(19) ORGANISATION AFRICAINE DE LA PROPRIETE INTELLECTUELLE

(51) Inter. Cl.[8] B63H 20/04 (06.01)

(11) N° 17410

FASCICULE DE BREVET D'INVENTION

(21) Numéro de dépôt : 1201500196
(PCT/FI12/051249)

(22) Date de dépôt : 14/12/2012

(30) Priorité(s) :

(24) Délivré le : 29/02/2016

(45) Publié le : 29.09.2016

(73) Titulaire(s) :

Rolls-Royce OY AB,
POB 220, FI-26101 RAUMA (FI)

(72) Inventeur(s) :

RUOSTEMAA Esa (FI)
KARPPINEN Mikko (FI)
KNUUTI Mikko (FI)

(74) Mandataire : Cabinet ÉKÉMÉ LYSAGHT SARL,
B.P. 6370, YAOUNDE (CM).

(54) **Titre : Method for disassembling and/or assembling an underwater section of a retractable thruster unit.**

(57) **Abrégé :**

The present invention relates to a method for disassembling and/or assembling an underwater section of a retractable thruster unit of a swimming vessel. In the method a supporting cradle (21) is detachably fixed to the underwater section (12) from below, and the thruster unit (10) is lifted so that the underwater section (12) is at least partly brought inside the well (17) formed in the bottom of the vessel. Lifting wires (24) of auxiliary lifting means (23) are connected to the supporting cradle (21) for supporting the thruster unit. Water is drained from the well (17), and the lower gear (13) is disengaged and the intermediate section and the lower gear are sealed. After that water is let to ingress into the well (17) and the underwater section (12) is lowered down by the auxiliary lifting means (23) to dock bottom or sea bed, from where the underwater section is picked up with a crane.

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ORIGINAL

D E M A N D E DE B R E V E T D ' I N V E N T I O N

Rolls-Royce OY AB

Method for disassembling and/or assembling an underwater section of a retractable thruster unit

INVENTEURS : RUOSTEMAA Esa
KARPPINEN Mikko
KNUUTI Mikko

Rolls-Royce OY AB

Method for disassembling and/or assembling an underwater section of a retractable thruster unit

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a method for disassembling and/or assembling an underwater section of a retractable thruster unit of a swimming vessel. The invention is specifically directed to a method for disassembling and/or assembling an underwater section of an azimuthing retractable thruster unit comprising an upper gear connected to a power source, an underwater section including a lower gear connected to the actual propeller, and a vertical steering tube connecting the upper gear with the underwater section and containing a vertical shaft through which power and torque are transmitted from the upper gear to the lower gear.

BACKGROUND OF THE INVENTION

A thruster unit described above is normally mounted in a swimming vessel so that at first a well is formed in the bottom of said vessel. The well is open downwards but the top of the well is provided with a covering plate by which the well is sealed and closed upwards. The upper gear of the thruster unit is placed above the covering plate which is provided with a sealed lead-in through which the vertical steering tube extends from the upper gear to the underwater section of the thruster unit. The well is conventionally dimen-

sioned so that the underwater section of the thruster unit fits into it. Thereby, if necessary, the thruster unit can be lifted so that the underwater section is completely retracted into the well above the bottom of the vessel.

From time to time the thruster unit needs maintenance and repairs and in some cases it has to be replaced by another thruster unit. In prior art cases in which the thruster unit has to be removed for maintenance or repairs the vessel has normally been brought to dry dock in which it has been possible to execute this kind of maintenance and replacement work. Dry docking of a vessel is extremely expensive because the work itself on a dry dock is expensive and the preparations for taking a vessel to a dry dock are time consuming. Out-of-service time of a large vessel may become quite long and that costs money. Therefore, attempts have been made to get this dead time shorter and to make it possible to get the maintenance and repair work done without bringing the vessel to a dry dock.

Publication WO 2011/127987 describes a mounting method of thruster in which method the maintenance and replacement work is carried out as "dry work" so that the thruster unit is hoisted up through a well or a hoisting chamber onto the deck of the vessel or into a dry maintenance space in which necessary maintenance and repairs are to be done.

Publication WO 97/27102 describes method and apparatus for removing a propeller assembly from and for mount-

ing the same in an opening in the bottom of a swimming vessel. According to this publication the vessel is provided with a watertight hoisting chamber extending from the bottom of the vessel to above the waterline. For maintenance the thruster unit is hoisted through the hoisting chamber from the vessel.

Publications WO 2005/100151 and WO 2009/126097 describe methods and arrangements for disassembly/assembly of tunnel thrusters. Therefore these publications are not directly comparable with the present invention. The main idea in both of these documents is that the assembly work is done as underwater work. For the disassembly/assembly a sledge is mounted in the propeller tunnel, by which sledge the thruster unit is removed and replaced. No dry docking of the vessel is needed.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a method for disassembling and/or assembling an underwater section of a retractable thruster unit of a swimming vessel by which method the problems relating to prior art technique are avoided or at least minimized. The objects of the invention are achieved by the method and equipment characterized in the appended claims.

Several advantages over prior art are attainable by the present invention. The inventive method is applicable both for new building installations and for already installed thrusters. Docking is not required for

preparations for the method. Because docking is not required the out-of-service time of the vessel is shorter than before and the expenses relating to the dismounting/mounting work are lower.

Further advantages, characteristic features and embodiments of the invention will come out in more detail in the following description of the invention, in which the invention is described with reference to the accompanying drawings depicting various stages of disassembling a thruster unit.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a side view of the thruster unit according to the present invention, at a stage before starting the disassembling process.

Fig. 2 shows the thruster unit at a stage in which a supporting cradle has been attached to the thruster unit.

Fig. 3 shows the thruster unit in a lifted position.

Fig. 4 shows the thruster unit in a lifted position where the auxiliary lifting means are connected and attached to the cradle.

Fig. 5 shows the thruster unit at a stage in which the underwater section of the thruster unit is released.

Fig. 6 shows the thruster unit at a stage in which the underwater section has been lowered down beneath the bottom of the vessel for removing it for maintenance/repair.

Figs. 7 - 10 show the different stages of mounting of the sea valve on the cover of the well in the swimming vessel.

DETAILED DESCRIPTION OF THE INVENTION

Fig. 1 shows an azimuthing thruster unit 10 which is turnable around a vertical axis for steering. The thruster unit 10 comprises an upper gear 11 connected to a power source 16, an underwater section 12 including a lower gear 13 connected to the actual propeller 14, and a vertical steering tube 15 connecting the upper gear 11 with the lower gear 13. Said steering tube 15 contains a vertical shaft through which power and torque are transmitted from the upper gear 11 to the lower gear 13.

The thruster unit 10 is mounted in a swimming vessel so that a well 17 is formed in the bottom 18 of the vessel. The well 17 is open downwards but the top of the well is provided with a covering plate 19 by which the well 17 is sealed and closed upwards. As shown in the drawings the upper gear 11 of the thruster unit 10 is placed above the covering plate 19 which is provided with a sealed lead-in through which the vertical steering tube 15 extends from the upper gear 11 to the lower gear 13 of the thruster unit 10. The well 17 is

so dimensioned that in a lifted position the underwater section 12 of the thruster unit 10 comprising the lower gear 13 and the propeller 14 fits into it. The thruster unit 10 is retractable and provided with hydraulic lifting devices 20, e.g. cylinders by which the thruster unit 10 can be retracted so that the underwater section can be brought completely into the well 17 above the bottom 18 of the vessel and lowered back to the position shown in Fig. 1.

The stage depicted in Fig. 1 before the actual disassembly work is started is a preparation stage. At this stage the airtightness of the thruster unit 10 is secured. So at this stage the thruster unit 10 is made airtight if it wasn't before. Special plugging equipment is needed for making the thruster unit 10 airtight. Also the propeller 14 is locked in place. The well 17 can be filled with water at this stage.

At the stage shown in Fig. 2 a supporting cradle 21 for disassembly is fixed to the thruster unit 10. The cradle 21 on which the underwater section 12 comprising the lower gear 13 and the actual propeller 14 will be resting during the disassembly/assembly process comprises further a work platform for the divers. The cradle 21 is floated below the thruster unit 10 and into contact with the underwater section 12 and further it is fixed to said underwater section 12 by divers.

Fig. 3 shows the stage in which, firstly, the gear shaft of the upper gear 11 is disengaged from between

the power source 16 and the upper gear 11. Then the hydraulic lifting devices 20 have been used to lift the thruster unit 10 so that the underwater section 12 has been brought partly inside the well 17. The thruster unit 10 is mechanically locked in place in the lifted position with supports 22. Said supports 22 are arranged between the upper gear 11 and the supporting frame of the vessel. In Fig. 3 the supports are arranged between the upper gear 11 and the covering plate 19 of the well 17.

Fig. 4 shows the thruster unit 10 in its lifted position where the auxiliary lifting means 23 are connected and attached to the cradle 21 for supporting the thruster unit 10. The auxiliary lifting means 23 are preferably jacks provided with lifting wires 24 which are connected to the underwater section 12 of the thruster unit 10. In order to maintain the underwater section 12 in balance while it is lifted there are preferably three jacks 23 with lifting wires 24. The lifting wires 24 are connected to the underwater section 12 by divers. As seen in Fig. 4 the thruster unit 10 is continuously supported in the lifted position by supports 22.

The auxiliary lifting means 23, e.g. jacks are arranged above the covering plate 19, preferably above the water line of the vessel. So the wires 24 coming from said jacks 23 must go through the covering plate 19 to reach the underwater section 12 to which they are to be connected at connection points 25. Therefore the following preparations, as presented in Figs. 7-

10, have to be made in the covering plate 19 if it was not originally assembled for this kind of operation.

As Fig. 7 shows, at first a flange 32 for each lifting wire 24 is to be mounted and welded on the upper surface of the covering plate 19. Then, as shown by Fig. 8, a sea valve 33 is mounted on each flange 32. After that a drill 34 is mounted on the sea valve 33 and a hole 26 is drilled to the covering plate 19 through the sea valve 33. After drilling the sea valve 33 is closed and the drill 34 is removed. Then a blind flange 36 will be mounted on the sea valve 33. These steps are shown in Figs. 9 and 10. However, if right kind of drill is not available, the holes 26 in the covering plate 19 can be made by flame cutting to rough diameter and grinded to final diameter.

Before the lifting wires 24 of the auxiliary lifting means 23 are connected to the cradle 21, pipes for the lifting wires 24 are mounted and connected to the sea valves 33. So the lifting wires 24 are running through the sea valves 33 and inside said pipes, they are not running in a free space. After these preparations the lifting wires 24 are ready to be connected to the cradle 21 at the connection points 25. In order to keep the cradle 21 with the underwater section 12 of the thruster unit 10 centered in the well 17, adjustable side guides 27 are mounted on the structure of the cradle 21. Said side guides 27 are resting against the inner wall of the well 17.

Next, the well 17 and the input shaft of the upper gear 11 are sealed and pressurized air is supplied into the well 17. The purpose of the pressure air supply is to drain water from the well 17. After water has been drained from the well 17 the joint 28 between the lower gear 13 and the steering tube 15, i.e. the intermediate section of the thruster unit 10 is loosened. When the joint 28 has been loosened the lifting wires 24 are tightened to keep the lower gear 13 at its present place. Then the steering tube 15 with the upper gear 11 of the thruster unit 10 are lifted, so that the upper and lower flanges 29, 30 of the joint 28 are separated from each other and a space is formed between said flanges 29, 30. This is shown in Fig. 5. When an adequate space is formed between the flanges 29, 30 the steering tube 15 with the upper gear 11 are mechanically locked in place with the supports 22.

In the lifted position shown in Fig. 5 and after the joint 28 between the lower gear 13 and the steering tube 15 is loosened and the flanges 29, 30 separated from each other blinds 31 are mounted and sealed on said flanges 29, 30 of the lower end of the steering tube 15 and the lower gear 13. The purpose of this is to prevent water from getting into the steering tube 15 and the lower gear 13. Then the side guides 27 are loosened and water let to ingress into the well 17.

Finally, in Fig. 6 it is shown that the cradle 21 with the underwater section 12 of the thruster unit 10 is lowered down by the jacks 23 and the wires 24. At this stage the underwater section 12 is supported by the

cradle 21 which is attached to the underwater section 12. The underwater section 12 is lowered down e.g. to the dock bottom or to sea bed. From the dock bottom or the sea bed the underwater section 12 of the thruster unit 10 can then be picked up with a crane. However, it is also possible to lift the underwater section 12 with the cradle 21 to within the range of a shore-based crane using lifting points and lifting equipment (not shown) attached to the underside of the hull of the swimming vessel. Alternatively, it is also possible to float the cradle and the underwater section 12 of the thruster unit 10 to within the range of a shore-based crane using buoyancy control. Divers will fasten the crane wires to the cradle 21 and loosen the lifting wires 24 of the jacks 23.

When the thruster unit or more precisely the underwater section 12 of the same is assembled back to its place or if a new underwater section will be assembled, the assembling process will be executed in a reverse order as explained above.

Above, the invention has been described by way of examples with reference to the exemplifying embodiments illustrated in the accompanying drawings. The invention is, however, not confined to the exemplifying embodiments shown in the drawings alone, but the invention may vary within the scope of the inventive idea defined in the accompanying claims.

22 MAI 2015
EKEME LYSAGHT Sarl
B.P. 6370
YAOUNDE - CAMEROUN
Tél.- Fax : 22 31 67 53

CLAIMS

1. Method for disassembling and/or assembling an underwater section of a retractable thruster unit of a swimming vessel, the thruster unit (10) comprising an upper gear (11) detachably connected to a power source (16), said underwater section (12) including a lower gear (13) and a propeller (14), and an intermediate section with a steering tube (15) connecting the upper gear (11) with the underwater section (12), said vessel being provided with a well (17) formed in the bottom (18) of the vessel, into which well (17) said underwater section (12) can be retracted when the thruster unit (10) is out of operation, said well (17) being closed upwards with a covering plate (19), whereby in disassembling the underwater section (12) the method is characterized by the steps of:

a) fixing a supporting cradle (21) detachably to the underwater section (12) from below, disengaging the upper gear (11) from the power source (16), and lifting the thruster unit (10) so that the underwater section (12) is at least partly brought inside the well (17) and locking the thruster unit (10) mechanically in place in the lifted position,

b) connecting auxiliary lifting means (23) provided with lifting wires (24) to the supporting cradle (21) for supporting the thruster unit (10),

c) draining water from the well (17) by supplying pressurized air into the well (17),

d) loosening the joint (28) between the lower gear (13) and intermediate section (15) of the thruster unit (10),

e) lifting the upper gear (11) and the intermediate section (15) further and locking them mechanically in place while the cradle (21) is supported in place by the auxiliary lifting means (23) so that a space is formed between the intermediate section (15) and the lower gear (13), and sealing the intermediate section (15) and the lower gear (13) to prevent water from getting into them,

f) letting water to ingress into the well (17) and lowering the underwater section (12) down by the auxiliary lifting means (23), attaching the wires of a crane, detaching the lifting wires (24) of the auxiliary lifting means (23), and picking up the underwater section (12) with the crane.

2. Method as claimed in claim 1, characterized in that sea valves (33) are mounted on the upper face of the covering plate (19) and holes (26) are made in the covering plate (19) at the sea valves (33), whereby the lifting wires (24) of the auxiliary lifting means (23) are set to run through said sea valves (33) and holes (26) from the auxiliary lifting means (23) above the covering plate (19) to the cradle (21).

3. Method as claimed in claim 2, characterized in that the holes (26) in the covering plate (19) are made by drilling.

4. Method as claimed in claim 3, characterized in that the holes (26) in the covering plate (19) are drilled through the sea valves (33).

5. Method as claimed in claim 2, characterized in that the holes (26) in the covering plate (19) are made by flame cutting to rough diameter and grinding to final diameter.

6. Method as claimed in any of the preceding claims, characterized in that the supporting cradle (21) is floated below the underwater section (12) and fixed to said underwater section (12) by divers.

7. Method as claimed in any of the preceding claims, characterized by providing supports (22) for locking the thruster unit (10) mechanically in place in the lifted position.

8. Method as claimed in any of the preceding claims, characterized by providing the cradle (21) with side guides (27) and making them rest against the inner wall of the well (17) for keeping the thruster unit (10) centered in the well (17).

9. Method as claimed in any of the preceding claims, characterized by providing the intermediate section (15) and the lower gear (13) with blinds (31) for sealing to prevent water from getting into them, when a space is formed between the intermediate section (15) and the lower gear (13).

10. Method as claimed in claim 1, characterized in that the underwater section (12) with the cradle (21) are lowered onto the dock bottom or sea bed for picking it up therefrom with the crane.

11. Method as claimed in claim 1, characterized in that the underwater section (12) with the cradle (21) are lifted to within the range of a shore-based crane, lifting equipment of which are attached to the underside of the hull of the swimming vessel, whereby the underwater section (12) with the cradle (21) are picked up by said shore-based crane.

12. Method as claimed in claim 1, characterized in that the underwater section (12) with the cradle (21) are floated to within the range of a shore-based crane using buoyancy control, by which shore-based crane the underwater section (12) with the cradle (21) are picked up.

13. Method as claimed in any of the preceding claims, characterized in that the steps for fixing the supporting cradle (21) to the underwater section (12), connecting the lifting wires (24) of the auxiliary lifting means (23) to the supporting cradle (21), disconnecting the lower gear (13) from the intermediate section (15) and sealing them, and connecting the lifting wires of the crane to the cradle (21) are executed by divers.

14. Method as claimed in claim 1, characterized in that before starting the disassembly and/or assembly work the thruster unit (10) is made airtight with

plugging equipment and the airtightness of the thruster unit (10) is secured.

15. Method as claimed in claim 1, characterized in that for assembling the thruster unit (10) the steps of the method are executed in a reverse order to the disassembling process.

22 MAI 2015
EKEME LYSAGHT Sarl
B.P. 6370
YAOUNDE - CAMEROUN
Tél.- Fax: 22 31 67 53

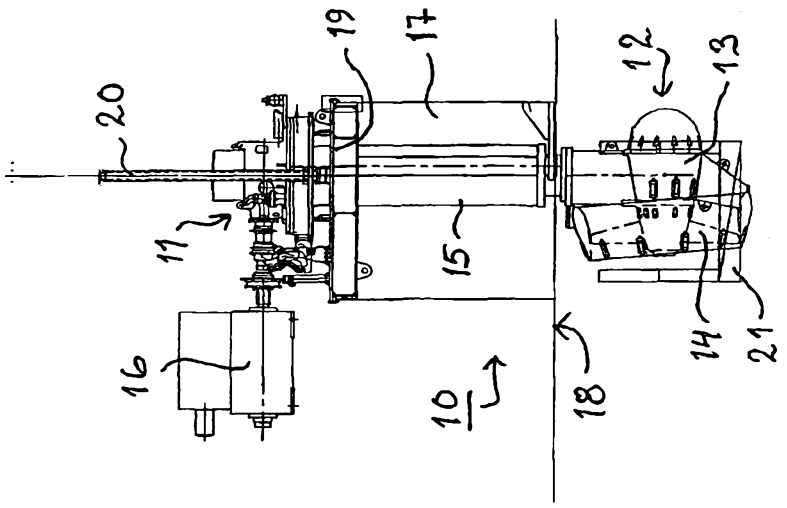


Fig. 2

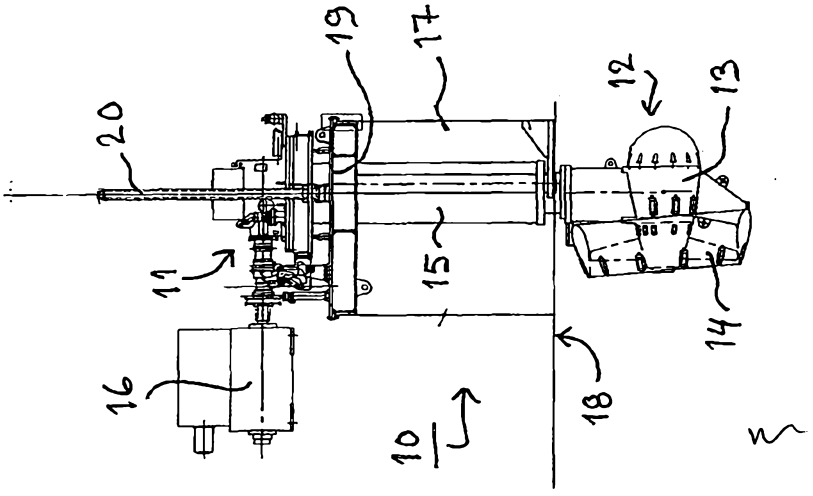


Fig. 1

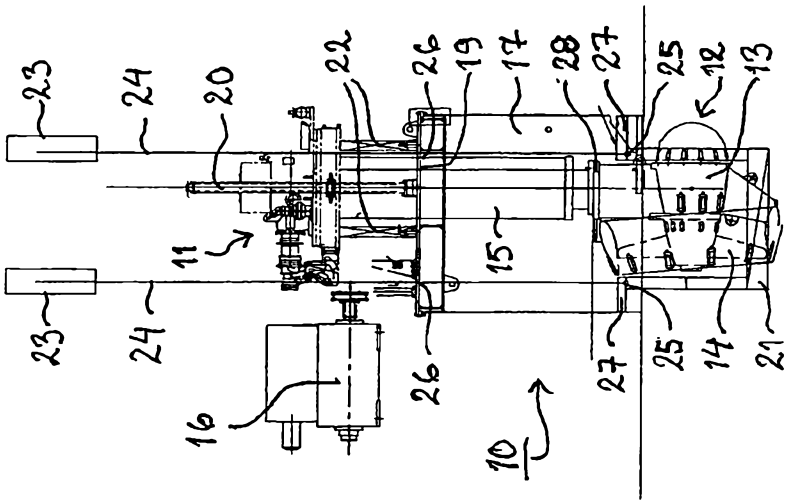


Fig. 4

Fig. 3

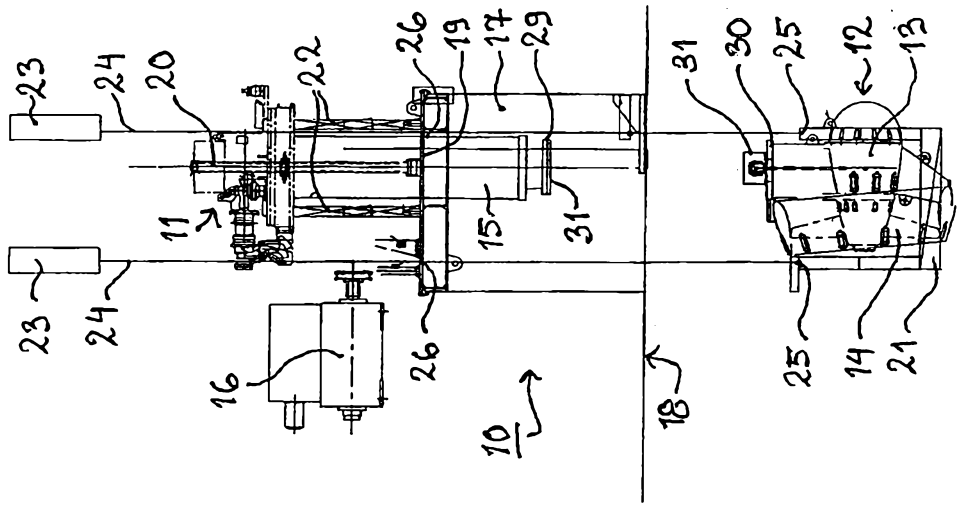

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Fig. 6

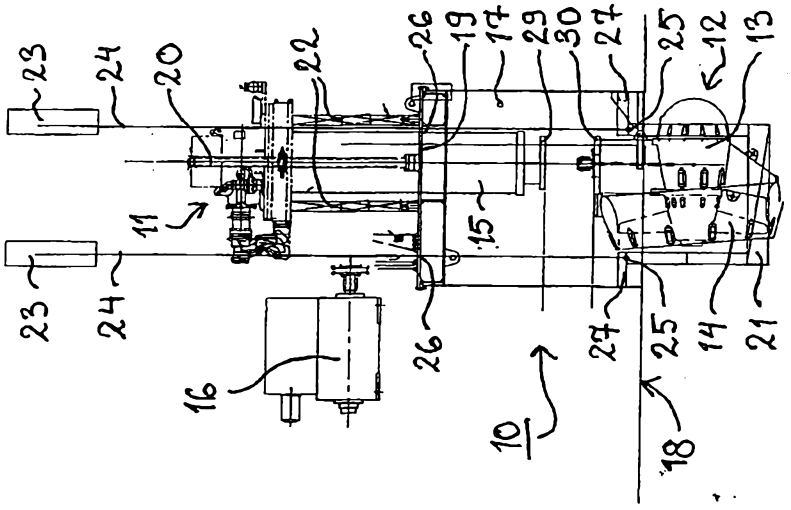

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Fig. 5

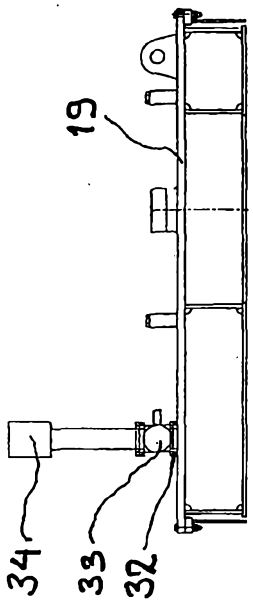


Fig. 9

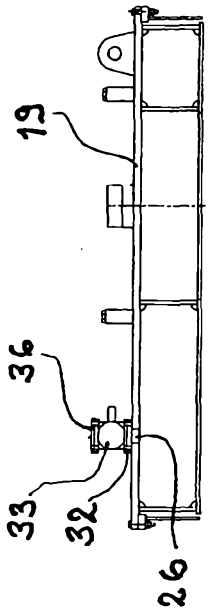


Fig. 10

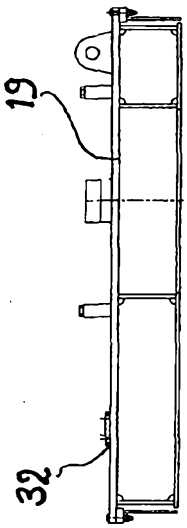


Fig. 7

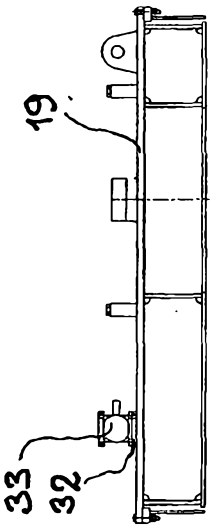


Fig. 8

22 MAI 2015
EKEMB LYSAGHT Sarl
B.P. 6370
YAOUNDE - CAMEROUN
Tél.- Fax.: 22 31 87 53

ABSTRACT

The present invention relates to a method for disassembling and/or assembling an underwater section of a retractable thruster unit of a swimming vessel. In the method a supporting cradle (21) is detachably fixed to the underwater section (12) from below, and the thruster unit (10) is lifted so that the underwater section (12) is at least partly brought inside the well (17) formed in the bottom of the vessel. Lifting wires (24) of auxiliary lifting means (23) are connected to the supporting cradle (21) for supporting the thruster unit. Water is drained from the well (17), and the lower gear (13) is disengaged and the intermediate section and the lower gear are sealed. After that water is let to ingress into the well (17) and the underwater section (12) is lowered down by the auxiliary lifting means (23) to dock bottom or sea bed, from where the underwater section is picked up with a crane.

22 MAI 2015
EKEME LYSAGHT Sarl
B.P 6370
YAOUNDE CAMEROUN
Tél.- Fax.. 22 31 67 53

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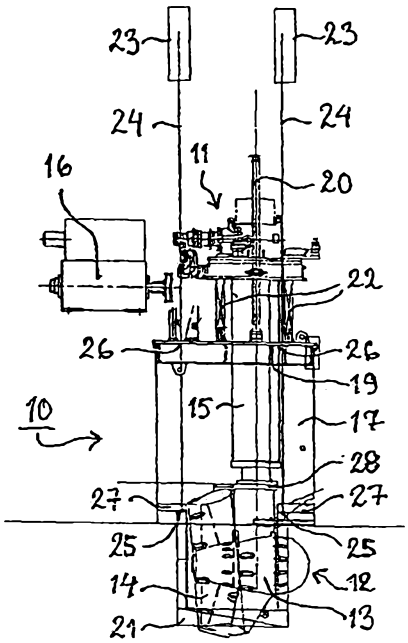


Fig. 4