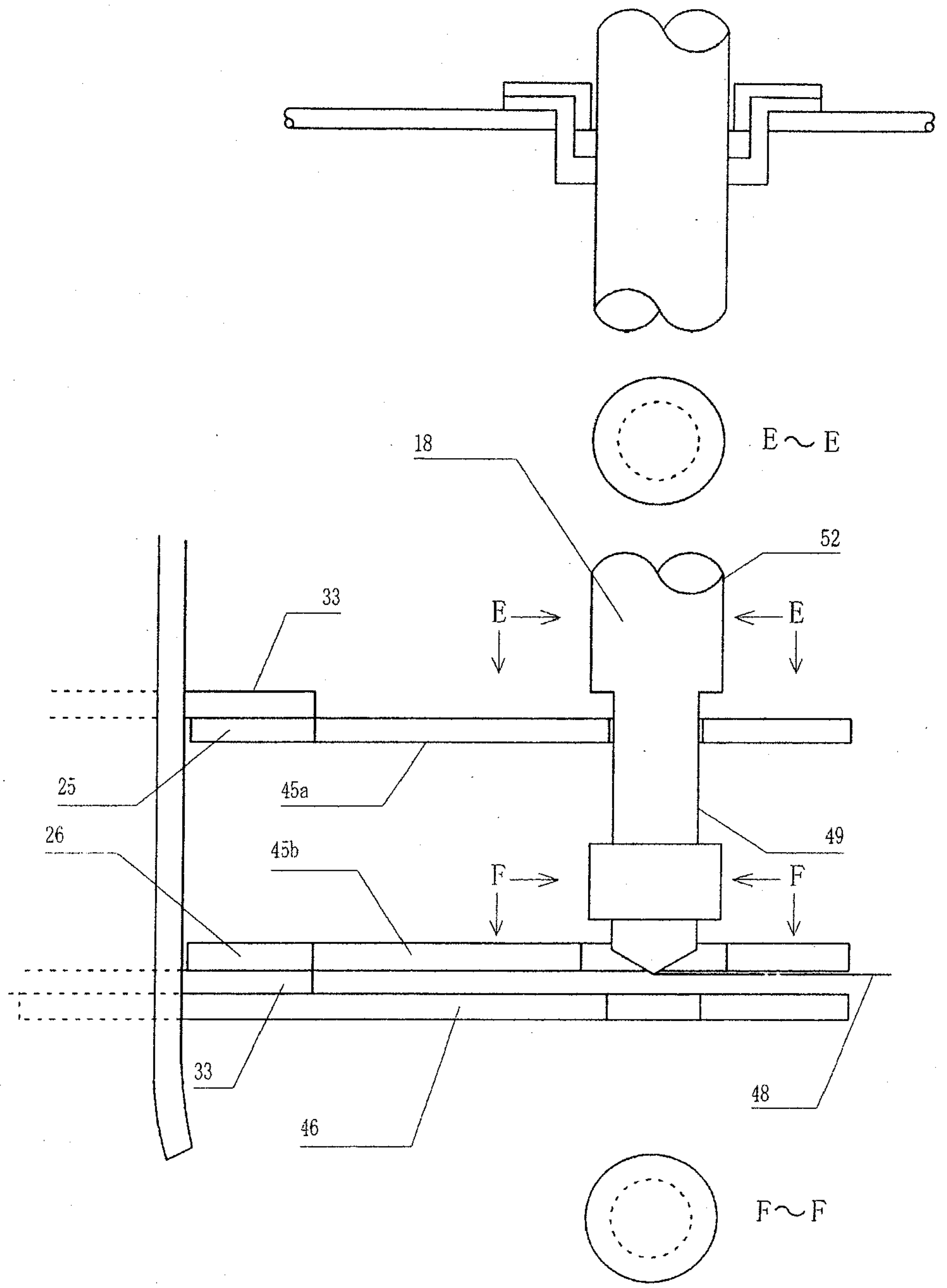


Fig. 19

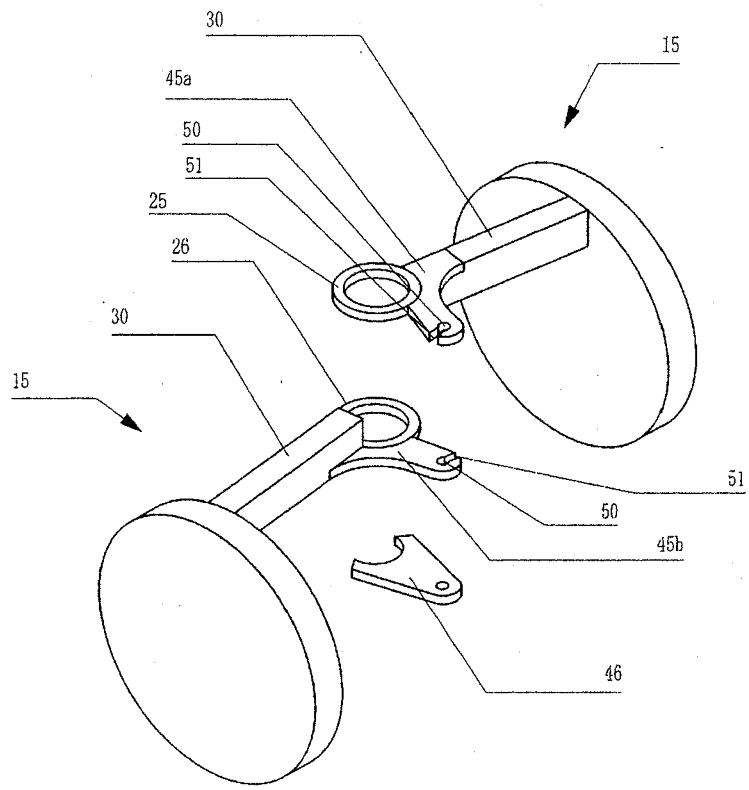


Fig. 20

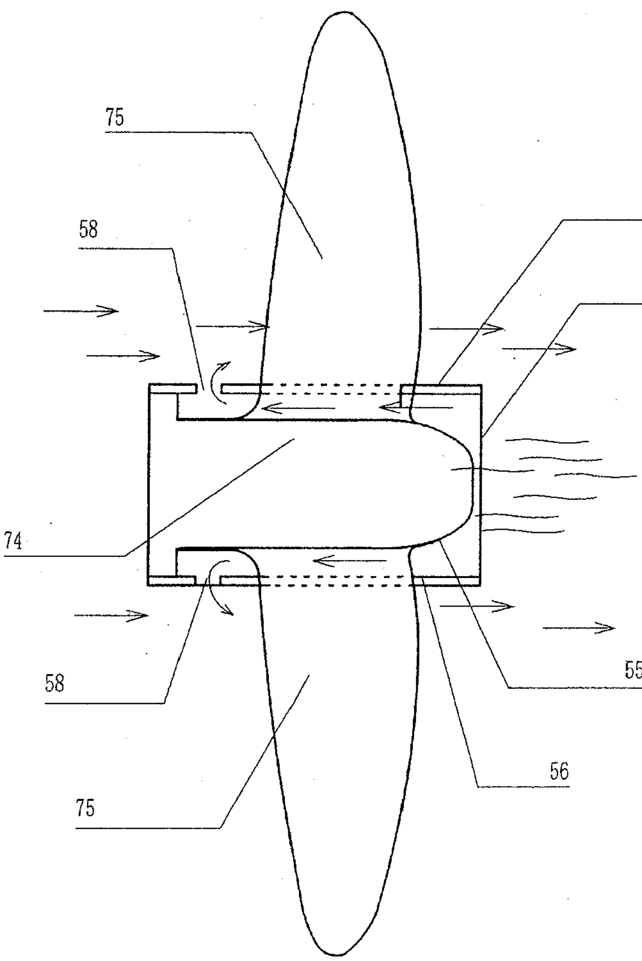


Fig. 21

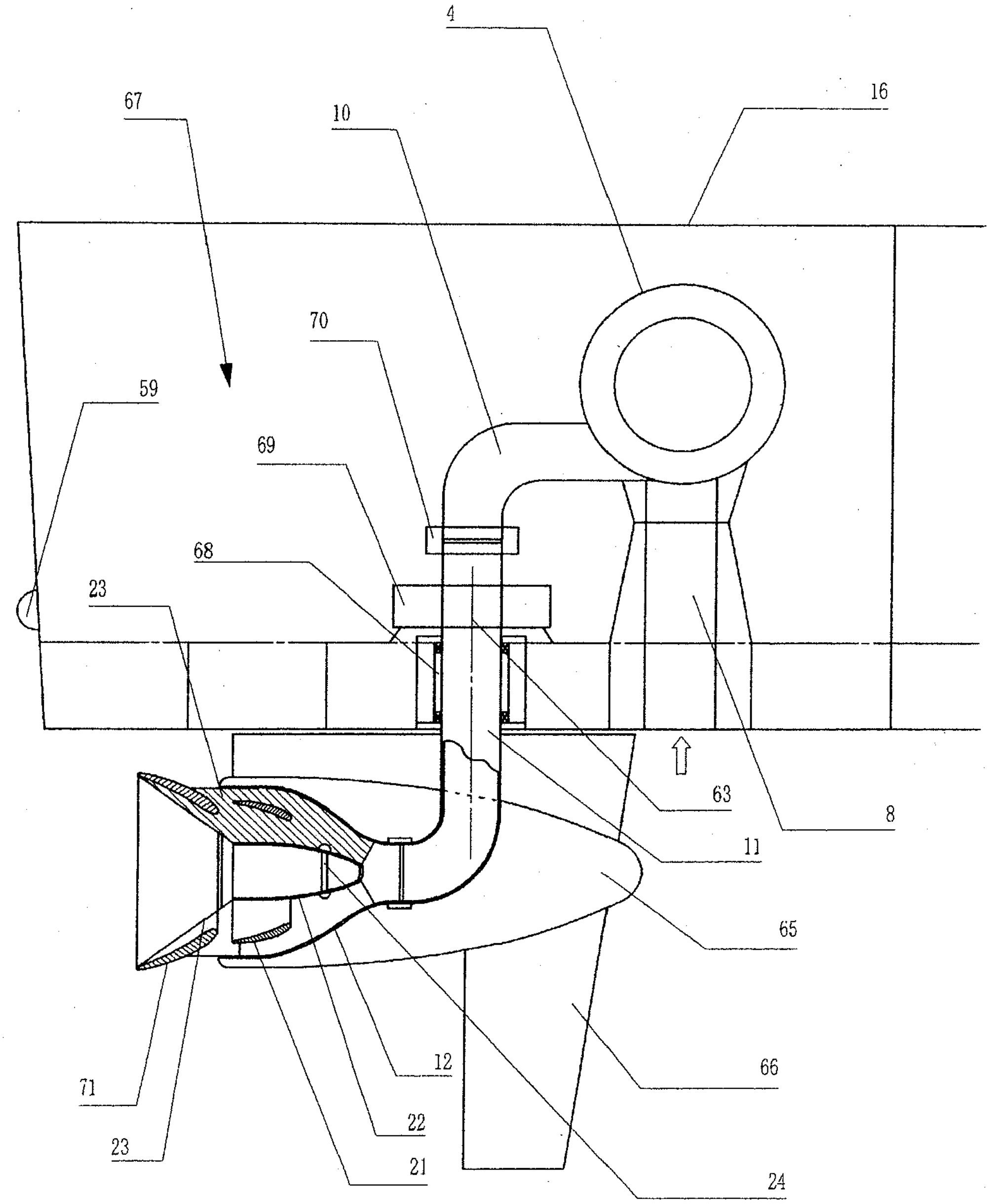
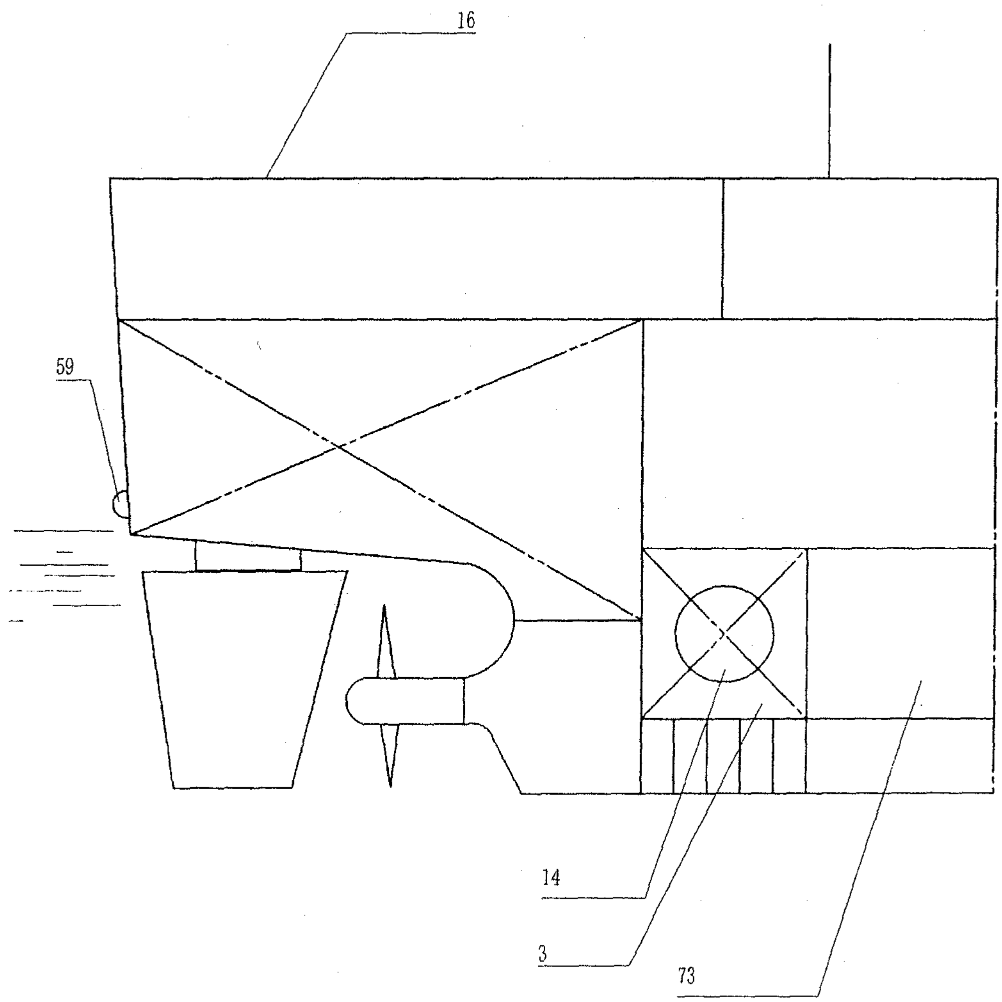


Fig. 22



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Patent documents cited in the description

- JP H05016594 U **[0003]**