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(54) **DOUBLE-ENDED TRIMARAN FERRY**

DOPPELEND-TRIMARAN-FÄHRE

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- **"'PRINSESSE BENEDIKTE'. THE FIRST OF A BRACE OF DIESEL-ELECTRIC POWERED, DOUBLE-ENDED FERRIES BUILT BY ORSKOV STAALKIBSVAERFT SCANDLINES", SHIPPING WORLD AND SHIPBUILDER, IMAREST PUBLICATIONS, LONDON, GB, vol. 198, no. 4133, 1 May 1997 (1997-05-01), pages 28/29,31-34,36, XP000690153, ISSN: 0037-3931**

EP 2 571 750 B1

Description

Introduction

[0001] The present invention relates to a double-ended trimaran ferry. More specifically, the trimaran ferry of the invention is designed for use in rough seas with large waves being prevailing quartering and beam seas to the ferry, but the trimaran ferry also has advantageous properties in environmentally sensitive waters due to its low wake wash signature.

Background:

[0002] A ferry solution was initially sought to a particular route across the Outer Oslofjord, but the solution found is also suitable for other relatively short but harsh ferry routes. The route particular route has the following characteristics:

- One way distance between planned terminal ramps is 7.4 nautical miles.
- Frequent departures, preferably every hour by one ferry
- Assuming minimum 6 minutes turn around time in port and 3 minutes for manoeuvring and acceleration/decelleration, 21 minutes are left for full speed. A service speed in excess of 21 knots is required.
- It is a rough weather route with predominant wind and wavedirection from south to south west. Large waves are only occuring from south to south west, and the large ocean waves will come into the fjord as quartering and beam seas to the ferry crossing the fjord.
- Greenfield ports with ramps and fendering systems will have to be built on both sides of the fjord in environmentally sensitive areas.
- It would be a great advantage with low ramps and fendering systems to have low profile ports which are more visually and environmentally acceptable.

Turning in port should be avoided due to a number of reasons: One should avoid disturbing nearby cottages and leisure crafts. Turning may be difficult or prohibited due to lack of space and it is very expensive to expand dredge/blast a rocky bottom. One should avoid disturbing bottom biotopes with the propulsion devices such as waterjets or propellers. One should save valuable turning time which could otherwise be used for steaming.

- Hinterland infrastructure and a densely populated area on the western side of the fjord makes it difficult for large trucks to enter the port without large investments. Thus, the need for transporting large quantities of trucks would be limited, and the ferry should be small to medium sized as the traffic volume will be limited to cars, light trucks and busses. Thus a relatively small ferry will be used, which shall have a relatively high service speed in comparison to its waterline length, thus the ferry will operate at a high Froude number, Fn = v / sqrt (L*g); v= vessel speed in m/s, L = waterline length in m, and g is the acceleration of gravity.
- Environmental NOx tax is according to diesel consumption. Installed power should be low, and alternative fuels such as LNG or biogas should be considered.

[0003] A large and high powered double-ended conventional ferry (over 100 meters in length over all), may be designed with a service speed of 21 knots, but such a conventional ferry would be expensive to build and operate. The capacity of such a ferry would significantly surpass demand on this route.

[0004] Double-ended catamarans have slender hulls and may operate at high Froude numbers to reach a speed of over 21 knots service speed with a reasonable vessel size compared to demand. However, double-ended catamarans are stiff and uncomfortable in quartering and beam seas. The tunnel clearance will have to be high to avoid slamming in the large ocean waves (and wave reflexions from shore). Tunnel clearance will drive investment costs of port facilities.

[0005] German Gebrauchsmuster DE 20 2004 020 606 U1 describes such a double-ended catamaran hull ferry. The German catamaran has long, slender hulls. Propellers are arranged in the catamaran tunnel. Further, the German ferry has a generally open car deck. As such the ferry according to the German Gebrauchsmuster is not suited for exposed waters under harsh conditions and subject to quartering and beam seas. Heavy head seas would be prohibitive for a ferry according to the German Gebrauchsmuster. Another disadvantage is that such a catamaran design will be very stiff and uncomfortable.

[0006] Ordinary catamaran and trimaran fast ferries may be built the right size according to route demand. While the catamaran is stiff and uncomfortable in quartering and beam seas, a trimaran would offer superior sea keepings and comfort. Both a conventional catamaran and a conventional trimaran would have to turn in port, and they would require longer time for manoeuvring and turnaround than a double-ended ferry. Thus the required service speed and propulsion power would significantly exceed that of a double-ended vessel. Moreover, the ports would have to be expanded by dredging or blasting (if at all possible), both at heavy cost.

Short summary of the invention

[0007] The invention is a double-ended trimaran ferry with a central displacement hull with a first end and a second end, two side hulls, at least one engine providing power to propulsors, and a main deck for vehicles or cargo, comprising:

* said central displacement hull arranged for carrying

a major share of the displacement of the ferry;

* said side hulls being symmetrical about a vessel centre line of said ferry;

* said central displacement hull and said side hulls being generally fore and aft symmetrical about a midship section;

* said side hulls having a design waterline length of between one third and a full length of a design waterline length of said central displacement hull.

[0008] The ferry according to the invention will have good sea keepings in exposed waters with quartering and beam seas compared to double-ended ferries according to the background art.

[0009] In a preferred embodiment of the invention, the double-ended trimaran ferry's main deck comprises a central deck extending generally along an entire length between the first end and the second end. In a preferred embodiment of the invention, the double-ended trimaran ferry comprises side decks arranged to either sides of the main central deck. In a preferred embodiment of the invention, the vehicle entry ramps of the ferry will be along the main central deck of the ferry. Alternatively, the deck may be provided with a quartering or side ramp. The central portion of the main deck may comprise a recess so as for allowing head clearance for large vehicles in the central hull.

Advantages of the invention

[0010] One particular advantage of the invention is its rough weather capabilities, i.e. the seaworthiness of the vessel of the invention.

[0011] Further, the trimaran according to the invention has a low wake wash and is thus suitable for environmentally sensitive waters and will do very little harm to beaches and to other traffic and to pleasure boats, even at high speed.

[0012] The invention and solution to the problem, the double-ended trimaran vessel, will offer the same main advantages as conventional doubled-ended ferries. That is, it will not have to turn in port, it will be easy manoeuvrable and the car deck will offer drive through for cars and trucks, and walk through for passengers.

[0013] The ferry of the invention may have a relatively high service speed and may operate comfortably and efficiently in rough weather with quartering and beam seas. The ferry according to the invention will be comfortable for the passengers, in particular advantages over other hull shapes with regard to quartering and beam seas.

[0014] Further, heavy head seas would not cause heavy slamming for a ferry according to the present invention due to the side hull arrangement with relatively narrow tunnels as compared to the very wide tunnel of a catamaran of comparable size.

[0015] A significant advantage of the double-ended trimaran ferry of the invention is the fact that It does not have to turn in port, and saves the time otherwise required or manoeuvring and turnaround. Thus the required service speed and propulsion power is significantly reduced compared to an ordinary catamaran or trimaran ferry. Moreover, the double-ended trimaran ferry is highly manoeuvrable and requires very little space for manoeuvring in port.

[0016] The double-ended trimaran construction will allow for slender hull design of both the central hull and the side hulls, and the service speed may significantly surpass that of a conventional double-ended ferry of same length. In terms of service speed the trimaran will be competing with double-ended catamarans of similar length. However, the double-ended trimaran ferry of the invention will have significant advantages with respect to rough weather, particularly in quartering and beam seas.

[0017] The double-ended trimaran concept is scaleable, and double-ended trimarans may be built as small passenger ferries to large double-ended ro-ro ferries.

[0018] An advantage of the double ended trimaran vessel of the invention is that the hull is less dead weight sensitive as compared to a double ended catamaran vessel. This reduced dead weight sensitivity combined with the possibility to arrange the engine room centrally will allow for relatively heavy fuel cells or diesel electric arrangements to be used in combination with alternative fuels such as LNG or biogas.

[0019] Moreover, with a large and protected centre hull carrying a gas tank such as an LNG fuel tank, the double-ended trimaran would provide enhanced safety as compared to ordinary monohull vessels or catamaran hull arrangements.

[0020] An advantage of the ferry is the strength which may be provided by the cross section shape of the vessel. In general the double-ended trimaran may have a midship section shape which is more efficient resisting longitudinal bending moment and torsional moments, than the midship section shape of a double-ended catamaran. Thus, the double-ended trimaran will be lighter, given the same load and speed requirements. Especially this will be true in exposed waters with requirements for enclosed, or semi enclosed weather decks. In an additionally advantageous embodiment of the invention provided with a superstructure over the deck, the superstructure of the double-ended trimaran may form an integral part of the global vessel strength.

[0021] An advantage of an embodiment of the invention is the combination of a water jet propulsion system in either ends of the central hull, with pivotable rounded bulb head which may be lowered for forming an ordinary bulb head shape when functioning as a bulb bow, and for being raised for exposing a water jet nozzle.

Short figure captions

[0022] The invention is illustrated in the attached drawings of which

Fig. 1 is the general arrangement of the ferry according to the invention. Fig. 1 a shows a longitudinal section and part side elevation view of an embodiment of the vessel according to the invention,
Fig. 1b shows a midship cross section of the embodiment of the vessel shown in Fig. 1a,
Fig. 1c shows a plan view along a waterline section of the hulls of the vessel of Figs. 1 a and 1 b.
Fig. 2 shows an embodiment of the invention with a water jet propulsor arranged as an integrated part of a bulb bow arrangement of the central hull. Fig. 2a is a part longitudinal section and part side elevation view of the water jet arrangement,
Fig. 2b is a part horizontal section near the water line, showing an end portion of the trimaran hulls showing parts of the water jet arrangement of the bulb comprising a pivotable rounded bulb head,
Fig. 2c is an end view of the trimaran ferry of the invention showing with the pivotable rounded bulb head raised and exposing the nozzle of the water jet.
Fig. 2d is similar to Fig. 2a but with the pivotable rounded bulb head in a lowered position for forming an ordinary bulb head shape, and with redirected water jet currents.
Fig. 2e is similar to Fig. 2b illustrating the lowered rounded bulb head with partly laterally redirected water jet currents.
Fig. 2f shows the same view as Fig. 2c but with the pivotable rounded bulb head lowered for forming an ordinary bulb head shape.
Fig. 3a is a side elevation view of an embodiment of the invention having a thruster arranged below an end portion of the central hull.
Fig. 3b is a side elevation view of an embodiment of the invention having an icebreaking bow with ice knife and arranged with a conventional rudder, and with an ordinary variable pitch propeller at either ends of the central hull.

Embodiments of the invention

[0023] The embodiment of the invention illustrated in Fig. 1 is a double-ended trimaran ferry (1) with a central displacement hull (2) with a first end (21 a) and a second end (21 b) and two side hulls (3), at least one engine (25), and a propulsion system (4). The side hulls may be generally identical. The side hulls (3) are symmetrically arranged about the central hull (2), and about a centre line of the central displacement hull (2). In the longitudinal direction of the ferry, the central hull (2), which is the main displacement hull, and the side hulls (3) are generally symmetrical about a midship section. In this way the trimaran ferry may run either way. The central hull (2) is significantly larger than the side hulls and is arranged for carrying a major share of the displacement of the ferry (1). The side hulls generally contribute to the static and dynamic stability of the ferry. The ferry (1) further comprises a main deck (5, 5c). The side hulls (3) have a design waterline length of between one third and three quarters or even a full length of a design waterline length of the central displacement hull (2). The side hulls (3) are mainly for providing stability to the ferry, and they may further allow for a wide span of the deck (5, 5c, 5s) in order to provide large a deck area for vehicles or cargo.

[0024] The vessel according to the invention is scaleable according to market needs. The vessel is more easily scaleable than conventional double-ended ferries, particularly on exposed routes with rather high speed requirements.

[0025] In a preferred embodiment of the invention, the double-ended trimaran ferry's (1) main deck (5) comprises a central deck (5c) extending generally along an entire length between the first end (21 a) and the second end (21 b). The ferry may have side decks (5s) arranged to either sides of the main central deck (5c). The deck (5, 5c, 5s) may extend laterally to the full beam of the ferry. In an embodiment the ferry has a bow visir port arranged in each end, both ends of the central deck (5, 5c) provided with a so-called bow connector for connecting the ferry to a link span in the port.

[0026] Each of the side hulls (3) may be symmetrical transversally. In an embodiment, each of the side hulls (3) is asymmetrical transversally, such as shown in Fig. 1 b. The side hulls (3) are symmetrical transversally to either sides of the longitudinal axis of the vessel, also as illustrated in Fig. 1 b.

[0027] In an embodiment of the invention the outward facing hull side (33) of each side hull (3) is generally plane, or at least parallel with the ferry's centre line along a major proportion of the side hull's (3) length. In a preferred embodiment the outward facing hull side (33) is provided with one or more horizontally extending fenders (35) arranged at least along the generally plane portion of the outward facing hull side (33), and arranged in a low position and above the waterline. With this arrangement the ferry according to the invention may berth against a low quay with conventional fendering, e.g. tyres. In this manner the ferry according to the invention requires no high and expensive quay fender arrangements.

[0028] In a preferred embodiment of the invention, the side hulls (3) are arranged for being of the displacement type, generally without dynamic lift. They may also be arranged planing, or for otherwise providing dynamic lift using planing surfaces.

[0029] The side hulls (3) have, in a preferred embodiment of the invention, a design waterline length of between one half and three quarters of the design waterline length of the central displacement hull (2).

[0030] In a preferred embodiment of the invention, a beam of the trimaran ferry (1) is between one fifth and one half of the design waterline length of the central displacement hull (2). The beam/lenght ratio may depend on the length of the actual vessel, cargo demand, cargo mix, and general route characteristics.

[0031] Tunnels formed between the central displace-

ment hull (2) and the side hulls (3) have a clearance from the design waterline. Preferably, the tunnels have a clearance varying in the longitudinal direction. The clearance may be varying in the transversal direction having a generally inverted U-shape.

[0032] The first and / or second end (21 a, 21 b) may comprise a bulbous bow, an icebreaking bow, a round bilge bow, a wave-piercing bow, or a semi swath type bow.

[0033] The main deck (5, 5c) is outlined with a broken line in Fig. 1c. In a preferred embodiment of the invention it may be a vehicle deck which is curved concave upwards in the longitudinal direction to provide low vehicle ramps in each end of the vessel and thus requiring low shore ramps. This is a significant advantage both with regard to the cost of building the shore facilities as well as allowing for land terminals with low, visually environmentally friendly silhouettes. In a preferred embodiment of the invention, the main deck (5, 5c, 5s) has a width generally equal to the beam of the ferry (1), for utilizing the full beam of the vessel to cater for a large vehicle/cargo deck, such as indicated in Fig. 1c.

[0034] The central portion (5c) of the main deck (5) may be recessed relative to the side decks (5s). The recessed portion (5c) of the deck may comprise a vehicle lane(s) designed with little, none or negative curvature longitudinally. The recessed portion (5c) will provide head clearance to busses and trucks. This will allow for the ferry according to the invention to carry buses or trucks at a smaller vessel size than compared to a catamaran ferry.

[0035] The main central hull (2) and the side hulls (3) may be provided with control actuator surfaces (15) near one or more of the first and the second ends (31 a, 31b) of the side hulls (3). The control actuator surfaces may be controlled to reduce rotational motions of the vessel during sailing in rough seas, particularly with regard to roll, but possibly also with regard to pitching. In a preferred embodiment of the invention the control actuator surfaces (15) are arranged on the side hulls (3), please see Fig. 1c, the actuator surfaces (15) directed towards the central hull (2) so as for not to conflict with the quay during berthing. Further, trim and pitch control actuator surfaces (16) are arranged near the fore and aft ends of the central hull (2) as illustrated in Fig. 1a and Fig. 1 c. The purpose of the trim and pitch control actuator surfaces (16) is to control trim and pitch as well as to work as hydrodynamic dampeners of the vessel's motion.

[0036] The propulsion system (4) may comprise thrusters or ordinary propellers, variable pitch propellers, or voigth-schneider propulsors arranged towards the first and the second end (21 a, 21 b). Pump jets, rim jets or water jets may advantageously be used. Such water jet propulsion may provide a reduced interaction between the propulsion unit and the hulls, and reduced appendage resistance as compared to thrusters.

[0037] In an embodiment of the invention the ferry has the engine (25) arranged in a central position of the central hull (2), preferably in an engine compartment (26) arranged near or at the midship section of the central hull (2). The engine does not have to be arranged exactly at the midship cross section and may change place with one of the fuel tank rooms in either direction. Due to the relatively larger draught and width of the central hull (2) there is ample space for the engine (25) under the deck (5, 5c) and in the compartments near the midship section of the central hull (2). In an embodiment one or more fuel tanks (27) are also arranged in the central hull (2), preferably near and to either sides of the midship section, such as illustrated in Figs. 1 a and 1 c, in water tight compartments (45) separated from the engine room (26) by transverse bulkheads (42). The fuel tanks (27) may be ordinary diesel tanks, pressurised gas tanks, cryogenic gas tanks, according to the nature of the engine (25) and the fuel. The centrally arranged engine may provide power to the propulsors (4) at either ends of the central hull.

[0038] In case of an embodiment of the invention implemented as a small ferry with limited propulsion power requirements one may use simple truck engines arranged over the propulsors with direct drive propulsors at either ends of the vessel. This may constitute a simple and cheap arrangement for easy maintenance, in that a forklift is capable of lifting an engine in or out of engagement with the direct drive propulsor.

[0039] The power transfer from the engine (25) to the propulsors (4) may be via rotating shafts (48) extending from a gear box (29) of the engine (25), via other gears (49) and shafts, to the propulsors (4).

[0040] In an embodiment of the invention the power transfer from the engine (25) may run via an electrical generator (29') arranged near the engine (25), via electrical power cables to electrical motors driving the propulsors (4).

[0041] The centrally arranged engine (25) may save weight and building costs and the centrally arranged weight will contribute to a reduced rotational moment of inertia about the pitch axis, which results in improved sea keeping. The near-centre fuel tanks (27) will contribute to safety with regard to grounding and collision. In a centrally arranged engine room there may be space for relatively heavy fuel cells or diesel electric arrangements, to be used in combination with alternative fuels such as LNG or biogas. In case of using fuel cells this may replace the centrally arranged engine (25) and electrical generator with the fuel cell (25').

[0042] Depending on the size of the vessel, the service speed required, and the harbour depth, the propulsors (4) may comprise ordinary shaft-mounted propellers at either ends (21 a, 21 b) of the central hull (2), such shaft-mounted propellers may be arranged driven by shafts from the engine room. Alternatively, the engine shafts or electrical motors to thrusters arranged below either ends (21 a, 21 b) of the central hull (2) such as illustrated in Fig. 3a, if the water depth allows so. The thrusters may also be arranged to either sides of either ends (21 a, 21

b) of the central hull (2) as illustrated in Figs. 1a and 1c, if required due to depth considerations, particularly in harbours.

[0043] The vessel may be provided with ordinary rudders (51) or control surfaces in each end, to assist in maneouvering. In an embodiment of the invention the double-ended trimaran ferry has a propulsor and rudder arrangement such as illustrated in Fig. 3b with an ice-breaking bow with an ice knife (50) and arranged with a conventional rudder (51), and with an ordinary variable pitch propeller (52) at either ends of the central hull (2). The central shaft (48) runs from the engine (25) to a gear box (49) which drives the propeller shaft.

[0044] In an embodiment of the invention the propulsors (4) may include water jets (81) integrated in the fore and aft ends (21 a, 21 b) of the central hull (2), with corresponding water inlets (83) arranged through the bottom of the central hull (2) some distance away from the fore and aft ends (21 a, 21 b). An impeller (86) arranged downstream after the water inlet (83) receives power from the main engine (25) and pressurizes the water and ejects via nozzle (85). In a preferred embodiment such water jets (81) may be arranged as integrated parts of bulbs (82), such as indicated in Fig. 1 a. Such a bulb-integrated water jet may comprise a pivot arrangement for a rounded bulb head (84) which may raised to expose a horizontally arranged main water jet nozzle (85) when the vessel is running in one direction so as for the water jet forming part of a rear end of the hull, please see Figs. 2a, 2b and 2c. The rounded bulb head (84) may be lowered to cover the main jet nozzle (85), please see Figs. 2d, 2e, and 2f. When the water jet is in the passive state when the vessel is running in the opposite direction, the lowered bulb head (84) forms the forward running bow end of the hull. The elevation and lowering of the rounded bulb head (84) may be conducted using hydraulic or electric actuators.

[0045] The rounded bulb head (84), which may be called a water jet "bucket", may comprise deviation channels (87) for the water in order for the bulb head (84) to redirect the water jet when in the lowered state such as for deceleration or for auxiliary propulsion, please see Fig. 2e particularly, but also Fig. 2d. The nozzle (85) may be arranged for slightly redirecting the water current so as for selecting one of the deviation channels (87) in the rounded bulb head in order for forming a side thrust. The two water jets, one in either end of the vessel, may thus be used in combination to provide thrust in any desired horizontal direction.

[0046] The concept of double-ended trimarans will work with a wide range of hull shapes and bow arrangements, such as for instance bulbows, semi-swath, or ice breaker bows. Thus the main dimensions, hull shapes and general arrangement may be optimised according to route characteristics, payload, speed, environmental considerations and economy.

[0047] The double-ended trimaran's hulls (2, 3) may be arranged and designed to avoid slamming even in rough seas. The double-ended trimaran construction offers superior sea keepings in quartering and beam seas as compared to conventional double-ended ferries and double-ended catamarans of similar length. Accelerations and pitch and roll angles are decisive for passenger comfort and the need for lashing cars. To further enhance the favourable sea keeping characteristics, the double-ended trimaran may be fitted with an active motion dampening system. Passive stabilizers, fins or keels may also be installed. The excitation forces on the double-ended trimaran hull of the vessel according to the invention are significantly smaller than for a comparable double-ended catamaran ferry. Moreover, it is less demanding to dampen and control the motions of a hydrostacially and hydrodynamically softer double-ended trimaran than a stiff double-ended catamaran.

[0048] In calm water operations the double-ended trimaran construction may be arranged with low tunnel clearance, high beam and long side hulls to provide a large vehicle deck. Oppositely, a double-ended trimaran ferry for operating under harsh weather conditions may be arranged with high tunnel clearance and lower beam and shorter side hulls in order to be less exposed to slamming, and pitch- and roll- inducing forces.

[0049] The tunnel clearance may be designed to vary longitudinally as well as transversally. Longitudinally the tunnel clearance may vary from the height of the centre hull top deck in the forepart of the vessel, to as low as the water line at midship section. The tunnel may also be designed with a constant clearance to the water line, varying from zero to the height of the centre hull top deck.

[0050] In case of a double-ended car or ro-ro trimaran, the ramps may be arranged as bow ramps, quartering or side ramps. The choice of ramps will depend on vessel size, its bow entry lines, shore facilities and mix of cargo. The shore facilities may be fitted with ramps able to connect to the vessel and prevent the vessel from excessive trimming when loading and unloading large trucks. Rapid response ballast tanks may also solve the problem of excessive trimming. The problem of excessive trimming when loading/unloading trucks will diminish with vessel size.

[0051] Double-ended trimarans have an advantage over double-ended catamarans while berthing. Double-ended catamarans are light, wide and stiff, and thus even small waves in port, even the ships own waves approaching the port on arrival, could make it time consuming to connect to the link span because of excessive roll and vertical movements. Double-ended trimarans are hydrodynamically "softer" and will not have this problem.

[0052] The double-ended trimaran may be designed with low fenders and low main deck to allow for low shore ramps and cheap and visually environmentally friendly port facilities.

[0053] The main car deck may be designed with an upward curvature longitudinally towards the midship section to allow for low shore ramps in each end, while utilizing the maximum beam of the vessel to cater for as large vehicle/cargo deck area as possible. The centre

lane or lanes may be designed with less, or without curvature to give deck clearance to busses and trucks. With such an arrangement, a suspension deck arrangement may also be fitted over the central deck. The double-ended trimaran construction will be able to carry busses and trucks at a smaller vessel size, compared to hi-speed catamarans and double-ended catamarans with enclosed or semi closed weather decks.

[0054] With potential of rapid acceleration to service speed, a low hump in the resistance curve and low wake wash, the double-ended trimaran could be a viable option in environmentally sensitive areas. The double-ended trimaran inherently has a favourably low wake wash, and it may be designed with ultra slender hulls in order to reduce such wake wash as much as possible.

[0055] The double ended trimaran may be designed with a low air draft and a low silhouette. This in combination with a minimum of manoeuvring in port, quick response in congested waters, low wake wash, low draft and the possibility of building low silhouette port and docking facilities could be decisive for the viability of a ferry route in an environmentally sensitive area.

[0056] The superstructure of a double-ended trimaran may form an integral part of the load bearing structure and thus contribute to the global vessel strength. In general the double-ended trimaran will have a midship cross section which more efficiently resists longitudinal bending moment and torsional moments, than the midship section of a double-ended catamaran. Thus, the double-ended trimaran will be lighter, given the same load and speed requirements. Especially this will be true in exposed waters with requirements for enclosed, or semi enclosed weather decks. The double-ended trimaran will typical have a major share of its displacement carried by its larger central hull to minimize resistance. The factors above in combination, will give the double-ended trimaran a lower wetted surface and less resistance as compared to a double-ended catamaran with similar speed and load requirements.

[0057] The double-ended trimaran according to the invention is provided with longitudinally directed water tight bulkheads (41) as indicated in the cross-section drawing of Fig. 1 b. The number of and precise lateral placement of the longitudinal bulkheads (41) may be determined by the ship's designer. Advantageously the central hull (2) and the side hulls (3) are provided with transverse water tight bulkheads (42, 44) forming water tight compartments (45, 47), please see Figs. 1 a and 1 c, in order to assure the vessel's damage stability. Further, one or more of the water tight compartments (45) of the central hull (2) may be provided with a double bottom (43) as illustrated in Figs. 1 a and 1 b. The central hull (2) has a significantly larger draught than the side hulls (3) and thus it is more exposed to raking damage than the side hulls (3). In case of puncture to one or more of water tight compartments (45) of the central hull (2) the vessel will float on the side hulls (3) and the remaining intact compartments of the central hull. Thus little stability will be lost. In case of damage to one of the water tight compartments (47) of the side hulls (3), each of those compartments have a low volume and will only incur a low listing moment to the ferry. All in all, the arrangement of the trimaran hulls and the sectioning of them into water tight compartments provides a safe platform with good damage stability in case of grounding, raking damage or collision. This contributes to passenger safety and may facilitate passenger evacuation in a state of low listing and low trim.

[0058] A double-ended catamaran will usually have engines arranged in each hull, and often have four engines and four propulsors. Such an arrangement thus requires four engine rooms which are costly and disadvantageous to operate. Moreover such a weight distribution with the weight towards the fore and aft is unfavourable in terms of sea keeping capability. Double-ended trimarans according to the invention may have one engine room and two propulsors, e.g. one in each end of the vessel. Due to the larger centre hull and the general arrangement of the double-ended trimaran, as compared to the more narrow hulls of a double-ended catamaran, the designer will have a wider choice of suitable engines, fuels and propulsors.

[0059] With a large and protected centre hull, the double-ended trimaran could be fitted with tanks for liquefied or pressurized gas, such as e.g. LNG or CNG. Such a hull arrangement provides significant collision zones about the protected location of the LNG tanks which is an advantage in case of collision and grounding. This would be difficult to achieve on a double-ended catamaran due to safety regulations requiring protective location.

[0060] The double-ended trimaran according to the invention has a significantly higher speed potential than conventional double-ended ferries, rough weather capability and short turnaround time in port. The double-ended trimaran will compete with conventional and fast ferries on short to moderate long routes.

[0061] The viability of the double-ended ferry concept is significantly expanded with the invention of the double-ended trimaran ferry of the invention.

Claims

1. A double-ended trimaran ferry (1) with a central displacement hull (2) with a first end (21 a) and a second end (21 b), two side hulls (3), at least one engine (25) providing power to propulsors (4), and a main deck (5) for vehicles or cargo;
   characterised by

   * said central displacement hull (2) arranged for carrying a major share of the displacement of the ferry (1);
   * said side hulls (3) being symmetrical about a vessel centre line of said ferry (1),
   * said central displacement hull (2) and said side

hulls (3) being generally fore and aft symmetrical about a midship section;
* said side hulls (3) having a design waterline length of between one third and a full length of a design waterline length of said central displacement hull (2).

2. The double-ended trimaran ferry (1) of claim 1, said main deck (5) comprising a central deck (5c) extending generally along an entire length between said first end (21 a) and said second end (21 b).

3. The double-ended trimaran ferry (1) of claim 2, comprising side decks (5s) arranged to either sides of said main central deck (5c).

4. The double-ended trimaran ferry (1) of claim 1, wherein said side hulls (3) are symmetrical with respect to a centre line of the vessel.

5. The double-ended trimaran ferry (1) of claim 1, an outward facing hull side (33) of each side hull (3) being generally plane and parallel with the ferry's centre line along a major proportion of the side hull's (3) length, said outward facing hull side (33) being provided with a horizontally extending fender (35) arranged at least along the generally plane portion of said outward facing hull side (33), and arranged in a low position above the waterline.

6. The double-ended trimaran ferry (1) of claim 1, said side hulls (3) having a design waterline length of between one half and two thirds of said design waterline length of said central displacement hull (2).

7. The double-ended trimaran ferry (1) of claim 1, a beam of said trimaran ferry (1) being between one fifth and one half of said design waterline length of said central displacement hull (2).

8. The double-ended trimaran ferry (1) of claim 12, said beam of said trimaran ferry (1) being one third of said design waterline length of said central displacement hull (2).

9. The double-ended trimaran ferry (1) of claim 1, wherein tunnels formed between said central displacement hull (2) and said side hulls (3) have a clearance from said design waterline, wherein said tunnels have a clearance varying in the longitudinal direction.

10. The double-ended trimaran ferry (1) of claim 1, said main deck (5, 5c) being a vehicle deck which is curved concave upwards in the longitudinal direction to allow for low shore ramps in each end, wherein said main deck (5, 5c, 5s) has a width generally equal to said beam of said ferry (1), for utilizing the full beam of the vessel to cater for a large vehicle/cargo deck.

11. The double-ended trimaran ferry (1) of claim 1, wherein said central portion (5c) of said main deck (5) comprises a vehicle lane(s) are designed with little, no or negative curvature longitudinally to provide a recessed central portion (5c) of said main deck to provide head clearance to busses and trucks.

12. The double-ended trimaran ferry (1) of claim 1, said side hulls (3) provided with control actuators (15) near one or more of said first and said second ends (31 a, 31 b) of said side hulls (3).

13. The double-ended trimaran ferry (1) of claim 1, said propulsion system (4) comprising thrusters, propellers, water jets, pump jets or rim jets arranged towards said first and said second ends (21 a, 21 b).

14. The double-ended trimaran ferry (1) of claim 1, said main engine (25) arranged in said central hull (2) and near said midship section.

15. The double-ended trimaran ferry (1) of claim 1, provided with longitudinal water tight bulkheads (41) between said central hull (2) and said side hulls (3), and said central hull (2) provided with one or more transverse water tight bulkheads (42) separating said central hull (2) into water tight compartments (45), and said side hulls (3) provided with transverse water tight bulkheads (44) forming water tight compartments (47).

Patentansprüche

1. Doppelend-Trimaran-Fähre (1) mit einem zentralen Verdrängerrumpf (2) mit einem ersten Ende (21a) und einem zweiten Ende (21b), zwei Nebenrümpfen (3), wenigstens eine Antriebsmaschine (25) zur Lieferung von Leitung an Propulsoren (4), und einem Hauptdeckt (5) für Fahrzeuge und Fracht;
dadurch gekennzeichnet, dass

- der zentrale Verdrängerrumpf (2) zum Tragen eines Großteils der Verdrängung der Fähre (1) ausgebildet ist;
- die Nebenrümpfe (3) symmetrisch um eine Schiffslängsachse der Fähre (1) sind;
- der zentrale Verdrängerrumpf (2) und die Nebenrümpfe (3) im Wesentlichen längsschiffs symmetrisch um eine Mittschiffssektion sind;
- die Nebenrümpfe (3) eine Konstruktionswasserlinienlänge zwischen einem Drittel und der gesamten Länge der Konstruktionswasserlinienlänge des zentralen Verdrängerrumpfs (2) aufweisen.

2. Doppelend-Trimaran-Fähre (1) nach Anspruch 1, wobei das Hauptdeck (5) ein Zentraldeck (5c) umfasst, welches sich im Wesentlichen über die gesamte Länge zwischen dem ersten Ende (21a) und dem zweiten Ende (21b) erstreckt.

3. Doppelend-Trimaran-Fähre (1) nach Anspruch 2, umfassend zu beiden Seiten des Zentraldecks (5c) angeordnete Nebendecks (5s).

4. Doppelend-Trimaran-Fähre (1) nach Anspruch 1, wobei die Nebenrümpfe (3) symmetrisch in Bezug auf eine Mittelachse des Schiffes sind.

5. Doppelend-Trimaran-Fähre (1) nach Anspruch 1, wobei eine nach außen gerichtete Rumpfseite (33) jedes Nebenrumpfes (3) im Wesentlich plan und parallel zur Mittelachse der Fähre über einen erheblichen Teil der Länge des jeweiligen Nebenrumpfes (3) ist, wobei die nach außen gerichtete Rumpfseite (33) einen sich horizontal erstreckenden Fender (35) aufweist, der entlang des im Wesentlichen planen Bereichs der nach außen gerichtete Rumpfseite (33) und in einer niedrigen Position über der Wasserlinie angeordnet ist.

6. Doppelend-Trimaran-Fähre (1) nach Anspruch 1, wobei die Nebenrümpfe (3) eine Konstruktionswasserlinienlänge zwischen der Hälfte und zwei Dritteln der Konstruktionswasserlinienlänge des zentralen Verdrängerrumpfs (2) aufweisen.

7. Doppelend-Trimaran-Fähre (1) nach Anspruch 1, wobei die größte Breite der Trimaran-Fähre (1) zwischen einem Fünftel und der Hälfte der Konstruktionswasserlinienlänge des zentralen Verdrängerrumpfs (2) ist.

8. Doppelend-Trimaran-Fähre (1) nach Anspruch 7, wobei die größte Breite der Trimaran-Fähre (1) ein Drittel der Konstruktionswasserlinienlänge des zentralen Verdrängerrumpfs (2) ist.

9. Doppelend-Trimaran-Fähre (1) nach Anspruch 1, wobei zwischen dem zentralen Verdrängerrumpf (2) und den Nebenrümpfen (3) Tunnel mit eine lichten Höhe ausgehend von der Konstruktionswasserlinie ausgebildet sind, wobei die lichte Höhe der Tunnel in Längsrichtung variierend ist.

10. Doppelend-Trimaran-Fähre (1) nach Anspruch 1, wobei das Hauptdeck (5, 5c) ein Fahrzeugdeck ist, welches in Längsrichtung nach oben konkav gewölbt ist, um an beiden Enden niedrige Küstenrampen zuzulassen, wobei das Hauptdeck (5, 5c, 5s) eine Breite im Wesentlichen gleich der Breite der Fähre (1) zur Ausnutzung der gesamten Schiffsbreite für ein große Fahrzeug/Frachtgut-Deck hat.

11. Doppelend-Trimaran-Fähre (1) nach Anspruch 1, wobei der Zentralbereich (5c) des Hauptdecks (5) eine Fahrspur(en) umfasst, die nur mit wenig, keine oder negative Wölbung in Längsrichtung konstruiert sind, um eine vertieften zentralen Abschnitt für ausreichende lichte Höhe für Busse und Lastkraftwagen zu schaffen.

12. Doppelend-Trimaran-Fähre (1) nach Anspruch 1, wobei die Nebenrümpfe (3) Stellaktuatoren (15) nahe einem oder mehrerer der ersten und zweiten Enden (31a, 31b) der Nebenrümpfe (3) aufweisen.

13. Doppelend-Trimaran-Fähre (1) nach Anspruch 1, wobei das Antriebssystem (4) zum ersten und zweiten Ende (21a, 21b) hin angeordnete Strahlruder, Schrauben, Wasserstrahlantriebe, Pumpenantriebe oder Rim-Jet-Antriebe umfasst.

14. Doppelend-Trimaran-Fähre (1) nach Anspruch 1, wobei die Hauptantriebseinheit (25) in dem zentralen Verdrängerrumpf (2) und nahe der Mittschiffssektion angeordnet ist.

15. Doppelend-Trimaran-Fähre (1) nach Anspruch 1, wobei wasserdichte Längsspundwände (41) zwischen dem zentralen Verdrängerrumpf (2) und den Nebenrümpfen (3) vorgesehen sind, und der zentrale Verdrängerrumpf (2) eine oder mehrere wasserdichte Querspundwände (41) aufweist, mit denen der zentrale Verdrängerrumpf (2) in wasserdichte Abteile (45) aufgeteilt wird, und die Nebenrümpfe (3) wasserdichte Querspundwände (44) zur Bildung wasserdichter Abteile (47) aufweist.

Revendications

1. Ferry de type trimaran à double extrémité (1) avec une coque centrale de déplacement (2) avec une première extrémité (21 a) et une seconde extrémité (21 b), deux coques latérales (3), au moins un moteur (25) fournissant de l'énergie à des propulseurs (4), et un pont principal (5) pour des véhicules ou des marchandises,
caractérisé en ce que

   • ladite coque centrale de déplacement (2) est conçue pour porter une part importante du déplacement du ferry (1);
   • lesdites coques latérales (3) étant symétriques autour d'une ligne centrale dudit ferry (1),
   • ladite coque centrale de déplacement (2) et lesdites coques latérales (3) étant généralement symétriques longitudinalement par rapport à une section à mi-navire,
   • lesdites coques latérales (3) ayant un profil de longueur de ligne de flottaison entre un tiers et

la totalité de la longueur du profil de ligne de flottaison de ladite coque centrale de déplacement (2).

2. Ferry de type trimaran à double extrémité (1) selon la revendication 1, ledit pont principal (5) comprenant un pont central (5c) s'étendant généralement sur toute la longueur entre ladite première extrémité (21 a) et ladite seconde extrémité (21 b).

3. Ferry de type trimaran à double extrémité (1) selon la revendication 2, comprenant des ponts latéraux (5s) agencés de chaque coté dudit pont central principal (5c).

4. Ferry de type trimaran à double extrémité (1) selon la revendication 1, dans lequel lesdites coques latérales (3) sont symétriques par rapport à une ligne centrale du navire.

5. Ferry de type trimaran à double extrémité (1) selon la revendication 1, un côté de la coque orienté vers l'extérieur (33) de chaque coque latérale (3) étant généralement plan et parallèle avec la ligne centrale du ferry le long d'une portion importante de la longueur des coques latérales (3), ledit côté de la coque orienté vers l'extérieur (33) étant muni d'une aile (35) s'étendant horizontalement, agencée au moins le long de la partie généralement plane dudit côté de la coque orienté vers l'extérieur (33), et agencée dans une position basse au-dessus de la ligne de flottaison.

6. Ferry de type trimaran à double extrémité (1) selon la revendication 1, lesdites coques transversales (3) ayant un profil de longueur de ligne de flottaison entre une moitié et les deux tiers dudit profil de longueur de ligne de flottaison de ladite coque centrale de déplacement (2).

7. Ferry de type trimaran à double extrémité (1) selon la revendication 1, une largeur dudit ferry de type trimaran (1) étant entre un cinquième et la moitié dudit profil de longueur de ligne de flottaison de ladite coque centrale de déplacement (2).

8. Ferry de type trimaran à double extrémité (1) selon la revendication 1, ladite largeur dudit ferry de type trimaran (1) étant un tiers dudit profil de longueur de ligne de flottaison de ladite coque centrale déplacement (2).

9. Ferry de type trimaran à double extrémité (1) selon la revendication 1, dans lequel des tunnels formés entre ladite coque centrale de déplacement (2) et lesdites coques latérales (3) présentent un tirant d'air à partir dudit profil de ligne de flottaison, dans lequel lesdits tunnels présentent un tirant d'air variable dans la direction longitudinale.

10. Ferry de type trimaran à double extrémité (1) selon la revendication 1, ledit pont principal (5, 5c) étant un pont pour véhicules qui est courbé de manière concave vers le haut dans la direction longitudinale pour permettre d'agencer des rampes basses de chargement à chaque extrémité, dans lequel ledit pont principal (5, 5c, 5s) a une largeur généralement égale à ladite largeur dudit ferry (1), pour utiliser la largeur totale du navire pour accueillir un pont large pour véhicules ou marchandises.

11. Ferry de type trimaran à double extrémité (1) selon la revendication 1, dans lequel ladite partie centrale (5c) dudit pont principal (5) comprend une ou des voies pour véhicules, agencées avec peu ou pas de courbure, ou avec une courbure négative longitudinalement pour fournir une partie centrale en retrait (5c) dudit pont principal pour fournir une hauteur libre aux cars et camions.

12. Ferry de type trimaran à double extrémité (1) selon la revendication 1, lesdites coques latérales (3) munis avec des actionneurs de commande (15) à proximité de l'une ou plusieurs de ladite première extrémité et de ladite deuxième extrémité (31 a, 31 b) desdites coques latérales (3).

13. Ferry de type trimaran à double extrémité (1) selon la revendication 1, ledit système de propulsion (4) comprenant des propulseurs, des hélices, des jets d'eau, des jets de pompe ou des jets d'étrave disposés vers ladite première extrémité et ladite seconde extrémité (21 a, 21 b).

14. Ferry de type trimaran à double extrémité (1) selon la revendication 1, ledit moteur principal (25) disposé dans ladite coque centrale (2) et à proximité de ladite section à mi-navire.

15. Ferry de type trimaran à double extrémité (1) selon la revendication 1, pourvu de cloisons longitudinales (41) étanches à l'eau entre ladite coque centrale (2) et lesdites coques latérales (3), et ladite coque centrale (2) pourvue avec une ou plusieurs cloisons transverses (42) étanches à l'eau séparant ladite coque centrale (2) en compartiments (45) étanches à l'eau, et lesdites coques latérales pourvues avec des cloisons transverses (44) étanches à l'eau formant des compartiments (47) étanches à l'eau.

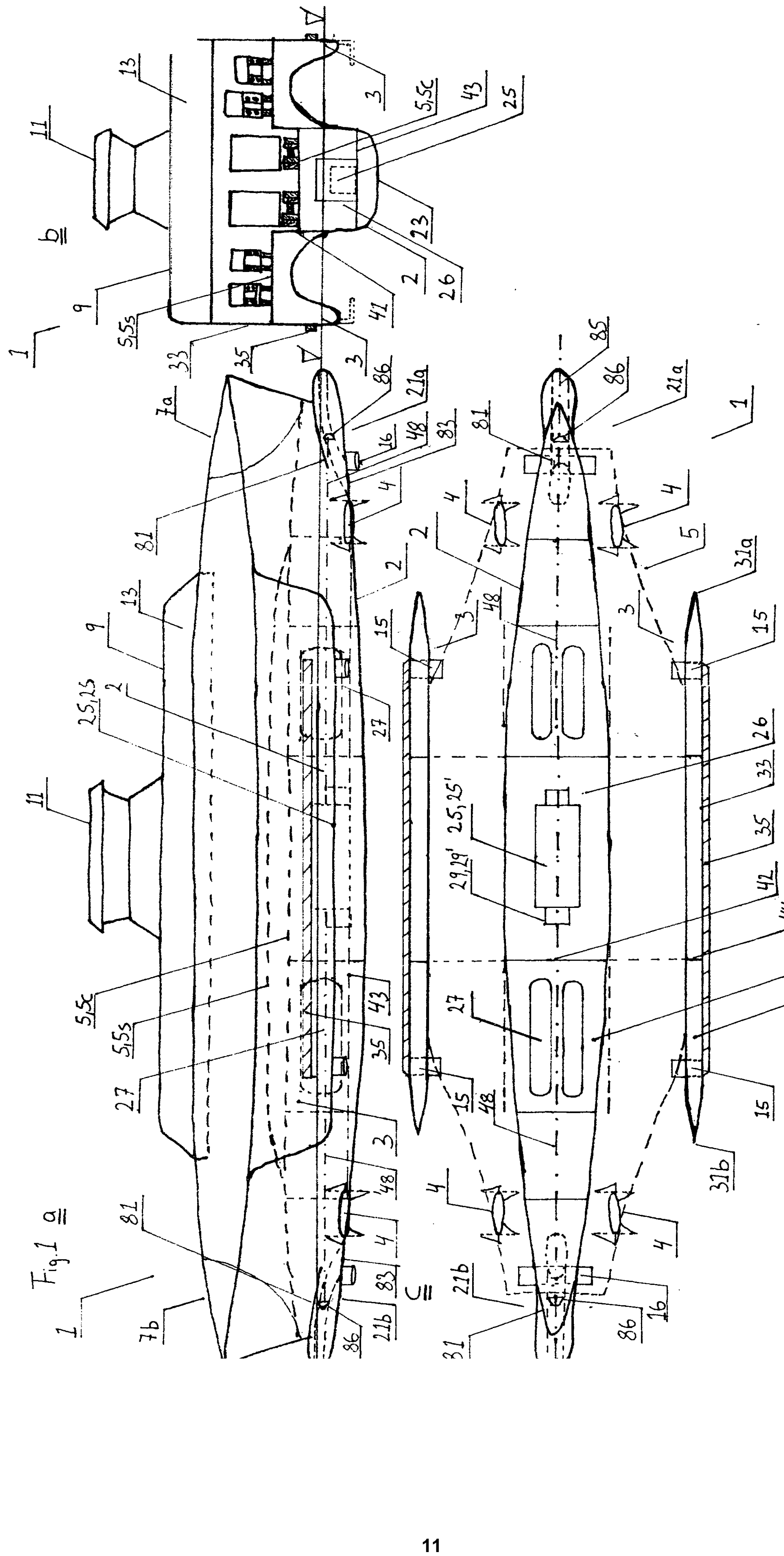


Fig.1 a
b
c
1
2
3
4
5
5,5c
5,5s
7a
7b
9
11
13
15
16
21a
21b
23
25
25,25
25,25'
26
27
29,29'
31a
31b
33
35
41
42
43
44
45
47
48
81
83
85
86

Fig. 2a

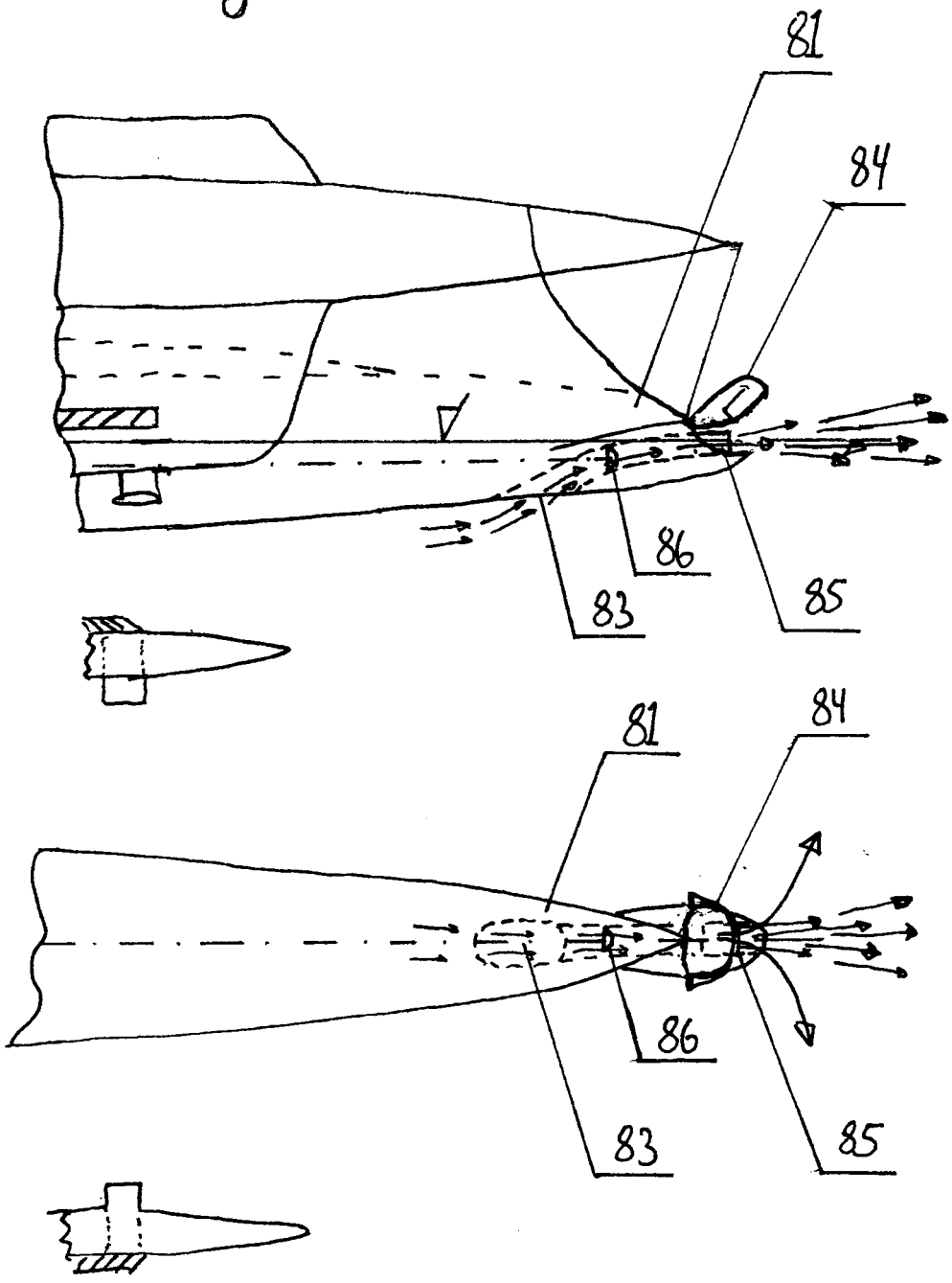
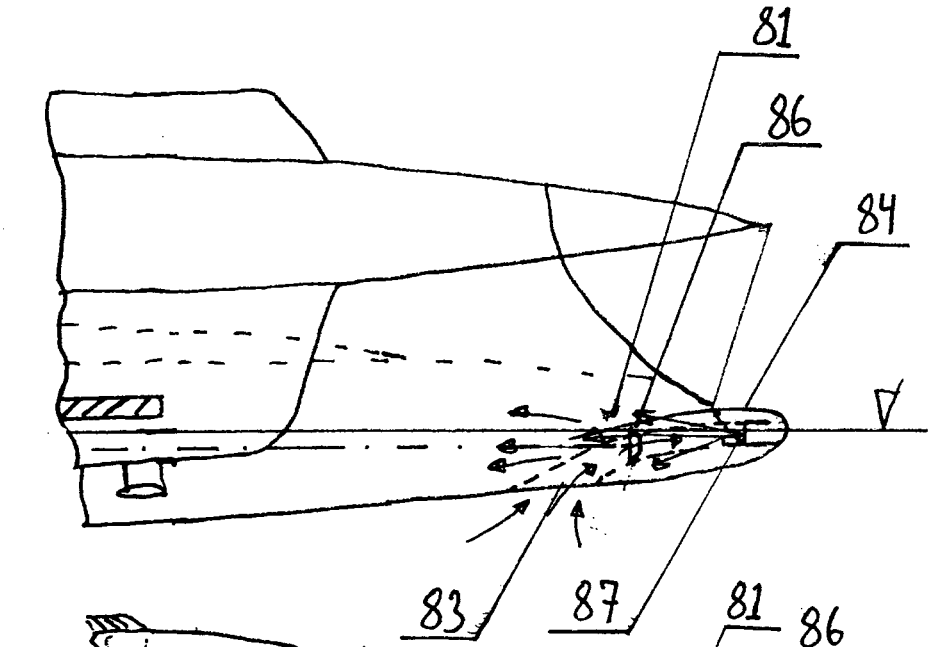


Fig. 2b

Fig. 2d



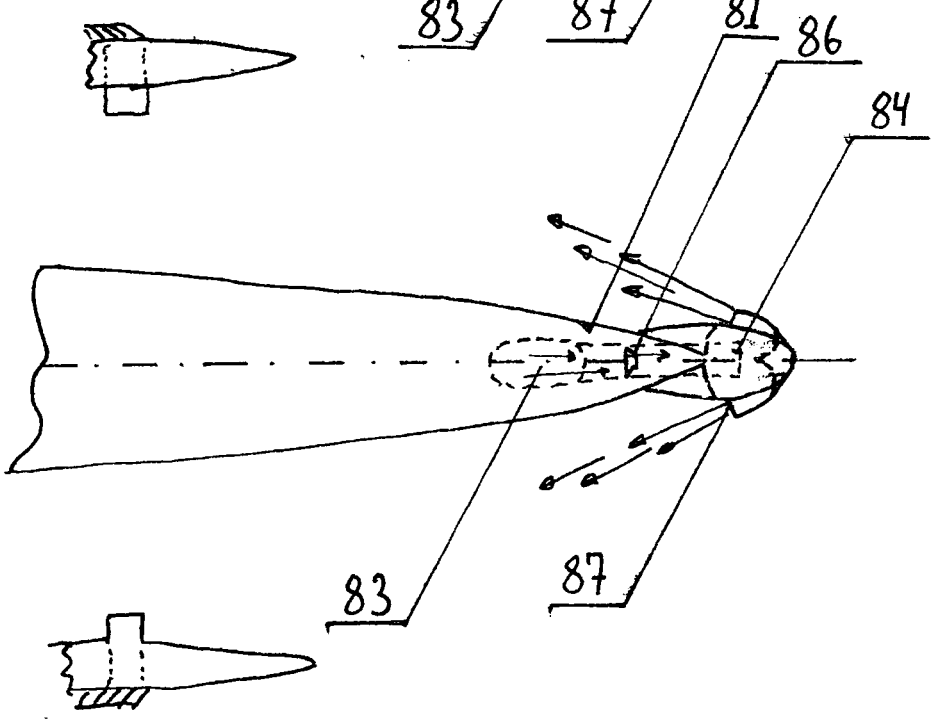


Fig. 2e

Fig. 2c

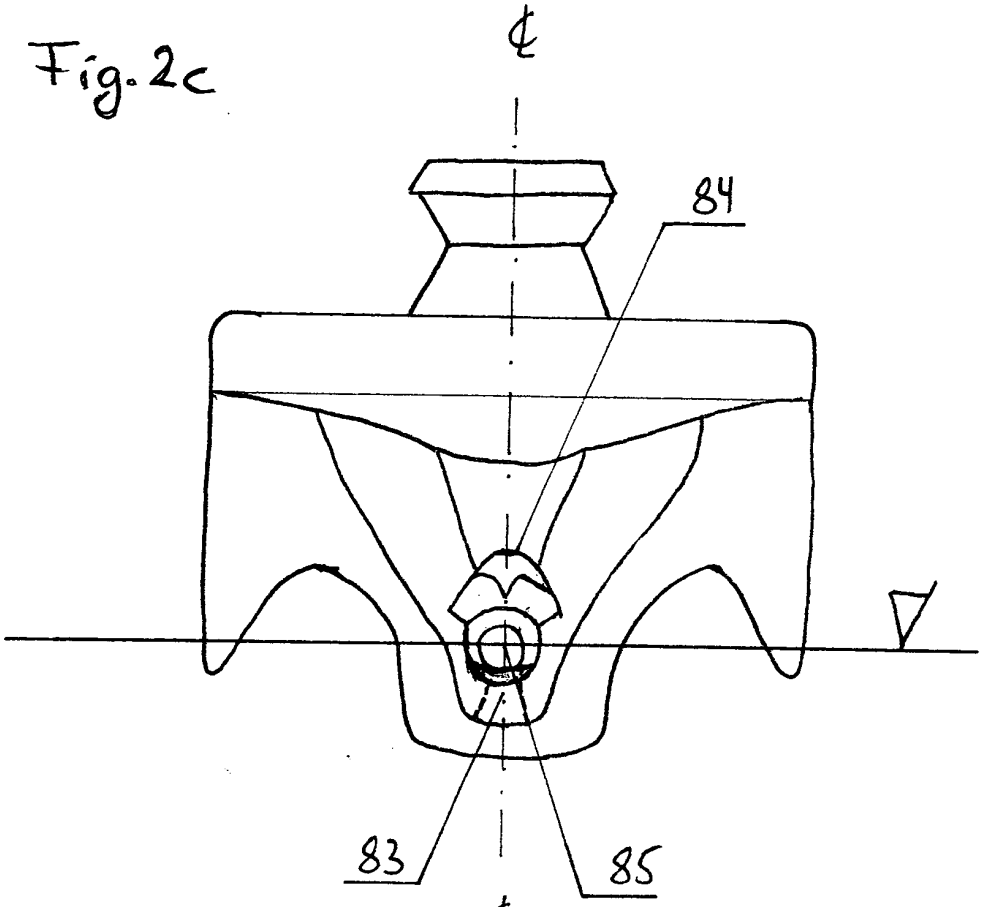


Fig. 2F

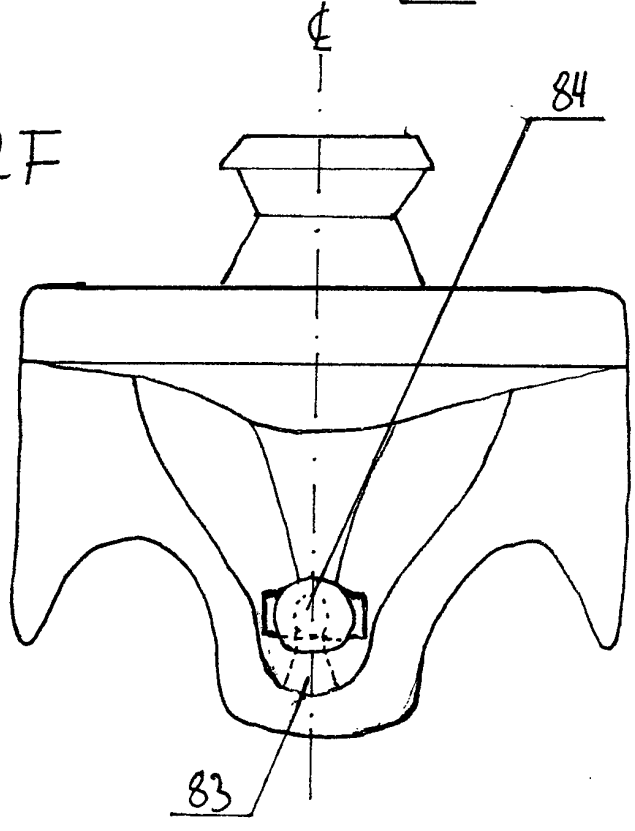


Fig. 3a

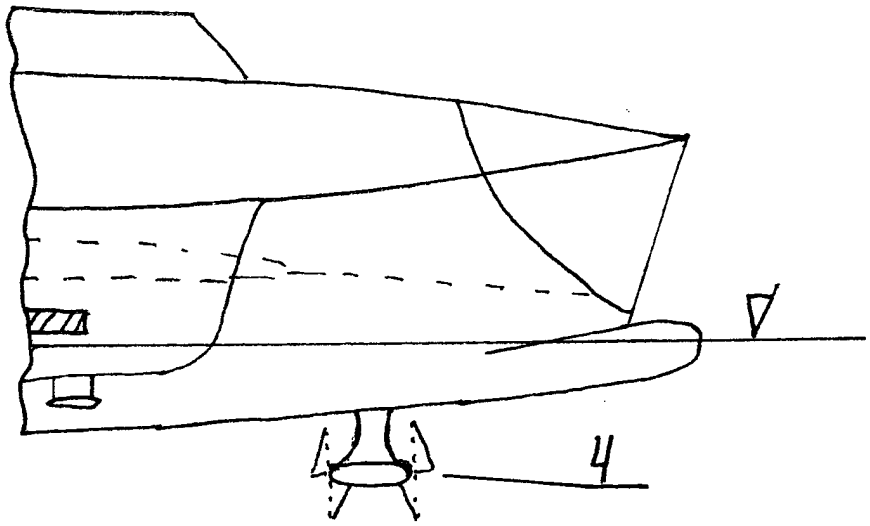
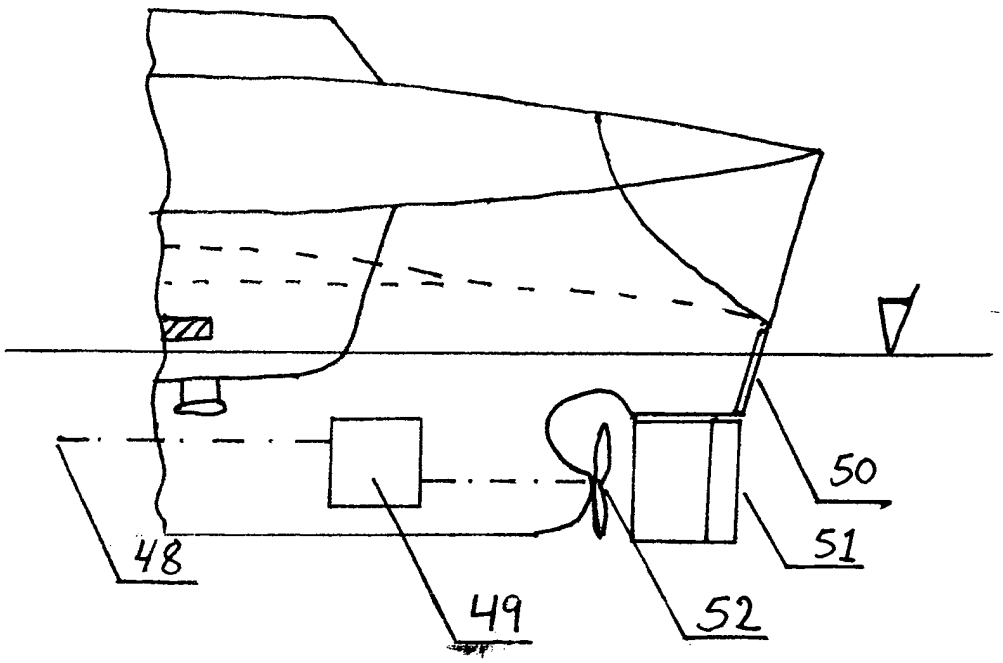


Fig. 3b



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