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(54) **Retractable thruster for vessels**

(57) A thruster device provides thrust for moving a vessel. A thruster unit (1) has a propeller (8) for generating the thrust and a compact power system (9,10) for providing power to rotate the propeller. A compact retractor assembly moves the thruster unit between a recessed position and an operational position. The thruster unit (1) has a piston element (3), and the retractor assembly comprises a housing (2) having an inner space

(21) for receiving the piston element. The inner space receives a pressure fluid (24) for applying a hydraulic pressure on the piston element for the moving of the thruster unit. The propeller has an outer ring (80). The outer ring has a sequence of magnets (9) cooperating with coils (10). A coil current provided by a power control unit generates a magnetic force on the sequence of magnets to rotate the propeller.

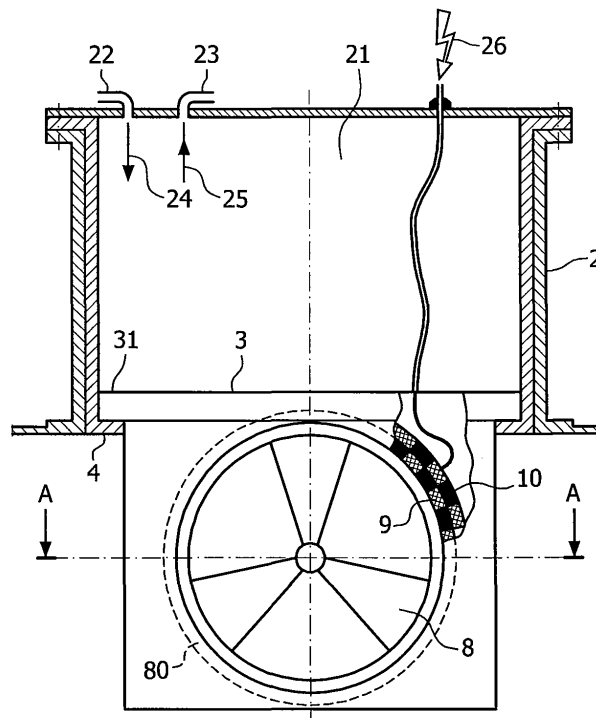


FIG. 2

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Description

FIELD OF THE INVENTION

[0001] The invention relates to a thruster device for providing thrust for moving a vessel forward or sideways, the device comprising a thruster unit having a propeller for generating the thrust in a watery fluid while rotating and power means for providing power to rotate the propeller, and a retractor assembly for moving the thruster unit between a recessed position inside the hull and an operational position outside it.

BACKGROUND OF THE INVENTION

[0002] A retractable bow thruster is known from US 4,294,186. The thruster device comprises a main support housing which is secured to the hull of a vessel. An opening is made within the lower portion of the housing through the vessel hull to allow a thruster drive assembly to be lowered into operative position. The drive assembly includes an upper gear housing which mounts a drive gear. The upper gear housing is pivotally mounted to rotate around the axis of rotation of the drive gear. The opposite end of the upper gear housing is pivotally attached to a vertically displaceable lower gear housing which mounts an idler gear and a propeller. The idler gear drives a ring gear disposed about the propeller. When the upper gear housing is moved about its pivot axis, the lower gear housing moves vertically causing the propeller to move from a recessed position to an operative position below the bow of the boat. In the operative position the retractable bow thruster provides lateral thrust to the boat.

SUMMARY OF THE INVENTION

[0003] It is an object of the invention to provide a thruster system that is more efficient and more easily retractable.

[0004] For this purpose, according to a first aspect of the invention, the thruster unit comprises a piston element, and the retractor assembly comprises a housing having an inner space for receiving the piston element, the inner space being arranged for receiving a pressure fluid for applying hydraulic pressure on the piston element for said moving of the thruster unit.

[0005] The measures have the effect that the thruster unit is easily moved by applying hydraulic pressure. In particular an upper surface of the thruster unit may constitute the piston element, which may be moved into the inner space in the recessed position. Advantageously the unit is pushed out of its recessed position by filling the inner space with the pressure fluid. It is noted that water, in which a vessel operates the thruster system, may constitute said watery fluid and/or said pressure fluid.

[0006] For this purpose, according to a further aspect

of the invention, in the thruster unit the propeller comprises an outer ring, the outer ring comprising a sequence of magnets, and the power means comprises at least one coil for, by a coil current provided by a power control unit, generating a magnetic force on the sequence of magnets to rotate the propeller.

[0007] The measures have the effect that the sequence of magnets and the coil essentially constitute a ring-shaped linear electrical motor. The linear motor allows a compact build and efficient power transfer to the propeller. Moreover, by generating a suitable coil current, the rotation rate and the direction can be easily controlled. The power is transferred to the propeller without mechanical coupling to the power source, i.e. obviating the need for a gear immersed in the watery fluid between the power source and the propeller. Hence transmission power loss as well as wear and maintenance are substantially reduced.

[0008] The invention is also based on the following recognition. From the prior art retractable thrusters a complex mechanical construction is known for lowering the thruster unit and/or driving the propeller. Another known way is providing side thrust by a propeller in a fixed position in a tube running across the hull of a vessel below the waterline. However, the known methods of providing side thrust have severe impact on the layout of the vessel, and may require maintenance. The inventor has provided a mechanism for driving the propeller and for moving the thruster unit that is compact and efficient, may be located anywhere on the vessel, and requires little maintenance.

[0009] In an embodiment of the thruster device the retractor assembly comprises a hydraulic power source for providing the pressure fluid for moving the thruster unit from the recessed position to the operational position. This has the advantage that, when operation of the thruster is required, the pressure fluid is automatically provided by the hydraulic power source, usually a self-switching pressure pump.

[0010] In an embodiment of the thruster device, the retractor assembly is arranged for reducing the hydraulic pressure for moving the thruster unit from the operational position to the recessed position. This has the advantage that, by simply reducing the hydraulic pressure in the inner chamber the thruster unit will move to its recessed position. The hydraulic pressure may be reduced by a pump, which may be the same pump used to move the thruster down, e.g. by reversing the flow of the pressure fluid using valves or by reversing the turning direction of the pump.

[0011] In an embodiment of the thruster device, the power means comprise a hydraulic drive unit for providing hydraulic power to rotate the propeller. This has the advantage that subsequent to moving the thruster unit to its operational position, the same hydraulic power is used for generating the thrust by suitable guiding the pressure fluid to the hydraulic drive unit.

[0012] In an embodiment the thruster unit comprises a housing having a tubular slot shaped to receive the

outer ring. This has the advantage that mechanical stability of the propeller is increased. In particular the tubular slot and/or the outer ring may comprise grooves for guiding the watery fluid while rotating for constituting a fluid layer to reduce friction. This has the advantage that the watery fluid itself constitutes a lubricating cushion between the static housing and the rotating propeller.

[0013] Further preferred embodiments of the device according to the invention are given in the appended claims, disclosure of which is incorporated herein by reference.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] These and other aspects of the invention will be apparent from and elucidated further with reference to the embodiments described by way of example in the following description and with reference to the accompanying drawings, in which

Figure 1 shows a thruster system in a vessel,
 Figure 1 a shows a vessel in side view,
 Figure 1 b shows part of a vessel and a thruster device having a thruster unit in operational position,
 Figure 1 c shows part of a vessel and a thruster device having a thruster unit in recessed position,
 Figure 2 shows a thruster device having a hydraulic lift system,
 Figure 3 shows a cross-section of a thruster unit,
 Figure 4 shows a retractable thruster device having a mechanical lift system,
 Figure 5 shows a retractable thruster device having mechanical drive system,
 Figure 6 shows a thruster device having a hydraulic drive system, and
 Figure 7 shows a retractable thruster device having an electrical lift system.

Corresponding elements in different Figures may have identical reference numerals.

DETAILED DESCRIPTION OF EMBODIMENTS

[0015] Figure 1 shows a thruster system in a vessel. Figure 1a shows a vessel in side view. The vessel 10 has a retractable thruster device 11 near the bow, usually called a bow thruster or side thruster. Alternatively, or additionally, a retractable thruster 12 is shown near the stern. The vessel has a thruster 13 for propulsion in forward (or backward) direction. It is noted that thruster 13 may be a normal propeller in a fixed position, for example powered by a diesel engine. However, thruster 13 may also be a thruster unit as described below, in a fixed or retractable setup.

[0016] Figure 1 b shows part of a vessel and a thruster device having a thruster unit in operational position. The thruster device 11 has a thruster unit 1 that has been moved to an operational position as indicated by arrow

14, i.e. the propeller is immersed in the water around the vessel for generating thrust while rotating.

[0017] Figure 1 c shows part of a vessel and a thruster device having a thruster unit in recessed position. The thruster unit 1 has been moved to a recessed position as indicated by arrow 15, i.e. the propeller is retracted from direct contact with the water around the vessel to a location inside the hull substantially not affecting the shape of the hull. It is noted that the shape of the thruster unit may be designed to substantially close the opening in the hull when recessed. Alternatively a separate closing element may be moved to close the opening.

[0018] Figure 2 shows a thruster device having a hydraulic lift system. The Figure shows a thruster unit 1 movable in a housing 2. The assembly of the housing and thruster unit, called thruster device, is fixed to the inside bottom of a vessel. The thruster device is to provide a thrust for moving the vessel. The thruster unit has a propeller 8 for generating the thrust in a watery fluid while rotating and power system 9,10 for providing power to rotate the propeller. The thruster device has a retractor assembly for moving the thruster unit between a recessed position and an operational position. The thruster unit has a piston element 3, and the housing 2 has an inner space 21 for receiving the piston element 3. The piston element 3 may be constituted by part of the outer walls and the upper surface of the thruster unit, and functions as a piston in the inner space 21. The inner space 21 constitutes a chamber that is intended for receiving a pressure fluid as indicated by arrow 24 for applying hydraulic pressure on the piston element 3 to move the thruster unit 1 out of the housing 2. Thereto the chamber is connected to a pressure fluid source via pipes 22,23 which are controlled by valves (not shown) to guide the pressure fluid into and out of the inner space 21.

[0019] The pressure in the inner space may be controlled by a hydraulic system coupled to the pipes 22,23 for applying a hydraulic pressure on the piston element for moving of the thruster unit between the recessed position and the operational position.

[0020] The pressure fluid system may a closed system based on any suitable fluid for operating various equipments on the vessel. Usually the fluid is water like the water in which the vessel runs. The pressure fluid may also be provided from a pressurised reservoir, or by manual force. Conveniently, the pressure fluid may be provided by a hydraulic power source, e.g. a self-switching pump, coupled to or forming an integral part of the thruster device. When the hydraulic pressure is reduced, the thruster unit will start moving from the operational position to the recessed position.

[0021] Figure 3 shows a cross-section of a thruster unit. The Figure shows a cross-section along line A-A in Figure 2. Seen from above, the thruster unit 1 is oblong in shape. It can travel up and down in the housing in the manner of a piston by applying or reducing pressure (or apply suction) in the chamber above the thruster unit. Water may be used as hydraulic fluid. A standard self-

switching outside water pump may be used to pressurize the chamber.

[0022] When the thruster unit 1 is fully lowered, a flange 31 at the upper side of the thruster unit 1 lands on a matching flange 4 in the lower end of the housing 2, sealing off the chamber. The pressure on the fluid above the thruster unit will help fixate the thruster unit in that position. A mechanical locking mechanism (not shown) may be used to fixate the thruster unit in the operational position, and subsequently the hydraulic pressure is no longer required.

[0023] When the thruster unit is in raised position, it may be held in place by a magnetic or mechanical locking mechanism (not shown), so that hydraulic pressure is no longer required which will permit the pressure pump to be switched off while the unit is not in use.

[0024] The thruster unit 1 is shown having an electrical power system for providing power to rotate the propeller. The propeller 8 has an outer ring 80. The outer ring 80 has a sequence of magnets 9. The power system further has one or more coils 10 for generating a magnetic force on the sequence of magnets to rotate the propeller. A coil current 26 is provided by a power control unit (not shown) to the coils 10. During rotation, the coil current appropriately alternates to generate the magnetic force when the magnets 9 pass the coils 10, the system constituting a substantially linear motor moving in a circular way. The magnets and coils are positioned at close range, as is well-known as such in the field of linear electrical motors. Hence the propeller may be electrically driven by the permanent magnets 9 embedded in the ring and electromagnets, e.g. coils 10, built into the thruster unit housing. Suitably controlled alternating current in the electromagnets makes the ring turn. An electronic control unit is used to control the alternating current and by it the speed and the direction of rotation.

[0025] In general, the propeller is ring-shaped with propeller blades inside the ring 80. The ring having a cross-section 81 may fit into a matching tubular slot 82 in the thruster unit housing as shown in Figure 3. Friction between the propeller unit and the housing, which due to the thrust generated will be mainly lateral, may be absorbed by bearings 32 on both sides of the ring, and/or by the magnetic force generated by the magnets.

[0026] In an embodiment water pressure may be built up on the side of the ring where the friction occurs. The water pressure can be built up by the same pump used to raise and lower the thruster unit, and/or by the rotation of the propeller. Thereto the tubular slot 82 and/or the outer ring 81 may have grooves for guiding the watery fluid while rotating to create a fluid layer constituting a cushion. Advantageously the unit may be water-lubricated to avoid complex underwater oil-based lubrication. Suitable materials are available that are sufficiently strong, water resistant, non corrosive and have a low frictional resistance enhanced by water lubrication. Advanced plastics such as carbon or graphite reinforced polytetrafluoroethylene (PTFE, also called Teflon) are to be considered.

[0027] It is noted that a grating may be added on each side of the propeller to prevent underwater debris from entering the space between the blades. The blades may be sharpened to cut through debris like seaweed.

[0028] It is noted that the thruster device may be operated from a control panel with an electronic control unit, e.g. for lowering and raising the thruster unit before and after operation.

[0029] Figure 4 shows a retractable thruster device having a mechanical lift system. The electrical drive system of the propeller corresponds to Figure 3. The Figure shows mechanical lift system consisting of two vertical screw jacks 41 running through the thruster unit 1, driven by a worm wheel array 43 on the top of the housing, and a motor 42 mounted on the side of the unit. It is noted that the mechanical lift system may also be powered differently, e.g. manually.

[0030] Figure 5 shows a retractable thruster device having mechanical drive system. The hydraulic lift system corresponds to Figure 3. The Figure shows a mechanical drive system for the propeller. The ring 80 is fitted with a longitudinal groove 83 in which a belt 51 fits, for example a V belt. The belt runs over a small drive wheel 52 in the upper part of the housing 2, which is driven by a electric motor 54 on the outside of the housing. In raised position, the idle drive wheel 52 fits into a cavity 53 in the upper part of the piston element 3. The length of the belt 51 is such that when the thruster unit 1 is lowered, the belt 51 tensions around the drive wheel 52 and the ring 80. To avoid slip, cogged wheels and a toothed belt may be used. In a further embodiment the mechanical drive system may be formed by a cog wheel driven by a motor coupled, either directly or via a gear, to the propeller.

[0031] Figure 6 shows a thruster device having a hydraulic drive system. The hydraulic lift system corresponds to Figure 3. The Figure shows a hydraulic drive system for the propeller. The ring 80 is equipped with blades or cogs 64 and driven by pressurized water pumped into the unit through channels 61, 62. An additional cog wheel 63 may be used to convert the force from the pressure fluid in a rotating movement. In this case, a single outside pressure pump 65 may be used to drive the unit and to raise and lower the thruster unit. Valves 66 may be used to direct the pressure as needed.

[0032] Figure 7 shows a retractable thruster device having an electrical lift system. The drive system of the propeller may correspond to any of the drive systems described above with Figures 3-6. The Figure shows an electrical lift system consisting of permanent magnets 72 in the edges of the piston element 3 and row of opposing electromagnets 71 built into the housing 2. Current 73 in the electromagnets will make the thruster unit 1 move down or up. Thus the lift mechanism works as a linear motor. An electronic control unit is used to steer the current and the direction of motion.

[0033] It is to be noted that any type of vessel, leisure or commercial vessels of any size, may be equipped with

the thruster system according to the invention, either for generating side thrust for maneuvering the vessel, or for operational thrust for moving forward or backward.

[0034] It may further be noted that boats of all sorts are increasingly being equipped with side thrusters as side thrusters greatly facilitate maneuvering a vessel. The advantages of the thruster device over existing thrusters are to be noted.

[0035] An example of retractable side thrusters from US 4,294,186 has been discussed above. Known retractable thrusters mostly have a delicate lowering system with various seals to prevent leakage around moving parts. The propeller is usually driven by a conventional motor making the unit fairly wide, thus requiring a quite large hull opening. The unit itself is comparatively large and heavy.

[0036] The lateral tube of a conventional side thruster of the transverse tube type causes considerable drag when sailing, reducing speed and increasing fuel consumption of the vessel. The thruster unit of the invention causes virtually no drag when retracted.

[0037] Also to be noted is that boat design has changed considerably over the past years. Boats are lighter and wider, with less draught and a flatter bottom, as a result of which there is less room to fit a conventional tube thruster. At the same time there is a tendency to increase the hull height above the waterline. This leads to the need for a side thruster, as the hull will catch considerably more wind making the vessel difficult to maneuver. The new thruster device provides an evident solution for these design implications.

[0038] Advantageously, the thruster device can be placed at any convenient point in the hull. Due to its comparatively small size, it can be placed far forward in the vessel where the side-thrust effect on the bow is optimal, reducing the power required. Also the thruster device may be placed off-centre. Ships may have a keel beam or other vital parts which may not be affected, or the interior layout may stand in the way of placing the unit in the centre line of the ship.

[0039] Note that the thruster device is equally suitable as a stern thruster. At the stern, vessels tend to be even flatter than at the bow, making the fitting of a tube thruster difficult or impossible.

[0040] The thruster device will need just a small oblong opening in the hull, the sacrificed skin surface being much smaller than for other types of thruster. The thruster device is easy to install.

[0041] The thruster device provides for easy maintenance. The top of the housing may be a removable plate. This permits the unit to be lifted out of the housing inside the vessel, allowing easy repair or replacement. As in most cases the top of the housing will be above the waterline of the vessel, this can be done without the need to lift the vessel out of the water.

[0042] The thruster unit can be protected against being lowered or kept downward above a preset speed by an electronic link to the ship's log (speed indicator).

[0043] Although the invention has been explained mainly by embodiments showing the thruster unit in combination with a retractor assembly, it is to be noted that the thruster unit on its own is suitable for any type of vessel. The thruster unit may be mounted in a single, predetermined operational position, or may be movable in any suitable way to an operational position, e.g. hinged, or by a mechanical attachment system. Furthermore, although the lift mechanism of the thruster device has been mainly discussed based on a hydraulic power source like a pump, other power sources for movement may be selected where appropriate, e.g. manual force on a small vessel.

[0044] It is noted, that in this document the word 'comprising' does not exclude the presence of other elements or steps than those listed and the word 'a' or 'an' preceding an element does not exclude the presence of a plurality of such elements, that any reference signs do not limit the scope of the claims, that the electrical control units of the invention may be implemented by means of both hardware and software, and that several 'means' may be represented by the same item of hardware. Further, the invention is not limited to the embodiments, and lies in each and every novel feature or combination of features described above.

Claims

1. Thruster device for providing a thrust for moving a vessel, the device comprising

- a thruster unit (1) having a propeller (8) for generating the thrust in a watery fluid while rotating and power means (9,10) for providing power to rotate the propeller, and
- a retractor assembly for moving the thruster unit between a recessed position and an operational position,

characterized in that

- the thruster unit (1) comprises a piston element (3), and
- the retractor assembly comprises a housing (2) having an inner space (21) for receiving the piston element, the inner space being arranged for receiving (24) a pressure fluid for applying hydraulic pressure on the piston element for said moving of the thruster unit.

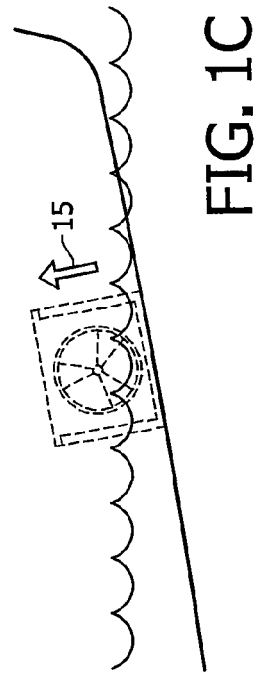
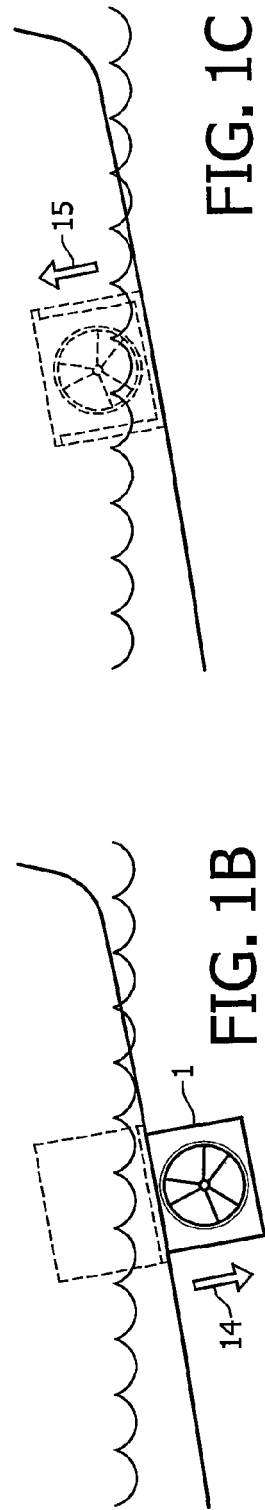
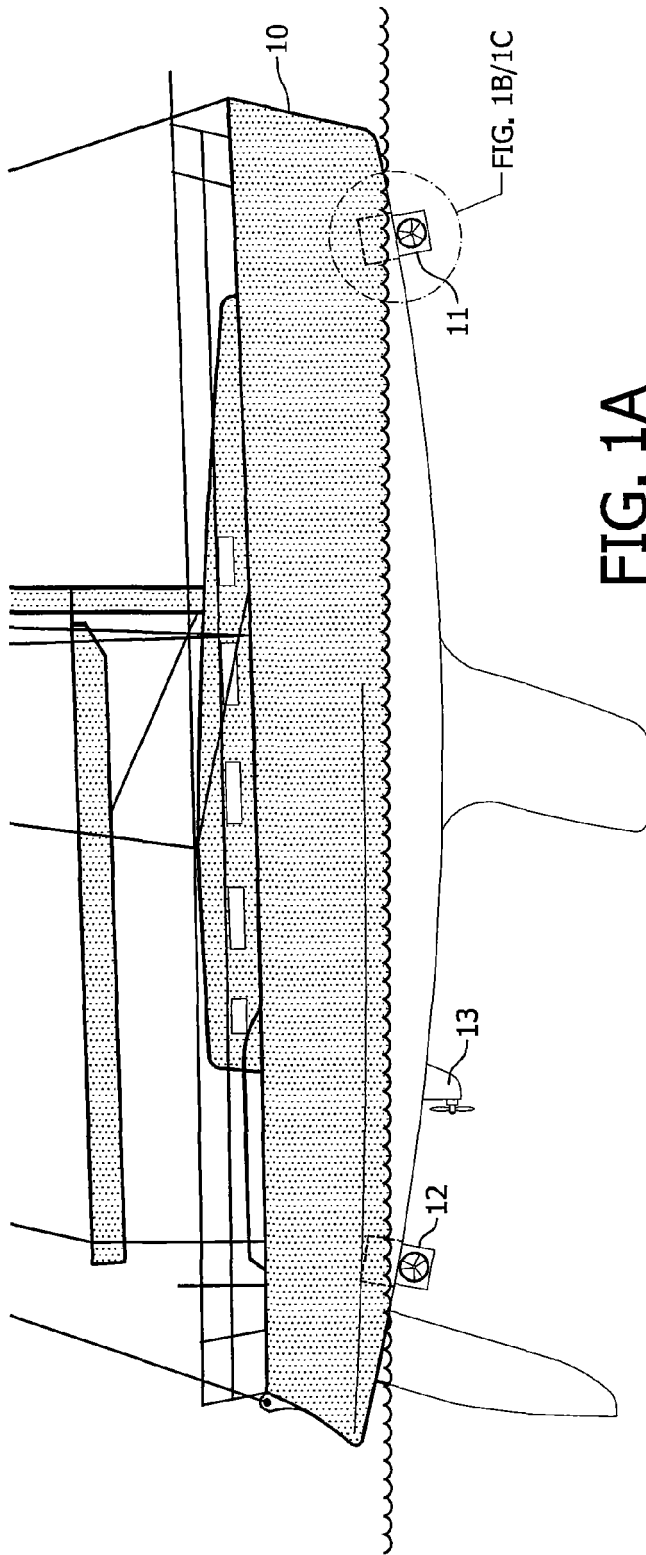
2. Thruster device as claimed in claim 1, wherein the retractor assembly comprises a hydraulic power source (65) for providing the pressure fluid for moving the thruster unit from the recessed position to the operational position.

3. Thruster device as claimed in claim 1, wherein the

retractor assembly is arranged for reducing (25) the hydraulic pressure for moving the thruster unit from the operational position to the recessed position.

any of claims 1 to 7, or a thruster unit as claimed in any of claims 8 to 10.

4. Thruster device as claimed in claim 1, wherein the piston element (3) comprises a flange (31) for contacting a flange (4) of the housing (2) in the operational position. 5
5. Thruster device as claimed in claim 1, wherein the power means comprise a hydraulic drive system (61,62,63,64) for providing hydraulic power to rotate the propeller. 10
6. Thruster device as claimed in claim 1, wherein the power means comprise a motor (54) and mechanical coupling means (51,52) for providing power to rotate the propeller. 15
7. Thruster device as claimed in claim 1, wherein the propeller (8) comprises an outer ring (80), the outer ring comprising a sequence of magnets (9), and the power means comprise at least one coil (10) for, by a coil current provided by a power control unit, generating a magnetic force on the sequence of magnets to rotate the propeller. 20 25
8. Thruster unit for providing a thrust for moving a vessel, the unit comprising 30
- a propeller (8) for generating the thrust in a watery fluid while rotating,
 - power means (9,10) for providing power to rotate the propeller,
- 35
- wherein
- the propeller comprises an outer ring (80), the outer ring comprising a sequence of magnets (9), and
- 40
- the power means comprises
- at least one coil (10) for, by a coil current provided by a power control unit, generating a magnetic force on the sequence of magnets to rotate the propeller.
- 45
9. Thruster unit as claimed in claim 8, wherein the thruster unit comprises a housing (33) having a tubular slot (82) shaped to receive the outer ring (81). 50
10. Thruster unit as claimed in claim 8, wherein the tubular slot (82) and/or the outer ring (81) comprise grooves for guiding the watery fluid while rotating for constituting a fluid layer to reduce friction. 55
11. Vessel comprising a thruster device as claimed in



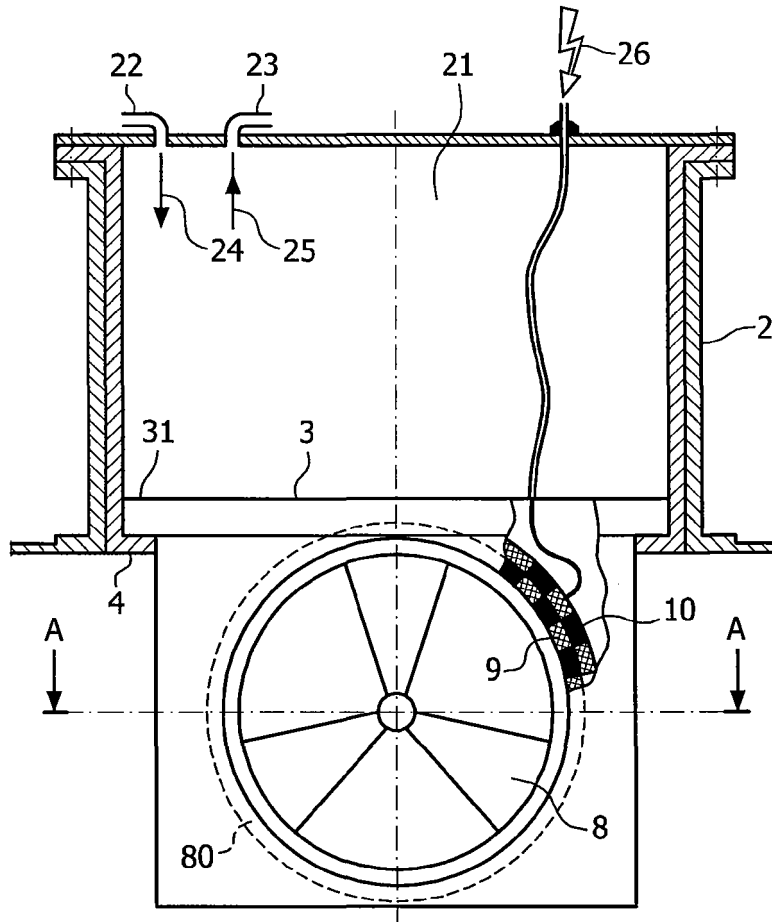


FIG. 2

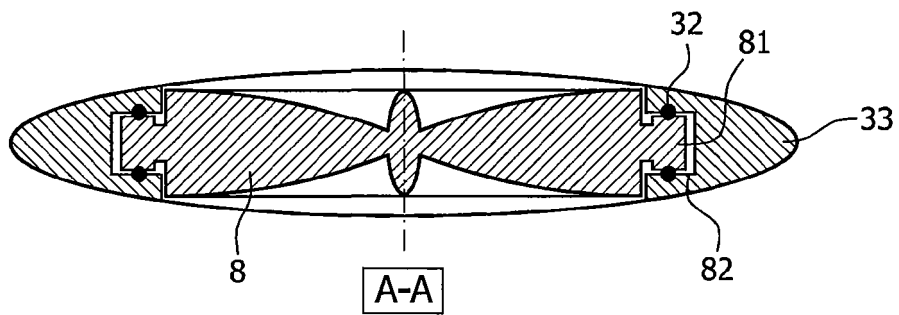
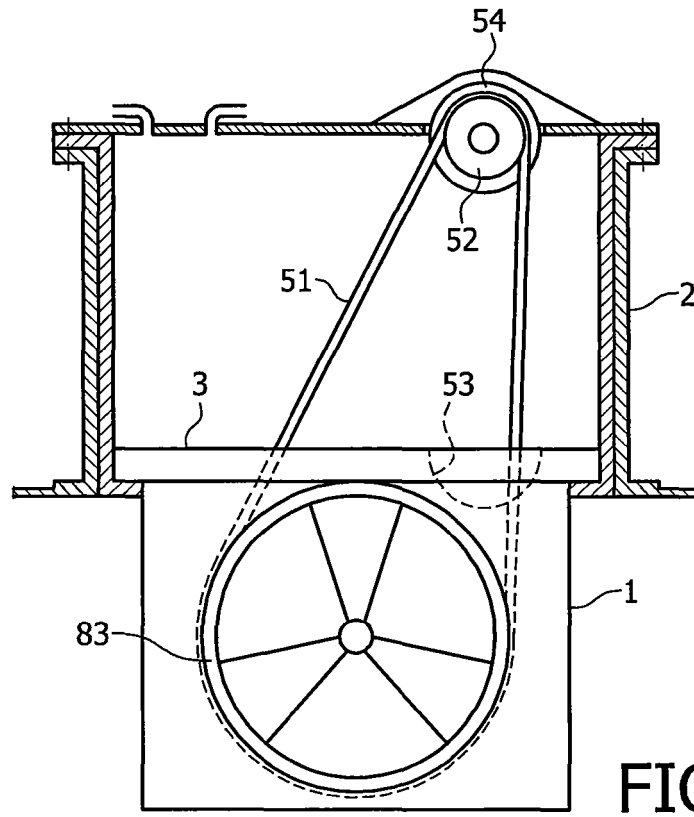
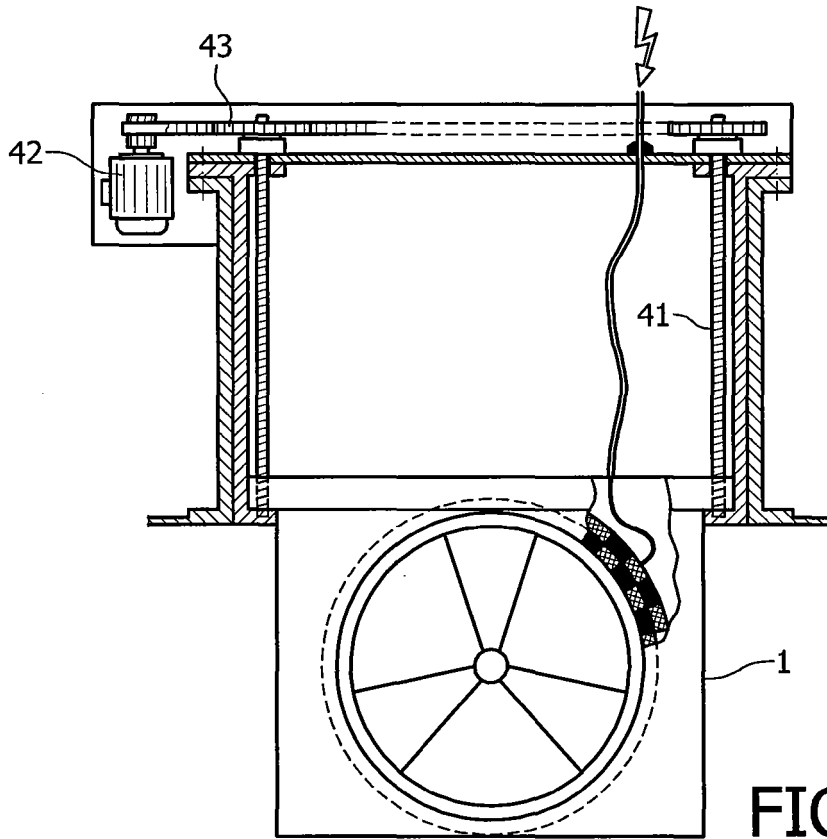


FIG. 3



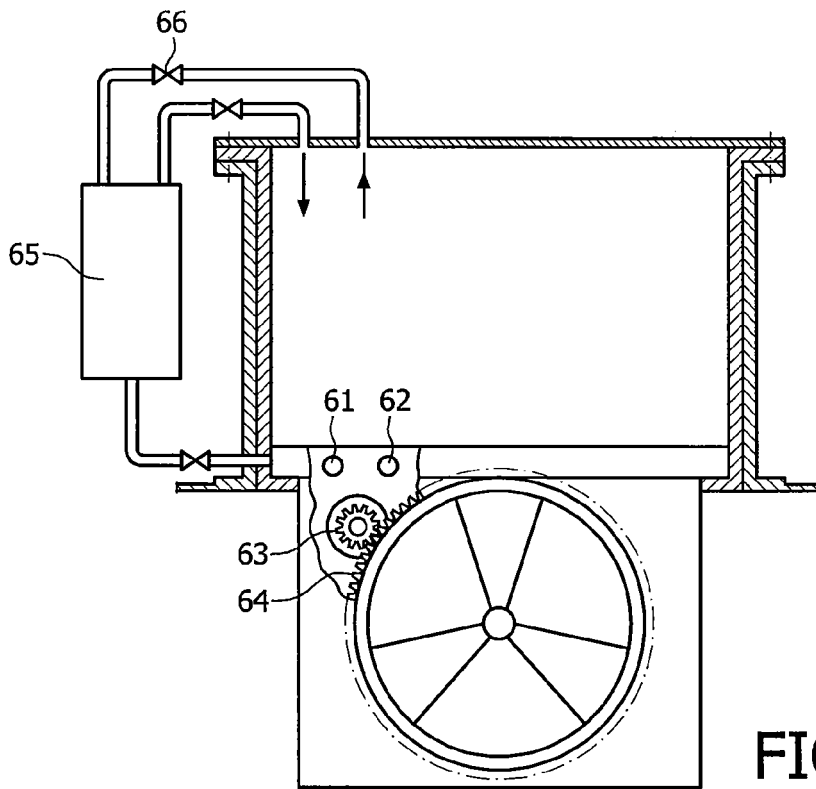


FIG. 6

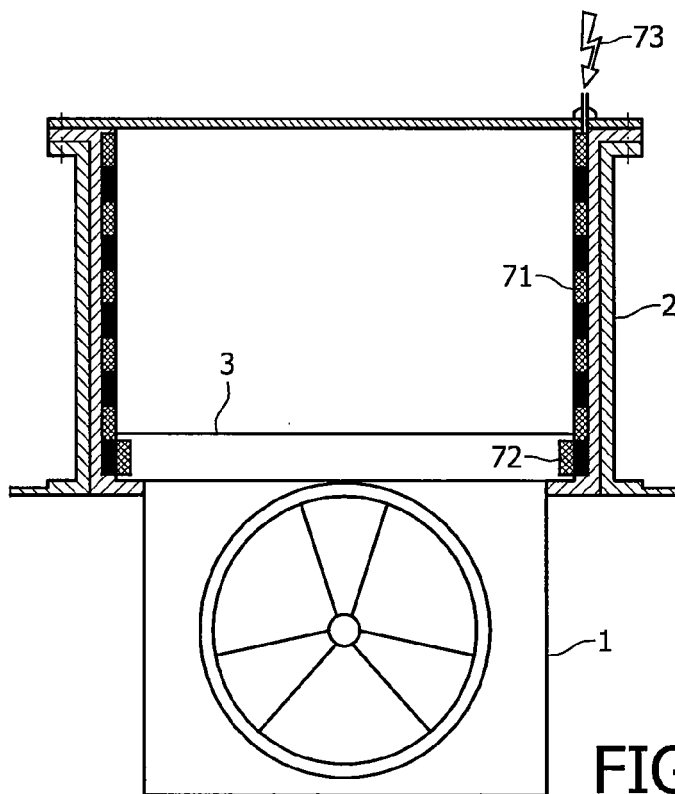


FIG. 7

REFERENCES CITED IN THE DESCRIPTION

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