

FIN DEVICE AND SHIP

DESCRIPTION

Technical Field

[0001]

The present invention relates to a fin device and a ship, and more particularly to a fin device suitable for energy saving of a ship and a ship including the fin device.

Background Art

[0002]

In recent years, from the viewpoints of an increase in crude oil prices and environmental problems such as a reduction in carbon dioxide emission, the demand for fuel efficiency improvement for a ship has increased, and further energy saving is required. Incidentally, in a stern part, a bilge vortex (separation vortex) is generally generated, and propulsion efficiency can be improved by collecting this bilge vortex with a propeller. As a device that collects this bilge vortex, for example, a device in which a substantially cylindrical duct is disposed immediately in front of a propeller (see Patent Literature 1) or a device in which fins are disposed on side surface parts of a hull (see Patent Literatures 2 , 3) have already been proposed.

[0003]

In the duct device disclosed in Patent Literature 1, a

water flow (wake) including a bilge vortex is taken into the duct, so that the flow of the water flow can be straightened in the axial direction and the bilge vortex can be efficiently collected. In addition, in the fin device disclosed in Patent Literature 2, generation of a bilge vortex is suppressed by a front fin, and spreading of a bilge vortex is suppressed by a back fin. In addition, in the bilge structure disclosed in Patent Literature 3, a bilge vortex is guided to a propeller by changing the flow direction of the generated bilge vortex toward a ship bottom.

[0004]

However, a wake at a stern part has a complicated flow, and has a zone with low speed (hereinafter referred to as a "slow zone") in addition to a bilge vortex. Therefore, in the methods of suppressing generation of a bilge vortex or straitening the direction of a bilge vortex as described in Patent Literatures 1 to 3 described above, there is a problem that a decrease in propulsion efficiency due to a slow zone other than a bilge vortex cannot be suppressed.

[0005]

In order to solve such a problem, the applicant of the present application has already obtained a patent regarding an invention of improving propulsion efficiency by concentrating regions of slow zones on a propeller surface

by disposing a fin within a predetermined range of a hull
(See Patent Literature 4).

Citation List

Patent Literature

[0006]

Patent Literature 1: JP 5132140 B1

Patent Literature 2: JP 3808726 B1

Patent Literature 3: Japanese Utility Model

Registration No. 3097653

Patent Literature 4: JP 6041440 B1

Summary of Invention

Technical Problem

[0007]

Even in the invention disclosed in Patent Literature 4, although propulsion efficiency can be improved, for example, in the case of a fat ship with a large block coefficient (CB), regions of slow zones tend to be wide, and there is room for further improvement.

[0008]

Embodiments of the present invention has been made in view of such a problem, and embodiments of the present invention seek to provide a fin device and a ship that may be capable of improving propulsion efficiency and enabling energy saving by concentrating regions of slow zones on a propeller surface.

Solution to Problem

[0009]

According to a first aspect of the present invention, a fin device disposed on a hull provided with a side flat having a planar shape and formed in the ship length direction on a ship side is provided. The fin device has a plurality of fins at least part of which of the plurality of fins is disposed within a region surrounded by a straight line L_1 connecting a stern-side lowest point P_1 of the side flat and an intersection Q between a design waterline DWL and a propeller line PL indicating a position of a propeller, a bilge height line BHL indicating a bilge height, and the propeller line PL, wherein the region includes a first region surrounded by a straight line L_2 passing through an intersection P_2 between a rear end line SEL of the side flat and the bilge height line BHL and parallel to the straight line L_1 , the straight line L_1 , the bilge height line BHL, and the propeller line PL, and at least part of each of the plurality of fins is disposed in the first region, wherein the plurality of fins includes at least two fins whose positions in a horizontal direction are different, and a fin positioned on a stern-part side is disposed above a fin positioned on a bow-part side.

[0009a]

According to a second aspect of the present invention, there is provided a fin device disposed on a hull provided with a side flat having a planar shape and formed in a ship

length direction on a ship side, the fin device comprising:
a plurality of fins at least part of which is disposed
within a region surrounded by a straight line L_1 connecting
a stern-side lowest point P_1 of the side flat and an
intersection Q between a design waterline DWL and a
propeller line PL indicating a position of a propeller, a
bilge height line BHL indicating a bilge height, and the
propeller line PL, wherein the region includes a second
region surrounded by a straight line L_3 passing through an
intersection P_3 between a vertical line FTL passing through
a front end of a first fin disposed closest to a bow part
and the bilge height line BHL and parallel to the straight
line L_1 , the straight line L_1 , the bilge height line BHL,
and the propeller line PL, and at least part of each of the
plurality of fins is disposed in the second region, wherein
the plurality of fins includes at least two fins whose
positions in a horizontal direction are different, and a
fin positioned on a stern-part side is disposed above a fin
positioned on a bow-part side.

[0010]

In addition, as disclosed, a ship including a fin
device disposed on a hull provided with a side flat having
a planar shape and formed in the ship length direction on a
ship side is provided. The ship has a plurality of fins at
least part of each of the plurality of fins is disposed

within a region surrounded by a straight line L_1 connecting a stern-side lowest point P_1 of the side flat and an intersection Q between a design waterline DWL and a propeller line PL indicating the position of a propeller, a bilge height line BHL indicating a bilge height, and the propeller line PL.

[0011]

In the fin device and the ship described above, the region may include a first region surrounded by a straight line L_2 passing through an intersection P_2 between a rear end line SEL of the side flat and the bilge height line BHL and parallel to the straight line L_1 , the straight line L_1 , the bilge height line BHL, and the propeller line PL, and at least part of the plurality of fins may be disposed in the first region.

[0012]

In addition, the region may include a second region surrounded by a straight line L_3 passing through an intersection P_3 between a vertical line FTL passing through a front end of a first fin disposed closest to a bow part and the bilge height line BHL and parallel to the straight line L_1 , the straight line L_1 , the bilge height line BHL, and the propeller line PL, and at least part of the plurality of fins may be disposed in the second region.

[0013]

In addition, the plurality of fins may include at least two fins whose horizontal positions are different, and a fin positioned on a stern-part side may be disposed above a fin positioned on a bow-part side.

[0014]

In addition, the plurality of fins may be disposed not to exceed a ship width.

[0015]

In addition, the plurality of fins may be disposed substantially horizontally.

[0016]

In addition, the plurality of fins may be disposed such that vortices generated by the plurality of fins interfere with each other.

[0017]

In addition, the ship may be disposed in front of a propeller disposed at a stern part, and may have a straightening device which straightens a water flow flowing into the propeller.

Advantageous Effects of Invention

[0018]

According to the fin device and the ship according to the present invention described above, since the plurality of fins is disposed within the predetermined range of the stern part, slow zones can be disturbed by vortices generated by the fins and water flows forming the slow zones can be concentrated and led to the propeller. In addition, due to synergetic effect of vortices generated by the plurality of fins, slow zones can be disturbed and concentrated more effectively. Therefore, according to the present invention, it is possible to improve propulsion efficiency and enable energy saving by concentrating

regions of slow zones on a propeller surface.

Brief Description of Drawings

[0019]

Fig. 1 is a perspective view illustrating a stern part of a ship including a fin device according to an embodiment of the present invention.

Fig. 2 is a profile diagram of the ship illustrated in Fig. 1.

Fig. 3 is a diagram illustrating a positioning method of fins, (A) illustrates a first example, and (B) illustrates a second example.

Fig. 4 is a diagram illustrating a positioning method of fins, (A) illustrates a third example, (B) illustrates a fourth example, (C) illustrates a fifth example, (D) illustrates a sixth example, and (E) illustrates a seventh example.

Fig. 5 is a diagram illustrating a positioning method of fins, (A) illustrates an eighth example, and (B) illustrates a ninth example.

Fig. 6 is a distribution diagram illustrating the relationship between the positional relationship of fins and wake fraction improvement effect.

Figs. 7(A) and 7(B) are side views illustrating a stern part of a ship including a fin device and a straightening device, (A) illustrates a case where there are two fins,

and (B) illustrates a case where there are three fins.

Fig. 8 is a comparative diagram illustrating energy saving effect.

Description of Embodiments

[0020]

Hereinafter, an embodiment of the present invention will be described with reference to Figs. 1 to 8. Here, Fig. 1 is a perspective view illustrating a stern part of a ship including a fin device according to an embodiment of the present invention. Fig. 2 is a profile diagram of the ship illustrated in Fig 1. Note that in Fig. 1, for the sake of convenience of the description, drawings of structures (a propeller, a rudder, and the like) other than a hull are omitted.

[0021]

As illustrated in Figs. 1 and 2, a ship 1 according to an embodiment of the present invention includes a fin device 2 disposed on a hull provided with a side flat 11 having a planar shape and formed in the ship length direction on a ship side. The ship 1 has two fins (a first fin 21 and a second fin 22) within a region α surrounded by a straight line L_1 connecting a stern-side lowest point P_1 of the side flat 11 and an intersection Q between a design waterline DWL and a propeller line PL indicating the position of a propeller 12, a bilge height line BHL

indicating a bilge height, and the propeller line PL. Note that in the following description, the first fin 21 and the second fin 22 will be collectively referred to as fins 21, 22.

[0022]

The profile diagram illustrated in Fig. 2 is obtained by integrating a plurality of profile diagrams of the ship 1 into one diagram. Here, six profile diagrams of a hull center profile diagram F1 (solid line) illustrating the outer shape on the vertical plane including a hull center line, a side flat profile diagram F2 (solid line) illustrating the outer edge of the side flat 11, a water plane profile diagram F3 (solid line) illustrating the outer shape on a horizontal plane including the first fin 21, a water plane profile diagram F4 (solid line) illustrating the outer shape on the horizontal plane including the second fin 22, a waterline plane profile diagram F5 (broken line) illustrating the outer shape on the horizontal plane including a design waterline DWL, and a deck plane profile diagram F6 (two-dot chain line) illustrating the outer shape on the horizontal plane including a deck are illustrated in an integrated manner.

[0023]

Note that regarding the water plane profile diagram F3, the water plane profile diagram F4, the waterline plane

profile diagram F5, and the deck plane profile diagram F6, only the right half region (starboard side) with respect to the hull center line is illustrated. Therefore, $B/2$ illustrated in the diagram indicates the half width of the ship width B .

[0024]

In the hull center profile diagram F1, the straight part at the lower end indicates a ship bottom 13 of the ship 1 and the straight part at the upper end indicates a deck 14 of the ship 1. The position of the ship bottom 13 is generally referred to as a baseline BL. In addition, in Fig. 2, reference sign 1a indicates a bow part, and reference sign 1b indicates a stern part.

[0025]

The side flat 11 is formed in a substantially central part in side view of the hull and has a straight part 11a substantially parallel to the ship bottom 13. The rear end of the straight part 11a corresponds to the stern-side lowest point P_1 of the side flat 11. In addition, the difference (vertical distance) between the ship bottom 13 and the straight part 11a indicates the bilge height (height of a curved portion on both sides of the ship bottom 13). Note that in the present embodiment, the straight part 11a coincides with the bilge height line BHL.

[0026]

In addition, the side flat 11 has a rear end part 11b formed substantially vertically on the stern part 1b side. In the present embodiment, a straight line including the rear end part 11b is defined as a rear end line SEL. In addition, the profile of the side flat 11 connecting the lower end of the rear end part 11b and the rear end (stern-side lowest point P_1) of the straight part 11a has an inclined part 11c rising from the ship bottom 13 side to the deck 14 side as it proceeds toward the stern part 1b. Note that in the case of a ship 1 which does not have a rear end part 11b, a rear end line SEL is configured of the vertical line passing through the intersection between an inclined part 11c and a deck 14.

[0027]

In addition, as illustrated in the water plane profile diagram F3 and the water plane profile diagram F4, the first fin 21 and the second fin 22 are disposed so as not to exceed the ship width B. The positions of the first fin 21 and the second fin 22 may be shifted so as not to exceed the ship width B, or a portion of the first fin 21 and the second fin 22 protruding from the ship width B may be cut.

[0028]

For example, as illustrated in Fig. 1, each of the first fin 21 and the second fin 22 is formed of a flat plate having a substantially rectangular shape, and a

corner part thereof may be rounded as needed. The attachment angle of each of the fins 21, 22 with respect to the hull is set, for example, substantially horizontal, and the angle of attack of each of the fins 21 and 22 with respect to the water flow is set, for example, 0° . In addition, although not illustrated, in order to reduce water flow resistance, each of the fins 21, 22 may have a streamline shape or a wing shape. Note that in the present embodiment, "substantially horizontal" is meant to include a state of being inclined by several degrees with respect to the horizontal.

[0029]

Next, a method of positioning the fins will be described with reference to Figs. 3(A) to 5(B). Here, Fig. 3 is a diagram illustrating a positioning method of fins, (A) illustrates a first example, and (B) illustrates a second example. Fig. 4 is a diagram illustrating a positioning method of fins, (A) illustrates a third example, (B) illustrates a fourth example, (C) illustrates a fifth example, (D) illustrates a sixth example, and (E) illustrates a seventh example. Fig. 5 is a diagram illustrating a positioning method of fins, (A) illustrates an eighth example, and (B) illustrates a ninth example. Note that in each diagram, the shape of the propeller 12 is schematically illustrated, and drawings of accessories such

as a rudder and a duct are omitted.

[0030]

As illustrated in Fig. 3(A), Q denotes the intersection between the propeller line PL indicating the position of the propeller 12 and the design waterline DWL. The propeller line PL is a propeller blade base line perpendicular to the axis of the propeller 12. In side view of the stern part 1b, L₁ denotes a straight line connecting the stern-side lowest point P₁ of the side flat 11 and the intersection Q. Assuming that a region (hatched portion in the diagram) surrounded by the straight line L₁, the design waterline DWL, and the bilge height line BHL is α , the fins 21, 22 are disposed in the region α . Note that "disposed in the region α " means that it is sufficient that at least part of the fins 21, 22 is disposed in the region α .

[0031]

For example, as illustrated in Fig. 3(A), in a case where the fin device 2 includes two fins (the first fin 21 and the second fin 22) whose positions in the horizontal direction are different, the second fin 22 disposed on the stern part 1b side is disposed above the first fin 21 positioned on the bow part 1a side. Here, the positions of the fins 21, 22 in the horizontal direction are determined, for example, based on the end parts (front end) on the bow

part 1a side. In addition, "above" means that at least part of the second fin 22 is positioned above (on the water surface side of) the first fin 21.

[0032]

For example, as illustrated in Fig. 3(B), in a case where the fin device 2 includes three fins (first fin 21 to third fin 23) whose positions in the horizontal direction are different, the positional relationship of the first fin 21 and the second fin 22 is such that the second fin 22 positioned on the stern part 1b side is disposed above the first fin 21 positioned on the bow part 1a side, and the positional relationship of the second fin 22 and the third fin 23 is such that the third fin 23 positioned on the stern part 1b side is disposed above the second fin 22 positioned on the bow part 1a side.

[0033]

Note that although not illustrated, even in a case where the fin device 2 includes four or more fins at different positions in the horizontal direction, if two fins which are disposed side by side in the front-rear direction are selected, the fin located on the stern part 1b side is disposed above the fin positioned on the bow part 1a side.

[0034]

In addition, the present embodiment is not limited to

arrangement of the fins illustrated in Figs. 3(A) and 3(B). For example, the third to fifth examples illustrated in Figs. 4(A) to 4(C) indicate positioning methods in the case of two fins, and the sixth and seventh examples illustrated in Figs. 4(D) and 4(E) indicate positioning methods in the case of three fins.

[0035]

In the third example illustrated in Fig. 4(A), the second fin 22 is disposed above and at a location horizontally identical to that of the first fin 21. As illustrated, it is sufficient that part of the second fin 22 is included in the region α , and part of the second fin 22 may protrude from the region α . Note that although not illustrated, part of the first fin 21 may protrude from the region α .

[0036]

In the fourth example illustrated in Fig. 4(B), the second fin 22 is disposed above and in front of the first fin 21. Here, "in front of" means that at least the front end of the second fin 22 is positioned in front (on the bow part 1a side) of the front end of the first fin 21.

[0037]

In the fifth example illustrated in Fig. 4(C), the second fin 22 is disposed behind and at a height identical to that of the first fin 21. Here, "behind" means that at

least the front end of the second fin 22 is positioned behind (on the stern part 1b side) of the rear end of the first fin 21.

[0038]

In the sixth example illustrated in Fig. 4(D), the second fin 22 is disposed above and behind the first fin 21, and the third fin 23 is disposed behind and at a height identical to that of the second fin 22. Note that although not illustrated, the first fin 21 and the second fin 22 may have the positional relationship of any of the third to fifth examples illustrated in Figs. 4(A) to 4(C).

[0039]

In the seventh example illustrated in Fig. 4(E), the second fin 22 is disposed above and behind the first fin 21, and the third fin 23 is disposed below and behind the second fin 22. Note that although not illustrated, the first fin 21 and the second fin 22 may have the positional relationship of any of the third to fifth examples illustrated in Figs. 4(A) to 4(C).

[0040]

In addition, as illustrated in Fig. 5(A), P_2 denotes an intersection between the rear end line SEL of the side flat 11 and the bilge height line BHL, and L_2 denotes a straight line passing through this intersection P_2 and parallel to the straight line L_1 . At this time, the fins 21, 22 may be

disposed in a first region β surrounded by the straight line L_2 , the straight line L_1 , the bilge height line BHL, and the propeller line PL. As illustrated, the first region β is a region included in the region α .

[0041]

In addition, as illustrated in Fig. 5(B), a vertical line passing through the front end of the first fin (first fin 21) disposed closest to the bow is defined as FTL, an intersection between this vertical line FTL and the bilge height line BHL is defined as P_3 , and a straight line passing through this intersection P_3 and parallel to the straight line L_1 is defined as L_3 . At this time, the fins 21, 22 may be disposed in a second region γ surrounded by the straight line L_3 , the straight line L_1 , the bilge height line BHL, and the propeller line PL.

[0042]

In the eighth and ninth examples described above, the case where there are two fins 21, 22 is illustrated; however, there may be three or more fins. In addition, arrangement of the fins 21, 22 may be the configuration illustrated in any of the third to fifth examples described above. In addition, although not illustrated, at least part of the fins 21, 22 may be included in the first region β or the second region γ , and entirety of the fins 21, 22 is not necessarily included in the first region β or the

second region γ .

[0043]

Next, the relationship between the positional relationship of the fins 21, 22 and wake fraction improvement effect in the case of two fins will be described with reference to Fig. 6. Here, Fig. 6 is a distribution diagram illustrating the relationship between the positional relationship of the fins and the wake fraction improvement effect.

[0044]

Generally, surrounding water close to the hull of the ship 1 is pulled by the ship 1 as the ship 1 travels and runs in the direction identical to that of the ship 1. A flow of water that follows the ship 1 is referred to as a wake. A value obtained by dividing the speed of the wake by the speed of the ship 1 is referred to as a wake percentage w . Assuming that the speed of the ship 1 is V and the advance speed of the propeller 12 is V_p , $V_p = V(1 - w)$ is established. " $1 - w$ " is generally referred to as a wake fraction. Therefore, as the value of the wake fraction w is larger, the advance speed V_p of the propeller 12 becomes slower with respect to the speed V of the ship 1, and propulsion efficiency is improved.

[0045]

As illustrated in Fig. 2, ΔX denotes the distance in

the horizontal direction between the front end of the first fin 21 and the front end of the second fin 22, and ΔZ denotes the distance in the vertical direction between the first fin 21 and the second fin 22. Fig. 6 illustrates simulation results of wake fraction improvement effect in the case of changing ΔX in the range of 0 to 50 m and ΔZ in the range of 2 to 8 m. Note that the numerical values of ΔX and ΔZ are merely illustrative, and are not limited to such numerical values.

[0046]

As illustrated in Fig. 6, the wake fraction can be effectively improved by disposing the second fin 22 behind (on the stern part 1b side of) and above (on the water surface side of) the first fin 21. In addition, by disposing the second fin 22 relatively close to the first fin 21, high wake fraction improvement effect can be obtained.

[0047]

In addition, three one-dot chain lines illustrated in Fig. 6 indicate the straight lines L_1 , L_2 and L_3 used in the methods of positioning the fins 21, 22 described above. As can be understood from this diagram, by disposing the fins 21, 22 in a range which is not above the straight line L_1 , it is possible to obtain certain wake fraction improvement effect. In addition, certain wake fraction improvement

effect can be obtained also by disposing the fins 21, 22 between the straight line L_1 and the straight line L_2 , and certain wake fraction improvement effect can be obtained also by disposing the front ends of the fins 21, 22 between the straight line L_1 and the straight line L_3 .

[0048]

Here, the principle of wake fraction improvement effect illustrated in Fig. 6 will be discussed with reference to Figs. 7(A) and 7(B). Figs. 7(A) and 7(B) are side views illustrating the stern part of the ship including the fin device and a straightening device, (A) illustrates a case where there are two fins, and (B) illustrates a case where there are three fins. The illustrated ship 1 includes a straightening device 15 which is disposed in front of the propeller 12 disposed in the stern part 1b and straightens a water flow flowing into the propeller 12, and a rudder 16 which is disposed behind the propeller 12 and controls the traveling direction of the ship 1.

[0049]

The straightening device 15 is, for example, a substantially cylindrical or substantially semicylindrical duct disposed immediately in front of the propeller 12. For example, a known device disclosed in JP 03-066197 B, JP 5132140 B1 or the like can be arbitrarily applied to such a straightening device 15.

[0050]

Since a water flow at the bottom part of the stern part 1b flows from the ship bottom 13 rearward (stern part 1b side) and upward (water surface side), a water flow that has hit the first fin 21 disposed substantially horizontally generates a flow (vortex 21v) that goes from the lower surface toward the upper surface of the first fin 21. Similarly, a water flow that has hit the second fin 22 generates a flow (vortex 22v) that goes from the lower surface toward the upper surface of the second fin 22.

[0051]

It is considered that these vortices 21v, 22v grow and move downstream, and at a certain point, interfere with each other to behave like a larger vortex 2v. It is considered that if this large vortex 2v is generated, slow zones of the stern part 1b can be effectively disturbed, and water flows forming the slow zones can be collected and led to the propeller 12.

[0052]

In addition, in a case where the first fin 21 and the second fin 22 are too close to each other or too far from each other, it is difficult to generate a large vortex 2v, and the influence on the slow zones of the stern part 1b is reduced. This consideration is consistent with the tendency of the wake fraction improvement effect

illustrated in Fig. 6.

[0053]

In addition, the above-described consideration also applies to the case of three fins, as illustrated in Fig. 7(B). A water flow that has collided with the third fin 23 generates a flow (vortex 23v) that goes from the lower surface toward the upper surface of the third fin 23. The vortices 21v, 22v, 23v grow and move downstream, and at a certain point, interfere with one another to behave like a larger vortex 2v.

[0054]

Therefore, based on the above consideration, it is preferable that the plurality of fins be disposed such that vortices generated by the respective fins interfere with each other. Note that even in a case where the vortices generated by the respective fins do not interfere with each other, the vortices have effect of disturbing and concentrating slow zones of the stern part 1b to some extent. That is, as long as a plurality of fins is disposed within the range described in the above-described methods for positioning fins, vortices generated by the respective fins do not necessarily have to interfere with each other.

[0055]

Finally, energy saving effect of the fin device 2

according to the present embodiment will be described.

Here, Fig. 8 is a comparative diagram illustrating energy saving effect. Sample A indicates a ship having one fin (for example, only a first fin 21), sample B indicates a ship having two fins (for example, a first fin 21 and a second fin 22), sample C indicates a ship having only a straightening device 15, sample D indicates a ship having one fin and a straightening device 15, and sample E indicates a ship having two fins and a straightening device 15.

[0056]

The energy saving effect illustrated in Fig. 8 is calculated from the results of water tank tests using a hull model. Specifically, hull models of sample A to sample E were manufactured, propulsion performance tests were performed under identical conditions for the respective samples, fuel consumption amounts were calculated from the test results, and energy saving effect was calculated from the fuel consumption amounts that was able to be reduced.

[0057]

As illustrated in Fig. 8, if sample A and sample B are compared, in a case where there are two fins, that is, the second fin 22 is added, greater energy saving effect than that in the case of one fin can be obtained. In addition,

if sample D is compared with sample E, energy saving effect of sample E is improved more than that of sample D by the amount corresponding to the number of fins increased.

[0058]

In addition, in sample D, energy saving effect of ΔE_1 can be obtained by synergistic effect of one fin (first fin 21) and the straightening device 15. This synergetic effect is due to the fact that by disposing the first fin 21, it is possible to collect wakes in slow zones which cannot be collected by a straightening device 15 in a conventional ship.

[0059]

In addition, in sample E, energy saving effect of ΔE_2 can be obtained by synergistic effect of two fins (the first fin 21 and the second fin 22) and the straightening device 15. As illustrated, ΔE_2 represents a larger numerical value than ΔE_1 , and it can be seen that sample E has higher synergistic effect than that of sample D. This means that by disposing two fins, it is possible to collect wakes in slow zones which cannot be collected by the straightening device 15 in the ship of sample D.

[0060]

The ship 1 according to the present embodiment described above is not limited to a fat ship such as a tanker, a bulk carrier, an LNG ship, an LPG ship, a ferry,

or the like, and may be applied to a fine ship such as a PCC (pure car carrier), a general cargo ship, a container ship, or the like.

[0061]

The present invention is not limited to the above-described embodiment, and it goes without saying that various modifications can be made without departing from the spirit of the present invention.

Reference Signs List

[0062]

- 1 Ship
 - 1a Bow part
 - 1b Stern part
- 2 Fin device
 - 11 Side flat
 - 11a Straight part
 - 11b Rear end part
 - 11c Inclined part
 - 12 Propeller
- 13 Ship bottom
- 14 Deck
- 15 Straightening device
- 16 Rudder
- 21 First fin
- 22 Second fin

23 Third fin

2v, 21v, 22v, 23v Vortex

F1 Hull center profile diagram

F2 Side flat profile diagram

F3 Water plane profile diagram including first fin

F4 Water plane profile diagram including second fin

F5 Waterline plane profile diagram

F6 Deck plane profile diagram

BL Baseline

BHL Bilge height line

DWL Design waterline

FTL Vertical line

L₁, L₂, L₃ Straight line

P₁ Stern-side lowest point

P₂, P₃, Q Intersection

PL Propeller line

SEL Rear end line

CLAIMS

1. A fin device disposed on a hull provided with a side flat having a planar shape and formed in a ship length direction on a ship side, the fin device comprising:

a plurality of fins at least part of which is disposed within a region surrounded by a straight line L_1 connecting a stern-side lowest point P_1 of the side flat and an intersection Q between a design waterline DWL and a propeller line PL indicating a position of a propeller, a bilge height line BHL indicating a bilge height, and the propeller line PL, wherein

the region includes a first region surrounded by a straight line L_2 passing through an intersection P_2 between a rear end line SEL of the side flat and the bilge height line BHL and parallel to the straight line L_1 , the straight line L_1 , the bilge height line BHL, and the propeller line PL, and at least part of each of the plurality of fins is disposed in the first region, wherein

the plurality of fins includes at least two fins whose positions in a horizontal direction are different, and a fin positioned on a stern-part side is disposed above a fin positioned on a bow-part side.

2. A fin device disposed on a hull provided with a side flat having a planar shape and formed in a ship length

direction on a ship side, the fin device comprising:

a plurality of fins at least part of which is disposed within a region surrounded by a straight line L_1 connecting a stern-side lowest point P_1 of the side flat and an intersection Q between a design waterline DWL and a propeller line PL indicating a position of a propeller, a bilge height line BHL indicating a bilge height, and the propeller line PL, wherein

the region includes a second region surrounded by a straight line L_3 passing through an intersection P_3 between a vertical line FTL passing through a front end of a first fin disposed closest to a bow part and the bilge height line BHL and parallel to the straight line L_1 , the straight line L_1 , the bilge height line BHL, and the propeller line PL, and at least part of each of the plurality of fins is disposed in the second region, wherein

the plurality of fins includes at least two fins whose positions in a horizontal direction are different, and a fin positioned on a stern-part side is disposed above a fin positioned on a bow-part side.

3. The fin device according to claim 1 or 2, wherein the plurality of fins is disposed such that vortices generated by the plurality of fins interfere with each other.

4. The fin device according to claim 1 or 2, wherein the plurality of fins is disposed so as not to exceed a ship width.

5. The fin device according to claim 1 or 2, wherein the plurality of fins is disposed substantially horizontally.

6. A ship comprising a fin device disposed on a hull provided with a side flat having a planar shape and formed in a ship length direction on a ship side, wherein
the fin device is the fin device according to any one of claims 1 to 5.

7. The ship according to claim 6 comprising a straightening device which is disposed in front of a propeller disposed in a stern part and straightens a water flow flowing into the propeller.