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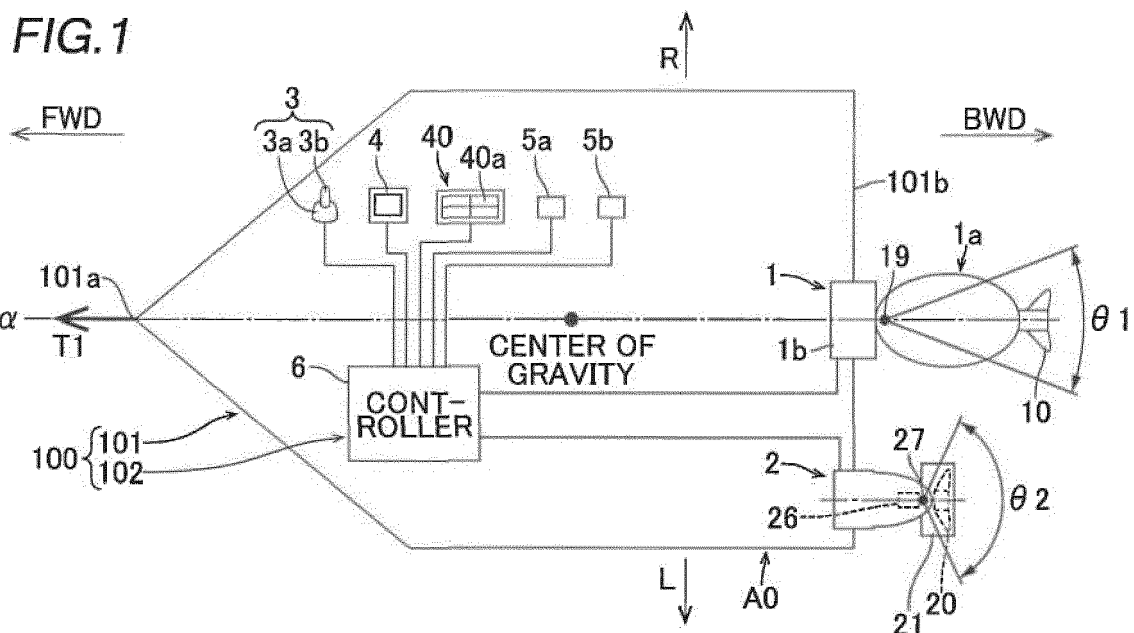
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(54) **MARINE PROPULSION SYSTEM**

(57) A marine propulsion system (102) includes a main propulsion device (1) configured to rotate in a right-left direction to change a direction of a thrust, an auxiliary propulsion device (2) including an electric motor configured to drive an auxiliary thruster (20) and configured to rotate in the right-left direction to change a direction of a thrust, and a controller (6) configured or programmed to perform a drift control to move a hull (101)

under external forces including wind and water flow while maintaining an orientation (T1) of a bow (101a) of the hull at a target orientation by rotating the hull. The controller is configured or programmed to maintain the orientation of the bow at the target orientation by rotating the hull by driving the auxiliary thruster while stopping a main thruster (10) of the main propulsion device in the drift control.



Description

[0001] The present invention relates to a marine propulsion system, a marine vessel with a marine propulsion system and a method for controlling a marine propulsion system.

[0002] A marine propulsion system including a main propulsion device and an auxiliary propulsion device is known in general. Such a marine propulsion system is disclosed in JP 2000-168692 A, for example.

[0003] JP 2000-168692 A discloses a marine vessel position control device including a main propulsion device, a pair of auxiliary propulsion devices provided respectively on the right side and the left side of the main propulsion device, and a controller to perform a control to maintain the position of a hull at a predetermined position by driving only the auxiliary propulsion devices to cause a bow to face the wind while the orientation of the bow is directed to the windward side. The pair of auxiliary propulsion devices are attached to the hull while being inclined with respect to a centerline of the hull in a right-left direction in a plan view such that a rotational moment is applied to the hull when a thrust is generated, and turn the hull when the thrust is generated. The turning by the rotational moment indicates gradually changing the orientation of the bow while moving forward. Therefore, the position of the hull is not maintained when the hull is turned.

[0004] Although not clearly described in JP 2000-168692 A, conventionally, there has been known a drift control to move a hull under external forces including wind and water flow while maintaining the orientation of a bow of the hull at a target orientation by rotating the hull. When the control to maintain the position of the hull at the predetermined position by causing the bow to face the wind while the orientation of the bow is directed to the windward side described in JP 2000-168692 A is applied to such a drift control, a control is conceivably performed to drive only the auxiliary propulsion devices instead of driving both the main propulsion device and the auxiliary propulsion devices. However, in such a case, it is necessary to make a turn in which the position of the hull is not maintained in order to move the hull to the predetermined position with only the auxiliary propulsion devices. Therefore, it takes a relatively long time to direct the bow to the target orientation, and thus the orientation maintenance performance of the bow is conceivably low. Recent years, in the field of marine vessels, from the viewpoint of SDGs (Sustainable Development Goals), it is desired to reduce environmental burdens, such as reducing the amount of carbon dioxide emissions associated with driving of propulsion devices of marine vessels.

[0005] It is an object of the present invention to provide a marine propulsion system and a method for controlling a marine propulsion system that improves the orientation maintenance performance of a bow in a drift control while reducing environmental burdens associated with driving of propulsion devices as much as possible. According to

the present invention, said object is solved by a marine propulsion system having the features of independent claim 1. Moreover, according to the present invention, said object is solved by a method for controlling a marine propulsion system having the features of independent claim 12. Preferred embodiments are laid down in the dependent claims.

[0006] A marine propulsion system according to a preferred embodiment includes a main propulsion device configured to rotate in a right-left direction to change a direction of a thrust, an auxiliary propulsion device including an electric motor configured to drive an auxiliary thruster to generate a thrust, configured to rotate in the right-left direction to change a direction of the thrust, and having a maximum output smaller than a maximum output of the main propulsion device, and a controller configured or programmed to perform a drift control to move a hull under external forces including wind and water flow while maintaining an orientation of a bow of the hull at a target orientation by rotating the hull. The controller is configured or programmed to maintain the orientation of the bow at the target orientation by rotating the hull by driving the auxiliary thruster while stopping a main thruster configured to generate the thrust from the main propulsion device in the drift control. The term "rotating the hull" indicates changing the orientation of the bow while maintaining the position of the hull, unlike turning of the hull accompanied by forward or rearward movement of the hull.

[0007] A marine propulsion system according to a preferred embodiment includes the controller configured or programmed to perform a control to maintain the orientation of the bow at the target orientation by rotating the hull by driving the auxiliary thruster operable to rotate in the right-left direction to change the direction of the thrust while stopping the main thruster operable to generate a thrust from the main propulsion device in the drift control to move the hull under the external forces including wind and water flow while maintaining the orientation of the bow of the hull at the target orientation by rotating the hull. Accordingly, while the position of the hull is maintained, the hull is rotated by the auxiliary propulsion device by rotating the auxiliary propulsion device in the right-left direction. In other words, the rotation of the hull changes the orientation of the hull in a short period of time, unlike turning of the hull accompanied by forward movement of the hull. Consequently, the orientation maintenance performance of the bow in the drift control is improved. Furthermore, the auxiliary propulsion device includes the electric motor to drive the auxiliary thruster to generate a thrust. Accordingly, the amount of carbon dioxide emitted from the auxiliary propulsion device is reduced as compared with a case in which the auxiliary propulsion device is an engine propulsion device. Thus, the orientation maintenance performance of the bow in the drift control is improved while environmental burdens associated with driving of the propulsion devices are reduced as much as possible.

[0008] In a marine propulsion system according to a preferred embodiment, the main propulsion device is preferably attached to a stern of the hull and is preferably provided on a centerline of the hull in the right-left direction, and the auxiliary propulsion device is preferably attached to the stern and is preferably provided to one side of the centerline of the hull in the right-left direction. Accordingly, the auxiliary propulsion device is spaced farther apart from the center of gravity of the hull as compared with the main propulsion device, and thus a relatively large rotational moment is generated by the auxiliary propulsion device at the time of rotating the hull. Therefore, the hull is more quickly rotated.

[0009] In a marine propulsion system according to a preferred embodiment, the controller is preferably configured or programmed to rotate the hull by driving the auxiliary thruster while stopping the main thruster without rotating the main propulsion device in the right-left direction in the drift control. Accordingly, the main propulsion device is not rotated in the right-left direction when the hull is rotated, and thus the hull is prevented from swinging due to rotation of the main propulsion device in the right-left direction. Furthermore, noise generated from the main propulsion device is reduced, and thus escape of fish during fishing, for example, is reduced or prevented.

[0010] In such a case, the main propulsion device is preferably configured to maintain a rudder angle of the main thruster at a rudder angle along a centerline of the hull in the right-left direction while stopping the main thruster when the hull is rotated by driving the auxiliary thruster in the drift control. Accordingly, when the hull is rotated, the main propulsion device is kept on standby at the rudder angle along the centerline of the hull in the right-left direction, which corresponds to the rudder angle of the main thruster, and thus a thrust is immediately generated in the forward-rearward direction from the main thruster without changing the rudder angle of the main propulsion device after the rotation is completed in the drift track mode in which the hull is moved toward the target point using the external forces and forward movement.

[0011] In a marine propulsion system according to a preferred embodiment, the auxiliary propulsion device preferably has a right-left rotatable angle range to change the direction of the thrust larger than a right-left rotatable angle range of the main propulsion device. Accordingly, the hull is rotated (pivot-turned) by the electric motor-driven (electric) auxiliary propulsion device that has the right-left rotatable angle range to change the direction of the thrust larger than the right-left rotatable angle range of the main propulsion device such that a change in the position of the hull becomes smaller.

[0012] A marine propulsion system according to a preferred embodiment preferably further includes a mode switching operator configured to receive an operation to switch between a normal drift mode in which the drift control is performed using only the external forces as a

power source to move the hull directed to the target orientation while the main thruster of the main propulsion device is stopped and a drift track mode in which the drift control is performed to move the hull toward a target point using the thrust of at least one of the main thruster or the auxiliary thruster in addition to the external forces as the power source. Accordingly, the normal drift mode and the drift track mode are easily switched by the mode switching operator.

[0013] In such a case, the controller is preferably configured or programmed to start the drift track mode in either a first driving state in which the external forces and the main thruster are used as the power source to move the hull toward the target point or a second driving state in which the external forces and the auxiliary thruster are used as the power source to move the hull toward the target point when the normal drift mode is switched to the drift track mode by the mode switching operator. Accordingly, in the first driving state, the hull is moved toward the target point by the main propulsion device, which has the maximum output larger than the maximum output of the auxiliary propulsion device, and thus the hull is moved faster as compared with a case in which the hull is moved toward the target point by the auxiliary propulsion device. In the second driving state, the hull is rotated and moved toward the target point by the auxiliary thruster driven by the electric motor, and thus quietness in the drift control is improved while environmental burdens are reduced.

[0014] A marine propulsion system that starts the drift track mode in the first driving state or the second driving state preferably further includes a thrust adjustment operator configured to receive an operation to adjust levels of thrust magnitudes of the main propulsion device and the auxiliary propulsion device, and the controller is preferably configured or programmed to start the drift track mode in the first driving state when the normal drift mode is switched to the drift track mode by the mode switching operator, and switch the first driving state to the second driving state based on the thrust adjustment operator receiving an operation to change the levels of the thrust magnitudes to predetermined levels or less in the drift track mode. Accordingly, the first driving state is easily switched to the second driving state in response to an operation on the thrust adjustment operator to lower the thrust levels, and the hull is moved toward the target point.

[0015] A marine propulsion system including the mode switching operator is preferably configured to automatically switch from the drift track mode to the normal drift mode when the hull reaches the target point and another target point is not specified. Accordingly, even when the hull reaches the target point and another target point is not specified, the drift track mode is automatically switched to the normal drift mode, and thus the drift control is continued.

[0016] In a marine propulsion system according to a preferred embodiment, the main propulsion device is

preferably an engine outboard motor including an engine configured to drive a main propeller corresponding to the main thruster and provided on a centerline of the hull in the right-left direction, and the auxiliary propulsion device is preferably an electric outboard motor including the electric motor configured to drive an auxiliary propeller corresponding to the auxiliary thruster and provided to one side of the centerline of the hull in the right-left direction. Accordingly, environmental burdens are reduced due to driving of the electric outboard motor, and the drift control is performed on the hull including the engine outboard motor and the electric outboard motor.

[0017] The above and other elements, features, steps, characteristics and advantages of preferred embodiments will become more apparent from the following detailed description of the preferred embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018]

FIG. 1 is a schematic view showing a marine vessel including a marine propulsion system and a hull according to a preferred embodiment.

FIG. 2 is a side view showing a main propulsion device of a marine propulsion system according to a preferred embodiment.

FIG. 3 is a side view showing an auxiliary propulsion device of a marine propulsion system according to a preferred embodiment.

FIG. 4 is a block diagram of a marine vessel including a marine propulsion system and a hull according to a preferred embodiment.

FIG. 5 is a diagram illustrating the power range of an engine of a main propulsion device and the power range of an electric motor of an auxiliary propulsion device according to a preferred embodiment.

FIG. 6 is a diagram showing a joystick of a marine propulsion system according to a preferred embodiment.

FIG. 7 is a diagram showing a display example for a drift control of a display of a marine propulsion system according to a preferred embodiment.

FIG. 8 is a diagram illustrating a normal drift mode of a drift control by a controller of a marine propulsion system according to a preferred embodiment.

FIG. 9 is a diagram illustrating a drift track mode of a drift control by a controller of a marine propulsion system according to a preferred embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0019] Preferred embodiments are hereinafter described with reference to the drawings.

[0020] The structure of a marine vessel 100 including a marine propulsion system 102 according to preferred

embodiments is now described with reference to FIGS. 1 to 9.

[0021] In the figures, arrow FWD represents the forward movement direction of the marine vessel 100 in a forward-rearward direction, and arrow BWD represents the rearward movement direction of the marine vessel 100 in the forward-rearward direction. Arrow R represents the starboard direction of the marine vessel 100 in a right-left direction (a direction perpendicular to the forward-rearward direction), and arrow L represents the portside direction of the marine vessel 100 in the right-left direction.

[0022] As shown in FIG. 1, the marine vessel 100 includes a hull 101 and the marine propulsion system 102 provided on or in the hull 101. The hull 101 may be a hull of a fishing boat or a fishing vessel for a user to fish, or a relatively large hull such as a passenger vessel, for example.

[0023] The marine propulsion system 102 includes a main propulsion device 1, an auxiliary propulsion device 2, a joystick 3, a display 4 that displays navigation-related information, etc., an operation panel 40, an orientation sensor 5a, a position sensor 5b, and a controller 6. The joystick 3, the display 4, the operation panel 40, the orientation sensor 5a, the position sensor 5b, and the controller 6 are mounted on or in the hull 101.

[0024] The marine propulsion system 102 (controller 6) performs a drift control to move the hull 101 under external forces F including wind and water flow while maintaining the orientation $T1$ of a bow 101a of the hull 101 at a target orientation $T2$ by rotating the hull 101 (see FIG. 7).

[0025] In the drift control (normal drift mode), the controller 6 rotates the hull 101 to maintain the orientation $T1$ of the bow 101a at the target orientation $T2$ by driving an auxiliary propeller 20 while stopping a main propeller 10 that generates a thrust from the main propulsion device 1. In the drift control, the hull 101 is automatically rotated without the user maneuvering the marine vessel. The drift control is described below in detail. The main propeller 10 is an example of a "main thruster". The auxiliary propeller 20 is an example of an "auxiliary thruster".

[0026] Only one main propulsion device 1 shown in FIGS. 2 and 4 is attached to a stern 101b (transom) of the hull 101. The main propulsion device 1 is an engine outboard motor including an engine 12 to drive the main propeller 10 to generate a thrust. The main propulsion device 1 is provided on a centerline α of the hull 101 in the right-left direction. The main propulsion device 1 rotates in the right-left direction to change the direction of the thrust of the main propeller 10.

[0027] The main propulsion device 1 includes a main propulsion device body 1a and a steering mechanism 1b provided on the main propulsion device body 1a. The main propulsion device body 1a is attached to the stern 101b of the hull 101 via the steering mechanism 1b.

[0028] The main propulsion device body 1a includes the main propeller 10, an engine control unit (ECU) 11,

the engine 12, a cowling 13, a shift actuator 14, a drive shaft 15, a gearing 16, a propeller shaft 17, and a steering control unit (SCU) 18.

[0029] The ECU 11 is a control circuit, for example, and includes a central processing unit (CPU). The ECU 11 controls driving of the engine 12 based on a command from the controller 6.

[0030] The engine 12 is a drive source for the main propeller 10. The engine 12 is provided in an upper portion of the main propulsion device 1, and is an internal combustion engine driven by explosive combustion of gasoline, light oil, or the like. The engine 12 is covered with the cowling 13. As an example, the maximum output P10 (see FIG. 5) of the engine 12 is about 200 horsepower.

[0031] The shift actuator 14 switches the shift state of the main propulsion device 1 to any one of a forward movement state (shift F), a reverse movement state (shift R), and a neutral state (shift N) by switching the meshing of the gearing 16. When the shift state of the main propulsion device 1 is in the forward movement state, a thrust is generated from the main propeller 10 toward the FWD side, and when the shift state is in the reverse movement state, a thrust is generated from the main propeller 10 toward the BWD side. When the shift state is in the neutral state, a thrust is not generated from the main propeller 10.

[0032] When the shift state is switched, the meshing state of the gearing 16 of the main propulsion device 1 is changed, and thus a shift shock occurs in the gearing 16. That is, when the shift state is switched, the gearing 16 of the main propulsion device 1 generates relatively loud noise and vibrations.

[0033] The drive shaft 15 is connected to a crankshaft (not shown) of the engine 12 so as to transmit a power from the engine 12. The drive shaft 15 extends directly below the engine 12 with the main propeller 10 located in the water.

[0034] The gearing 16 transmits a rotational force from the drive shaft 15 to the propeller shaft 17. The main propeller 10 is attached to a rear end of the propeller shaft 17. The main propeller 10 generates a thrust in the axial direction of the propeller shaft 17 by rotating in the water. The main propeller 10 moves the hull 101 forward or rearward by switching the direction of the thrust between a forward direction and a rearward direction according to the rotational direction switched depending on the shift state.

[0035] The SCU 18 is a control circuit, for example, and includes a central processing unit (CPU). The SCU 18 controls driving of the steering mechanism 1b based on a command from the controller 6.

[0036] The steering mechanism 1b rotates the main propulsion device body 1a in the right-left direction with a steering shaft 19 extending in an upward-downward direction as a central axis of rotation. That is, the steering mechanism 1b changes the orientation of the main propulsion device body 1a in the right-left direction. When the orientation of the main propulsion device body 1a in

the right-left direction changes, the direction of the thrust of the main propeller 10 also changes according to the orientation of the main propulsion device body 1a.

[0037] As an example, a right-left rotatable angle range $\theta 1$ (see FIG. 1) to change the direction of the thrust of the main propulsion device 1 is about 60 degrees (30 degrees on one side). As an example, the steering mechanism 1b includes a hydraulic cylinder (not shown) to apply a rotational force to the steering shaft 19, an electric pump (not shown) to pressure-feed oil to drive the hydraulic cylinder, etc.

[0038] Only one auxiliary propulsion device 2 shown in FIGS. 3 and 4 is attached to the stern 101b (transom) of the hull 101. The auxiliary propulsion device 2 is an electric outboard motor including an electric motor 23 to drive the auxiliary propeller 20 to generate a thrust. The auxiliary propulsion device 2 is provided to one side of the centerline of the hull 101 in the right-left direction. Specifically, the auxiliary propulsion device 2 is located on the left side relative to the centerline α (see FIG. 1) of the hull 101 in the right-left direction. The auxiliary propulsion device 2 rotates in the right-left direction to change the direction of the thrust of the auxiliary propeller 20.

[0039] The auxiliary propulsion device 2 includes the auxiliary propeller 20, a duct 21, a motor control unit (MCU) 22, the electric motor 23, a cowling 24, a steering control unit (SCU) 25, and a steering mechanism 26.

[0040] The duct 21 is provided in a lower portion of the auxiliary propulsion device 2 with the auxiliary propeller 20 located in the water. The duct 21 has a cylindrical shape and supports the auxiliary propeller 20 on the inner peripheral side such that the auxiliary propeller 20 is rotatable. In FIG. 3, the central position of rotation of the auxiliary propeller 20 is indicated by a central axis β . That is, the auxiliary propeller 20 generates a thrust in a direction along the central axis β .

[0041] The MCU 22 is a control circuit, for example, and includes a central processing unit (CPU). The MCU 22 controls driving of the electric motor 23 based on a command from the controller 6.

[0042] The electric motor 23 is a drive source for the auxiliary propeller 20. The electric motor 23 is driven by power from a battery (not shown) mounted on the hull 101, for example. The maximum output P20 of the electric motor 23 of the auxiliary propulsion device 2 is smaller than the maximum output P10 of the engine 12 of the main propulsion device 1. As an example, the maximum output P20 (see FIG. 5) of the electric motor 23 is about 20 horsepower.

[0043] The electric motor 23 includes a stator 23a integral and unitary with the duct 21 and a rotor 23b integral and unitary with the auxiliary propeller 20.

[0044] The cowling 24 covers an upper portion of the auxiliary propulsion device 2 such that electrical wiring and the like are not exposed. The cowling 24 does not rotate in the right-left direction unlike the auxiliary propeller 20 when the direction of the thrust in the right-left

direction is changed. That is, the auxiliary propulsion device 2 does not rotate the entire auxiliary propulsion device 2 (auxiliary propulsion device body) excluding the steering mechanism 26 in the right-left direction but rotates only a portion (such as the duct 21 and the auxiliary propeller 20) of the auxiliary propulsion device 2 on the lower side, unlike the main propulsion device 1 that rotates the entire main propulsion device body 1a excluding the steering mechanism 1b in the right-left direction.

[0045] Therefore, the auxiliary propulsion device 2 does not need to rotate a relatively large structure such as the engine 12 of the main propulsion device 1 in the right-left direction, and thus a right-left rotatable angle range $\theta 2$ (see FIG. 1) to change the direction of the thrust is relatively large. As an example, the right-left rotatable angle range $\theta 2$ to change the direction of the thrust of the auxiliary propulsion device 2 is about 140 degrees (70 degrees on one side).

[0046] The auxiliary propeller 20 generates a thrust by rotating in the water. The drive source for the auxiliary propeller 20 is the electric motor 23, and thus the auxiliary propeller 20 is able to freely switch between forward rotation, reverse rotation (the direction of the thrust in the forward-rearward direction), and stop without generating a shift shock unlike the main propulsion device 1.

[0047] The SCU 25 is a control circuit, for example, and includes a central processing unit (CPU). The SCU 25 controls driving of the steering mechanism 26 based on a command from the controller 6.

[0048] The steering mechanism 26 is built into the auxiliary propulsion device 2. The steering mechanism 26 rotates the duct 21 in the right-left direction with a steering shaft 27 extending in the upward-downward direction as a central axis of rotation. When the orientation of the duct 21 in the right-left direction changes, the direction of the thrust of the auxiliary propeller 20 supported by the duct 21 also changes.

[0049] As an example, the steering mechanism 26 includes a reduction gear unit (not shown) to apply a rotational force to the steering shaft 27, an electric motor (not shown) to drive the reduction gear unit, etc.

[0050] The joystick 3 shown in FIG. 6 is an operator to maneuver the marine vessel. The joystick 3 includes a main body 3a and a columnar stick 3b extending upward from the main body 3a. The stick 3b is a portion that is gripped by the user during maneuvering of the marine vessel.

[0051] The main body 3a includes a joystick button 30, three buttons to start an automatic marine vessel maneuvering mode including a Stay Point (registered trademark) button 31a, a Fish Point (registered trademark) button 31b, and a drift button 31c, and a thrust adjustment operation button 32. The thrust adjustment operation button 32 is an example of a "thrust adjustment operator".

[0052] The joystick button 30 receives operations to start and end a joystick mode. That is, the joystick button 30 switches between a normal state and a state (joystick mode) in which the joystick 3 is used to maneuver the

marine vessel. In the normal state, the marine vessel is maneuvered using a remote control lever (not shown) to switch the shift state and adjust the engine speed, for example, and a steering wheel (not shown) to operate steering.

[0053] The Stay Point button 31a receives operations to start and end a Stay Point (fixed point holding) control. The Stay Point (fixed point holding) control refers to an automatic marine vessel maneuvering control to maintain the orientation T1 of the bow 101a of the hull 101 at the target orientation and maintain the position of the hull 101 at a target point A1.

[0054] The Fish Point button 31b receives operations to start and end a Fish Point control. The Fish Point control refers to an automatic marine vessel maneuvering control to direct the stern 101b (or the bow 101a) of the hull 101 to the target point A1 by rotating the hull 101 and maintain the hull 101, the stern 101b (or the bow 101a) of which has been directed to the target point A1, at the target point A1 by moving the hull 101 in the forward-rearward direction. The hull 101 does not move laterally in the Fish Point control.

[0055] The drift button 31c receives operations to start and end the drift control. The drift control refers to an automatic marine vessel maneuvering control to move the hull 101 under the external forces F (see FIG. 7) including wind and water flow while maintaining the orientation T1 of the bow 101a of the hull 101 at the target orientation T2 by rotating the hull 101, as described above.

[0056] The drift control has two modes including a normal drift mode and a drift track mode. In the normal drift mode, the drift control is performed using only the external forces F as a power source to move the hull 101 directed to the target orientation T2 while the main propeller 10 of the main propulsion device 1 is stopped. In the drift track mode, the drift control is performed to move the hull 101 toward the target point A1 using the thrust of at least one of the main propeller 10 or the auxiliary propeller 20 in addition to the external forces F as the power source. In the drift track mode, the controller 6 generates a thrust in the forward-rearward direction mainly from at least one of the main propeller 10 or the auxiliary propeller 20.

[0057] The normal drift mode and the drift track mode are switched by a mode switching operation button 40a on the operation panel 40 (see FIG. 1). The mode switching operation button 40a receives an operation to switch between the normal drift mode and the drift track mode, and is one of various buttons provided on the operation panel 40. The mode switching operation button 40a is an example of a "mode switching operator".

[0058] The controller 6 starts a control from the normal drift mode instead of the drift track mode when the drift control is started by the drift button 31c.

[0059] The controller 6 starts the drift track mode in a first driving state when the drift control is started by the drift button 31c and the normal drift mode is switched to

the drift track mode by the mode switching operation button 40a. The first driving state refers to the driving state of the marine propulsion system 102 in which the external forces F and the main propeller 10 are used as power sources to move the hull 101 toward the target point A1.

[0060] The thrust adjustment operation button 32 receives an operation to adjust the level of the thrust magnitude of the marine vessel 100 (the main propulsion device 1 and the auxiliary propulsion device 2). The thrust adjustment operation button 32 includes a plus button 32a to increase the level of the thrust magnitude and a minus button 32b to decrease the level of the thrust magnitude.

[0061] As an example, there are five levels including levels 1 to 5 to set the level of the thrust magnitude. At level 1, the thrust magnitude is the smallest, and the thrust magnitude gradually increases in the order of levels 2, 3, 4, and 5. When the drift control (normal drift mode) is started, the level of the thrust magnitude is automatically set to level 2, which is the second smallest from the bottom, at the time of start.

[0062] When the set level is level 2, 3, 4, or 5 in the drift track mode, the auxiliary propulsion device 2 rotates the hull 101, and the main propulsion devices 1 moves the hull 101 in the forward-rearward direction. When the set level is level 1 in the drift track mode, the auxiliary propulsion device 2 rotates and moves the hull 101 in the forward-rearward direction.

[0063] In the joystick mode, the marine vessel 100 moves in the tilting direction of the stick 3b while maintaining the orientation T1 of the bow 101a based on a tilting operation of the stick 3b by the user. In such a case, the orientations T1 of the bow 101a before and after the movement are parallel to each other. Predetermined calibration is performed in advance on the marine vessel 100 (controller 6) by a boat builder or the like such that the tilting direction of the stick 3b matches the actual moving direction of the hull 101.

[0064] In the joystick mode, the marine vessel 100 rotates in the twisting direction of the stick 3b based on a twisting operation of the stick 3b by the user.

[0065] In the joystick mode, the marine vessel 100 turns in the tilting and twisting directions of the stick 3b based on simultaneous tilting and twisting operations of the stick 3b by the user. The term "tum" indicates moving the hull 101 in the tilting direction of the stick 3b while gradually changing the orientation T1 of the bow 101a in the twisting direction of the stick 3b.

[0066] In the drift control, automatic marine vessel maneuvering is performed, and thus the stick 3b is not operated by the user.

[0067] As shown in FIG. 7, the display 4 includes a touch panel 4a. As an example, when the drift button 31c (see FIG. 6) is operated to start the drift control, the display 4 displays a simplified model D of the hull 101 and a surrounding map M around the hull 101 including an obstacle O around the hull 101.

[0068] The display 4 receives the setting of the target

orientation T2 based on a user's touch operation on the touch panel 4a in the drift control. Furthermore, the display 4 receives the setting of the target point A1 in the drift track mode of the drift control. The setting of the target orientation T2 and the target point A1 may be performed via another operator such as the operation panel 40 (see FIG. 1). The display 4 displays the target orientation T2 and the target point A1 set on the surrounding map M. The display 4 also displays the current orientation T1 of the marine vessel 100 on the surrounding map M.

[0069] The orientation sensor 5a shown in FIG. 1 measures the current orientation T1 of the marine vessel 100, which is the orientation (FWD) of the bow 101a of the marine vessel 100. The orientation sensor 5a is used to determine whether or not the current orientation T1 of the marine vessel 100 is deviated from the target orientation T2 in the drift control, for example. As an example, the orientation sensor 5a includes an electronic compass.

[0070] The position sensor 5b measures the current position A0 of the hull 101. The marine vessel 100 also acquires the current speed of the marine vessel 100 based on the time change of the current position A0 of the hull 101 measured by the position sensor 5b. As an example, the position sensor 5b includes a global positioning system (GPS) device.

[0071] The controller 6 is a control circuit, for example, and includes a central processing unit (CPU).

[0072] The controller 6 performs the drift control to move the hull 101 under the external forces F including wind and water flow while maintaining the orientation T1 of the bow 101a of the hull 101 at the target orientation T2 by rotating the hull 101. In the drift control, the controller 6 rotates the hull 101 to maintain the orientation T1 of the bow 101a at the target orientation T2 by driving the auxiliary propeller 20 while stopping the main propeller 10 that generates a thrust from the main propulsion device 1.

[0073] In the drift control, the controller 6 rotates the hull 101 by driving the auxiliary propeller 20 while stopping the main propeller 10 without rotating the main propulsion device 1 in the right-left direction.

[0074] In such a case, the main propulsion device 1 maintains the rudder angle of the main propeller 10 at a rudder angle along the centerline α of the hull 101 in the right-left direction while stopping the main propeller 10 when the hull 101 is rotated by driving the auxiliary propeller 20 in the drift control.

[0075] As described above, the controller 6 starts the drift track mode in the first driving state when the normal drift mode is switched to the drift track mode by the mode switching operation button 40a. In the drift track mode, the controller 6 switches the first driving state to a second driving state based on the thrust adjustment operation button 32 receiving an operation to change the level of the thrust magnitude to a predetermined level or less. The second driving state refers to the driving state of the marine propulsion system 102 in which the external forces

es F and the auxiliary propeller 20 are used as power sources to move the hull 101 toward the target point A1.

[0076] Specifically, in the drift track mode control, the controller 6 switches the first driving state in which the hull 101 is moved in the forward-rearward direction by driving the main propeller 10 while the auxiliary propeller 20 is stopped to the second driving state in which the hull 101 is moved in the forward-rearward direction by driving the auxiliary propeller 20 while the main propeller 10 is stopped based on the thrust adjustment operation button 32 receiving the operation to change the level of the thrust magnitude to the predetermined level or less (the operation to change level 2 to level 1). The controller 6 causes the auxiliary propeller 20 to generate a thrust to rotate the hull 101 in both the first driving state and the second driving state.

[0077] The normal drift mode of the drift control is now described with reference to FIG. 8. The controller 6 moves the hull 101 only by the external forces F including wind and water flow in the normal drift mode. When the orientation T1 of the bow 101a is deviated from the target orientation T2 at this time, the controller 6 corrects the misorientation by rotating the hull 101 by driving the auxiliary propeller 20 while stopping the main propeller 10.

[0078] The drift track mode of the drift control is now described with reference to FIG. 9. The controller 6 moves the hull 101 toward the target point A1 by the external forces F including wind and water flow that act on the hull 101 and the main propulsion device 1 in the drift track mode. The controller 6 rotates the hull 101 only with the auxiliary propulsion device 2 as in the normal drift mode. In the drift track mode, the hull 101 is moved toward the target point A1 specified by the user. One or more target points A1 may be specified. The drift track mode is used when the external forces F including wind and water flow that act on the hull 101 are not directed straight toward the target point A1, for example.

[0079] In the drift track mode, the controller 6 adjusts the thrust of the main propeller 10 to direct the resultant force of the external forces F including wind and water flow and the forward or rearward thrust of the main propeller 10 to the target point A1.

[0080] The marine propulsion system 102 automatically switches from the drift track mode to the normal drift mode when the hull 101 reaches the target point A1 and another target point A1 is not specified. That is, the marine propulsion system 102 switches to the normal drift mode and continues the drift control when the hull 101 reaches the final target point A1 in the drift track mode.

[0081] According to the various preferred embodiments described above, the following advantageous effects are achieved.

[0082] According to a preferred embodiment, the marine propulsion system 102 includes the controller 6 configured or programmed to perform a control to maintain the orientation T1 of the bow 101a at the target orientation T2 by rotating the hull 101 by driving the auxiliary propeller 20 operable to rotate in the right-left direction to

change the direction of the thrust while stopping the main propeller 10 operable to generate a thrust from the main propulsion device 1 in the drift control to move the hull 101 under the external forces F including wind and water flow while maintaining the orientation T1 of the bow 101a of the hull 101 at the target orientation T2 by rotating the hull 101. Accordingly, while the position of the hull 101 is maintained, the hull 101 is rotated by the auxiliary propulsion device 2 by rotating the auxiliary propulsion device 2 in the right-left direction. In other words, the rotation of the hull 101 changes the orientation of the hull 101 in a short period of time, unlike turning of the hull 101 accompanied by forward movement of the hull 101. Consequently, the orientation maintenance performance of the bow 101a in the drift control is improved. Furthermore, the auxiliary propulsion device 2 includes the electric motor 23 to drive the auxiliary propeller 20 to generate a thrust. Accordingly, the amount of carbon dioxide emitted from the auxiliary propulsion device 2 is reduced as compared with a case in which the auxiliary propulsion device 2 is an engine propulsion device. Thus, the orientation maintenance performance of the bow 101a in the drift control is improved while environmental burdens associated with driving of the propulsion devices are reduced as much as possible.

[0083] According to a preferred embodiment, the main propulsion device 1 is attached to the stern 101b of the hull 101 and is provided on the centerline α of the hull 101 in the right-left direction, and the auxiliary propulsion device 2 is attached to the stern 101b and is provided to one side of the centerline of the hull 101 in the right-left direction. Accordingly, the auxiliary propulsion device 2 is spaced farther apart from the center of gravity of the hull 101 as compared with the main propulsion device 1, and thus a relatively large rotational moment is generated by the auxiliary propulsion device 2 at the time of rotating the hull 101. Therefore, the hull 101 is more quickly rotated.

[0084] According to a preferred embodiment, the controller 6 is configured or programmed to rotate the hull 101 by driving the auxiliary propeller 20 while stopping the main propeller 10 without rotating the main propulsion device 1 in the right-left direction in the drift control. Accordingly, the main propulsion device 1 is not rotated in the right-left direction when the hull 101 is rotated, and thus the hull 101 is prevented from swinging due to rotation of the main propulsion device 1 in the right-left direction. Furthermore, noise generated from the main propulsion device 1 is reduced, and thus escape of fish during fishing, for example, is reduced or prevented.

[0085] According to a preferred embodiment, the main propulsion device 1 is operable to maintain the rudder angle of the main propeller 10 at the rudder angle along the centerline α of the hull 101 in the right-left direction while stopping the main propeller 10 when the hull 101 is rotated by driving the auxiliary propeller 20 in the drift control. Accordingly, when the hull 101 is rotated, the main propulsion device 1 is kept on standby at the rudder

angle along the centerline α of the hull 101 in the right-left direction, which corresponds to the rudder angle of the main propeller 10, and thus a thrust is immediately generated in the forward-rearward direction from the main propeller 10 without changing the rudder angle of the main propulsion device 1 after the rotation is completed in the drift track mode in which the hull 101 is moved toward the target point A1 using the external forces F and forward movement.

[0086] According to a preferred embodiment, the auxiliary propulsion device 2 has the right-left rotatable angle range $\theta 2$ to change the direction of the thrust larger than the right-left rotatable angle range of the main propulsion device 1. Accordingly, the hull 101 is rotated (pivoted) by the electric motor-driven (electric) auxiliary propulsion device 2 that has the right-left rotatable angle range $\theta 2$ to change the direction of the thrust larger than the right-left rotatable angle range of the main propulsion device 1 such that a change in the position of the hull 101 becomes smaller.

[0087] According to a preferred embodiment, the marine propulsion system 102 further includes the mode switching operation button 40a to receive an operation to switch between the normal drift mode in which the drift control is performed using only the external forces F as a power source to move the hull 101 directed to the target orientation T2 while the main propeller 10 of the main propulsion device 1 is stopped and the drift track mode in which the drift control is performed to move the hull 101 toward the target point A1 using the thrust of at least one of the main propeller 10 or the auxiliary propeller 20 in addition to the external forces F as the power source. Accordingly, the normal drift mode and the drift track mode are easily switched by the mode switching operation button 40a.

[0088] According to a preferred embodiment, the controller 6 is configured or programmed to start the drift track mode in either the first driving state in which the external forces F and the main propeller 10 are used as the power sources to move the hull 101 toward the target point A1 or the second driving state in which the external forces F and the auxiliary propeller 20 are used as the power sources to move the hull 101 toward the target point A1 when the normal drift mode is switched to the drift track mode by the mode switching operation button 40a. Accordingly, in the first driving state, the hull 101 is moved toward the target point A1 by the main propulsion device 1, which has the maximum output P10 larger than the maximum output of the auxiliary propulsion device 2, and thus the hull 101 is moved faster as compared with a case in which the hull 101 is moved toward the target point A1 by the auxiliary propulsion device 2. In the second driving state, the hull 101 is rotated and moved toward the target point A1 by the auxiliary propeller 20 driven by the electric motor 23, and thus quietness in the drift control is improved while environmental burdens are reduced.

[0089] According to a preferred embodiment, the ma-

rine propulsion system 102 further includes the thrust adjustment operation button 32 to receive an operation to adjust the levels of the thrust magnitudes of the main propulsion device 1 and the auxiliary propulsion device 2, and the controller 6 is configured or programmed to start the drift track mode in the first driving state when the normal drift mode is switched to the drift track mode by the mode switching operation button 40a, and to switch the first driving state to the second driving state based on the thrust adjustment operation button 32 receiving the operation to change the levels of the thrust magnitudes to the predetermined levels or less in the drift track mode. Accordingly, the first driving state is easily switched to the second driving state in response to an operation on the thrust adjustment operation button 32 to lower the thrust levels, and the hull 101 is moved toward the target point A1.

[0090] According to a preferred embodiment, the marine propulsion system 102 is operable to automatically switch from the drift track mode to the normal drift mode when the hull 101 reaches the target point A1 and another target point A1 is not specified. Accordingly, even when the hull 101 reaches the target point A1 and another target point A1 is not specified, the drift track mode is automatically switched to the normal drift mode, and thus the drift control is continued.

[0091] According to a preferred embodiment, the main propulsion device 1 is an engine outboard motor including the engine 12 to drive the main propeller 10 and provided on the centerline α of the hull 101 in the right-left direction, and the auxiliary propulsion device 2 is an electric outboard motor including the electric motor 23 to drive the auxiliary propeller 20 and provided to one side of the centerline of the hull 101 in the right-left direction. Accordingly, environmental burdens are reduced due to driving of the electric outboard motor, and the drift control is performed on the hull 101 including the engine outboard motor and the electric outboard motor.

[0092] The preferred embodiments described above are illustrative for present teaching but the present teaching also relates to modifications of the preferred embodiments.

[0093] For example, while the marine propulsion system preferably includes only one main propulsion device in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the marine propulsion system may alternatively include a plurality of main propulsion devices.

[0094] While the marine propulsion system preferably includes only one auxiliary propulsion device in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the marine propulsion system may alternatively include a plurality of auxiliary propulsion devices.

[0095] While the main thruster of the main propulsion device is preferably the main propeller in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the main thrust-

er of the main propulsion device may alternatively be a jet that generates a thrust by jetting water.

[0096] While the auxiliary thruster of the auxiliary propulsion device is preferably the auxiliary propeller in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the auxiliary thruster of the auxiliary propulsion device may alternatively be a jet that generates a thrust by jetting water.

[0097] While the main propulsion device is preferably provided on the centerline of the hull in the right-left direction in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the main propulsion device may alternatively be shifted from the centerline of the hull in the right-left direction.

[0098] While the main propulsion device preferably includes the engine as a drive source for the main propeller in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the main propulsion device may alternatively include an electric motor as a drive source for the main propeller.

[0099] While the main propulsion device and the auxiliary propulsion device are preferably outboard motors in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the main propulsion device and the auxiliary propulsion device may alternatively be inboard-outboard motors, for example.

Claims

1. A marine propulsion system (102) configured to be provided on or in a hull (101) of a marine vessel (100), the marine propulsion system (102) comprising:

a main propulsion device (1) configured to rotate in a right-left direction with regard to the hull (101) to change a direction of a thrust;

an auxiliary propulsion device (2) including an electric motor (23) configured to drive an auxiliary thruster (20) to generate a thrust, configured to rotate in the right-left direction to change a direction of the thrust with regard to the hull (101), and configured to have a maximum output (P20) smaller than a maximum output of the main propulsion device (1); and

a controller (6) configured or programmed to perform a drift control to move the hull (101) under external forces (F) including wind and water flow while maintaining an orientation (T1) of a bow (101a) of the hull (101) at a target orientation (T2) by rotating the hull (101); wherein the controller (6) is configured or programmed to maintain the orientation (T1) of the bow (101a) at the target orientation (T2) by rotating the hull (101) by driving the auxiliary thruster (20) while

stopping a main thruster (10) configured to generate the thrust from the main propulsion device (1) in the drift control.

2. The marine propulsion system (102) according to claim 1, wherein the main propulsion device (1) is configured to be attached to a stern (101b) of the hull (101) and is configured to be provided on a centerline (α) of the hull (101) in the right-left direction; and the auxiliary propulsion device (2) is configured to be attached to the stern (101b) and is configured to be provided to one side of the centerline (α) of the hull (101) in the right-left direction.
3. The marine propulsion system (102) according to claim 1 or 2, wherein the controller (6) is configured or programmed to rotate the hull (101) by driving the auxiliary thruster (20) while stopping the main thruster (10) without rotating the main propulsion device (1) in the right-left direction in the drift control.
4. The marine propulsion system (102) according to claim 3, wherein the main propulsion device (1) is configured to maintain a rudder angle of the main thruster (10) at a rudder angle along a centerline (α) of the hull (101) in the right-left direction while stopping the main thruster (10) when the hull (101) is rotated by driving the auxiliary thruster (20) in the drift control.
5. The marine propulsion system (102) according to any one of claims 1 to 4, wherein the auxiliary propulsion device (2) has a right-left rotatable angle range ($\theta 2$) configured to change the direction of the thrust larger than a right-left rotatable angle range of the main propulsion device (1).
6. The marine propulsion system (102) according to any one of claims 1 to 5, further comprising: a mode switching operator (40a) configured to receive an operation to switch between a normal drift mode in which the drift control is performed using only the external forces (F) as a power source to move the hull (101) directed to the target orientation (T2) while the main thruster (10) of the main propulsion device (1) is stopped and a drift track mode in which the drift control is performed to move the hull (101) toward a target point (A1) using the thrust of at least one of the main thruster (10) or the auxiliary thruster (20) in addition to the external forces (F) as the power source.
7. The marine propulsion system (102) according to claim 6, wherein the controller (6) is configured or programmed to start the drift track mode in either a first driving state in which the external forces (F) and the main thruster (10) are used as the power source

to move the hull (101) toward the target point (A1) or a second driving state in which the external forces (F) and the auxiliary thruster (20) are used as the power source to move the hull (101) toward the target point (A1) when the normal drift mode is switched to the drift track mode by the mode switching operator (40a).

8. The marine propulsion system (102) according to claim 7, further comprising:

a thrust adjustment operator (32) configured to receive an operation to adjust levels of thrust magnitudes of the main propulsion device (1) and the auxiliary propulsion device (2); wherein the controller (6) is configured or programmed to:

start the drift track mode in the first driving state when the normal drift mode is switched to the drift track mode by the mode switching operator (40a); and
switch the first driving state to the second driving state based on the thrust adjustment operator (32) receiving an operation to change the levels of the thrust magnitudes to predetermined levels or less in the drift track mode.

9. The marine propulsion system (102) according to any one of claims 6 to 8, configured to automatically switch from the drift track mode to the normal drift mode when the hull (101) reaches the target point (A1) and another target point (A1) is not specified.

10. The marine propulsion system (102) according to any one of claims 1 to 9, wherein the main propulsion device (1) is an engine outboard motor including an engine (12) configured to drive a main propeller corresponding to the main thruster (10) and configured to be provided on a centerline (α) of the hull (101) in the right-left direction; and
the auxiliary propulsion device (2) is an electric outboard motor including the electric motor (23) configured to drive an auxiliary propeller corresponding to the auxiliary thruster (20) and configured to be provided to one side of the centerline (α) of the hull (101) in the right-left direction.

11. A marine vessel (100) that includes a hull (101) and a marine propulsion system (102) according to at least one of claims 1 to 10.

12. A method for controlling a marine propulsion system (102) provided on or in a hull (101) of a marine vessel (100) with a main propulsion device (1) configured to rotate in a right-left direction with regard to the hull (101) to change a direction of a thrust, and an aux-

iliary propulsion device (2) including an electric motor (23) configured to drive an auxiliary thruster (20) to generate a thrust, configured to rotate in the right-left direction to change a direction of the thrust with regard to the hull (101), and configured to have a maximum output (P20) smaller than a maximum output of the main propulsion device (1); the method comprising:

performing a drift control to move the hull (101) under external forces (F) including wind and water flow while maintaining an orientation (T1) of a bow (101a) of the hull (101) at a target orientation (T2) by rotating the hull (101), and maintaining the orientation (T1) of the bow (101a) at the target orientation (T2) by rotating the hull (101) by driving the auxiliary thruster (20) while stopping a main thruster (10) configured to generate the thrust from the main propulsion device (1) in the drift control.

FIG. 1

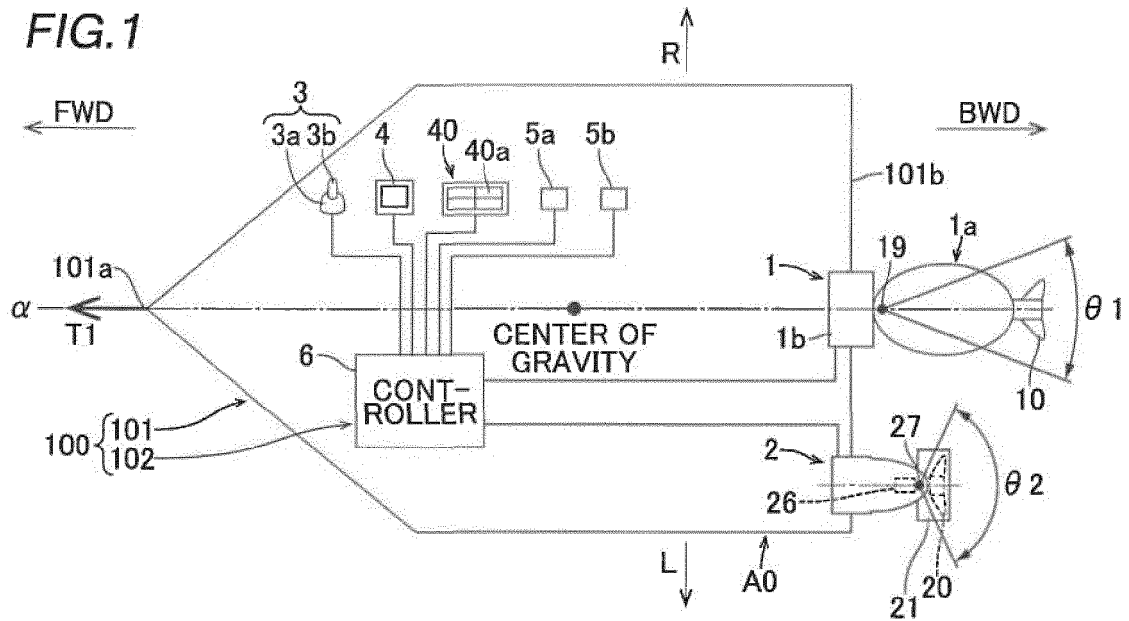


FIG. 2

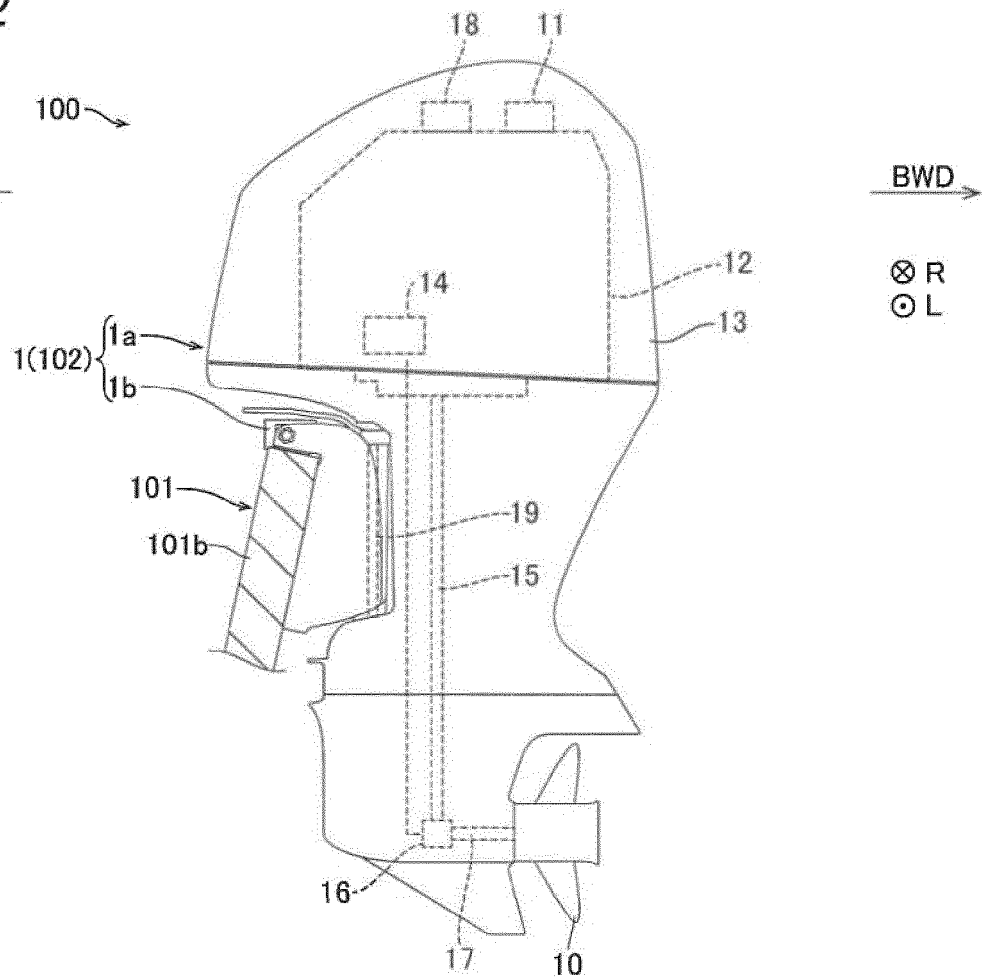


FIG.3

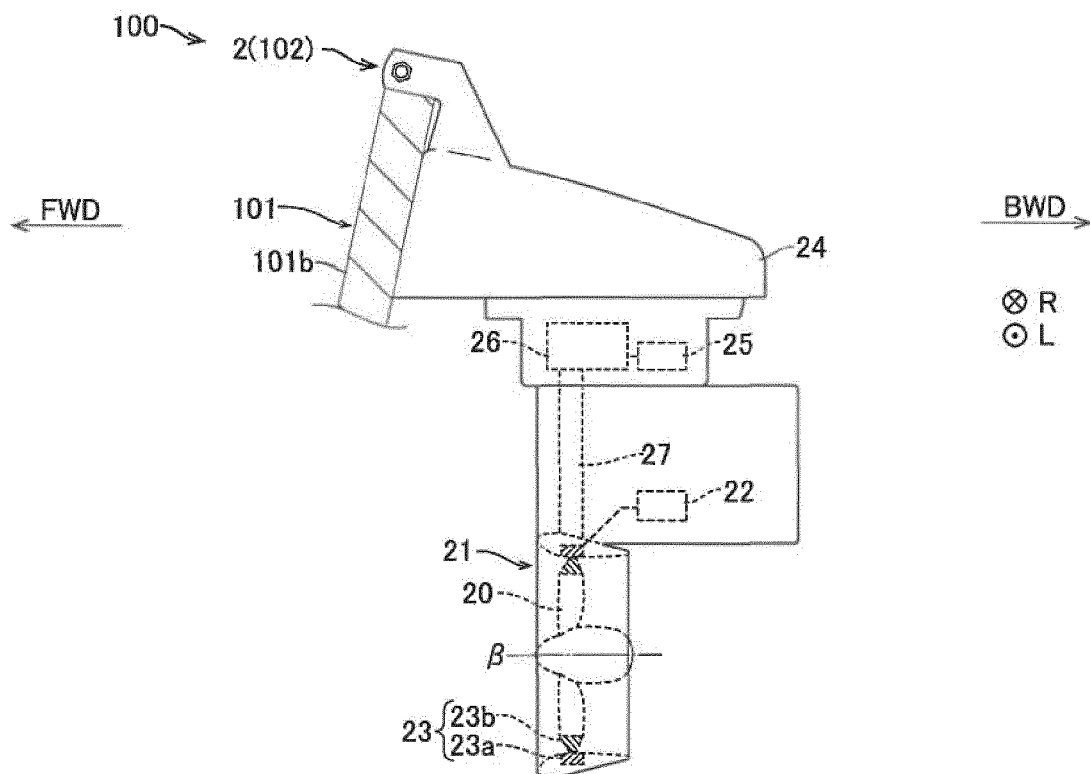


FIG.4

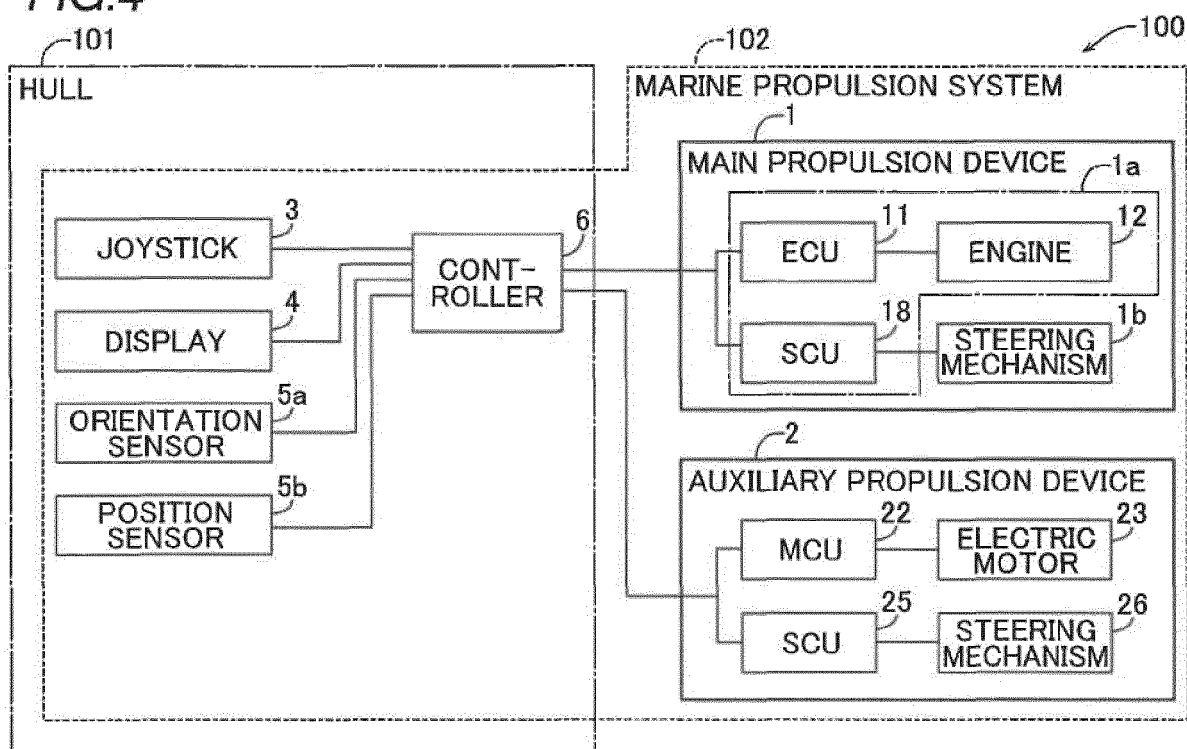


FIG.5

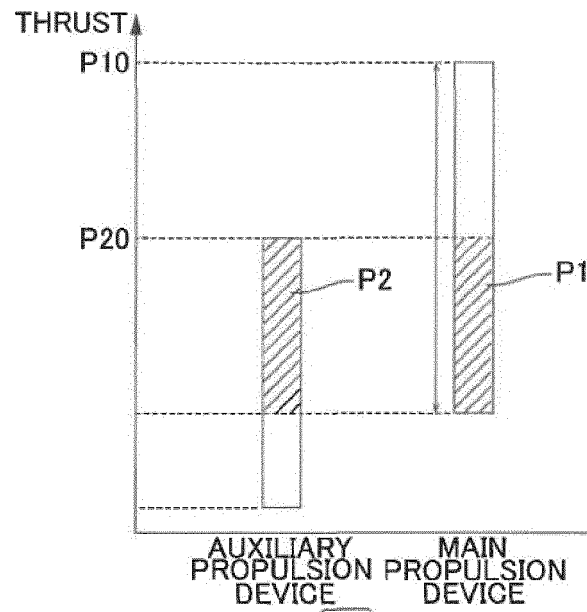


FIG.6

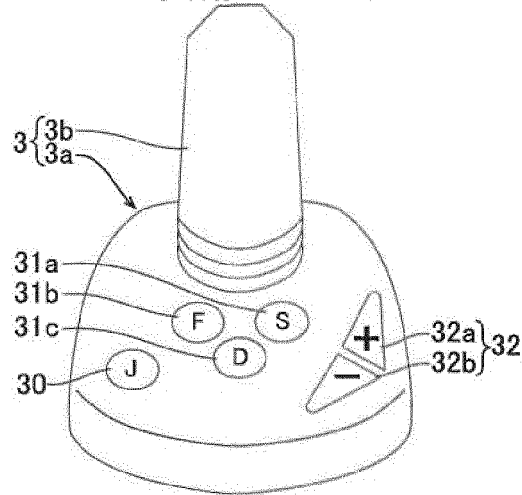


FIG.7

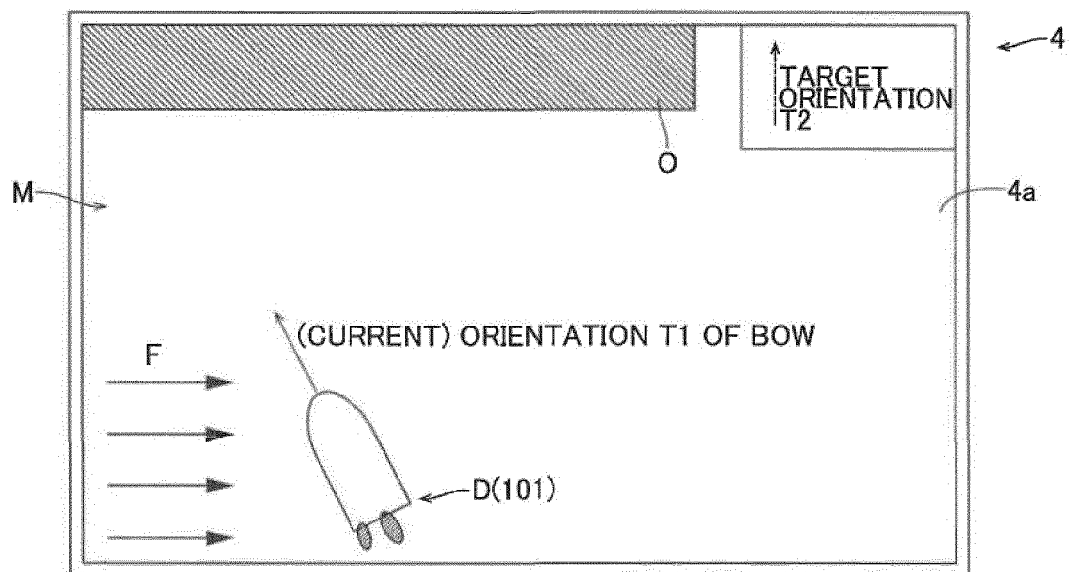


FIG.8

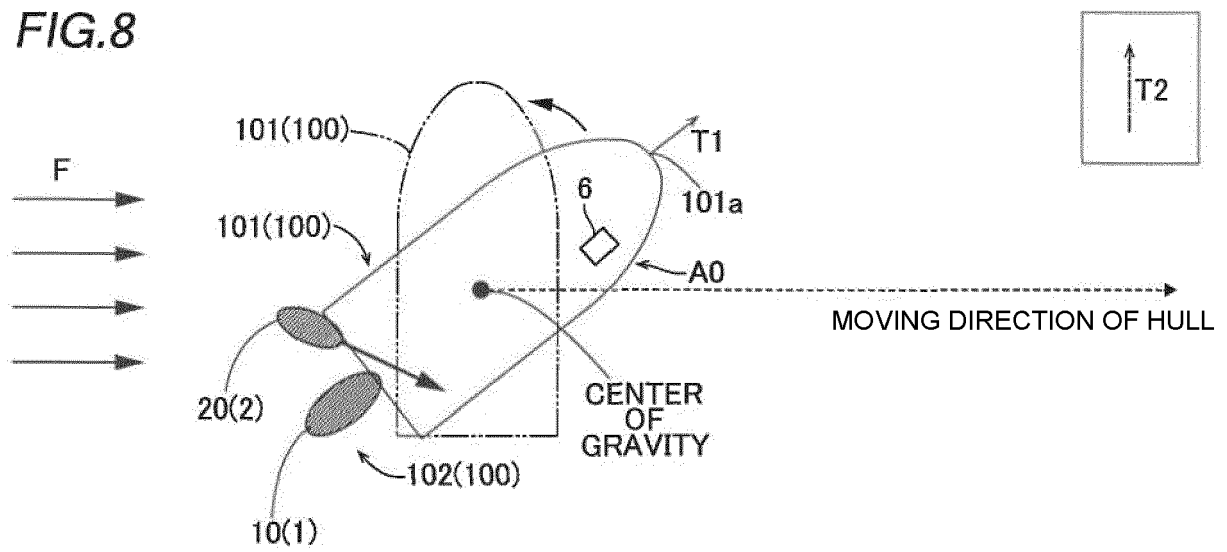
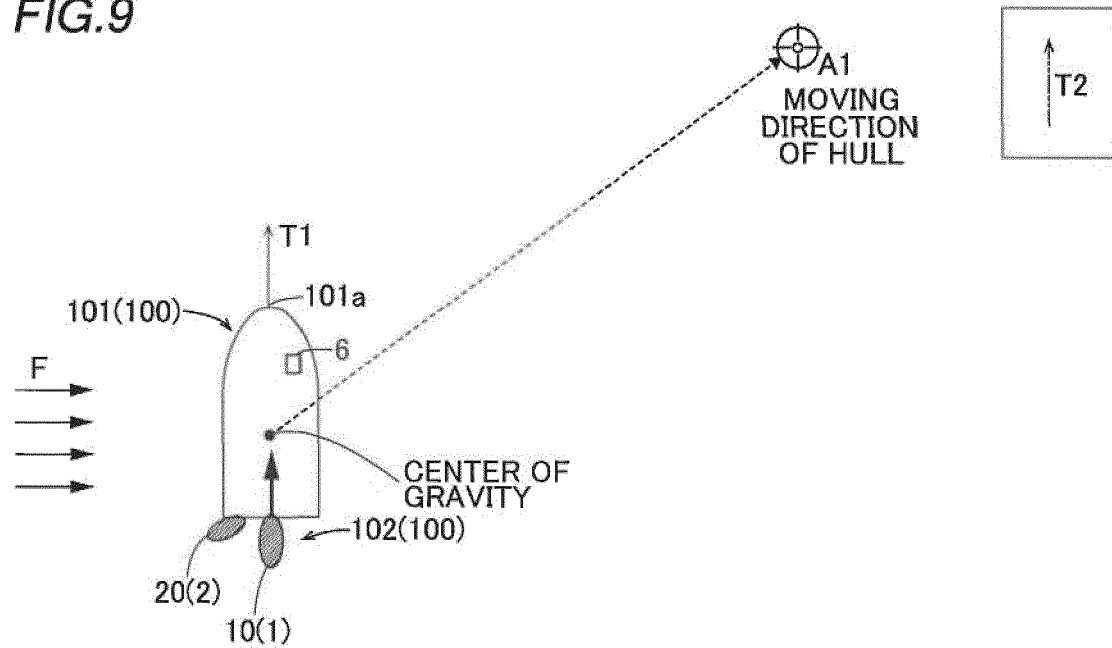


FIG.9





EUROPEAN SEARCH REPORT

Application Number

EP 22 20 3444

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			B63H
The present search report has been drawn up for all claims			

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Place of search

The Hague

Date of completion of the search

29 March 2023

Examiner

Hutter, Manfred

CATEGORY OF CITED DOCUMENTS

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