



(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
19.03.2025 Bulletin 2025/12

(51) International Patent Classification (IPC):
B63H 20/00 (2006.01) **B63H 20/12** (2006.01)
B63H 25/42 (2006.01)

(21) Application number: 24193096.5

(52) Cooperative Patent Classification (CPC):
B63H 25/42; **B63H 20/007**; **B63H 20/12**;
B63H 21/17; B63H 2020/003; B63H 2021/205;
B63H 2025/026

(22) Date of filing: 06.08.2024

(84) Designated Contracting States:
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB
GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL
NO PL PT RO RS SE SI SK SM TR**

Designated Extension States:

BA

Designated Validation States:

GE KH MA MD TN

(30) Priority: 10.08.2023 JP 2023130811

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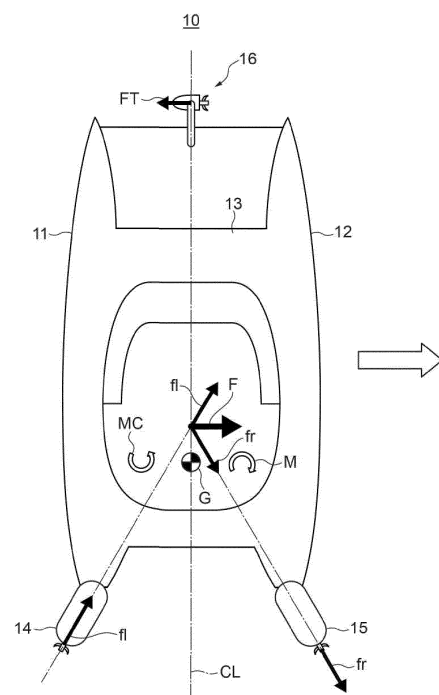
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(54) MARINE PROPULSION SYSTEM ENABLING MOVEMENT OF MARINE VESSEL IN LATERAL DIRECTION, AND CONTROL METHOD THEREOF

(57) A marine propulsion system which prevents rotation of a hull during lateral movement and maintains navigation performance. The system comprises a controller, first propulsion devices disposed at a stern of the hull, and a second propulsion device disposed on a bow side of the hull. To move the hull laterally, the controller steers the first propulsion device on a port side in a leftward turning direction, and fully steers the first propulsion device on a starboard side in a rightward turning direction; causes one first propulsion device to generate forward/rearward thrust and causes the other one to generate rearward/forward thrust, to position a point of action of a resultant force of the generated thrusts in front of a turning center of the hull; and generates, by the second propulsion device, a counter moment cancelling a yaw moment about the turning center generated by the resultant force.

FIG. 9



Description

[0001] The present invention relates to a marine propulsion system for a marine vessel enabling movement of the marine vessel in a lateral direction and a control method thereof.

[0002] In a marine vessel including a plurality of, for example, two outboard motors at a stern, when a hull is moved in a lateral direction, the outboard motor on a port side is steered in a leftward turning direction and the outboard motor on a starboard side is steered in a rightward turning direction, thereby causing the outboard motor on the port side to generate forward or rearward thrust and causing the outboard motor on the starboard side to generate thrust in a direction opposite to the thrust generated by the outboard motor on the port side. At this time, a resultant force of the thrust generated by the outboard motor on the starboard side and the thrust generated by the outboard motor on the port side acts on the hull as a lateral movement force.

[0003] Meanwhile, in a marine vessel having a wide width such as a twin boat, a plurality of outboard motors may be provided at the stern while being spaced apart from each other. In this case, even when the outboard motor on the port side and the outboard motor on the starboard side are fully steered, a point of action of the resultant force may be in front of a turning center of the hull. As a result, a yaw moment about the turning center is generated by the resultant force, and the marine vessel rotates on its own axis in a yaw direction during lateral movement of the marine vessel.

[0004] Therefore, a technology in which the point of action of the resultant force of the thrusts generated when one outboard motor and the other outboard motor are steered is moved by changing an attachment angle of each outboard motor with respect to the hull, so that the point of action of the resultant force of the thrusts and the turning center of the hull coincide each other is known (see, for example, U.S. Patent No. 10202179). According to the technology, no yaw moment about the turning center is generated by the resultant force of the thrusts, which makes it possible to prevent the marine vessel from rotating on its own axis in the yaw direction during the lateral movement of the marine vessel. In this technology, as illustrated in FIG. 12, in order to change an attachment angle of each of outboard motors 122 and 123 with respect to a hull 120, each of the outboard motors 122 and 123 is attached to the hull 120 via a wedge plate 124 or 125 for adjusting the attachment angle.

[0005] However, when each of the outboard motors 122 and 123 is attached to the hull 120 via the wedge plate 124 or 125, a steerable angle of the outboard motor in a direction opposite to a direction in which each of the outboard motors 122 and 123 is inclined by the wedge plate 124 or 125 decreases, which affects turning performance of the marine vessel. In addition, in a neutral state related to steering of each of the outboard motors 122 and 123, a rear side of each of the outboard motors 122 and 123 may protrude from an outer side of the hull 120, which may lead to an increase in resistance during navigation. Therefore, there is still room for improvement in achieving both prevention of rotation of the marine vessel on its own axis during lateral movement of the marine vessel and maintenance of navigation performance of the marine vessel.

[0006] It is the object of the present invention to provide a marine propulsion system for a marine vessel and a control method of a marine propulsion system for a marine vessel, which achieve both prevention of rotation of a marine vessel during lateral movement of the marine vessel and maintenance of navigation performance of the marine vessel.

[0007] According to the present invention said object is solved by a marine propulsion system for a marine vessel having the features of independent claim 1. Moreover, said object is also solved by a control method of a marine propulsion system for a marine vessel having the features of independent claim 15. Preferred embodiments are laid down in the dependent claims.

[0008] According to a preferred embodiment, a marine propulsion system comprising a plurality of first propulsion devices disposed at a stern of a hull, and a second propulsion device disposed on a bow side of the hull, wherein when moving the hull in a lateral direction, a controller of the marine propulsion system fully steers, in a leftward turning direction, the first propulsion device positioned on a port side with respect to a center line extending in a front-rear direction of the hull, and fully steers, in a rightward turning direction, the first propulsion device positioned on a starboard side with respect to the center line, whereby the first propulsion device on the port side and the first propulsion device on the starboard side form an inverted V shape in plan view; causes the first propulsion device on the port side to generate forward thrust or rearward thrust and causes the first propulsion device on the starboard side to generate thrust in a direction opposite to the thrust generated by the first propulsion device on the port side, whereby a point of action of a lateral movement force that is a resultant force of the thrust generated by the first propulsion device on the port side and the thrust generated by the first propulsion device on the starboard side is positioned in front of a turning center of the hull; and controls the second propulsion device to generate another thrust to generate a counter yaw moment that cancels a yaw moment about the turning center generated by the lateral movement force.

[0009] With this configuration, when moving the hull in the lateral direction, in a case where the point of action of the lateral movement force, which is the resultant force of the thrust generated by the first propulsion device on the port side and the thrust generated by the first propulsion device on the starboard side, is positioned in front of the turning center of the hull, the counter yaw moment that cancels the yaw moment about the turning center generated by the lateral movement force is generated by another thrust generated by the second propulsion device. As a result, even in a case where the point

of action of the lateral movement force is positioned in front of the turning center of the hull, it is not necessary to change attachment angles of the first propulsion devices on both sides with respect to the hull to make the point of action of the resultant force coincide with the turning center of the hull. That is, it is possible to eliminate the need to use wedge plates for attachment of the first propulsion devices on both sides to the hull. As a result, it is possible to prevent rotation of the marine vessel during lateral movement of the marine vessel without deteriorating navigation performance of the marine vessel. That is, it is possible to achieve both prevention of rotation of the marine vessel during lateral movement of the marine vessel and maintenance of navigation performance of the marine vessel.

[0010] The above and other elements, features, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011]

FIG. 1 is a plan view of a marine vessel to which a marine propulsion system according to a first preferred embodiment is applied.

FIG. 2 is a side view of the marine vessel to which the marine propulsion system according to the present preferred embodiment is applied.

FIG. 3 is a block diagram schematically illustrating a configuration of the marine propulsion system according to the present preferred embodiment.

FIG. 4 is a view for describing a problem during movement of the marine vessel in a lateral direction.

FIG. 5 is a view for describing a form during movement of the marine vessel in a rightward lateral direction, in the present preferred embodiment.

FIG. 6 is a view for describing a form during movement of the marine vessel in a leftward lateral direction, in the present preferred embodiment.

FIG. 7 is a plan view of the marine vessel in which a distance from a turning center to a propeller is increased, in the present preferred embodiment.

FIGS. 8A to 8D are views for describing a configuration for increasing the distance from the turning center to the propeller, in the present preferred embodiment.

FIG. 9 is a view for describing a form during movement of a marine vessel in a rightward lateral direction, in a second preferred embodiment.

FIG. 10 is a view for describing a form during movement of the marine vessel in a leftward lateral direction, in the present preferred embodiment.

FIG. 11 is a plan view of the marine vessel in which a distance from a turning center to a propeller is increased, in the present preferred embodiment.

FIG. 12 is a view for describing movement of a marine vessel in a lateral direction using a conventional marine propulsion system.

DESCRIPTION OF THE EMBODIMENTS

[0012] Hereinafter, preferred embodiments will be described with reference to the drawings.

[0013] FIG. 1 is a plan view of a marine vessel 10 to which a marine propulsion system according to a first preferred embodiment is applied. FIG. 2 is a side view of the marine vessel 10 to which the marine propulsion system according to the present preferred embodiment is applied.

[0014] In FIGS. 1 and 2, the marine vessel 10 is a twin-hulled pontoon boat, and includes a long and narrow hull 11 positioned on a port side (port side hull) with respect to a center line CL, which is pass through the center of the marine vessel 10 in a left-right direction and extending in a front-rear direction, and a long and narrow hull 12 positioned on a starboard side (starboard side hull) with respect to the center line CL. In addition, in the marine vessel 10, outboard motors 14 and 15 (first propulsion devices) are attached to sterns of the left hull 11 and the right hull 12, respectively. The outboard motors 14 and 15 can be steered in a rightward turning direction and a leftward turning direction with respect to the corresponding hulls 11 and 12, respectively.

[0015] In the present preferred embodiment, the steering in the rightward turning direction refers to a state in which the outboard motor 14, 15 rotates counterclockwise around the stern of the hull 11, 12 as fulcrum in plan view of the marine vessel 10. The steering in the leftward turning direction refers to a state in which the outboard motor 14, 15 rotates clockwise around the stern of the hull 11, 12 as fulcrum in plan view of the marine vessel 10. In addition, in the marine vessel 10, each of the outboard motors 14 and 15 is configured to be steered by, for example, 30° in each of the rightward turning direction and the leftward turning direction.

[0016] A pontoon boat, for example, has a configuration in which a deck 13 spans between the left and right hulls 11 and 12, and thus, the pontoon boat is wider than a normal monohull boat. Therefore, an arrangement interval (pitch) between the outboard motors 14 and 15 attached to the pontoon boat is also larger than that of outboard motors attached to a normal monohull boat. In addition, the pontoon boat is focused on stability rather than speed performance, and is suitably used for

relatively low-speed cruising, fishing while staying on water, and the like. Therefore, the marine vessel 10 includes a small outboard motor for low-speed navigation or position adjustment during mooring, in addition to the outboard motors 14 and 15. For example, the marine vessel 10 includes a trolling motor 16 (second propulsion device) disposed on a bow side. **[0017]** The trolling motor 16 includes a spindle-shaped submerged body 17 that houses an electric motor for driving a propeller 17a, and the submerged body 17 is attached to a distal end of a rod 18. In the trolling motor 16, a vessel operator or a rotary unit (not illustrated) axially rotates the rod 18 to which the submerged body 17 is attached, so that an orientation of the submerged body 17 can be freely changed. As a result, the trolling motor 16 can change a direction of thrust generated by the propeller 17a to a desired direction, and the trolling motor 16 can be used for course change at the time of low-speed navigation or position adjustment during mooring of the marine vessel 10. Normally, the trolling motor 16 is repositionable and can be arranged on the center line of the bow of one hull. As illustrated in the drawing, the trolling motor 16 can also be arranged on the center line CL of the bows of the hulls 11 and 12 (on the center line CL of the bow of the pontoon boat). In a case where the marine vessel 10 is navigating at a relatively high speed, the trolling motor 16 is pulled up to the deck 13 or the hulls 11 and 12 so as not to become a resistor.

[0018] FIG. 3 is a block diagram schematically illustrating a configuration of a marine propulsion system 19 according to the present preferred embodiment mounted on the marine vessel 10 in FIG. 1. In FIG. 3, the marine propulsion system 19 includes a boat control unit (BCU) 20, a multi function display (MFD) 21, a global navigation satellite system (GNSS) which is, for example, a global positioning system (GPS) 22, an inertial measurement unit (IMU) 23, a compass 24, a remote control unit 25, a joystick 26, a steering mechanism 27, a vessel operation panel 28, a remote control ECU 29, a main operation unit 30, and a steering control unit (SCU) 31. The constituent elements of the marine propulsion system 19 are communicatively connected to one another.

[0019] The GPS 22 grasps the current position of the marine vessel 10 and transmits the current position of the marine vessel 10 to the BCU 20. The IMU 23 measures behaviors of the hulls 11 and 12 and transmits a measurement result to the BCU 20. The compass 24 grasps a bearing of the marine vessel 10 and transmits the bearing of the marine vessel 10 to the BCU 20.

[0020] The remote control unit 25 includes levers 25a corresponding to the outboard motors 14 and 15, respectively. The vessel operator operates levers 25a to switch the directions of the thrusts generated by the respective outboard motors 14, 15 back and forth, and adjusts outputs of the respective outboard motors 14, 15 to adjust a vessel speed. At this time, the remote control unit 25 transmits a signal(s) for controlling the outboard motors 14, 15 in response to the operation of the levers 25a to the BCU 20 and the remote control ECU 29. The joystick 26 is a control stick for operating the marine vessel 10, and transmits a signal for moving the marine vessel 10 in a tilting direction to the BCU 20 and the remote control ECU 29. The steering mechanism 27 is a device for the vessel operator to determine a course of the marine vessel 10. The vessel operator can turn the marine vessel 10 rightward and leftward by rotating a steering wheel 27a of the steering mechanism 27 leftward and rightward. At this time, the steering mechanism 27 transmits a steering angle corresponding to a rotation operation on the steering wheel 27a to the remote control ECU 29 and the SCU 31.

[0021] The main operation unit 30 includes a main switch 30a and an engine shut-off switch 30b. The main switch 30a is an operator for collectively starting and collectively stopping engines (not illustrated) which are power sources of the outboard motors 14 and 15. The engine shut-off switch 30b is a switch for emergently stopping the engines of the outboard motors 14 and 15. The MFD 21 is, for example, a color LCD display, and functions as a display that displays various types of information and also functions as a touch panel that receives an input from the vessel operator. The vessel operation panel 28 includes switches (not illustrated) corresponding to various vessel operation modes, and the vessel operator switches a mode of the marine vessel 10 to a desired vessel operation mode, for example, a fixed point holding mode, by operating the corresponding switch.

[0022] The SCU 31 is provided corresponding to each of the outboard motors 14 and 15. Each of the SCUs 31 controls a steering unit (not illustrated), which turns the corresponding outboard motor 14 or 15 with respect to the hull 11 or 12, to change the direction of the thrust of each of the outboard motors 14 and 15.

[0023] The BCU 20 grasps a situation of the marine vessel 10 based on signals transmitted from the constituent elements of the marine propulsion system 19, determines the magnitude of the thrust to be generated by each of the outboard motors 14 and 15 and the direction of the thrust to be taken, and transmits the determined magnitude and the determined direction to each remote control ECU 29. In addition, the BCU 20 controls a rotation unit of the trolling motor 16 to change the magnitude and direction of the thrust of the trolling motor 16.

[0024] One remote control ECU 29 is provided correspondingly to each of the outboard motors 14 and 15, and the remote control ECU 29 transmits signals for controlling the engine and steering unit of the outboard motor 14, 15 to an engine ECU (not illustrated) and the SCU 31 of the outboard motor 14, 15 according to signals transmitted from the BCU 20, the steering mechanism 27, the remote control unit 25, the joystick 26, and the like, thereby adjusting the magnitude

and direction of the thrust of each of the outboard motors 14 and 15.

[0025] FIG. 4 is a view for describing a problem during movement of the marine vessel 10 in a lateral direction. For example, to move the marine vessel 10 in a rightward lateral direction (a direction of a white rightward arrow in the drawing), the vessel operator operates the joystick 26 and/or the steering mechanism 27 to input an instruction for movement in the rightward lateral direction. At this time, the one SCU 31 steers the outboard motor 14 on the port side in the leftward turning direction and the other SCU 31 steers the outboard motor 15 on the starboard side in the rightward turning direction, so that the outboard motor 14 on the port side and the outboard motor 15 on the starboard side form an inverted V shape in plan view. In particular, a line of thrust generated by the outboard motor 14 on the port side and a line of thrust generated by the outboard motor 15 on the starboard side form an inverted V shape in plan view and with respect to a front direction of the hull. Then, the one remote control ECU 29 causes the outboard motor 14 on the port side to generate forward thrust f_l and the other remote control ECU 29 causes the outboard motor 15 on the starboard side to generate rearward thrust f_r . A magnitude of the forward thrust f_l and a magnitude of the rearward thrust f_r are the same. As a result, a resultant force of the forward thrust f_l and the rearward thrust f_r acts on the marine vessel 10 as a lateral movement force F of the marine vessel 10 in the rightward lateral direction. In the present description, "forward" means a direction in which the bow of the marine vessel 10 faces, and "rearward" means a direction in which the stern of the marine vessel 10 faces.

[0026] Meanwhile, as described above, the marine vessel 10 is a pontoon boat, and thus the pitch of the outboard motors 14 and 15 is larger than that of outboard motors attached to a normal monohull boat. Therefore, even when the outboard motor 14 on the port side is fully steered in the leftward turning direction and the outboard motor 15 on the starboard side is fully steered in the rightward turning direction, a point P of action of the lateral movement force F remains in front of a turning center G of the hulls. At this time, a clockwise yaw moment M about the turning center G is generated by the lateral movement force F , and when the marine vessel 10 moves in the rightward lateral direction, the marine vessel 10 rotates in a yaw direction about the turning center G .

[0027] In the present preferred embodiment, in order to suppress the rotation of the marine vessel 10 in the yaw direction about the turning center G when the marine vessel 10 moves in the rightward lateral direction, the thrust of the trolling motor 16 is used to generate a counter yaw moment MC that cancels the yaw moment M generated by the lateral movement force F .

[0028] FIG. 5 is a view for describing a form during movement of the marine vessel 10 in the rightward lateral direction, in the present preferred embodiment. In the present preferred embodiment, to move the marine vessel 10 in the rightward lateral direction (a direction of a white rightward arrow in the drawing), the one SCU 31 turns the outboard motor 14 on the port side in the rightward turning direction and the other SCU 31 turns the outboard motor 15 on the starboard side in the leftward turning direction, so that the outboard motor 14 on the port side and the outboard motor 15 on the starboard side form a V shape in plan view. In particular, a line of thrust generated by the outboard motor 14 on the port side and a line of thrust generated by the outboard motor 15 on the starboard side form a V shape in plan view and with respect to a front direction of the hull.

[0029] In the marine vessel 10, when the outboard motor 14 on the port side is fully steered in the rightward turning direction and the outboard motor 15 on the starboard side is fully steered in the leftward turning direction, the outboard motor 14 on the port side and the outboard motor 15 on the starboard side approach each other. In the marine vessel 10, the pitch of the outboard motors 14 and 15 is set to be large to such an extent that the outboard motor 14 on the port side and the outboard motor 15 on the starboard side do not interfere with each other at this time.

[0030] Then, the one remote control ECU 29 causes the outboard motor 14 on the port side to generate rearward thrust f_l , and the other remote control ECU 29 causes the outboard motor 15 on the starboard side to generate forward thrust f_r . A magnitude of the rearward thrust f_l and a magnitude of the forward thrust f_r are the same. As a result, a resultant force of the rearward thrust f_l and the forward thrust f_r acts on the marine vessel 10 as a lateral movement force F of the marine vessel 10 in the rightward lateral direction.

[0031] At this time, as illustrated in the drawing, since a line of action of the rearward thrust f_l of the outboard motor 14 on the port side and a line of action of the forward thrust f_r of the outboard motor 15 on the starboard side intersect each other behind the turning center G , a point P of action of the lateral movement force F is also positioned behind the turning center G . That is, since the point P of action of the lateral movement force F does not coincide with the turning center G , a counterclockwise yaw moment M about the turning center G is generated by the lateral movement force F .

[0032] Meanwhile, the BCU 20 axially rotates the rod 18 of the trolling motor 16 to cause the trolling motor 16 to generate thrust FT (another thrust) in the rightward lateral direction. At this time, the thrust FT generates the counter yaw moment MC about the turning center G . Since the trolling motor 16 is disposed on the bow side, the counter yaw moment MC is a clockwise yaw moment. Therefore, the yaw moment M generated by the lateral movement force F in the rightward lateral direction can be canceled by the counter yaw moment MC .

[0033] A magnitude of the thrust FT to be generated by the trolling motor 16 is determined in consideration of a magnitude of the yaw moment M and a distance from the turning center G to the trolling motor 16. Specifically, the magnitude of the thrust FT is determined by the following Formula (1).

Thrust $FT = (\text{Yaw moment } M)/(\text{Distance from turning center } G \text{ to trolling motor } 16) \dots$

(1)

[0034] Although the yaw moment M and the counter yaw moment MC are drawn to be offset from the turning center G for easy understanding in FIG. 5 and subsequent drawings, both the yaw moment M and the counter yaw moment MC are moments about the turning center G as described above.

[0035] FIG. 6 is a view for describing a form during movement of the marine vessel 10 in the leftward lateral direction, in the present preferred embodiment. To move the marine vessel 10 in the leftward lateral direction (a direction of a white leftward arrow in the drawing), the SCUs 31 steer the outboard motor 14 on the port side and the outboard motor 15 on the starboard side such that the outboard motor 14 on the port side and the outboard motor 15 on the starboard side form a V shape in plan view, in a similar manner to the case of moving the marine vessel 10 in the rightward lateral direction.

[0036] Then, the one remote control ECU 29 causes the outboard motor 14 on the port side to generate forward thrust fl and the other remote control ECU 29 causes the outboard motor 15 on the starboard side to generate rearward thrust fr . A magnitude of the forward thrust fl and a magnitude of the rearward thrust fr are the same. As a result, a resultant force of the forward thrust fl and the rearward thrust fr acts on the marine vessel 10 as a lateral movement force F of the marine vessel 10 in the leftward lateral direction.

[0037] Also at this time, similar to the case of moving the marine vessel 10 in the rightward lateral direction, a line of action of the forward thrust fl of the outboard motor 14 on the port side and a line of action of the rearward thrust fr of the outboard motor 15 on the starboard side intersect each other behind the turning center G , and thus a point P of action of the lateral movement force F is also positioned behind the turning center G . Then, a clockwise yaw moment M about the turning center G is generated by the lateral movement force F of which point P of action is positioned behind the turning center G .

[0038] Meanwhile, the BCU 20 causes the trolling motor 16 to generate thrust FT in the leftward lateral direction. At this time, the thrust FT generates a counterclockwise counter yaw moment MC about the turning center G . The yaw moment M generated by the lateral movement force F in the leftward lateral direction can be canceled by the counter yaw moment MC . Similarly in a case of moving the marine vessel 10 in the leftward lateral direction, a magnitude of the thrust FT generated by the trolling motor 16 is determined by Formula (1) above.

[0039] According to the present preferred embodiment, in a case of the marine vessel 10 to be moved in the lateral direction, the outboard motor 14 on the port side and the outboard motor 15 on the starboard side are steered such that the outboard motor 14 on the port side and the outboard motor 15 on the starboard side form a V shape in plan view. Then, the thrust fl and the thrust fr opposite to each other are generated by the outboard motor 14 on the port side and the outboard motor 15 on the starboard side, so that the lateral movement force F of which point P of action is positioned behind the turning center G is generated. Further, the thrust FT in the same direction as the lateral movement force F is generated by the trolling motor 16 disposed on the bow side. As a result, the yaw moment M generated by the lateral movement force F can be canceled by the counter yaw moment MC generated by the thrust FT .

[0040] As a result, it is not necessary to change attachment an angle(s) of the outboard motor 14 on the port side and/or the outboard motor 15 on the starboard side with respect to the hull 11 or 12 to make the point of action of the resultant force of the thrust fl and the thrust fr coincide with the turning center G . That is, it is possible to eliminate the need to use wedge plates for attaching the outboard motor 14 on the port side to the hull 11 and the outboard motor 15 on the starboard side to the hull 12. As a result, it is possible to prevent rotation of the marine vessel 10 in the yaw direction during lateral movement of the marine vessel 10 without deteriorating navigation performance of the marine vessel 10. That is, it is possible to achieve both prevention of rotation of the marine vessel 10 during lateral movement of the marine vessel 10 and maintenance of navigation performance of the marine vessel 10.

[0041] In addition, in the present preferred embodiment, an acting direction of the lateral movement force F , which is the resultant force of the thrust fl of the outboard motor 14 on the port side and the thrust fr of the outboard motor 15 on the starboard side, is the same as an acting direction of the thrust FT generated by the trolling motor 16. Therefore, not only the lateral movement force F but also the thrust FT contributes to the lateral movement of the marine vessel 10, so that lateral movement efficiency of the marine vessel 10 can be improved.

[0042] In the present preferred embodiment, the trolling motor 16 is used as a generation source of the thrust FT that generates the counter yaw moment MC . However, in a case where the marine vessel 10 includes a bow thruster or a side thruster on the bow side, the thrust FT may be generated by the bow thruster or the side thruster.

[0043] By the way, in the present preferred embodiment, since the line of action of the thrust fl of the outboard motor 14 on the port side and the line of action of the thrust fr of the outboard motor 15 on the starboard side intersect each other considerably behind the turning center G , an arm of the yaw moment M is long, and the yaw moment M is large. In order to cancel the large yaw moment M , it is necessary to increase the thrust FT generated by the trolling motor 16 to balance the counter yaw moment MC with the yaw moment M .

[0044] However, the trolling motor 16 is configured to be repositionable, and thus, the trolling motor 16 is a relatively small propulsion device. Therefore, an electric motor included in the trolling motor 16 is also relatively small, and thus, the

magnitude of the thrust FT that can be generated by the trolling motor 16 is limited. In addition, when the thrust FT is increased, electricity cost worsens, and in some cases, a charge amount of a battery (not illustrated) included in the marine vessel 10 may become 0 during lateral movement. Therefore, it is preferable that the thrust FT to be generated by the trolling motor 16 is small.

[0045] Therefore, in order to decrease the thrust FT while maintaining the magnitude of the counter yaw moment MC, it is preferable to increase a "distance from the turning center G to the propeller 17a that generates the thrust FT", which is an arm length of the counter yaw moment MC, as illustrated in FIG. 7. Specifically, the thrust FT is generated in front of the bow of the hull 11 (12).

[0046] FIGS. 8A to 8D are views for describing a configuration for increasing the distance from the turning center G to the propeller 17a.

[0047] For example, as illustrated in FIG. 8A, the trolling motor 16 may include an arm 32 that can extend forward, and the rod 18 may be attached at vicinity of a front end of the arm 32. In this case, as illustrated in FIG. 8B, the arm 32 extends by sliding forward with respect to the hull 11 (12), so that the submerged body 17 having the propeller 17a is positioned in front of the bow. As a result, the distance from the turning center G to the propeller 17a is increased, and therefore the counter yaw moment MC that cancels the yaw moment M can be generated even with the small thrust FT.

[0048] Further, for example, as illustrated in FIG. 8C, the trolling motor 16 may include a case 33 that can be tilted, and the rod 18 may be housed in the case 33 in an extendable manner. In this case, as illustrated in FIG. 8D, the case 33 is tilted so that a lower side of the case 33 moves forward, and further, the rod 18 is extended from the case 33. At this time, the rod 18 is inclined with respect to the water surface. Then, the submerged body 17 attached to the distal end of the rod 18 is submerged in front of the bow. With such a configuration as well, it is possible to increase the distance from the turning center G to the propeller 17a of the submerged body 17.

[0049] Although in FIGS. 8A to 8D, the submerged body 17 is directed forward, the submerged body 17 is directed in a movement direction (lateral direction) when the marine vessel 10 moves in the lateral direction.

[0050] Next, a second preferred embodiment will be described. Configurations and operations in the second preferred embodiment are basically the same as those of the first preferred embodiment described above. Therefore, in the following description, descriptions of configurations and effects overlapping those of the first preferred embodiment will be omitted, and configurations and effects different from those of the first preferred embodiment will be described.

[0051] In the first preferred embodiment described above, a method of suppressing rotation in a yaw direction about a turning center G by using thrust FT of a trolling motor 16 in a case where an outboard motor 14 on a port side and an outboard motor 15 on a starboard side form a V shape has been described. In the second preferred embodiment, a method of suppressing the rotation in the yaw direction about the turning center G by using the thrust FT of the trolling motor 16 in a case where the outboard motor 14 on the port side and the outboard motor 15 on the starboard side form an inverted V shape will be described.

[0052] FIG. 9 is a view for describing a form during movement of a marine vessel 10 in a rightward lateral direction, in the second preferred embodiment. In the present preferred embodiment, to move the marine vessel 10 in the rightward lateral direction (a direction of a white rightward arrow in the drawing), one SCU 31 steers the outboard motor 14 on the port side in a leftward turning direction and the other SCU 31 steers the outboard motor 15 on the starboard side in a rightward turning direction, so that the outboard motor 14 on the port side and the outboard motor 15 on the starboard side form an inverted V shape in plan view.

[0053] Then, the one remote control ECU 29 causes the outboard motor 14 on the port side to generate forward thrust fl and the other remote control ECU 29 causes the outboard motor 15 on the starboard side to generate rearward thrust fr. A magnitude of the forward thrust fl and a magnitude of the rearward thrust fr are the same. As a result, a resultant force of the forward thrust fl and the rearward thrust fr acts on the marine vessel 10 as a lateral movement force F of the marine vessel 10 in the rightward lateral direction.

[0054] At this time, as illustrated in the drawing, since a line of action of the forward thrust fl of the outboard motor 14 on the port side and a line of action of the rearward thrust fr of the outboard motor 15 on the starboard side intersect each other in front of the turning center G, a point P of action of the lateral movement force F is also positioned in front of the turning center G. That is, since the point P of action of the lateral movement force F does not coincide with the turning center G, a clockwise yaw moment M about the turning center G is generated by the lateral movement force F.

[0055] Meanwhile, a BCU 20 axially rotates a rod 18 of the trolling motor 16 to cause the trolling motor 16 to generate the thrust FT of which a direction is opposite to the lateral movement force F ("a direction opposite to the lateral movement force F" is a leftward lateral direction). The thrust FT in the leftward lateral direction generates a counter yaw moment MC about the turning center G. The counter yaw moment MC is a counterclockwise yaw moment. Therefore, the yaw moment M generated by the lateral movement force F in the rightward lateral direction can be canceled by the counter yaw moment MC. Also in the present preferred embodiment, a magnitude of the thrust FT generated by the trolling motor 16 is determined by Formula (1) above.

[0056] FIG. 10 is a view for describing a form during movement of the marine vessel 10 in the leftward lateral direction, in the present preferred embodiment. Similarly, to move the marine vessel 10 in the leftward lateral direction, the SCUs 31

steer the outboard motor 14 on the port side and the outboard motor 15 on the starboard side such that the outboard motor 14 on the port side and the outboard motor 15 on the starboard side form an inverted V shape in plan view.

[0057] Then, the one remote control ECU 29 causes the outboard motor 14 on the port side to generate rearward thrust f_l , and the other remote control ECU 29 causes the outboard motor 15 on the starboard side to generate forward thrust f_r . A magnitude of the rearward thrust f_l and a magnitude of the forward thrust f_r are the same. As a result, a resultant force of the rearward thrust f_l and the forward thrust f_r acts on the marine vessel 10 as a lateral movement force F of the marine vessel 10 in the leftward lateral direction.

[0058] Also at this time, similar to the case of moving the marine vessel 10 in the rightward lateral direction, a line of action of the rearward thrust f_l of the outboard motor 14 on the port side and a line of action of the forward thrust f_r of the outboard motor 15 on the starboard side intersect each other in front of the turning center G , and thus a point P of action of the lateral movement force F is also positioned in front of the turning center G . That is, since the point P of action of the lateral movement force F does not coincide with the turning center G , a counterclockwise yaw moment M about the turning center G is generated by the lateral movement force F .

[0059] Meanwhile, a BCU 20 axially rotates a rod 18 of the trolling motor 16 to cause the trolling motor 16 to generate the thrust FT of which a direction is opposite to the lateral movement force F ("a direction opposite to the lateral movement force F " is the rightward lateral direction). The thrust FT in the rightward lateral direction generates a counter yaw moment MC about the turning center G . The counter yaw moment MC is a clockwise yaw moment. Therefore, the yaw moment M generated by the lateral movement force F in the leftward lateral direction can be canceled by the counter yaw moment MC . Also in the present preferred embodiment, a magnitude of the thrust FT generated by the trolling motor 16 is determined by Formula (1) above.

[0060] According to the present preferred embodiment, in a case of the marine vessel 10 to be moved in the lateral direction, the outboard motor 14 on the port side and the outboard motor 15 on the starboard side are steered such that the outboard motor 14 on the port side and the outboard motor 15 on the starboard side form an inverted V shape in plan view. Then, the thrust f_l of the outboard motor 14 on the port side and the thrust f_r of the outboard motor 15 on the starboard side opposite to each other are generated, so that the lateral movement force F of which point P of action is positioned in front of the turning center G is generated. Further, the thrust FT in a direction opposite to the lateral movement force F is generated by the trolling motor 16 disposed at the bow side. As a result, the yaw moment M generated by the lateral movement force F can be canceled by the counter yaw moment MC generated by the thrust FT . As a result, the present preferred embodiment can also achieve effects similar to those of the first preferred embodiment.

[0061] As described above, also in the second preferred embodiment, the magnitude of the thrust FT generated by the trolling motor 16 is determined by Formula (1) above. In the second preferred embodiment, a distance from the lateral movement force F to the turning center is very short as compared with that in the first preferred embodiment, whereas a distance from the turning center G to the trolling motor 16 is similar to that in the first preferred embodiment. Therefore, in the second preferred embodiment, the thrust FT may be very small as compared with the first preferred embodiment, and for example, the thrust FT may be smaller than the lateral movement force F . As a result, it is possible to use the smaller lower-output trolling motor 16.

[0062] In the present preferred embodiment, since an acting direction of the lateral movement force F is opposite to an acting direction of the thrust FT generated by the trolling motor 16, the thrust FT inhibits the marine vessel 10 from moving in the lateral direction. As described above, since the thrust FT is smaller than the lateral movement force F , the movement of the marine vessel 10 in the lateral direction is not stopped by the thrust FT . However, from the viewpoint of efficiently moving the marine vessel 10 in the lateral direction, it is preferable that the thrust FT generated by the trolling motor 16 is smaller.

[0063] Therefore, in order to decrease the thrust FT while maintaining a magnitude of the counter yaw moment MC , also in the second preferred embodiment, similarly to the first preferred embodiment, a distance from the turning center G to a propeller 17a that generates the thrust FT may be increased (see FIG. 11). Specifically, the thrust FT may be generated in front of the bow of the hull 11 (12). Also in the second preferred embodiment, it is preferable to increase the distance from the turning center G to the propeller 17a by providing the configurations illustrated in FIGS. 8A to 8D.

[0064] The marine propulsion system according to each of the preferred embodiments is applied to a pontoon boat that is a twin boat as an example. However, the marine vessel to which the marine propulsion system according to each of the preferred embodiments is applied may be any marine vessel as long as it includes an outboard motor on each of the port side and the starboard side. For example, the marine propulsion system according to each of the preferred embodiments may be applied to a trimaran having a larger width, or may be applied to a monohull boat having a wide hull shape and having a large pitch between left and right outboard motors. The outboard motor may include an electric motor as a power source instead of the engine.

[0065] In addition, the marine propulsion system according to each of the preferred embodiments may be applied to a marine vessel including three or more outboard motors. Further, the marine propulsion system according to each of the preferred embodiments may be applied not only to a marine vessel including outboard motors at the sterns of both sides, but also to a marine vessel including inboard/outboard motors or jet propulsion devices at the sterns of both sides.

[0066] The present teaching can be applied not only in a case where the marine vessel 10 moves in the lateral direction

but also in a case where the marine vessel 10 moves obliquely forward or obliquely rearward, wherein the gist of the present invention is to suppress rotation in the yaw direction about the turning center G during movement by the thrust FT of the trolling motor 16.

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Claims

1. A marine propulsion system (19) for a marine vessel (10) having a hull (11, 12, 13), the system comprising first port side propulsion device (14) configured to be positioned on a stern of a port side of the hull (11), and a first starboard side propulsion device (15) positioned on a stern of starboard side of the hull (12), wherein the first port side propulsion device (14) and the first starboard side propulsion device (15) are configured to be steered in each of a rightward turning direction and a leftward turning direction with respect to a center line (CL) extending in a front-rear direction of the hull (11, 12, 13), respectively, a second propulsion device (16) configured to be disposed on a bow side of the hull (11, 12, 13), and a controller (31) for controlling the first port side propulsion device (14) and the first starboard side propulsion device (15), wherein

for moving the hull (11, 12, 13) in a lateral direction with respect to the center line (CL) extending in the front-rear direction of the hull (11, 12, 13), the controller (31) of the marine propulsion system (19) is configured to control the first port side propulsion device (14) positioned on a port side with respect to the center line (CL) to fully steer in the leftward turning direction, and

control the first starboard side propulsion device (15) positioned on a starboard side with respect to the center line (CL), to fully steer in the rightward turning direction, whereby a line of thrust generated by the first port side propulsion device (14) and a line of thrust generated by the first starboard side propulsion device (15) form an inverted V shape in plan view;

control the first port side propulsion device (14) to generate forward thrust or rearward thrust and control the first starboard side propulsion device (15) to generate thrust in a direction opposite to the thrust generated by the first port side propulsion device (14), whereby a point (P) of action of a lateral movement force that is a resultant force of the thrust generated by the first port side propulsion device (14) and the thrust generated by the first starboard side propulsion device (15) is positioned in front of a turning center (G) of the hull (11, 12, 13) with respect to the front-rear direction of the hull (11, 12, 13); and

control the second propulsion device (16) to generate another thrust to generate a counter yaw moment that cancels a yaw moment about the turning center (G) generated by the lateral movement force.
2. The marine propulsion system (19) according to claim 1, wherein the controller (31) is configured to control the first port side propulsion device (14) to be steered in the rightward turning direction and configured to control the first starboard side propulsion device (15) to be steered in the leftward turning direction, whereby the line of thrust generated by the first port side propulsion device (14) and the line of thrust generated by the first starboard side propulsion device (15) form a V shape in plan view;

the controller (31) is configured to control the first port side propulsion device (14) to generate forward thrust or rearward thrust and configured to control the first starboard side propulsion device (15) to generate thrust in a direction opposite to the thrust generated by the first port side propulsion device (14), whereby a point (P) of action of a lateral movement force that is a resultant force of the thrust generated by the first port side propulsion device (14) and the thrust generated by the first starboard side propulsion device (15) is positioned behind the turning center (G) with respect to the front-rear direction of the hull (11, 12, 13), and

the controller (31) is configured to control the second propulsion device (16) to generate another thrust in the same direction as the resultant force.
3. The marine propulsion system (19) according to claim 2, wherein even when the first port side propulsion device (14) is steered in the rightward turning direction and the first starboard side propulsion device (15) is steered in the leftward turning direction, the first port side propulsion device (14) and the first starboard side propulsion device (15) are configured to not interfere with each other.
4. The marine propulsion system (19) according to claim 2 or 3, wherein the second propulsion device (16) is configured to generates the another thrust in the same direction as the resultant force in front of a bow of the hull (11, 12, 13) with respect to the front-rear direction of the hull (11, 12, 13).
5. The marine propulsion system (19) according to claim 4, wherein the second propulsion device (16) includes a

propeller (17a) configured to generate the another thrust, and an extendable arm (32), and the second propulsion device (16) is configured to extend the extendable arm (32) to move the propeller (17a) to front of the bow of the hull (11, 12, 13) with respect to the front-rear direction of the hull (11, 12, 13).

- 5 6. The marine propulsion system (19) according to claim 4, wherein the second propulsion device (16) includes a propeller (17a) configured to generate the another thrust, and an extendable rod (18), wherein the propeller (17a) is disposed at a distal end of the extendable rod (18), and the second propulsion device (16) is configured to incline the extendable rod (18) with respect to a water line of the hull (11, 12, 13) in consideration of a water surface to submerge the propeller (17a) in front of the bow of the hull (11, 12, 13) with respect to the front-rear direction of the hull (11, 12, 13).
10
7. The marine propulsion system (19) according to any one of claims 2 to 6, wherein the controller (31) is configured to control the first port side propulsion device (14) to generate rearward thrust, configured to control the first starboard side propulsion device (15) to generate forward thrust, and configured to control the second propulsion device (16) to generate another thrust toward the starboard side, to move the hull (11, 12, 13) in the lateral direction to the starboard side, and
15 the controller (31) is configured to control the first port side propulsion device (14) to generate forward thrust, configured to control the first starboard side propulsion device (15) to generate rearward thrust, and configured to control the second propulsion device (16) to generate another thrust toward the port side to move the hull (11, 12, 13) in the lateral direction to the port side.
20
8. The marine propulsion system (19) according to claim 1, wherein the controller (31) is configured to control the second propulsion device (16) to generate another thrust in a direction opposite to the resultant force.
9. The marine propulsion system (19) according to claim 8, wherein a magnitude of the another thrust in the direction
25 opposite to the resultant force is smaller than a magnitude of the resultant force.
10. The marine propulsion system (19) according to claim 8 or 9, wherein the second propulsion device (16) configured to generate the another thrust in the direction opposite to the resultant force in front of a bow of the hull (11, 12, 13) with respect to the front-rear direction of the hull (11, 12, 13).
30
11. The marine propulsion system (19) according to claim 10, wherein the second propulsion device (16) includes a propeller (17a) configured to generate the another thrust, and an extendable arm (32), and the second propulsion device (16) is configured to extend the extendable arm (32) to move the propeller (17a) to front of the bow of the hull (11, 12, 13) with respect to the front-rear direction of the hull (11, 12, 13).
35
12. The marine propulsion system (19) according to claim 10, wherein the second propulsion device (16) includes a propeller (17a) configured to generate the another thrust, and an extendable rod (18), wherein the propeller (17a) is disposed at a distal end of the extendable rod (18), and the second propulsion device (16) is configured to incline the extendable rod (18) with respect to a water line of the hull (11, 12, 13) in consideration of a water surface to submerge the propeller (17a) in front of the bow of the hull (11, 12, 13) with respect to the front-rear direction of the hull (11, 12, 13).
40
13. The marine propulsion system (19) according to any one of claims 8 to 12, wherein the controller (31) is configured to control the first port side propulsion device (14) to generate forward thrust, configured to control the first starboard side propulsion device (15) to generate rearward thrust, and configured to control the second propulsion device (16) to generate another thrust toward the port side, to move the hull (11, 12, 13) in the lateral direction to the starboard side, and
45 the controller (31) is configured to control the first port side propulsion device (14) to generate rearward thrust, configured to control the first starboard side propulsion device (15) to generate forward thrust, and configured to control the second propulsion device (16) to generate another thrust toward the starboard side, to move the hull (11, 12, 13) in the lateral direction to the port side.
50
14. A marine vessel (10) having a hull (11, 12, 13) and comprising a marine propulsion system (19) according to any one of claims 1 to 13.
- 55 15. A control method of a marine propulsion system (19) for a marine vessel (10) having a hull (11, 12, 13), the system comprising first port side propulsion device (14) configured to be positioned on a stern of the port side of the hull (11), and a first starboard side propulsion device (15) positioned on a stern of starboard side of the hull (12), wherein the first port side propulsion device (14) and the first starboard side propulsion device (15) are configured to be steered in each

of a rightward turning direction and a leftward turning direction with respect to a center line (CL) extending in a front-rear direction of the hull (11, 12, 13), respectively, a second propulsion device (16) configured to be disposed on a bow side of the hull (11, 12, 13), and a controller (31) for controlling the first port side propulsion device (14) and the first starboard side propulsion device (15), wherein

for moving the hull (11, 12, 13) in a lateral direction with respect to the center line (CL) extending in the front-rear direction of the hull (11, 12, 13), the control method comprising:

fully steering in the leftward turning direction the first port side propulsion device (14) positioned on a port side with respect to the center line (CL), and

fully steering in the rightward turning direction the first starboard side propulsion device (15) positioned on a starboard side with respect to the center line (CL), whereby a line of thrust generated by the first port side propulsion device (14) and a line of thrust generated by the first starboard side propulsion device (15) form an inverted V shape in plan view;

generating a forward thrust or rearward thrust by the first port side propulsion device (14) and generating thrust by the first starboard side propulsion device (15) in a direction opposite to the thrust generated by the first port side propulsion device (14), whereby a point (P) of action of a lateral movement force that is a resultant force of the thrust generated by the first port side propulsion device (14) and the thrust generated by the first starboard side propulsion device (15) is positioned in front of a turning center (G) of the hull (11, 12, 13) with respect to the front-rear direction of the hull (11, 12, 13); and

generating another thrust by the second propulsion device (16) to generate a counter yaw moment that cancels a yaw moment about the turning center (G) generated by the lateral movement force.

FIG. 1

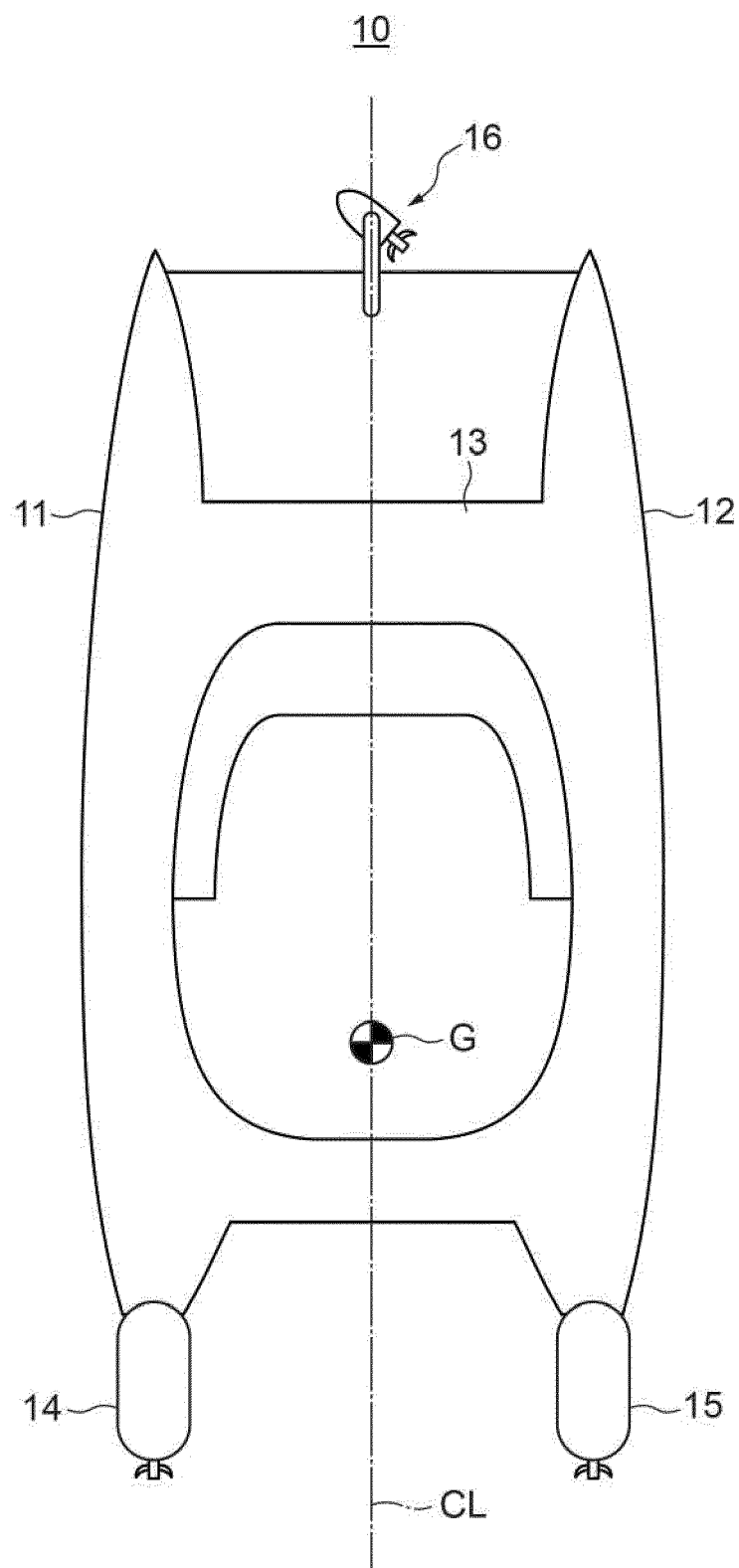


FIG. 2

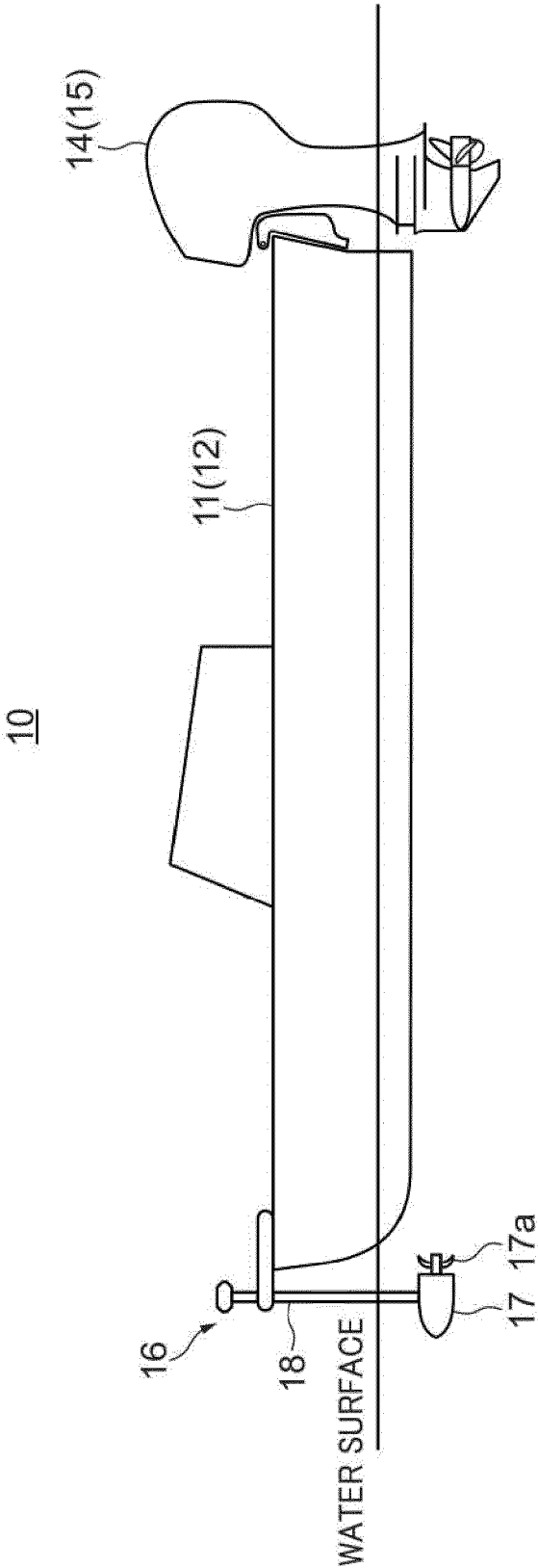


FIG. 3

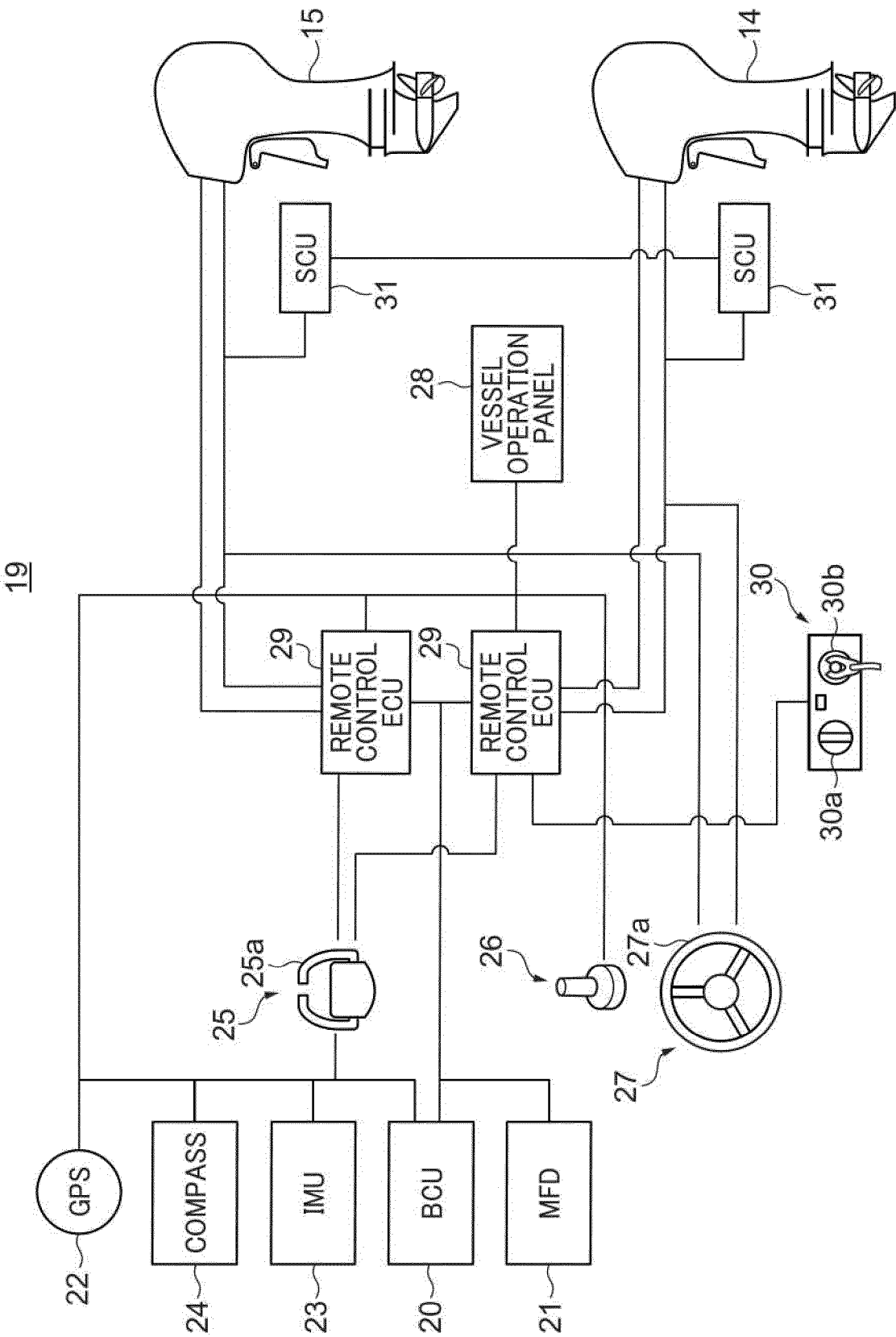


FIG. 4

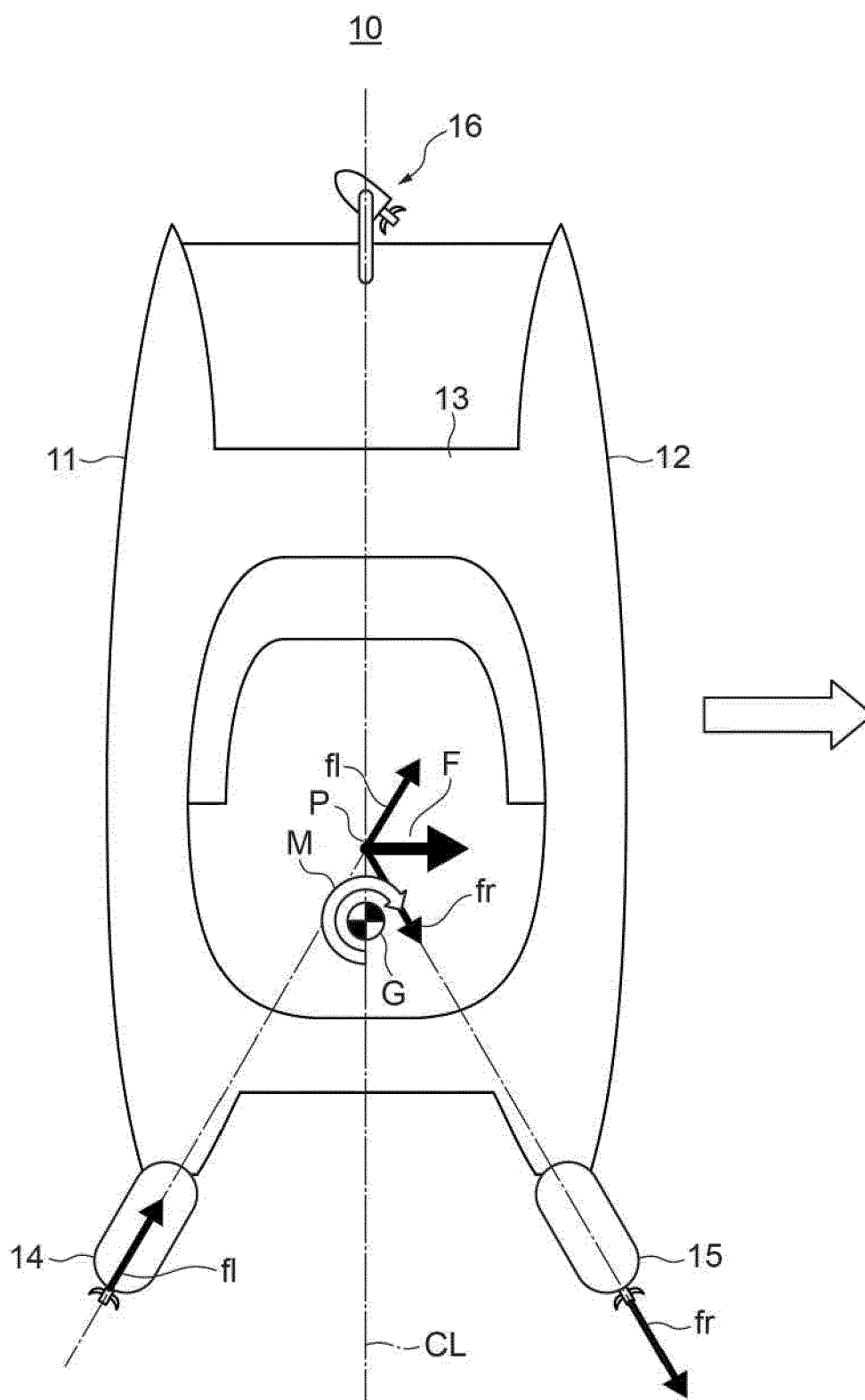


FIG. 5

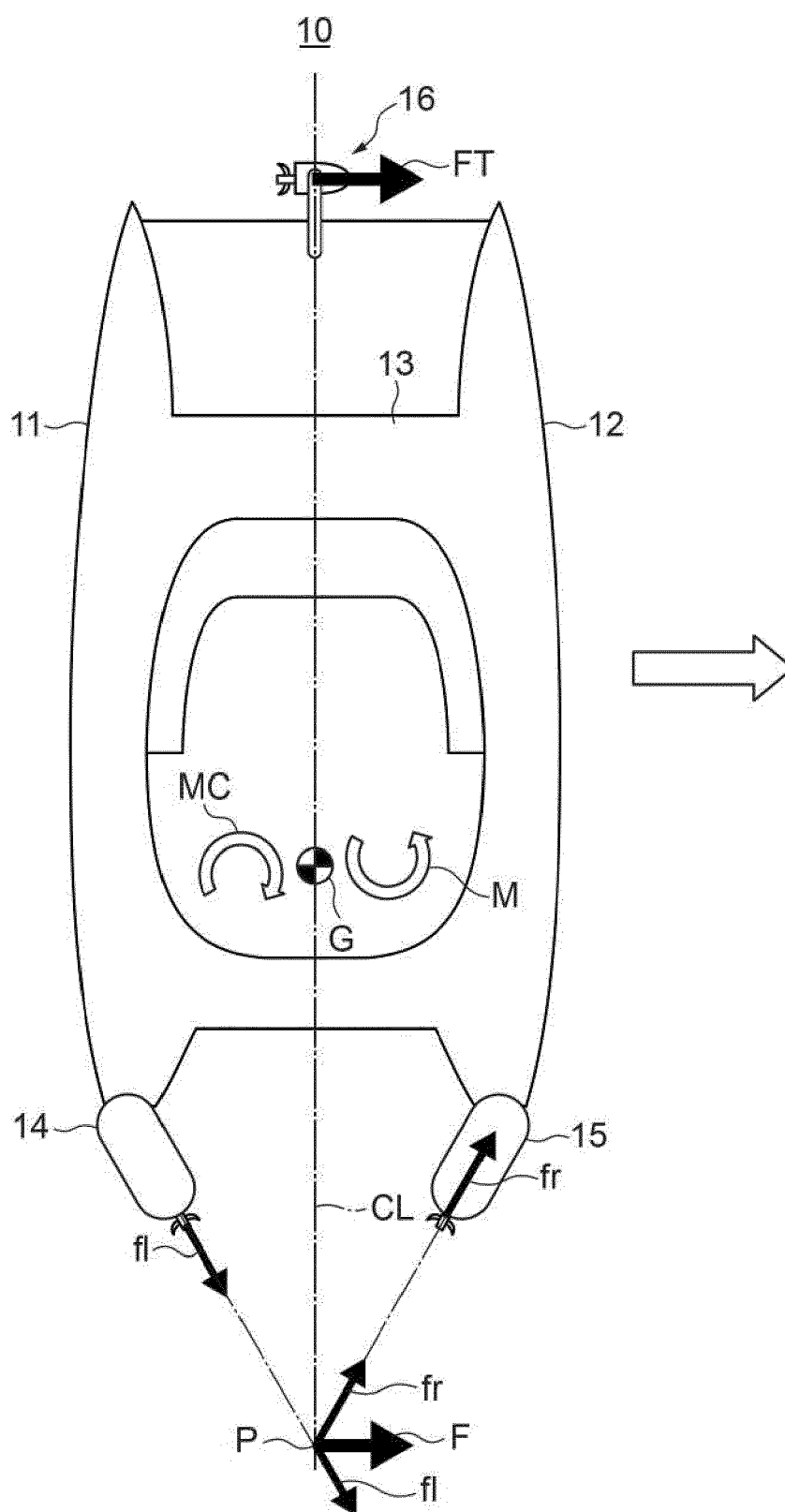


FIG. 6

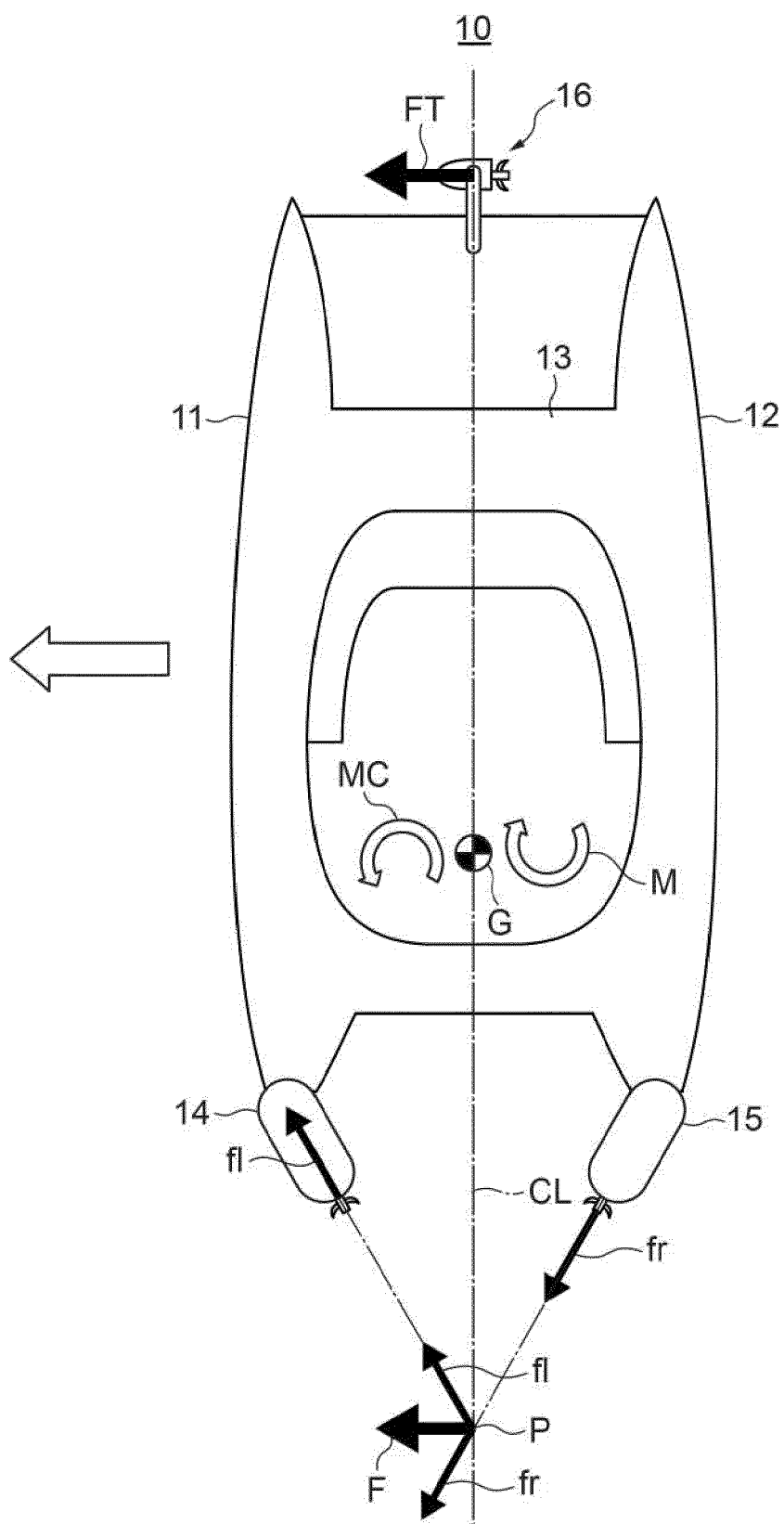


FIG. 7

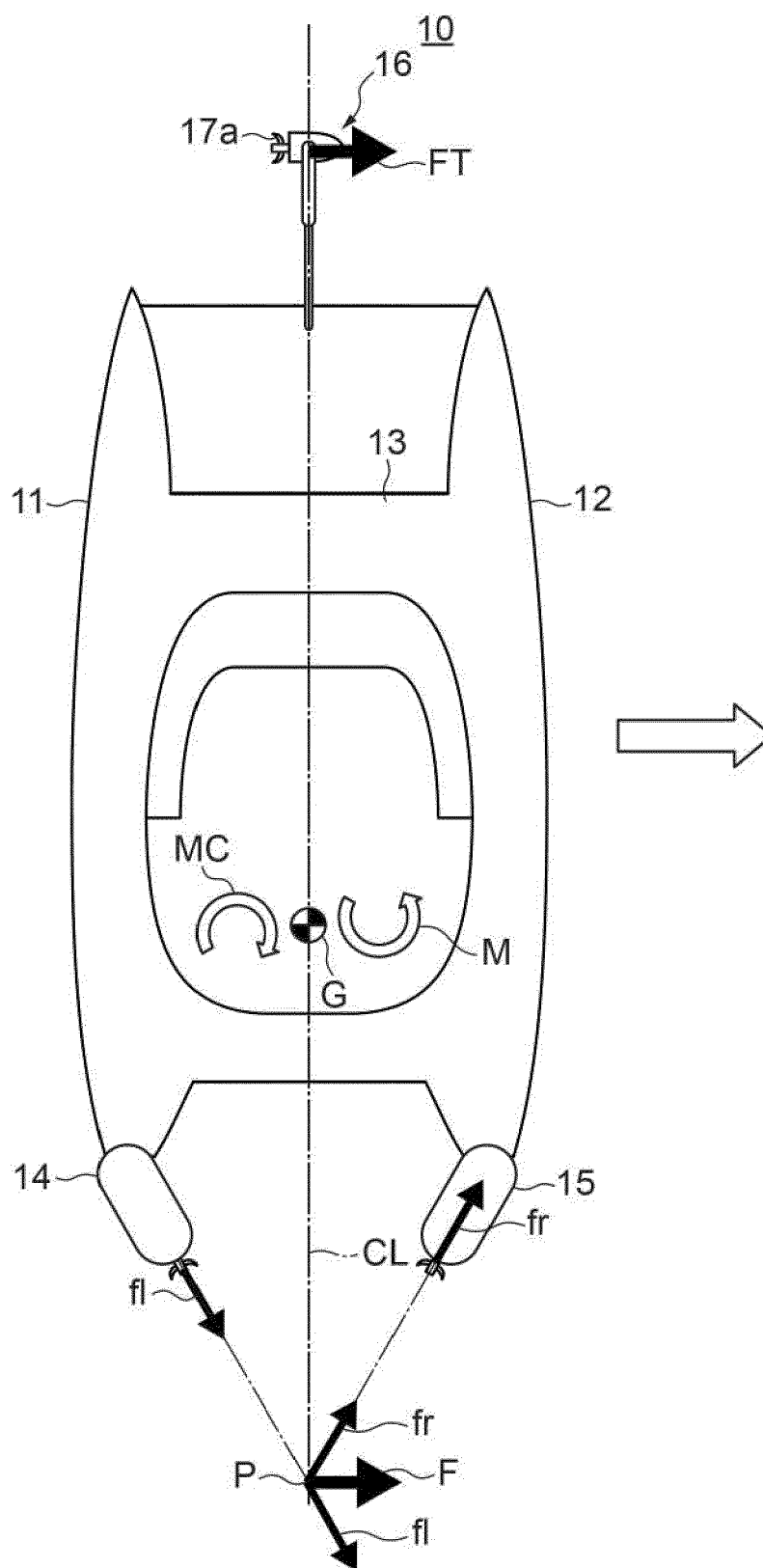


FIG. 8A

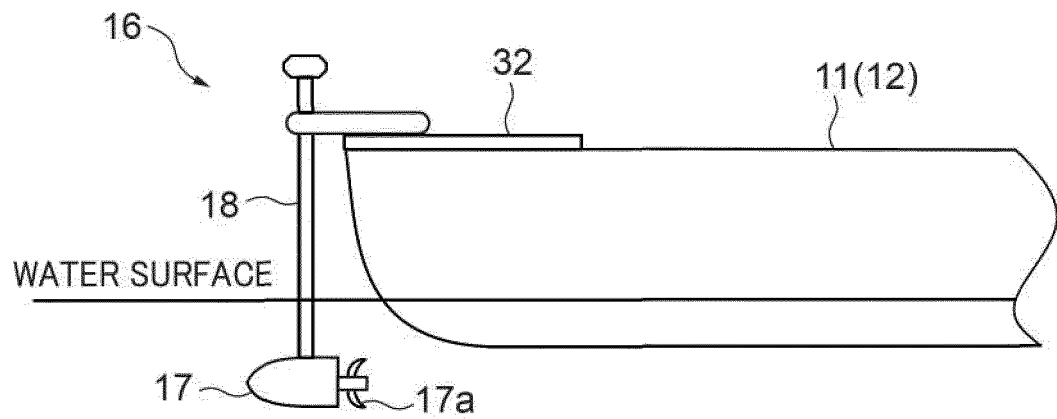


FIG. 8B

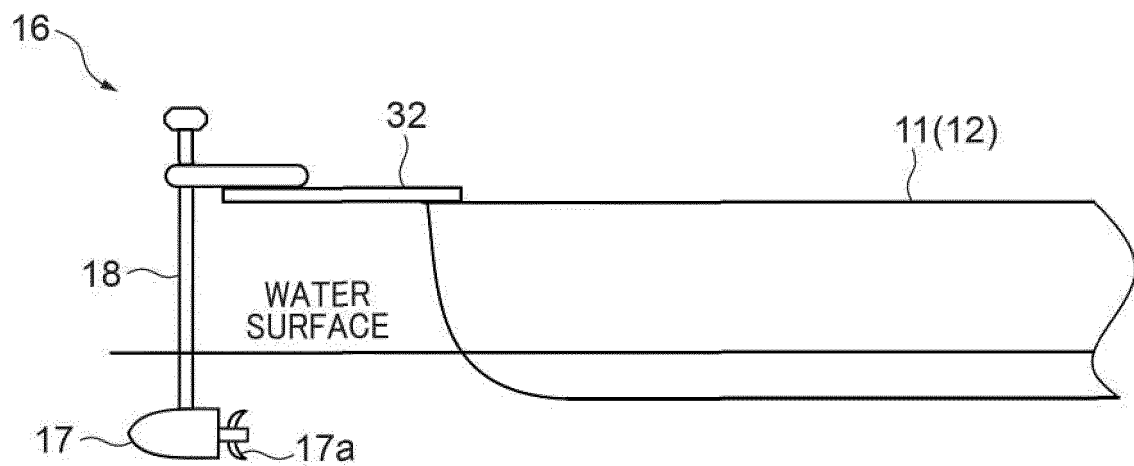


FIG. 8C

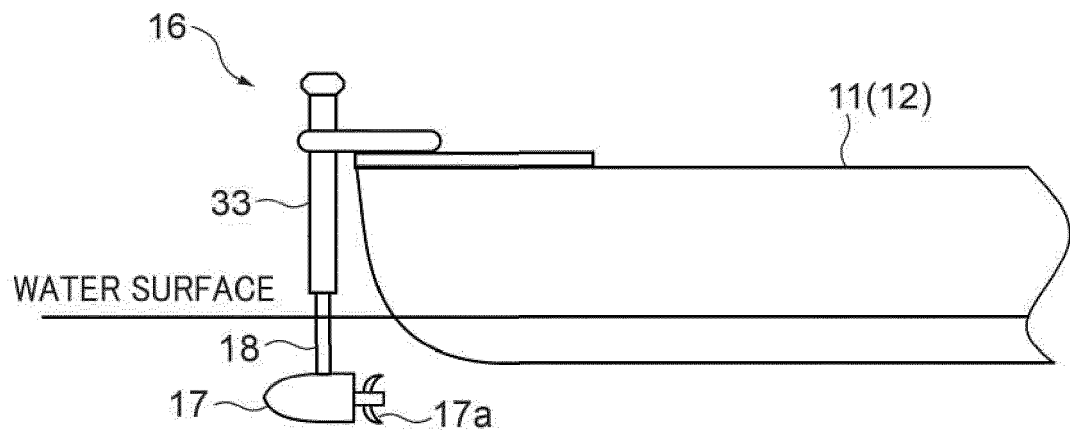


FIG. 8D

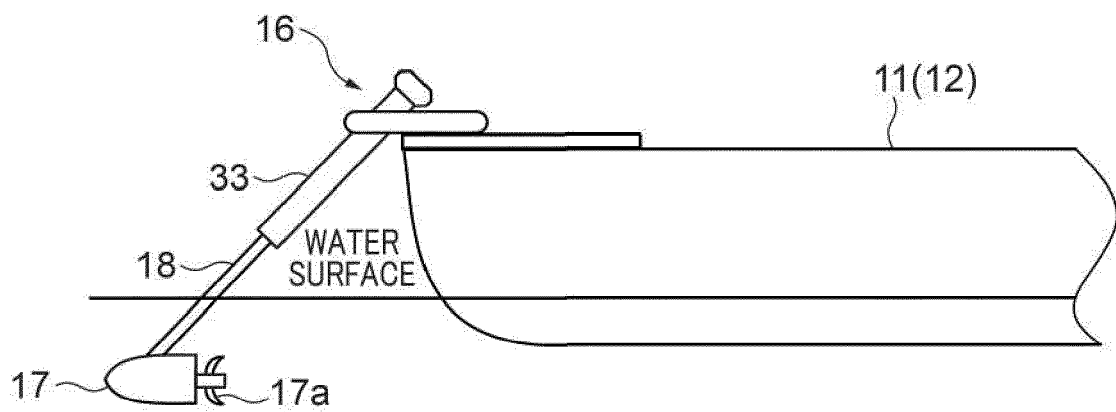


FIG. 9

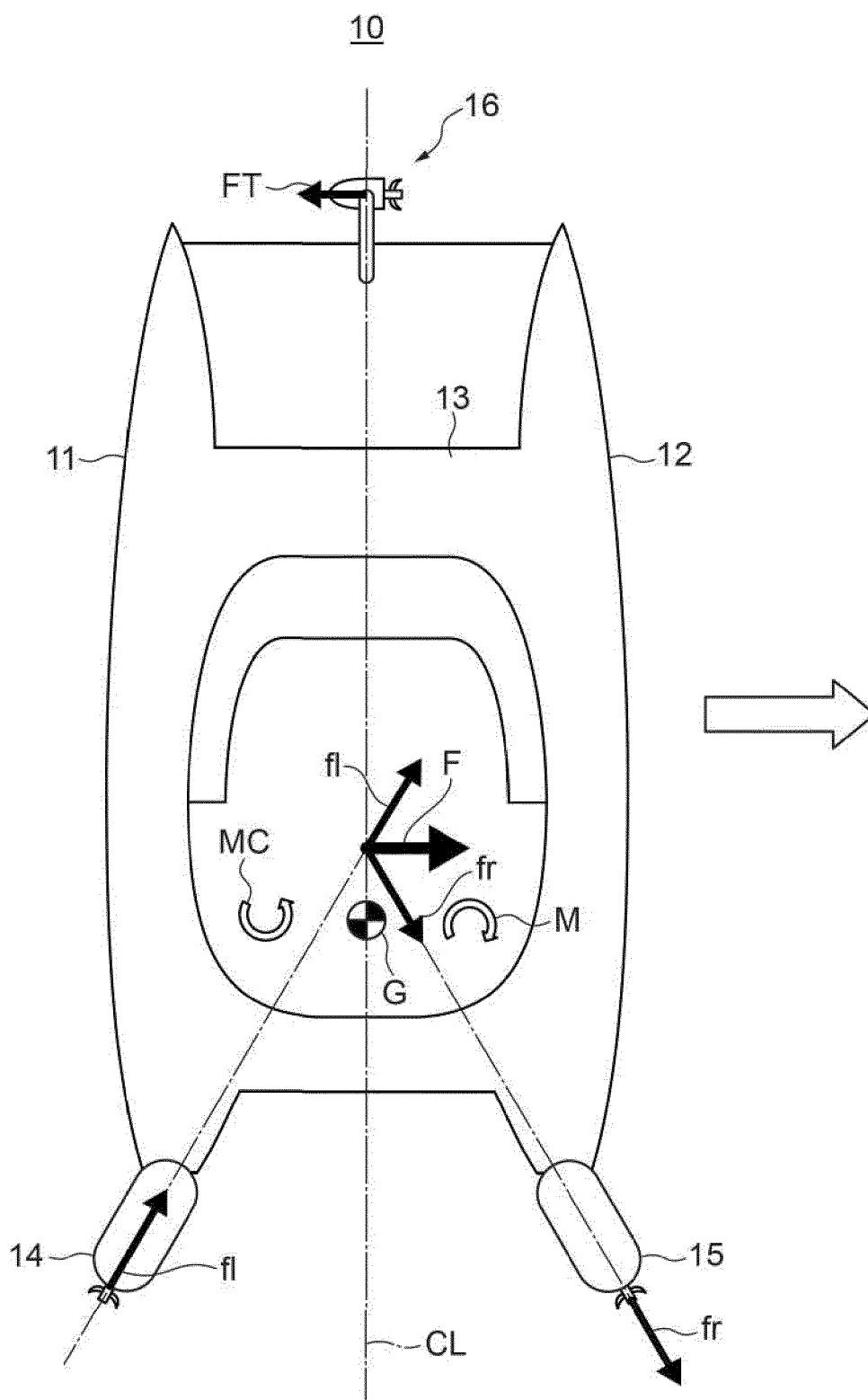


FIG. 10

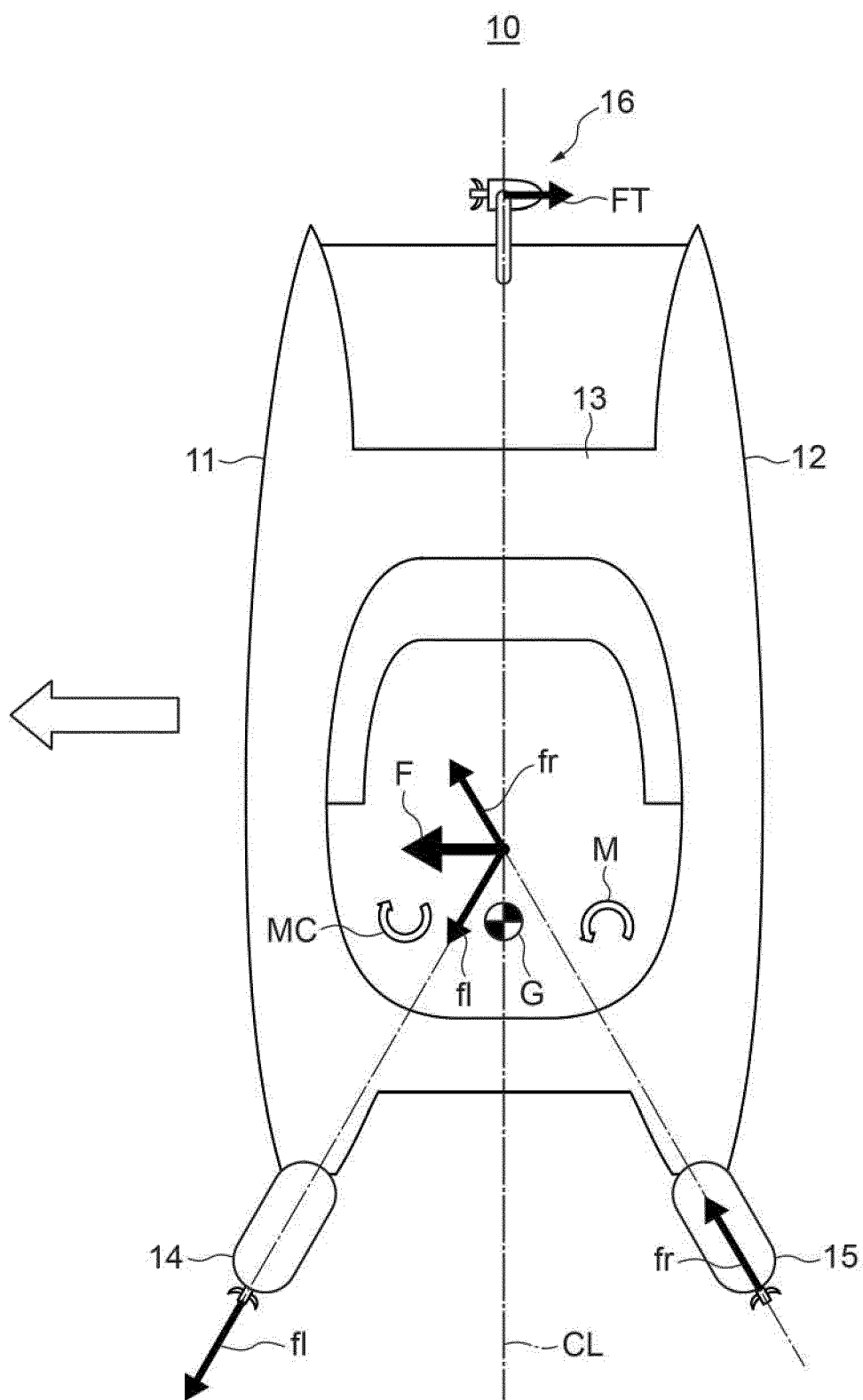


FIG. 11

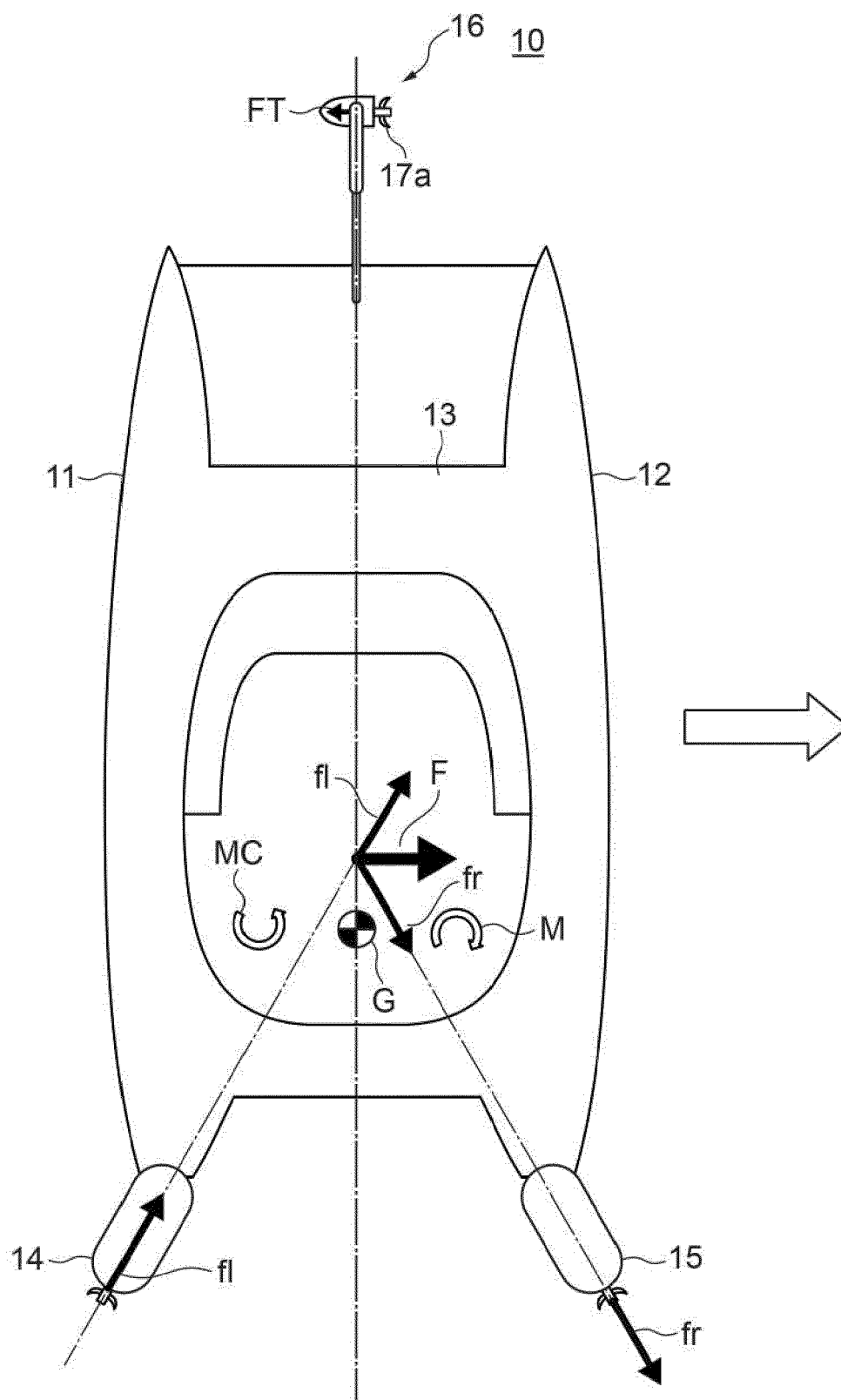
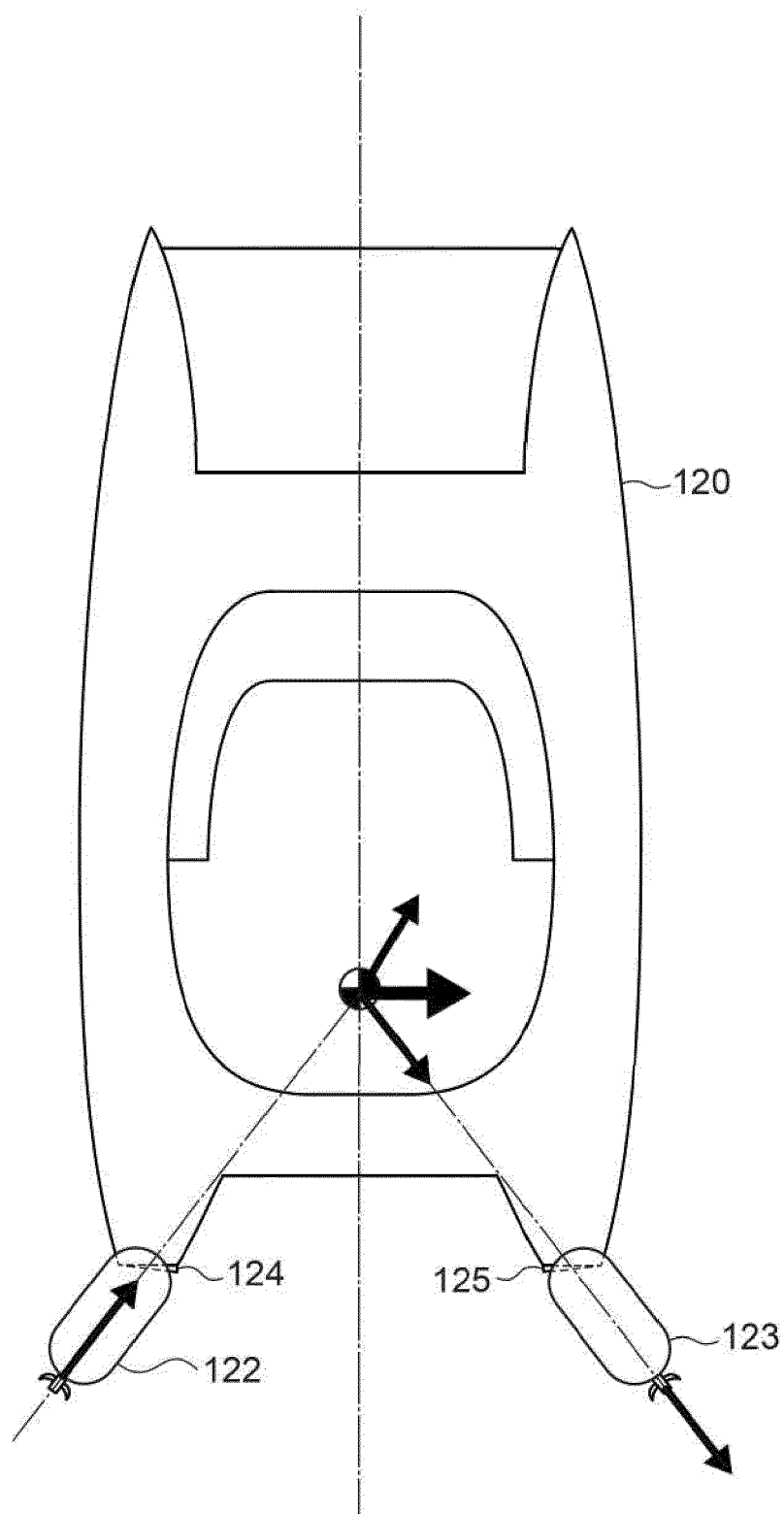


FIG. 12

PRIOR ART





EUROPEAN SEARCH REPORT

Application Number

EP 24 19 3096

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 2020/069750 A1 (CPAC SYSTEMS AB [SE]) 9 April 2020 (2020-04-09) * figure 2B *	1-15	INV. B63H20/00 B63H20/12 B63H25/42
A	US 2009/076671 A1 (MIZUTANI MAKOTO [JP]) 19 March 2009 (2009-03-19) * figures 7C, 7D *	1-15	
A	US 2014/046515 A1 (MIZUTANI MAKOTO [JP]) 13 February 2014 (2014-02-13) * figures 9, 10, 11 *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			B63H
The present search report has been drawn up for all claims			
Place of search		Date of completion of the search	Examiner
The Hague		28 January 2025	Freire Gomez, Jon
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T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EP 24 19 3096

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28-01-2025

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