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(54) **STABILISATION SYSTEM**

(57) A stabilisation system for a watercraft is provided, the watercraft having a hull comprising a longitudinal axis extending along the length of the hull, the stabilisation system comprising: a stabilisation member for counteracting movement of the watercraft, where the stabilisation member is configured to be arranged below the waterline of the hull, where the stabilisation member has an elongated member having a longitudinal axis having a first end and a second end and extending in a direction away from the hull, where the first end is proximal to the hull and the second end is distal to the hull during oper-

ation, and where the stabilisation member is pivotally connected with the watercraft and having a first pivot axis, a stabilisation actuation device, having a second longitudinal axis, configured to provide actuation to the stabilisation member to provide pivotal movement to the stabilisation member to pivot, one or more attachment members being configured to provide attachment between an outer surface of the hull and configured to fix the stabilisation actuation device relative to the outer surface of the hull.

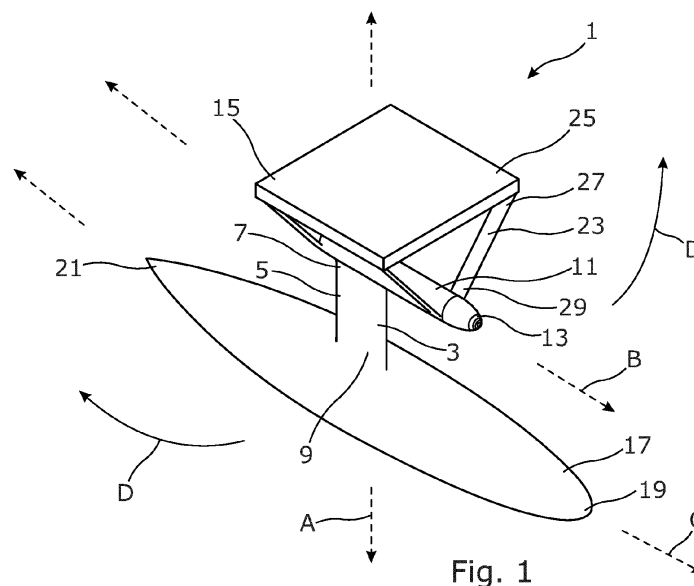


Fig. 1

Description

TECHNICAL FIELD

[0001] A stabilisation system for a watercraft is provided, the watercraft having a hull comprising a longitudinal axis extending along the length of the hull.

BACKGROUND

[0002] A marine vessel may be considered as being a body that is capable of floating in a body of water, where the vessel may be manoeuvred from one position to another position on the body of water. The marine vessel may be a watercraft. The body of a marine vessel may be a hull, where the hull may have various shapes, depending upon the needs of the design of the watercraft and the requirements for the buoyancy of the watercraft.

[0003] The hull of the marine vessel may have different shapes and forms, where the hull floats on the body of water, and where the shape and form of the hull influences the stability of the hull in a body of water. A number of different types of hulls are known, and a marine vessel may have more than one hull, such as a multihull marine vessel, similar to a catamaran or a hull having an outrigger, or a trimaran. However, the choice of hull for a particular marine vessel is chosen for its purpose and its required stability in the water.

[0004] However, a number of different types of marine vessels are provided with stability systems, where the stability systems are intended to minimise the roll or pitch of a vessel when the vessel is used on a body of water. Such stability measures may be active or passive, where active systems may counteract the motion of the vessel, such as stabiliser fins, gyroscopic internal stabilisers, and passive systems that may utilise weight or a hydrodynamic force to stabilise the hull, such as fins or keels.

[0005] The active stabiliser systems for hulls are often introduced to the hull during the building phase of the hull, which allows the systems to be installed in a correct manner and which allows the ship builder to position the hardware for the stabiliser in the optimum place for the design of the marine vessel.

[0006] However, if an active stabiliser system is to be installed on an existing hull, i.e. to retrofit a stabiliser system to an existing hull, there are a number of problems with the retrofitting, as the stabilising components have to be mounted to the hull and elements of the system have to be mounted inside the hull. Thus, there is a need to find a correct position for the hardware, as the hull and the remaining parts of the marine vessel have not been designed for having stabiliser components on and inside the hull of the ship. This may require the ship to be taken out of water and into a dry dock for a long period of time, which means that the marine vessel cannot be utilised in this period.

[0007] Thus, there is a need to provide a stabilising system for a marine vessel that may be easily attached

to a marine vessel without the need of complex modifications to the marine vessel.

DESCRIPTION

[0008] In accordance with the invention, a stabilisation system for a watercraft is provided, the watercraft having a hull comprising a longitudinal axis extending along the length of the hull, the stabilisation system comprising: a stabilisation member for counteracting movement of the watercraft, where the stabilisation member is configured to be arranged below the waterline of the hull, where the stabilisation member has an elongated member having a longitudinal axis having a first end and a second end and extending in a direction away from the hull, where the first end is proximal to the hull and the second end is distal to the hull during operation, and where the stabilisation member is pivotally connected with the watercraft and having a first pivot axis, a stabilisation actuation device, having a second longitudinal axis, configured to provide actuation to the stabilisation member to provide pivotal movement to the stabilisation member to pivot, one or more attachment members being configured to provide attachment between an outer surface of the hull and configured to fix the stabilisation actuation device relative to the outer surface of the hull.

[0009] The provision of the stabilisation system on a watercraft means that the use of the watercraft in turbulent waters may be improved, as the stabilisation system may reduce the roll or the pitch of the marine vessel. As the attachment members are provided to fix the stabilisation actuation device relative to the outer surface of the hull, the stabilisation system may be retrofitted to a watercraft, without having to modify the position of components of the watercraft inside the hull of the watercraft or without having to make large openings in the hull to house the actuation device inside the hull of the watercraft. This ensures that the cost of modification of a marine vessel is reduced compared to the provision of known stabilisation systems, as the main components of the stabilisation system, at least the mechanical components, are provided on the outside of the hull of the watercraft. Thus, when a stabilisation system is being mounted, the watercraft workers (shipbuilders) have to find a suitable position for a motor and a transmission to provide power to the stabilisation member, and in an already built ship there is often not any suitable positions inside the hull of the ship. Thus, by providing the stabilisation actuation device outside of the hull, there is little or no space needed inside the hull of the vessel, as the motor and/or transmission may be positioned outside the hull of the watercraft in the form of the stability actuation device.

[0010] The control systems, sensors, a human interface, or other electronical components of a stabilisation system may be provided within the boundary of the hull of the watercraft, where wired or wireless signal communication may be provided between the control devices

and the external stabilisation system.

[0011] Within the context of the present disclosure, the term "fix" may mean that the position of the stabilisation actuation device may be fixed relative to the outer surface of the hull. The fixation may be both in a rotational direction, as well as longitudinal or transverse direction. Thus, it may be understood that at least parts of the stabilisation actuation device are static during use relative to the hull, where the attachment member(s) may provide a counterforce between the stabilisation member and the hull, so that the stabilisation force provided by the stabilisation member may be transferred mechanically to the hull of the watercraft. Thus, if the stabilisation member moves relative to the hull, the centre of gravity or the centre of buoyancy of the watercraft may be changed in response to the movement of the stabilisation member. By fixing at least part of the stabilisation actuation device relative to the hull, it may be possible to let a stationary part of the actuation device, attachment members or the hull absorb the torque, torsion or any other forces that occur when the stabilisation member is moved, or alternatively when the stabilisation member is fixed in its position, and a force is applied to the stabilisation member via the body of water (such as waves) the attachment member and/or the hull will absorb the torsional forces, thereby preventing the stabilisation actuation member to move relative to the hull.

[0012] The stabilisation actuation device may have a static part and a dynamic part, where the static part may be fixed relative to the hull of the watercraft, while the dynamic part may provide the actuation and/or movement to pivot the stabilisation member relative to the static part and/or the hull. The stabilisation actuation device may comprise one or more of a motor, a transmission, a drive shaft or other components that are capable of transforming electrical energy into mechanical energy or conveying mechanical energy from an electric motor to the stabilisation member.

[0013] The stabilisation member may pivotally move relative to the hull, where the stabilisation member pivots along a pivotal axis, where the first end may be positioned close to the pivot axis, and the second end is positioned distal to the pivotal axis, so that the second end travels a longer distance than the first end during pivotal movement of the stabilisation member. Thus, the second end of the stabilisation member may have a buoyancy body or a counterweight body configured to provide a counterforce to the movement of the watercraft.

[0014] According to the present disclosure, a stabilisation member may be understood as a keel, a hydrodynamic keel, an airkeel, or any kind of element that is capable of stabilising the heel and/or pitch of a marine vessel. A stabilisation member should not be understood as a fin, ballast tanks, rolling weights, bilge keels, an internal gyroscope, or other internal systems of a marine vessel.

[0015] The stabilisation member may be a stabilisation member that is capable of providing a counterforce in a direction of the rolling motion of the marine vessel. As an

example, if a marine vessel rolls to the starboard side, the stabilisation member may provide an equal counterforce in the opposite direction (towards the port side). When the counterforce has been applied, and the marine vessel may be inclined to roll towards the port side, the stabilisation member may provide a countermovement in the opposite direction (towards the starboard side). When the system is activated, the stabilisation member may be continuously adjusted in either direction to counteract the force applied to the marine vessel providing a potential rolling motion in order to counteract the rolling motion. This is especially helpful when the marine vessel is provided with no propulsion in a forwards or backwards direction, or when the marine vessel is propelled at very low speeds, as the marine vessel may follow the movement of the waves, wind and/or other factors when there is little or no propulsion.

[0016] Optionally, the processing unit may be provided with a memory device, where the memory device may be provided with algorithms capable of identifying the sensor data and providing a predefined response to the sensor data and/or the contents of the data signal and provide a control signal that is intended to allow the stabilising element to counteract the coming movement of the marine vessel. The algorithms may be algorithms that are specifically adjusted for the specific marine vessel, and/or may also be generic algorithms that are adapted to respond to known movements of a marine vessel.

[0017] In one exemplary embodiment, the stabilisation member may be configured to counteract a rolling movement of the hull of the marine vessel in relation to wave movement of the surrounding body of water that interacts with the hull. The stabilisation member may be a stabilisation member that is capable of providing a counterforce in a direction of the rolling motion of the marine vessel. As an example, if a marine vessel rolls to the starboard side, the stabilisation member may provide an equal counterforce in the opposite direction (towards the port side). When the counterforce has been applied, and the marine vessel may be inclined to roll towards the port side, the stabilisation member may provide a countermovement in the opposite direction (towards the starboard side). When the system is activated, the stabilisation member may be continuously adjusted in either direction to counteract the force applied to the marine vessel providing a potential rolling motion, in order to counteract the rolling motion. This is especially helpful when the marine vessel is provided with no propulsion in a forwards or backwards direction, or when the marine vessel is propelled at very low speeds, as the marine vessel may follow the movement of the waves, wind and/or other factors when there is little or no propulsion.

[0018] In one exemplary embodiment, the control input controls an angular movement of the stabilisation member. The control unit may provide a control input and may be adapted provide a specific angular position of the stabilisation member as an input to the sensor output and/or the control output of processor. Thus, when a sensor

output is received by the processor, and a predefined control output is transmitted to the control unit, the control unit may respond by adjusting an angular position of the stabilisation member and/or to maintain a predefined position of the stabilisation member. This may mean that if a wave hits the hull of the marine vessel, the sensor may register the resulting movement of the hull, and where the processor receives the sensor output and makes computations and/or calculation based on rules and/or algorithms to respond to the sensor output and transmit a control input to the control unit, to adjust the angular position of the stabilisation member to counteract the force applied to the hull by the wave.

[0019] The stabilisation member may be any kind of stabilisation member capable of affecting the hull of the marine vessel in a rolling movement in the starboard direction and/or the port direction. The stabilisation member may be in the form of a plurality of parts that individually provide a force in one direction but may also be a single element capable of providing a force in at least two directions.

[0020] In one exemplary embodiment, the attachment member may be configured to be attached to an outer surface of the watercraft. The attachment member may be configured to be attached directly to an outer surface of the watercraft, such as on the outer surface of the hull of the watercraft. This may be done with traditional attachment methods, and the outer surface of the watercraft may be reinforced to be able to absorb the forces that are transferred via the stabilisation system to the hull.

[0021] In one exemplary embodiment, the watercraft may be a marine vessel. The watercraft may be a single hull marine vessel or a multi hull marine vessel, such as a catamaran. The stabilisation system may be attached in relation to the outer surface of the hull of the vessel or at least may be attached in relation to the outer surface of the hull of the vessel that faces the body of water. Thus, the stabilisation system may be utilised to counteract movements, such as waves or current of the body of water, and thereby to provide a stabilisation of the marine vessel by counteracting the movement and minimising roll or pitch of the marine vessel.

[0022] In one embodiment, the stabilisation system may further comprise a sensor unit providing first sensor data providing information relating to the movement and/or positioning of the marine vessel, a processing unit receiving the first sensor data and providing a first control output, and a control unit receiving the first control output and providing a first control input to the stabilisation member to counteract a rolling movement and/or positioning of the marine vessel.

[0023] The first sensor data may e.g. be in the form of data received from a gyroscope and/or an accelerometer, where the data provide indications on the current roll angle of a marine vessel, providing an indication on the forces affecting the hull of the marine vessel when e.g. rolling or heeling. The sensor data may be real-time sensor data, where the sensed data may be provided instan-

taneously to the processing unit via signal communication parts capable of communicating signal data between two parts of the system via wired and/or wireless communication. The signal communication part may e.g. be a wired electrical communication, a wired optical communication, wireless radiofrequency signals, optical signals, or any suitable signal communication pathway.

[0024] The system may operate by the use of sensor data, where the sensor data may be capable of providing data that indicate the movement and/or the positioning of the marine vessel. The sensor data may also be capable of measuring a change of movement and/or positioning of the marine vessel, where the change in movement or position may e.g. be due to windy conditions, currents, tides, waves and other elements that may affect the movement and/or the positioning of a marine vessel. The sensors may detect a change in position or movement of the vessel, where the sensor sends first sensor data representing this movement to a processing unit. The processing unit may receive the first sensor data and process the data in accordance with the type of data and the contents of the data. Upon processing the sensor data, the processing data may send a first control output which contains information on what the processor has computed as a necessary counteraction to the movement or, in a certain situation where no movement is present, may compute the lack of a counteraction.

[0025] In one exemplary embodiment, the stabilisation member comprises a stabilisation body positioned at the second end of the elongated member of the stabilisation member. The elongated member may thereby be configured to transfer the pivotal movement to the stabilisation body, allowing the stabilisation body to move relative to the pivot axis of the stabilisation member. The elongated member may be a stiff or a rigid member, where the pivotal movement of the stabilisation actuation device is transferred to the stabilisation body. Thus, the length of the elongated member affects the movement of the second end of the stabilisation member, so that a short elongated member will move the second end a smaller distance than a long elongated member.

[0026] In one exemplary embodiment, the stabilisation element may be a counterweight keel and/or a positive buoyancy keel (floatation body keel), where optionally the hydrodynamic keel may be a counterweight keel and/or a positive buoyancy keel. The term "keel" may be understood as a projection extending from the hull of the watercraft, where the keel may provide sideways resistance in the water against movement of the watercraft provided either by waves or wind. By providing a counterweight keel or a positive buoyancy keel, where the keels may be adapted to move relative to the outer surface of the hull. Thus, the stabilisation element may be adapted to operate below the waterline of the boat, where the movement of the keel may be used to counteract the rolling movement of the hull. As an example, when a counterweight keel is used, the keel may be moved in a direction opposite to the rolling motion to counteract the

rolling motion of the hull, i.e. when the rolling motion is in a starboard direction the counterweight keel may move in a port direction, i.e. in an opposite direction from the movement of the hull. In another example, when a positive buoyancy keel is used, the keel may be moved in the same direction as the rolling movement, in order to provide increased buoyancy in the direction of the rolling movement, so that the increased buoyancy maintains the roll position of the marine vessel and reduces and/or eliminates the roll of the hull.

[0027] In one exemplary embodiment, the stabilisation system comprises a stabilisation housing having a longitudinal axis, where the stabilisation housing houses the stabilisation actuation device, and optionally where the stabilisation housing extends in parallel to the longitudinal axis of the hull. The stabilisation housing may be in the form of an elongated housing having a housing volume that is capable of housing the components for the stabilisation actuation device. The elongated housing may have a length extending along the length of the watercraft, where the elongated housing may be attached to an outer surface of the hull via the attachment member(s).

[0028] In one exemplary embodiment, the stabilisation member is configured to be manoeuvred relative to the stabilisation actuation device. The stabilisation member may be manoeuvrable relative to at least part of the stabilisation actuation device, where the stabilisation member may pivot relative to the stabilisation actuation device, where the stabilisation actuation device provides the force needed to pivot the stabilisation member.

[0029] In one exemplary embodiment, the stabilisation actuation device comprises an electrical motor that is in mechanical communication with the stabilisation member, so that the mechanical force produced by the electrical motor may be transmitted or transferred to the stabilisation member, allowing the stabilisation member to pivot relative to the hull of the watercraft. The transmission of the force from the electrical motor may be performed via a transmission, where the power of the motor is transmitted to an axle of stabilisation member. The transmission may be provided with speed changing gears or driveshaft, allowing the power of the electric motor to be geared down or up, to increase or decrease the torque transmitted from the motor and which is applied to the stabilisation member.

[0030] In one exemplary embodiment, the stabilisation member has a first extended position where the second end is positioned at a first distance from the stabilisation actuation device, and a second retracted position where the second end is positioned at a second distance from the stabilisation actuation device, where the first distance is greater than the second distance. This means that the second end of the stabilisation member may be retracted from its extended position, so that the position of the stabilisation member may be within a boundary of the hull of the watercraft in case the watercraft is to be manoeuvred in shallow waters or if the watercraft is to be posi-

tioned in e.g. a drydock. This is especially helpful in case the watercraft has more than one hull, such as a catamaran, where the stabilisation system may be positioned between the first and the second hull, and the second end of the stabilisation member may be retracted into the volume separating the two hulls of the watercraft. Thus, during use, the second end of the stabilisation member may extend beyond the lowest point of the hull, in a vertical direction, but in a retracted position, the stabilisation member is withdrawn into a position where the lowest point of the watercraft is the lowest part of the hull, e.g. the bottom of the first and/or second hull parts of a catamaran. This may also be utilised for single hull watercrafts, where the stabilisation member may be withdrawn relative to the stabilisation actuation device and may e.g. be parked in a substantially horizontal position, ensuring that the stabilisation member does not extend significantly in a vertical direction away from the hull. This may ensure that the lowest part of the watercraft may be the stabilisation actuation device, where the elongated member of the stabilisation member may extend in a horizontal direction, where a first end of the elongated member is on one side of the stabilisation actuation device and a second end of the elongated member is on the opposite side of the stabilisation actuation device, and a central part of the elongated member extends through the stabilisation actuation device.

[0031] In one exemplary embodiment, the transformation from the first extended position and the second retracted position is performed using a buoyancy of the stabilisation member. In accordance with the present disclosure, the buoyancy of the stabilisation member may be adjusted, especially in case the stabilisation member may be in the form of a positive buoyancy stabilisation member, where liquids may be pumped into and out of a volume of the stabilisation member, where the buoyancy may be adjusted. Thus, in order to transform the stabilisation member from its extended position to its retracted position, the stabilisation member may be set in a predefined pivotal position, where the buoyancy may be increased, and a connection between the stabilisation member and the stabilisation actuation device may be released, i.e. unlocking the position of the stabilisation member relative to the stabilisation actuation device, allowing the first end and/or the second end of the elongated member and/or the stabilisation member to move in a vertical direction upwards relative to the stabilisation actuation device. When the elongated member and/or the stabilisation member have moved relative to the stabilisation actuation device into its retracted position, the connection between the stabilisation member and the stabilisation actuation device may be re-engaged, so that the position of the stabilisation member may be locked in its retracted position. Within the understanding of the present disclosure, the stabilisation member may be locked in its retracted position and/or its extended position, so that the positioning of the stabilisation member is fixed relative to the stabilisation actuation device, at least in

the direction of extension and retraction along a longitudinal axis of the elongated member and/or the stabilisation member.

[0032] In one exemplary embodiment, the pivot axis of the stabilisation member may be parallel to the longitudinal axis of the hull and/or the longitudinal axis of the stabilisation actuation device. The longitudinal axis of the hull and/or the longitudinal axis of the stabilisation actuation device may extend along the length of the watercraft, i.e. the longitudinal axis extends in a direction of travel of the watercraft and may be parallel to the sailing direction of the watercraft. By having the pivot axis parallel to the longitudinal axis, it is possible to pivot the stabilisation member in a direction towards the starboard or port side of the hull, where the stabilisation member may be adapted to counteract the roll of the vessel in a starboard or port direction.

[0033] In one exemplary embodiment, the second longitudinal axis of the stabilisation actuation device may be positioned at a distance from an outer surface of the hull in a vertical direction. An outer surface of the hull of the watercraft may be any part of the outer surface of the hull, or an outer area of the watercraft which may be positioned between a first hull and a second hull, should the watercraft be a multi-hull watercraft. By positioning the stabilisation actuation device at a distance from the outer surface of the hull, the stabilisation actuation device may be in some longitudinal position at a distance from the hull allowing the stabilisation actuation device or at least the dynamic parts of the stabilisation actuation device to be manoeuvred freely around its longitudinal axis. This may e.g. be achieved by providing one or more attachment members that have a length and extend from the outer surface of the hull towards a peripheral part of the stabilisation actuation device. The attachment member(s) may be located at a first and/or a second end of the stabilisation actuation device, allowing a central part of the stabilisation actuation device to be at a distance from the outer surface of the hull. Thus, the attachment members may offset the stabilisation actuation device a predetermined distance away from the outer surface of the hull, thereby providing the stabilisation actuation device, or at least parts of it, with gaps between the outer surface of the hull and the stabilisation actuation device.

[0034] In one exemplary embodiment, the pivot axis of the stabilisation member and the second longitudinal axis may be coaxial or coextensive. This may mean that the pivot axis and the second longitudinal axis of the stabilisation actuation device may be coextensive (coaxial), so that when the stabilisation member is provided with pivotal movement, the pivotal movement occurs along the longitudinal axis of the stabilisation actuation device. This may mean that the pivot axis and the second longitudinal axis are positioned in the same position and may be seen as having a common axis. Thus, a moveable part of the stabilisation actuation device may rotate along with the stabilisation member. By having the two axes coextensive, it may be possible to reduce the diameter of the

pivoting part of the stabilisation system, thereby reducing the diameter or the cross-sectional dimensions of the connection between the stabilisation member and the stabilisation actuation device. This may also mean that the stabilisation member may be connected to a moveable part of the stabilisation actuation device, such as a moveable part of the body of the stabilisation actuation device, allowing the body (housing) to protect the components of the stabilisation actuation device, while also allowing the housing to transfer the pivotal force to the stabilisation member.

[0035] In one exemplary embodiment, the attachment member may have a first end that is attached to an outer surface of the hull and a second end that may be in attachment with the stabilisation actuation device. The first end of the attachment member may be attached to an outer surface of the hull, where it may be possible to retrofit the attachment member to the outer surface of the hull by bolting, welding or otherwise fixating the first end to the outer surface of the hull. The opposite end of the attachment member may be fixed to a part of the stabilisation actuation device, allowing the stabilisation actuation device to be securely fixed in all directions relative to the outer surface of the hull. Thus, by fixing the attachment member to the hull and the stabilisation actuation device, it may be possible to transfer any force applied via the stabilisation actuation device and/or the stabilisation member directly to the hull of the watercraft, thereby providing a secure counterforce to any force that is applied via the stabilisation actuation device, or to transfer a force from the stabilisation member via the stabilisation actuation device and the attachment member to the outer surface of the hull. Thus, any counterforce applied via the stabilisation member may be directly transferred to the hull to counteract any rolling motion of the hull of the marine vessel.

[0036] In one exemplary embodiment, the stabilisation actuation device may have an actuation axle, where the actuation axle is coaxial or coextensive with the pivotal axis. The actuation axle of the stabilisation actuation device may be a part of the stabilisation actuation device that transmits the force from the electrical motor and/or a transmission to the stabilisation member. Thus, the actuation axle may be a dynamic part of the stabilisation actuation device, where the motor, transmission or other parts of the stabilisation actuation device may be static parts of the stabilisation actuation device. Thus, the actuation axle may be fixed relative to the stabilisation member, so that any rotational movement of the actuation axle that is initiated or actuated by the motor or the transmission may be transmitted directly into pivotal movement of the stabilisation member.

[0037] In one exemplary embodiment, where the stabilisation actuation device may have a first cross-sectional diameter and a first length, where the first length is at least a ratio of 4:1 of the cross-sectional diameter, or more specifically where the first length is at least a ratio of 6:1 of the cross-sectional diameter, or more specifically

where the first length is at least a ratio of 8:1 of the cross-sectional diameter, or more specifically where the first length is at least a ratio of 10:1 of the cross sectional diameter, or more specifically where the first length is at least a ratio of 12:1 of the cross-sectional diameter, or more specifically where the first length is at least a ratio of 14:1 of the cross-sectional diameter. As the stabilisation actuation device is arranged at the outer part of the hull of the watercraft, the hydrodynamic shape of the stabilisation actuation device may affect the drag and/or the turbulence created by the stabilisation actuation device, especially in a situation where the stabilisation actuation device is arranged below the waterline of the vessel. Thus, it has been discovered that the length of the stabilisation actuation device has to be greater than the cross-sectional diameter or the cross-sectional dimensions of the stabilisation actuation device. The cross-sectional diameter and/or the cross-sectional dimension may be in a direction that is perpendicular to the longitudinal axis of the stabilisation actuation device. Thus, the ratio of length vs. diameter, should be seen that the length of the stabilisation actuation device is at least four times longer than the diameter of the stabilisation actuation device.

[0038] In one exemplary embodiment, the stabilisation body may have a primary cross-sectional diameter and a second length, where the second length is at least a ratio of 4:1 of the cross-sectional diameter, or more specifically where the second length is at least a ratio of 6:1 of the cross-sectional diameter, or more specifically where the second length is at least a ratio of 8:1 of the cross-sectional diameter, or more specifically where the second length is at least a ratio of 10:1 of the cross-sectional diameter, or more specifically where the second length is at least a ratio of 12:1 of the cross-sectional diameter, or more specifically where the second length is at least a ratio of 14:1 of the cross-sectional diameter.

[0039] In one exemplary embodiment, the stabilisation actuation device may be positioned at a vertical position below the waterline of the hull. This means that the stabilisation actuation device may be positioned in such a way that the stabilisation actuation device is positioned below the surface of the water when the watercraft is at low speeds and/or at high speeds. As the waterline of the watercraft may raise during forward or backwards propulsion, the stabilisation actuation device may be positioned below the waterline at low speeds but may at least partly be raised towards and/or above the waterline at higher speeds.

[0040] The stabilisation system may be positioned in any suitable position on a watercraft. The stabilisation system may be arranged so that the longitudinal axis of the stabilisation actuation device may be arranged in a transverse direction across the watercraft. This may be suitable when the watercraft is a vessel similar to a dredger, where the stabilisation is not intended for roll stabilisation, but may be used to provide a counterweight or an increased buoyancy to counteract the work being

done on a dredger using suction, lifting or any other excavation from below the waterline of the watercraft. Thus, the stabilisation system could e.g. be positioned at a stern end or a bow end of the watercraft, where the stabilisation may be provided at an angle that is different from the longitudinal axis of the watercraft. Thus, the longitudinal axis of the stabilisation actuation device and/or the stabilisation member (or stabilisation body of the stabilisation member) may be arranged at an angle that is different from the longitudinal axis of the watercraft. As an example the longitudinal axis of the stabilisation actuation device and/or the stabilisation member may be arranged at 90 degrees (in a horizontal direction) from the longitudinal axis of the watercraft.

[0041] In one exemplary embodiment, the stabilisation actuation device may be configured to be positioned above the waterline of the hull. This means that the stabilisation actuation device is positioned relative to the hull of the watercraft so that during use the stabilisation actuation device is above the surface of the body of water, thereby reducing any form of draft in the body of water. Thus, the only drag forces that are relevant for the stabilisation actuation device may be air resistance, and not any resistance to the water. Thus, when the stabilisation actuation device is above the surface of the body of water, the stabilisation member penetrates the surface of water, allowing the stabilisation member to provide counterforce in the body of water, either as buoyancy or counterweight.

[0042] In one exemplary embodiment, the stabilisation body has a predefined primary cross-sectional diameter. During use, the stabilisation body is intended to be positioned beneath the surface of the body of water, where the stabilisation body contributes to the stabilisation of the watercraft along with the elongated member of the stabilisation member. It is preferred that the position of the stabilisation body is configured to be arranged at least a first depth, where the first depth is at least equal to the primary cross-sectional diameter, or may optionally be larger than the length of the primary cross-sectional diameter, or may optionally be up to a length that is two times the length of the primary cross sectional diameter. By positioning the stabilisation body at the above depth below the surface of the body of water, it is possible to reduce or eliminate any wave creation during forwards or backwards propulsion made by the stabilisation body.

BRIEF DESCRIPTION OF THE DRAWINGS

[0043] The following is an explanation of exemplary embodiments with reference to the drawings, in which

Fig. 1 is a perspective view of an embodiment of the stabilisation system for a watercraft according to the present disclosure,

Fig. 2 is a side view of an embodiment of the stabilisation system for a watercraft according to the present disclosure,

Fig 3A and 3B show a front view of an embodiment of the stabilisation system for a watercraft mounted to a multi hull marine vessel during operation according to the present disclosure, and

Fig. 4A and 4B show a front view of an embodiment of the stabilisation system for a watercraft mounted to a multi hull marine vessel in extended and retracted position, respectively, according to the present disclosure.

DETAILED DESCRIPTION

[0044] Various exemplary embodiments and details are described hereinafter with reference to the figures when relevant. It should be noted that the figures may or may not be drawn to scale and that elements of similar structures or functions are represented by like reference numerals throughout the figures. It should also be noted that the figures are only intended to facilitate the description of the embodiments. They are not intended as an exhaustive description of the disclosure or as a limitation on the scope of the disclosure. In addition, an illustrated embodiment needs not have all the aspects or advantages shown. An aspect or an advantage described in conjunction with a particular embodiment is not necessarily limited to that embodiment and can be practiced in any other embodiments even if not so illustrated, or if not so explicitly described. Fig. 1 shows a perspective view of a stabilisation system 1 in accordance with the present disclosure, where the stabilisation system comprises a stabilisation member 3 having an elongated member 5 having a first end 7 and a second end 9, the elongated member 5 having a longitudinal axis A that intersects the first end 7 and the second end 9. The system 1 further comprising a stabilisation actuation device 11, having a first end 13 and a second end 15 and having a second longitudinal axis B, intersecting the first end 13 and the second end 15 of the stabilisation actuation device 11.

[0045] The pivotal axis P of the stabilisation member 3 is shown in this embodiment to be coextensive with the longitudinal axis B of the stabilisation actuation device 11, allowing the stabilisation member 3 to pivot relative to the hull of the watercraft (not shown) along the pivot axis P and the longitudinal axis B. Thus, when the stabilisation member 3 pivots, the longitudinal axis A of the elongated member pivots in a starboard or port direction relative to the stabilisation actuation device 11.

[0046] The stabilisation member 3 comprises a stabilisation body 17, having a first end 19 and a second end 21, and having a longitudinal axis C intersecting the first end 19 and the second end 21. The stabilisation body 17 may be a body holding a counterweight or may be a buoyancy body, allowing the stabilisation member to be either a counterweight member or a positive buoyancy body.

[0047] The stabilisation system may further comprise one or more attachment members 23, where the attachment members 23 extend between the hull of the water-

craft (not shown) and the stabilisation actuation device 11. The attachment members are configured to fix the stabilisation actuation device 11 relative to an outer surface of the hull. In this embodiment, the attachment members 23 are attached to an attachment plate 25, where the attachment plate 25 may be securely fixed to the outer surface of the hull (not shown). Alternatively, the first ends 27 of the attachment members may be directly attached to an outer surface of the hull, while the second ends 29 are attached to the stabilisation actuation device 11.

[0048] The embodiment shown in Fig. 1, shows a stabilisation actuation device 11, where the actuation device comprises a motor, as well as a transmission, to transfer the torque of the motor into pivotal movement of the stabilisation member 3, as seen in Fig. 3A and 3B. The control elements and the electronic components required to control and provide actuation signals of the stabilisation system may be mounted inside the hull of the watercraft, where electric signal communication may be provided to the stabilisation actuation device via wired or wireless communication from the electrical components. It may be assumed that the power to the motor may be in the form of an electrical wired cable, that runs from a battery or a power generation system inside the watercraft, and e.g. through the hull and to the stabilisation actuation device. Additionally or alternatively, the stabilisation actuation device may have a local power source, such as a battery, to provide electric power to drive the motor and/or transmission to pivot the stabilisation member.

[0049] Fig. 2 shows the same system as seen in Fig. 1 from the side, where it may be seen that the stability actuation device comprises an electric motor 31, a transmission 33, where the transmission 33 is connected to a pivoting part 35 of the stabilisation actuation device via a transmission axle 37, which may provide mechanical energy to drive the stabilisation member 3 in a port or a starboard direction D, as seen in Fig. 1. The first end 13 and the second end 15 of the stabilisation actuation device 11 may be stationary relative to the attachment members 23 and the hull of the watercraft, providing a counterforce to the movement of the stabilisation member 3, while a pivoting part 35 of the stabilisation actuation device is capable of rotating along a rotational axis B relative to the stationary parts of the stabilisation actuation device 11.

[0050] Fig. 3A and 3B shows the stabilisation system 1 mounted to a watercraft 39, where the watercraft may be a dual hull catamaran, having a first hull part 41 and a second hull part 43, where the hull has a first volume 45 separating the first hull part 41 and the second hull part 43. The first hull part 41 and the second hull part 43 may have a bottom part 49, where the bottom part 49 defines the lowest part of the hull 51 of the watercraft 39. The stabilisation system 1 may be mounted in the first volume 45 between the first hull part 41 and the second hull part 43, where the first ends 27 of the attachment members 23 are attached to an outer surface 53 of the hull 51, and where the attachment members 23 suspend

the stabilisation actuation device 11 within the first volume 45, in an area between the first hull part 41 and the second hull part 43. Advantageously, the stabilisation actuation device is above the bottom part 49 of the first hull part 41 and the second hull part 43 but may be below the waterline of the hull 51, so that the stabilisation actuation device 11 and the stabilisation member 3 may be submerged during use.

[0051] In Fig. 3A, the stabilisation member 3 is shown as being in a vertical position, where the elongated member 5 and the stabilisation body 17 are positioned as having the longitudinal axis A of the stabilisation member 3 in a vertical position, where the stabilisation member 3 may function as a stationary keel. However, during use of the stabilisation system 3, the stabilisation member 3 may be pivoted along its pivotal axis P in the direction D towards a transverse side of the hull 51 (either the starboard or port side), where the pivotal movement may be utilised to stabilise the watercraft either by increasing the buoyancy on the side where it has moved or by providing a counterweight to the opposite side of the hull 51. As may be seen in Fig. 3A and 3B, the first volume 45 allows the mounting of the stabilisation system to an existing watercraft, where the mechanical parts of the stabilisation system may be provided on an outside of the hull 51, thereby minimising the constructional modifications of the watercraft, in opposite if some of the mechanical parts would be mounted on an inner side of the hull 51.

[0052] In Fig. 1, 2 and 3A and 3B, the stabilisation member is provided in an extended position, where the first end 7 of the elongated member 5 is positioned close to or abutting the stabilisation actuation device 11, and the opposing end 9 is positioned distal to the stabilisation actuation device 11.

[0053] Fig. 4A and 4B show a front view of a hull 51 of a watercraft 39, where the stabilisation member 3 has been transitioned from its extended position, as shown in Fig. 3A and 3B, where the first end 7 of the elongated member 5 has been manoeuvred into close proximity of the outer surface 53 of the hull, and where the second end 9 has been moved closer to the stabilisation actuation device 11 and its central axis B. This allows the stabilisation member 3 to be retracted relative to the hull 51 of the watercraft 39, thereby reducing the risk that the stabilisation member is damaged when the watercraft 39 is positioned in a drydock, or similar. Fig. 4B shows how the stabilisation member 3 may be pivoted in its retracted position, so that the elongated member is manoeuvred into a substantially horizontal position, thereby allowing a majority of the stabilisation system to be positioned within the confines of the first volume 45, thereby ensuring that when the watercraft is on land, the stabilisation member 3 will not come into direct contact with the ground, or at least be in minimal contact with the ground.

[0054] The transition between the extended position and the retracted position may be done using an active mechanism, where the active mechanism draws the elongated member 3 in the direction as shown in Fig. 4A,

or may be done using a passive mechanism, where the buoyancy of the stabilisation member may be increased, so that the buoyancy force of the stabilisation member and/or the stabilisation body provides the force required to retract the stabilisation member as shown in Fig. 4A, and/or to use a negative buoyancy force to extend the stabilisation member into its extended position as shown in Fig. 3A. The stabilisation actuation device may be provided with a locking mechanism, allowing the stabilisation member to be locked in its retracted position and/or its extended position.

[0055] The use of the terms "first", "second", "third" and "fourth", "primary", "secondary", "tertiary" etc. does not imply any particular order but are included to identify individual elements. Moreover, the use of the terms "first", "second", "third" and "fourth", "primary", "secondary", "tertiary" etc. does not denote any order or importance, but rather the terms "first", "second", "third" and "fourth", "primary", "secondary", "tertiary" etc. are used to distinguish one element from another. Note that the words "first", "second", "third" and "fourth", "primary", "secondary", "tertiary" etc. are used here and elsewhere for labelling purposes only and are not intended to denote any specific spatial or temporal ordering.

[0056] Furthermore, the labelling of a first element does not imply the presence of a second element and vice versa.

[0057] It is to be noted that the word "comprising" does not necessarily exclude the presence of other elements or steps than those listed.

[0058] It is to be noted that the words "a" or "an" preceding an element do not exclude the presence of a plurality of such elements.

[0059] It should further be noted that any reference signs do not limit the scope of the claims.

[0060] Although features have been shown and described, it will be understood that they are not intended to limit the claimed invention, and it will be made obvious to those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the claimed invention. The specification and drawings are, accordingly, to be regarded in an illustrative rather than restrictive sense. The claimed invention is intended to cover all alternatives, modifications, and equivalents.

List of references

[0061]

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| 1 | Stabilisation system |
| 3 | Stabilisation member |
| 5 | Elongated member |
| 7 | First end of Elongated member |
| 9 | Second end of elongated member |
| 11 | Stabilisation actuation device |
| 13 | First end of Stabilisation actuation device |
| 15 | Second end of Stabilisation actuation device |

17 Stabilisation Body
 19 First end of Stabilisation body
 21 Second end of Stabilisation body
 23 Attachment member
 25 Attachment Plate
 27 First end of attachment member
 29 Second end of attachment member
 31 Electric motor
 33 Transmission
 35 Pivoting part
 37 Transmission axle
 39 Watercraft
 41 First hull part
 43 Second hull part
 45 First volume
 49 Bottom part
 51 Hull
 53 Outer surface of hull
 A Longitudinal axis of elongated part
 B Longitudinal axis of Stabilisation actuation device
 C Longitudinal axis of Stabilisation body.

Claims

1. A stabilisation system for a watercraft, the watercraft having a hull comprising a longitudinal axis extending along the length of the hull, the stabilisation system comprising:
 - a stabilisation member for counteracting movement of the watercraft, where the stabilisation member is configured to be arranged below the waterline of the hull, where the stabilisation member has an elongated member having a longitudinal axis having a first end and a second end and extending in a direction away from the hull, where the first end is proximal to the hull and the second end is distal to the hull during operation, and where the stabilisation member is pivotally connected with the watercraft and having a first pivot axis,
 - a stabilisation actuation device, having a second longitudinal axis, configured to provide actuation to the stabilisation member to provide pivotal movement to the stabilisation member to pivot,
 - one or more attachment members configured to provide attachment between an outer surface of the hull and configured to fix the stabilisation actuation device relative to the outer surface of the hull (torque and longitudinal fixation).
2. A stabilisation system in accordance with claim 1, where the attachment member is configured to be attached to an outer surface of the watercraft
3. A stabilisation system in accordance with any one

of claim 1 or 2, where the watercraft is a marine vessel.

4. A stabilisation system in accordance with any one of the preceding claims, wherein the stabilisation member comprises a stabilisation body positioned at the second end of the elongated member of the stabilisation member.
5. A stabilisation system in accordance with any one of the preceding claims, where the stabilisation member is a positive buoyancy keel.
6. A stabilisation system in accordance with any one of the preceding claims, where the stabilisation system comprises a stabilisation housing having a longitudinal axis, where the stabilisation housing houses the stabilisation actuation device, and optionally where the stabilisation housing extends in parallel to the longitudinal axis of the hull.
7. A stabilisation system in accordance with any one of the preceding claims, where the stabilisation member is configured to be manoeuvred relative to the stabilisation actuation device.
8. A stabilisation system in accordance with any one of the preceding claims, where the stabilisation member has a first extended position where the second end is positioned at a first distance from the stabilisation actuation device and a second retracted position where the second end is positioned at a second distance from the stabilisation actuation device, where the first distance is greater than the second distance.
9. A stabilisation system in accordance with claim 8, where the transformation from the first extended position and the second retracted position is performed using the buoyancy of the stabilisation member.
10. A stabilisation system in accordance with any one of the preceding claims, where the pivot axis of the stabilisation member is parallel to the longitudinal axis of the hull and/or the longitudinal axis of the stabilisation actuation device.
11. A stabilisation system in accordance with any one of the preceding claims, where the pivot axis of the stabilisation member and the second longitudinal axis are coaxial or coextensive.
12. A stabilisation system in accordance with any one of the preceding claims, where the attachment member has a first end that is attached to an outer surface of the hull and a second end that is in attachment with the stabilisation actuation device.

13. A stabilisation system in accordance with any one of the preceding claims, where the stabilisation actuation device has an actuation axle, where the actuation axle is coaxial or coextensive with the pivotal axis. 5
14. A stabilisation system in accordance with any one of the preceding claims, where the stabilisation actuation device has a first cross-sectional diameter and a first length, where the first length is at least a ratio of 4:1 of the cross-sectional diameter, or more specifically where the first length is at least a ratio of 6:1 of the cross-sectional diameter, or more specifically where the first length is at least a ratio of 8:1 of the cross-sectional diameter, or more specifically where the first length is at least a ratio of 10:1 of the cross-sectional diameter, or more specifically where the first length is at least a ratio of 12:1 of the cross-sectional diameter, or more specifically where the first length is at least a ratio of 14:1 of the cross sectional diameter. 10 15 20
15. A stabilisation system in accordance with any one of the preceding claims, where the stabilisation actuation device may be positioned at a vertical position below the waterline of the hull. 25

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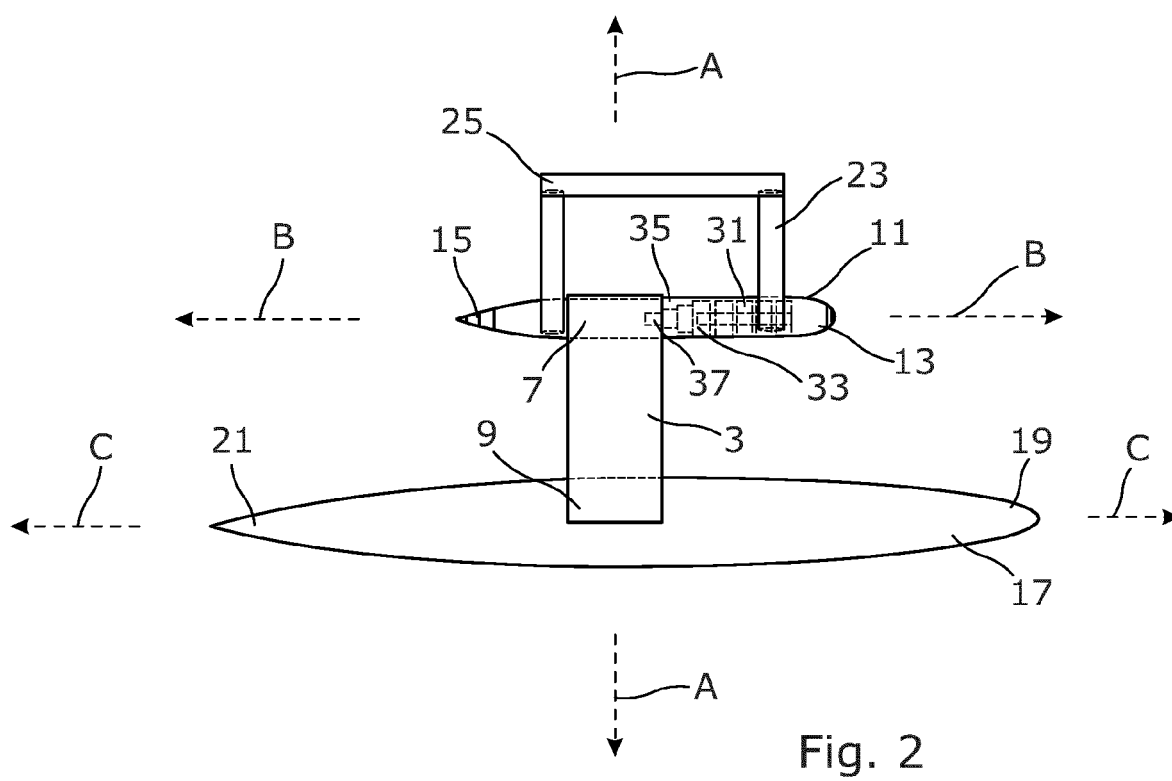
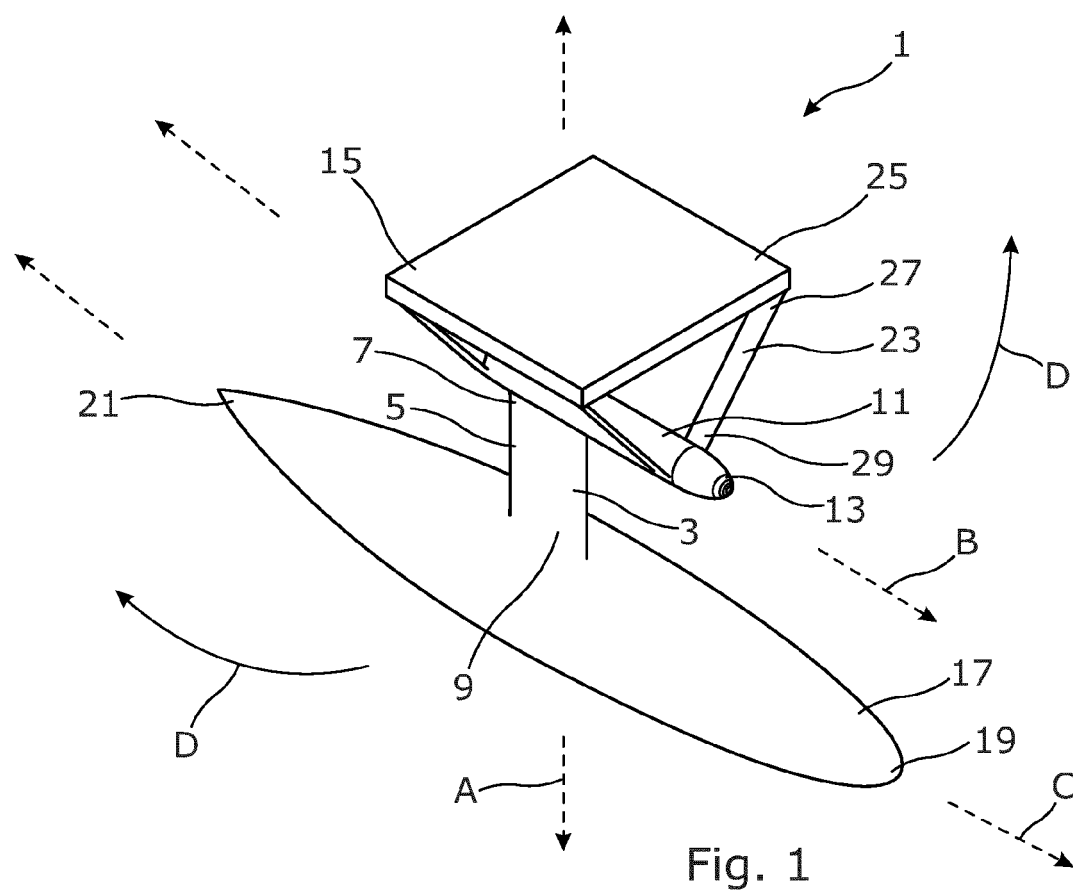
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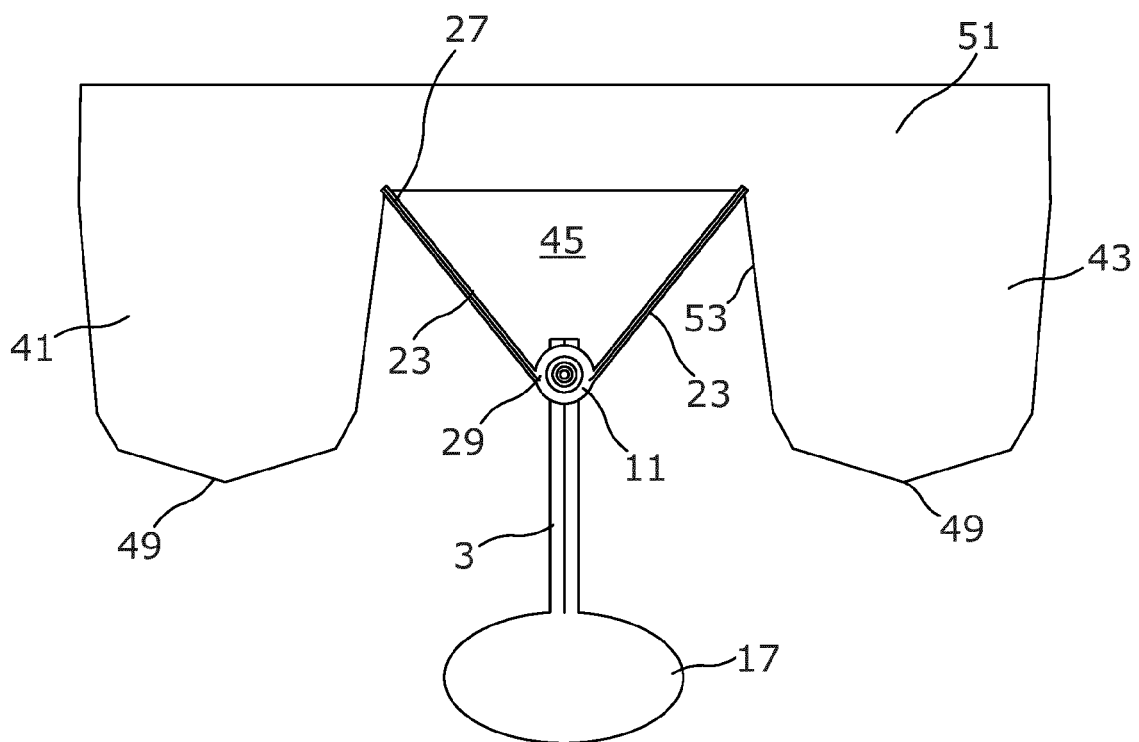


Fig. 3A

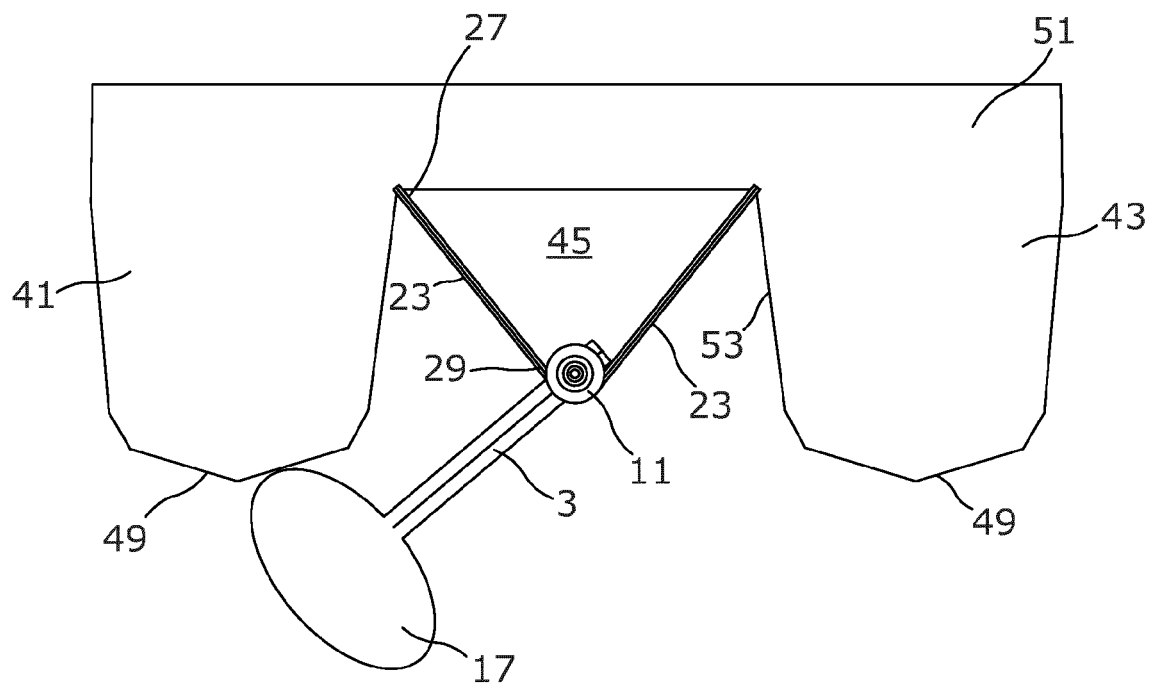


Fig. 3B

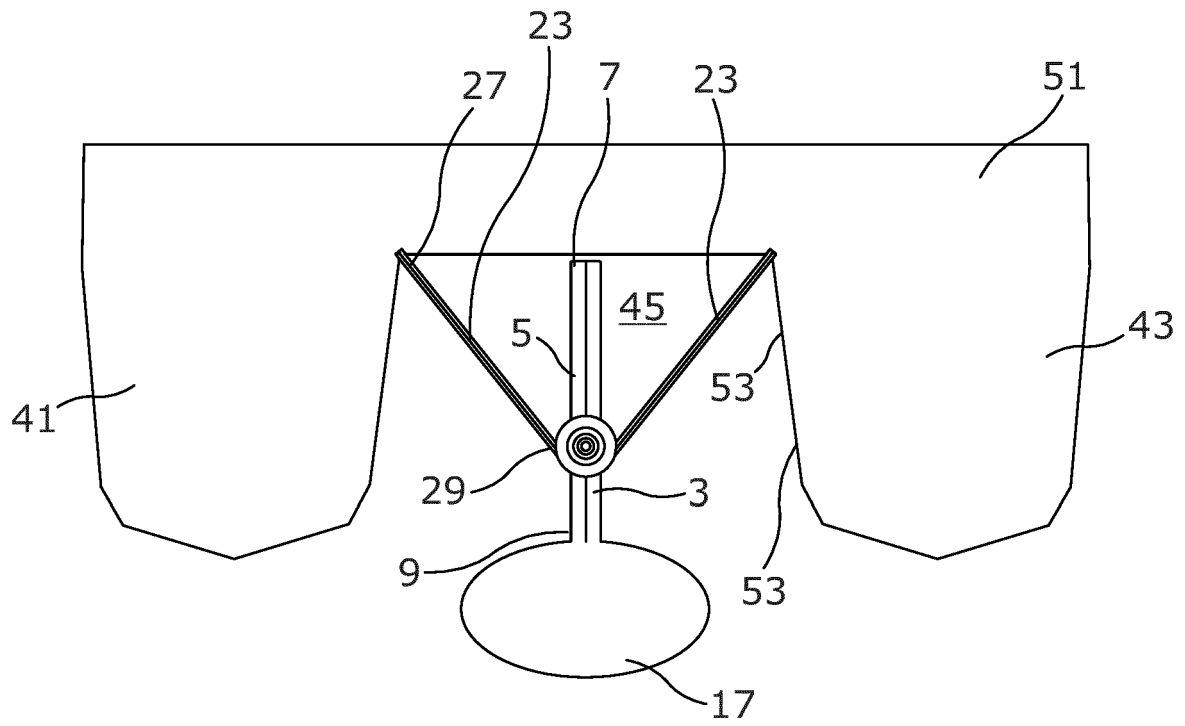


Fig. 4A

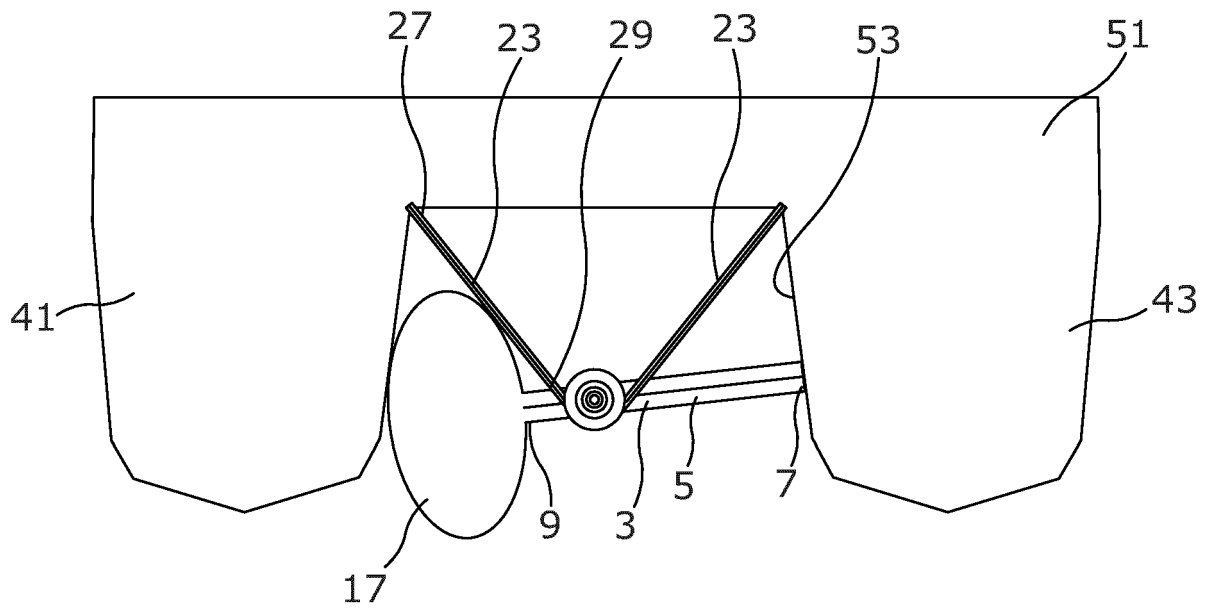


Fig. 4B



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Place of search The Hague		Date of completion of the search 27 October 2022	Examiner Martínez, Felipe
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