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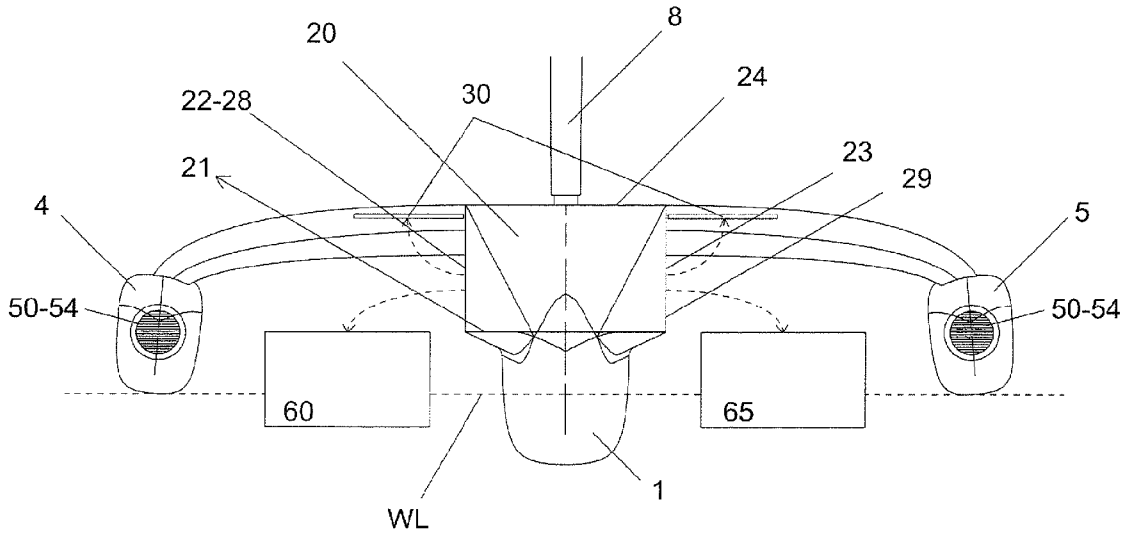



FIG 2

(57) **Abstract:** A trimaran sailing vessel, e.g. a cargo vessel, has a hull structure comprising a central main hull as well as port and starboard outer hulls along opposite lateral sides of the main hull. The hull structure further comprises port and starboard crossbeam structures rigidly connecting the respective outer hull to the main hull, each crossbeam structure comprising, or consists of, a forward crossbeam and a rearward crossbeam spaced from one another in longitudinal direction of the outer hull, with an opening in between crossbeams. The main hull is provided with a sailing system erected on the main hull, e.g. comprising one or more wing sails. The main hull is provided with a mechanical propulsion drive system comprising a drive train including a motor driving a mechanical propulsion device, which motor is powered directly or indirectly by a fuel. The hull structure of the vessel is provided with one or more compartments accommodating main fuel tanks for storage of said fuel, which one or more compartments are located in one or both of the outer hulls.

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# TRIMARAN SAILING VESSEL AND METHOD FOR DISTRIBUTION OF CARGO.

The present invention relates to the field of trimaran sailing vessels. In particular embodiments, the invention relates to transportation of cargo by means of a trimaran sailing vessel.

In the field of sailing yachts, e.g. for around-the-world sailing races, trimaran sailing vessels are known having a hull structure comprising:

- a central main hull,

- port and starboard outer hulls along opposite lateral sides of the main hull respectively,

- port and starboard crossbeam structures rigidly connecting the respective outer hull to the main hull, each crossbeam structure comprising, or consists of, a forward crossbeam and a rearward crossbeam spaced from one another in longitudinal direction of the outer hull, e.g. with an opening in between the crossbeams,

wherein the main hull is provided with a sailing system erected on the main hull, e.g. comprising one or more wing sails,

wherein the main hull is provided with a propulsion drive system comprising a drive train including a motor driving a propeller, which motor is powered directly or indirectly by a fuel, commonly diesel.

In these known sailing yachts, the motor is rather minimalistic as its main use is maneuvering in a harbour.

For transportation of cargo and other purposes, trimaran vessels are known of a different design, e.g. as developed and made by the Australian shipbuilding company Austal. Herein the hull structure comprises:

- a central main hull,

- port and starboard outer hulls along opposite lateral sides of the main hull respectively,

wherein a main deck of the vessel extends over both outer hulls and the main hull. Effectively, in front view of the hull, the deck defines longitudinal tunnels above the water surface between each outer hull and the main hull, which tunnel is open at the bow and the stern only.

Many of the Austal vessel are configured for high-speed operations, such as ferries, military vessels, patrol vessels, and therefore Austal's range of vessels do not include a vessel with a sailing system.

In view of emission regulations Austal does offer an LNG propulsion, possibly as a dual-fuel propulsion wherein the motor runs on LNG or diesel.

In the Austal vessel having LNG propulsion, the main LNG tanks are mounted in the main hull. In embodiments, a double bottom design of the main hull allows for the double bottom to function as main diesel tank.

The provision of a propulsion of the Austal trimaran based on a gaseous fuel is discussed in WO2012016295. The "gaseous fuel" includes compressed gas fuel such as compressed natural gas (CNG) and hydrogen (H2), and liquefied gaseous fuel such as liquefied natural gas (LNG) or liquefied petroleum gas (LPG).

WO2012016295 discusses that a prime concern in the operation of a vessel carrying gaseous fuels is that of safety. It is mentioned that LNG has a boiling point of -163°C at atmospheric pressure, yet will only ignite if the ratio of gas and air is within a relatively small ratio band. LNG floats on water and will evaporate very rapidly. In view of the desire to power the trimaran vessel with LNG the document teaches to arrange the main fuel tanks for storage of these gaseous fuels in the main hull, so that the outer hulls afford side impact protection to the fuel tanks in the central main hull, e.g. in case of a ship-to-ship collision.

The present invention aims to provide a trimaran vessel that is primarily propelled by its sailing system, yet has an adequately sized fuel based mechanical propulsion system. For example, when embodied as a commercial vessel, e.g. as a cargo vessel, it is desirable that the vessel can travel primarily using its sailing system. In case of lack of wind and/or unfavorable wind direction, the vessel desirably can switch to its mechanical propulsion system or assist the sailing with this system. The same system can, of course, be used for maneuvering (e.g. when in a harbour, channel, etc.).

According to a first aspect thereof, the invention provides for a trimaran sailing vessel, e.g. a cargo vessel, having a hull structure comprising:

- a central main hull,

- port and starboard outer hulls along opposite lateral sides of the main hull, respectively,

- port and starboard crossbeam structures rigidly connecting the respective outer hull to the main hull, each crossbeam structure comprising, or consists of, a forward crossbeam and a

rearward crossbeam spaced from one another in longitudinal direction of the outer hull, e.g. with an unobstructed opening in between crossbeams,

wherein the main hull is provided with a sailing system erected on the main hull, e.g. comprising one or more sails or wingsails, e.g. a telescopic wingsail,

wherein the main hull is provided with a mechanical propulsion drive system comprising a drive train including a motor driving a mechanical propulsion device, e.g. a propeller or a pumpjet, which motor is powered directly or indirectly by a fuel,

wherein the hull structure of the vessel is provided with one or more compartments accommodating main fuel tanks for storage of said fuel, which one or more compartments are located in one or both of the outer hulls.

In contrast to the teaching of WO2012016295, the main fuel tanks are thus located in the outer hull or in both outer hulls of the trimaran vessel.

Herein, it is of relevance that, in contrast to the Austal trimaran vessels discussed above, each outer hull is connected to the main hull via a crossbeam structure comprising, or consists of, a forward crossbeam and a rearward crossbeam spaced from one another in longitudinal direction of the outer hull, with an unobstructed opening in between crossbeams. This design is not only beneficial in view of use of the sailing system of the vessel, but also in view of safety when using fuel like LNG.

For example, the fuel is one of:

- (mainly) methane, e.g. CNG (Compressed Natural Gas) or LNG (Liquified Natural Gas),
- hydrogen, for example compressed or liquid,
- ammonia,
- methanol,
- any biofuel, e.g. gaseous biofuel.

Generally, due to the structure of the hull and the arrangement of the main fuel tanks, the distance created by the crossbeams as well as the open space between the crossbeams, enhances safety. In case of an incident, fuel leaking from an outer hull towards the main hull will have the opportunity to evaporate easily, in presence of an abundance of air, in an open environment. Furthermore, as the mechanical propulsion drive system comprising a drive train including a motor is installed in the main hull of the trimaran vessel, there is no need for crew to access any engine room in the outer hull, the vessel preferably being devoid of any engine room in the outer hulls.

Below, for each mentioned fuel, the inventive concept will be elucidated.

For ammonia, which is highly toxic for humans, the advantage of the design according to the first aspect of the invention is that the distance between the outer hull and the main hull allows to keep humans onboard the main hull away from any potential leakage.

As is a preferred embodiment of the vessel, only the main hull is provided with a wheelhouse and accommodation for crew and/or passengers, e.g. the outer hull only being accessed for maintenance and inspection, and (optionally) for exchange of the fuel tanks as will be discussed herein.

For compressed hydrogen, which is highly explosive, a further advantage of the design according to the first aspect of the invention is that even when an outer hull would fail, e.g. in an explosion of the fuel tank, the trimaran vessel will stay afloat and upright as the main hull and the remaining outer hull will then provide sufficient buoyancy and stability. In contrast, when housed inside the main hull, an explosion of the hydrogen fuel tank would significantly impair the buoyancy, and the structure of the entire vessel would be affected. It is noted that a catamaran would capsize and a monohull vessel would sink in the same situation.

For liquid hydrogen, which is extremely cryogenic, a leak in the fuel tank is likely to make the skin of the outer hull brittle and prone to leak or break, although aluminum is far less problematic in this regard than steel. As this would only affect the outer hull, the trimaran vessel will still remain afloat and upright. The distance to the main hull will likely protect the main hull from being affected by the hydrogen leak.

For methanol, which has the property that in case of fire the flame is not visible so fire detection is less straightforward, the storage in the outer hull brings along that fire detection and extinction can be organized very effectively. For example, due to main fuel storage in an outer hull of the trimaran, a fire is quick to extinguish - even if detected late – e.g. by filling the compartment or the entire outer hull, with an inert gas. As crew accommodation, the wheelhouse, any control room(s), engine room(s), are, as preferred, only present on the main hull the use of inert gas fire extinction in the outer hull is not problematic.

In an embodiment, the one or more main fuel tanks are independent from the skin of the outer hull.

For example, the fuel tanks are embodied as IMO Type-B or Type-C cargo tanks for gas tankers. For example, a spacing between the fuel tank and the skin of the outer hull is present.

For example, the spacing is - seen in width direction - being at least 1/10$^{th}$ of the local width of the outer hull, e.g. the fuel tank has a width of at most 2/3 of the local width of the outer hull.

In an embodiment, an outer hull of the vessel accommodates a series of fuel tanks in longitudinal direction of one or both outer hulls, e.g. between 2 and 4 fuel tanks in an outer hull.

In an embodiment, each main fuel tank is embodied as an exchangeable fuel tank that is accommodated in an exchangeable manner in the outer hull so as to replace an empty fuel tank for a full fuel tank. For example, the fuel tank is a containerized tank, e.g. an ISO Tank Container having an ISO dimensions frame holding a gas tank. For example, each fuel tank is embodied as an ISO 20 ft. or ISO 40 ft. tank container, e.g. configured to be transported and handled as a ISO 20 ft. or ISO 40 ft. tank container.

In an embodiment, each main fuel tank is embodied as an exchangeable fuel tank, e.g. a containerized tank, which is accommodated in an exchangeable manner in an outer hull so as to replace an empty fuel tank for a full fuel tank, wherein the outer hull is configured to allow for horizontal removal and introduction of the exchangeable fuel tank. For example, the exchangeable fuel tank is transferable into and out of the outer hull via an opening in a stern of the outer hull. For example, the outer hull has a compartment with a stern opening configured to insert and remove one or more, e.g. a series of, exchangeable main fuel tanks, e.g. containerized tanks, into and out of the outer hull, e.g. in series. For example, use is made of a barge that is docked to the stern of the outer hull for exchange of one or more main fuel tanks. For example, a main fuel tank is slid off the barge and into the outer hull via an opening at the stern of the vessel. For example, the outer hull has one or more doors for closing said opening in the stern of the outer hull.

In an embodiment, the vessel has a container handling crane, e.g. on an outer hull, e.g. on a stern end of the outer hull, e.g. for use in handling of a n exchangeable fuel tank container. For example, the crane is used for handling of fuel tank containers that are to be moved into the outer hull via a stern opening thereof.

In an embodiment, an elongated compartment extends from a stern opening in the outer hull horizontally towards the bow of the outer hull, e.g. the elongated compartment being configured to accommodate multiple exchangeable fuel tanks in series, e.g. the elongated compartment having one or more of rails, carts, and/or rollers to allow transporting the exchangeable fuel tank along the compartment, e.g. the compartment having mobile barriers, e.g. doors, allowing to provide sub-compartments separated from one another and each accommodating an exchangeable fuel container.

For example, the mechanical propulsion device is embodied as a propellor, e.g. embodied as a propellor mounted on a shaft extending from the main hull, as a pod drive, as a thruster drive, or the mechanical propulsion device is a pump jet (e.g. allowing for shallow waters), etc.

For example, the drive motor is an electric drive motor or a combustion engine, e.g. a dual fuel combustion engine.

In an embodiment, the main hull has a cargo hold with a cargo deck. For example, the cargo hold is accessible via one or more cargo transfer openings located above waterline in one or both lateral sides of the main hull. For example, the cargo hold is accessible via a cargo transfer opening at the stern end of the deck, e.g. allowing access for vehicles. For example, the stern transfer opening of the cargo deck may be embodied as known for Ro-Ro shipping. In embodiments, one or more cargo hold doors are provided for closing the cargo transfer openings, e.g. wherein the cargo hold is configured for holding one or more ISO container, e.g. 20ft. ISO containers. For example, lateral side cargo transfer opening(s) are to be closed by upwardly pivoting door(s).

In an embodiment, only the main hull is provided with one or more cargo holds, the outer hulls being devoid of cargo holds and primarily serving for buoyancy, stability, and as sole location for the one or more main fuel tanks.

In an embodiment, the vessel is configured for transportation of passengers, e.g. as a ferry or as a cruise ship. In such embodiment, the passenger accommodation is part of the main hull, preferably with no such accommodation elsewhere on the vessel.

In an embodiment, the main hull provides a significant part of the buoyancy of the vessel, e.g. more than 50% thereof, e.g. more than 75% thereof, e.g. more than 85% thereof, e.g. effectively all of the buoyancy as is preferred.

In an embodiment, the outer hulls primarily serve to provide stability and, as preferred, to accommodate the main fuel tanks.

In an embodiment, the main hull provides all of the buoyancy, with the outer hulls providing buoyancy only as the vessel heels during sailing and/or due to wind. In embodiments, the outer hulls are above waterline when the vessel is upright.

In an embodiment, the main hull of the vessel has a transverse cross-section with an extended width above the waterline, e.g. said extended width contributing to the width of a cargo deck of the vessel, e.g. the cargo deck being part of a cargo hold further delimited by lateral walls of the cargo hold and a cargo hold roof, e.g. the roof being embodied as part of

a main outer deck of the main hull, e.g. the sailing system (when present) being provided on said main outer deck.

In an embodiment, the vessel is equipped for semi-autonomous navigation and/or collision avoidance, e.g. provided with one or more cameras, e.g. high-definition cameras, and/or other sensors, e.g. radar(s), e.g. linked to an anti-collision system, e.g. the vessel being equipped with an AI (Artificial Intelligence) System for any of these purposes.

The first aspect of the invention also relates to a trimaran sailing vessel, e.g. a cargo vessel, having a hull structure comprising:

- a central main hull,

- port and starboard outer hulls along opposite lateral sides of the main hull, respectively,

- port and starboard crossbeam structures rigidly connecting the respective outer hull to the main hull, each crossbeam structure comprising, or consists of, a forward crossbeam and a rearward crossbeam spaced from one another in longitudinal direction of the outer hull, with an unobstructed opening in between crossbeams,

wherein the main hull is provided with a sailing system erected on the main hull, e.g. comprising one or more wing sails,

wherein the main hull is provided with a mechanical propulsion drive system comprising a drive train including a motor, e.g. an electric motor, e.g. driving a propeller or a pumpjet,

wherein the hull structure of the vessel is provided with one or more compartments accommodating main batteries for storage of electricity powering the motor, which one or more compartments are located in one or both of the outer hulls.

The main risk associated with the main batteries is a fire followed by explosion. Such situation can be remedied fairly easily by filling the compartment or the entire outer hull with an inert gas (e.g. nitrogen, CO2). The use of inert gas fire suppression in the outer hull, so remote from the main hull where the crew and possible passengers are located, is acceptable. As discussed, even when the outer hull would fail, the vessel will remain buoyant and stable.

According to a second aspect thereof, the present invention relates to a trimaran vessel, e.g. a sailing vessel, e.g. a cargo vessel, having a hull structure comprising:

- a central main hull,

- port and starboard outer hulls along opposite lateral sides of the main hull, respectively,

wherein the vessel is provided with a mechanical propulsion drive system comprising a drive train including a motor, e.g. driving a propellor or a pumpjet, which motor is powered directly or indirectly by a fuel,

wherein the hull structure of the vessel is provided with one or more compartments accommodating one or more main fuel tanks for storage of said fuel.

As discussed above, WO2012016295 teaches to arrange the main fuel tanks, in particular for gaseous fuel, in the main hull.

The second aspect of the invention aims to provide a trimaran in which the supply of fuel to the vessel is facilitated, e.g. allow for replenishing fuel in locations where no fuel hose is connectable to the vessel, e.g. when the vessel is to be replenished away from or outside of a harbour that is accessible by the vessel.

According to the second aspect of the invention, as described in claim 16, the one or more main fuel tanks are located in the outer hull or in both outer hulls of the trimaran vessel, and each fuel tank is embodied as an exchangeable fuel tank, e.g. a containerized tank, that is accommodated in an exchangeable manner in an outer hull so as to replace an empty fuel tank for a full fuel tank.

Preferably, the outer hull is configured to allow for horizontal removal and introduction of the exchangeable fuel tank, e.g. via an opening in a stern of the outer hull, e.g. the outer hull having a compartment with a stern opening configured to insert and remove a series of exchangeable tanks, e.g. containerized tanks, in series into and out of the outer hull. For example, a main fuel tank is slid off the barge and into the outer hull via an opening at the stern of the vessel. For example, the outer hull has one or more doors for closing said opening in the stern of the outer hull.

For example, the vessel has an elongated compartment that extend from a stern opening in the outer hull horizontally towards the bow of the outer hull, e.g. the elongated compartment being configured to accommodate multiple exchangeable fuel tanks in series, e.g. the elongated compartment having one or more of rails, carts, and/or rollers to allow transporting the exchangeable fuel tank along the compartment, e.g. the compartment having mobile barriers, e.g. doors, allowing to provide sub-compartments separated from one another and each accommodating an exchangeable fuel container.

It will be appreciated that the trimaran vessel according to the second aspect of the invention may comprise one or more features discussed herein with reference to the first aspect of the invention, e.g. a sailing system, port and starboard crossbeam structures, and/or solely the main hull being provided with a mechanical propulsion drive system comprising a drive train

including a motor driving a mechanical propulsion device, which motor is powered directly or indirectly by the fuel stored in the one or more exchangeable main fuel tanks.

A third aspect of the invention relates to a trimaran sailing cargo vessel according to claim 17 having a hull structure comprising:

- a central main hull,

- port and starboard outer hulls along opposite lateral sides of the main hull respectively,

- port and starboard crossbeam structures rigidly connecting the respective outer hull to the main hull, each crossbeam structure comprising, or consists of, a forward crossbeam and a rearward crossbeam spaced from one another in longitudinal direction of the outer hull, with an unobstructed opening in between crossbeams,

wherein the main hull is provided with a sailing system,

wherein the main hull has a cargo hold with a cargo deck,

wherein the cargo hold is accessible via one or more cargo transfer openings located above waterline in one or both lateral sides of the main hull, wherein one or more cargo hold doors for closing the cargo transfer openings.

The third aspect thus envisages a trimaran hull design nowadays known from sailing yachts to be used in a cargo vessel, wherein transfer of cargo is done via one or more cargo transfer openings located above waterline in one or both lateral sides of the main hull.

For example, the vessel is configured for accommodating one or more ISO 20 ft. and/or ISO 40 ft. containers in the cargo hold.

In an embodiment, vessel has a cargo deck and the cargo hold further being delimited by lateral walls of the cargo hold and a cargo hold roof, e.g. a sailing system being provided on said cargo hold roof. For example, the main hull of the vessel has a transverse cross-section with an extended width above the waterline, e.g. said extended width contributing to the width of a cargo deck of the vessel.

For example, the cargo hold is accessible via cargo transfer openings in each of the lateral sides of the main hull, e.g. cargo transfer openings being symmetrical relative to the mid-plane of the main hull.

In embodiments, the vessel is provided with mooring facilities for mooring a barge to the vessel at a location between the outer hull and the main hull, adjacent the one or more cargo transfer openings in one or both lateral sides of the main hull, for transfer of cargo between the cargo hold in the main hull and the barge. The mooring facilities may include one or more

fenders, e.g. permanently installed fenders or mobile fenders that are mobile between a retracted and deployed position, e.g. supported by a linkage. The mooring facilities may include one or more bollards, mooring winches, etc. for temporarily fastening the barge to the vessel e.g. to the main hull.

The barge may, for example, be embodied as a (fairly small) inland waterway cargo vessel, e.g. as a canal boat.

In an embodiment, an outer hull at the inner side facing the main hull is provided with fenders for the barge, e.g. to avoid damage of the outer hull, e.g. when accommodation the main fuel tank(s) as discussed with reference to the first aspect of the invention.

In embodiments, a cargo hold door in a lateral side of the main hull is pivotally upward between a closed and an opened position thereof.

In embodiments, the vessel is provided with cargo handling equipment, e.g. a crane, e.g. an overhead crane deployable from within the main hull when the cargo hold door has been opened, for assisting in loading and unloading cargo e.g. wherein a pivotal cargo hold door supports an overhead crane for assisting in loading and unloading cargo. In an embodiment, a crane is supported (in part) on one or both of the crossbeams.

It will be appreciated that trimaran sailing cargo vessel of the third aspect of the invention may be complemented with one or more features discussed herein with reference to the first and/or second aspect of the invention.

For example, the trimaran sailing cargo vessel may include a propulsion system and arrangement of the one or more main fuel tanks as discussed with reference to the first aspect of the invention.

The invention also relates to a cargo distribution system comprising a trimaran vessel as discussed herein, e.g. according to the third aspect of the invention, and one or more barges, wherein the barge is configured to be moored between the main hull and an outer hull for transfer of cargo between the cargo hold in the main hull and the barge.

In embodiment, the vessel has a cargo hold that is configured for accommodating one or more ISO 20 ft. and/or ISO 40 ft. containers in the cargo hold, wherein the barge is configured for accommodating one or more ISO 20 ft. and/or ISO 40 ft. Herein, preferably, the vessel is provided with cargo handling equipment, e.g. a crane, e.g. an overhead crane deployable from within the main hull when the cargo hold door has been opened, for assisting in loading and unloading cargo, for example the ISO 40 ft. or 20 ft. container.

In an embodiment, the barge is self-propelled. Alternatively, the barge is towed.

In an embodiment, the barge is provided with a Dynamic Position system (DP) configured to position the barge relative to the vessel, e.g. the barge and/or the vessel having one or more position detectors, e.g. cameras or other visual sensors, measuring the position of the barge with respect to the vessel and the system adjusting the barge based upon signals for said one or more position detectors.

The present invention also relates to a method for cargo distribution wherein use is made of a trimaran vessel as discussed herein or a cargo distribution system as discussed herein.

In an embodiment of the method, a barge is moored between the main hull and an outer hull and cargo is transferred between a cargo hold in the main hull and the barge. For example, two barges are moored simultaneously at opposite lateral sides of the main hull. For example, as discussed herein, the main hull has a cargo hold with one or more lateral cargo transfer openings allowing for easy transfer of cargo between the cargo hold and the barge.

For example, the trimaran vessel is anchored near a shoreline, e.g. outside a harbour, and wherein the barge is used for shuttling of cargo between the vessel and the shoreline, e.g. a harbour or jetty at the shoreline, e.g. the harbour or jetty not being accessible for the trimaran vessel. The barge may also travel inland, e.g. along a river, to distribute the cargo further inland and transfer cargo to the trimaran vessel.

The trimaran vessel can, for example, be used for cargo distribution in areas on the world where a suitable harbour for the vessel is absent, e.g. the local harbour being too small, or just a minor jetty being present. For example, the vessel is to be anchored at a sheltered location that is easily accessible by barges (estuary, bay, ..), outside the harbour. The vessel may also be of relevance in areas where high demands are placed on emissions, e.g. in environmentally fragile areas, and/or in areas where fuel costs are problematic and sailing offers an economical benefit.

The vessel may take along the one or more cargo shuttling barges, e.g. stored on a deck, but it is preferred that one or more barges are already present at each location where the vessel is to be unloaded/loaded, e.g. the local community near a shoreline has one or more barges, e.g. self-propelled barges.

The invention will now be explained with reference to the drawings. In the drawings:

- fig. 1 shows an example of a trimaran sailing cargo vessel according to the invention,

- fig. 2 illustrates in a cross-sectional view the transfer of cargo between the vessel of figure 1 and barges moored between the outer hulls and the main hull of the vessel,

- fig. 3 shows the accommodation of main fuel tanks in the outer hulls of the vessel of figure 1,

- fig. 4 shows in a view of figure 3 the provision of an overhead crane on the vessel for transfer of cargo between the vessel and the barges.

With reference to figures 1 – 4 now the inventive concepts and embodiments thereof will be discussed.

The figure 1 generally shows a trimaran sailing cargo vessel having a hull structure comprising:

- a central main hull 1,

- port and starboard outer hulls 2, 3 along opposite lateral sides of the main hull respectively,

- port and starboard crossbeam structures rigidly connecting the respective outer hull to the main hull, each crossbeam structure comprising, or consists of, a forward crossbeam 4 and a rearward crossbeam 5 spaced from one another in longitudinal direction of the outer hull, with an unobstructed opening in between crossbeams 4, 5.

For example, the vessel has one or more, e.g. 2 x 2, daggerboards in main hull.

For example, minimum main dimensions of the vessel are:

- central main hull overall length 50 m

- outer hulls overall length 25 m

- overall vessel width 25 m.

The main hull 1 provides a significant part of the buoyancy of the vessel, e.g. more than 50% thereof, e.g. more than 75% thereof, e.g. more than 85% thereof, e.g. effectively all of the buoyancy as is preferred.

The outer hulls 2, 3, preferably serve to provide stability and, as preferred to accommodate the one or more main fuel tanks.

It is illustrated that the main hull 1 provides all of the buoyancy, with the outer hulls 2, 3 providing buoyancy as the vessel heels during sailing. In embodiments, as illustrated, the outer hulls 2,3, are effectively above waterline when the vessel is upright.

The main hull is provided with a sailing system, here comprising wing sails 7, 8, 9 erected on the main hull 1. The one or more wing sails may be designed as discussed in EP2822851 of Propelwind, which is incorporated herein by reference.

As preferred, only the main hull 1 is provided with a wheelhouse 10 and accommodation for crew and/or passengers.

As preferred, the outer hulls 2, 3 are in operation of the vessel only to be accessed for maintenance and inspection, and, optionally, for exchange of the main fuel tanks.

The main hull 1 has a cargo hold 20, e.g. extending over a major part of the length of the main hull.

The cargo hold 20 has a cargo deck 21, above waterline, the cargo hold further being delimited by lateral walls 22, 23 of the cargo hold and a cargo hold roof 24, here also forming an upper deck of the vessel.

It is illustrated that the main hull 1 of the vessel has a transverse cross-section with an extended width above the waterline, said extended width contributing to the width of a cargo deck 21 of the vessel. The cargo deck does not extend to the outer hulls 3, 4.

In another embodiment, the cargo hold has cargo decks are different heights, e.g. an upper cargo deck as shown above and a lower cargo deck below waterline. For example, in an embodiment, the upper cargo deck is provided with an opening therein, e.g. centrally in the hold, providing access to the lower cargo deck deeper in the main hull.

The sailing system 7, 8, 9 is/are installed on the cargo hold roof 24, here embodied as an outer deck of the main hull as is preferred. The one or more sailing systems can be installed on the hull centerline, but may also be installed offset from said line, e.g. close to one or both of the lateral sides of the main hull.

The cargo hold 20 is accessible via one or more cargo transfer openings 28, 29 that are located above waterline in one or both lateral sides of the main hull 1 (here both lateral sides).

One or more cargo hold doors 30 are present for closing the cargo transfer openings 28, 29 in the lateral sides.

For example, as shown, the vessel is configured for accommodating one or more ISO 20 ft. and/or ISO 40 ft. containers in the cargo hold. Of course, other cargo can be loaded into the cargo hold as well.

The vessel, e.g. the main hull 1, is provided with cargo handling equipment, e.g. one or more cranes, e.g. an overhead crane 35 deployable from within the main hull when the cargo hold door has been opened, for assisting in loading and unloading cargo e.g. wherein a pivotal cargo hold door supports an overhead crane for assisting in loading and unloading cargo.

The main hull 1 is provided with a mechanical propulsion drive system comprising a drive train including a motor, e.g. in an engine room in the main hull, the motor driving a mechanical propulsion device, which motor is powered directly or indirectly by a fuel, e.g. one or more of the fuels specifically discussed herein. The motor drives a mechanical propulsion device, e.g. a propellor or a pumpjet.

Possibly, the vessel has multiple mechanical propulsion drive systems, e.g. multiple pumpjets, e.g. one or more pumpjets fore and aft on the main hull.

The hull structure of the vessel is provided with one or more compartments, here one elongated compartment 40 per outer hull (only one visible), accommodating one or more main fuel tanks 50, 51, 52, 53, for storage of the fuel that directly or indirectly, e.g. via a fuel powered generator, drives the motor.

The one or more main fuel tanks are all located in one or more compartments that are located in one or both of the outer hulls 2, 3.

For example, the fuel is a gaseous fuel.

For example, the fuel is one of:

- methane, e.g. CNG or LNG,

- hydrogen, e.g. liquid or compressed hydrogen,

- ammonia,

- methanol,

- a biofuel.

For example, each fuel tank 50 – 54, or one or more of all main fuel tanks of the vessel, is embodied as an exchangeable fuel tank, which is accommodated in an exchangeable manner in the outer hull so as to replace an empty fuel tank for a full fuel tank. For example, each tank 50 - 54 is a containerized tank, e.g. an ISO Tank Container having an ISO dimensions frame holding a gas tank, e.g. an ISO 20 ft. or ISO 40 ft. tank container, e.g. configured to be transported and handled as an ISO 20 ft. or ISO 40 ft. tank container. For example, the containerized tank is provided with multiple gas cylinders arranged vertically or horizontally in an ISO dimensions frame.

It is illustrated that the outer hull 3 is configured to allow for horizontal removal and introduction of the one or more exchangeable fuel tanks 50 - 54, as preferred via an opening 42 in a stern of the outer hull 3. Preferably, a door is provided to open and close the stern opening 42.

It is illustrated, that the outer hull 3 has a main fuel tanks compartment 40, here with a stern opening 42, configured to insert and remove a series of exchangeable tanks, e.g. containerized tanks, in series into and out of the outer hull. In more detail, an elongated compartment 40 extends from a stern opening 42 in the outer hull horizontally towards the bow of the outer hull. The elongated compartment 40 is configured to accommodate multiple exchangeable fuel tanks 50 – 54 in series. For example, the elongated compartment 40 has conveyance equipment, e.g. one or more of rails, carts, and/or rollers to allow transporting the one or more exchangeable fuel tank 50 – 54 along the compartment.

By providing several tanks, typically 2 to 4 tanks, in a row in an outer hull the effect may be achieved that when the outer hull would bend or break due to a collision, the tanks, or most of the tanks, will remain gas - and liquid tight.

The use of standard tank containers 50 – 54, e.g. ISO 20 ft. or 40 ft. gas tank containers, may provide important advantages:

- quick refueling, just replacing an empty tank by a full one (no need to pump, no need to compress, no need for a hose connection),

- easy fuel supply chain, for example fuel tank containers 50 – 54 are brought to the cargo terminal by road or rail; no need for bunker ship, large shore tank, loading arms etc..

Loading and unloading the fuel tanks 50 - 54 horizontally, e.g. at the stern of the outer hull, minimizes vertical handling and the risk of tank dropping.

For example, the compartment 40 has one or more mobile barriers, e.g. doors, e.g. gas-tight, allowing to provide sub-compartments separated from one another and each accommodating an exchangeable fuel container 50 – 54, preferably also a fire detection and extinguishing system.

It is illustrated that the cargo hold 20 is accessible via cargo transfer openings 28, 29 in each of the lateral sides of the main hull 1, e.g. cargo transfer openings being symmetrical relative to the mid-plane of the main hull 1.

As preferred, the vessel is provided with mooring facilities for mooring a barge 60, 65 to the vessel at a location between the outer hull 3,4 and the main hull 1, adjacent the one or more cargo transfer openings 28, 29 in one or both lateral sides of the main hull, for transfer of cargo between the cargo hold in the main hull 1 and the barge 60, 65.

It is illustrated that a cargo hold door 30 in a lateral side of the main hull 1 is pivotally upward between a closed and an opened position thereof.

It is illustrated that for transfer of cargo from or to the vessel, a barge 60, 65 is to be moored between the main hull 1 and an outer hull 2, 3 for transfer of cargo between the cargo hold in the main hull and the barge. For example, two barges are moored simultaneously at opposite lateral sides of the main hull.

It illustrated that the vessel has a cargo hold 20 that is configured for accommodating one or more ISO 20 ft. and/or ISO 40 ft. containers in the cargo hold, and each barge60, 65 is configured for accommodating one or more ISO 20 ft. and/or ISO 40 ft.

Preferably, the barge 60, 65 is self-propelled.

In an embodiment, the barge is provided with a Dynamic Position system (DP) configured to position the barge relative to the vessel, e.g. the barge and/or the vessel having one or more position detectors, e.g. cameras or other visual sensors, measuring the position of the barge with respect to the vessel and the system adjusting the barge based upon signals for said one or more position detectors.

The trimaran vessel can, for example, be used for cargo distribution in areas on the world where a suitable harbour for the vessel is absent, e.g. the local harbour being too small, or just a minor jetty being present. For example, the vessel is anchored at a sheltered location that is easily accessible by barges (estuary, bay, ..), outside the harbour.

The vessel may take along the one or more barges, e.g. stored on a deck, but it is preferred that one or more barges 60, 65 are already present at each location where the vessel is to be unloaded/loaded, e.g. the local community near a shoreline has one or more barges 60, 65.

The vessel is the anchored near the shoreline, e.g. outside a harbour, and the barges 60, 65 are used to for shuttling of cargo between the vessel and the shoreline. The barges 60, 65 are moored between the outer hull and main hull, which provides a degree of protection from waves, e.g. the waves from other ships passing by during cargo handling, and/or wind.

C L A I M S

1. Trimaran sailing vessel, e.g. a cargo vessel, having a hull structure comprising:

- a central main hull,

- port and starboard outer hulls along opposite lateral sides of the main hull, respectively,

- port and starboard crossbeam structures rigidly connecting the respective outer hull to the main hull, each crossbeam structure comprising, or consists of, a forward crossbeam and a rearward crossbeam spaced from one another in longitudinal direction of the outer hull, with an unobstructed opening in between crossbeams,

wherein the main hull is provided with a sailing system erected on the main hull, e.g. comprising one or more wing sails,

wherein the main hull is provided with a mechanical propulsion drive system comprising a drive train including a motor driving a mechanical propulsion device, e.g. a propeller or pumpjet, which motor is powered directly or indirectly by a fuel,

wherein the hull structure of the vessel is provided with one or more compartments accommodating main fuel tanks for storage of said fuel, which one or more compartments are located in one or both of the outer hulls.

2. Vessel according to claim 1, wherein the drive train includes a motor that is powered directly or indirectly by a fuel that is one of:

- methane, e.g. CNG or LNG,

- hydrogen,

- ammonia,

- methanol,

- a biofuel.

and wherein said compartment in one or both of the outer hulls accommodate one or more main fuel tanks configured to contain said fuel.

3. Vessel according to claim 1 or 2, wherein only the main hull is provided with a wheelhouse and accommodation for crew and/or passengers, e.g. the outer hull only being accessed for maintenance and inspection, and, optionally, for exchange of the fuel tanks.

4. Vessel according to any one or more of claims 1 - 3, wherein the main fuel tanks are independent from the skin of the outer hulls, e.g. wherein the fuel tanks are embodied as

IMO Type-B or Type-C cargo tanks for gas tankers, e.g. wherein spacing between the fuel tank and the skin of the outer hull is present, e.g. the spacing - seen in width direction - being at least 1/10$^{th}$ of the local width of the outer hull, e.g. wherein the fuel tank has a width of at most 2/3 of the local width of the outer hull.

5. Vessel according to any one or more of claims 1 – 4, wherein an outer hull accommodates a series of fuel tanks in longitudinal direction of one or both outer hulls, e.g. between 2 and 4 fuel tanks in an outer hull.

6. Vessel according to any one or more of claims 1 – 5, wherein each fuel tank is embodied as an exchangeable fuel tank that is accommodated in an exchangeable manner in the outer hull so as to replace an empty fuel tank for a full fuel tank.

7. Vessel according to claim 6, wherein the exchangeable fuel tank is a containerized tank, e.g. an ISO Tank Container having an ISO dimensions frame holding a gas tank, e.g. an ISO 20 ft. or ISO 40 ft. tank container, e.g. configured to be transported and handled as a ISO 20 ft. or ISO 40 ft. tank container, that is accommodated in an exchangeable manner in the outer hull so as to replace an empty fuel tank for a full fuel tank.

8. Vessel according to any one or more of claims 1 – 7 , wherein each fuel tank is embodied as an exchangeable fuel tank that is accommodated in an exchangeable manner in an outer hull so as to replace an empty fuel tank for a full fuel tank, wherein the outer hull is configured to allow for horizontal removal and introduction of the exchangeable fuel tank.

9. Vessel according to claim 8, wherein the outer hull is configured with an opening in a stern of the outer hull to allow for horizontal removal and introduction of the exchangeable fuel tank, e.g. the outer hull having a compartment with a stern opening configured to insert and remove a series of exchangeable tanks, e.g. containerized tanks, in series into and out of the outer hull.

10. Vessel according to claim 8 or 9, wherein an elongated compartment extends from a stern opening in the outer hull horizontally towards the bow of the outer hull, e.g. the elongated compartment being configured to accommodate multiple exchangeable fuel tanks in series.

11. Vessel according to claim 10, wherein the elongated compartment has conveyance equipment, e.g. one or more of rails, carts, and/or rollers, to allow transporting the one or more exchangeable fuel tank along the compartment.

12. Vessel according to any of claims 9 - 11, wherein the compartment has mobile barriers, e.g. doors, allowing to provide sub-compartments separated from one another and each accommodating an exchangeable fuel container.

13. Vessel according to any one or more of claims 1 – 12, wherein the main hull has a cargo hold with a cargo deck.

14. Vessel according to claim 13, wherein the cargo hold is accessible via one or more cargo transfer openings located above waterline in one or both lateral sides of the main hull, wherein one or more cargo hold doors are provided for closing the cargo transfer openings, e.g. wherein the cargo hold is configured for holding one or more ISO container, e.g. 20ft. ISO containers.

15. Vessel according to any one or more of claims 1 – 14, wherein the main hull of the vessel has a transverse cross-section with an extended width above the waterline.

16. Trimaran vessel, e.g. a sailing vessel, e.g. a cargo vessel, having a hull structure comprising:

- a central main hull,

- port and starboard outer hulls along opposite lateral sides of the main hull, respectively,

wherein the vessel is provided with a mechanical propulsion drive system comprising a drive train including a motor driving a mechanical propulsion device, e.g. a propeller or a pumpjet, which motor is powered directly or indirectly by a fuel,

wherein the hull structure of the vessel is provided with one or more compartments accommodating one or more main fuel tanks for storage of said fuel, which one or more compartments are located in one or both of the outer hulls,

wherein a main fuel tank is embodied as an exchangeable fuel tank, e.g. a containerized tank, that is accommodated in an exchangeable manner in an outer hull so as to replace an empty fuel tank for a full fuel tank, wherein, preferably, the outer hull is configured to allow for horizontal removal and introduction of the exchangeable fuel tank, e.g. via an opening in a stern of the outer hull, e.g. the outer hull having a compartment with a stern opening configured to insert and remove one or more exchangeable fuel tanks, e.g. containerized tanks, in series into and out of the outer hull.

17. Trimaran sailing cargo vessel having a hull structure comprising:

- a central main hull,

- port and starboard outer hulls along opposite lateral sides of the main hull respectively,

- port and starboard crossbeam structures rigidly connecting the respective outer hull to the main hull, each crossbeam structure comprising, or consists of, a forward crossbeam and a rearward crossbeam spaced from one another in longitudinal direction of the outer hull, with an unobstructed opening in between crossbeams,

wherein the main hull is provided with a sailing system,

wherein the main hull has a cargo hold with a cargo deck,

wherein the cargo hold is accessible via one or more cargo transfer openings located above waterline in one or both lateral sides of the main hull, wherein one or more cargo hold doors for closing the cargo transfer openings,

wherein, for example, the vessel is configured for accommodating one or more ISO 20 ft. and/or ISO 40 ft. containers in the cargo hold.

18. Vessel according to claim 17, wherein the cargo hold is accessible via cargo transfer openings in each of the later sides of the main hull, e.g. cargo transfer openings being symmetrical relative to the mid-plane of the main hull.

19. Vessel according to claim 17 or 18, wherein the vessel is provided with mooring facilities for mooring a barge to the vessel at a location between the outer hull and the main hull, adjacent the one or more cargo transfer openings in one or both lateral sides of the main hull, for transfer of cargo between the cargo hold in the main hull and the barge.

20. Vessel according to any one or more of claims 17 - 19, wherein a cargo hold door in a lateral side of the main hull is pivotally upward between a closed and an opened position thereof.

21. Vessel according to any one or more of claims 17 - 20, wherein the vessel is provided with cargo handling equipment, e.g. a crane, e.g. an overhead crane deployable from within the main hull when the cargo hold door has been opened, for assisting in loading and unloading cargo.

22. Vessel according to claim 21, wherein a pivotal cargo hold door supports an overhead crane for assisting in loading and unloading cargo.

23. Cargo distribution system comprising a trimaran vessel according to any one or more of claims 1 – 22, e.g. trimaran sailing cargo vessel according to any one or more of claims 16 – 22, and one or more barges, wherein the barge is configured to be moored between the main hull and an outer hull for transfer of cargo between the cargo hold in the main hull and the barge.

24. Cargo distribution system according to claim 23, wherein the vessel has a cargo hold that is configured for accommodating one or more ISO 20 ft. and/or ISO 40 ft. containers in the cargo hold, and wherein the barge is configured for accommodating one or more ISO 20 ft. and/or ISO 40 ft. containers.

25. Cargo distribution system according to claim 23 or 24, wherein the barge is self-propelled, e.g. wherein the barge is provided with a Dynamic Position system (DP) configured to position the barge relative to the vessel, e.g. the barge and/or the vessel having one or more position detectors, e.g. cameras or other visual sensors, measuring the position of the barge with respect to the vessel and the system adjusting the barge based upon signals for said one or more position detectors.

26. Method for cargo distribution wherein use is made of a trimaran vessel according to any one or more of claims 1 – 22 or a cargo distribution system according to any one or more of claims 23 - 25, wherein a barge is moored between the main hull and an outer hull and cargo is transferred between a cargo hold in the main hull and the barge, e.g. wherein two barges are moored simultaneously at opposite lateral sides of the main hull, e.g. the main hull having a cargo hold with one or more lateral cargo transfer openings.

27. Method according to claim 26, wherein the vessel is anchored near a shoreline, e.g. outside a harbour, and wherein the barge is used for shuttling of cargo between the vessel and the shoreline, e.g. a harbour or jetty at the shoreline, e.g. the harbour or jetty not being accessible for the trimaran vessel.

28. Method according to claim 26 or 27, wherein the barge is used for shuttling cargo between the trimaran vessel and an inland location, e.g. as an inland river cargo barge.

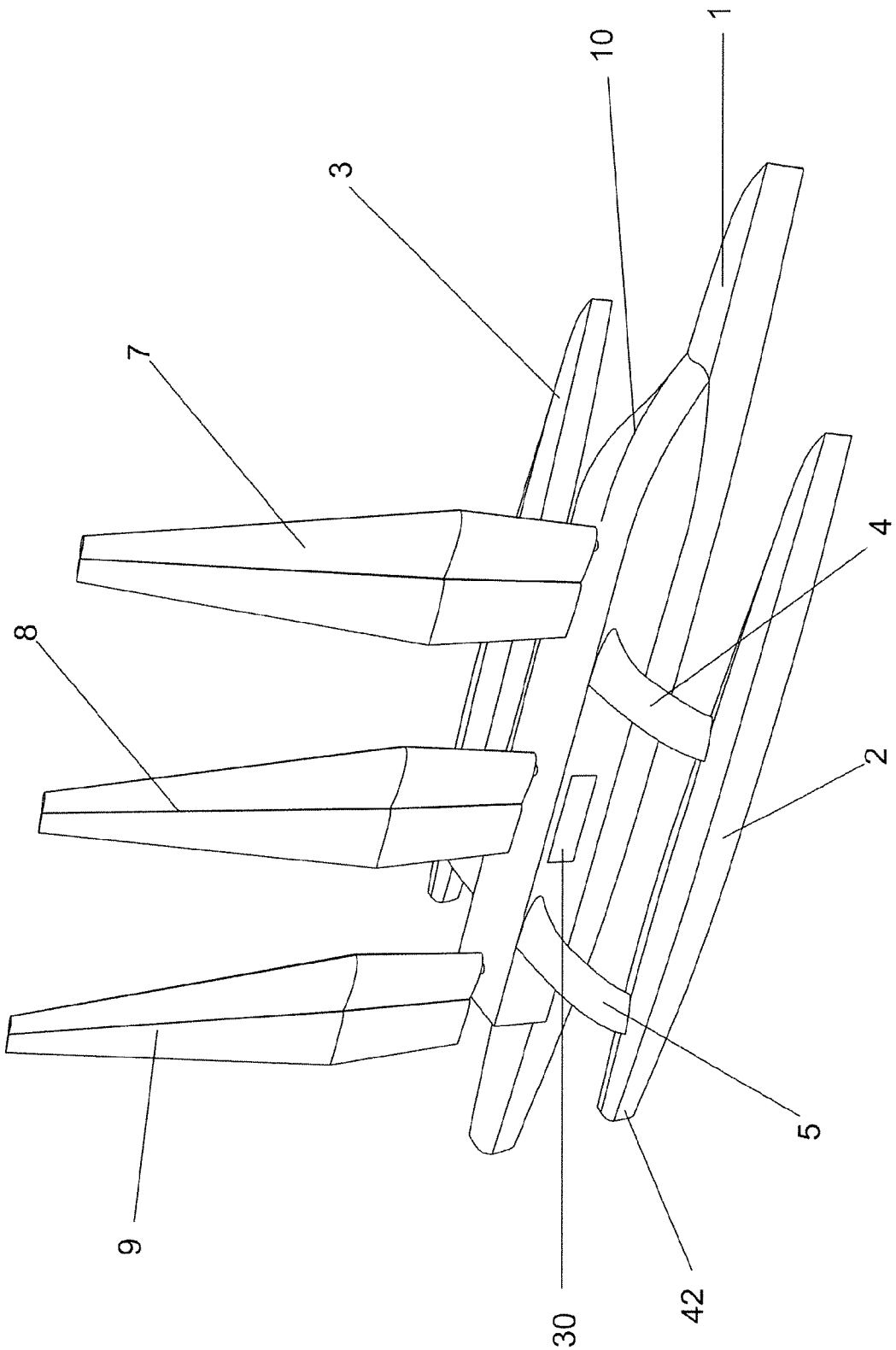



FIG 1

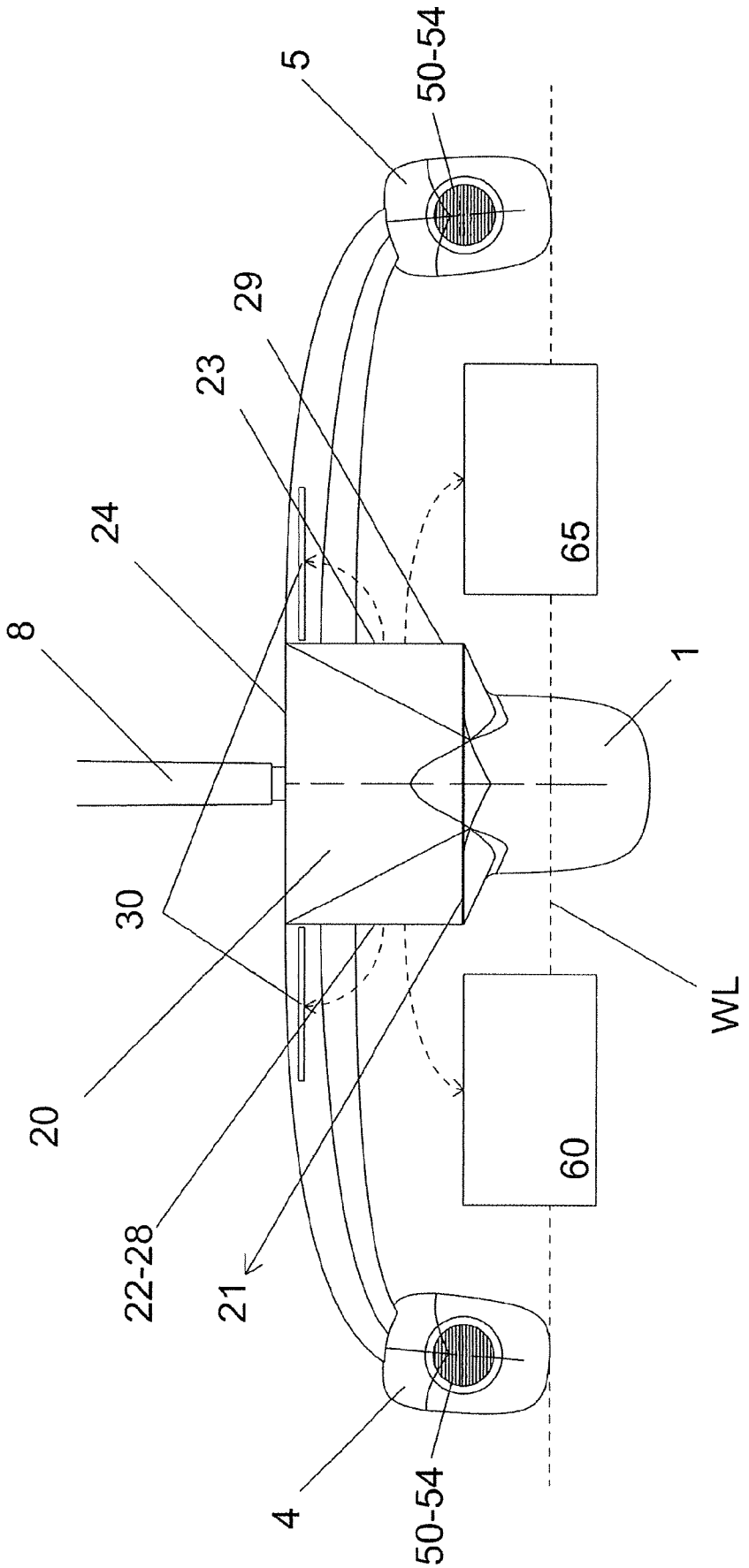



FIG 2

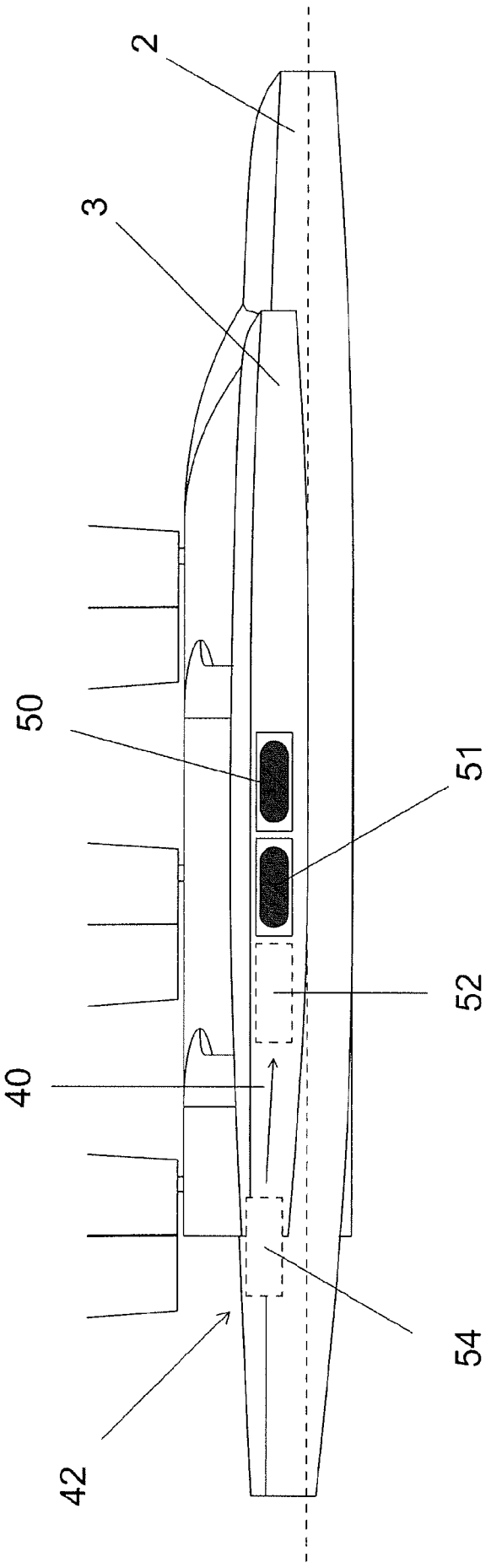



FIG 3

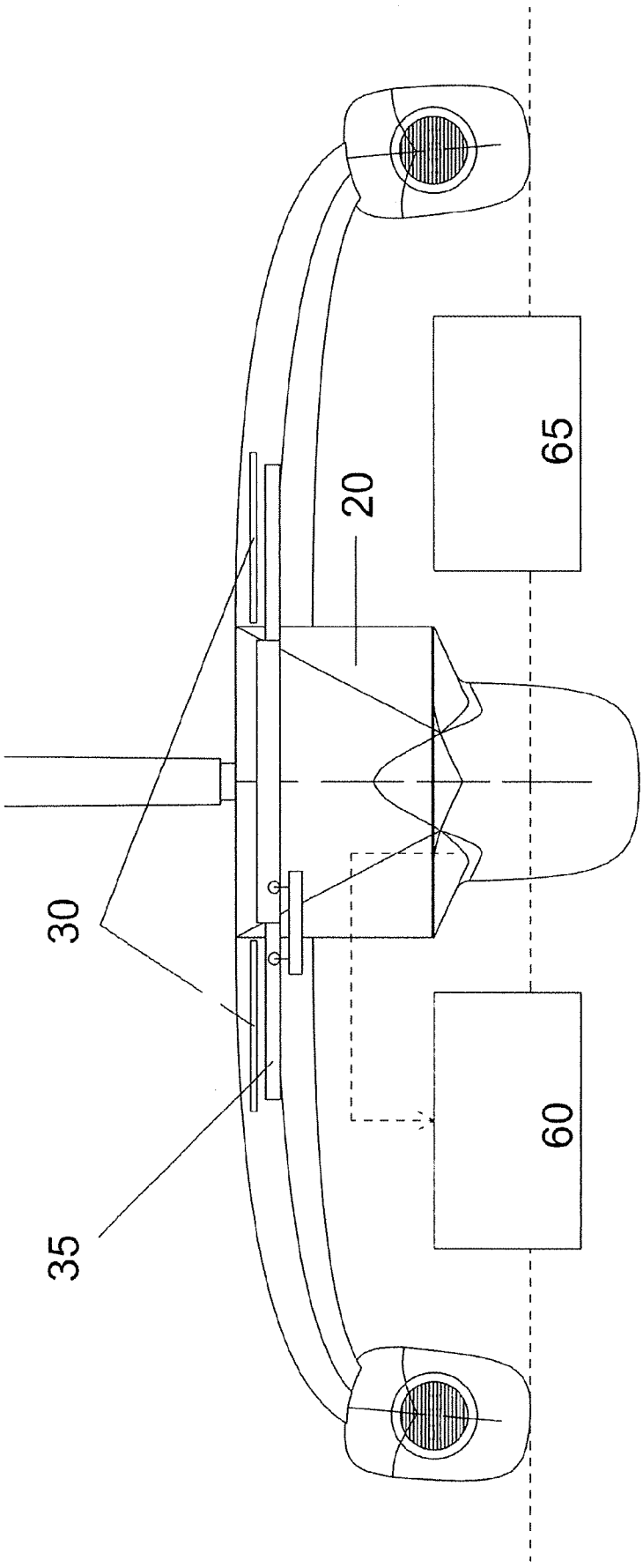



FIG 4