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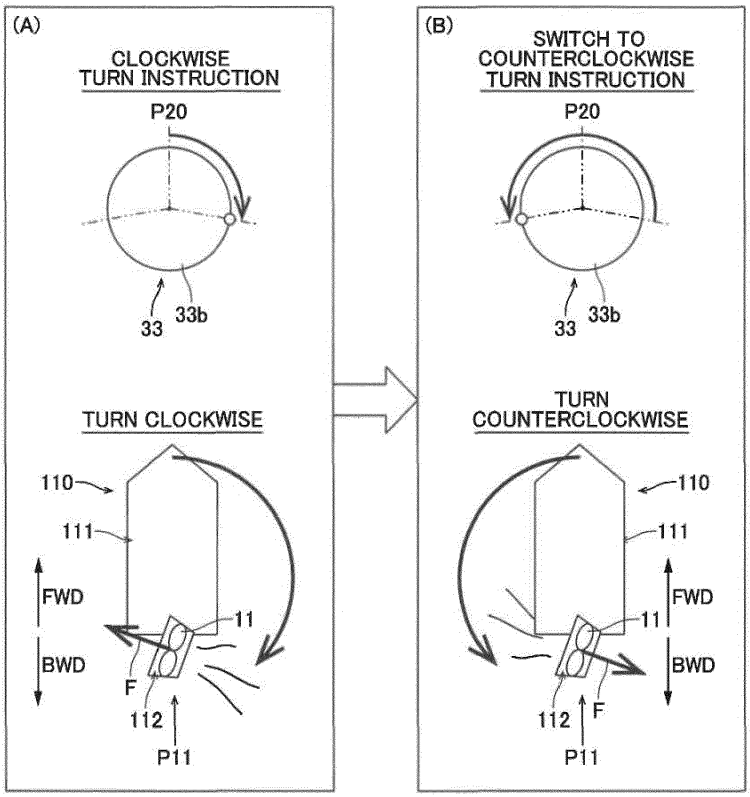
(54) **MARINE VESSEL MANEUVERING SYSTEM**

(57) A marine vessel maneuvering system (100) includes a controller (41, 42) configured or programmed to perform a propulsion reverse direction control to change a direction of a propulsive force (F) of a propulsion generator (10) to a reverse direction when a user operates an operator (30) to turn a marine vessel (110) either counterclockwise or clockwise with the marine vessel (110) turned either clockwise or counterclockwise.

FIG.7



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Description

[0001] The present invention relates to a marine vessel maneuvering system, a marine vessel with a marine vessel maneuvering system and a marine vessel maneuvering method. In particularly, it relates to a marine vessel maneuvering system that turns a marine vessel based on a user's operation on an operator.

[0002] A marine vessel that is turned based on a user's operation on an operator is known in general. Such a marine vessel is disclosed in JP 2011-140272 A, for example.

[0003] JP 2011-140272 A discloses a marine vessel including a joystick (operator) to maneuver the marine vessel, and a hull electronic control unit (ECU) to control generation of a propulsive force by a propulsion generator and steering by a steering mechanism based on a user's operation on the joystick. In the marine vessel described in JP 2011-140272 A, when the joystick is rotated clockwise from a neutral position, the hull ECU controls the steering mechanism and the propulsion generator to steer the propulsion generator in a portside direction from a reference position (a position at which the direction of the propulsive force of the propulsion generator is parallel to the forward-rearward direction of the marine vessel) by a predetermined steering angle and generate a propulsive force. Thus, the marine vessel is turned clockwise. Similarly, when the joystick is rotated counterclockwise from the neutral position, the hull ECU controls the steering mechanism and the propulsion generator to steer the propulsion generator in a starboard direction from the reference position by a predetermined steering angle and generate a propulsive force. Thus, the marine vessel is turned counterclockwise.

[0004] However, in the marine vessel described in JP 2011-140272 A, when an operation is performed to turn the marine vessel counterclockwise (i.e., when the joystick is rotated counterclockwise from the neutral position) with the marine vessel turned clockwise (i.e., with the joystick rotated clockwise from the neutral position), it is necessary to steer the propulsion generator from a portside rotation position to a starboard rotation position with respect to the reference position after temporarily stopping generation of the propulsive force by the propulsion generator, and then generate a propulsive force by the propulsion generator again. The same applies when an operation is performed to turn the marine vessel clockwise with the marine vessel turned counterclockwise. That is, in the marine vessel described in JP 2011-140272 A, when the turning direction of the marine vessel is reversed, it takes time (a few seconds, for example) for the propulsion generator to be steered from one of the starboard and portside rotation positions to the other with respect to the reference position. Therefore, it is desired to decrease the length of time between performing an operation to reverse the turning direction of the marine vessel and completing reversal of the turning direction of the marine vessel.

[0005] It is an object of the present invention to provide a marine vessel maneuvering system and a marine vessel that each decrease the length of time between performing an operation to reverse the turning direction of the marine vessel and completing reversal of the turning direction of the marine vessel. According to the present invention, said object is solved by a marine vessel maneuvering system having the features of independent claim 1. Preferred embodiments are laid down in the dependent claims.

[0006] A marine vessel maneuvering system according to a preferred embodiment includes an operator to maneuver a marine vessel including a propulsion generator and a steering mechanism, and a controller configured or programmed to control a propulsive force of the propulsion generator and steering by the steering mechanism based on a user's operation on the operator, and the controller is configured or programmed to perform a propulsion reverse direction control to change a direction of the propulsive force of the propulsion generator to a reverse direction when a user operates the operator to turn the marine vessel either counterclockwise or clockwise with the marine vessel turned either clockwise or counterclockwise.

[0007] In a marine vessel maneuvering system according to a preferred embodiment, the controller is configured or programmed to perform the propulsion reverse direction control to change the direction of propulsive force of the propulsion generator to the reverse direction when the user operates the operator to turn the marine vessel either counterclockwise or clockwise with the marine vessel turned either clockwise or counterclockwise. Accordingly, while the marine vessel is turned clockwise or counterclockwise, the direction of the propulsive force of the propulsion generator is changed to the reverse direction such that the turning direction of the marine vessel is reversed without steering the propulsion generator from one of a portside rotation position (first rotation position) or a starboard rotation position (second rotation position) to the other with respect to the reference position. That is, when the turning direction of the marine vessel is reversed, the time (several seconds, for example) required to steer the propulsion generator from one of the portside rotation position (first rotation position) or the starboard rotation position (second rotation position) to the other with respect to the reference position is eliminated. Consequently, the steering is not required, and thus the length of time between performing an operation to reverse the turning direction of the marine vessel and completing reversal of the turning direction of the marine vessel is decreased.

[0008] In a marine vessel maneuvering system according to a preferred embodiment, the controller is preferably configured or programmed to perform the propulsion reverse direction control while a steering angle by the steering mechanism is maintained when the user operates the operator to turn the marine vessel either counterclockwise or clockwise with the marine vessel turned ei-

ther clockwise or counterclockwise. Accordingly, the propulsion reverse direction control is performed while the steering angle by the steering mechanism is maintained such that as compared with a case in which the propulsion reverse direction control is performed with the steering angle by the steering mechanism changed, a complex control of the propulsive force of the propulsion generator is significantly reduced or prevented after the direction of the propulsive force of the propulsion generator is changed to the reverse direction.

[0009] In a marine vessel maneuvering system according to a preferred embodiment, the operator preferably includes a joystick that is rotated clockwise from a neutral position to turn the marine vessel clockwise and is rotated counterclockwise from the neutral position to turn the marine vessel counterclockwise, and the controller is preferably configured or programmed to perform the propulsion reverse direction control when the user rotates the joystick either counterclockwise or clockwise with the joystick rotated either clockwise or counterclockwise and the marine vessel turned either clockwise or counterclockwise. Accordingly, the direction of operation (direction of rotation) on the joystick is the same as the turning direction of the marine vessel, and thus the joystick (operator) is operated to reverse the turning direction of the marine vessel in an intuitively easy-to-understand state.

[0010] In such a case, the controller is preferably configured or programmed to control the steering mechanism such that the propulsion generator is returned to a reference position from either a portside rotation position (first rotation position) or a starboard rotation position (second rotation position) by the steering mechanism when the joystick is rotated either clockwise or counterclockwise and is returned to the neutral position, and to perform the propulsion reverse direction control with the propulsion generator returned to either the portside rotation position or the starboard rotation position by the steering mechanism when the joystick is rotated either counterclockwise or clockwise before the propulsion generator is returned to the reference position by the steering mechanism. Accordingly, a control (propulsion reverse direction control) performed when the joystick changes from a state of being rotated either clockwise and counterclockwise to a state of being rotated either counterclockwise or clockwise (i.e., when the joystick is operated to reverse the turning direction of the marine vessel) is distinguished from a control performed when the joystick returns to the neutral position from a state of being rotated either clockwise or counterclockwise (i.e., when the joystick is operated to stop the marine vessel). At the reference position, the direction of the propulsive force of the propulsion generator is parallel to the forward-rearward direction of the marine vessel.

[0011] In a marine vessel maneuvering system including the controller configured or programmed to perform the propulsion reverse direction control with the propulsion generator returned to either the portside rotation position or the starboard rotation position by the steering mechanism when the joystick is rotated either counterclockwise or clockwise before the propulsion generator is returned to the reference position by the steering mechanism, the controller is preferably configured or programmed to perform the propulsion reverse direction control when the joystick is switched from a state of being rotated either clockwise or counterclockwise to a state of being rotated either counterclockwise or clockwise in a time shorter than a predetermined first length of time. Accordingly, a case in which the joystick changes from a state of being rotated either clockwise or counterclockwise to a state of being rotated either counterclockwise or clockwise (i.e., the joystick is operated to reverse the turning direction of the marine vessel) is easily distinguished from a case in which the joystick returns to the neutral position from a state of being rotated either clockwise or counterclockwise (i.e., the joystick is operated to stop the marine vessel). Consequently, a control to stop the marine vessel is prevented from being performed when the joystick is operated to reverse the turning direction of the marine vessel, and a control to reverse the turning direction of the marine vessel is prevented from being performed when the joystick is operated to stop the marine vessel.

[0012] In a marine vessel maneuvering system including the controller configured or programmed to perform the propulsion reverse direction control with the propulsion generator returned to either the portside rotation position or the starboard rotation position by the steering mechanism when the joystick is rotated either counterclockwise or clockwise before the propulsion generator is returned to the reference position by the steering mechanism, the controller is preferably configured or programmed to perform the propulsion reverse direction control when a length of time during which the joystick is located at the neutral position while the joystick is switched from a state of being rotated either clockwise or counterclockwise to a state of being rotated either counterclockwise or clockwise is shorter than a predetermined second length of time. Accordingly, a case in which the joystick changes from a state of being rotated either clockwise or counterclockwise to a state of being rotated either counterclockwise or clockwise (i.e., the joystick is operated to reverse the turning direction of the marine vessel) is easily distinguished from a case in which the joystick returns to the neutral position from a state of being rotated either clockwise or counterclockwise (i.e., the joystick is operated to stop the marine vessel). Consequently, a control to stop the marine vessel is prevented from being performed when the joystick is operated to reverse the turning direction of the marine vessel, and a control to reverse the turning direction of the marine vessel is prevented from being performed when the joystick is operated to stop the marine vessel.

[0013] In a marine vessel maneuvering system according to a preferred embodiment, the controller is preferably configured or programmed to perform the propulsion reverse direction control while adjusting the propulsive

force of the propulsion generator such that a magnitude of the propulsive force of the propulsion generator with respect to a magnitude of an amount of operation on the operator to turn the marine vessel clockwise becomes same as a magnitude of the propulsive force of the propulsion generator with respect to a magnitude of an amount of operation on the operator to turn the marine vessel counterclockwise when the user operates the operator to turn the marine vessel either counterclockwise or clockwise with the marine vessel turned either clockwise or counterclockwise. Accordingly, even when the magnitude of the propulsive force of the propulsion generator with respect to the magnitude of the amount of operation on the operator differs depending on a direction in which the propulsive force is generated, the propulsive force is adjusted such that the magnitude of the propulsive force of the propulsion generator with respect to the magnitude of the amount of operation on the operator does not differ, and the turning direction of the marine vessel is reversed. In general, in order to make the magnitude of the propulsive force of the propulsion generator 10 to move the marine vessel forward different from the magnitude of the propulsive force of the propulsion generator to move the marine vessel rearward, the magnitude of the forward propulsive force generated in the propulsion generator is different from the magnitude of the rearward propulsive force generated in the propulsion generator even when the magnitude of the amount of operation on the operator is the same.

[0014] In such a case, the operator preferably includes a joystick that is rotated clockwise from a neutral position to turn the marine vessel clockwise and is rotated counterclockwise from the neutral position to turn the marine vessel counterclockwise, and the controller is preferably configured or programmed to control a magnitude of the propulsive force of the propulsion generator to turn the marine vessel according to a magnitude of an amount of rotation of the joystick, and to perform the propulsion reverse direction control while adjusting the propulsive force of the propulsion generator such that a magnitude of the propulsive force of the propulsion generator with respect to a magnitude of an amount of clockwise rotation of the joystick becomes same as a magnitude of the propulsive force of the propulsion generator with respect to a magnitude of an amount of counterclockwise rotation of the joystick when the user operates the joystick to turn the marine vessel either counterclockwise or clockwise with the joystick rotated either clockwise or counterclockwise and the marine vessel turned either clockwise or counterclockwise. Accordingly, the direction of operation (direction of rotation) on the joystick is the same as the turning direction of the marine vessel, and thus the joystick (operator) is operated to reverse the turning direction of the marine vessel in an intuitively easy-to-understand state. Furthermore, even when the magnitude of the propulsive force of the propulsion generator with respect to the magnitude of rotation of the joystick (operator) differs depending on the direction in which the propulsive force is generated, the propulsive force is adjusted such that the magnitude of the propulsive force of the propulsion generator with respect to the magnitude of rotation of the joystick (operator) does not differ, and the turning direction of the marine vessel is reversed.

[0015] In a marine vessel maneuvering system according to a preferred embodiment, the controller is preferably configured or programmed to perform the propulsion reverse direction control on the propulsion generator corresponding to an electric propulsion device driven by a motor. Accordingly, in the electrically driven marine vessel, the length of time between performing an operation to reverse the turning direction of the marine vessel and completing reversal of the turning direction of the marine vessel is decreased. Furthermore, unlike an engine, the motor does not directly emit CO_2, and thus a preferable device structure is obtained from the viewpoint of SDGs.

[0016] In a marine vessel maneuvering system according to a preferred embodiment, a steering angle by the steering mechanism is preferably 60 degrees or more and 80 degrees or less when the operator is operated to turn the marine vessel clockwise or counterclockwise. Accordingly, the steering angle by the steering mechanism is 60 degrees or more and 80 degrees or less, and thus the turning radius of the marine vessel is relatively small when the marine vessel is turned. For the present teaching it has been confirmed by experiments that when the marine vessel is turned, the turning radius of the marine vessel becomes relatively small when the steering angle by the steering mechanism is 60 degrees or more and 80 degrees or less.

[0017] In a marine vessel maneuvering system according to a preferred embodiment, the controller is preferably configured or programmed to perform the propulsion reverse direction control on the propulsion generator provided in one outboard motor, which is attached to a hull of the marine vessel, based on a user's operation on the operator. Accordingly, in the marine vessel (an outboard motor boat including one outboard motor) including the hull to which one outboard motor is attached, the length of time between performing an operation to reverse the turning direction of the marine vessel and completing reversal of the turning direction of the marine vessel is decreased.

[0018] In a marine vessel maneuvering system according to a preferred embodiment, the controller is preferably configured or programmed to perform the propulsion reverse direction control again when the user operates the operator to turn the marine vessel either clockwise or counterclockwise with the direction of the propulsive force of the propulsion generator changed to the reverse direction. Accordingly, even when an operation is performed again to reverse the turning direction of the marine vessel, the turning direction of the marine vessel is reversed again while the length of time between performing an operation to reverse the turning direction of the marine vessel and completing reversal of the turning direction of the marine vessel is decreased.

[0019] 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

[0020]

FIG. 1 is a schematic view showing a marine vessel according to a preferred embodiment.
FIG. 2 is a perspective view showing a marine propulsion unit according to a preferred embodiment.
FIG. 3 is a block diagram showing the structure of a marine vessel maneuvering system according to a preferred embodiment.
FIG. 4 is a schematic view showing the structure of a steering mechanism of a marine propulsion unit according to a preferred embodiment.
FIG. 5 is a perspective view showing a joystick to maneuver a marine vessel according to a preferred embodiment.
FIG. 6 is a first diagram illustrating the state of a joystick and the state of a marine propulsion unit when a marine vessel according to a preferred embodiment is turned.
FIG. 7 is a second diagram illustrating the state of a joystick and the state of a marine propulsion unit when a marine vessel according to a preferred embodiment is turned.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] Preferred embodiments are hereinafter described with reference to the drawings.

[0022] The structure of a marine vessel maneuvering system 100 and the structure of a marine vessel 110 according to preferred embodiments are now described with reference to FIGS. 1 to 7. The marine vessel maneuvering system 100 is a system to maneuver the marine vessel 110. The marine vessel maneuvering system 100 is provided in the marine vessel 110. Arrow FWD and arrow BWD in the figures represent the front side and the rear side of the marine vessel 110, respectively.

[0023] As shown in FIG. 1, the marine vessel 110 (marine vessel maneuvering system 100 (see FIG. 3)) includes a hull 111 and an outboard motor 112. The outboard motor 112 is attached to a rear portion of the hull 111. Furthermore, only one outboard motor 112 is attached to the hull 111 in the marine vessel 110. That is, the marine vessel 110 is an outboard motor boat including one outboard motor. The marine vessel 110 is a relatively small marine vessel. The marine vessel 110 is used for sightseeing in a canal and a lake, for example. The outboard motor 112 is an example of a "marine propulsion unit".

[0024] As shown in FIG. 2A, the outboard motor 112 includes a propulsion generator 10 to generate a propulsive force F (see FIG. 1) in order to propel the marine vessel 110 (see FIG. 1), and a steering mechanism 20 to steer the propulsion generator 10. The expression "steer the propulsion generator 10" refers to changing the direction of the propulsion generator 10 in the outboard motor 112 (and thus in the marine vessel 110).

[0025] The propulsion generator 10 includes a propeller 11. As shown in FIG. 3, the propulsion generator 10 includes a motor 12. The propeller 11 (see FIG. 2A) rotates as the motor 12 rotates such that the propulsion generator 10 generates the propulsive force F (see FIG. 1). That is, the propulsion generator 10 is an electric propulsion device driven by the motor 12. When the propeller 11 rotates in a forward direction, the direction of the propulsive force F is forward in the propulsion generator 10. When the propeller 11 rotates in a reverse direction, the direction of the propulsive force F is rearward in the propulsion generator 10.

[0026] As shown in FIG. 4, the steering mechanism 20 includes a motor 21, a steering shaft 22 fixed to the propulsion generator 10 (see FIG. 2A), and a plurality of gears 23 to transmit the rotational force of the motor 21 to the steering shaft 22. The steering shaft 22 is a shaft-shaped member. The motor 21 is a DC motor with a brush, for example. The plurality of gears 23 include a spur gear 23a, a spur gear 23b, a spur gear 23c, a spur gear 23d, a worm gear 23e, and a worm wheel 23f, for example.

[0027] The spur gear 23a is fixed to a rotation shaft of the motor 21 to rotate coaxially with the rotation shaft of the motor 21. The spur gear 23b meshes with the spur gear 23a. The spur gear 23c is fixed to the spur gear 23b to rotate coaxially with the spur gear 23b. The spur gear 23d meshes with the spur gear 23c. The worm gear 23e is fixed to the spur gear 23d to rotate together with the spur gear 23d. The worm wheel 23f meshes with the worm gear 23e. The worm wheel 23f is fixed to the steering shaft 22 to rotate coaxially with the steering shaft 22 about a steering center axis A1.

[0028] The steering mechanism 20 rotates the steering shaft 22 due to rotation of the motor 21 to steer the propulsion generator 10 (see FIG. 2A). In the steering mechanism 20, the rotation of the motor 21 is decelerated by the plurality of gears 23 (at a reduction ratio of about 1/400, for example) and transmitted to the steering shaft 22.

[0029] Thus, as shown in FIG. 2B, the steering mechanism 20 steers the propulsion generator 10 in a portside direction from a reference position P10 (a state in FIG. 2A) (rotates the propulsion generator 10 counterclockwise). As shown in FIG. 2C, the steering mechanism 20 steers the propulsion generator 10 in a starboard direction from the reference position P10 (rotates the propulsion generator 10 clockwise). As shown in FIG. 1, at the reference position P10, the direction of the propulsive force F of the propulsion generator 10 is parallel to the

forward-rearward direction of the marine vessel 110.

[0030] Thus, the direction of the propulsive force F of the propulsion generator 10 is changed to a desired direction with respect to the hull 111 (see FIG. 1) (within a predetermined angular range in which the propulsion generator 10 is steerable). In FIG. 1, a state in which the propulsion generator 10 is located at the reference position P10 and a state in which the propulsion generator 10 is steered in the portside direction from the reference position P10 by a steering angle θ and the direction of the propulsive force F is forward in the propulsion generator 10 are shown by a broken line and a solid line, respectively.

[0031] As shown in FIG. 3, the hull 111 includes an operator 30 to maneuver the marine vessel 110 (see FIG. 1). The operator 30 receives a user's (a user of the marine vessel 110) operation. The operator 30 includes a remote control 31, a steering wheel 32, and a joystick 33. The joystick 33 is an example of an "operator".

[0032] The remote control 31 includes a lever, and when the lever is operated, the magnitude of the propulsive force F (see FIG. 1) of the propulsion generator 10 (the rotation speed of the propeller 11 (see FIG. 1)) and the direction of the propulsive force F in the propulsion generator 10 (the rotational direction of the propeller 11) are adjusted.

[0033] The steering wheel 32 is rotatable, and the steering wheel 32 is rotated such that steering of the propulsion generator 10 by the steering mechanism 20 (the direction of the propulsion generator 10) is adjusted. Thus, an operation on the remote control 31 and an operation on the steering wheel 32 are combined such that the marine vessel 110 (see FIG. 1) is translated (moved forward, rearward, transversely, and obliquely while the direction of the hull 111 (see Figure 1) is maintained) or turned, for example.

[0034] As shown in FIG. 5, the joystick 33 includes a base 33a and a lever 33b. The lever 33b is attached to the base 33a so as to be tiltable and rotatable. The lever 33b is urged by an urging member such as a spring to automatically return to a neutral position P20 when not operated by the user. At the neutral position P20, the lever 33b is upright and is not rotated.

[0035] Operations on the joystick 33 are roughly divided into three operations: an operation to tilt the lever 33b, an operation to tilt and rotate the lever 33b, and an operation to rotate the lever 33b.

[0036] The operation to tilt the lever 33b corresponds to an operation to translate the marine vessel 110 (see FIG. 1). That is, when the lever 33b is tilted, the magnitude of the propulsive force F (see FIG. 1) of the propulsion generator 10 (see FIG. 2) (the rotation speed of the propeller 11 (see FIG. 1)) is adjusted according to the amount of tilting of the lever 33b, and the direction of the propulsive force F in the propulsion generator 10 (the rotational direction of the propeller 11) and the steering of the propulsion generator 10 by the steering mechanism 20 (see FIG. 2) (the direction of the propulsion generator 10) are adjusted according to the tilting direction of the lever 33b.

[0037] The operation to tilt and rotate the lever 33b corresponds to an operation to rotate the marine vessel 110 (see FIG. 1). That is, when the lever 33b is tilted and rotated, the magnitude of the propulsive force F (see FIG. 1) of the propulsion generator 10 (see FIG. 2) (the rotation speed of the propeller 11 (see FIG. 1)) is adjusted according to the amount of tilting of the lever 33b such that the marine vessel 110 is rotated, and the direction of the propulsive force F in the propulsion generator 10 (the rotational direction of the propeller 11) and the steering of the propulsion generator 10 by the steering mechanism 20 (see FIG. 2) (the direction of the propulsion generator 10) are adjusted according to the tilting direction, the rotational direction, and the amount of rotation of the lever 33b.

[0038] The operation to rotate the lever 33b corresponds to an operation to turn the marine vessel 110 (see FIG. 1) (change the direction of the hull 111 (see FIG. 1) on the spot). That is, when the lever 33b is rotated, the magnitude of the propulsive force F (see FIG. 1) of the propulsion generator 10 (see FIG. 2) (the rotation speed of the propeller 11 (see FIG. 1)) is adjusted according to the amount of rotation of the lever 33b such that the marine vessel 110 is rotated, and the steering of the propulsion generator 10 by the steering mechanism 20 (see FIG. 2) (the direction of the propulsion generator 10) is adjusted according to the rotational direction of the lever 33b.

[0039] According to preferred embodiments, when the joystick 33 is operated to turn the marine vessel 110 (see FIG. 1) clockwise or counterclockwise, the steering angle θ (see FIG. 1) by the steering mechanism 20 (see FIG. 2) is about 60 degrees or more and about 80 degrees or less. Specifically, when the lever 33b is rotated, the steering mechanism 20 steers the propulsion generator 10 at a predetermined steering angle θ regardless of the amount of rotation of the lever 33b. The predetermined steering angle θ is uniquely (for example, 70 degrees) set in advance from a range of about 60 degrees or more and about 80 degrees or less. Turning of the marine vessel 110 is described below in detail.

[0040] As shown in FIG. 3, the marine vessel maneuvering system 100 includes a first controller 41, a second controller 42, and a control switch 43. The first controller 41, the second controller 42, and the control switch 43 include circuit boards including a central processing unit (CPU), a read-only memory (ROM), a random access memory (RAM), etc., for example. The second controller 42 is an example of a "controller".

[0041] The first controller 41 controls the propulsive force F (see FIG. 1) of the propulsion generator 10 and steering by the steering mechanism 20 based on user's operations on the remote control 31 and the steering wheel 32. The second controller 42 controls the propulsive force F of the propulsion generator 10 and steering by the steering mechanism 20 based on a user's opera-

tion on the joystick 33.

[0042] The first controller 41 and the second controller 42 perform a feedback control on the propulsive force F (see FIG. 1) of the propulsion generator 10 and steering by the steering mechanism 20 by a PI control. Specifically, the propulsion generator 10 includes a propulsion controller 13 and a rotation speed sensor 14. The propulsion controller 13 includes a motor driver and an inverter, for example. The rotation speed sensor 14 detects the rotation speed of the motor 12. The first controller 41 and the second controller 42 control the rotation speed of the motor 12 via the propulsion controller 13 such that the rotation speed of the motor 12 detected by the rotation speed sensor 14 becomes a target value.

[0043] The steering mechanism 20 includes a steering controller 24 and a steering angle sensor 25. The steering controller 24 includes a motor driver, for example. The steering angle sensor 25 detects the rotation angle of the steering shaft 22 (see FIG. 4). As shown in FIG. 4, the steering mechanism 20 includes a sensor gear 26. The sensor gear 26 includes a spur gear 26a and a spur gear 26b. The spur gear 26a is fixed to the worm wheel 23f to rotate coaxially with the worm wheel 23f. The spur gear 26b meshes with the spur gear 26a and rotates about a steering angle sensor axis A2. Although not shown in FIG. 4, the steering angle sensor 25 is provided in the vicinity of or adjacent to the spur gear 26b to detect the amount of rotation of the spur gear 26b. The steering angle sensor 25 is an optical sensor or a magnetic sensor, for example. As shown in FIG. 3, the first controller 41 and the second controller 42 control the rotation speed of the motor 21 via the steering controller 24 such that the rotation angle of the steering shaft 22 detected by the steering angle sensor 25 becomes a target value.

[0044] The control switch 43 switches between a state in which the first controller 41 controls the propulsive force F (see FIG. 1) of the propulsion generator 10 and steering by the steering mechanism 20 and a state in which the second controller 42 controls the propulsive force F of the propulsion generator 10 and steering by the steering mechanism 20. As shown in FIG. 5, a joystick mode switch 33c is provided on the base 33a of the joystick 33. The joystick mode switch 33c is pressed such that the control switch 43 switches between a state in which the marine vessel maneuvering system 100 receives an operation on the joystick 33 (joystick mode) and a state in which the marine vessel maneuvering system 100 does not receive an operation on the joystick 33.

[0045] As shown in FIG. 6A, when an operation is performed to turn the marine vessel 110 clockwise (when the user gives an instruction to turn the marine vessel 110 clockwise), the second controller 42 (see FIG. 3) controls the propulsion generator 10 and the steering mechanism 20 (see FIG. 2) such that the propulsion generator 10 is steered in the portside direction (rotated counterclockwise) and a forward propulsive force F in the propulsion generator 10 (see FIG. 2) is generated. The "operation to turn the marine vessel 110 clockwise" corresponds to rotating the joystick 33 clockwise from the neutral position P20 (the state of FIG. 6B). That is, the joystick 33 is rotated clockwise from the neutral position P20 in order to rotate the marine vessel 110 clockwise. Then, while the propulsion generator 10 is steered in the portside direction and a forward propulsive force F is generated in the propulsion generator 10, the marine vessel 110 turns clockwise. While the clockwise turn instruction is continued, a state in which the marine vessel 110 turns clockwise is maintained.

[0046] As shown in FIG. 6B, when the marine vessel 110 turns clockwise (the state of FIG. 6A) and the user no longer gives an instruction, the second controller 42 (see FIG. 3) controls the propulsion generator 10 and the steering mechanism 20 (see FIG. 2) such that generation of the propulsive force F by the propulsion generator 10 (see FIG. 2) is stopped and the propulsion generator 10 is steered (returned) to the reference position P10. The expression "the user no longer gives an instruction" corresponds to a state in which the joystick 33 has been returned to the neutral position P20. That is, according to preferred embodiments, the second controller 42 controls the steering mechanism 20 such that the propulsion generator 10 is returned to the reference position P10 from either a portside rotation position (first rotation position) or a starboard rotation position (second rotation position) by the steering mechanism 20 when the joystick 33 is rotated either clockwise or counterclockwise and is returned to the neutral position P20.

[0047] As shown in FIG. 6C, when an operation is performed to turn the marine vessel 110 counterclockwise (when the user gives an instruction to turn the marine vessel 110 counterclockwise), the second controller 42 (see FIG. 3) controls the propulsion generator 10 and the steering mechanism 20 (see FIG. 2) such that the propulsion generator 10 (see FIG. 2) is steered in the starboard direction (rotated clockwise) and a forward propulsive force F in the propulsion generator 10 is generated. The "operation to turn the marine vessel 110 counterclockwise" corresponds to rotating the joystick 33 counterclockwise from the neutral position P20 (the state of FIG. 6B). That is, the joystick 33 is rotated counterclockwise from the neutral position P20 in order to rotate the marine vessel 110 counterclockwise. Then, while the propulsion generator 10 is steered in the starboard direction and a forward propulsive force F is generated in the propulsion generator 10, the marine vessel 110 turns counterclockwise. While the counterclockwise turn instruction is continued, a state in which the marine vessel 110 turns counterclockwise is maintained.

[0048] As shown in FIG. 6B, when the marine vessel 110 turns counterclockwise (the state of FIG. 6C) and the user no longer gives an instruction, the second controller 42 (see FIG. 3) controls the propulsion generator 10 and the steering mechanism 20 (see FIG. 2) such that generation of the propulsive force F by the propulsion generator 10 (see FIG. 2) is stopped and the propulsion generator 10 is steered (returned) to the reference posi-

tion P10.

[0049] According to preferred embodiments, as shown in FIGS. 7A and 7B, the second controller 42 (see FIG. 3) performs a propulsion reverse direction control to change the direction of the propulsive force F of the propulsion generator 10 (see FIG. 2) to the reverse direction when the user operates the joystick 33 to turn the marine vessel 110 either counterclockwise or clockwise (i.e., when the user rotates the joystick 33 either counterclockwise or clockwise) with the joystick 33 rotated either clockwise or counterclockwise and the marine vessel 110 turned either clockwise or counterclockwise.

[0050] Specifically, as shown in FIGS. 7A and 7B, the second controller 42 (see FIG. 3) controls the propulsion generator 10 and the steering mechanism 20 (see FIG. 2) such that a rearward propulsive force F is generated in the propulsion generator 10 (the propeller 11 is rotated in a reverse direction) while a state in which the propulsion generator 10 (see FIG. 2) is steered in the portside direction is maintained (the state of FIG. 7B) when the user performs an operation to turn the marine vessel 110 counterclockwise (i.e., when the user gives a counterclockwise turn instruction) with the marine vessel 110 turned clockwise (with the user continuously giving a clockwise turn instruction) (the state of FIG. 7A). While the propulsion generator 10 is steered in the portside direction and a rearward propulsive force F is generated in the propulsion generator 10, the marine vessel 110 turns counterclockwise. That is, while the propulsion generator 10 is steered in the portside direction, the marine vessel 110 may turn clockwise or counterclockwise.

[0051] The second controller 42 (see FIG. 3) performs a similar control in which the right and left are reversed when the user performs an operation to turn the marine vessel 110 clockwise (i.e., when the user gives a clockwise turn instruction) with the marine vessel 110 turned counterclockwise (i.e., with the user continuously giving a counterclockwise turn instruction) (the state of FIG. 7B). That is, while the propulsion generator 10 is steered in the starboard direction, the marine vessel 110 may turn counterclockwise or clockwise. In the following description, the details of a case in which the user performs an operation to turn the marine vessel 110 clockwise with the marine vessel 110 turned counterclockwise (the state of FIG. 7B) are omitted.

[0052] According to preferred embodiments, the second controller 42 (see FIG. 3) performs a propulsion reverse direction control while the steering angle θ (see FIG. 1) by the steering mechanism 20 (see FIG. 2) is maintained when the user operates the joystick 33 to turn the marine vessel 110 either counterclockwise or clockwise with the marine vessel 110 turned either clockwise or counterclockwise. Specifically, the second controller 42 controls the propulsion generator 10 and the steering mechanism 20 such that a rearward propulsive force F is generated in the propulsion generator 10 (i.e., the propeller 11 is rotated in the reverse direction) while a state in which the propulsion generator 10 (see FIG. 2) is steered in the portside direction by a predetermined steering angle θ is maintained (the state of FIG. 7B) when the user performs an operation to turn the marine vessel 110 counterclockwise with the marine vessel 110 turned clockwise (the state of FIG. 7A). That is, the second controller 42 controls the steering mechanism 20 such that the propulsion generator 10 is not steered before and after the propulsion reverse direction control.

[0053] According to preferred embodiments, the second controller 42 (see FIG. 3) performs a propulsion reverse direction control with the propulsion generator 10 returned to either the portside rotation position or the starboard rotation position by the steering mechanism 20 when the joystick 33 is rotated either counterclockwise or clockwise before the propulsion generator 10 is returned to the reference position P10 by the steering mechanism 20 (see FIG. 2). Specifically, when the joystick 33 is rotated clockwise and is returned to the neutral position P20, the propulsion generator 10 is immediately started to return to the reference position P10 by the steering mechanism 20. Steering by the steering mechanism 20 takes a relatively long time (several seconds, for example) with respect to the time required to rotate the joystick 33. Thus, when the joystick 33 is returned to the neutral position P20 and then immediately rotated counterclockwise (i.e., the joystick 33 is operated to reverse the turning direction of the marine vessel 110), the propulsion generator 10 has not been returned to the reference position P10 from the portside rotation position by the steering mechanism 20. Therefore, the second controller 42 performs a propulsion reverse direction control with the propulsion generator 10 steered to the portside rotation position closer to the current position than the starboard rotation position that is reverse with respect to the reference position P10 by the steering mechanism 20 (i.e., with the propulsion generator 10 returned to the original rotation position by the steering mechanism 20).

[0054] According to preferred embodiments, the second controller 42 (see FIG. 3) performs a propulsion reverse direction control when the joystick 33 is switched from a state of being rotated either clockwise or counterclockwise to a state of being rotated either counterclockwise or clockwise in a time shorter than a predetermined first length of time. Specifically, the second controller 42 performs a propulsion reverse direction control when the joystick 33 is switched to a state of being rotated counterclockwise in a time shorter than the first length of time (several seconds, for example) after the joystick 33 is rotated clockwise (the state of FIG. 7A) and starts being rotated toward the neutral position P20. On the other hand, the second controller 42 does not perform a propulsion reverse direction control when the joystick 33 is not switched to a state of being rotated counterclockwise (i.e., is returned to the neutral position P2) in a time shorter than the first length of time (several seconds, for example) after the joystick 33 is rotated clockwise (the state of FIG. 7A) and starts being rotated toward the neutral position P20.

[0055] According to preferred embodiments, the second controller 42 (see FIG. 3) performs a propulsion reverse direction control while adjusting the propulsive force F of the propulsion generator 10 such that the magnitude of the propulsive force F of the propulsion generator 10 (see FIG. 2) with respect to the magnitude of the amount of clockwise rotation of the joystick 33 (the magnitude of the amount of operation on the joystick 33 to turn the marine vessel 110 clockwise) becomes substantially the same as the magnitude of the propulsive force F of the propulsion generator 10 with respect to the magnitude of the amount of counterclockwise rotation of the joystick 33 (the magnitude of the amount of operation on the joystick 33 to turn the marine vessel 110 counterclockwise) when the user operates the joystick 33 to turn the marine vessel 110 either counterclockwise or clockwise with the joystick 33 rotated either clockwise or counterclockwise and the marine vessel 110 turned either clockwise or counterclockwise. Specifically, the second controller 42 controls the propulsion generator 10 (see FIG. 2) to generate a propulsive force F with a magnitude corresponding to the magnitude of the amount of rotation of the joystick 33. Furthermore, in order to make the magnitude of the propulsive force F of the propulsion generator 10 to move the marine vessel 110 forward different from the magnitude of the propulsive force F of the propulsion generator 10 to move the marine vessel 110 rearward, the magnitude of the forward propulsive force F generated in the propulsion generator 10 (during forward rotation of the propeller 11) is different from the magnitude of the rearward propulsive force F generated in the propulsion generator 10 (during reverse rotation of the propeller 11) even when the magnitude of the amount of rotation of the joystick 33 is the same. Therefore, when the direction of the propulsive force F in the propulsion generator 10 is changed to the reverse direction (when the propeller 11 is rotated in the reverse direction), the propulsive force F of the propulsion generator 10 is adjusted such that the magnitudes of the propulsive forces F in the propulsion generator 10 do not differ from each other before and after the propulsion reverse direction control with respect to the same amount of rotation of the joystick 33.

[0056] According to preferred embodiments, the second controller 42 (see FIG. 3) performs a propulsion reverse direction control again when the user operates the joystick 33 to turn the marine vessel 110 either clockwise or counterclockwise with the direction of the propulsive force F of the propulsion generator 10 changed to the reverse direction. That is, when the joystick 33 is repeatedly operated to reverse the turning direction of the marine vessel 110, the propulsion reverse direction control is successively performed.

[0057] According to the various preferred embodiments described above, the following advantageous effects are achieved.

[0058] According to a preferred embodiment, the second controller 42 is configured or programmed to perform a propulsion reverse direction control to change the direction of propulsive force F of the propulsion generator 10 to the reverse direction when the user operates the joystick 33 to turn the marine vessel 110 either counterclockwise or clockwise with the marine vessel 110 turned either clockwise or counterclockwise. Accordingly, while the marine vessel 110 is turned clockwise or counterclockwise, the direction of the propulsive force F of the propulsion generator 10 is changed to the reverse direction such that the turning direction of the marine vessel 110 is reversed without steering the propulsion generator 10 from one of the starboard and portside rotation positions to the other with respect to the reference position P10. That is, when the turning direction of the marine vessel 110 is reversed, the time (several seconds, for example) required to steer the propulsion generator 10 from one of the starboard and portside rotation positions to the other with respect to the reference position P10 is eliminated. Consequently, the steering is not required, and thus the length of time between performing an operation to reverse the turning direction of the marine vessel 110 and completing reversal of the turning direction of the marine vessel 110 is decreased.

[0059] According to a preferred embodiment, the second controller 42 is configured or programmed to perform a propulsion reverse direction control while the steering angle θ by the steering mechanism 20 is maintained when the user operates the joystick 33 to turn the marine vessel 110 either counterclockwise or clockwise with the marine vessel 110 turned either clockwise or counterclockwise. Accordingly, the propulsion reverse direction control is performed while the steering angle θ by the steering mechanism 20 is maintained such that as compared with a case in which the propulsion reverse direction control is performed with the steering angle θ by the steering mechanism 20 changed, a complex control of the propulsive force F of the propulsion generator 10 is significantly reduced or prevented after the direction of the propulsive force F of the propulsion generator 10 is changed to the reverse direction.

[0060] According to a preferred embodiment, the joystick 33 is rotated clockwise from the neutral position P20 to turn the marine vessel 110 clockwise, and is rotated counterclockwise from the neutral position P20 to turn the marine vessel 110 counterclockwise. Furthermore, the second controller 42 is configured or programmed to perform a propulsion reverse direction control when the user rotates the joystick 33 either counterclockwise or clockwise with the joystick 33 rotated either clockwise or counterclockwise and the marine vessel 110 turned either clockwise or counterclockwise. Accordingly, the direction of operation (direction of rotation) on the joystick 33 is the same as or substantially the same as the turning direction of the marine vessel 110, and thus the joystick 33 is operated to reverse the turning direction of the marine vessel 110 in an intuitively easy-to-understand state.

[0061] According to a preferred embodiment, the second controller 42 is configured or programmed to control

the steering mechanism 20 such that the propulsion generator 10 is returned to the reference position P10 from either the portside rotation position or the starboard rotation position by the steering mechanism 20 when the joystick 33 is rotated either clockwise or counterclockwise and is returned to the neutral position P20, and to perform a propulsion reverse direction control with the propulsion generator 10 returned to either the portside rotation position or the starboard rotation position by the steering mechanism 20 when the joystick 33 is rotated either counterclockwise or clockwise before the propulsion generator 10 is returned to the reference position P10 by the steering mechanism 20. Accordingly, a control (propulsion reverse direction control) performed when the joystick 33 changes from a state of being rotated either clockwise and counterclockwise to a state of being rotated either counterclockwise or clockwise (i.e., when the joystick 33 is operated to reverse the turning direction of the marine vessel 110) is distinguished from a control performed when the joystick 33 returns to the neutral position P20 from a state of being rotated either clockwise or counterclockwise (i.e., when the joystick 33 is operated to stop the marine vessel 110).

[0062] According to a preferred embodiment, the second controller 42 is configured or programmed to perform a propulsion reverse direction control when the joystick 33 is switched from a state of being rotated either clockwise or counterclockwise to a state of being rotated either counterclockwise or clockwise in a time shorter than the predetermined first length of time. Accordingly, a case in which the joystick 33 changes from a state of being rotated either clockwise or counterclockwise to a state of being rotated either counterclockwise or clockwise (i.e., the joystick 33 is operated to reverse the turning direction of the marine vessel 110) is easily distinguished from a case in which the joystick 33 returns to the neutral position P20 from a state of being rotated either clockwise or counterclockwise (i.e., the joystick 33 is operated to stop the marine vessel 110). Consequently, a control to stop the marine vessel 110 is prevented from being performed when the joystick 33 is operated to reverse the turning direction of the marine vessel 110, and a control to reverse the turning direction of the marine vessel 110 is prevented from being performed when the joystick 33 is operated to stop the marine vessel 110.

[0063] According to a preferred embodiment, the second controller 42 is configured or programmed to perform a propulsion reverse direction control while adjusting the propulsive force F of the propulsion generator 10 such that the magnitude of the propulsive force F of the propulsion generator 10 with respect to the magnitude of the amount of clockwise rotation of the joystick 33 (the magnitude of the amount of operation on the joystick 33 to turn the marine vessel 110 clockwise) becomes substantially the same as the magnitude of the propulsive force F of the propulsion generator 10 with respect to the magnitude of the amount of counterclockwise rotation of the joystick 33 (the magnitude of the amount of operation on the joystick 33 to turn the marine vessel 110 counterclockwise) when the user operates the joystick 33 to turn the marine vessel 110 either counterclockwise or clockwise with the joystick 33 rotated either clockwise or counterclockwise and the marine vessel 110 turned either clockwise or counterclockwise. Accordingly, even when the magnitude of the propulsive force F of the propulsion generator 10 with respect to the magnitude of the amount of rotation of the joystick 33 differs depending on a direction in which the propulsive force F is generated, the propulsive force is adjusted such that the magnitude of the propulsive force F of the propulsion generator 10 with respect to the magnitude of the amount of rotation of the joystick 33 does not differ, and the turning direction of the marine vessel 110 is reversed.

[0064] According to a preferred embodiment, the second controller 42 is configured or programmed to perform a propulsion reverse direction control on the propulsion generator 10 corresponding to an electric propulsion device driven by the motor 12. Accordingly, in the electrically driven marine vessel 110, the length of time between performing an operation to reverse the turning direction of the marine vessel 110 and completing reversal of the turning direction of the marine vessel 110 is decreased. Furthermore, unlike an engine, the motor 12 does not directly emit CO2, and thus a preferable device structure is obtained from the viewpoint of SDGs.

[0065] According to a preferred embodiment, the steering angle θ by the steering mechanism 20 is substantially 60 degrees or more and substantially 80 degrees or less when the joystick 33 is operated to turn the marine vessel 110 clockwise or counterclockwise. Accordingly, the steering angle θ by the steering mechanism 20 is substantially 60 degrees or more and substantially 80 degrees or less, and thus the turning radius of the marine vessel 110 is relatively small when the marine vessel 110 is turned.

[0066] According to a preferred embodiment, the second controller 42 is configured or programmed to perform a propulsion reverse direction control on the propulsion generator 10 provided in the outboard motor 112, which is attached to the hull 111 of the marine vessel 110, based on a user's operation on the joystick 33. Accordingly, in the marine vessel 110 (an outboard motor boat including one outboard motor) including the hull 111 to which one outboard motor 112 is attached, the length of time between performing an operation to reverse the turning direction of the marine vessel 110 and completing reversal of the turning direction of the marine vessel 110 is decreased.

[0067] According to a preferred embodiment, the second controller 42 is configured or programmed to perform a propulsion reverse direction control again when the user operates the joystick 33 to turn the marine vessel 110 either clockwise or counterclockwise with the direction of the propulsive force F of the propulsion generator 10 changed to the reverse direction. Accordingly, even when an operation is performed again to reverse the turning

direction of the marine vessel 110, the turning direction of the marine vessel 110 is reversed again while the length of time between performing an operation to reverse the turning direction of the marine vessel 110 and completing reversal of the turning direction of the marine vessel 110 is decreased.

[0068] The preferred embodiments described above are illustrative for present teaching but the present teaching also relates to modifications of the preferred embodiments.

[0069] For example, while the second controller 42 (controller) is preferably configured or programmed to perform a propulsion reverse direction control again in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the controller may alternatively be configured or programmed to not perform a propulsion reverse direction control again (i.e., not successively perform a propulsion reverse direction control).

[0070] While the second controller 42 (controller) is preferably configured or programmed to perform a propulsion reverse direction control on the propulsion generator 10 provided in the outboard motor 112 that is attached to the hull 111 of the marine vessel 110 in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the controller may alternatively be configured or programmed to perform a propulsion reverse direction control on a propulsion generator provided in an inboard motor provided inside the hull of the marine vessel or may alternatively be configured or programmed to perform a propulsion reverse direction control on a propulsion generator provided in an inboard-outboard motor attached to the hull of the marine vessel such that a portion of the inboard-outboard motor is provided inside the hull.

[0071] While the steering angle θ by the steering mechanism 20 is preferably substantially 60 degrees or more and substantially 80 degrees or less when the joystick 33 is operated to turn the marine vessel 110 clockwise or counterclockwise in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the steering angle by the steering mechanism may alternatively be less than 60 degrees or more than 80 degrees when the joystick is operated to turn the marine vessel clockwise or counterclockwise.

[0072] While the second controller 42 (controller) is preferably configured or programmed to perform a propulsion reverse direction control on the propulsion generator 10 corresponding to an electric propulsion device driven by the motor 12 in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the controller may alternatively be configured or programmed to perform a propulsion reverse direction control on a propulsion generator driven by an engine or on a hybrid propulsion generator driven by a motor and an engine.

[0073] While the second controller 42 (controller) is preferably configured or programmed to perform a propulsion reverse direction control while adjusting the propulsive force F of the propulsion generator 10 such that the magnitude of the propulsive force F of the propulsion generator 10 with respect to the magnitude of the amount of clockwise rotation of the joystick 33 (the magnitude of the amount of operation on the joystick 33 to turn the marine vessel 110 clockwise) becomes substantially the same as the magnitude of the propulsive force F of the propulsion generator 10 with respect to the magnitude of the amount of counterclockwise rotation of the joystick 33 (the magnitude of the amount of operation on the joystick 33 to turn the marine vessel 110 counterclockwise) in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the controller may alternatively be configured or programmed to perform a propulsion reverse direction control without adjusting the propulsive force of the propulsion generator such that the magnitude of the propulsive force of the propulsion generator with respect to the magnitude of the amount of clockwise rotation of the joystick (the magnitude of the amount of operation on the operator to turn the marine vessel clockwise) becomes substantially the same as the magnitude of the propulsive force of the propulsion generator with respect to the magnitude of the amount of counterclockwise rotation of the joystick (the magnitude of the amount of operation on the operator to turn the marine vessel counterclockwise).

[0074] While the second controller 42 (controller) is preferably configured or programmed to perform a propulsion reverse direction control when the joystick 33 is switched from a state of being rotated either clockwise or counterclockwise to a state of being rotated either counterclockwise or clockwise in a time shorter than the predetermined first length of time in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the controller may alternatively be configured or programmed to perform a propulsion reverse direction control when the length of time during which the joystick is located at the neutral position while the joystick is switched from a state of being rotated either clockwise or counterclockwise to a state of being rotated either counterclockwise or clockwise is shorter than a predetermined second length of time (hundreds of milliseconds to a few seconds, for example).

[0075] While the second controller 42 (controller) is preferably configured or programmed to perform a propulsion reverse direction control while the steering angle θ by the steering mechanism 20 is maintained in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the controller may alternatively be configured or programmed to perform a propulsion reverse direction control with the steering angle by the steering mechanism changed.

[0076] While a joystick is preferably applied as an operator in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, a remote control or a steering wheel may alter-

natively be applied as an operator. In such a case, the first controller 41 is a controller. Furthermore, a turning switch to turn the marine vessel may alternatively be applied as an operator. In such a case, the marine vessel maneuvering system is only required to include a right turning switch to turn the marine vessel clockwise and a left turning switch to turn the marine vessel counterclockwise.

[0077] While the marine vessel 110 may be preferably turned clockwise or counterclockwise with the propulsion generator 10 steered in the portside direction, and the marine vessel 110 may be preferably turned counterclockwise or clockwise with the propulsion generator 10 steered in the starboard direction in preferred embodiments described above, the present teaching is not restricted to this. In the present teaching, the steering direction of the propulsion generator may alternatively be fixed to one of the portside direction and the starboard direction when the marine vessel is turned (i.e., the steering direction of the propulsion generator may alternatively be the same all the time when the marine vessel is turned). For example, both when the marine vessel is turned clockwise and when the marine vessel is turned counterclockwise, the steering direction of the propulsion generator may be starboard, and the propulsion generator may generate forward and rearward propulsive forces when the marine vessel is turned clockwise and counterclockwise, respectively.

Claims

1. A marine vessel maneuvering system (100) comprising:

an operator (30) configured to maneuver a marine vessel (110) including a propulsion generator (10) and a steering mechanism (20); and
a controller (41, 42) configured or programmed to control a propulsive force (F) of the propulsion generator (10) and to control steering by the steering mechanism (20) based on a user's operation on the operator (30); wherein
the controller (41, 42) is configured or programmed to perform a propulsion reverse direction control to change a direction of the propulsive force (F) of the propulsion generator (10) to a reverse direction when a user operates the operator (30) to turn the marine vessel (110) either counterclockwise or clockwise with the marine vessel (110) turned either clockwise or counterclockwise.

2. The marine vessel maneuvering system (100) according to claim 1, wherein the controller (41, 42) is configured or programmed to perform the propulsion reverse direction control while a steering angle (θ) by the steering mechanism (20) is maintained when the user operates the operator (30) to turn the marine vessel (110) either counterclockwise or clockwise with the marine vessel (110) turned either clockwise or counterclockwise.

3. The marine vessel maneuvering system (100) according to claim 1 or 2, wherein the operator (30) includes a joystick (33) that is configured to be rotated clockwise from a neutral position (P20) to cause turn of the marine vessel (110) clockwise and is configured to be rotated counterclockwise from the neutral position (P20) to cause turn of the marine vessel (110) counterclockwise.

4. The marine vessel maneuvering system (100) according to claim 3, wherein the controller (42) is configured or programmed to perform the propulsion reverse direction control when the user rotates the joystick (33) either counterclockwise or clockwise with the joystick (33) rotated either clockwise or counterclockwise and the marine vessel (110) turned either clockwise or counterclockwise.

5. The marine vessel maneuvering system (100) according to claim 4, wherein the controller (42) is configured or programmed to control the steering mechanism (20) such that the propulsion generator (10) is returned to a reference position (P10) from either a first rotation position or a second rotation position by the steering mechanism (20) when the joystick (33) is rotated either clockwise or counterclockwise and is returned to the neutral position (P20), and to perform the propulsion reverse direction control with the propulsion generator (10) returned to either the first rotation position or the second rotation position by the steering mechanism (20) when the joystick (33) is rotated either counterclockwise or clockwise before the propulsion generator (10) is returned to the reference position (P10) by the steering mechanism (20).

6. The marine vessel maneuvering system (100) according to claim 5, wherein the controller (42) is configured or programmed to perform the propulsion reverse direction control when the joystick (33) is switched from a state of being rotated either clockwise or counterclockwise to a state of being rotated either counterclockwise or clockwise in a time shorter than a predetermined first length of time.

7. The marine vessel maneuvering system (100) according to claim 5, wherein the controller (42) is configured or programmed to perform the propulsion reverse direction control when a length of time during which the joystick (33) is located at the neutral position (P20) while the joystick (33) is switched from a state of being rotated either clockwise or counterclockwise to a state of being rotated either counter-

clockwise or clockwise is shorter than a predetermined second length of time.

8. The marine vessel maneuvering system (100) according to any one of claims 1 to 7, wherein the controller (41, 42) is configured or programmed to perform the propulsion reverse direction control while adjusting the propulsive force (F) of the propulsion generator (10) such that a magnitude of the propulsive force (F) of the propulsion generator (10) with respect to a magnitude of an amount of operation on the operator (30) to turn the marine vessel (110) clockwise becomes same as a magnitude of the propulsive force (F) of the propulsion generator (10) with respect to a magnitude of an amount of operation on the operator (30) to turn the marine vessel (110) counterclockwise when the user operates the operator (30) to turn the marine vessel (110) either counterclockwise or clockwise with the marine vessel (110) turned either clockwise or counterclockwise.

9. The marine vessel maneuvering system (100) according to claim 3 or 8, wherein the controller (42) is configured or programmed to control a magnitude of the propulsive force (F) of the propulsion generator (10) to turn the marine vessel (110) according to a magnitude of an amount of rotation of the joystick (33), and to perform the propulsion reverse direction control while adjusting the propulsive force (F) of the propulsion generator (10) such that a magnitude of the propulsive force (F) of the propulsion generator (10) with respect to a magnitude of an amount of clockwise rotation of the joystick (33) becomes same as a magnitude of the propulsive force (F) of the propulsion generator (10) with respect to a magnitude of an amount of counterclockwise rotation of the joystick (33) when the user operates the joystick (33) to turn the marine vessel (110) either counterclockwise or clockwise with the joystick (33) rotated either clockwise or counterclockwise and the marine vessel (110) turned either clockwise or counterclockwise.

10. The marine vessel maneuvering system (100) according to any one of claims 1 to 9, wherein the controller (41, 42) is configured or programmed to perform the propulsion reverse direction control on the propulsion generator (10) corresponding to an electric propulsion device driven by a motor (12).

11. The marine vessel maneuvering system (100) according to any one of claims 1 to 10, wherein the steering mechanism (20) is configured to provide a steering angle (θ) of 60 degrees or more and 80 degrees or less when the operator (30) is operated to turn the marine vessel (110) clockwise or counterclockwise.

12. The marine vessel maneuvering system (100) according to any one of claims 1 to 11, wherein the controller (41, 42) is configured or programmed to perform the propulsion reverse direction control on the propulsion generator (10) provided in one outboard motor (112), which is attached to a hull (111) of the marine vessel (110), based on a user's operation on the operator (30).

13. The marine vessel maneuvering system (100) according to any one of claims 1 to 12, wherein the controller (41, 42) is configured or programmed to perform the propulsion reverse direction control again when the user operates the operator (30) to turn the marine vessel (110) either clockwise or counterclockwise with the direction of the propulsive force (F) of the propulsion generator (10) changed to the reverse direction.

14. A marine vessel (110) having a hull (111) and a propulsion generator (10) provided in one outboard motor (112), which is attached to a hull (111), wherein the marine vessel (110) is provided with the marine vessel maneuvering system (100) according to any one of claims 1 to 13.

15. A marine vessel maneuvering method for a marine vessel (110) provided with an operator (30) configured to maneuver the marine vessel (110) including a propulsion generator (10) and a steering mechanism (20), the method comprises:

controlling a propulsive force (F) of the propulsion generator (10) and to control steering by the steering mechanism (20) based on a user's operation on the operator (30); and
performing a propulsion reverse direction control to change a direction of the propulsive force (F) of the propulsion generator (10) to a reverse direction when a user operates the operator (30) to turn the marine vessel (110) either counterclockwise or clockwise with the marine vessel (110) turned either clockwise or counterclockwise.

FIG.1

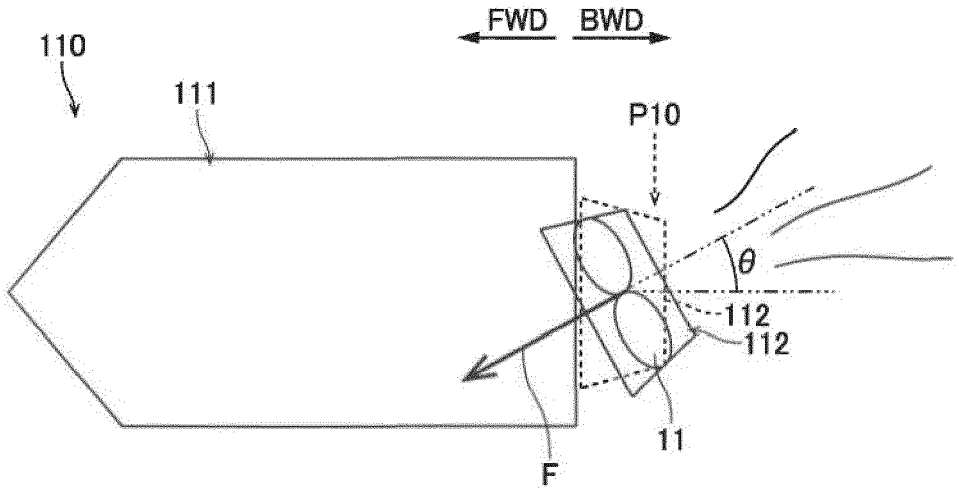

FWD
BWD
110
111
P10
θ
112
112
11
F

FIG.2

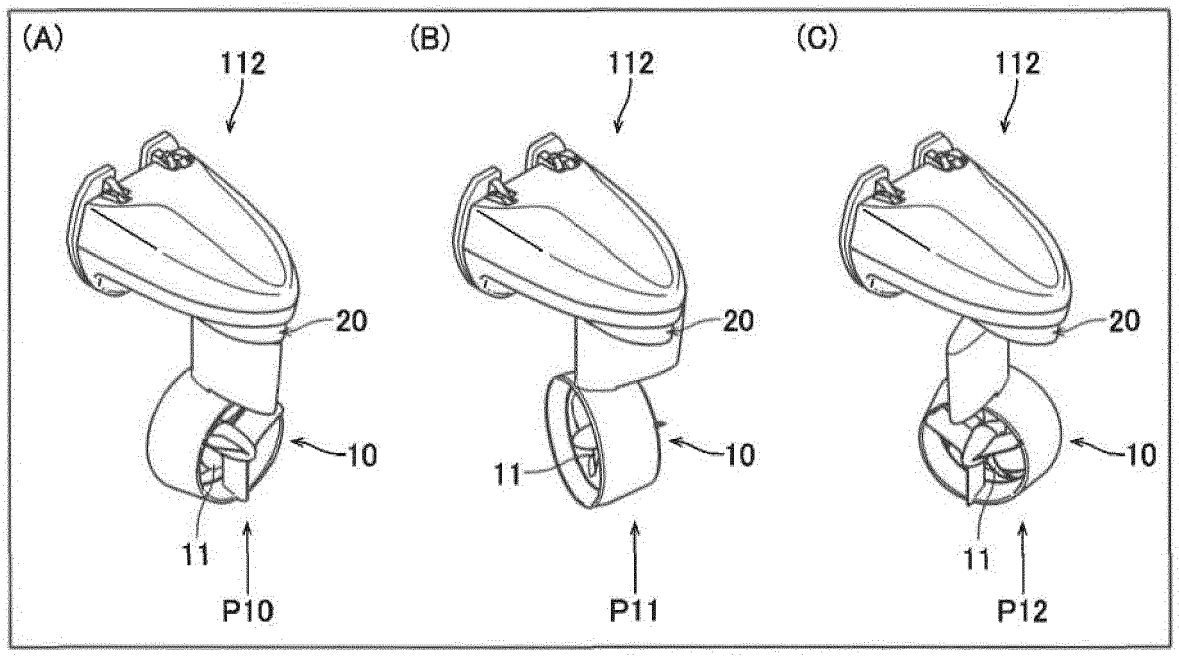

(A)
112
20
10
11
P10
(B)
112
20
11
10
P11
(C)
112
20
10
11
P12

FIG.3

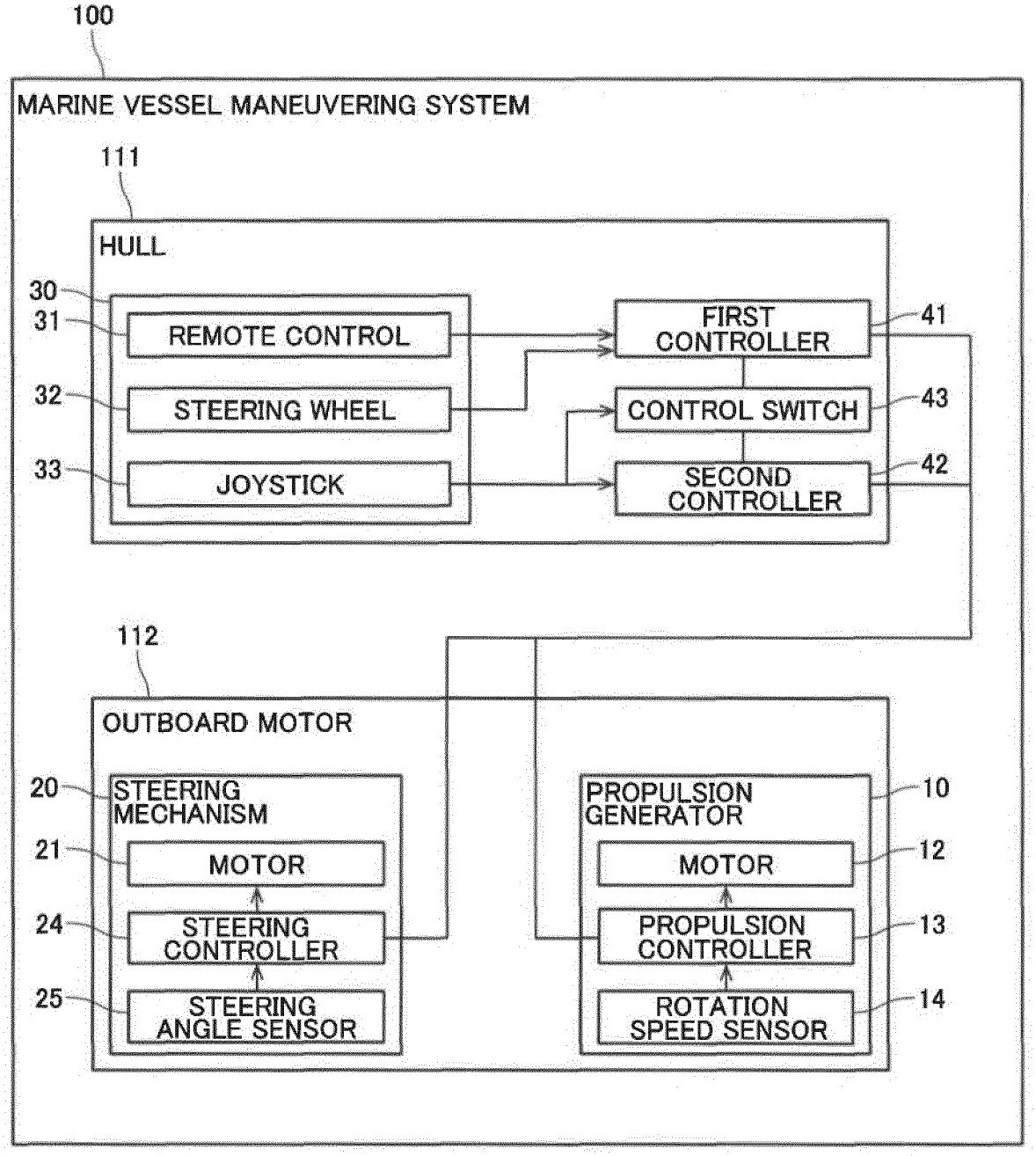

100
MARINE VESSEL MANEUVERING SYSTEM
111
HULL
30
31
REMOTE CONTROL
32
STEERING WHEEL
33
JOYSTICK
FIRST CONTROLLER
41
CONTROL SWITCH
43
SECOND CONTROLLER
42
112
OUTBOARD MOTOR
20
STEERING MECHANISM
21
MOTOR
24
STEERING CONTROLLER
25
STEERING ANGLE SENSOR
PROPULSION GENERATOR
10
MOTOR
12
PROPULSION CONTROLLER
13
ROTATION SPEED SENSOR
14

FIG.4

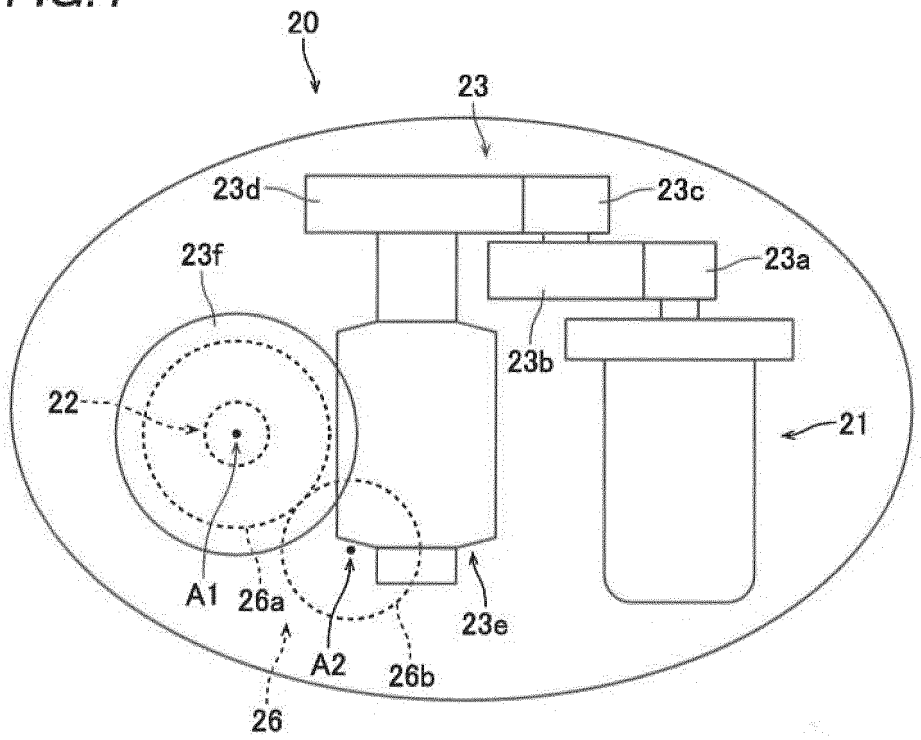

20
23
23d
23c
23f
23a
23b
22
21
A1
26a
A2
26b
23e
26

FIG.5

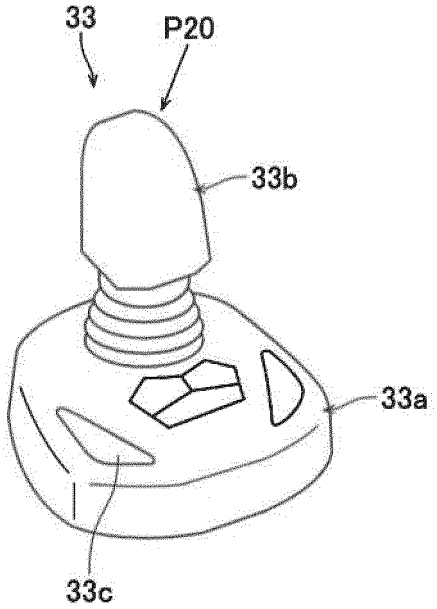

33
P20
33b
33a
33c

FIG.6

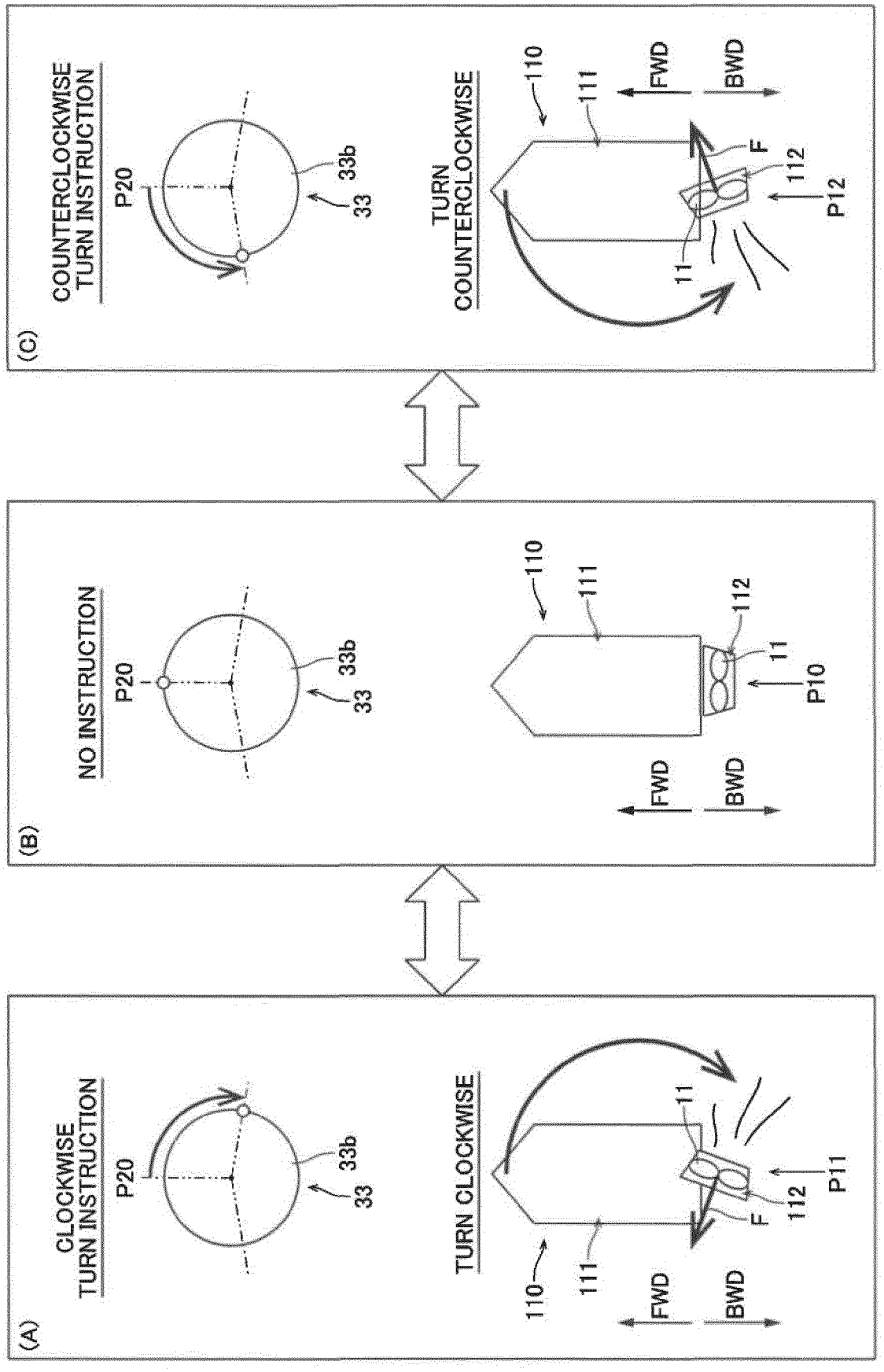
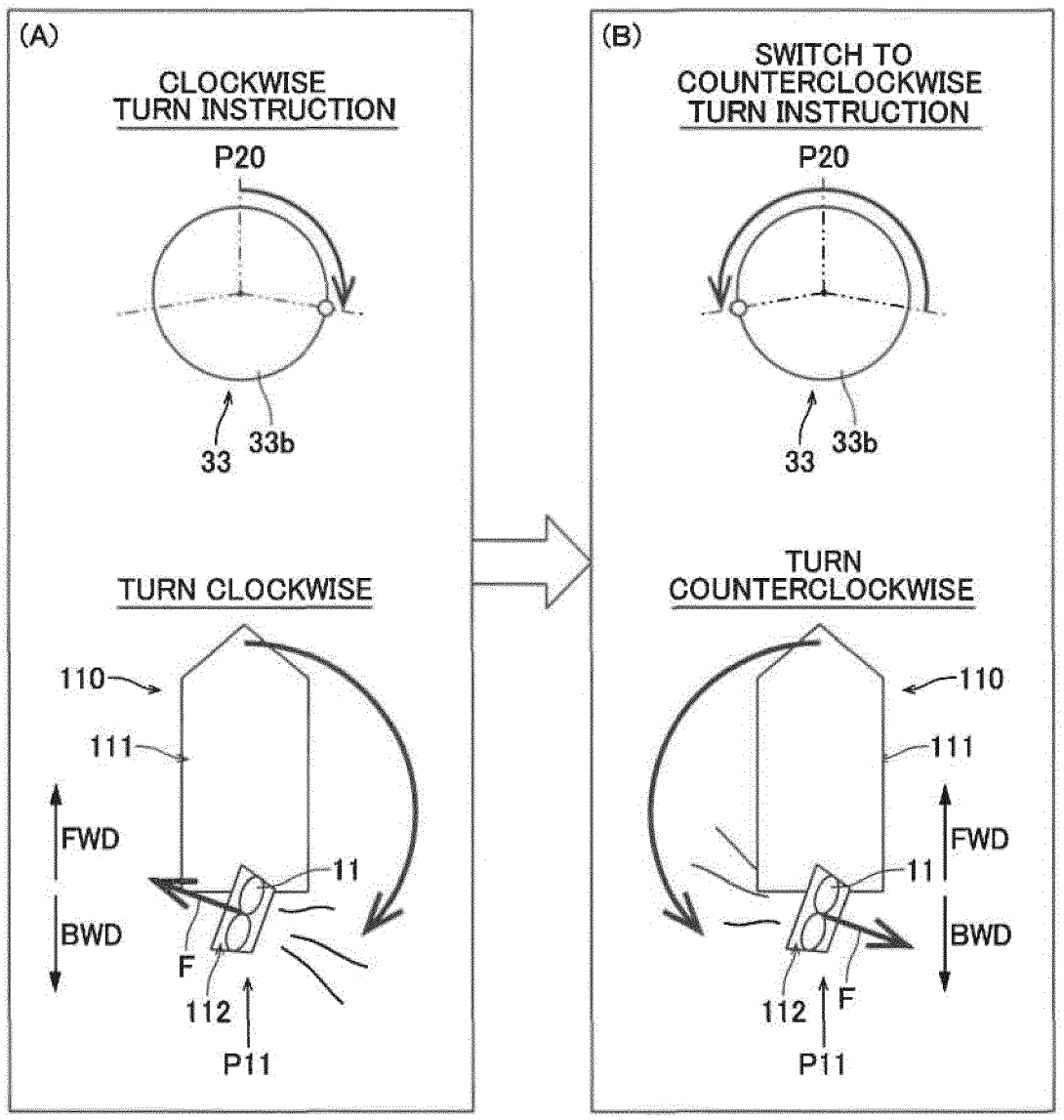

(A)
CLOCKWISE TURN INSTRUCTION
P20
33b
33
TURN CLOCKWISE
110
111
11
112
F
P11
FWD
BWD
(B)
NO INSTRUCTION
P20
33b
33
110
111
112
11
P10
FWD
BWD
(C)
COUNTERCLOCKWISE TURN INSTRUCTION
P20
33b
33
TURN COUNTERCLOCKWISE
110
111
FWD
BWD
F
112
P12
11

FIG.7


(A)
CLOCKWISE TURN INSTRUCTION
P20
33
33b
TURN CLOCKWISE
110
111
FWD
BWD
11
F
112
P11
(B)
SWITCH TO COUNTERCLOCKWISE TURN INSTRUCTION
P20
33
33b
TURN COUNTERCLOCKWISE
110
111
FWD
BWD
11
112
F
P11

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2011140272 A **[0002] [0003] [0004]**