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(54) SMALL MARINE VESSEL CAPABLE IN WHICH ACTION POSITION OF THRUST FORCE IS CHANGEABLE

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(57) **ABSTRACT**

A small marine vessel includes a hull and an outboard motor attached to the hull to be rotatable about a first axis extending along a front-rear direction of the hull and to be movable in an up-down direction of the hull so as to more actively contribute to the maneuverability of the small marine vessel.

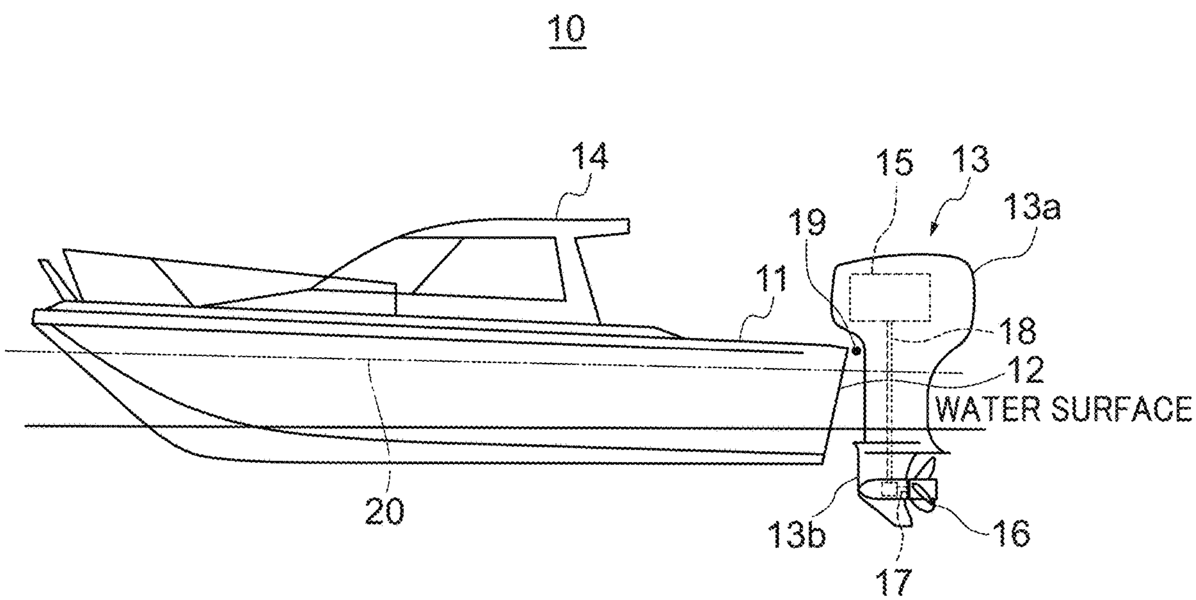


FIG. 1A

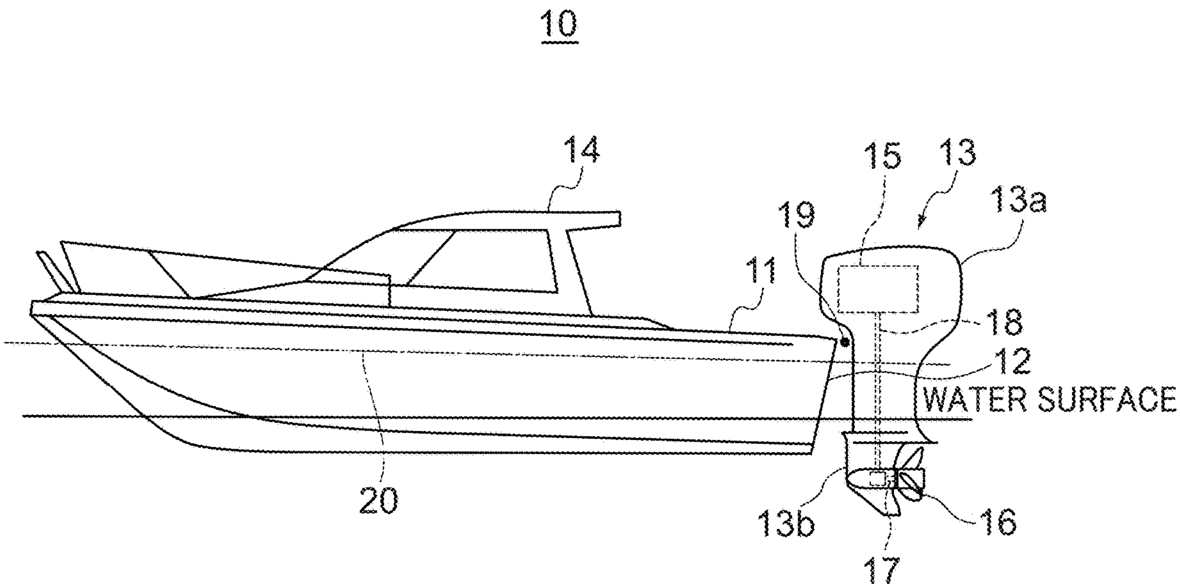
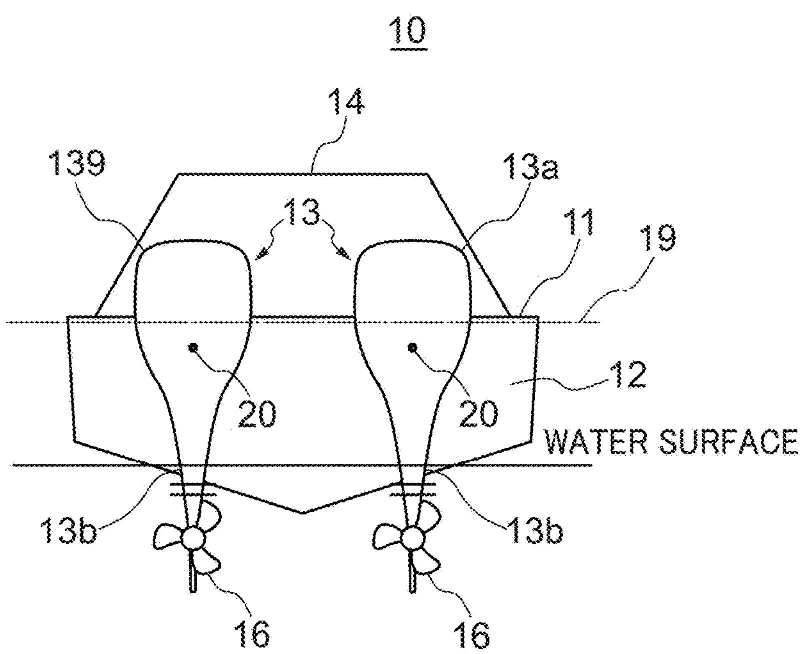

10
14
15
13
13a
19
11
18
12
WATER SURFACE
20
13b
16
17

FIG. 1B


10
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13a
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WATER SURFACE
13b
13b
16
16

FIG. 2A

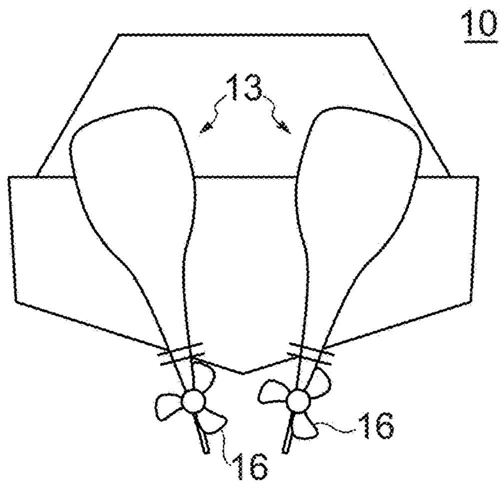


FIG. 2B

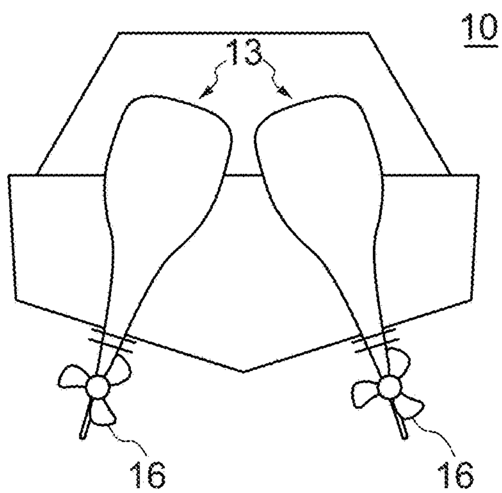


FIG. 2C

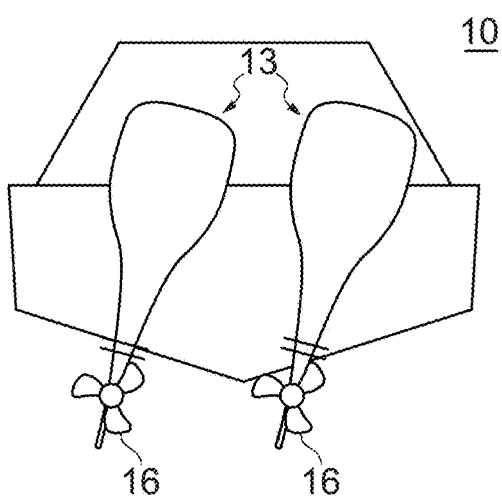


FIG. 3A

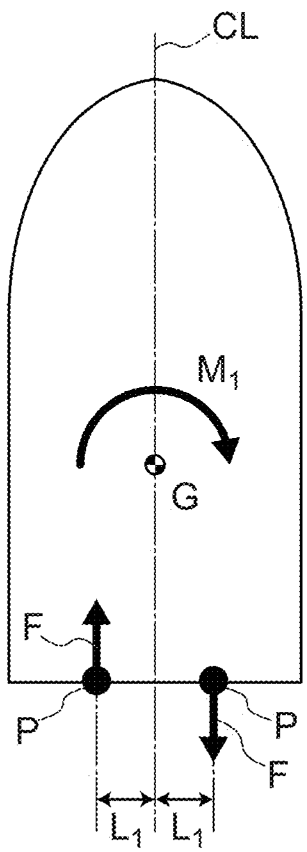


FIG. 3B

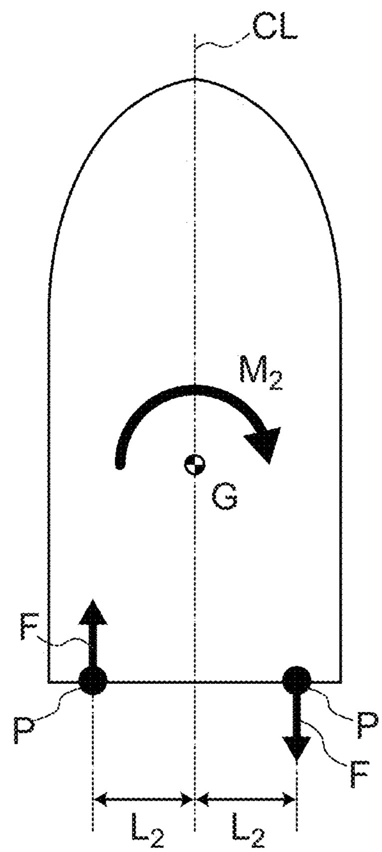


FIG. 4A

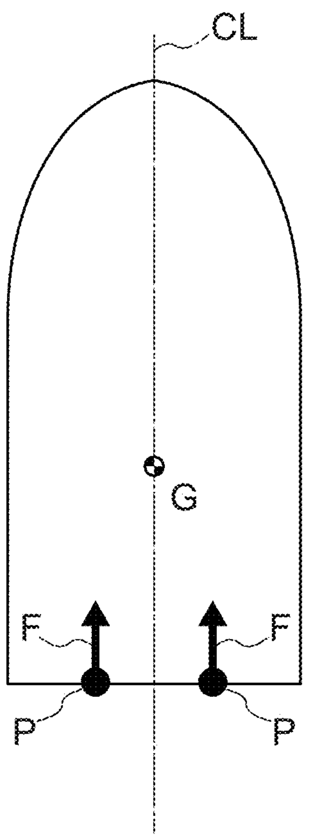


FIG. 4B

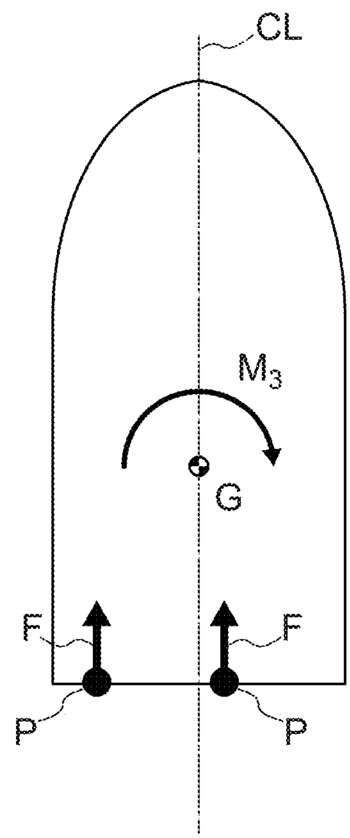


FIG. 5A

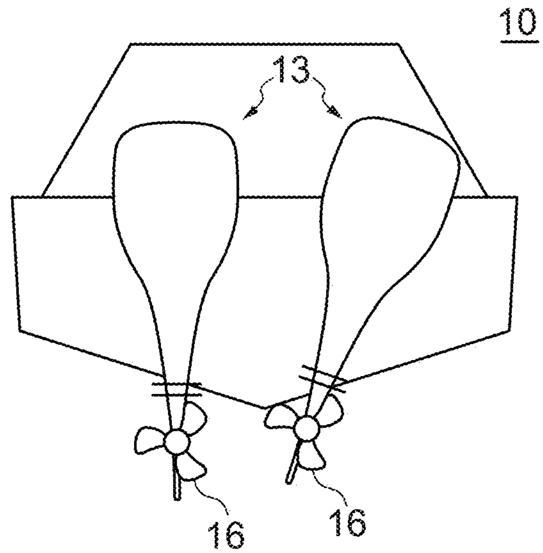


FIG. 5B

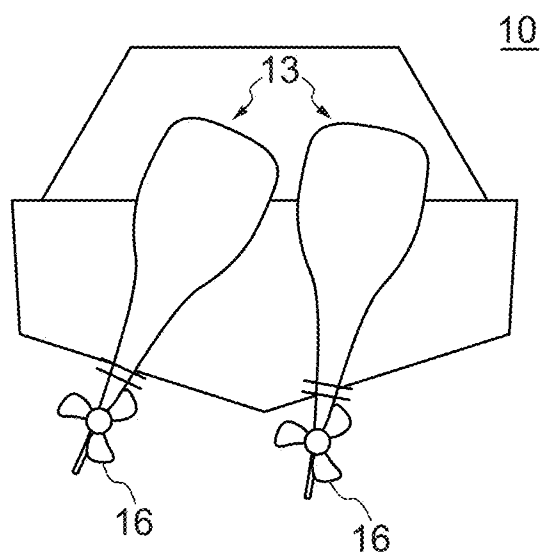


FIG. 6A

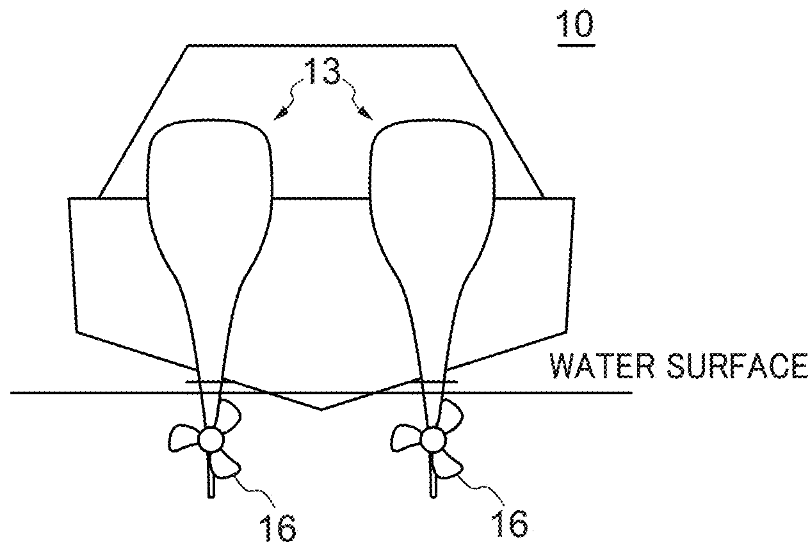


FIG. 6B

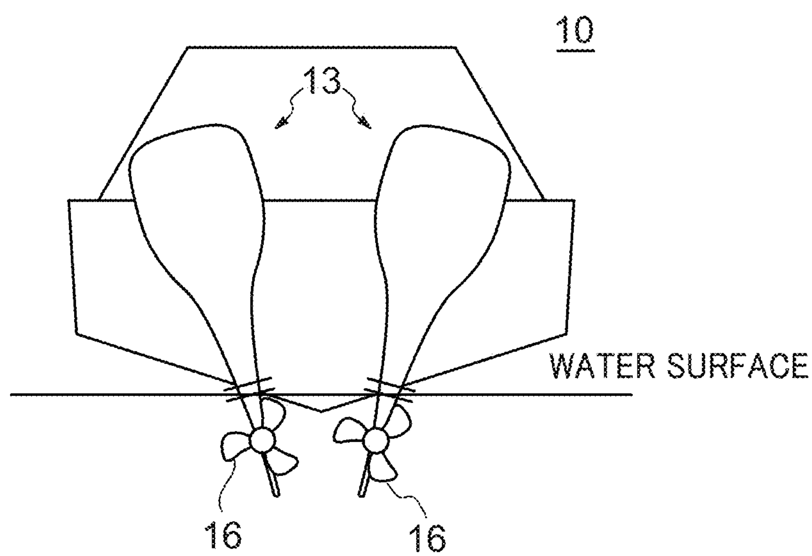


FIG. 7A

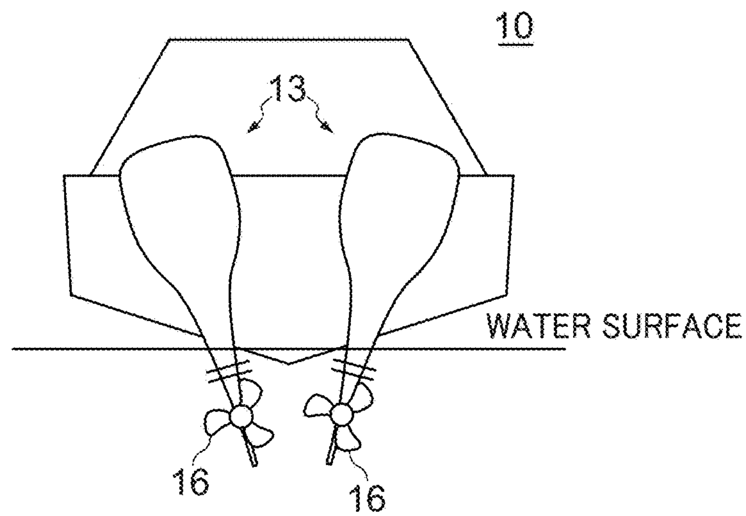


FIG. 7B

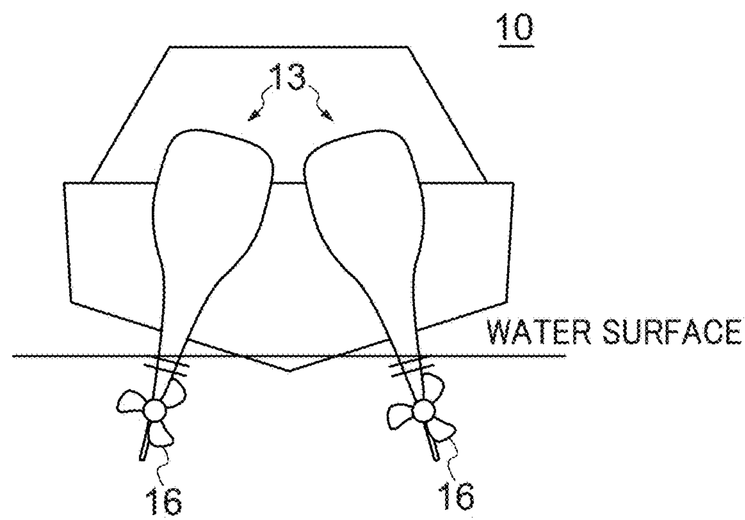


FIG. 7C

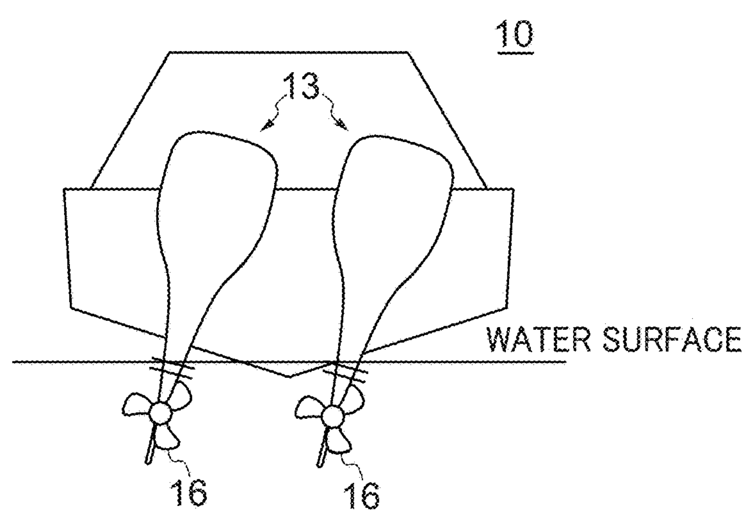


FIG. 8A

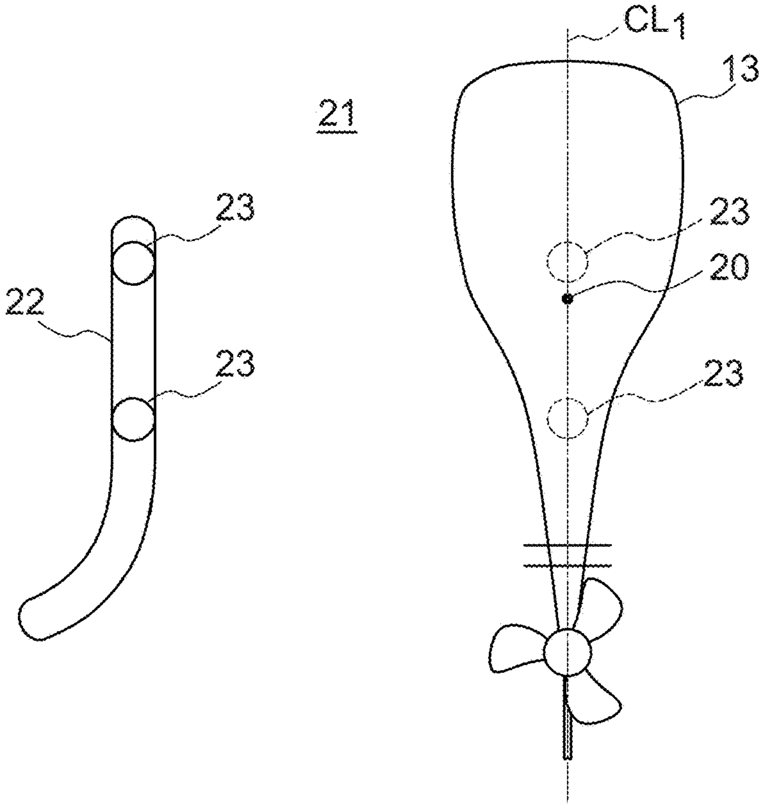


FIG. 8B

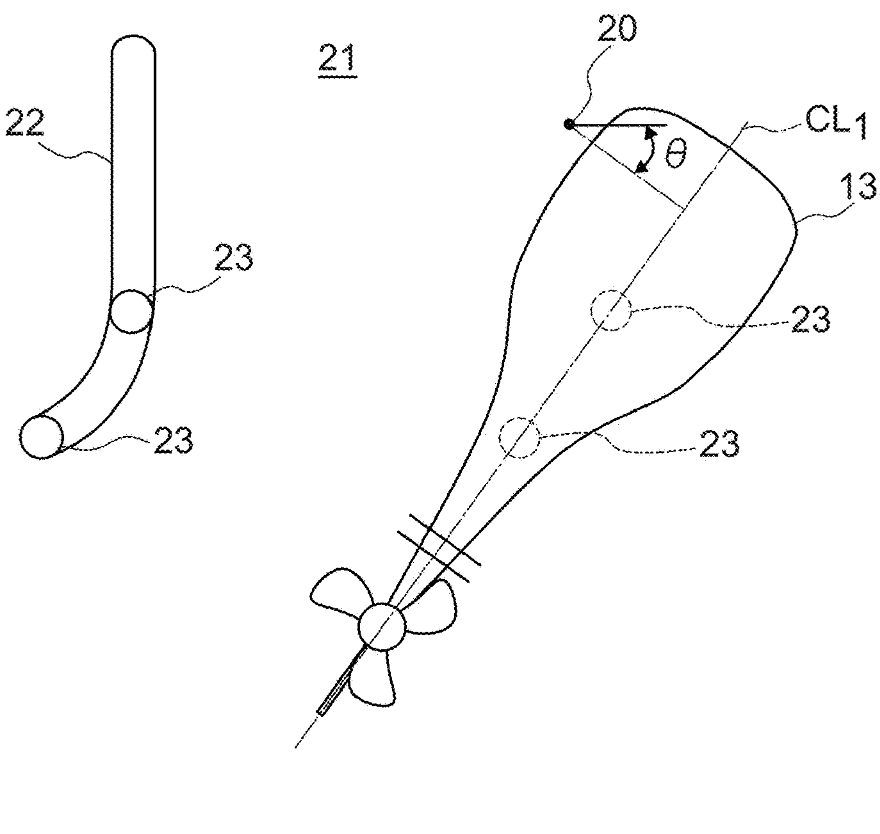


FIG. 9A

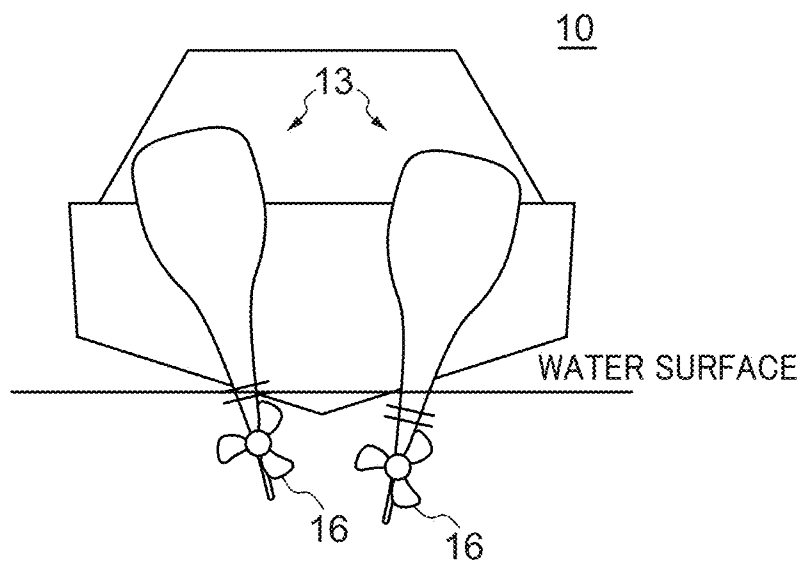


FIG. 9B

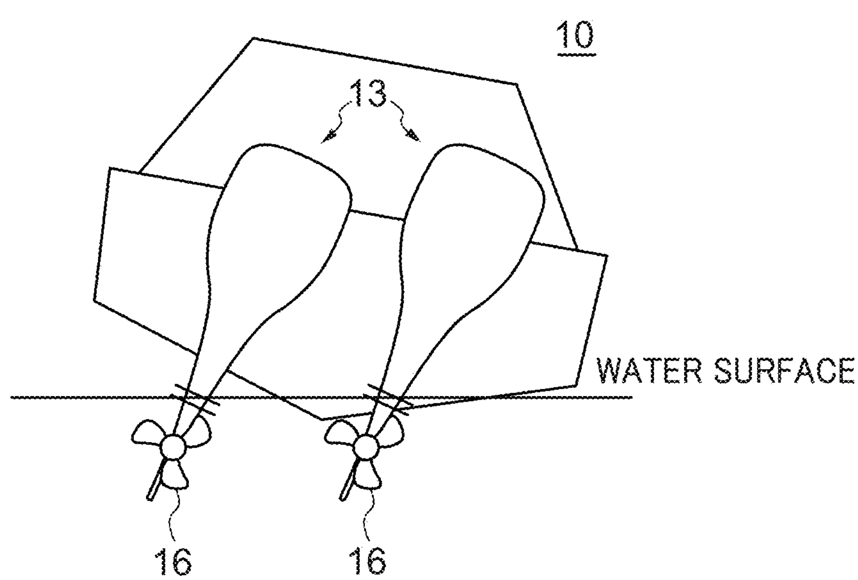


FIG. 10A

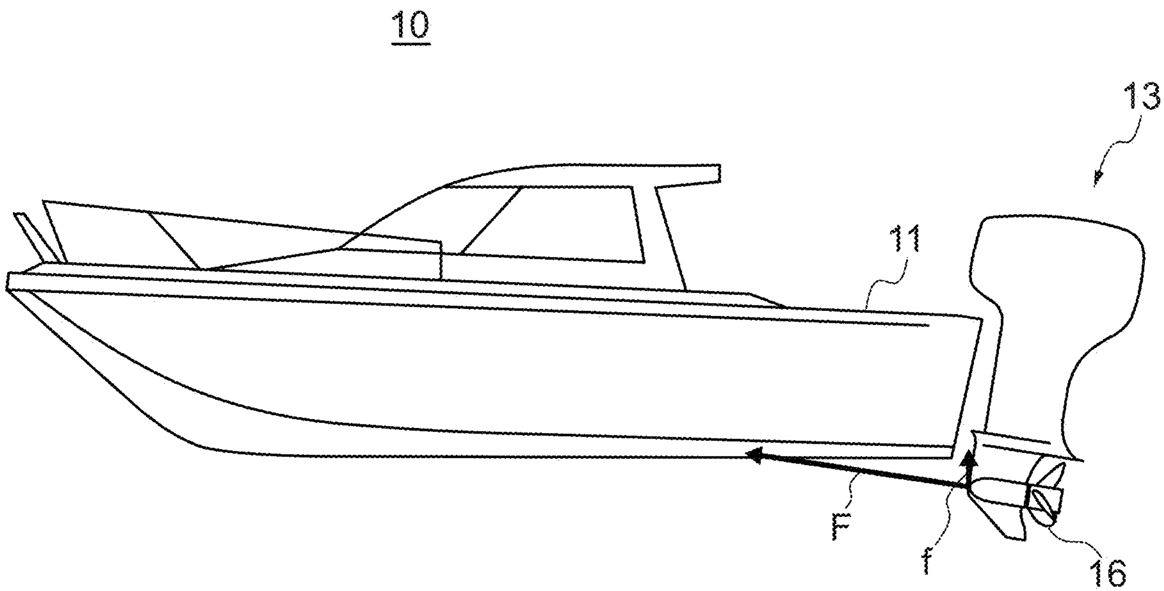


FIG. 10B

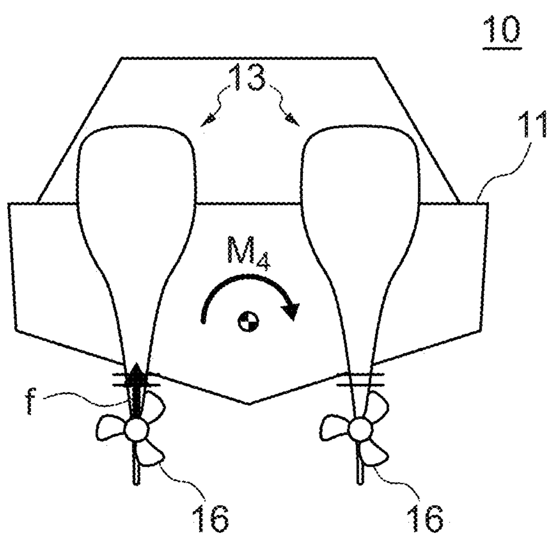


FIG. 11A

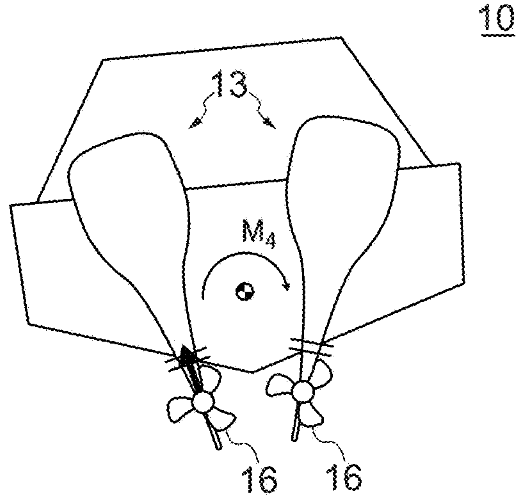


FIG. 11B

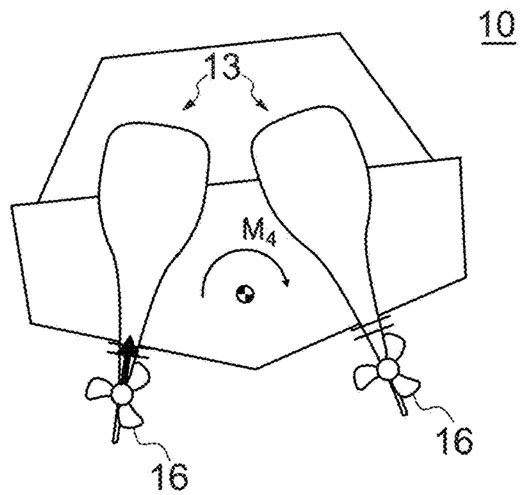
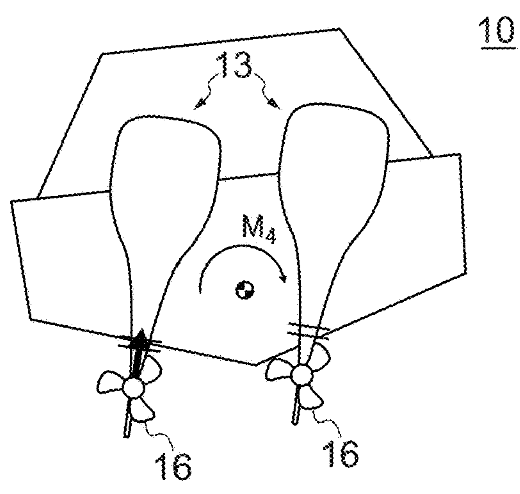


FIG. 11C



SMALL MARINE VESSEL CAPABLE IN WHICH ACTION POSITION OF THRUST FORCE IS CHANGEABLE

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of Japanese Patent Application No. 2022-94002, filed on Jun. 9, 2022, which is hereby incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002] The present invention relates to a small marine vessel including an outboard motor that can change an action position of a thrust force.

2. Description of the Related Art

[0003] A relatively small marine vessel such as a planing boat includes an outboard motor as a propulsion device. The outboard motor is attached to a stern of a hull so as to rotate about a tilt axis extending along a left-right direction of the hull. The outboard motor rotates (tilts up) such that an upper portion of the outboard motor moves forward and downward and a lower portion of the outboard motor moves rearward and upward about the tilt axis, or rotates (trims in) such that the upper portion moves rearward and downward and the lower portion moves forward and upward about the tilt axis (see, for example, Japanese Patent Application Laid-Open No. H01-317893).

[0004] In such a marine vessel, an action angle of a thrust force generated by a propeller of the outboard motor is changed by the tilting up or trimming in the outboard motor. For example, to maintain planing, the action angle of the thrust force is changed such that a bow is lowered by trimming in the outboard motor. In this manner, a posture of the hull can be controlled by the outboard motor being tilted up or trimmed in.

[0005] However, an action position of the thrust force does not change in the left-right direction of the hull even if the outboard motor is tilted up or trimmed in, and thus, the tilting-up or trimming-in of the outboard motor does not contribute to a change in yaw of the marine vessel, that is, an improvement in the turning performance of the marine vessel. The reason why the movement of the outboard motor is mainly limited to the tilting-up and the trimming-in is that an internal combustion engine is conventionally used as a power source of the outboard motor, and it is difficult to tilt the outboard motor in a direction other than a certain direction in order to establish circulation of lubricating oil in the internal combustion engine.

[0006] As a way for achieving sustainable development goals (SDGs) proposed in recent years, implementation of carbon-free of transportation has been promoted, and replacement of a power source of a marine vessel from the internal combustion engine to an electric motor has been studied. Since the electric motor does not require lubricating oil, the restriction on the movement of the outboard motor is reduced in the case of using the electric motor as the power source as compared with the case of using the internal combustion engine as the power source, and it is considered that there is room for the movement of the outboard motor to more actively contribute to maneuverability of the marine vessel.

SUMMARY OF THE INVENTION

[0007] Preferred embodiments of the present invention provide outboard motors that are each able to more actively contribute to the maneuverability of a marine vessel.

[0008] According to a preferred embodiment of the present invention, a small marine vessel includes a hull and at least one outboard motor attached to the hull, wherein the at least one outboard motor is attached to the hull to be rotatable about a first axis extending along a front-rear direction of the hull and to be movable in an up-down direction of the hull.

[0009] According to another preferred embodiment of the present invention, a small marine vessel includes a hull and at least one outboard motor attached to the hull, wherein the at least one outboard motor includes an electric motor as a power source, and the least one outboard motor is attached to the hull to be rotatable about a first axis extending along a front-rear direction of the hull.

[0010] According to the above configuration, the outboard motor can be not only rotated about a tilt axis extending along a left-right direction of the hull but also rotated about the first axis extending along a front-rear direction of the hull. Therefore, it is possible to change an action position of a thrust force generated by the propeller of the outboard motor in the left-right direction of the hull to actively change the yaw of the marine vessel. That is, it is possible to more actively contribute the movement of the outboard motor to the maneuverability of the marine vessel.

[0011] The above and other elements, features, steps, characteristics and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] FIGS. **1**A and **1**B are views schematically illustrating a configuration of a small marine vessel according to a first preferred embodiment of the present invention.

[0013] FIGS. **2**A to **2**C are views for describing a case where each of the outboard motors rotates about a corresponding roll axis.

[0014] FIGS. **3**A and **3**B are views for describing why a head-turning characteristic is able to be improved when the marine vessel performs turning on the spot.

[0015] FIGS. **4**A and **4**B are views for describing why the turning performance of the marine vessel is able to be improved.

[0016] FIGS. **5**A and **5**B are views for describing a modification of a case where each of the outboard motors rotates about a corresponding roll axis.

[0017] FIGS. **6**A and **6**B are views for describing how each propeller comes closer to a water surface when each of the outboard motors rotates about a corresponding roll axis.

[0018] FIGS. **7**A to **7**C are views for describing a case where each of the outboard motors is rotated about a corresponding roll axis and moved downward with respect to a hull according to a second preferred embodiment of the present invention.

[0019] FIGS. **8**A and **8**B are views for describing a mechanism of a link mechanism configured to tilt the outboard motor toward left/right with respect to an up-down direction along with movement of the outboard motor in the up-down direction.

[0020] FIGS. **9**A and **9**B are views for describing a modification of a case where each of the outboard motors is rotated about a corresponding roll axis and moved downward with respect to a hull.

[0021] FIGS. **10**A and **10**B are views for describing an effect caused when the outboard motor is rotated about a tilt axis in the marine vessel.

[0022] FIGS. **11**A to **11**C are views for describing a case where each of the outboard motors is rotated about a corresponding roll axis and the outboard motor on a port side is trimmed in according to a third preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0023] Hereinafter, preferred embodiments of the present invention will be described with reference to the drawings.

[0024] FIGS. **1**A and **1**B are views schematically illustrating a configuration of a small marine vessel **10** according to a first preferred embodiment of the present invention. FIG. **1**A illustrates the small marine vessel **10** when viewed from the side, and FIG. **1**B illustrates the small marine vessel **10** when viewed from the rear.

[0025] In FIGS. **1**A and **1**B, the marine vessel **10**, which is a small marine vessel, is, for example, a planing boat, and includes a hull **11** and at least one, for example in the present preferred embodiment, two outboard motors **13** as propulsion devices attached to a stern **12** of the hull **11**. A cabin **14** also serving as a cockpit is disposed on the hull **11**. Although the marine vessel **10** in FIGS. **1**A and **1**B is assumed to be a planing boat, the marine vessel **10** is not limited to a planing boat, and may be, for example, a relatively small marine vessel of a displacement type.

[0026] The outboard motor **13** includes an electric motor **15** as a power source. The electric motor **15** is disposed in an upper portion **13***a* of the outboard motor **13**. Moreover, the outboard motor **13** includes a propeller **16** disposed in a lower portion **13***b*, a propeller shaft **17** configured to rotate the propeller **16**, and a drive shaft **18** configured to transmit a driving force of the electric motor **15** to the propeller shaft **17**. The outboard motor **13** applies a thrust force to the marine vessel **10** by the propeller **16** rotated by the driving force of the electric motor **15**.

[0027] The outboard motor **13** is provided with a steering mechanism (not illustrated), and the steering mechanism swings the outboard motor **13** in a left-right direction of the hull **11** (hereinafter, "of the hull **11**" is omitted and simply referred to as the "left-right direction") with respect to the hull **11** to adjust an acting direction of the thrust force generated by the propeller **16** of the outboard motor **13** to the left and right.

[0028] Each of the outboard motors **13** is attached to the stern **12** of the hull **11** in a state of being rotatable about a roll axis **20** (first axis) extending in a front-rear direction of the hull **11** (hereinafter, "of the hull **11**" is omitted and simply referred to as the "front-rear direction"). The roll axis **20** corresponds to each of the two outboard motors **13**, and one outboard motor **13** rotates about its corresponding roll axis **20** independently of the other outboard motor **13** rotating about its corresponding roll axis **20**.

[0029] The outboard motor **13** is attached to the stern **12** of the hull **11** in a state of being rotatable about a tilt axis **19** (second axis) extending in the left-right direction. Each of the outboard motors **13** is configured to rotate counterclockwise about the tilt axis **19** in FIG. **1**A such that the upper portion **13***a* moves forward and downward of the hull **11** and the lower portion **13***b* moves rearward and upward of the hull **11**. Each of the outboard motors **13** is configured to rotate clockwise about the tilt axis **19** in FIG. **1**A such that the upper portion **13***a* moves rearward and downward of the hull **11** and the lower portion **13***b* moves forward and upward of the hull **11**. Hereinafter, with respect to the rotation of the outboard motor **13**, the former rotation is referred to as "tilting-up", and the latter rotation is referred to as "trimming-in".

[0030] FIGS. **2**A to **2**C are views for describing a case where each of the outboard motors **13** rotates about its corresponding roll axis **20**. FIGS. **2**A to **2**C illustrate the marine vessel **10** when viewed from the rear, wherein it is assumed that each of the outboard motors **13** is neither tilted up nor trimmed in.

[0031] For example, as illustrated in FIG. **2**A, each of the outboard motors **13** can rotate about its own roll axis **20** such that propellers **16** provided in the respective outboard motors move closer to each other. In this case, a position where the thrust force generated by each of the outboard motors **13** is generated is closer to the center of the hull **11** in the left-right direction, and thus, straight traveling performance of the marine vessel **10** is improved during sailing with one motor, for example, when one outboard motor **13** fails and sailing is performed only with the other outboard motor **13**.

[0032] As illustrated in FIG. **2**B, each of the outboard motors **13** can rotate about its own roll axis **20** such that propellers **16** provided in the respective outboard motors are spaced farther apart from each other. In this case, a head-turning characteristic at the time of turning on the spot in which the marine vessel **10** rotates in a yaw direction without moving forward and rearward is improved.

[0033] FIGS. **3**A and **3**B are views for describing why the head-turning characteristic is able to be improved when the marine vessel **10** performs turning on the spot. In each of FIGS. **3**A and **3**B, a line passing through the center of the hull **11** in the left-right direction and extending in the front-rear direction is referred to as a center line CL, and action points P at which thrust forces F of the respective outboard motors **13** act on the marine vessel **10** are indicated by black circles. In FIGS. **3**A and **3**B, the thrust force F to move the marine vessel **10** forward acts on the action point P on a port side, and the thrust force F to move the marine vessel **10** rearward acts on the action point P on a starboard side, so that the marine vessel **10** performs the turning on the spot toward the starboard side.

[0034] In a case where the propellers **16** of the outboard motors **13** are spaced farther apart from each other (FIG. **3**B), a distance L**2** in the left-right direction from each of the action points P to the center line CL is larger than a distance L_1 in the left-right direction from each of the action points P to the center line CL in a case where each of the outboard motors **13** does not rotate about the roll axis **20** (FIG. **3**A). As a result, regarding a yaw moment about a center of gravity G caused by the respective thrust forces F, a yaw moment M2 in a case where each of the outboard motors **13** rotates about the roll axis **20** is larger than a yaw moment M1 in a case where each of the outboard motors **13** does not rotate about the roll axis **20**. Therefore, when the propellers **16** of the outboard motors **13** are rotated about the roll axes **20** so as to be spaced farther apart from each other at the time of performing turning on the spot, the head-turning characteristic of the marine vessel **10** is improved.

[0035] Further, as illustrated in FIG. **2**C, each of the outboard motors **13** is able to turn about their roll axis **20** such that the respective propellers **16** move toward the port side (in the same direction). In this case, the turning performance of the marine vessel **10** to the starboard side is improved.

[0036] FIGS. **4**A and **4**B are views for describing why the turning performance of the marine vessel **10** is able to be improved. In each of FIGS. **4**A and **4**B, the thrust forces F of the same magnitude that move the marine vessel **10** forward act on the action point P on the port side and the action point P on the starboard side.

[0037] When the respective outboard motors **13** do not rotate about the roll axis **20** (FIG. **4**A), distances from the respective action points P to the center line CL in the left-right direction become equal. Therefore, a yaw moment about the center of gravity G caused by the thrust force F acting on the action point P on the port side and a yaw moment about the center of gravity G caused by the thrust force F acting on the action point P on the starboard side cancel each other, and as a result, the yaw moment about the center of gravity G caused by the respective thrust forces F becomes zero.

[0038] On the other hand, when both of the propellers **16** of the respective outboard motors **13** move toward the port side (FIG. **4**B), a distance in the left-right direction from the action point P on the port side to the center line CL is larger than a distance in the left-right direction from the action point P on the starboard side to the center line CL. Therefore, a yaw moment about the center of gravity G generated due to the thrust force F acting on the action point P on the port side is larger than a yaw moment about the center of gravity G generated due to the thrust force F acting on the action point P on the starboard side. As a result, a yaw moment M3 about the center of gravity G that facilitates turning of the marine vessel **10** to the starboard side is generated due to the respective thrust forces F. Therefore, when both of the propellers **16** of the respective outboard motors **13** are rotated about their roll axes **20** so as to move toward the port side, the turning performance of the marine vessel **10** toward the starboard side is improved.

[0039] Note that the outboard motors **13** may rotate about their roll axes **20** such that the respective propellers **16** move toward the starboard side. In this case, the turning performance of the marine vessel **10** toward the port side is improved.

[0040] According to the present preferred embodiment, each of the outboard motors **13** is able to be independently rotated about their roll axis **20**. Therefore, positions of the action points P of the thrust forces F generated by the propellers **16** of the respective outboard motors **13** can be changed in the left-right direction of the marine vessel **10** to actively change the yaw of the marine vessel **10**. That is, the movement of each of the outboard motors **13** more actively contributes to the maneuverability of the marine vessel **10**.

[0041] Since the power source of each of the outboard motors **13** is the electric motor **15** in the present preferred embodiment, it is unnecessary to consider an influence of tilting of the outboard motor **13** on the circulation of lubricating oil, and a rotation amount (roll amount) of each of the outboard motors **13** about the roll axis **20** can be increased. Therefore, the positions of the action points P of the thrust forces F can be changed more greatly in the left-right direction of the marine vessel **10**, and the yaw of the marine vessel **10** can be further actively changed.

[0042] Moreover, according to the present preferred embodiment, the yaw of the marine vessel **10** can be actively changed by rotating each of the outboard motors **13** about their roll axis **20**. Therefore, it is unnecessary to increase an output of the electric motor **15** of each of the outboard motors **13** more than necessary in order to improve the head-turning characteristic when turning on the spot. Further, it is unnecessary to dispose the outboard motors **13** to be greatly spaced apart from each other in the left-right direction. Therefore, the outboard motors **13** can be downsized, and the degree of freedom of the layout of the outboard motors **13** is able to be improved.

[0043] Note that in each of the cases illustrated in FIGS. **2**A to **2**C, absolute values of the roll amounts about the roll axes **20** of the left and right outboard motors **13** are the same. Instead, only one outboard motor **13** may be rotated about its corresponding roll axis **20** as illustrated in FIG. **5**A. Alternatively, as illustrated in FIG. **5**B, the absolute values of the roll amounts about the roll axes **20** of the left and right outboard motors **13** may be made different.

[0044] Next, a second preferred embodiment of the present invention will be described. The second preferred embodiment is different from the first preferred embodiment in that each of the outboard motors **13** moves also in an up-down direction of the hull **11** (hereinafter, "of the hull **11**" is omitted and simply referred to as the "up-down direction"), but is basically the same as the first preferred embodiment described above in terms of the other configurations and actions thereof. The configurations and actions thereof overlapping with those of the first preferred embodiment will not be described. Hereinafter, configurations and actions of the second preferred embodiment, different from those of the first preferred embodiment, will be described.

[0045] In a case where the marine vessel **10** as a planing boat sails at a high speed, lift acting on a vessel bottom is generated, and the marine vessel **10** shifts to a planing state. In this case, the hull **11** rises, which brings the draft shallower and brings the propellers **16** closer to a water surface. Then, when the outboard motors **13** rotate about their respective roll axes **20** (FIG. **6**B), the propellers **16** move upward with respect to the hull **11** due to the rotation, and the propellers **16** come even closer to the water surface as compared with a case where the outboard motors **13** do not rotate about their respective roll axes **20** (FIG. **6**A). Therefore, there is a possibility that cavitation occurs in the propellers **16** or air entrainment occurs in which the propellers **16** take in air above the water surface. To cope with this, the outboard motors **13** are configured to be movable in the up-down direction in the present preferred embodiment.

[0046] FIGS. **7**A to **7**C are views for describing a case where each of the outboard motors **13** is rotated about their corresponding roll axis **20** and moved downward with respect to the hull **11**. FIGS. **7**A to **7**C illustrate the marine vessel **10** when viewed from the rear, wherein it is assumed that each of the outboard motors **13** is neither tilted up nor trimmed in.

[0047] For example, as illustrated in FIG. **7**A, when each of the outboard motors **13** is rotated about their roll axis **20** such that the respective propellers **16** move closer to each other, each of the outboard motors **13** is able to be moved downward so as to cancel the upward movement of each of the propellers **16** caused by the rotation about the roll axis **20**.

[0048] Further, as illustrated in FIG. **7**B, when each of the outboard motors **13** is rotated about their roll axis **20** such that the respective propellers **16** are spaced farther apart from each other, each of the outboard motors **13** is able to be moved downward so as to cancel the upward movement of each of the propellers **16** caused by the rotation about the roll axis **20**.

[0049] Moreover, as illustrated in FIG. **7**C, when each of the outboard motors **13** is rotated about their roll axis **20** such that the respective propellers **16** move toward the port side, each of the outboard motors **13** is able to be moved downward so as to cancel the upward movement of each of the propellers **16** caused by the rotation about the roll axis **20**. Even when each of the outboard motors **13** is rotated about the roll axis **20** corresponding to each of the outboard motors such that the respective propellers **16** move toward the starboard side, each of the outboard motors **13** can be moved downward so as to cancel the upward movement of each of the propellers **16** caused by the rotation about the roll axis **20**.

[0050] According to the present preferred embodiment, since each of the outboard motors **13** is able to be moved downward in response to the rotation of each of the outboard motors **13** about their roll axis **20**, the upward movement of each of the propellers **16** caused by the rotation about the roll axis **20** is canceled which prevents each of the propellers **16** from being closer to the water surface. Therefore, it is possible to prevent the occurrence of cavitation and the occurrence of air entrainment in each of the propellers **16**.

[0051] Further, in the present preferred embodiment, the rotation about the roll axis **20** and the movement in the up-down direction of the outboard motor **13** are performed independently. In this case, two actuators including an actuator for the rotation and an actuator for the movement in the up-down direction are required. Therefore, in order to reduce the number of actuators, the marine vessel **10** may be provided with a link mechanism that tilts the outboard motor **13** toward the left-right direction with respect to the up-down direction along with the movement of the outboard motor **13** in the up-down direction.

[0052] FIGS. **8**A and **8**B are views for describing a mechanism of a link mechanism **21** configured to tilt the outboard motor **13** toward the left/right with respect to the up-down direction along with the movement of the outboard motor **13** in the up-down direction. FIGS. **8**A and **8**B illustrate the marine vessel **10** when viewed from the rear.

[0053] The link mechanism **21** includes a curved or J-shaped guide rail **22** and two cylindrical guides **23** that are loosely engaged with the guide rail **22** and are configured to be movable along the guide rail **22**. The guide rail **22** is provided on the stern **12** of the hull **11** so that a linear portion in an upper portion of the guide rail **22** extends along the up-down direction, and a curved portion in a lower portion of the guide rail **22** is offset from the upper linear portion in the left-right direction as it extends downward. Further, each of the guides **23** is provided on the front side (which faces the stern **12**) of the outboard motor **13** so as to protrude forward (toward the marine vessel **10** side). Furthermore, the guides **23** are arranged along the center line CL_1 extending in the up-down direction of the outboard motor **13**.

[0054] In the link mechanism **21**, as illustrated in FIG. **8**A, the guides **23** are loosely engaged with the linear portion in the upper portion of the guide rail **22** before the outboard motor **13** moves downward, and thus, the respective guides **23** are positioned along the up-down direction. The center line CL_1 of the outboard motor **13** is not tilted with respect to the up-down direction, and thus, the outboard motor **13** is also not tilted with respect to the up-down direction. On the other hand, as illustrated in FIG. **8**B, when the outboard motor **13** moves downward, the lower guide **23** is loosely engaged with the curved portion in the lower portion of the guide rail **22**, and thus, the lower guide **23** is offset more greatly in the left-right direction than the upper guide **23**. As a result, the center line CL_1 of the outboard motor **13** is tilted toward the left-right direction with respect to the up-down direction, and the outboard motor **13** is also tilted toward the left-right direction with respect to the up-down direction.

[0055] In the link mechanism **21**, the outboard motor **13** can be tilted toward the left-right direction with respect to the up-down direction along with the movement of the outboard motor **13** in the up-down direction. Therefore, it is possible to change the positions of the action points P of the thrust forces F generated by the propellers **16** in the left-right direction, thus actively changing the yaw of the marine vessel **10**. Further, in the link mechanism **21**, the outboard motor **13** can be tilted toward the left-right direction with respect to the up-down direction only by the actuator for moving the outboard motor **13** in the up-down direction, and thus, the number of actuators to be used is reduced.

[0056] Note that in the link mechanism **21**, the outboard motor **13** does not rotate about the roll axis **20**. However, an angle θ (rotation angle about the roll axis **20**) formed by a normal line extending from the roll axis **20** to the center line CIA_ and the left-right direction is larger than 0° when the outboard motor **13** is tilted toward the left-right direction (in FIG. **8**B, the upper portion **13**_a_ of the outboard motor **13** is tilted toward the right) with respect to the up-down direction, and thus, the outboard motor **13** substantially rotates about the roll axis **20**.

[0057] Further, the guide rail **22** is provided on the stern **12** of the hull **11** such that the linear portion in the upper portion is disposed along the up-down direction, but the linear portion in the upper portion may be slightly tilted toward the left-right direction with respect to the up-down direction.

[0058] In each of the cases illustrated in FIGS. **7**A to **7**C, the amount of downward movement of the left outboard motor **13** and the amount of downward movement of the right outboard motor **13** are the same. However, one outboard motor **13** may be configured to be movable in the up-down direction independently of the other outboard motor **13**, and the amount of movement of one outboard motor **13** in the downward direction may be different from the amount of movement of the other outboard motor **13** in the downward direction. For example, as illustrated in FIG. **9**A, the amount of downward movement of the outboard motor **13** on the starboard side may be larger than the amount of downward movement of the outboard motor **13** on the port side. In this case, the propeller **16** on the starboard side sinks deeper than the propeller **16** on the port side. Therefore, due to a difference in water pressure, the thrust force F on the starboard side becomes larger than the thrust force F on the port side, which generates a yaw moment that turns the marine vessel **10** to the port side.

[0059] When the marine vessel **10** turns, the hull **11** rolls so that one outboard motor **13** out of the left and right outboard motors **13** is lifted, and the propeller **16** of the lifted outboard motor **13** comes closer to the water surface. In this case, as illustrated in FIG. **9**B, the upward movement of the propeller **16** by the roll of the hull **11** is canceled by the lifted outboard motor **13** being moved downward, and the propellers **16** are prevented from being close to the water surface.

[0060] A third preferred embodiment of the present invention will be described. The third preferred embodiment is different from the first preferred embodiment in that each of the outboard motors **13** is not only rotated about the roll axis **20** but also rotated about the tilt axis **19**, but is basically the same as the first preferred embodiment described above in terms of the other configurations and actions thereof. The configurations and actions thereof overlapping with those of the first preferred embodiment will not be described. Hereinafter, configurations and actions thereof of the third preferred embodiment, different from those of the first preferred embodiment, will be described.

[0061] FIGS. **10**A and **10**B are views for describing an effect caused when the outboard motor **13** is rotated about the tilt axis **19** in the marine vessel **10**. In the present preferred embodiment, it is assumed that only the outboard motor **13** on one side, for example, only the outboard motor **13** on the port side is tilted up or trimmed in, and the outboard motor **13** on the starboard side is not rotated about the tilt axis **19**. Note that the right outboard motor **13** is not illustrated in FIG. **10**A.

[0062] When the outboard motor **13** on the port side is trimmed in, the thrust force F on the port side acts obliquely upward on the hull **11**, and an upward component force f is generated (FIG. The component force f lifts the port side of the hull **11**. That is, a roll moment M**4** to tilt the hull **11** to the starboard side is generated by the component force f (FIG. **10**B). Further, when only the outboard motor **13** on the port side is tilted up, the thrust force F on the port side acts obliquely downward on the hull **11**, and a downward component force is generated, and thus, a roll moment to tilt the hull **11** to the port side is generated.

[0063] Although the outboard motor **13** on the starboard side does not rotate about the tilt axis **19** in FIGS. **10**A and **10**B, the outboard motor **13** on the starboard side may also rotate about the tilt axis **19**. In such a case, it is necessary to make the component force f of the thrust force F on the port side different from a component force f of the thrust force F on the starboard side in order to generate the roll moment M**4**. Therefore, it is necessary to configure the outboard motor **13** on the starboard side to be rotatable about the tilt axis **19** independently of the outboard motor **13** on the port side, and rotate the outboard motor **13** on the starboard side such that a rotation angle about the tilt axis **19** of the outboard motor **13** on the starboard side is different from a rotation angle about the tilt axis **19** of the outboard motor **13** on the port side.

[0064] FIGS. **11**A to **11**C are views for describing a case where each of the outboard motors **13** is rotated about its corresponding roll axis **20** and the outboard motor **13** on the port side is trimmed in. FIGS. **11**A to **11**C illustrate the marine vessel **10** when viewed from the rear.

[0065] For example, as illustrated in FIG. **11**A, each of the outboard motors **13** is rotated about their respective roll axis such that the respective propellers **16** move closer to each other. At this time, an interval between the action points P of the thrust forces F is narrowed, which makes it difficult for the hull **11** to balance in the left-right direction, and the hull **11** is likely to tilt toward one side. In this case, the outboard motor **13** on one side is trimmed in to generate the roll moment M**4** so as to cancel the tilt. FIG. **11**A illustrates a case where the hull **11** tilts toward the port side. In this case, the outboard motor **13** on the port side is trimmed in to generate the roll moment M**4** that causes the hull **11** to be tilted toward the starboard side.

[0066] Further, as illustrated in FIG. **11**B, each of the outboard motors **13** is rotated about their corresponding roll axis **20** such that the propellers **16** of the respective outboard motors are spaced farther apart from each other so as to perform turning on the spot. At this time, the resistance of water acts on the side of the hull **11** and generates a roll moment, and thus the hull **11** is likely to tilt toward one side. In this case, the outboard motor **13** on one side is trimmed in to generate the roll moment M**4** so as to cancel the roll moment generated due to the resistance of water. FIG. **11**B illustrates a case where the resistance of water acts on the starboard side of the hull **11** so that the hull **11** tilts toward the port side when turning on the spot is performed toward the starboard side. In this case, the outboard motor **13** on the port side is trimmed in to generate the roll moment M**4** to tilt the hull **11** toward the starboard side.

[0067] Moreover, when the marine vessel **10** turns to the starboard side, in order to generate a yaw moment that facilitates turning to the starboard side, each of the outboard motors **13** is turned about their respective roll axis **20** such that the propellers **16** of the respective outboard motors move toward the port side as illustrated in FIG. **11**C. At this time, when the marine vessel **10** sails at a low speed, the marine vessel **10** behaves like a displacement type vessel, and thus, the hull **11** is likely to tilt toward the port side. In this case, the outboard motor **13** on the port side is trimmed in to generate the roll moment M**4** to tilt the hull **11** toward the starboard side.

[0068] Note that in a case where the marine vessel **10** is traveling at a low speed, the hull **11** is likely to tilt toward the starboard side when each of the outboard motors **13** is rotated about their respective roll axis **20** such that the propellers **16** of the respective outboard motors move toward the starboard side when the marine vessel **10** turns to the port side. In this case, the outboard motor **13** on the starboard side is trimmed in to generate a roll moment to tilt the hull **11** toward the port side.

[0069] According to the present preferred embodiment, since the outboard motor **13** on the side of the hull **11** sinking into the water is trimmed in in response to a tilt toward one side of the hull **11**, the roll moment M**4** that cancels the tilt is generated, and thus, the ride comfort is able to be improved.

[0070] Note that it is assumed that the rotation angle about the tilt axis **19** of the outboard motor **13** on the starboard side is different from the rotation angle about the tilt axis **19** of the outboard motor **13** on the port side in the present preferred embodiment, but these rotation angles may be the same. Further, each of the outboard motors **13** may be moved in the up-down direction as in the second preferred embodiment. In this case, amounts of downward movement of the left and right outboard motors **13** may be the same or different from each other.

[0071] Although preferred embodiments of the present invention have been described above, the present invention is not limited to the above-described respective preferred embodiments, and various modifications and changes can be made within the scope of the gist of the present invention. For example, the outboard motor **13** of each of the above-described preferred embodiments includes the electric motor **15** as the power source. However, the outboard motor **13** may include, as the power source, for example, a rotary engine which is an internal combustion engine in which the circulation of lubricating oil is established even when the outboard motor **13** is greatly rotated about the roll axis **20**, or a reciprocating engine that is able to suck up lubricating oil from an oil pan by a strainer even with a large tilt.

[0072] Although preferred embodiments of the present invention have been applied to the marine vessel **10** including the outboard motors **13**, the present invention may be applied to a small marine vessel including at least one inboard/outboard motor.

[0073] While preferred embodiments of the present invention have been described above, it is to be understood that variations and modifications will be apparent to those skilled in the art without departing from the scope and spirit of the present invention. The scope of the present invention, therefore, is to be determined solely by the following claims.

What is claimed is:

1. A small marine vessel comprising:
a hull; and
at least one outboard motor attached to the hull; wherein
the at least one outboard motor is attached to the hull to be rotatable about a first axis extending along a front-rear direction of the hull and to be movable in an up-down direction of the hull.

2. The small marine vessel according to claim **1**, wherein
the at least one outboard motor includes a plurality of outboard motors each having the first axis extending along the front-rear direction of the hull;
each of the plurality of outboard motors is rotatable about the first axis; and
among the plurality of outboard motors, one outboard motor is rotatable about the first axis independently of another outboard motor being rotatable about the first axis.

3. The small marine vessel according to claim **2**, wherein
each of the plurality of outboard motors includes a propeller; and
each of the plurality of outboard motors is rotatable about the first axis such that the propellers of the plurality of outboard motors are spaced farther apart from each other.

4. The small marine vessel according to claim **3**, wherein
each of the plurality of outboard motors is movable in the down direction of the hull when each of the plurality of outboard motors rotates about the first axis such that the propellers of the plurality of outboard motors are spaced farther apart from each other.

5. The small marine vessel according to claim **2**, wherein
each of the plurality of outboard motors includes a propeller; and
each of the plurality of outboard motors is rotatable about the first axis such that the propellers of the plurality of outboard motors move closer to each other.

6. The small marine vessel according to claim **5**, wherein
each of the plurality of outboard motors is movable in the downward direction of the hull when each of the plurality of outboard motors rotates about the first axis such that the propellers of the outboard motors move closer to each other.

7. The small marine vessel according to claim **2**, wherein
each of the plurality of outboard motors includes a propeller; and
each of the plurality of outboard motors is rotatable about the first axis such that the propellers of the plurality of outboard motors move in a same direction with respect to a left-right direction of the hull.

8. The small marine vessel according to claim **7**, wherein
each of the plurality of outboard motors is movable in the down direction of the hull when each of the plurality of outboard motors rotates about the first axis such that the propellers of the plurality of outboard motors move in the same direction with respect to the left-right direction of the hull.

9. The small marine vessel according to claim **1**, wherein
the at least one outboard motor includes a plurality of outboard motors; and
among the plurality of outboard motors, one outboard motor is movable in the up-down direction of the hull independently of another outboard motor being movable in the up-down direction.

10. The small marine vessel according to claim **9**, wherein
each of the plurality of outboard motors is rotatable about the first axis when moving in the up-down direction of the hull.

11. The small marine vessel according to claim **10**, further comprising:
a J-shaped guide rail and a guide movable along the J-shaped guide rail, correspondingly to each of the outboard motors, and
the guide rail is provided on the hull, and the guide is provided on the outboard motor.

12. The small marine vessel according to claim **1**, wherein
the at least one outboard motor is attached to the hull to be rotatable about a second axis extending along a left-right direction of the hull.

13. The small marine vessel according to claim **12**, wherein
the at least one outboard motor includes a plurality of outboard motors each having the second axis extending along the left-right direction of the hull;
each of the plurality of outboard motors is rotatable about the second axis; and
among the plurality of outboard motors, one outboard motor is rotatable about the second axis independently of another outboard motor being rotatable about the second axis.

14. The small marine vessel according to claim **13**, wherein
when each of the plurality of outboard motors is rotatable about the second axis, a rotation angle of the one outboard motor about the second axis is different from a rotation angle of the another outboard motor about the second axis.

15. The small marine vessel according to claim **14**, wherein

each of the plurality of outboard motors includes a propeller; and

each of the plurality of outboard motors is rotatable about the first axis such that the propellers of the plurality of outboard motors are spaced farther apart from each other.

16. The small marine vessel according to claim **14**, wherein

each of the plurality of outboard motors includes a propeller; and

each of the plurality of outboard motors is rotatable about the first axis such that the propellers of the plurality of outboard motors move closer to each other.

17. The small marine vessel according to claim **14**, wherein

each of the plurality of outboard motors includes a propeller; and

each of the plurality of outboard motors is rotatable about the first axis such that propellers of the plurality of outboard motors move in a same direction with respect to the left-right direction of the hull.

18. The small marine vessel according to claim **1**, wherein

the at least one outboard motor includes a power source including an electric motor or an internal combustion engine.

19. A small marine vessel comprising:

a hull; and

at least one outboard motor attached to the hull; wherein

each of the least one outboard motor includes an electric motor as a power source; and

each of the least one outboard motor is attached to the hull to be rotatable about a first axis extending along a front-rear direction of the hull.

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