

DESCRIPTION

STERN ADDING STRUCTURE AND VESSEL

Technical Field

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The present invention relates to a stern adding structure and a vessel, and more particularly, to a stern adding structure disposed on a vessel bottom above a propeller, and a vessel that includes the stern adding structure.

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Background Art

As disclosed in Patent Literature 1, when a propeller rotates in a water flow having a non-uniform velocity distribution, the propeller receives a large fluctuation pressure. Therefore, vibration is generated, and propagates to the hull. To reduce this hull vibration, there has been a proposed technique by which a stern tunnel fin is attached to the hull from the vessel side to a position above the propeller (see Fig. 4 to 6 of Patent Literature 1).

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As such a stern tunnel fin is attached to the hull, the water flow from the vessel side can be guided along the stern tunnel fin to a position above the propeller, so that

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the water flow in a portion where the water flow is slow
becomes faster, the velocity distribution of the water flow
flowing into the propeller is smoothed, and the hull
vibration due to the non-uniform flow velocity distribution
5 can be reduced.

Citation List

Patent Literature

10 Patent Literature 1: JP 62-137289 A

Summary of Invention

Technical Problem

15 However, in the tunnel fin as disclosed in Patent
Literature 1, it is necessary to straighten the water flow
so as to guide the water flow to a position above the
propeller. Therefore, the tunnel fin is likely to become
larger in size. Since the tunnel fin is installed, the
20 hull resistance becomes higher, and the required horsepower
increases, leading to a problem that it is difficult to
achieve energy saving.

 The present invention has been made in view of such
25 problems, and aims to provide a stern adding structure and

a vessel that are capable of reducing thrust loss and saving energy.

Solution to Problem

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The present invention provides a stern adding structure disposed on the vessel bottom above a propeller, and the stern adding structure includes: a first surface located ahead of the position of the propeller; and a second
10 surface located behind the position of the propeller. A thrust force is obtained from a pressure difference generated between the first surface and the second surface.

The first surface may be a surface that receives a
15 negative pressure when a pressure distribution during an operation of the propeller is indicated by a differential pressure, and the second surface may be a surface that receives a positive pressure when the pressure distribution during an operation of the propeller is indicated by a
20 differential pressure.

The stern adding structure may be disposed in a region where the flow velocity of the hull wake distribution is low, and have a shape not having a fin-shaped protrusion
25 that protrudes in a region where the flow velocity of the

hull wake distribution is high.

A first angle of the first surface with respect to a horizontal line may be set to an angle that is not smaller
5 than 0° and not larger than 45° .

A second angle of the second surface with respect to a horizontal line may be set to an angle that is larger than 0° but not larger than 90° .
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The first surface may have one of the shape of a flat surface, the shape of a curved surface, or a shape protruding downward.

15 The first surface may be designed to have a lateral width that is smaller at a portion closer to the rear.

The second surface may have one of the shape of a flat surface, the shape of a curved surface, or a shape
20 protruding rearward.

The stern adding structure may have an opening immediately above the propeller.

25 The stern adding structure may include a rear extension

portion that covers part of the root portion of a rudder.

Further, the present invention provides a vessel that includes a stern adding structure having any of the
5 configurations described above.

Advantageous Effects of Invention

With the stern adding structure and the vessel
10 according to the present invention described above, the first surface located ahead of the position of the propeller, and the second surface located behind the position of the propeller are formed in the stern adding structure. Accordingly, a thrust force can be obtained
15 from a pressure difference generated between the first surface and the second surface. Thus, thrust loss can be reduced, and energy saving can be achieved.

Brief Description of Drawings

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Fig. 1 is a side view of a stern portion, illustrating a vessel that includes a stern adding structure according to a first embodiment of the present invention.

Fig. 2 is a perspective view of the stern portion
25 illustrated in Fig. 1.

Fig. 3 is views illustrating the stern adding structure illustrated in Fig. 2: (A) is a side view, (B) is a view from the direction of an arrow B in Fig. 3(A), and (C) is a view from the direction of an arrow C in Fig. 3(A).

5 Fig. 4 is a wake distribution diagram illustrating a relationship between the stern adding structure and flow velocity.

Fig. 5 is pressure distribution maps around the stern portion when the propeller is in operation: (A) illustrates
10 a case where the stern adding structure is not provided, and (B) illustrates a case where the stern adding structure is provided.

Fig. 6 is a perspective view of a stern portion, illustrating a vessel that includes a stern adding
15 structure according to a second embodiment of the present invention.

Fig. 7 is views illustrating the stern adding structure illustrated in Fig. 6: (A) is a side view, (B) is a view from the direction of an arrow B in Fig. 7(A), and (C) is a
20 view from the direction of an arrow C in Fig. 7(A).

Fig. 8 is a side view of a stern portion, illustrating a vessel that includes a stern adding structure according to a third embodiment of the present invention.

Fig. 9 is a perspective view of the stern portion
25 illustrated in Fig. 8.

Fig. 10 is views illustrating the stern adding structure illustrated in Fig. 9: (A) is a side view, (B) is a view from the direction of an arrow B in Fig. 10(A), and (C) is a view from the direction of an arrow C in Fig.

5 10(A).

Fig. 11 is a perspective view of a stern portion, illustrating a vessel that includes a stern adding structure according to a fourth embodiment of the present invention.

10 Fig. 12 is views illustrating the stern adding structure illustrated in Fig. 11: (A) is a side view, (B) is a view from the direction of an arrow B in Fig. 12(A), and (C) is a view from the direction of an arrow C in Fig. 12(A).

15 Fig. 13 is a perspective view of a stern portion, illustrating a vessel that includes a stern adding structure according to a fifth embodiment of the present invention.

20 Fig. 14 is a perspective view of a stern portion, illustrating a vessel that includes a stern adding structure according to a sixth embodiment of the present invention.

Fig. 15 is a chart showing results of water tank tests using models.

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Description of Embodiments

In the description below, embodiments of the present invention will be described with reference to Figs. 1 to 15.

5 Here, Fig. 1 is a side view of the stern portion, illustrating a vessel including a stern adding structure according to a first embodiment of the present invention. Fig. 2 is a perspective view of the stern portion illustrated in Fig. 1. Fig. 3 is views illustrating the
10 stern adding structure illustrated in Fig. 2: (A) is a side view, (B) is a view from the direction of an arrow B in Fig. 3(A), and (C) is a view from the direction of an arrow C in Fig. 3(A).

15 As illustrated in Figs. 1 and 2, a vessel 1 according to the first embodiment of the present invention includes a stern adding structure 2 disposed on a vessel bottom 12 above a propeller 11, and the stern adding structure 2 includes a first surface 21 located ahead of the position
20 of the propeller 11, and a second surface 22 located behind the position of the propeller 11. Note that, in Fig. 2, the propeller 11 is not shown, for ease of explanation.

In the present specification, a "stern adding
25 structure" is intended to include both "a structure in

which an additional member that is a separate part from the hull is attached to the vessel bottom" and "a structure formed by partially deforming the hull that forms the vessel bottom".

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Further, Fig. 1 illustrates only the stern portion of the vessel 1, for ease of explanation. The vessel 1 includes: a bushing 13 that is located below the vessel bottom 12 and protrudes rearward; the propeller 11 rotatably supported by the bushing 13; a stern frame 14 disposed between the vessel bottom 12 and the bushing 13; a rudder 15 disposed on the rear side of the propeller 11; and a rudder horn 16 that is disposed on the vessel bottom 12 and supports the rudder 15.

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As illustrated in Fig. 1, the stern adding structure 2 is a protrusion disposed on the vessel bottom 12 in the space surrounded by the propeller 11 and the rudder 15 (the rudder horn 16). For example, as illustrated in Fig. 2 and Figs. 3(A) to 3(C), the stern adding structure 2 includes: the first surface 21 that is disposed on the side of the propeller 11 and has a flat surface inclined by a first angle α with respect to a horizontal line Lh; the second surface 22 that is disposed on the side of the rudder 15 and has a curved surface standing up by a second angle β

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with respect to the horizontal line Lh; a third surface 23 formed so as to be disposed on the vessel bottom 12; and a front edge 24 formed with the line of intersection between the first surface 21 and the third surface 23.

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The first surface 21 is the surface forming the bottom surface of the stern adding structure 2 facing the side of the propeller 11. The first surface 21 is designed so that the front is inclined upward by the first angle α .

10 Alternatively, the first surface 21 may be a convex surface protruding downward, though it is formed in a planar shape in the present embodiment.

The first angle α is set to an angle that is 0° or
15 larger but is not larger than 45° , for example. The numerical value of the first angle α is set within the range of $0^\circ \leq \alpha \leq 45^\circ$, depending on conditions such as the shape of the vessel bottom 12 and the horizontal length and thickness of the stern adding structure 2, for example.

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The second surface 22 is the surface forming the rear surface of the stern adding structure 2 facing the side of the rudder 15 (the rudder horn 16). The second surface 22 has the shape of a substantially partial cylindrical side
25 surface that is curved along a side peripheral surface of

the space surrounded by the first surface 21 and the third surface 23, for example. That is, the second surface 22 has a shape that protrudes rearward. With such a configuration, it is possible to reduce the increase to be
5 caused in hull resistance by the stern adding structure 2.

In the present embodiment, the side surfaces and the rear surface of the stern adding structure 2 are formed with a continuous curved surface, but the boundary between
10 the side surfaces and the rear surface may be clearly distinguished from the rest of the portions. Also, the second surface 22 is formed in the form of a curved surface in the present embodiment, but may be formed with a flat surface. Further, although not shown in the drawings, the
15 second surface 22 may have the shape of a curved surface that is recessed frontward.

The second angle β is set to an angle that is larger than 0° but not larger than 90° , for example. The
20 numerical value of the second angle β is set within the range of $0^\circ < \beta \leq 90^\circ$, depending on conditions such as the shape of the vessel bottom 12, the shape of the first surface 21, and the shape of the rudder horn 16, for example.

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The third surface 23 is a surface formed along the shape of the vessel bottom 12 at the position where the stern adding structure 2 is installed, and is not limited to the shape illustrated in the drawing. Also, the front edge 24 is formed in a substantially V-shape in conformity with the shape of the stern frame 14. Note that the front edge 24 may have a thickness. Further, the front edge 24 is not limited to the shape illustrated in the drawing.

Here, Fig. 4 is a wake distribution map illustrating the relationship between the stern adding structure and the flow velocity. In the drawing, a circle drawn below the vessel bottom 12 indicates the propeller diameter of the propeller 11. Further, the thin lines in the drawing illustrate the flow velocity at the position of the propeller surface of the propeller 11 in contour lines. A portion closer to the vessel bottom 12 has a lower flow velocity, and a portion closer to the rotating portion of the propeller 11 has a higher flow velocity.

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The stern adding structure 2 is disposed along the region that is close to the vessel bottom 12 and has a low flow velocity. For example, the stern adding structure 2 is disposed so as to fall within the range colored in gray in the drawing. Further, as illustrated in Figs. 1 and 4,

the stern adding structure 2 has a predetermined gap G
between the position of the lowermost end of the stern
adding structure 2 and the upper end of the propeller 11 in
a side view. That is, the stern adding structure 2 does
5 not have such a shape as to cover the upper portion of the
propeller 11 like a conventional tunnel fin.

Also, the stern adding structure 2 has a shape not
having a fin-shaped protrusion that protrudes in a region
10 where the flow velocity in the hull wake distribution is
high. For example, in a conventional tunnel fin, a fin
that gathers the water flow in the propeller is disposed so
as to cover the upper portion of the propeller 11. In that
case, the tip of the tunnel fin protrudes in the portion
15 where the flow velocity is high, and the hull resistance
increases. On the other hand, the stern adding structure 2
according to the present embodiment is disposed only in the
region where the flow velocity in the hull wake
distribution is low, and thus, the increase in hull
20 resistance can be reduced.

Further, in Fig. 1, where the position of the propeller
surface of the propeller 11 is represented by P, the first
surface 21 includes a surface located ahead of the position
25 P of the propeller surface, and the second surface 22

includes a surface located behind the position P of the propeller surface.

Here, Fig. 5 is a pressure distribution map around the stern portion when the propeller is in operation: (A) illustrates a case where the stern adding structure is not provided, and (B) illustrates a case where the stern adding structure is provided. The pressure distributions shown in Figs. 5(A) and 5(B) illustrate the pressure distributions in terms of differential pressure during an operation of the propeller 11.

As illustrated in Fig. 5(A), in a situation where the stern adding structure is not provided on the vessel bottom 12, a negative pressure is generated on the front side of the propeller 11 (the front side of the position P of the propeller surface) when the propeller 11 is in operation, and a positive pressure is generated on the rear side of the propeller 11 (the rear side of the position P of the propeller surface). As indicated by the arrows in the drawing, a negative pressure generates a force F1 that pulls the hull rearward, and a positive pressure generates a force F2 that pushes the rudder 15 rearward.

The vessel bottom 12 above the propeller 11 has a

surface inclined upward from the front side toward the rear side of the propeller 11, so that the pulling force F1 is generated in a direction substantially perpendicular to the surface of the vessel bottom 12 on the front side of the propeller 11, and the pushing force F2 is generated in a direction substantially perpendicular to the surface of the vessel bottom 12 on the rear side of the propeller 11. The pulling force F1 generated on the vessel bottom 12 acts obliquely rearward and downward, and the pushing force F2 generated on the vessel bottom 12 acts obliquely forward and upward, which causes a thrust loss.

As illustrated in Fig. 5(B), in a case where the stern adding structure 2 including the first surface 21 and the second surface 22 is installed on the vessel bottom 12 above the propeller 11, the first surface 21 forms a surface that receives a negative pressure when the pressure distribution during an operation of the propeller 11 is illustrated by differential pressure, and the second surface 22 forms a surface that receives a positive pressure when the pressure distribution during an operation of the propeller 11 is illustrated by differential pressure.

Therefore, as indicated by arrows in the drawing, the force F1 that pulls diagonally forward and downward, which

is a direction substantially perpendicular to the first surface 21, is generated, and the force F2 that pushes forward, which is a direction substantially perpendicular to the second surface 22, is generated. That is, as the
5 stern adding structure 2 is provided, the force F1 that pulls the hull rearward can be reduced, and the force F2 that pushes the hull forward can be increased. Accordingly, the thrust force can be obtained through the pressure difference generated between the first surface 21 and the
10 second surface 22. Thus, the thrust loss in the vessel 1 can be reduced, and energy saving in the vessel 1 can be achieved.

Next, a stern adding structure 2 according to a second
15 embodiment of the present invention is described with reference to Figs. 6 to 7(C). Here, Fig. 6 is a perspective view of a stern portion, illustrating a vessel including a stern adding structure according to the second embodiment of the present invention. Fig. 7 is views
20 illustrating the stern adding structure illustrated in Fig. 6: (A) is a side view, (B) is a view from the direction of an arrow B in Fig. 7(A), and (C) is a view from the direction of an arrow C in Fig. 7(A). Note that, in Fig. 6, the propeller 11 is not shown, for ease of explanation.

In the stern adding structure 2 according to the second embodiment, the protrusion is formed with flat surfaces. Specifically, the stern adding structure 2 includes: a first surface 21 that is disposed on the side of the propeller 11 and has a flat surface inclined by a first angle α with respect to a horizontal line Lh; a second surface 22 that is disposed on the side of a rudder 15 and has a flat surface standing by a second angle β with respect to the horizontal line Lh; a third surface 23 formed so as to be disposed on the vessel bottom 12; a front edge 24 formed with the line of intersection between the first surface 21 and the third surface 23; and a pair of fourth surfaces 25 that are surrounded by the first to third surfaces 21 to 23 and form the side surfaces on the starboard side and the portside of the protrusion.

As illustrated in Figs. 6 and 7(C), for example, the stern adding structure 2 is designed to have substantially the same thickness in the lateral direction (vessel width direction) of the vessel bottom 12, and the first surface 21 has a shape protruding downward. The first surface 21 is formed with a polyhedron that includes a main bottom surface 21a located at the center, a pair of sub bottom surfaces 21b adjacent to the pair of fourth surfaces 25, and a joining surface 21c that joins the main bottom

surface 21a and the sub bottom surfaces 21b, for example.

Note that the configuration of the first surface 21 illustrated in the drawings is merely an example, and the first surface 21 may be a polyhedron having a larger number of surfaces or a polyhedron having a smaller number of surfaces. Alternatively, the first surface 21 may be formed with a curved surface having a downwardly protruding shape as a whole.

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Also, the first surface 21 may be designed to have a lateral width that is smaller at a portion closer to the rear. For example, the lateral width W_r on the side of the second surface 22 is designed to be smaller than the lateral width W_f on the side of the front edge 24. With such a configuration, the hull resistance to be generated by the stern adding structure 2 can be lowered.

The second surface 22 is formed with a flat surface forming the rear surface of the stern adding structure 2. The second angle β is set to 90° , for example, but the second surface 22 may be a flat surface inclined by an angle within the range of $0 < \beta \leq 90^\circ$. In the first embodiment described above, the second surface 22 and the side surfaces are formed with a continuous curved surface.

However, as in the second embodiment, the second surface 22 and the fourth surfaces 25 may be distinguished from each other by flat surfaces.

5 Next, a stern adding structure 2 according to a third embodiment of the present invention is described with reference to Figs. 8 to 10(C). Here, Fig. 8 is a side view of the stern portion, illustrating a vessel including a stern adding structure according to the third embodiment of
10 the present invention. Fig. 9 is a perspective view of the stern portion illustrated in Fig. 8. Fig. 10 is views illustrating the stern adding structure illustrated in Fig. 9: (A) is a side view, (B) is a view from the direction of an arrow B in Fig. 10(A), and (C) is a view from the
15 direction of an arrow C in Fig. 10(A). Note that, in Fig. 9, the propeller 11 is not shown, for ease of explanation.

A stern adding structure 2 according to the third embodiment includes a rear extension portion 26 designed to
20 cover part of a root portion (a rudder horn 16) of a rudder 15. Specifically, the stern adding structure 2 includes: a first surface 21 that is disposed on the side of the propeller 11 and has a substantially horizontal flat surface (first angle $\alpha = 0^\circ$); a second surface 22 that is
25 disposed on the side of the rudder 15 and has a flat

surface inclined by a second angle β with respect to a horizontal line L_h ; a third surface 23 formed so as to be disposed on a vessel bottom 12; a front edge 24 formed with the line of intersection between the first surface 21 and the third surface 23; and a pair of fourth surfaces 25 that are surrounded by the first to third surfaces 21 to 23 and form the side surfaces on the starboard side and the portside of the protrusion.

10 The second surface 22 is formed with the lower surface of the rear extension portion 26. As the rear extension portion 26 forming the second surface 22 of the stern adding structure 2 is designed so as to cover the portion of the rudder horn 16 on the side of the vessel bottom 12, 15 it is possible to fill the space formed between the rudder horn 16 and the stern adding structure 2, reduce generation of vortices, and lower the hull resistance.

Further, as illustrated in Fig. 10(B), the rear 20 extension portion 26 may be designed so that the lateral width is smaller at a portion closer to the rear. With such a configuration, the increase to be caused in hull resistance by the stern adding structure 2 can be reduced.

25 Furthermore, even in a case where the second surface 22

is inclined rearward ($0^\circ < \beta < 90^\circ$), the pushing force F2 is generated in a direction perpendicular to the second surface 22 during an operation of the propeller 11, and thus, thrust loss can be reduced.

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Further, in the present embodiment, the first surface 21 is formed with a horizontal surface. In this case, the stern adding structure 2 tends to be long in the forward direction, and therefore, there is a possibility that the hull resistance will increase. Therefore, the length L21 of the first surface 21 in the ship length direction is preferably set to be a length smaller than the interval D in the ship length direction between an inflection point Q of the stern frame 14 and the rudder 15.

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Note that, as for the shape of the stern adding structure 2 at the connecting portion between the stern adding structure 2 and the root portion (the rudder horn 16) of the rudder 15, the shape based on the assumption that the rudder horn 16 is not provided is illustrated in Figs. 10(A) to 10(C), for ease of explanation. The shape of the connecting portion is formed in conformity with the shape of the rudder horn 16, and varies depending on the shape of the rudder horn 16.

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Next, a stern adding structure 2 according to a fourth embodiment of the present invention is described with reference to Figs. 11 to 12(C). Here, Fig. 11 is a perspective view of a stern portion, illustrating a vessel including a stern adding structure according to the fourth embodiment of the present invention. Fig. 12 is views illustrating the stern adding structure illustrated in Fig. 11: (A) is a side view, (B) is a view from the direction of an arrow B in Fig. 11(A), and (C) is a view from the direction of an arrow C in Fig. 11(A). Note that, in Fig. 11, the propeller 11 is not shown, for ease of explanation.

In the stern adding structure 2 according to the fourth embodiment, a first surface 21 is formed in the shape of a curved surface. The first surface 21 has a shape recessed upward as illustrated in Figs. 11 and 12(A), for example. The first angle α is defined by the angle of the tangent line of a portion standing from a boundary portion between the first surface 21 and the second surface 22. Further, the stern adding structure 2 according to the fourth embodiment illustrated in the drawings has a rear extension portion 26, but may not have the rear extension portion 26.

Note that, as for the shape of the stern adding structure 2 at the connecting portion between the stern

adding structure 2 and the root portion (the rudder horn 16) of the rudder 15, the shape based on the assumption that the rudder horn 16 is not provided is illustrated in Figs. 12(A) to 12(C), for ease of explanation. The shape of the connecting portion is formed in conformity with the shape of the rudder horn 16, and varies depending on the shape of the rudder horn 16.

Next, a stern adding structure 2 according to a fifth embodiment of the present invention is described with reference to Fig. 13. Here, Fig. 13 is a perspective view of a stern portion, illustrating a vessel including a stern adding structure according to the fifth embodiment of the present invention. Note that, in Fig. 13, the propeller 11 is not shown, for ease of explanation.

The stern adding structure 2 according to the fifth embodiment illustrated in Fig. 13 has an opening 27 formed immediately above a propeller 11. Specifically, the opening 27 is formed in a first surface 21. The opening 27 may be a recess formed in the stern adding structure 2, or may be a through hole formed to penetrate the stern adding structure 2.

As the opening 27 is formed immediately above the

propeller 11 in this manner, it is possible to ensure a sufficient gap between the propeller 11 and the stern adding structure 2, and reduce vibration to be caused in the hull by driving of the propeller 11. Note that the opening 27 may also be formed in the stern adding structure 2 not having the rear extension portion 26 as in the first embodiment or the second embodiment.

Next, a stern adding structure 2 according to a sixth embodiment of the present invention is described with reference to Fig. 14. Here, Fig. 14 is a perspective view of a stern portion, illustrating a vessel including a stern adding structure according to the sixth embodiment of the present invention. Note that, in Fig. 14, the propeller 11 is not shown, for ease of explanation.

The stern adding structure 2 according to the sixth embodiment illustrated in Fig. 14 is based on the assumption that a rudder 15 is a suspended rudder. The rudder 15 includes a fairing cover 17 that covers a shaft portion at a root portion. In this case, the stern adding structure 2 has a rear extension portion 26 designed to cover the front edge portion of the fairing cover 17, as illustrated in the drawing.

Note that the configuration of the stern adding structure 2 illustrated in Fig. 14 is substantially the same as the configuration of the stern adding structure 2 according to the third embodiment illustrated in Fig. 9.

Further, the configuration of the stern adding structure 2 may be changed to the configuration of the stern adding structure 2 according to the fourth embodiment or the fifth embodiment.

Next, results of water tank tests using models of the stern adding structures 2 according to the first embodiment, the second embodiment, and the third embodiment described above are described with reference to Fig. 15. Here, Fig. 15 is a chart illustrating the results of water tank tests using the models. In Fig. 15, the ordinate axis indicates the improvement effect (%), a positive numerical value indicates that there is an improvement effect, and a negative numerical value indicates that there is not an improvement effect.

Fig. 15 shows the results of the water tank tests in which the improvement effects of the first to third embodiments were calculated for each of the items of effective horsepower, $1-t$ (thrust deduction coefficient), $1-w_t$ (effective wake coefficient), and shaft horsepower.

White represents the first embodiment, gray represents the second embodiment, and black represents the third embodiment.

5 As for the item of effective horsepower, any improvement effect was not observed in the stern adding structures 2 of the first embodiment and the second embodiment, but an improvement effect of about 0.5% was observed in the stern adding structure 2 of the third
10 embodiment. As for the item of 1-t (thrust deduction coefficient), an improvement effect of about 3.0% was observed in the stern adding structure 2 of the first embodiment, an improvement effect of about 1.0% was observed in the stern adding structure 2 of the second
15 embodiment, and an improvement effect of about 1.0% was observed in the stern adding structure 2 of the third embodiment. As for the item of 1-wt (effective wake coefficient), any improvement effect was not observed in all the embodiments.

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 As for the item of shaft horsepower, an improvement effect of about 1.0% was observed in the stern adding structure 2 of the first embodiment, an improvement effect of about 0.5% was observed in the stern adding structure 2
25 of the second embodiment, and an improvement effect of

about 1.0% was observed in the stern adding structure 2 of the third embodiment. Although the presence/absence of an improvement effect varies with each item, an improvement effect can be eventually observed in all the embodiments in the evaluation of shaft horsepower, and it can be seen that an energy saving effect is comprehensively achieved.

The present invention is not limited to the embodiments described above, and various modifications can be made to them without departing from the scope of the present invention.

Reference Signs List

- 15 1 Vessel
- 2 Stern adding structure
- 11 Propeller
- 12 Vessel bottom
- 13 Bushing
- 20 14 Stern frame
- 15 Rudder
- 16 Rudder horn
- 17 Fairing cover
- 21 First surface
- 25 21a Main bottom surface

- 21b Sub bottom surface
- 21c Joining surface
- 22 Second surface
- 23 Third surface
- 5 24 Front edge
- 25 Fourth surface
- 26 Rear extension portion
- 27 Opening

CLAIMS

1. A stern adding structure that is disposed on a vessel bottom above a propeller, the stern adding structure comprising:

5 a first surface that is located ahead of a position of the propeller; and

 a second surface that is located behind the position of the propeller, wherein

 a thrust force is obtained from a pressure difference
10 generated between the first surface and the second surface.

2. The stern adding structure according to claim 1, wherein the first surface is a surface that receives a negative pressure when a pressure distribution during an operation of the propeller is indicated by a differential
15 pressure, and the second surface is a surface that receives a positive pressure when the pressure distribution during an operation of the propeller is indicated by a differential pressure.

3. The stern adding structure according to claim 1,
20 wherein the stern adding structure is disposed in a region where a flow velocity of the hull wake distribution is low, and has a shape not having a fin-shaped protrusion that protrudes in a region where the flow velocity of the hull wake distribution is high.

25 4. The stern adding structure according to claim 1,

wherein a first angle of the first surface with respect to a horizontal line is set to an angle that is not smaller than 0° and not larger than 45°.

5 5. The vessel according to claim 1, wherein a second angle of the second surface with respect to a horizontal line is set to an angle that is larger than 0° but not larger than 90°.

6. The stern adding structure according to claim 1, wherein the first surface has one of a shape of a flat
10 surface, a shape of a curved surface, or a shape protruding downward.

7. The stern adding structure according to claim 1, wherein the first surface has a lateral width that is smaller at a portion closer to a rear side.

15 8. The stern adding structure according to claim 1, wherein the second surface has one of a shape of a flat surface, a shape of a curved surface, or a shape protruding rearward.

9. The stern adding structure according to claim 1,
20 wherein the stern adding structure has an opening immediately above the propeller.

10. The stern adding structure according to claim 1, further comprising a rear extension portion that covers part of a root portion of a rudder.

25 11. A vessel comprising the stern adding structure

according to any one of claims 1 to 10.