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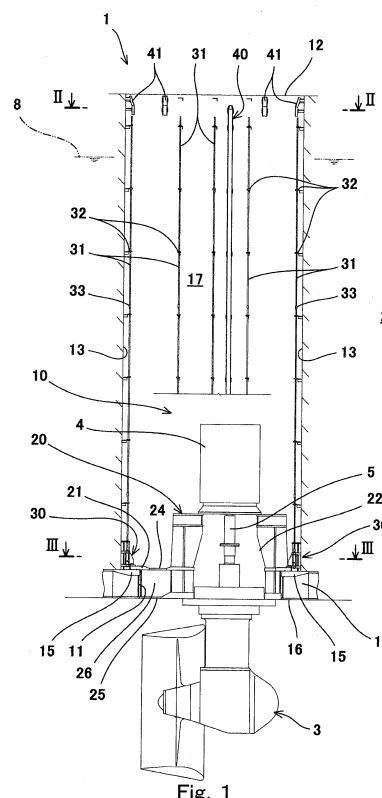
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(54) **IN-SHIP REMOVAL-TYPE THRUSTER DEVICE**

(57) A thruster apparatus (1) includes: a thruster arrangement portion (10) provided at a hull and configured to open in an upper-lower direction; a storage seat (20) by which a thruster (3) projecting downward from a thruster arrangement portion (10) is stored in the thruster arrangement portion (10); an attachment seat (15) provided at a position, to which the storage seat (20) is fixed, of the hull; and fixing bolts that fix the storage seat (20) to the attachment seat (15). The thruster arrangement portion (10) is surrounded by wall surfaces (13) constituting a part of a hull structure. Locking devices (30) configured to hold the storage seat (20) at the attachment seat (15) when the fixing by the fixing bolts is released are provided at the wall surfaces (13). Locked states of the locking devices (30) can be activated or released from an upper portion of the thruster arrangement portion (10). With this, the thruster of a drilling ship or the like can be detached at a position above a draft surface in the ship by a simple handling device such that the thruster can be inspected or repaired at an offshore operating site.



Description

Technical Field

[0001] The present invention relates to a thruster apparatus including a thruster that is detachable in a ship, the thruster being used to hold a drilling ship, a floating production facility, or the like at a fixed point or in a fixed direction.

Background Art

[0002] Conventionally, offshore oil and gas field have been developed at offshore marine areas away from lands. In recent years, water depth where the offshore oil and the gas field are developed tends to become deeper. Each of many of drilling ships, floating body type productive facilities, shuttle tankers, and the like (hereinafter may be collectively called "the drilling ships and the like (or the drilling ship or the like)") used for the developments at very deep marine areas includes a point holding system or direction holding system equipped with a plurality of thrusters. The drilling ship or the like controls its posture by the plurality of thrusters. With this, the drilling ship or the like can be held at a fixed point or in a fixed direction without being fixed to the seabed (hereinafter, these operations may be collectively called "the point holding and the like (or the point holding or the like)"). In the control of the posture for the point holding or the like, thrust forces, thrust force directions, and the like of the plurality of thrusters are controlled by utilizing, for example, GPS signals even in stormy weather such that the drilling ship or the like is held at a fixed point. The drilling ship or the like is provided with, for example, about four to six thrusters and can perform the point holding and the like.

[0003] The above thrusters require periodic maintenance and may break due to long-term use or require unexpected maintenance. However, while the drilling ship or the like is operating, for example, the drilling ship or the like has to keep on drilling the seabed by an excavation drill, so that the drilling ship or the like cannot leave the fixed position. Here, there is a thruster which can be detached and replaced underwater outside the ship when the thruster needs to be inspected or repaired (see PTL 1, for example). However, in order to detach the thruster underwater, for example, an operation of detaching the thruster underwater by divers is required. This underwater operation includes difficult operations, such as operations of attaching and detaching a plurality of wires necessary to handle the thruster underwater. As the thruster increases in size, the wires, coupling metal fittings, and the like used to detach the thruster increase in weight, and this makes the underwater operations of the divers more difficult. In addition, as a lift-up device, an inboard lift-up device and an outboard lift-up device are required. Further, since the operation of detaching the thruster cannot be performed depending on marine

weather conditions outside the ship, the detaching operation may be restricted.

[0004] The thruster may be inspected or repaired by moving the drilling ship or the like to a dock at the land. However, in this case, the timing when the thruster is inspected or repaired is restricted, and the inspection or repair of the thruster requires a large amount of time and cost.

[0005] In recent years, in order to realize the inspection and repair of the thruster at an offshore operating site, a device has been proposed, which is capable of pulling the thruster up to a position above a draft surface in the ship (in the present description and claims, the position in the ship (inboard) denotes a position in a structure, located above the draft surface, of the drilling ship or the like).

[0006] One example of this type of conventional art is a ship in which: a thruster, a thruster driving device, and a set of accessories are incorporated in a liftable tubular body; and the entire tubular body is lifted up and down by a rack & pinion drive system or a hydraulic cylinder drive system. The rack & pinion drive system is configured such that: pinions are provided at a lifted body; racks provided at a hull can extend upward; and the thruster is pulled upward by the pinions along the racks to a position above the draft surface. The hydraulic cylinder drive system is configured such that: a lifting cylinder is suspended under a deck; and a lifted body is lifted up and down by the lifting cylinder (see PTL 2, for example).

Citation List

Patent Literature

[0007]

PTL 1: Japanese Laid-Open Patent Application Publication No. 59-26397

PTL 2: Japanese Patent No. 4526184

Summary of Invention

Technical Problem

[0008] In PTL 2, the entire tubular body including the thruster and the like needs to be lifted up and down. Therefore, the weight to be lifted up and down becomes extremely large, so that a lifting device that lifts up and down the tubular body has to be a special lifting device for heavy weight. Thus, the lifting device becomes extremely expensive.

Solution to Problem

[0009] An object of the present invention is to provide a thruster apparatus including a thruster that is detachable at a position above a draft surface in a drilling ship or the like by a simple handling device such that the

thruster of the drilling ship or the like can be inspected or repaired at an offshore operating site.

[0010] To achieve this object, the present invention is an inboard detachable thruster apparatus including: a thruster arrangement portion provided at a predetermined position of a hull and configured to open in an upper-lower direction; a thruster projecting downward from a lower opening portion of the thruster arrangement portion; a storage seat by which the thruster and a thruster driving device are stored in the thruster arrangement portion; an attachment seat provided at a position, to which the storage seat is fixed, of the hull; and fixing units configured to fix the storage seat to the attachment seat, wherein: the thruster arrangement portion is surrounded by wall surfaces constituting a part of a hull structure; a locking device is provided at the wall surface and is configured to hold the storage seat at the attachment seat when the fixing by the fixing units is released; and a locked state of the locking device is activated or released from an upper portion of the thruster arrangement portion. In the present description and claims, the "hull" denotes a structure, such as a drilling ship, a floating production facility, or a shuttle tanker, floating on the ocean.

[0011] With this configuration, the upward load acting on the thruster and the storage seat by the water-level difference between the inside of the thruster arrangement portion and the outside of the hull when the fixing units that fix the thruster and the storage seat to the hull structure are detached can be held at the hull structure by the locking device. Therefore, in a state where water is not poured into the thruster arrangement portion, the operation of detaching the thruster and the storage seat from the thruster arrangement portion in the ship and the operation of attaching the thruster and the storage seat in the ship can be easily performed. Therefore, hard work underwater by divers becomes unnecessary, and two lift-up devices and the like also become unnecessary. At the time of the operation of pouring water into the thruster arrangement portion and detaching the thruster and the storage seat, the weight lifted up by the crane or the like is only the total of the weights of the thruster main body and the storage seat. Therefore, a lifting device for heavy weight is not required.

[0012] The inboard detachable thruster apparatus may be configured such that the fixing units are attachable to and detachable from the hull structure at a plurality of positions in the vicinity of the storage seat in the thruster arrangement portion.

[0013] According to this configuration, the operations of attaching and detaching the fixing units that fix the storage seat of the thruster, preparing operations before lifting-up, and post operations after lifting-down can be performed in a dry environment in the thruster arrangement portion.

[0014] The inboard detachable thruster apparatus may be configured such that: the locking device includes a locking piece configured to engage with the storage seat at a flange portion formed around the storage seat; and

by rotating a power transmission shaft, coupled to the locking piece and extending along the wall surface in the upper-lower direction, around an axis of the power transmission shaft, the locking piece is rotated around the power transmission shaft, and thereby, the locked state is activated or released.

[0015] According to this configuration, by rotating the power transmission shaft extending along the wall surface of the thruster arrangement portion in the upper-lower direction, the locking piece is rotated, and thereby, the locked state is activated or released.

[0016] The inboard detachable thruster apparatus may be configured such that: the locking device includes a wedge seat provided at an upper surface of a flange portion formed around the storage seat and a locking piece provided at the hull structure and including an engagement surface that engages with the wedge seat; and each of the wedge seat and the engagement surface of the locking piece is formed to have an inclination angle equal to or smaller than a friction angle by which a wedge effect is obtained.

[0017] According to this configuration, by rotating the locking piece of the locking device provided at the hull and causing the engagement surface of the locking piece to engage with the wedge seat, the locking piece can stably lock the wedge seat by a wedge effect. In addition, when the upward load acts, self-lock acts by the wedge effect. Therefore, the locking device can be configured to have a simple mechanism.

[0018] The inboard detachable thruster apparatus may be configured such that: the locking device is configured such that the locking piece rotates in a horizontal direction to engage with the wedge seat; a rotary driving unit configured to rotate the locking piece of the locking device to activate or release the locking device is provided at the upper portion of the thruster arrangement portion; and an expansion joint is provided between the locking device and the rotary driving unit for the locking device.

[0019] According to this configuration, since the expansion joint can prevent the upward load from acting on the rotary driving unit, the rotary driving unit is only required to transmit the rotational force to the locking device. Thus, the rotary driving unit can be configured to have a simple mechanism.

[0020] The inboard detachable thruster apparatus may be configured such that: the locking device includes a driving unit configured to cause the locking piece to engage with the wedge seat; and the driving unit is constituted by a driving machine configured to drive the locking piece by fluid pressure. For example, a rotary ram is used as a component configured to rotate the power transmission shaft by the fluid pressure.

[0021] According to this configuration, the operations become simpler, for example, the locking piece can be rotated by mechanical drive, and a plurality of locking pieces can be rotated at the same time.

[0022] The inboard detachable thruster apparatus may be configured such that: the flange portion of the storage

seat includes a seal member configured to contact the attachment seat at a position around the fixing units; and the locking device is arranged so as to be opposed to a strengthening member of the storage seat.

[0023] According to this configuration, the locking device holds a portion, where the bend amount in the upper-lower direction is small, of the flange portion. Thus, the bent amount of the flange portion is made small, and a compression return amount of the seal member provided at this flange portion is made small. Thus, the seal performance can be secured.

[0024] The inboard detachable thruster apparatus may be configured such that the thruster arrangement portion includes: lifting guides each extending in the upper-lower direction and configured to guide the storage seat, to which the thruster is attached, such that the storage seat is lifted up and down in the thruster arrangement portion; and a driving unit configured to activate or release the locking device.

[0025] According to this configuration, the locking device can be released by the driving unit in the thruster arrangement portion, and the storage seat to which the thruster is attached can be stably moved up and down along the lifting guides.

[0026] The inboard detachable thruster apparatus may be configured such that the lifting guides included in the thruster arrangement portion are at least two lifting guides respectively provided at opposing positions about a center of the storage seat.

[0027] According to this configuration, the thruster and the storage seat can be stably lifted up and down in the thruster arrangement portion, and the operation of attaching and detaching the thruster in the ship can be stably performed even if the thruster is large.

[0028] The inboard detachable thruster apparatus may be configured such that: the attachment seat includes insertion guides provided at at least two positions and configured to guide the storage seat to a predetermined position of the attachment seat when lifting down the storage seat; the thruster arrangement portion includes an opening portion whose horizontal cross section is rectangular; the at least two lifting guides are respectively provided at the opposing wall surfaces of the thruster arrangement portion, the opposing wall surfaces respectively corresponding to short sides of the opening portion; and the insertion guides provided at the at least two positions are respectively arranged on opposing surfaces of the attachment seat, the opposing surfaces respectively corresponding to the short sides of the opening portion.

[0029] According to this configuration, the lifting-up and lifting-down of the storage seat are guided by the lifting guides respectively provided at positions away from each other by a distance corresponding to a long side of the opening portion. Therefore, a rotation displacement amount of the storage seat to be lifted up and down can be made small.

[0030] The inboard detachable thruster apparatus may

be configured such that: each of the fixing units includes a fixing bolt fixed to the attachment seat and a bolt hole formed on the storage seat; each of the insertion guides includes an insertion guide pin fixed to the attachment seat and a pin hole formed on the storage seat; and when lifting down the storage seat, the pin holes are guided by the insertion guide pins, and thereby, the bolt holes of the storage seat are positioned at the fixing bolts.

[0031] According to this configuration, by setting a relation among a gap between the lifting guide and the lifting guide metal fitting provided at the flange portion of the storage seat, a gap between the fixing bolt and the bolt hole of the flange portion, and a gap between the insertion guide pin and the pin hole of the flange portion to a predetermined relation, the bolt holes are first positioned by the insertion guide pins even in a case where the fixing bolts are stud bolts. Therefore, the storage seat can be positioned relative to the attachment seat without causing the fixing bolts and the bolt holes of the flange portion to contact each other.

Advantageous Effects of Invention

[0032] According to the present invention, a thruster apparatus can be provided at low cost, the thruster apparatus being configured such that a thruster included in a drilling ship or the like can be lifted up to a position above a draft surface in the ship at an offshore operating site to be inspected or repaired.

Brief Description of Drawings

[0033]

Fig. 1 is a side view of an overall layout of an inboard detachable thruster apparatus according to one embodiment of the present invention.

Fig. 2 is an enlarged cross-sectional view taken along line II-II of Fig. 1.

Fig. 3 is an enlarged cross-sectional view taken along line III-III of Fig. 1.

Fig. 4A is an enlarged side view of a lifting guide shown in Fig. 1.

Fig. 4B is an enlarged front view of the lifting guide shown in Fig. 4A.

Fig. 5 is an enlarged view of a portion V shown in Fig. 3.

Fig. 6A is an enlarged side view showing another example of the lifting guide shown in Fig. 4.

Fig. 6B is an enlarged front view of the lifting guide shown in Fig. 6A.

Fig. 7A is an enlarged plan view showing a gap between an upper lifting guide of Fig. 6B and a lifting guide metal fitting.

Fig. 7B is an enlarged plan view showing a gap between a lower lifting guide of Fig. 6B and the lifting guide metal fitting.

Fig. 8 is an enlarged front view showing another ex-

ample of the lifting guide metal fitting shown in Fig. 5. Fig. 9 is a plan view of the lifting guide metal fitting shown in Fig. 8.

Fig. 10 is an enlarged cross-sectional view of a portion where a fixing bolt is provided as a fixing unit shown in Fig. 1.

Fig. 11 is an enlarged cross-sectional view of a portion where a bolt hole positioning insertion guide pin shown in Fig. 3 is provided.

Fig. 12 is a front view of a locking device shown in Fig. 1 and is a cross-sectional front view taken along line XII-XII of Fig. 13.

Fig. 13 is a cross-sectional side view taken along line XIII-XIII of Fig. 12.

Fig. 14 is a cross-sectional plan view taken along line XIV-XIV of Fig. 13.

Fig. 15 is an enlarged view of a lock portion of a locking device shown in Fig. 12.

Fig. 16A is a side view for explaining a procedure of detaching the thruster apparatus of Fig. 1 in a ship.

Fig. 16B is a side view for explaining a procedure of detaching the thruster apparatus in the ship, the procedure being subsequent to the procedure of Fig. 16A.

Fig. 17A is a side view for explaining a procedure of detaching the thruster apparatus in the ship, the procedure being subsequent to the procedure of Fig. 16B.

Fig. 17B is a side view for explaining a procedure of detaching the thruster apparatus in the ship, the procedure being subsequent to the procedure of Fig. 17A.

Fig. 18A is a side view for explaining a procedure of attaching the thruster apparatus of Fig. 1 in the ship.

Fig. 18B is a side view for explaining a procedure of attaching the thruster apparatus in the ship, the procedure being subsequent to the procedure of Fig. 18A.

Fig. 19A is a side view for explaining a procedure of attaching the thruster apparatus in the ship, the procedure being subsequent to the procedure of Fig. 18B.

Fig. 19B is a side view for explaining a procedure of attaching the thruster apparatus in the ship, the procedure being subsequent to the procedure of Fig. 19A.

Description of Embodiments

[0034] Hereinafter, one embodiment of the present invention will be explained based on the drawings. As one example, the embodiment below will explain a lifting-type thruster apparatus provided in a ship. In the following explanations, a left-right direction on the sheet of Fig. 1 corresponds to a front-rear direction, and a direction perpendicular to the sheet of Fig. 1 corresponds to a left-right direction. The front-rear direction and the left-right direction are shown in Figs. 2 and 3.

[0035] As shown in Fig. 1, according to an inboard detachable thruster apparatus 1 of the present embodiment, a thruster arrangement portion 10 that is open in the upper-lower direction is provided at a predetermined position of a hull 2, and a thruster 3 is provided so as to project downward from a lower opening portion 11 formed at a bottom portion of the thruster arrangement portion 10.

[0036] A horizontal cross section of the thruster arrangement portion 10 is a rectangular cross section. The thruster arrangement portion 10 extends from an upper opening portion 12 to a lower side while keeping the same cross section. The lower opening portion 11 whose cross-sectional area is smaller is formed at a lower end of the thruster arrangement portion 10. Wall surfaces 13 around the thruster arrangement portion 10 are also referred to as a hull structure 2. Since the hull 2 and the hull structure 2 are the same in configuration as each other, the same reference sign is used.

[0037] The thruster 3 is provided at a storage seat 20 that stores the thruster 3 and a thruster driving device (motor) 4. An outer shape of the storage seat 20 is formed such that the storage seat 20 is movable in the upper-lower direction in an internal space 17 of the thruster arrangement portion 10. The size of a lower portion of the storage seat 20 is set such that a predetermined gap is formed between the lower portion of the storage seat 20 and the lower opening portion 11 formed at the lower end of the thruster arrangement portion 10.

[0038] The lower opening portion 11 is formed at a structural portion 14 having a predetermined thickness at a hull bottom portion. An upper surface of the lower opening portion 11 is an attachment seat 15 for fixing a flange portion 21 provided around the storage seat 20. A lower surface of the structural portion 14 is a ship bottom member 16. The storage seat 20 is attached such that a lower portion thereof is inserted in the structural portion 14 of the lower opening portion 11. The thruster 3 projects downward from a ship bottom.

[0039] The storage seat 20 is provided with a storage portion 22 located at a position above the flange portion 21 fixed to the attachment seat 15, and a driving device 4 is provided at an upper portion of the storage portion 22. The thruster 3 of the present embodiment is attached to a lower surface of the storage seat 20, and a driving shaft 5 thereof extends through the inside of the storage portion 22 to be coupled to the driving device 4. It should be noted that components other than the driving device 4 are not shown. By detaching the flange portion 21 of the storage seat 20 from the attachment seat 15 of the hull, the thruster 3 can be detached integrally with the storage seat 20.

[0040] Each of locking devices 30 configured to hold the flange portion 21 at the attachment seat 15 in a state where below-described fixing units 60 are detached is provided between the flange portion 21 provided around the storage seat 20 and the attachment seat 15 of the hull.

[0041] A plurality of locking devices 30 are provided

around the thruster arrangement portion 10. Each of the locking devices 30 is provided with a power transmission shaft 31 extending along the wall surface 13 of the thruster arrangement portion 10 to an upper portion of the thruster arrangement portion 10. The power transmission shaft 31 is supported by a plurality of bearings 32 provided at the wall surface 13, and parts of the power transmission shaft 31 are coupled to each other by a joint 33, provided at an intermediate portion of the power transmission shaft 31, so as to be continuous in the upper-lower direction of the thruster arrangement portion 10. A rotary driving unit configured to activate or release the locking device 30 is provided at an upper portion of the power transmission shaft 31.

[0042] As described below, when an operator rotates an operating lever 55 (see Fig. 17A) that is the rotary driving unit provided at the upper portion of the thruster arrangement portion 10, the locking device 30 of the present embodiment can be activated or released through the power transmission shaft 31. A configuration in which: the power transmission shaft 31 is rotated by the operating lever 55; and as described below, the power transmission shaft 31 rotates a locking piece 34 of the locking device 30 is the rotary driving unit for the locking device 30. A component that rotates the power transmission shaft 31 may be a component, such as a rotary ram (not shown), which rotates the power transmission shaft 31 by fluid pressure. By using a mechanical drive component, such as the rotary ram, for example, a plurality of power transmission shafts 31 can be rotated at the same time. The present embodiment has explained an example of the rotary driving unit configured to activate or release the locking device 30 by the rotary operation. However, for example, depending on the configuration of the locking device 30, a driving unit may be used, which activates or releases the locking device 30 by a linear operation of causing the power transmission shaft 31 to move in the upper-lower direction. The type of the driving unit may be determined in accordance with the configuration of the locking device.

[0043] Lifting guides 40 are provided at the wall surfaces 13 of the thruster arrangement portion 10 so as to extend in the upper-lower direction. Each of the lifting guides 40 is provided continuously from a lower portion of the thruster arrangement portion 10 to the upper portion thereof. In the present embodiment, two lifting guides 40 are respectively provided at positions opposed to each other about a left-right-direction center of the storage seat 20. The storage seat 20 is guided in the upper-lower direction along the lifting guides 40 in the thruster arrangement portion 10. Thus, the thruster 3 can be lifted up and down integrally with the storage seat 20. A plurality of lift-down guides 41, which are used when the storage seat 20 taken out upward from the thruster arrangement portion 10 is suspended to be put into the thruster arrangement portion 10, are provided at the upper portion of the thruster arrangement portion 10. As with the lifting guides 40, upper ends of the lift-down guides 41 are formed as

inclined portions (see Fig. 1).

[0044] As shown in Fig. 2, the lifting guides 40 are respectively arranged at two opposing positions of the wall surfaces 13 of the thruster arrangement portion 10 having the rectangular cross section. These two lifting guides 40 extend continuously from the lower portion of the thruster arrangement portion 10 to the upper portion thereof. The lifting guides 40 are respectively provided at short-side wall surfaces (left and right wall surfaces) 13 of the rectangular cross section. Since the lifting guides 40 are respectively provided at the short sides, a distance between the lifting guides 40 can be made long, that is, can be set to a distance of a long-side wall surface (front or rear wall surface). Thus, the lifting guides 40 can stably guide the storage seat 20. By the lifting guides 40, lifting guide metal fittings 23 provided at the flange portion 21 (shown by a chain double-dashed line) of the storage seat 20 are guided along the opposing wall surfaces 13 of the thruster arrangement portion 10.

[0045] A plurality of lift-down guides 41 provided at the upper portion of the thruster arrangement portion 10 are provided around the thruster arrangement portion 10. In this example, two lift-down guides 41 are provided at each of the surfaces of the thruster arrangement portion 10 having the rectangular cross section. The lift-down guides 41 are provided such that a predetermined gap is formed between each lift-down guide 41 and the periphery of the flange portion 21 of the storage seat 20. The flange portion 21 shown by the chain double-dashed line in Fig. 2 can be inserted into a center portion of the thruster arrangement portion 10.

[0046] As shown in Fig. 3, the storage seat 20 to which the thruster 3 is attached is provided such that a center of the storage portion 22 is located at a position displaced forward from a center of the thruster arrangement portion 10. The flange portion 21 provided around the storage seat 20 is fixed to the attachment seat 15 by a plurality of fixing bolts (fixing units) 60. The fixing bolts 60 can be attached and detached inside the thruster arrangement portion 10. Fig. 3 shows a part of the plurality of fixing bolts 60. The fixing bolts 60 are provided at regular intervals along a dashed line of Fig. 3 over the entire periphery.

[0047] A web member 26 couples a surface member 24 provided so as to be flush with the flange portion 21 of the storage seat 20 and a bottom plate member 25 (see Fig. 1) provided at the lower surface of the storage seat 20. For weight reduction, the surface member 24 is provided with opening portions 27 formed at portions other than a portion where the web member 26 is provided. The surface member 24 and the web member 26 constitute a girder member 28 that is a strengthening member.

[0048] A plurality of locking devices 30 are provided around the attachment seat 15. In this example, three locking devices 30 are provided at each of the wall surfaces 13 of the rectangular cross section. The locking devices 30 are provided at opposing positions located on extended lines of the web member 26 of the girder

member 28. The locking devices 30 hold a structural portion of the storage seat 20. The locking devices 30 are provided at the opposing positions on the extended lines of the girder member 28, so that even in a case where the flange portion 21 of the storage seat 20 is bent in the upper-lower direction by water pressure or the like, the storage seat 20 can be stably held at portions at each of which a bent amount is small. In a case where the bent amount of the flange portion 21 is smaller than the bent amount of a below-described seal member 29 for keeping water-tightness, the locking devices 30 do not have to be provided at all the opposing positions on the extended lines of the girder member 28.

[0049] Insertion guides 70 are respectively provided at positions of the attachment seat 15 respectively close to the wall surfaces 13 at which the lifting guides 40 are respectively provided. With this, the storage seat 20 inserted in the thruster arrangement portion 10 is arranged at a predetermined position of the attachment seat 15. The insertion guides 70 are provided at the attachment seat 15 so as to be respectively located at opposing positions of the lower opening portion 11. The details of the insertion guides 70 will be described later.

[0050] Further, the lifting guides 40 are respectively provided substantially at left and right sides of a center line of the storage portion 22 whose center is displaced as described above. With this, the lifting guides 40 guide portions of the vicinities of front-rear direction gravity centers of the storage seat 20 and the thruster 3.

[0051] As shown in Figs. 4A and 4B, the lifting guide 40 is provided so as to project from the wall surface 13 of the thruster arrangement portion 10 toward the internal space 17. The lifting guide 40 is supported by lifting guide supporting members 42 provided at the wall surface 13 of the thruster arrangement portion 10. A guide portion 43 is formed at an upper end of the lifting guide 40 of the present embodiment. The guide portion 43 is formed to have inclined surfaces that decrease in size toward the upper side in a width direction and a wall surface direction, so that the flange portion 21 of the storage seat 20 is easily inserted from above.

[0052] As shown in Fig. 5, the lifting guide metal fitting 23 guided by the lifting guide 40 is formed in a U shape so as to be guided along three surfaces by the lifting guide 40. The lifting guide metal fitting 23 is fixed to the flange portion 21 of the storage seat 20. A gap Cg between the lifting guide metal fitting 23 and the lifting guide 40 is formed in each of the left-right direction and the front-rear direction. These gaps Cg are determined depending on a relation with the insertion guide 70 as described later.

[0053] A lifting guide 45 shown in Figs. 6A and 6B is one example different from the lifting guide 40 shown in Figs. 4A and 4B. In the following explanations, the same reference signs are used for the same components as in Figs. 4A and 4B. In this example, the lifting guide 45 is constituted by a lower lifting guide 46 and an upper lifting guide 47. The upper lifting guide 47 is the same as the

lifting guide 40 shown in Figs. 4A and 4B. However, regarding the lower lifting guide 46, the gap Cg between the lower lifting guide 46 and the lifting guide metal fitting 23 is narrower. An upper end portion of the lower lifting guide 46 is obliquely cut such that when lifting down the storage seat 20, the lifting guide metal fitting 23 can easily move from the upper lifting guide 47 to the lower lifting guide 46. Since the other components are the same as those of the lifting guide 40, the same reference signs are used.

[0054] As shown in Fig. 7A, the lifting guide metal fitting 23 is lifted up and down in a state where there is the gap Cg between the upper lifting guide 47 and the lifting guide metal fitting 23. However, as shown in Fig. 7B, the lifting guide metal fitting 23 is lifted up and down in a state where there is a gap Ca between the lower lifting guide 46 and the lifting guide metal fitting 23. As above, since the gap Ca between the lower lifting guide 46 and the lifting guide metal fitting 23 is small, the storage seat 20 lifted down to the thruster arrangement portion 10 integrally with the thruster 3 can be guided and lifted down to a more accurate position.

[0055] As shown in Figs. 8 and 9, as the lifting guide metal fitting 23, an upper lifting guide metal fitting 51 may be provided at a makeshift upper lifting guide metal fitting attachment base 50 provided at an upper portion of the storage seat 20. The upper lifting guide metal fitting attachment base 50 is provided at a position to which the driving device 4 of the storage seat 20 is attached. The upper lifting guide metal fitting 51 provided at the upper lifting guide metal fitting attachment base 50 is provided on a vertical line of the lifting guide metal fitting 23 provided at the flange portion 21 of the storage seat 20.

[0056] By providing the upper lifting guide metal fitting 51 as above, the upper lifting guide metal fitting 51 and the lifting guide metal fitting 23 of the flange portion 21 are guided by the lifting guide 40 in a state where the upper lifting guide metal fitting 51 and the lifting guide metal fitting 23 are spaced apart from each other in the upper-lower direction. Therefore, when integrally lifting up and down the storage seat 20 and the thruster 3, the lifting guides 40 can guide the storage seat 20 and the thruster 3 more stably.

[0057] Therefore, according to this example, even in a case where the center of gravity of the storage seat 20 integrated with the thruster 3 and the center of buoyancy of the storage seat 20 when the thruster 3 is lifted up and down underwater as described later are different from each other in the front-rear direction and/or the left-right direction, the inclination of the thruster 3 when the thruster 3 is lifted up and down can be prevented by the upper lifting guide metal fittings 51 provided at the upper lifting guide metal fitting attachment bases 50 and the lifting guide metal fittings 23 provided at the flange portion 21, that is, by the support at four points that are two points at upper left and right sides of the storage seat 20 and two points at lower left and right sides of the storage seat 20. Figs. 8 and 9 shows different components, and the

other components are not shown.

[0058] As shown in Fig. 10, the flange portion 21 of the storage seat 20 is fixed to the hull 2 by the fixing bolts 60 provided at the attachment seat 15 of the hull structure 2. The fixing bolts 60 of the present embodiment are stud bolts implanted in the attachment seat 15. The fixing bolt 60 is inserted in a bolt hole 61 formed on the flange portion 21, and a nut 62 is tightened to the fixing bolt 60 from above to be fixed. The seal member 29 is provided at a lower surface of the flange portion 21 so as to be located at an inner side of the fixing bolt 60 of the flange portion 21. By fixing the flange portion 21 to the attachment seat 15 by the fixing bolts 60, the lower surface of the flange portion 21 and an upper surface of the attachment seat 15 tightly contact each other to be sealed by the seal member 29. For example, an O ring is used as the seal member 29.

[0059] As shown in Fig. 11, the insertion guide 70 includes: an insertion guide pin 71 provided between the fixing bolts 60; and a pin hole 72 which is formed on the flange portion 21 and through which the insertion guide pin 71 is inserted. A tapered portion 73 that decreases in diameter is formed at an upper portion of the insertion guide pin 71, so that the insertion guide pin 71 is easily, upwardly inserted through the pin hole 72 of the flange portion 21. According to the insertion guide 70, the pin hole 72 of the storage seat 20 lifted down is guided by the insertion guide pin 71, so that the fixing bolts 60 are respectively inserted into the bolt holes 61 of the flange portion 21.

[0060] A relation among a gap C_b between the fixing bolt 60 and the bolt hole 61 of the flange portion 21, a gap C_p between the insertion guide pin 71 and the pin hole 72 of the flange portion 21, and the gap C_g between the lifting guide 40 and the lifting guide metal fitting 23 provided at the flange portion 21 of the storage seat 20 is set so as to become a relation " $C_p < C_b < C_g$ ".

[0061] A height h of the insertion guide pin 71 is slightly higher than an upper end position of the fixing bolt 60. The height h is set such that when the flange portion 21 is located at a lower end of the tapered portion 73, the flange portion 21 does not contact the fixing bolt 60.

[0062] With this, even in a case where the fixing bolts 60 are the stud bolts, first, the pin holes 72 of the flange portion 21 of the storage seat 20 lifted down are positioned by the insertion guide pins 71, and therefore, the bolt holes 61 are positioned. On this account, the storage seat 20 can be positioned relative to the attachment seat 15 without causing the fixing bolts 60 and the bolt holes 61 of the flange portion 21 to contact each other.

[0063] Therefore, the storage seat 20 to be lifted down in a suspended state from above the thruster arrangement portion 10 can be lifted down to an accurate position of the attachment seat 15.

[0064] Fig. 12 is a diagram taken along line XII-XII of Fig. 13. Fig. 13 is a diagram taken along line XIII-XIII of Fig. 12. As shown in Figs. 12 and 13, the locking device 30 is provided at a corner portion between the hull struc-

ture 2 that is the wall surface 13 of the thruster arrangement portion 10 and the attachment seat 15. The locking device 30 includes the locking piece 34 that projects toward the flange portion 21 of the storage seat 20 or is stored toward the wall surface 13. A rotating shaft portion 35 of the locking piece 34 is supported by an attachment base 80 provided so as to project inward from the hull structure 2. The attachment base 80 includes plate-shaped members 81 spaced apart from each other in the upper-lower direction by a predetermined distance and each having a predetermined thickness. Each of the plate-shaped members 81 is provided with an attachment hole 82 penetrating therethrough in the upper-lower direction. Support shafts 36 respectively provided at upper and lower sides of the rotating shaft portion 35 are respectively inserted into the attachment holes 82. With this, the rotating shaft portion 35 is rotatably supported, so that the locking piece 34 is rotatable in a horizontal direction. Since the locking piece 34 is supported on the hull structure 2 by the attachment base 80, the load supported by the locking piece 34 is supported by the hull structure 2.

[0065] Further, the locking piece 34 is provided with a rotary driving shaft 37 projecting upward and provided at an upper portion of the support shaft 36 provided at an upper portion of the rotating shaft portion 35. The rotary driving shaft 37 of the present embodiment is formed to have a rectangular cross section. The rotary driving shaft 37 is coupled to an expansion joint 38 provided at a lower end of the power transmission shaft 31 located above the rotary driving shaft 37. The expansion joint 38 allows movements of the rotary driving shaft 37 in the upper-lower direction. With this, by rotating the power transmission shaft 31, the rotating shaft portion 35 of the locking piece 34 can be rotated through the expansion joint 38. Even if the rotating shaft portion 35 is displaced upward, the expansion joint 38 absorbs the upward displacement of the rotary driving shaft 37, so that the upward displacement is not transmitted to the power transmission shaft 31.

[0066] As above, according to the locking device 30, the upward load acting on the locking piece 34 is supported by the hull structure 2 through the attachment base 80. Therefore, the upward load does not act on the power transmission shaft 31 coupled to the rotary driving shaft 37 of the rotating shaft portion 35 through the expansion joint 38. With this, as described above, by rotating the power transmission shaft 31 by the rotary driving unit provided at the upper portion of the thruster arrangement portion 10, the locking device 30 provided at the lower portion of the thruster arrangement portion 10 can be operated.

[0067] As shown in Fig. 14, the locking piece 34 can be rotated in the horizontal direction in a range of about 90° in plan view. A wedge seat 90 with which the locking piece 34 engages is provided at the flange portion 21 of the storage seat 20. From a position shown by a chain double-dashed line in Fig. 14, the locking piece 34 is

rotated about 90° toward the wedge seat 90 to engage with an upper surface of the wedge seat 90. Thus, the locking piece 34 becomes a locked state. A stopper 83 with which the locking piece 34 contacts when the locking piece 34 is rotated toward the wall surface 13 is provided at the attachment base 80. The position which is shown by the chain double-dashed line and at which the locking piece 34 contacts the stopper 83 is a stored position, and the locking piece 34 is in an unlocked state.

[0068] As shown in Fig. 15, the upper surface of the wedge seat 90 is formed as a tapered surface 91 having an angle θ by which a wedge effect can be obtained. An engagement surface 39 of the locking piece 34 that engages with the wedge seat 90 is also formed to have the angle θ that is the same as the angle of the upper surface of the wedge seat 90. The angle θ is set depending on a force necessary to rotate the locking piece 34, a contact area, and the like.

[0069] Next, a procedure of detaching in the ship the thruster 3 provided in the thruster arrangement portion 10 will be explained based on Figs. 16A to 17B.

[0070] As shown in Fig. 16A, in an operating state, the locking devices 30 are in the locked states, and the flange portion 21 of the storage seat 20 is being fixed to the attachment seat 15 by the fixing bolts 60 (see Fig. 3). In addition, the components, such as the driving device 4, which drive the thruster 3 are also being attached. In the operating state, the locking devices 30 may be the locked states or the unlocked states. However, the present embodiment explains a case where in the operating state, the locking devices 30 are in the locked states.

[0071] As shown in Fig. 16B, after the thruster 3 is stopped, as preparation for detaching the thruster 3, the driving device 4 and the other components are detached, and waterproof covers and the like are attached to respective portions. Although many of the components are not shown, as the specific preparation for detaching the thruster 3, for example, pipes, electric wires, the driving device 4, the driving shaft 5, a lubricating oil pump unit, a swivel pump unit, and a swivel valve unit are detached, and the waterproof covers and the like are attached to those components. A wire 7 of a lift-up device is attached to predetermined positions of the storage seat 20.

[0072] After that, the locked states of the locking devices 30 are reconfirmed, and the fixing of the flange portion 21 by the fixing bolts 60 is released. The fixing of the flange portion 21 is released in such a manner that an operator gets into the internal space 17 of the thruster arrangement portion 10. The operator can operate in a dry environment. With this, the storage seat 20 is held at the attachment seat 15 only by the locking devices 30. To be specific, when the fixing bolts 60 are detached, the upward load acting on the thruster 3 and the storage seat 20 by the water-level difference between the inside of the thruster arrangement portion 10 and the outside of the hull is held at the hull structure by the locking devices 30 provided at plural positions around the storage seat 20.

[0073] Next, as shown in Fig. 17A, water is poured into the thruster arrangement portion 10. The water is poured until the water level in the internal space 17 of the thruster arrangement portion 10 becomes equal to that of an outer draft 8. With this, water pressure acting on the thruster 3 and the storage seat 20 from outside and water pressure acting on the thruster 3 and the storage seat 20 from inside are balanced.

[0074] When the water is poured to the same level as the outer draft 8, the operating lever 55 is attached to the upper portion of the power transmission shaft 31, and the operator rotates the operating lever 55. Thus, the power transmission shaft 31 is rotated. With this, the locking piece 34 of the locking device 30 is rotated to be unlocked (the state of the locking piece 34 shown by the chain double-dashed line in Fig. 14). At this time, the water pressure acting on the thruster 3 and the storage seat 20 from outside and the water pressure acting on the thruster 3 and the storage seat 20 from inside are balanced. In addition, the total of downward own weights of the storage seat 20 and the thruster 3 is larger than upward buoyant force acting on the storage seat 20 and the thruster 3, and these downward loads are supported by the attachment seat 15. Therefore, the upward load is not acting on the locking piece 34. On this account, the locking piece 34 can be easily rotated.

[0075] After that, divers confirms whether or not the locking devices 30 are unlocked. This operation by the divers is just a confirmation of the unlocked states, so that it is easy. In addition, since the divers get into the thruster arrangement portion 10 to perform this operation, the operation can be easily performed regardless of marine weather outside the ship.

[0076] By this operation, the operations of releasing the components which fix the thruster 3 and the storage seat 20 to the hull structure 2 are terminated.

[0077] After that, as shown in Fig. 17B, the storage seat 20 is lifted up by the wire 7 of the lift-up device, such as a winch or a crane. The storage seat 20 is lifted up in a state where the lifting guide metal fittings 23 of the flange portion 21 are guided by the lifting guides 40 (see Figs. 2 and 3). Therefore, the storage seat 20 and the thruster 3 can be integrally, stably lifted up.

[0078] In water, the weight lifted up by the wire 7 is weight obtained by subtracting the buoyant force acting on the storage seat 20 and the thruster 3 from the total of the own weights of the storage seat 20 and the thruster 3. In air after the storage seat 20 and the thruster 3 are lifted up from water, the weight lifted up by the wire 7 is the total of the own weights of the thruster 3 and the storage seat 20. Therefore, by the winch, the crane, or the like capable of lifting up such weight, the thruster 3 can be detached in the ship. Therefore, a special lifting device for heavy weight is not required, and the thruster 3 and the storage seat 20 can be lifted up and down by a normal simple winch or the like.

[0079] The thruster 3 lifted up from the thruster arrangement portion 10 in the ship is inspected or repaired

at a predetermined place.

[0080] By the above procedure, in a state where the point holding or the like of the drilling ship or the like is performed at an offshore operating site, the thruster 3 projecting downward from the hull structure 2 can be detached at a position above the draft surface in the ship by a simple handling device using a winch, a crane, or the like, and the thruster 3 can be inspected, repaired, or the like.

[0081] Next, the procedure of attaching the thruster 3, which has been inspected, repaired, or the like in the ship, to the thruster arrangement portion 10 will be explained based on Figs. 18A to 19B.

[0082] As shown in Fig. 18A, in a state where the water level in the thruster arrangement portion 10 is the same as the water level of the outer draft 8, the thruster 3 fixed integrally with the storage seat 20 is lifted down by the winch, the crane, or the like to be put into the thruster arrangement portion 10. At this time, the flange portion 21 of the storage seat 20 is guided by the lift-down guides 41 (see Fig. 2) provided at the upper portion of the thruster arrangement portion 10. Thus, the thruster 3 can be lifted down such that the lifting guide metal fittings 23 of the flange portion 21 respectively engage with the lifting guides 40 provided at the thruster arrangement portion 10 (see Figs. 2 and 3).

[0083] Then, when the thruster 3 is lifted down together with the storage seat 20, the insertion guide pins 71 provided at the attachment seat 15 are inserted into the pin holes 72 provided at the flange portion 21 of the storage seat 20 (see the chain double-dashed line in Fig. 11). With this, the flange portion 21 is accurately positioned. By further lifting down the storage seat 20, the fixing bolts 60 are respectively inserted into the bolt holes 61 of the flange portion 21. Then, by further lifting down the storage seat 20, the flange portion 21 of the storage seat 20 is placed on the attachment seat 15 (see a solid line in Fig. 11). With this, the seal member 29 (see Fig. 10) provided at the lower surface of the flange portion 21 tightly contacts the attachment seat 15 by the own weights of the storage seat 20 and the thruster 3. Thus, watertight seal is realized between the inside and outside of the thruster arrangement portion 10.

[0084] Next, as shown in Fig. 18B, the power transmission shafts 31 are rotated by the operating levers 55 attached to the upper portions of the power transmission shafts 31. With this, the locking pieces 34 of the locking devices 30 are rotated to respectively engage with the wedge seats 90 provided at the flange portion 21 of the storage seat 20. Thus, the flange portion 21 is locked to the attachment seat 15 (see a solid line in Fig. 14). In a state where the storage seat 20 and the thruster 3 are placed on the attachment seat 15 by their own weights, the locking pieces 34 are rotated toward the tapered surfaces 91 of the wedge seats 90. Therefore, even underwater, the locking pieces 34 can surely engage with the wedge seats 90. The locked states by the locking devices 30 are confirmed such that the divers get into water in

the thruster arrangement portion 10. This confirmation operation by the divers is just the confirmation of the locked states, so that it is easy. In addition, since the divers get into the thruster arrangement portion 10 to perform this operation, the operation can be easily performed regardless of the marine weather outside the ship.

[0085] By this operation, the operations of fixing the thruster 3 and the storage seat 20 to the attachment seat 15 of the hull structure 2 by the locking devices 30 are completed.

[0086] Next, as shown in Fig. 19A, the entire water in the thruster arrangement portion 10 is discharged. At this time, since the flange portion 21 and the attachment seat 15 are fixed to each other by the locking devices 30 as described above, the internal space 17 of the thruster arrangement portion 10 is sealed water-tightly by the seal member 29 provided between the flange portion 21 and the attachment seat 15. By discharging the entire water, the inside of the thruster arrangement portion 10 becomes the dry environment (space).

[0087] Next, as shown in Fig. 19B, the wire 7 of a lift-up device is detached. The flange portion 21 around the storage seat 20 is fixed by the fixing bolts 60 provided at the attachment seat 15 (see the state shown by the solid line in Fig. 11). Since these operations are performed after the water is discharged from the thruster arrangement portion 10, these are performed in the dry environment and can be easily performed. With this, the storage seat 20 and the thruster 3 are fixed to the hull structure 2.

[0088] After that, the waterproof covers and the like attached when detaching the thruster 3 are detached. Then, various components are attached. Although many of the components are not shown, specifically, pipes, electric wires, the driving device 4, the driving shaft 5, the lubricating oil pump unit, the swivel pump unit, the swivel valve unit, and the like are attached. After the components are attached, the adjustment of the devices and the confirmation of the driving are performed.

[0089] By the above procedure, in a state where the point holding or the like of the drilling ship or the like is performed at an offshore operating site, the thruster 3 can be attached to the lower portion of the thruster arrangement portion 10 in the ship by the simple handling device using the winch, the crane, or the like.

[0090] As above, according to the inboard detachable thruster apparatus 1, in a state where the point holding or the like of the drilling ship or the like is performed at an offshore operating site, the thruster 3 projecting from the ship bottom can be detached in the ship. Therefore, the thruster 3 detached in the ship can be inspected, repaired, or the like in the ship.

[0091] After the detached thruster 3 is inspected or repaired, it may be attached to the thruster arrangement portion 10, or while the detached thruster 3 is being inspected or repaired, the other thruster 3 may be arranged at the thruster arrangement portion 10. Thus, while maintaining the point holding or the like of the hull, a part of

the thrusters 3 can be easily inspected, repaired, or replaced.

[0092] Further, since a lifting device for heavy weight is not required for the purpose of detaching the thruster 3 in the ship, the inboard detachable thruster apparatus 1 can be configured at low cost.

[0093] Since the operation of detaching the thruster 3 in the ship does not have to be performed underwater outside the ship, the operation of detaching the thruster 3 can be quickly performed without being affected by weather at the time of malfunctions or the like of the thruster 3.

[0094] The above embodiment has explained an example in which the implanted fixing bolts (fixing units) 60 are used as the fixing units that fix the flange portion 21 of the storage seat 20 to the attachment seat 15. However, the fixing units may be tap bolts to be inserted from above the flange portion 21 or may be the other units. The fixing units are not limited to the above embodiment.

[0095] The locking device 30 of the above embodiment becomes the locked state in such a manner that the locking piece 34 engages with the wedge seat 90. However, the locking device may become the locked state by a component other than the wedge seat 90. The configuration of the locking device 30 is not limited to the above embodiment. In addition, the locking device 30 is activated or released by rotating the locking piece 34. However, the locking device 30 may be activated or released by a linear movement method instead of the rotary movement method, and the method is not limited to the above embodiment.

[0096] Further, the foregoing has explained an example in which two lifting guides 40 are respectively provided at the opposing wall surfaces 13 of the thruster arrangement portion 10. However, as long as the storage seat 20 can be stably lifted up and down, one lifting guide or three lifting guides may be used. The configuration of the lifting guide 40 is not limited to the above embodiment.

[0097] The above embodiment is one example, and various modifications may be made within the scope of the present invention. The present invention is not limited to the above embodiment.

Industrial Applicability

[0098] The inboard detachable thruster apparatus according to the present invention can be utilized in the drilling ship or the like in which the thruster is desired to be detached in the ship to be inspected, repaired, or the like while the point holding or the like of the ship is being performed on the ocean.

Reference Signs List

[0099]

- 1 inboard detachable thruster apparatus
- 2 hull (hull structure)

- 3 thruster
- 7 wire
- 8 outer draft
- 10 thruster arrangement portion
- 5 11 lower opening portion
- 12 upper opening portion
- 13 wall surface (hull structure)
- 15 attachment seat
- 17 internal space
- 10 20 storage seat
- 21 flange portion
- 22 storage portion
- 23 lifting guide metal fitting
- 28 girder member (strengthening member)
- 15 29 seal member
- 30 locking device
- 31 power transmission shaft (rotary driving unit)
- 34 locking piece
- 38 expansion joint
- 20 39 engagement surface
- 40 lifting guide
- 41 lift-down guide
- 42 lifting guide supporting member
- 43 guide portion
- 25 45 lifting guide
- 46 lower lifting guide
- 47 upper lifting guide
- 50 upper lifting guide metal fitting attachment base
- 51 upper lifting guide metal fitting
- 30 55 operating lever (rotary driving unit)
- 60 fixing bolt (fixing unit)
- 61 bolt hole
- 70 insertion guide
- 71 insertion guide pin
- 35 72 pin hole
- 80 attachment base
- 90 wedge seat
- 91 tapered surface

Claims

1. An inboard detachable thruster apparatus comprising:

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a thruster arrangement portion provided at a predetermined position of a hull and configured to open in an upper-lower direction;

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a thruster projecting downward from a lower opening portion of the thruster arrangement portion;

a storage seat by which the thruster and a thruster driving device are stored in the thruster arrangement portion;

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an attachment seat provided at a position, to which the storage seat is fixed, of the hull; and fixing units configured to fix the storage seat to the attachment seat, wherein:

- the thruster arrangement portion is surrounded by wall surfaces constituting a part of a hull structure;
 a locking device is provided at the wall surface and is configured to hold the storage seat at the attachment seat when the fixing by the fixing units is released; and
 a locked state of the locking device is activated or released from an upper portion of the thruster arrangement portion.
2. The inboard detachable thruster apparatus according to claim 1, wherein the fixing units are attachable to and detachable from the hull structure at a plurality of positions in the vicinity of the storage seat in the thruster arrangement portion.
3. The inboard detachable thruster apparatus according to claim 1, wherein:
- the locking device includes a locking piece configured to engage with the storage seat at a flange portion formed around the storage seat; and
 by rotating a power transmission shaft, coupled to the locking piece and extending along the wall surface in the upper-lower direction, around an axis of the power transmission shaft, the locking piece is rotated around the power transmission shaft, and thereby, the locked state is activated or released.
4. The inboard detachable thruster apparatus according to claim 1, wherein:
- the locking device includes
 a wedge seat provided at an upper surface of a flange portion formed around the storage seat, and
 a locking piece provided at the hull structure and including an engagement surface that engages with the wedge seat; and
 each of the wedge seat and the engagement surface of the locking piece is formed to have an inclination angle equal to or smaller than a friction angle by which a wedge effect is obtained.
5. The inboard detachable thruster apparatus according to claim 4, wherein:
- the locking device is configured such that the locking piece rotates in a horizontal direction to engage with the wedge seat;
 a rotary driving unit configured to rotate the locking piece of the locking device to activate or release the locking device is provided at the upper portion of the thruster arrangement portion; and
- an expansion joint is provided between the locking device and the rotary driving unit for the locking device.
6. The inboard detachable thruster apparatus according to claim 4, wherein:
- the locking device includes a driving unit configured to cause the locking piece to engage with the wedge seat; and
 the driving unit is constituted by a driving machine configured to drive the locking piece by fluid pressure.
7. The inboard detachable thruster apparatus according to any one of claims 1 to 6, wherein:
- the flange portion of the storage seat includes a seal member configured to contact the attachment seat at a position around the fixing units; and
 the locking device is arranged so as to be opposed to a strengthening member of the storage seat.
8. The inboard detachable thruster apparatus according to claim 1, wherein the thruster arrangement portion includes:
- lifting guides each extending in the upper-lower direction and configured to guide the storage seat, to which the thruster is attached, such that the storage seat is lifted up and down in the thruster arrangement portion; and
 a driving unit configured to activate or release the locking device.
9. The inboard detachable thruster apparatus according to claim 8, wherein the lifting guides included in the thruster arrangement portion are at least two lifting guides respectively provided at opposing positions about a center of the storage seat.
10. The inboard detachable thruster apparatus according to claim 9, wherein:
- the attachment seat includes insertion guides provided at at least two positions and configured to guide the storage seat to a predetermined position of the attachment seat when lifting down the storage seat;
 the thruster arrangement portion includes an opening portion whose horizontal cross section is rectangular;
 the at least two lifting guides are respectively provided at the opposing wall surfaces of the thruster arrangement portion, the opposing wall surfaces respectively corresponding to short

sides of the opening portion; and
the insertion guides provided at the at least two
positions are respectively arranged on opposing
surfaces of the attachment seat, the opposing
surfaces respectively corresponding to the short 5
sides of the opening portion.

11. The inboard detachable thruster apparatus accord-
ing to claim 10, wherein:

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each of the fixing units includes a fixing bolt fixed
to the attachment seat and a bolt hole formed
on the storage seat;
each of the insertion guides includes an insertion
guide pin fixed to the attachment seat and a pin 15
hole formed on the storage seat; and
when lifting down the storage seat, the pin holes
are guided by the insertion guide pins, and there-
by, the bolt holes of the storage seat are posi-
tioned at the fixing bolts. 20

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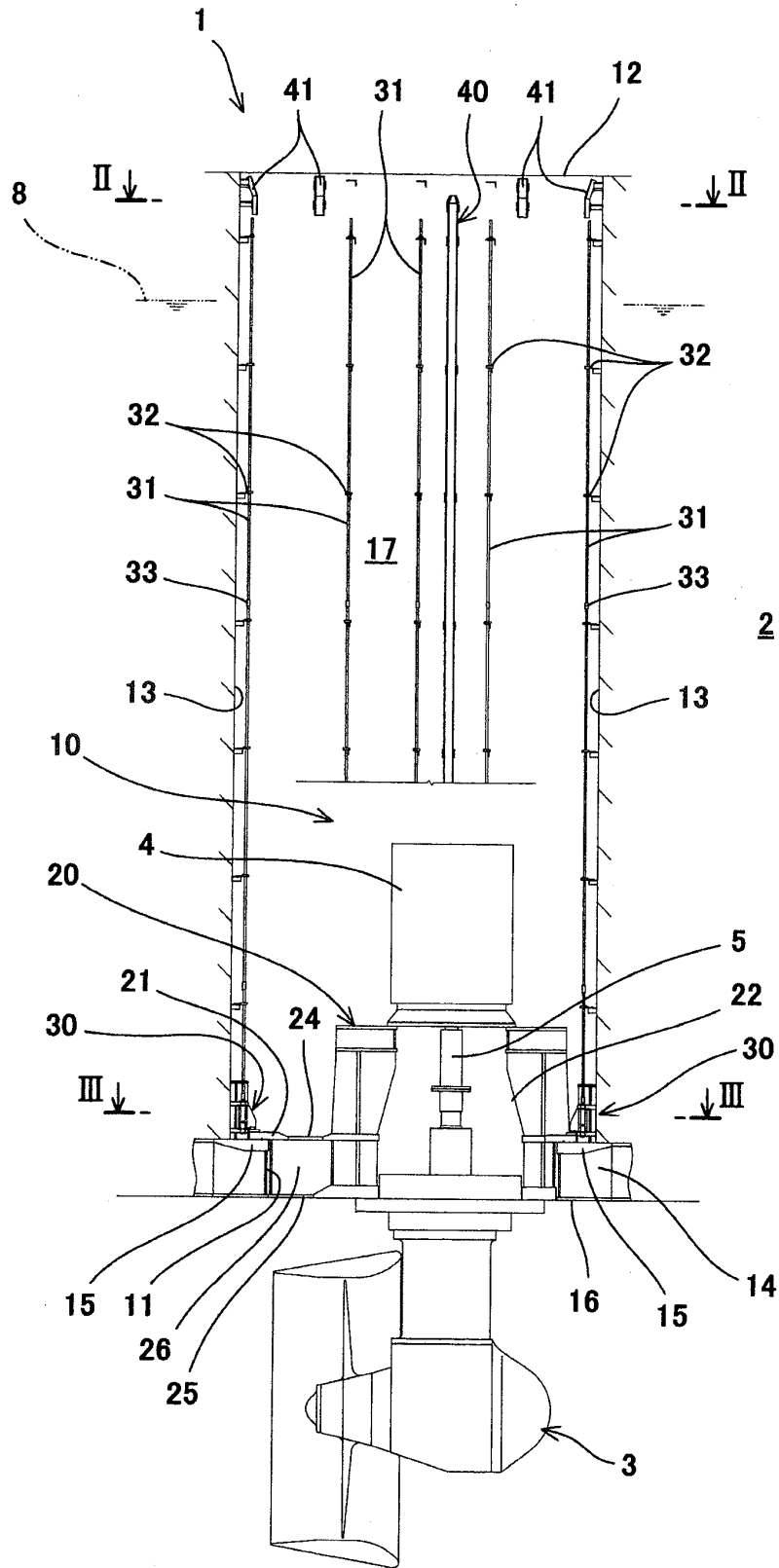


Fig. 1

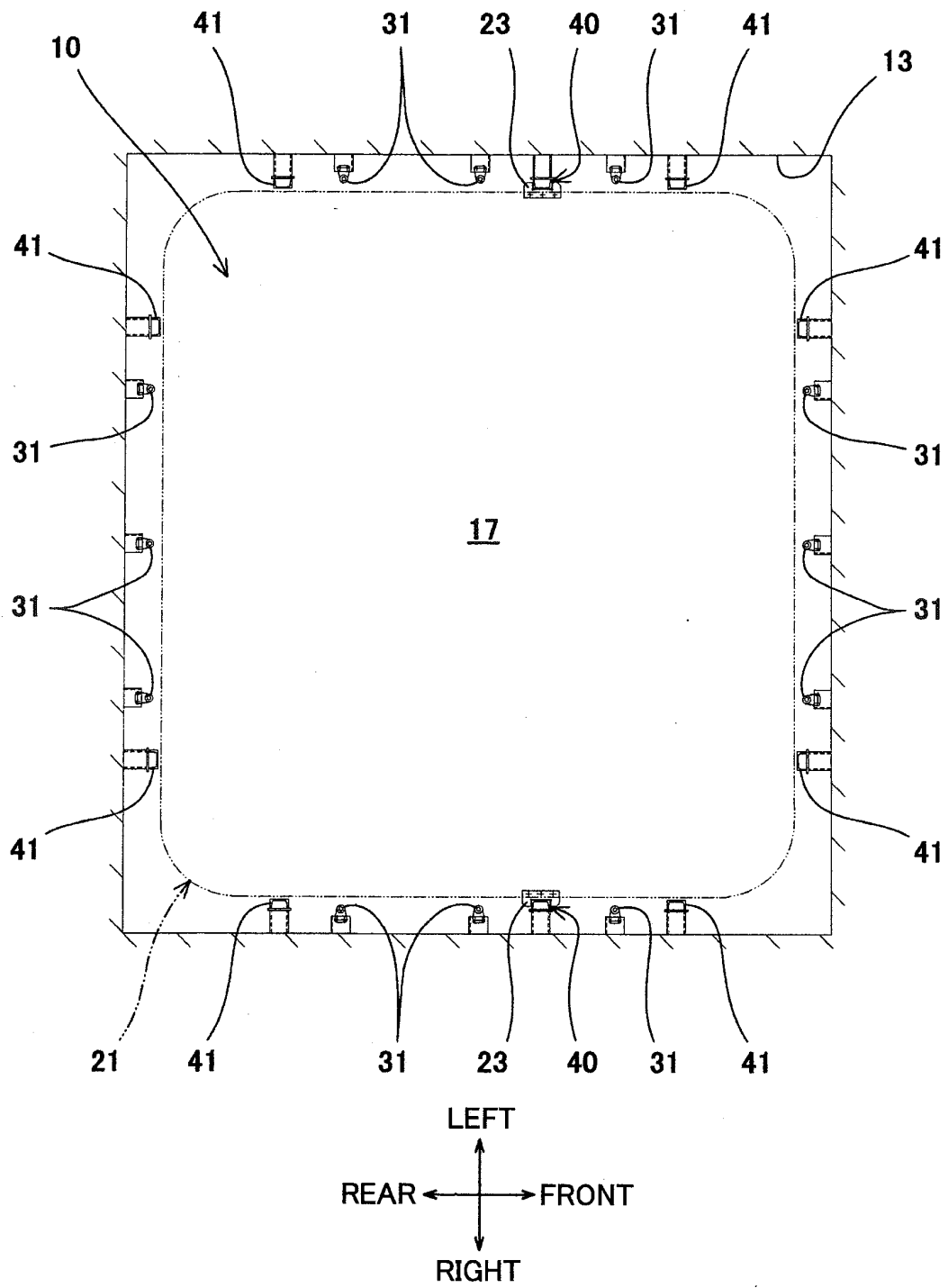


Fig. 2

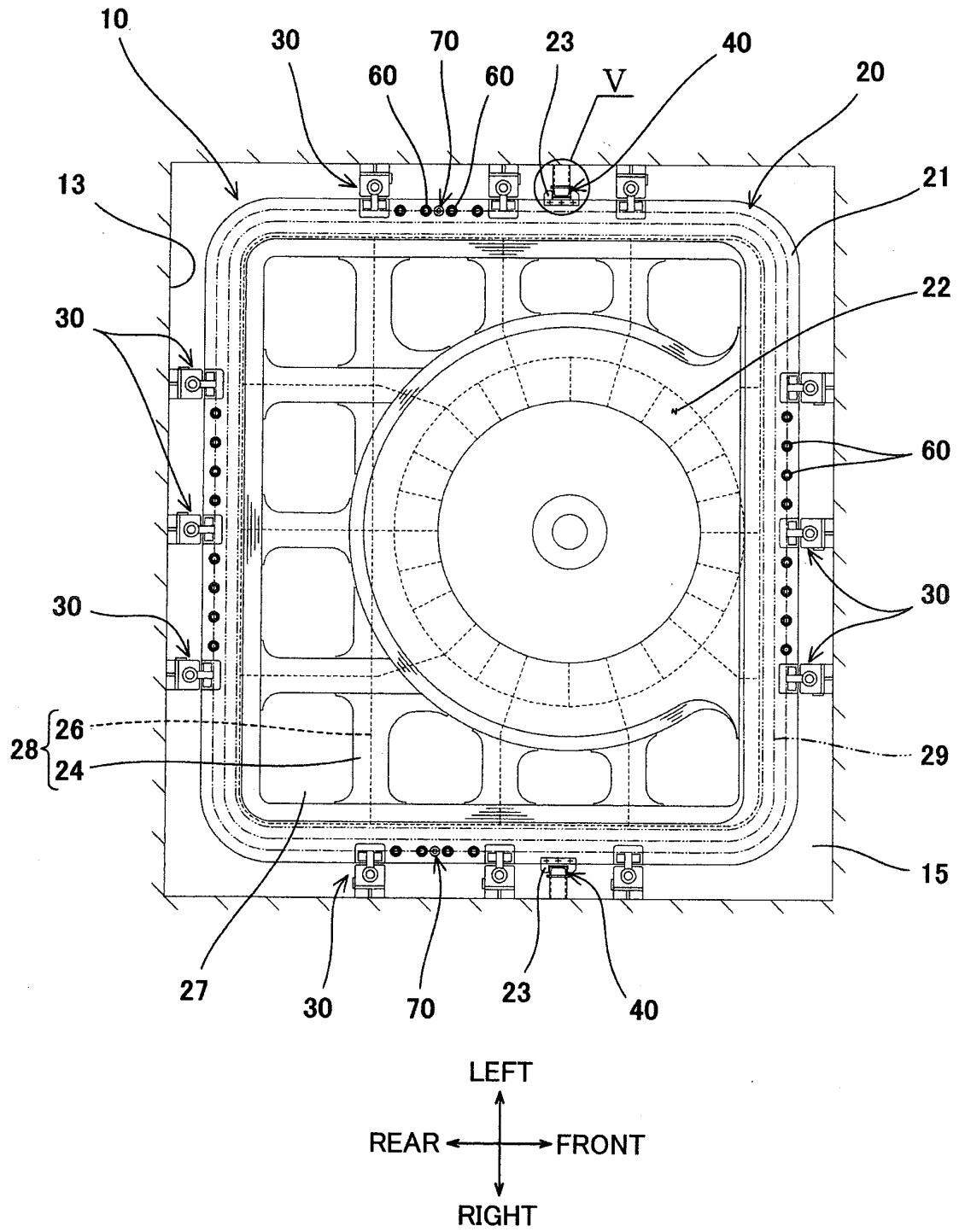


Fig. 3

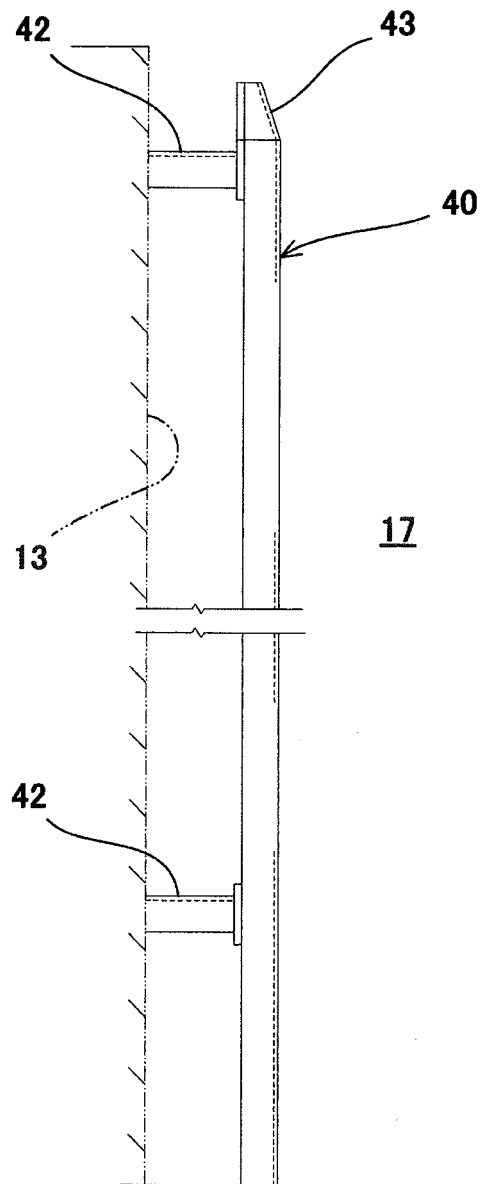


Fig. 4A

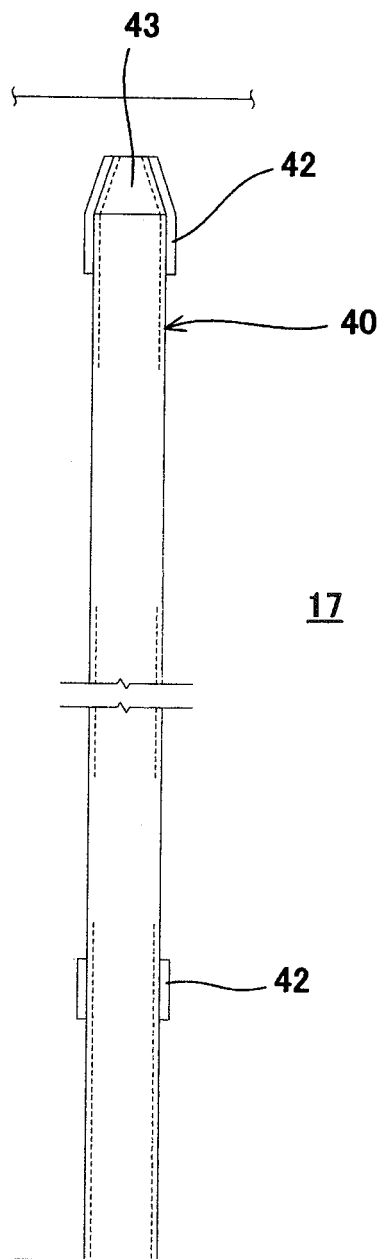


Fig. 4B

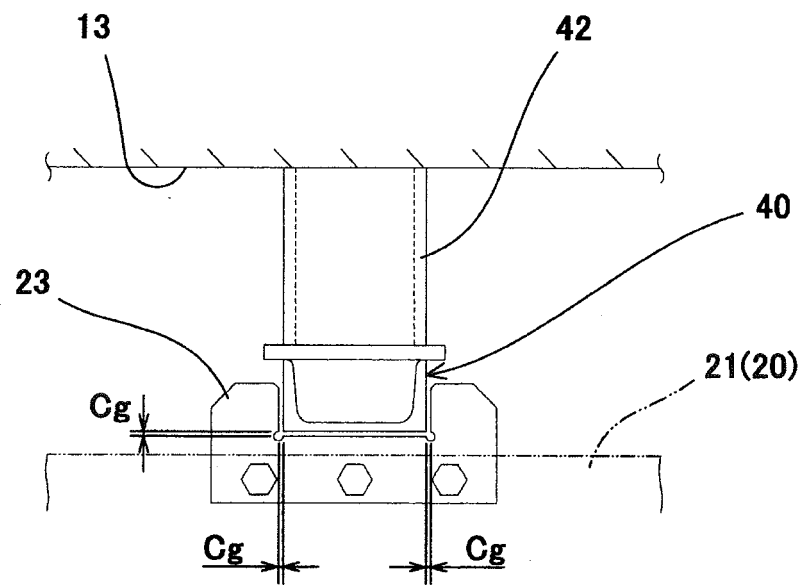


Fig. 5

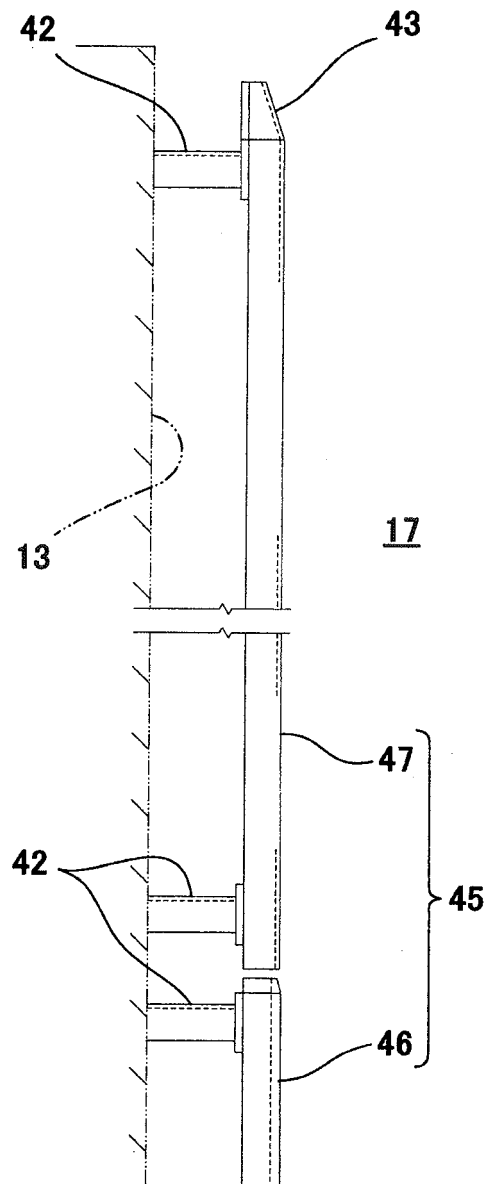


Fig. 6A

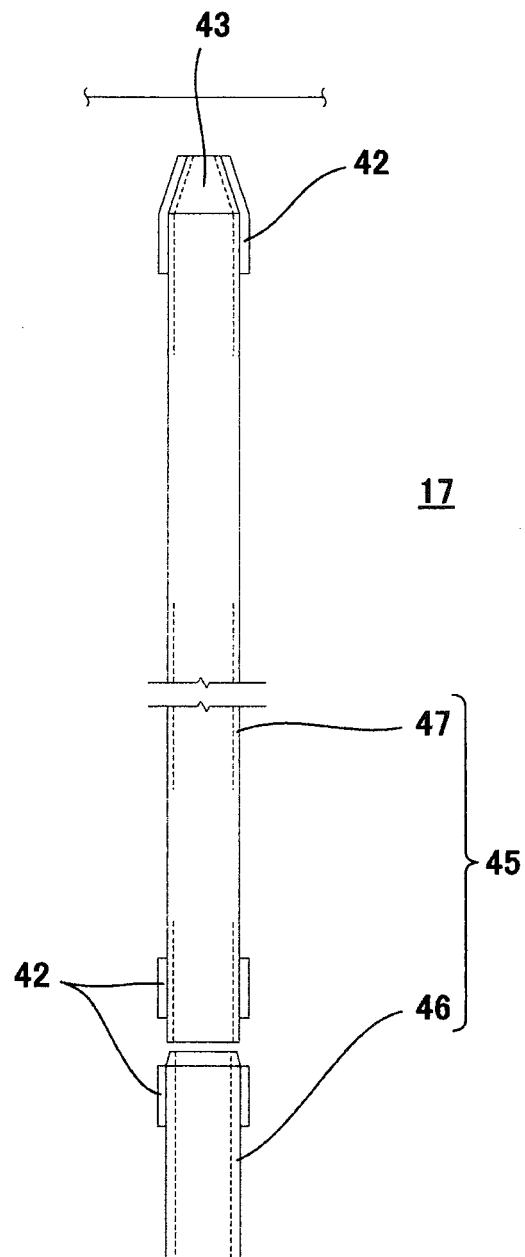


Fig. 6B

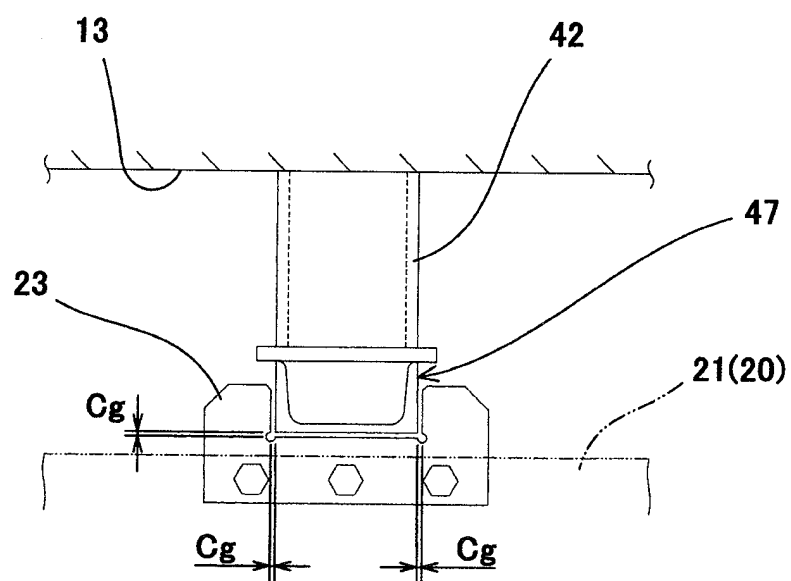


Fig. 7A

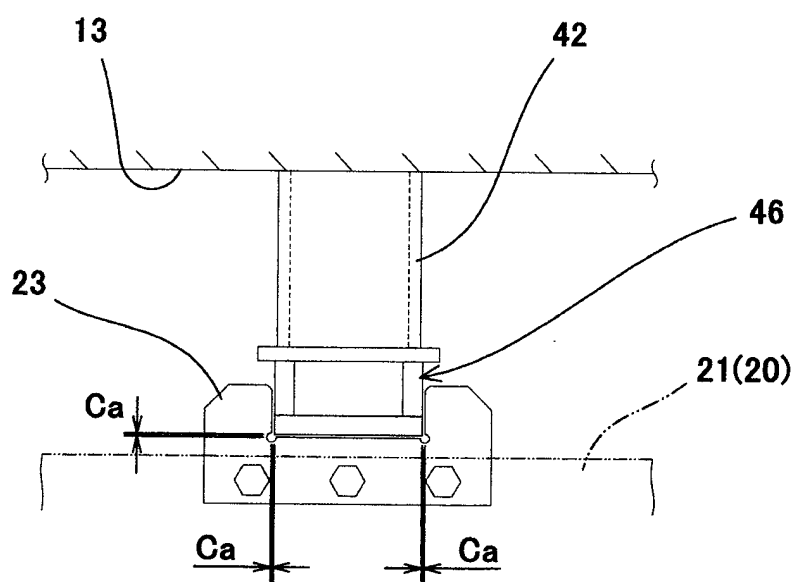


Fig. 7B

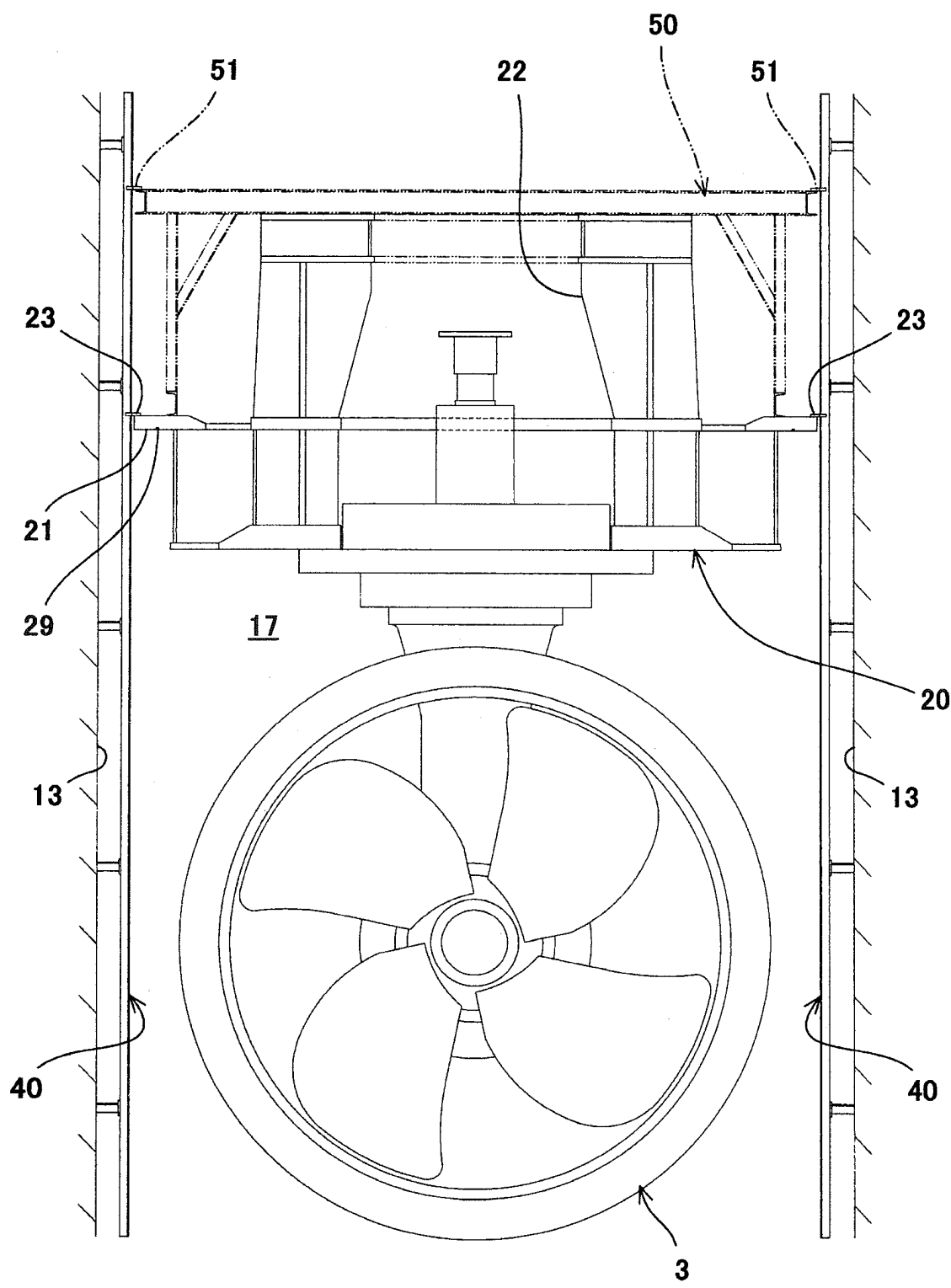


Fig. 8

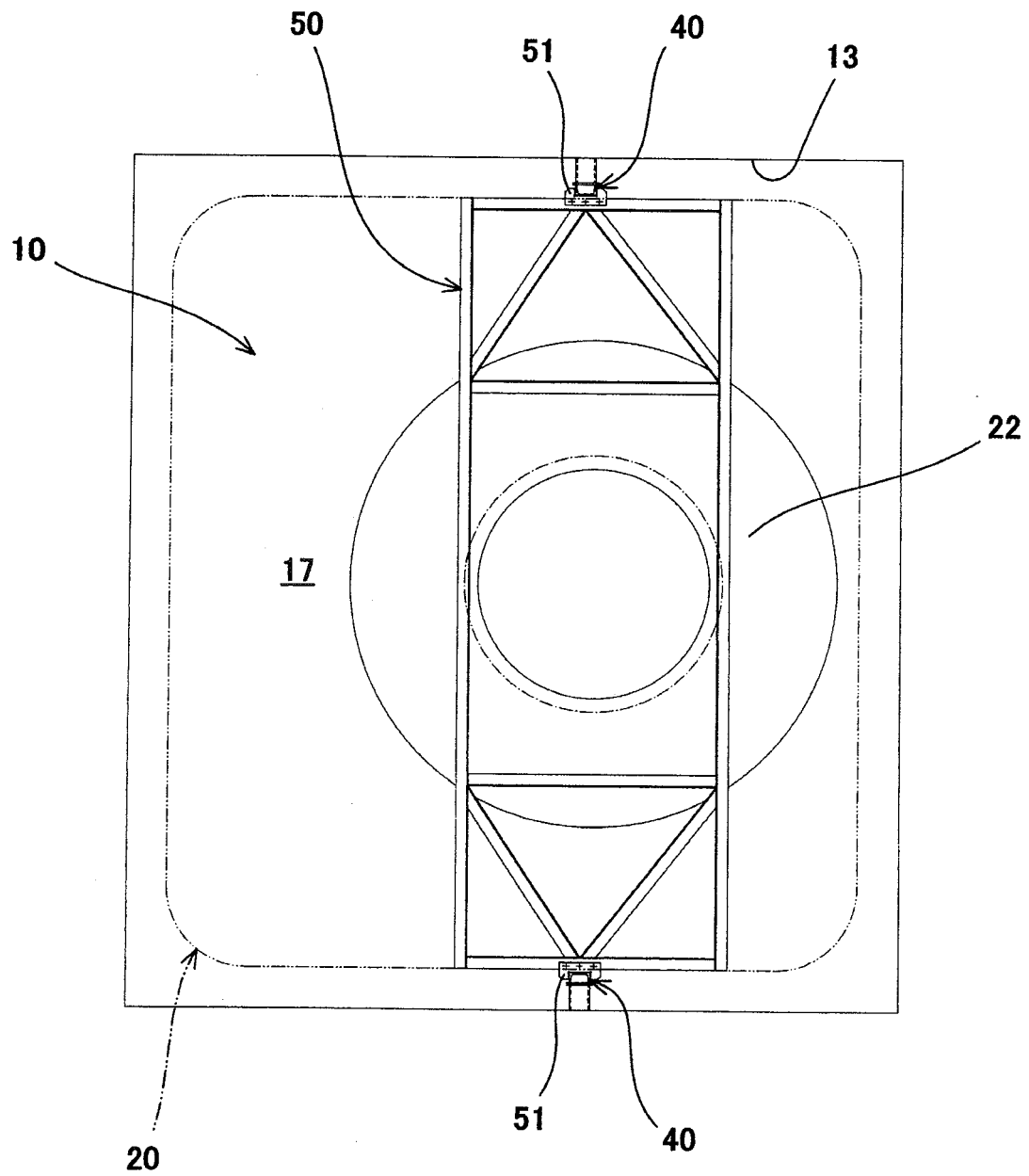


Fig. 9

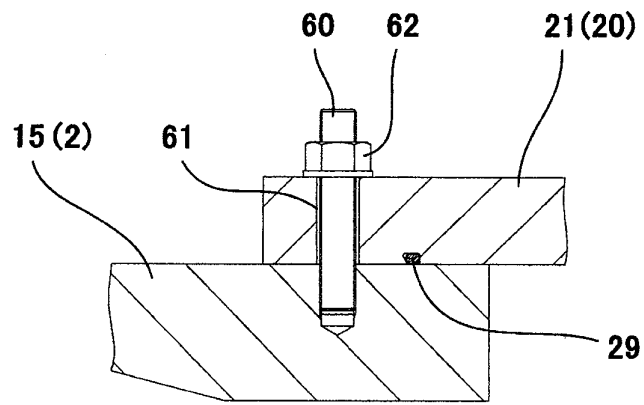


Fig. 10

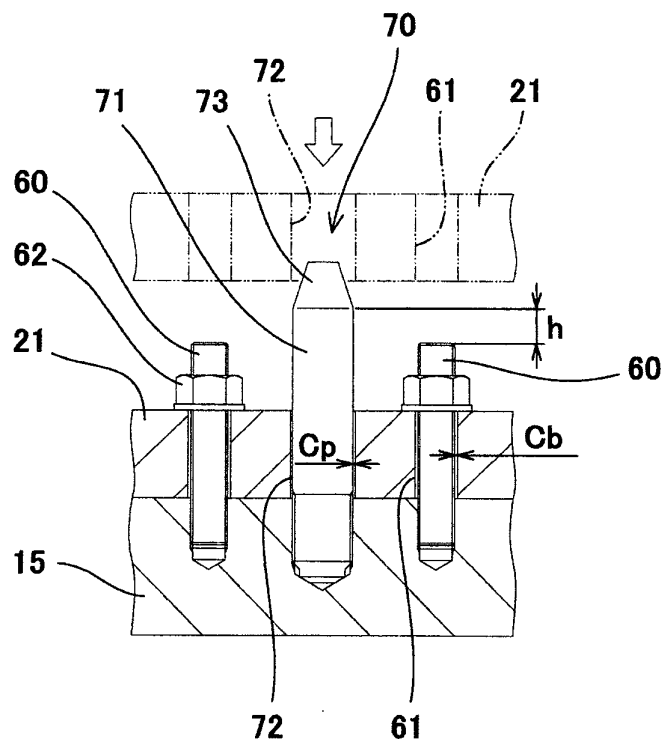


Fig. 11

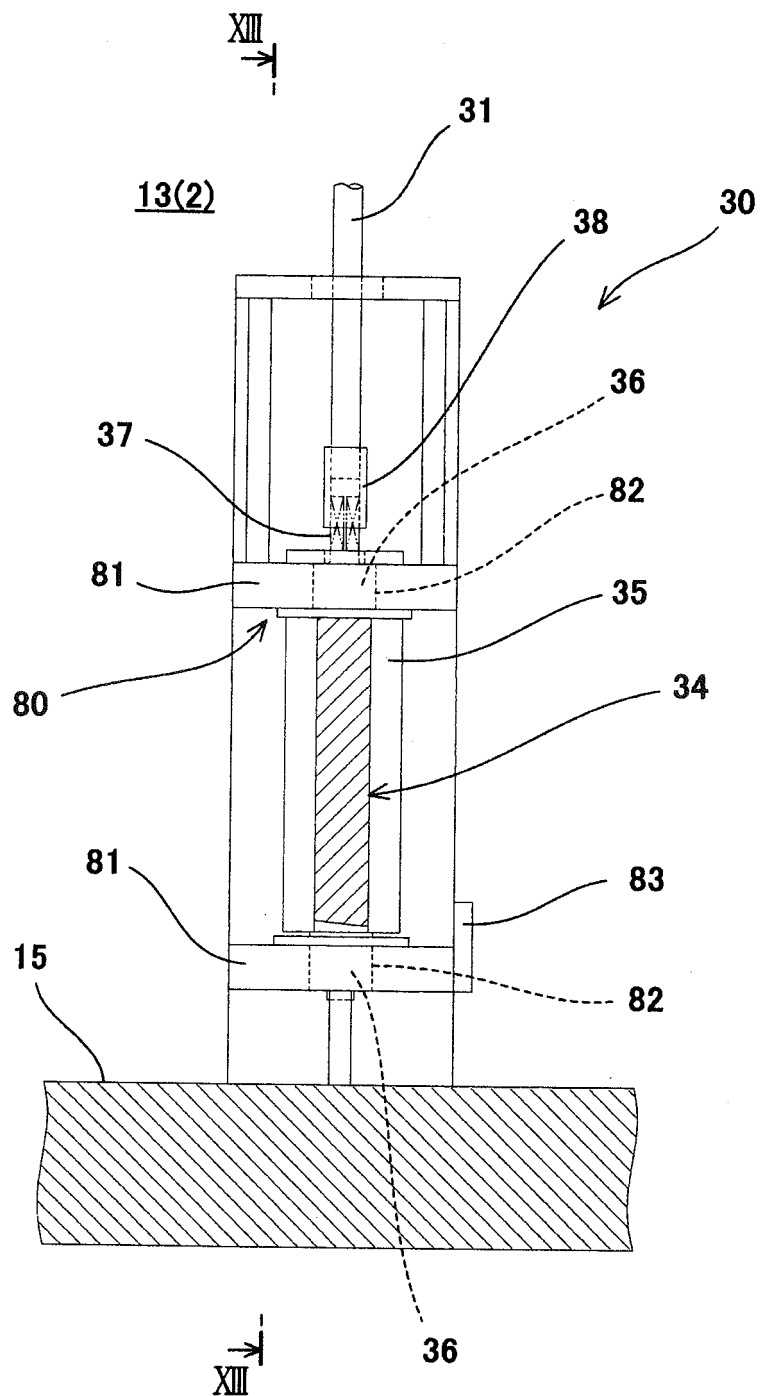


Fig. 12

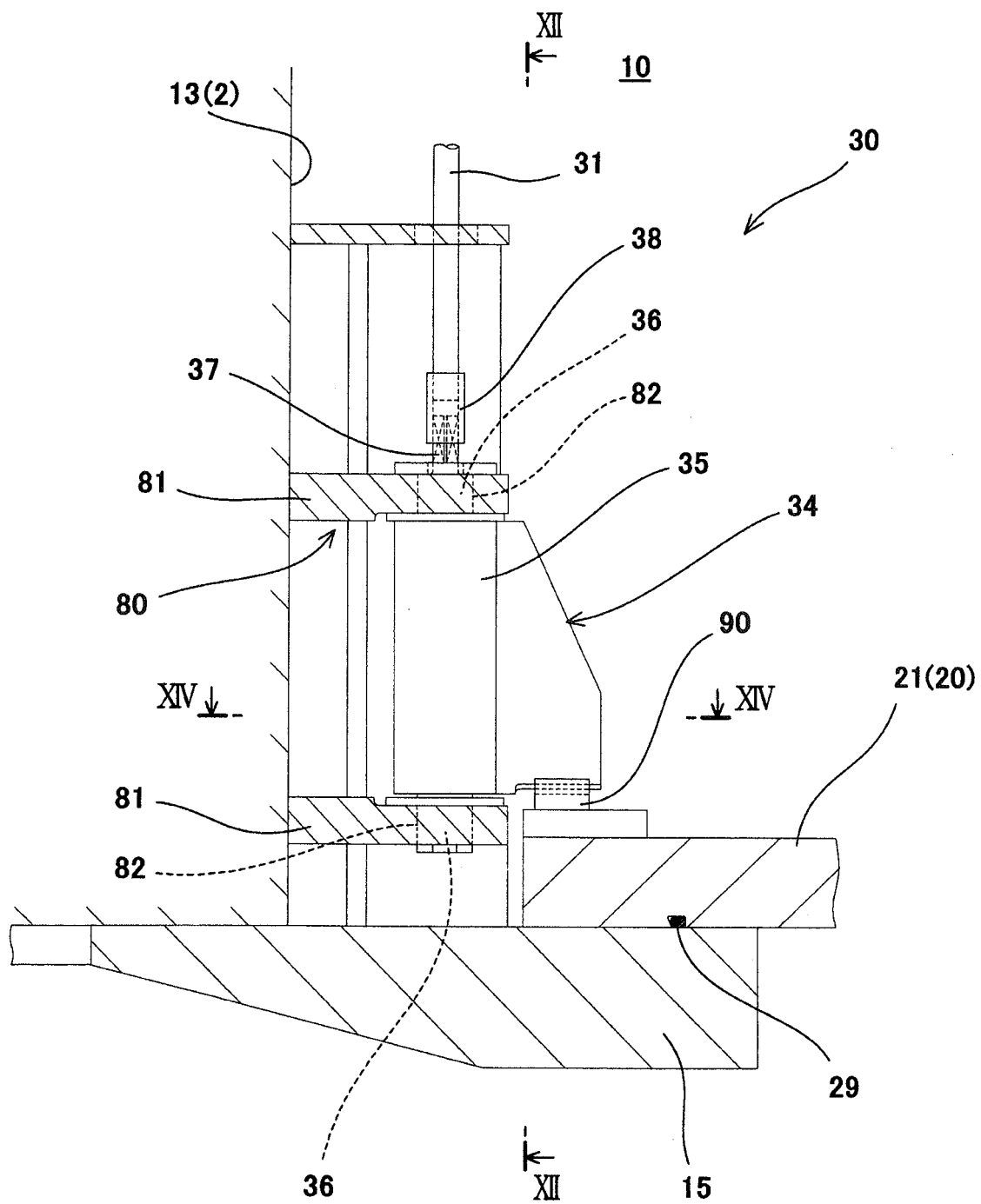


Fig. 13

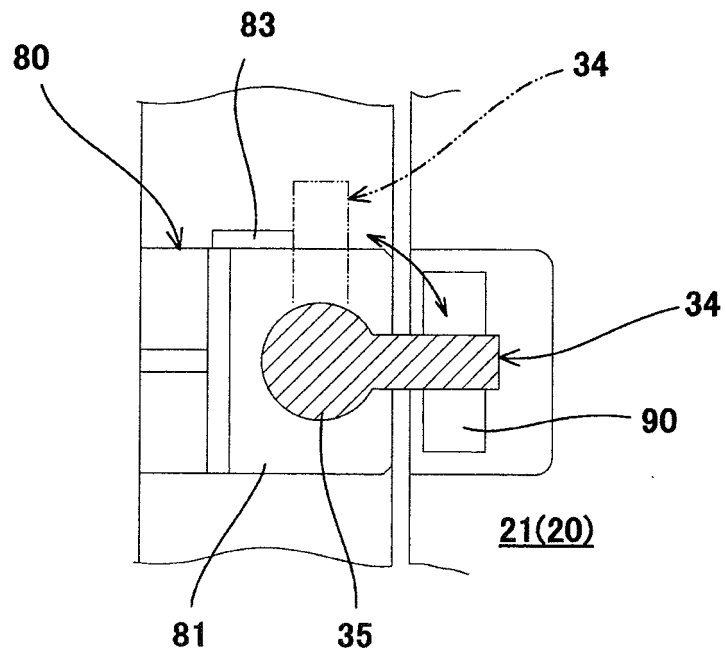


Fig. 14

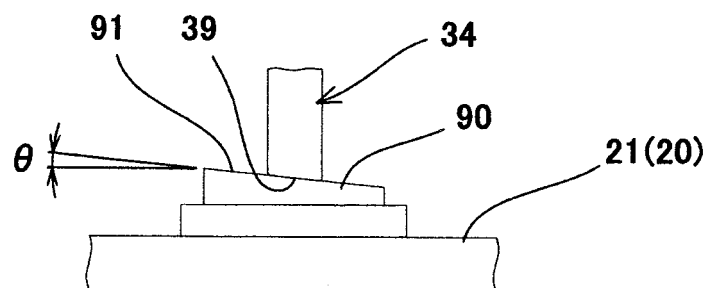


Fig. 15

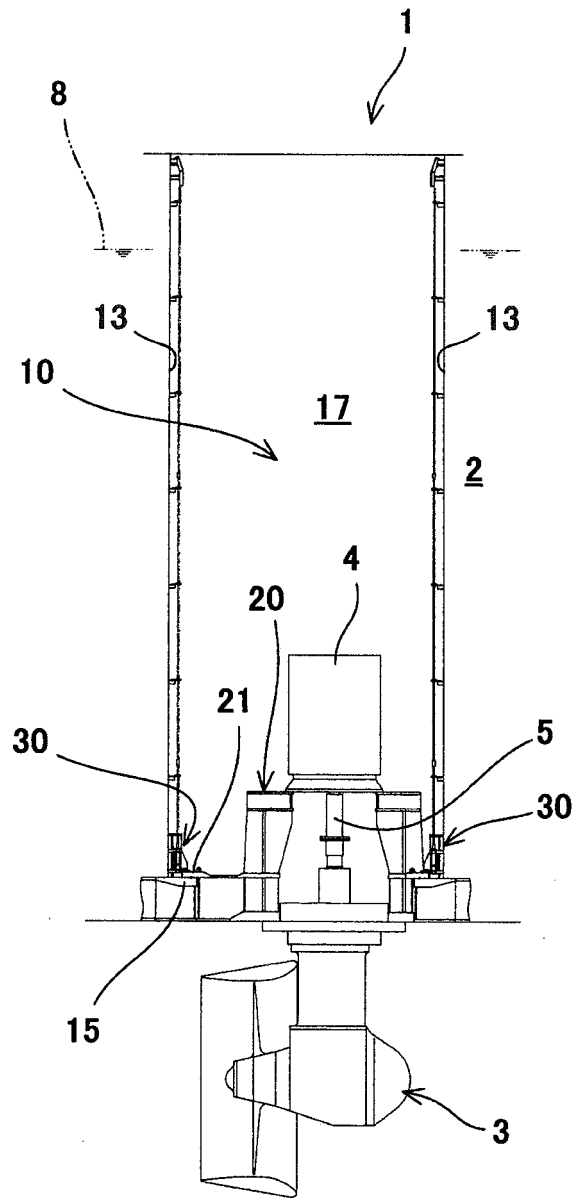


Fig. 16A

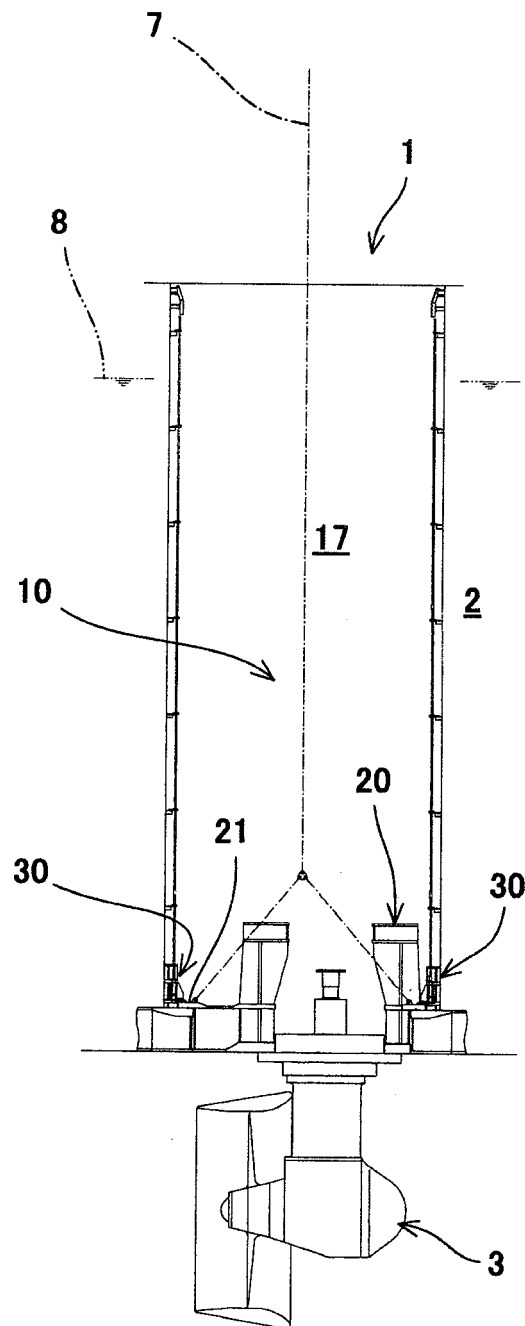


Fig. 16B

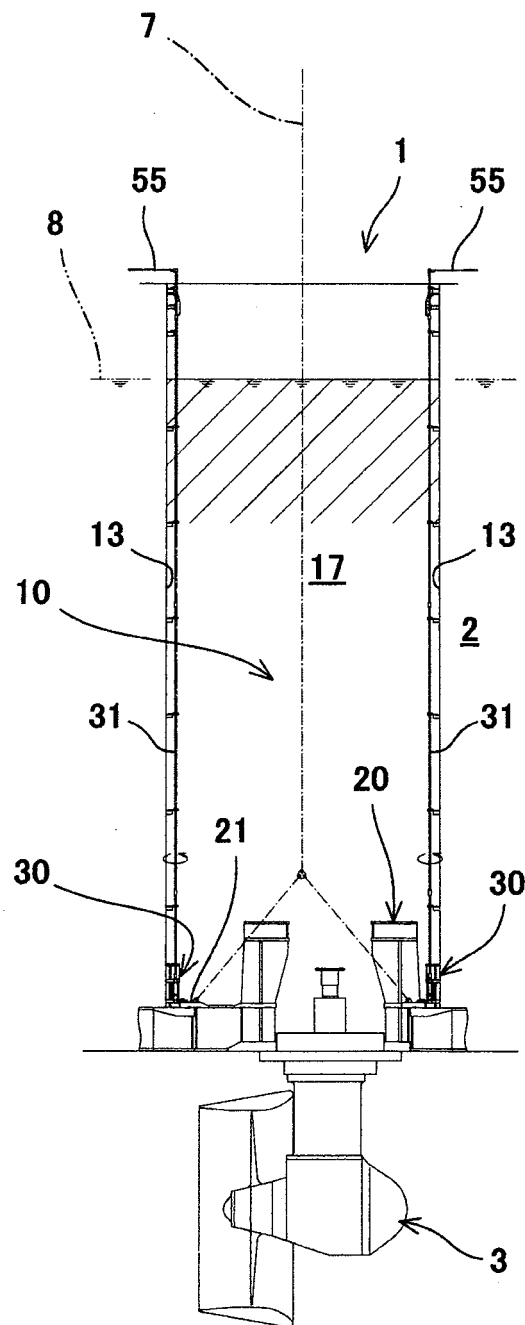


Fig. 17A

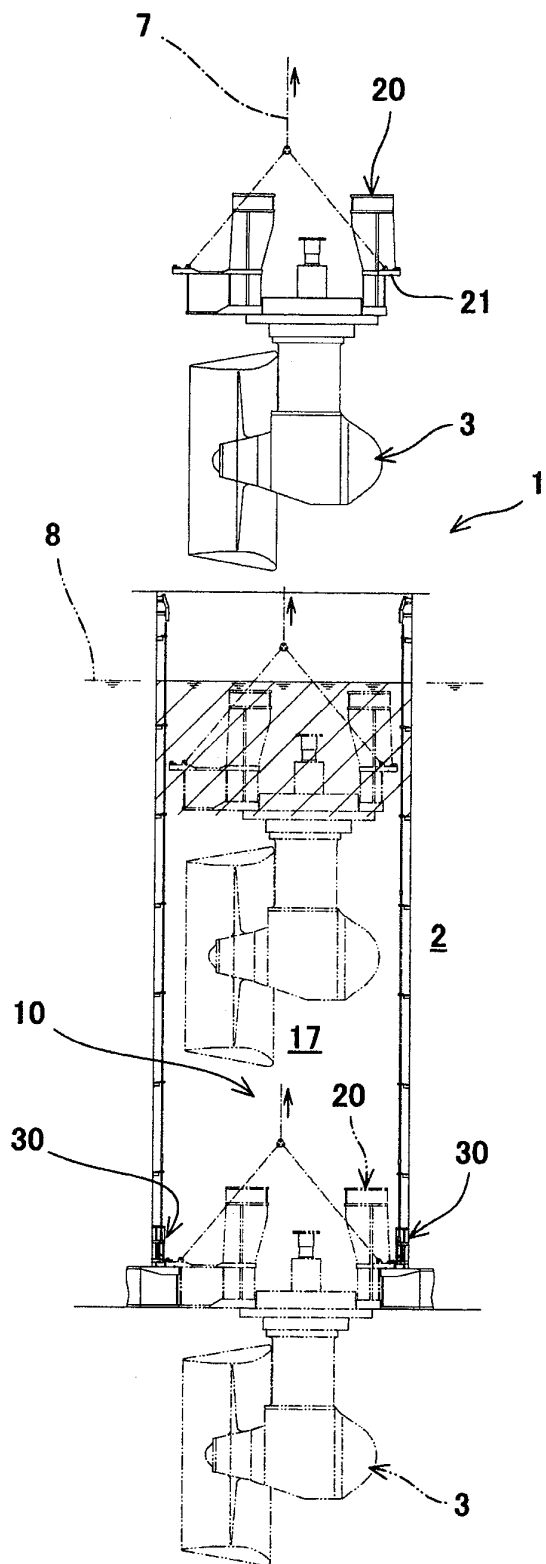


Fig. 17B

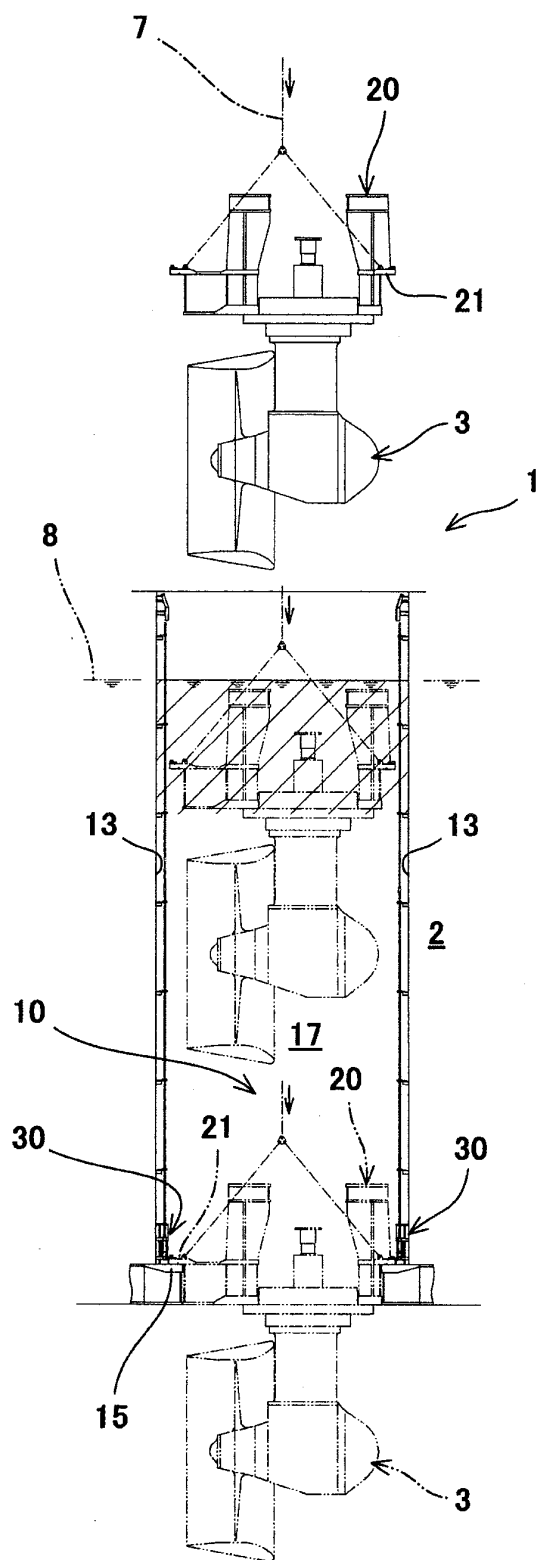


Fig. 18A

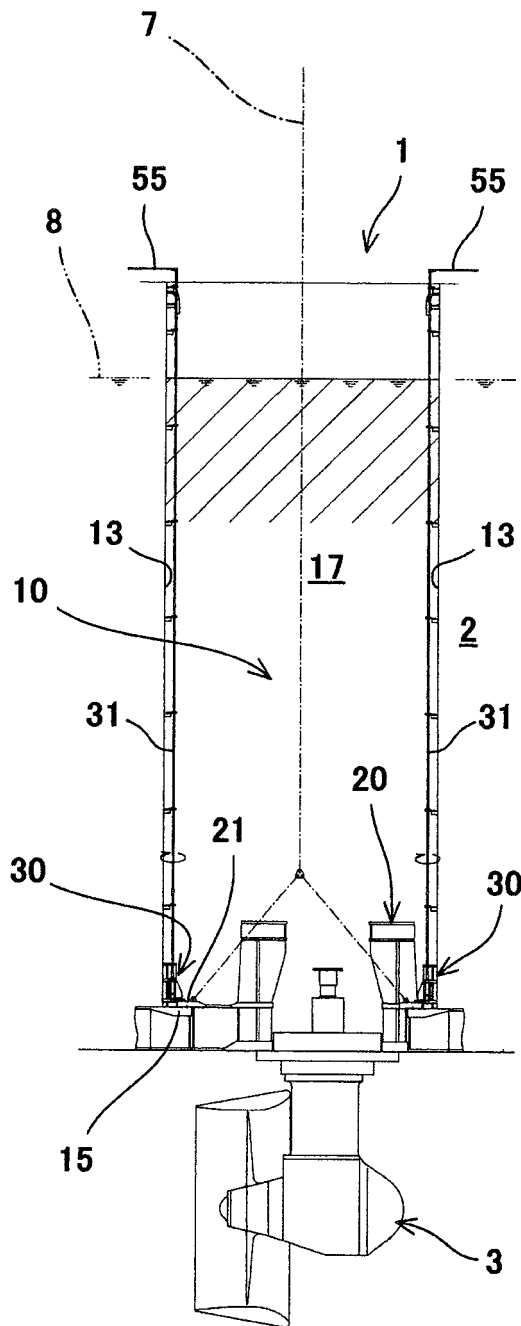


Fig. 18B

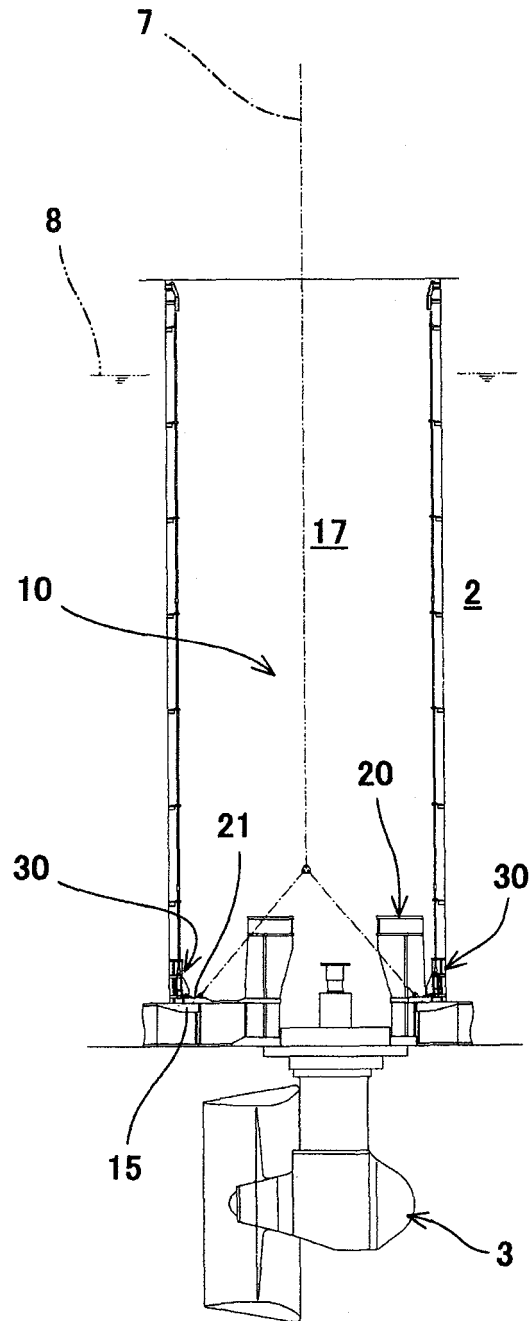


Fig. 19A

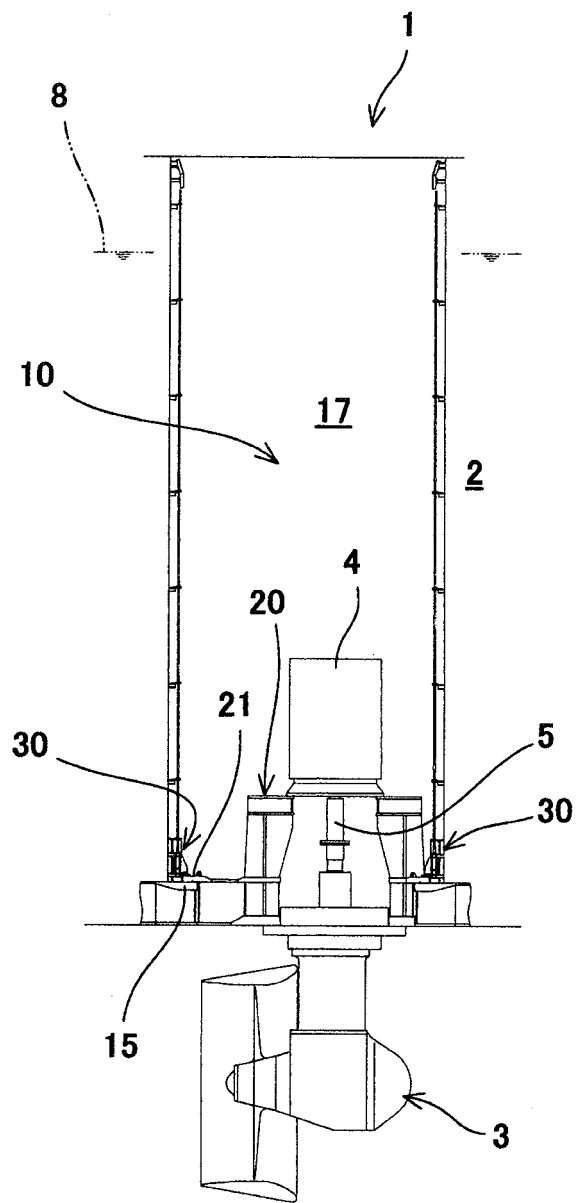


Fig. 19B

5	INTERNATIONAL SEARCH REPORT		International application No. PCT/JP2013/004346
	A. CLASSIFICATION OF SUBJECT MATTER B63H5/125(2006.01) i, B63H25/42(2006.01) i		
10	According to International Patent Classification (IPC) or to both national classification and IPC		
	B. FIELDS SEARCHED		
	Minimum documentation searched (classification system followed by classification symbols) B63H5/125, B63H25/42		
15	Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2013 Kokai Jitsuyo Shinan Koho 1971-2013 Toroku Jitsuyo Shinan Koho 1994-2013		
20	Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
	C. DOCUMENTS CONSIDERED TO BE RELEVANT		
	Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
25	Y A	US 2012/0058694 A1 (SCHOTTEL GMBH), 08 March 2012 (08.03.2012), paragraphs [0022] to [0030]; fig. 1 to 8 & JP 2012-528030 A & EP 2435294 A1 & WO 2010/136012 A1 & CA 2763257 A1 & KR 10-2012-0016138 A & CN 102448808 A	1-4, 6-9 5, 10-11
30	Y A	JP 2012-101580 A (Mitsubishi Heavy Industries, Ltd.), 31 May 2012 (31.05.2012), paragraphs [0021], [0027] to [0031]; fig. 3, 5, 7 (Family: none)	1-4, 6-9 5, 10-11
35			
40	☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
	* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
45			
50	Date of the actual completion of the international search 02 October, 2013 (02.10.13)		Date of mailing of the international search report 15 October, 2013 (15.10.13)
	Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
55	Facsimile No.		Telephone No.

5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2013/004346

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
10 Y A	JP 3-5355 B2 (Kawasaki Heavy Industries, Ltd.), 25 January 1991 (25.01.1991), column 3, lines 3 to 43; fig. 1 & JP 59-26397 A	3-4, 6 5
15 Y A	WO 2011/127987 A1 (WÄRTSILÄ FINLAND OY), 20 October 2011 (20.10.2011), description, page 8, line 1 to page 15, line 2; fig. 1 to 4 & JP 2012-525301 A & US 2013/0036962 A1 & EP 2406129 A1 & SG 175035 A1 & CN 102414079 A	8-9 10-11
20 A	JP 38-14234 B1 (Marei & Toregasa Inc.), 06 August 1963 (06.08.1963), fig. 4 to 6 (Family: none)	10-11
25		
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- JP 59026397 A [0007]
- JP 4526184 B [0007]