

Document Title: Specification

Title of Invention: A Structure and Method for Linking a Ship and Pusher Boat,
and a Ship Piloting Method

5 Technical Field

0001

The present invention relates to a structure for linking a ship and a pusher
boat, a linking method, and a ship piloting method, and more particularly to a
linking structure for pushing a barge with a pusher boat, a linking method for
10 same, and a piloting method for same.

Background Art

0002

It has been the convention in harbors and the like to push or tow large
15 vessels such as barges using another vessel. For example, when pushing a
barge with a pusher boat, the aft portion of the barge is linked to the stem end
portion of the pusher boat and steered by the pusher boat.

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20 As a linking structure between a barge and a pusher boat, Patent Citation 1,
for example, discloses a structure in which an indentation with a shape
corresponding to the front end portion of the pusher boat is formed at the back
end of a barge, whereby the front end portion of the pusher boat is brought into
contact with the deepest portion of the indentation, and the barge and pusher
25 boat are integrally affixed by insertion of a wedge in the gap between the pusher
boat side and the indentation.

Prior Art References

Patent Citations

30 0004

Patent Citation 1: Japanese Patent Application Publication No. 2003-40189

Summary of the Invention

Problems the Invention Seeks to Resolve

5 0005

However, pusher boats are extremely small compared to barges, so that sufficient turning ability is not attained even when steered hard by a pusher boat, and the barge's turning radius is enlarged. Therefore in circumstances such as navigating narrow bays or rivers, or where large numbers of vessels are crossing,
10 pushing of barges using a pusher boat has required extremely high skill.

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The present invention was undertaken in light of the aforementioned problems, and has the object of enabling a barge to be turned in a small turning
15 radius when the barge is being pushed.

Means for Resolving the Problem

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The linking mechanism between a vessel and a pusher boat of the present
20 invention is a linking mechanism between a vessel and a pusher boat for pushing the vessel, wherein at the back portion of the vessel, an indentation expanding in width toward the rear is formed, the deepest part of which presents an arcuate shape, and the front end portion of the pusher boat is brought into contact with the deepest portion of the indentation on the vessel; comprising a
25 pair of wires respectively connecting both sides of the indentation at the back portion of the vessel with the push boat, and a wire winching apparatus for respectively winding in and feeding out the pair of wires; whereby the pusher boat, with its front end portion in contact with the deepest portion of the vessel indentation, can be skewed as seen in plan view relative to the vessel.

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In the present invention thus constituted, with the front end portion of the pusher boat brought into contact with the deepest part of the indentation formed at the back portion of the vessel, both sides of the indentation at the back portion of the vessel are respectively connected with the back portion of the pusher boat by the pair of wires extending from the pair of wire winching apparatuses, therefore the pusher boat can be skewed relative to the vessel by winding up one of the wires using one of the wire winching apparatuses and feeding out the other wire using the other wire winching apparatus.

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In addition, in the present invention the deepest portion of the vessel indentation is formed in a shape corresponding to the front end portion of the pusher boat.

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Furthermore, in the present invention the deepest portion of the vessel indentation and the front end portion of the pusher boat respectively present corresponding arcuate shapes.

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In the present invention thus constituted, the indentation formed at the rear portion of the vessel and the front end portion of the pusher boat are formed in an arcuate shape, therefore the pusher boat can be smoothly rotated relative to the vessel with the outer perimeter surface of the front end portion of the pusher boat in contact with the inner perimeter surface of the deepest portion of the indentation formed at the rear portion of the vessel.

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Also, in the present invention the radius of the arcuate shape of the deepest portion of the indentation on the vessel is preferably approximately equal to the radius of the arc at the front end portion of the pusher boat.

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In the present invention thus constituted, the pusher boat can be turned around a vessel with the center of the arcuate shape of the front end portion of the pusher boat conformed to the deepest portion of the indentation formed in the indentation of the vessel. In addition, the contact surface area between the front end portion of the pusher boat and the deepest portion of the indentation on the vessel can be enlarged.

0012

Note that in the present invention the statement that the radius of the arcuate shape at the deepest portion of the vessel indentation is approximately equal to the radius of the arcuate shape at the front end portion of the pusher boat includes cases in which bumper material is attached to the front end portion of the pusher boat, and the distance from the center of the pusher boat arcuate shape to the outer perimeter surface of the bumper material is approximately equal to the radius of the arcuate shape of the deepest portion of the indentation, and the case in which bumper material is attached to the indentation, and the radius of the arcuate front end portion of the pusher boat is approximately equal to the distance between the center of the arcuate shape at the deepest portion of the indentation and the inner perimeter surface of the bumper material.

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The method for linking a vessel and a pusher boat of the present invention is a method for linking a vessel and a pusher boat for pushing the vessel, comprising; forming, at the back portion of the vessel, an indentation expanding in width toward the rear, the deepest part of which presents an arcuate shape; bring the front end portion of the pusher boat into contact with the deepest portion of the indentation on the vessel, connecting both sides of the indentation at the back portion of the vessel and the push boat respectively by respective pairs of wires, and providing a wire winching apparatus for respectively winding in and feeding out the pair of wires.

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The steering method in the present invention is a method for steering a vessel to which a pusher boat is connected by the linking structure above as the vessel is pushed by a pusher boat; wherein the vessel is steered by wounding in one of a pair of wires and feeding out the other to cause the pusher boat to turn relative to the vessel as seen in plan view.

In the present invention thus constituted, a vessel can be turned through a smaller turning radius by advancing the pusher boat with the pusher boat thus turned relative to the vessel.

Effect of the Invention

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In the present invention, a barge can change direction over a small radius when pushed by a pusher boat.

Brief Description of Figures

0016

Fig. 1: Shows a pusher boat in an embodiment of the present invention; (a) is a side elevation and (b) is a plan view.

Fig. 2: Shows a pusher boat in an embodiment of the present invention; (a) is a side elevation and (b) is a plan view.

Fig. 3: An expanded plan view of the ship stern area in Fig. 2(b).

Fig. 4: Shows the state in which a pusher boat is connected to the rear portion of a barge; (a) is a side elevation and (b) is a plan view.

Fig. 5: An expanded side elevation of the barge stern area in Fig. 4(a).

Fig. 6: An expanded plan view of the barge stern area in Fig. 4(b).

Fig. 7: An expanded side elevation showing the connecting structure with the barge hold empty.

Fig. 8: An expanded plan view of the barge stern area with the rear portion

of the pusher boat skewed to the port side.

Embodiments of the Invention

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5 Below, referring to drawings, we discuss in detail an embodiment of the structure and method for connecting the floating structure of the present invention and pusher boat 1, and a steering method for a floating structure. In the explanation that follows, we discuss the case in which barge 14 as a vessel is pushed by pusher boat 1.

10 Fig. 1 shows pusher boat 1 in the present embodiment; (a) is a side elevation and (b) is a plan view. Note that only the external shape of pusher boat 1 is shown in Fig. 1(b).

As shown in the these figures, pusher boat 1 in the present embodiment comprises a ship hull 2, a screw 4 disposed as a propulsion mechanism on the rear bottom portion of the ship hull 2, a rudder plate 6 as a steering mechanism
15 disposed at the rear of screw 4, and a control room 8 disposed on the deck of ship hull 2.

0018

20 Ship hull 2 is formed in its front portion as a semicircle with a predetermined radius, having the same width from the front portion to the back end portion, and rounded at the left and right corner portions at the rear. Shock absorbing materials 12A, 12B, formed, for example, of rubber, foam resin, or the like are attached to the outer perimeter surface of ship hull 2. As shown in Fig. 1,
25 shock absorbing material 12A is attached to the front portion of ship hull 2 to extend in the horizontal direction along an arcuate outer perimeter surface, and shock absorbing material 12B is attached to extend vertically from the front portion to the rear end portion of ship hull 2, separated by a gap in the horizontal direction. Wire affixing posts 10A, 10B for affixing a wire are vertically erected on
30 both sides of the rear portion of ship hull 2.

0019

Screw 4 is rotationally driven by an engine (not shown) disposed inside ship hull 2, and imparts a forward propulsive force to pusher boat 1. The drive/stop state and rotary speed of the engine that rotates screw 4 can be controlled by personnel operating a control device provided in control room 8. It is desirable that the engine rotating screw 4 have sufficient drive force to push barge 14 with pusher boat 1 connected to barge 14.

0020

Rudder plate 6 is affixed to extend rearward to rotary shaft 6a, which extends downward from the rear portion of ship hull 2. Rudder plate 6 can be rotated left and right about rotary shaft 6a, thereby enabling steering of pusher boat 1 in the advancing direction.

0021

Fig. 2 shows the barge 14 which is pushed in the present embodiment; (a) is a side elevation and (b) is a plan view. Fig. 3 is an expanded plan view of the ship stern area in Fig. 2(b). As shown in these figures, barge 14 comprises a ship hull 16, a hold 17 formed to extend in the horizontal direction of ship hull 16, and a wire maneuvering portion 20 provided at the rear portion of the ship.

0022

The shape of ship hull 16 from the front end portion to the mid portion is the same as the shape of known barge 14, and both sides at the back end are rounded in an arcuate shape. An indentation 18, approximately triangular when viewed in plan, and with the same sectional shape from the ship bottom to the gunwales, is formed at the center of the back end portion of barge 14. The indentation 18 is in a shape in which the inside edge portion of the deepest portion 18A of indentation 18 is in an arcuate shape centered on a point

positioned on the center axis of ship hull 16, and the breadth widens continuously toward the rear from this deepest portion 18A. The arcuate radius of the deepest portion 18A of indentation 18 is formed to be the same as the distance from the center of the arc at the front end portion 2A to the outside edge portion of pusher boat 1. Note that the term "outside edge portion of front end portion 2A of pusher boat 1" in this embodiment refers to the outer circumferential surface of shock absorbing material 12A; the distance from the center of the arc at front end portion 2A of pusher boat 1 to the outer edge portion is equal to a length comprised of a semicircular radius plus the thickness of shock absorbing material 12A.

Hold 17 is a rectangular space demarcated by ship hull 16, in which coal or the like is stored.

0023

Wire maneuvering portion 20 is formed of a pair of wire winch mechanisms 22A, 22B; each wire winch mechanisms 22A, 22B is able to independently wind up or feed out wires 24A and 24B. In this embodiment, prow wire winch mechanism 22B is capable of winding up or feeding out wire 24B extending on the starboard side of the ship; stern wire winch mechanism 22A is capable of winding up or feeding out wire 24A extending on the port side of the ship. Posts 26A, 26B are respectively placed at positions corresponding to the sides of the pair of wire winch mechanisms 22A, 22B at the edge of ship hull 2. In addition, guide hooks 28A, 28B are respectively provided on both side in the back end portion at the outer perimeter of ship hull 2. Wires 24A, 24B, which extend from the pair of wire winch mechanisms 22A, 22B toward the sides of ship hull, extend in the side direction, change directions due to posts 26A, 26B, and are guided by guide hooks 28A, 28B to extend rearward along the outer perimeter surface of ship hull 2.

0024

As described below, wire maneuvering portion 20 on barge 14 can be connected either wirelessly or by wire to a control device in control room 8 of pusher boat 1, and winding in or feeding out of wire to/from each wire winch mechanism 22A, 22B can be accomplished by operating the control device in
5 the control room 8 of pusher boat 1.

0025

Below we discuss a method for joining pusher boat 1 to the rear portion of barge 14.

10 Fig. 4 shows the state in which pusher boat 1 is connected to the rear portion of barge 14; (a) is a side elevation and (b) is a plan view. Figs. 5 and 6 are respectively an expanded side elevation and a plan view of the stern area of barge 14 in Figs. 4(a) and 4(b). As shown in these figures, when pusher boat 1 is joined to the rear portion of barge 14, pusher boat 1 is first disposed at the rear
15 of barge 14 so that a center axis extending longitudinally (referred to below simply as the "center axis") on the pusher boat 1 and barge 14 align, and pusher boat 1 is made to advance toward barge 14. When shock absorbing material 12A at the front end portion 2A of pusher boat 1 tightly contacts to the deepest portion 18A of indentation 18 formed at the rear portion of barge 14, pusher boat
20 1 is stopped.

0026

Next, the end portions of the pair of wires 24A, 24B extending from wire winch mechanisms 22A, 22B on barge 14 are respectively affixed to wire affixing
25 posts 10A, 10B disposed at the back end portion of pusher boat 1. The wire winch mechanisms 22A, 22B are operated using the control device in control room 8 of barge 14 so that the pair of wires 24A, 24B are wound up until slack is removed. A connection is thus made between the posts 26A, 26B on both sides of indentation 18 of barge 14 and the wire affixing posts 10A, 10B at the back of
30 pusher boat 1, using the pair of wires 24A, 24B.

0027

By doing so, front end portion 2A of pusher boat 1 comes into contact with the deepest portion 18A of indentation 18 of the barge 14, and both sides of the back end portion are pulled toward barge 14 by the pair of wires, thereby
5 enabling the front end portion 2A of barge 14 to be linked to the back end portion of pusher boat 1.

0028

10 Note that these Figs. 4(a) and 5 show the linkage structure with the hold 17 on barge 14 loaded with coal. In contrast, Fig. 7 is an expanded side elevation showing the connecting structure with the hold 17 of the barge 14 empty. Because the cross sectional shape of indentation 18 of the barge 14 is the same from the ship bottom to the top edge of the gunwales, the front end portion 2A of
15 pusher boat 1 can be made to contact the indentation 18 of the barge 14 irrespective of the amount of load on barge 14.

0029

With the linking structure between barge 14 and pusher boat 1, the arcuate
20 radius of the deepest portion 18A of indentation 18 is formed to be equal to the radius of the radial shape of the front end portion 2A of the pusher boat 1 plus the thickness of shock absorbing material 12A, therefore the relative angle (the angle of the respective center axes) of pusher boat 1 with respect to barge 14 can be changed. Below we discuss as one example the case in which barge 14
25 and pusher boat 1 are changed from a state of being arrayed in a straight line, as shown in Fig. 5, to one in which the back portion of pusher boat 1 is skewed toward the port side, as shown in Fig. 8.

0030

30 Wire 24A connected to the port side rear portion of pusher boat 1 is wound

using wire winch mechanism 22A, which corresponds to wire 24A on the port side of barge 14, and wire 24B connected to the starboard side rear portion of pusher boat 1, is fed out while slack is prevented from forming by wire winching mechanism 22B, which corresponds to starboard side wire 24B. The port side of the back end portion of pusher boat 1 is thus pulled to the side via wire 24A. Because it is formed to be equal in length to the radius of the semicircular shape of the front end portion 2A of the pusher boat 1 plus the thickness of shock absorbing material 12A, while front end portion 2A is brought into contact with the deepest portion 18A of indentation 18 on barge 14, it can be smoothly rotated about the center axis of the semicircular front end portion 2A, and the back portion of pusher boat 1 can be skewed toward the starboard side relative to the barge 14.

0031

When skewing the back portion of pusher boat 1 toward the starboard side of barge 14, it is sufficient for wire 24B connected to the starboard side of pusher boat 1 to be wound by wire winching mechanism 22B, which corresponds to the starboard side wire 24B of the barge 14, while wire 24A connected to the port side rear portion of pusher boat 1, is fed out by wire winch mechanism 22A, which corresponds to port side wire 24A, so that no slack occurs.

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Thus, using the linking structure between barge 14 and pusher boat 1 of the present embodiment, pusher boat 1 can be directed (skewed) in a desired direction relative to barge 14. Note that at this point each of the wires 24A, 24B contacts both sides of the back end portion of the ship hull 16 on barge 14. It is therefore preferable for both sides of the back end portion of the ship hull 16 of the barge 14 to be chamfered in an arcuate shape.

0033

Next we discuss a method for pushing pusher boat 1 using barge 14, with pusher boat 1 linked to the back portion of barge 14 as described above.

When barge 14 is advanced in a straight line, the pair of wire winch mechanisms 22A, 22B are first manipulated using the control device in control room 8 on pusher boat 1 to match the center axis of barge 14 with the center axis of pusher boat 1, as shown in Fig. 6. The control device in control room 8 of pusher boat 1 is then manipulated to turn screw 4 on pusher boat 1 and rotate rudder plate 6 to extend in the longitudinal direction. This results in pusher boat 1 advancing in the center axis direction of the vessel, and in barge 14 being pushed in the forward direction by pusher boat 1 so as to advance.

0034

Next we discuss the case in which barge 14 is turned through a large turning radius. When barge 14 is turned through a large turning radius, as when barge 14 is advanced in a straight line, the center axis of barge 14 is matched with the center axis of pusher boat 1, as shown in Fig 6. In this state, rudder plate 6 on pusher boat 1 is directed in the turning direction, screw 4 on pusher boat 1 is rotated, and pusher boat 1 is advanced. While it is true that because pusher boat 1 is small relative to barge 14, barge 14 cannot be turned through a small turning radius with the turning force obtained from rudder plate 6 on pusher boat 1, barge 14 can be turned by directing the rudder plate 6 on pusher boat 1.

0035

Next we discuss the case in which barge 14 is turned through a small turning radius. In the explanation below we discuss the case in which the direction of advance by barge 14 is turned toward the port side. When barge 14 is caused to turn through a small turning radius in this way, the pair of wire winching apparatuses is manipulated using the control device to direct the back portion of pusher boat 1 to the port side relative to barge 14. Note that in Fig. 8, pusher boat 1 is rotated until the side surface of the indentation 18 of the barge

14 and the side surface of pusher boat 1 come in contact, but it is sufficient for the rotational angle of pusher boat to correspond to the steering angle of barge 14. I.e., it is not necessarily required that pusher boat 1 be rotated until the side surface of the indentation 18 of the barge 14 and the side surface of pusher boat 1 come into contact.

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The rudder plate 6 on pusher boat 1 is thus positioned to extend in the front-to-back direction with pusher boat 1 skewed relative to barge 14; screw 4 is rotated so that pusher boat 1 is advanced in the center axis direction. This causes a propulsion force to be applied at the back portion of barge 14 in the forward direction of pusher boat 1 (i.e., the starboard direction of barge 14 when in the state shown in Fig. 8), so that pusher boat 1 can be significantly turned (turning the front toward port when in the state shown in Fig. 8). In other words, pusher boat 1 can be used in place of a rudder to turn barge 14.

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Moreover, to turn barge 14 further, pusher boat 1 can be skewed in the horizontal direction relative to barge 14, and the rudder plate 6 on pusher boat 1 rotated. In the state shown in Fig. 8, for example, rudder plate 6 of the pusher boat 1 can be directed so that the back portion thereof faces toward the port side, thus orienting the direction of advancement by pusher boat 1 toward the port side. By doing so, a greater sideways force acts on the back portion of barge 14 compared to the case of only skewing the back portion of pusher boat 1 toward the port side, thus enabling turning through a smaller turning radius.

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Note that in the discussion above we explained the case in which barge 14 is turned so that its advancing direction faces toward the port side, but turning the advancing direction of barge 14 toward the starboard side can be

accomplished by reversing left and right in the above-described operations.

0039

As described above, in the present embodiment, an indentation 18 shaped
5 to spread in width toward the back is formed at the back end portion of barge 14;
with front end portion 2A of pusher boat 1 placed in contact with the deepest
portion 18A of this indentation 18, the two sides of indentation 18 at the back
portion of barge 14 are respectively connected to wire affixing posts 10 on both
sides of the back portion of pusher boat 1 by the pair of wires 24A, 24B
10 extending from the pair of wire winch mechanisms 22A, 22B, therefore pusher
boat 1 can be skewed relative to barge 14 by winding one wire using one wire
winching mechanism while feeding out the other wire using the other wire
winching mechanism.

Because pusher boat 1 can be skewed relative to barge 14 according to
15 the present embodiment, pusher boat 1 can be utilized in place of a rudder to
turn barge 14. I.e., when using pusher boat 1 to push barge 14, it can be turned
using the rudder on pusher boat 1 alone if the turn is slight; if the turn is large, it
can be accomplished by skewing pusher boat 1 relative to barge 14, and if the
turn is even larger, turning can be accomplished by skewing pusher boat 1
20 relative to the barge 14, and further turning the rudder plate on pusher boat 1.
I.e., in the present embodiment, both large turning radius turns and small turning
radius turns can be easily accomplished when pushing barge 14 with pusher
boat 1.

25 0040

In the present embodiment, the deepest portion 18A of indentation 18 on
barge 14 is formed in an arcuate shape, and the front end portion 2A of pusher
boat 1 is formed in a corresponding arcuate shape, therefore by manipulating
wire winch mechanisms 22A, 22B in a state in which the outside edge portion of
30 the front end portion 2A of the pusher boat 1 is contacting the deepest portion

18A of indentation 18 on barge 14, pusher boat 1 can be smoothly rotated about the center of the arc.

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5 Furthermore, because the arcuate radius of the deepest portion 18A of indentation 18 on barge 14 is equal to the distance from the center of the arc shape on pusher boat 1 to the outer edge portion thereof, pusher boat 1 can be rotated relative to barge 14 with the center of the arcuate shape at the front end portion 2A of pusher boat 1 matched to the center of the arcuate shape of the
10 deepest portion 18A of indentation 18 on barge 14. In addition, the contact surface area between the front end portion of pusher boat 1 and the deepest portion 18A of the indentation 18 on barge 14 can be enlarged.

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15 By skewing pusher boat 1 relative to barge 14, and furthermore skewing the rudder plate 6 on pusher boat 1, barge 14 can be turned through a smaller turning radius.

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20 Note that in the present embodiment, a pair of wire winch mechanisms 22A, 22B is disposed on barge 14, but the invention is not limited thereto, and a pair of wire winch mechanisms on the pusher boat may also be provided.

0044

25 In the present embodiment, the deepest portion 18A of indentation 18 on barge 14 was formed so that the radius of the deepest portion 18A of indentation 18 on barge 14 would be equal to the distance from the center of the arc to the outer edge portion of the front end portion 2A of pusher boat 1, but the shape of indentation 18 is not limited thereto. For example, it is acceptable to form an
30 arcuate projection in the deepest portion of the barge indentation, and form an

indentation at the front end portion of the pusher boat with the same radius as this projection. However it is preferable that the shape of the deepest portion of the barge indentation be formed in a shape corresponding to the shape of the front end portion of the pusher boat.

5 It is also not necessarily a requirement that the radius of the arcuate shape in the deepest portion 18A of indentation 18 on barge 14 be equal to the distance from the arc center to the outer edge thereof on the front end portion 2A of pusher boat 1; for example, the pusher boat can be smoothly rotated even if the distance from the arc center to the outer edge thereof on the front end portion of
10 the pusher boat is made smaller than the radius of the arcuate shape of the deepest part of the indentation on the barge. However, a more stable linking structure is achieved when the radius of the arcuate shape of the deepest portion of the indentation on the barge is equal to the distance from the arc center to the outer edge thereof on the front end portion of the pusher boat,
15 since this results in a larger contacting part between the deepest part of the barge indentation and the front end portion of the pusher boat.

0045

 In the present embodiment, a shock absorbing material 12A is attached to
20 the outer perimeter of the front end portion 2A on pusher boat 1, but without such limitation, the shock absorbing material can also be attached to the inside perimeter surface of the barge indentation. In such cases it is preferable for the radius of the arcuate shape of the front end portion of the pusher boat to be equal to the distance from the center of the arcuate shape of the deepest portion
25 of the barge indentation to the inside perimeter surface of the shock absorbing material.

0046

 In the present embodiment, the ends of wires 24A, 24B were affixed to wire
30 affixing posts 10A, 10B disposed on both sides of the back portion of pusher

boat 1, but without such limitation, the wire affixing position may be freely positioned so long as it is behind the center of the front end portion semicircle on pusher boat 1.

Also, in the present embodiment wires 24A, 24B were disposed to along
5 the outside perimeter surface at the back of barge 14, but without such limitation, they could also be disposed, for example, to extend from posts 26A, 26B in a straight line to the pusher boat 1 wire affixing posts 10A, 10B.

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10 In the present embodiment, we discussed the case in which a barge 14 is pushed by a pusher boat 1, but without such limitation the present invention can also be applied to the pushing of vessels such as container ships or freighters, general passenger ships, and the like by pusher boats.

15 Explanation of Reference Numerals

0048

1:	pusher boat
2:	boat hull
4:	screw
20 6:	rudder plate
8:	control room
10A, 10B:	wire affixing posts
12A, 12B:	shock absorbing material
14:	barge
25 16:	ship hull
18:	indentation
18A:	deepest portion
20:	wire operating portion
22A, 22B:	wire winch mechanisms
30 24A, 24B:	wires

26A, 26B: posts

Document Title: Claims

Claim 1

A linking mechanism between a vessel and a pusher boat for pushing the vessel, wherein:

5 at the back portion of the vessel, an indentation expanding in width toward the rear is formed across approximately the entire width of the vessel;

 and the front end portion of the pusher boat is brought into contact with the deepest portion of the indentation on the vessel;

 wherein the mechanism comprising a pair of wires respectively connecting
10 both sides of the indentation at the back portion of the vessel with the push boat;

 and a wire winching apparatus for respectively winding in and feeding out the pair of wires;

 wherein the deepest portion of the vessel indentation and the front end portion of the pusher boat respectively present corresponding arcuate shapes,
15 and the radius of the arcuate shape of the deepest portion of the vessel indentation is approximately equal to the radius of the arcuate shape of the front end portion of the pusher boat; and

 wherein the pusher boat, with its front end portion in contact with the deepest portion of the vessel indentation, can be skewed as seen in plan view
20 relative to the vessel.

Claim 2

A linking method between a vessel and a pusher boat for pushing the vessel, comprising:

25 forming the pusher boat front end portion in an arcuate shape;

 forming an indentation at the back portion of the vessel so that its deepest portion corresponds to the front end portion of the pusher boat, with an arcuate shape approximately equal in radius to the arcuate shape of the front end portion, and with a rearward spreading width across approximately the entire width of the
30 vessel;

causing the front end portion of the pusher boat to contact the deepest portion of the vessel indentation so that, with the front end portion of the pusher boat thus brought into contact with the deepest portion of the vessel indentation, the pusher boat can be skewed as seen in plan view relative to the vessel;

5 connecting both sides of the indentation at the back portion of the vessel respectively by a pair of wires to the pusher boat; and

 providing a wire winching device for respectively winding up and feeding out the pair of wires.

10 Claim 3

 A method for steering a vessel while pushing with a pusher boat a vessel to which the pusher boat is connected by the connecting structure of Claim 1;

 wherein by winding up one and feeding out the other of the pair of wires using a wire windup apparatus, the vessel is steered by skewing the pusher boat
15 relative to the vessel as seen in plan view.