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Remarks:

Amended claims in accordance with Rule 137(2) EPC.

(54) **Unmanned underwater vehicle**

(57) The invention relates to a unmanned underwater vehicle 1 with two or more hulls 2, 3, comprising a means for crane deployment and recovery.

To provide a small, but efficient unmanned underwater vehicle, which can be launched or recovered safely

and easily the invention provides a framework 4 comprising at least one cross bar 12, 13, 14, 15 connected to the hulls 2, 3 at its endings 22, 23 and comprising two pivotable levers 16, 17 connected to each other by a main joint 18, 19, 20, 21.

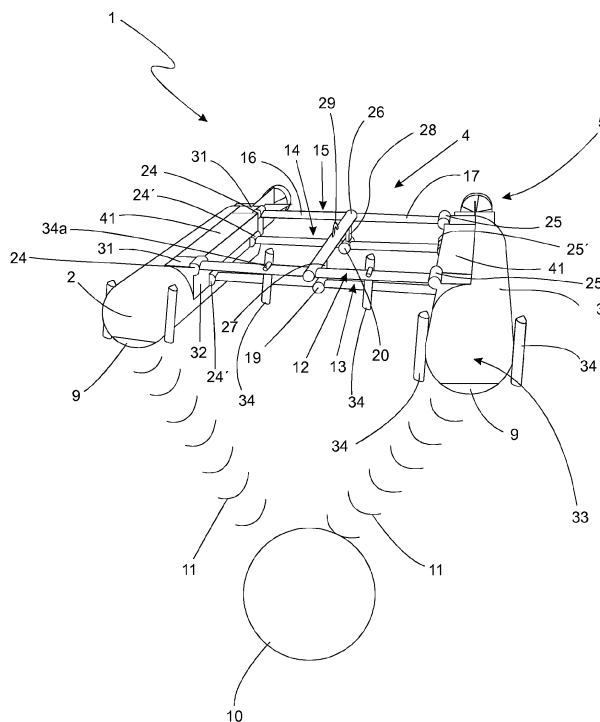


Fig. 3

Description

[0001] The invention relates to an unmanned underwater vehicle comprising two or more hulls and a framework coupling the hulls comprising a means for crane deployment and recovery.

[0002] Unmanned underwater vehicles may be broadly divided into the subclasses of remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs). Whereas remotely operated vehicles are usually controlled by a connecting cable, autonomous underwater vehicles fulfill a mission without being constantly monitored by a human operator. However, unmanned underwater vehicles and in particular autonomous underwater vehicles are cost effective tools for carrying out a variety of tasks in the underwater environment, e.g. pipeline surveys and investigations or military tasks.

[0003] For deploying submersible vehicles from a platform, for example a surface vessel, cranes are used. Launch and recovery are the most dangerous operations of the entire mission of a submersible vehicle due to the levitation of the vehicle. For successful launch and recovery sea motion and wind velocity have to be taken in consideration due to their effects on the vessels movement especially in terms of roll and pitch movement. Damage to the submersible vehicle or the support platform is a significant risk factor as well as possible hazards to personnel involved in the manoeuvre.

[0004] A known autonomous underwater vehicle (AUV) manufactured by the applicant, called "SeaOtter", is build up as a twin hull system with two tube-shaped hulls arranged in parallel containing different modules for propulsion, energy packages, communication, navigation and payload. The two hulls of the known autonomous underwater vehicle are arranged adjacently and are coupled by a framework comprising an eye for crane deployment and recovery.

[0005] A small AUV called "SeaBED" comprises two hulls connected by rigid spars. When the AUV is on duty the two hulls are located in a vertical plane due to negative buoyancy in the lower hull and positive buoyancy in the upper hull. The vertical arrangement of the hulls makes the vehicle stable in pitch and roll. The known AUV comprises an eye to coact with the hook of a crane, wherein the eye as the means for crane deployment and recovery is attached to the upper hull. Therefore, the known AUV is launched and recovered in a vertical position. In the vertical position the AUV is particularly susceptible for the effects of wind and sea motion and cannot be launched or recovered under rough environmental conditions.

[0006] In view of the above, it is therefore an object of the present invention to provide a small, but efficient unmanned underwater vehicle, which can be launched or recovered safely and easily.

[0007] This object is achieved by providing an unmanned underwater vehicle comprising two or more hulls and a framework coupling the hulls according to claim 1.

[0008] A framework comprising at least one cross bar comprising two pivotable levers connected to each other by a main joint, allows to fold and unfold the unmanned underwater vehicle comprising the framework to keep the vehicle in a compact folded state during launch or recovery. During launch or recovery of the vehicle the vehicle is carried by a crane, whereas the hulls remain adjacent to each other due to gravity. Thus, during crane engagement the weight of the dangling hulls takes effect downwards, i.e. in the opposite direction of the cranes holding force, generating torque in the cross bars and therefore rotation of the main joints to converge the hulls.

[0009] In the folded state the vehicle is much less fragile and therefore less sensitive for the dangerous effects of wind providing a safer manageability of the vehicle during launch or recovery operations. Furthermore, the vehicle is much more easy to store on deck of a support vessel in the folded and compact state. Moreover, the space needed for storing is reduced.

[0010] After launching the vehicle starts its mission in an unfolded state, wherein the hulls are spreaded and located distantly. In a preferred embodiment the unmanned underwater vehicle comprises two hulls arranged parallelly, which can be located very compactly in the folded state and provide a large width being spreaded in the unfolded operating state.

[0011] A large width of the vehicle is needed for special tasks like pipeline surveys, for example a width of 2,5 meters, to arrange coacting equipment like sonar equipment distantly to obtain improved operation results. Though the width of conventionally arranged underwater vehicles is limited by the accompanying fragility and sensitivity for wind effects, the foldable underwater vehicle provides an extendable width due to the possibility of being folded while being out of the water.

[0012] However, the distance of the hulls in the unfolded state improve the effectiveness of coacting equipment provided in different hulls, for example sonar equipment. Preferably, each hull comprises multibeam sonar giving the opportunity to evaluate the results from the several sonars, for example by a central control unit in one of the hulls.

[0013] Preferably, the main joints of the cross bars are attached to the means for crane deployment and recovery to induce the holding force of the crane directly in the housings of the main joint enabling the joints to disband torque in the cross bars generated by the hull's weight.

[0014] After releasing the vehicle and thus releasing the holding force of the crane the hulls are pushed apart from each other, spreading the levers of the cross bars, e.g. due to gravity of the framework and/or the hulls. The spreading of the levers of the cross bars can be supported by a spring acting on the cross bar(s) or other mechanisms involving positive and negative buoyancy elements. Preferably, the main joint is located in the middle of the cross bar to enable a symmetrical folding and unfolding of the vehicle.

[0015] In a preferred embodiment of the invention the framework comprises two or more cross bars with the main joints attached to a longitudinal bar, wherein the longitudinal bar comprises the means for crane deployment and recovery, for example a hook or an eye to coact with a crane. However, other detachable means for crane deployment and recovery but hooks may be comprised.

[0016] An arrangement with a longitudinal bar provides a stable framework with symmetrical load on the main joints of the cross bars. Furthermore, the weight of the longitudinal bar, which is located in the centre of the space between two hulls, supports the spreading movement of the hulls after releasing the vehicle from the crane.

[0017] Preferably, the endings of the cross bar comprise auxiliary joints, which are attached to the hulls of the underwater vehicle. The levers of the cross bars coacting with auxiliary joints and main joints constitute a gear unit, which enables a smooth-running folding movement of the framework. Moreover, the auxiliary joints as a part of the gear unit enable the hulls to remain in the orientation designated for the mission even during launching or recovering.

[0018] To provide a pivoting moveability of each lever, the auxiliary joints assigned to the same hull are located in a common plane. Thus, the auxiliary joints provided on the starboard side of the vehicle are arranged in a common plane and similarly the auxiliary joints provided on the port side are arranged in a common plane. In a preferred embodiment with the main joints located at half of the length of the cross bars, the location of the auxiliary joints in a common plane provides a symmetrically foldable framework, enabling the main joints of the cross bars to move on a longitudinal line between the common planes of the auxiliary joints during folding/unfolding events.

[0019] To increase the stability of the unmanned underwater vehicle the framework comprises cross bars in different parallel planes, wherein the cross bars located in a larger distance to the longitudinal bar than the other cross bars are attached to the longitudinal bar by means of struts. During launch or recovery of the vehicle the struts transfer the force induced by the crane symmetrically to the auxiliary joints of the cross bars. The length of the struts ensures synchronized movements of the levers of the cross bars. Moreover, in an embodiment with cross bars in different parallel planes providing auxiliary joints assigned to the same hull being located in a common plane, the cross bars can be equipped with instruments or other equipment requiring an adjusted arrangement, e.g. magnetometers. The instruments are attached to two adjacent levers of different cross bars located in different distances with regard to the longitudinal bar and are therefore adjusted in any state of the spreadable levers.

[0020] In a preferred embodiment the framework provides one or more telescoping cross bars to reduce the dimension of the vehicle in the folded state, which is advantageous in storing the vehicle. Furthermore, the telescoping movement of the cross bars improve the coaction of the main joints and the auxiliary joints and adjusts the levers to obtain a smooth-running behaviour of the framework.

[0021] The framework comprises a detachable locking mechanism, which is self-locking in an unfolded operating position of the unmanned underwater vehicle. When the vehicle is to be recovered, the locking mechanism is unlocked and the vehicle is folded by the lifting movement of the crane. The folding of the vehicle after unlocking the mechanism and engaging the crane is supported by water resistance, as far as the vehicle stays below the surface before starting the recovery operation. The crane might be engaged to the vehicle by a diver. Preferably, to initiate recovery the foldable vehicle releases a lifting body, which hits the surface and can be grappled like a buoy. The lifting body or buoy is preferably part of the means for crane deployment and recovery and is attached to the longitudinal bar of the framework, for example by using a salvage rope.

[0022] However, the locking mechanism can be unlocked by means provided in the vehicle. Another possibility to unlock the locking mechanism is a remote control or an unlocking by interference of the hook of a crane acting with the eye attached to the longitudinal bar of the framework.

[0023] In a preferred embodiment the hulls are constituted of modules to form assemblies of modules, each assembly comprising modules for example for propulsion, energy packages or power supplies, communication, payload and/or navigation. The modular design enables a low-cost construction of an unmanned underwater vehicle, especially an autonomous underwater vehicle, adapted to the special requirements of the designated mission.

[0024] Preferably, the vehicle is an autonomous underwater vehicle (AUV), which fulfills its missions without being monitored by a human operator. An AUV provides expensive and sensitive equipment, which is protected by applying a foldable framework to launch and recover the AUV in a folded and compact state.

[0025] Further advantageous embodiments and developments are defined in the dependent claims. These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter with reference to the accompanying drawings, in which:

Fig. 1 depicts a side view of an autonomous underwater vehicle according to an embodiment of the present invention;

Fig. 2 depicts a top view of the autonomous underwater vehicle shown in fig. 1;

Fig. 3 depicts a perspective view of an autonomous underwater vehicle according to fig. 1 or 2 in an

unfolded state;

Fig. 4 and Fig. 5 depict schematic views of a vessel deploying an autonomous underwater vehicle.

[0026] In the following description of an advantageous embodiment similar reference numeral is used for similar features.

[0027] Fig. 1, 2 and 3 depict an autonomous underwater vehicle (AUV) 1 with two parallelly arranged hulls 2, 3, which are connected by a foldable framework 4. The hulls 2, 3 are tube-shaped and built as pressure housings containing the electronics, the batteries and other system-requirements of the AUV 1 like means for navigation or communication as well as a control unit (not shown). Each hull 2, 3 comprises a propulsion unit 5 comprising a propeller 6, fins 7 and side rudders 8. Furthermore, each hull 2, 3 comprises a multibeam sonar 9.

[0028] The framework 4, which will be elucidated hereinafter, enables to fold or to crunch the AUV 1. In the folded state, which is shown in fig. 1 and 2, the hulls 2, 3 are arranged adjacently. In the unfolded state of the AUV 1, which is shown in fig. 3, the hulls 2, 3 are arranged in distance to each other, i.e. apart from each other, wherein the framework 4 determines the space between the hulls 2, 3. In the unfolded state, which is the operating state of the AUV 1, the hulls 2, 3 are spreaded providing a large width of the AUV 1. A large width of e.g. 2,5 meters is advantageous for a plurality of investigation tasks, for example surveying of pipelines 10. In Fig. 3 a pipeline 10 is monitored by the multibeam sonars 9 of both hulls 2, 3, wherein the sonar signals 11 are coordinated. Due to the spreading of the hulls 2, 3 the multibeam sonars 9 are able to send and receive sonar signals 11 in an advantageous angle in order to compute improved investigation results.

[0029] The framework 4 comprises four cross bars 12, 13, 14, 15, comprising two pivotable levers 16, 17 connected to each other by a main joint 18, 19, 20, 21, respectively.

[0030] The main joints 18, 19, 20, 21 are located in the centre, e.g. half of the length of the respective cross bar 12, 13, 14, 15, and build a hinge for rotation movement of the cross bars' levers 16, 17. The endings 22, 23 of the cross bars 12, 13, 14, 15 are attached to the hulls 2, 3 by auxiliary joints 24, 24', 25, 25', respectively. The main joints 18, 19, 20, 21 coacting with the auxiliary joints 24, 24', 25, 25' constitute a gear unit, which allows the hulls 2, 3 to move in a horizontal plane.

[0031] The main joints 18, 19, 20, 21 are attached to a longitudinal bar 26. During the folding operation the longitudinal bar 26 only moves in a basically vertical plane, i.e. perpendicular to a plain containing the hulls 2, 3.

[0032] The four cross bars 12, 13, 14, 15 are located in pairs in different planes, wherein the cross bars 13, 14 located in a larger distance from the longitudinal bar 26 than the other cross bars 12, 15 are attached to the longitudinal bar 26 by means of struts 27, 28. However, the cross bars 12, 15 located adjacent the longitudinal bar 26 are preferably attached directly to the longitudinal bar 26, i.e. without struts. In this arrangement the main joints 18, 19, 20, 21 of every cross bar 12, 13, 14, 15 is engaged with the common longitudinal bar 26, which comprises a means for crane deployment and recovery of the AUV 1.

[0033] In the embodiment shown in fig. 1, 2, 3 the means for crane deployment and recovery of the AUV 1 is an eye 29 rigidly attached to the longitudinal bar 26. During launching and recovering the longitudinal bar 26 is hooked by a crane 30 (Fig. 4, Fig. 5).

[0034] The auxiliary joints 24, 24', 25, 25' assigned to the same hull 2, 3 are located in a common plane, e.g. the auxiliary joints 24, 24' dedicated to the hull 2 on the starboard side of the AUV 1 are located in a common plane and similarly the auxiliary joints 25, 25' dedicated to the hull 3 on the port side of the AUV 1 are located in a common plane. In a preferred embodiment as depicted in Fig. 3 the levers 16, 17 of any cross bar have the same length, providing a central location of the main joints 18, 19, 20, 21 in a symmetrical arrangement and permitting the longitudinal bar 26 to move in the centre of the space between the hulls 2, 3. To arrange the auxiliary joints 24, 24' assigned to the starboard hull 2 in a common plane and similarly to arrange the auxiliary joints 25, 25' assigned to the port sided hull 2 in a common plane, joint holders 31 are attached to the hulls 2, 3, which are arched to fit on the surfaces on the tube-shaped hulls 2, 3. The joint holders 31 provide a plane 32 to carry the respective auxiliary joints 24, 25 and fill the distance between the auxiliary joints and the arched surface of the hulls 2, 3.

[0035] The pair of cross bars 12, 13 located adjacent to the bow 33 of the AUV 1 carries instruments 34 or other equipment of the AUV 1. The instruments 34 are longitudinally shaped and located on different levers 16, 17 of the cross bars 12, 13. Each of the instruments 34 are attached to both of the cross bars 12, 13 of the respective pair of cross bars by means of rotatable bearings 34a, 34b. Thus, the respective instrument 34 is attached to the foldable framework in different planes and adjusted in any state of the spreadable cross bars 12, 13. However, the bearings 34a, 34b enable the cross bars 12, 13 to transport the instruments 34 during the folding/unfolding movement of the AUV 1 and to locate them into operational position instantly after unfolding the AUV 1. In the folded state of the AUV 1 the instruments 34 are sheltered by the adjacent cross bars. In a preferred embodiment of the AUV 1 magnetometers are provided as instruments 34 being rotatably attached to a pair of cross bars.

[0036] Moreover, the AUV 1 comprises further instruments 34, e.g. magnetometers, attached to the hulls 2, 3, located

at the bow 33 of the AUV 1.

[0037] Fig. 4 and Fig. 5 illustrate the launching of the AUV 1 which takes place with the aid of the crane 30 mounted on board a buoyant platform, which is e.g. a surface vessel 35. Fig. 4 and Fig. 5 depict the stern of the vessel 35 with the crane 30 located amidships. However, in other embodiments stern-launching may be provided or the crane is located e.g. at the bow of a vessel.

[0038] When the AUV 1 is craned overboard, the AUV 1 remains in the folded state with hulls 2, 3 located adjacently, i.e. side-by-side. In the folded state the effect of wind in combination with wave-induced movements of the vessel 35 on the dangling AUV 1 is reduced. Another advantage of the folded state of the AUV 1 is the reduction of the space needed on board the vessel 31 for storing the AUV 1. For storing the AUV 1 a cradle is provided on the deck of the vessel 35.

[0039] When the currently launched AUV 1 reaches the surfaces 36, the AUV 1 is released from the crane 30, which causes spreading of the hulls 2, 3 shown in fig. 6. After being released from the crane 30 the longitudinal bar 26 moves downwards in direction of the arrow 37 due to gravity, pushing the hulls 2, 3 apart from each other due to the weight of the framework 4. To support the spreading movement appropriate to the arrow 38 the framework can comprise a spring (not shown), e.g. attached to one or all of the main joints 18. Furthermore, to support the spreading movement, the interior of the hulls can be arranged in a way, that provides an asymmetrical disposition of buoyancy with regard to the perimeter of the hulls 2, 3, e.g. negative buoyancy 39 in the upper half of the respective hull 2, 3 and positive buoyancy 40 in the lower half of the hulls 2, 3. Thus, when the spreading movement of the hulls 2, 3 being brought to water starts, the negative buoyancy 39 in the upper half of the respective hull 2, 3 and positive buoyancy 40 in the lower half of the hulls 2, 3 generate a pair of buoyancy forces. This pair of buoyancy forces support the spreading movement of the hulls 2, 3 since the hulls 2, 3 carry out circular motion contrariwise.

[0040] The framework 4 comprises a detachable locking mechanism, which is self-locking when reaching the unfolded operating position of the AUV 1. At the end of a mission, when the AUV is going to be recovered to the vessel 31, the locking mechanism is detached. After the crane being engaged with the AUV 1, the crane 30 lifts the longitudinal bar 26 converting the AUV 1 into the folded state. When the longitudinal bar 26 is being lifted by the crane, the hulls 2, 3 move towards one another enabling a safe recovery.

[0041] However, the locking mechanism might be detachable autonomously by the AUV 1 at the end of the mission, for example when the AUV 1 approaches at the surface. In another embodiment the locking mechanism is combined with the eye 29 of the longitudinal bar 26 and is detachable by engaging the eye 29 e.g. through the hook of the crane 30. The locking of the locking mechanism can be released indirectly by means of buoys released from the AUV 1 and floating on the surface 36. Thus, as depicted in fig. 3, the AUV 1 comprises buoyant bodies 41 providing positive buoyancy, which are located preferably amidships between the cross bars 12, 15. However, in other embodiments buoyant bodies are provided at other sections of the AUV 1 or the AUV comprises a single buoyant body. The buoyant bodies 41 comprise a foam material and act as buoys after being released from the AUV 1. The buoyant bodies 41 are attached to the eye 29 of the longitudinal bar 26, e.g. by using a salvage rope, enabling the crane 30 to detach the locking mechanism while lifting the AUV 1.

[0042] All the features of an unmanned underwater vehicle or its framework mentioned in the description and the claims are to be considered as disclosed individually as well as in any combination of any of these features.

Claims

1. Unmanned underwater vehicle comprising two or more hulls (2, 3) and a framework (4) coupling the hulls (2, 3), wherein the framework (4) comprises a means for crane deployment and recovery,
characterised in that
the framework (4) comprises at least one cross bar (12, 13, 14, 15) connected to the hulls (2, 3) at its endings (22, 23), said cross bar (12, 13, 14, 15) comprising two pivotable levers (16, 17) connected to each other by a main joint (18, 19, 20, 21).
2. Unmanned underwater vehicle according to claim 1,
characterised in that
the main joint (18, 19, 20, 21) of the cross bar (12, 13, 14, 15) is attached to the means for crane deployment and recovery.
3. Unmanned underwater vehicle according to claim 1 or 2,
characterised in that
the main joint (18, 19, 20, 21) is located in the centre of the cross bar (12, 13, 14, 15).
4. Unmanned underwater vehicle according to any of the proceeding claims,

characterized by

two or more cross bars (12, 13, 14, 15) with their main joints (18, 19, 20, 21) attached to a longitudinal bar (26), wherein said longitudinal bar (26) comprises the means for crane deployment and recovery.

- 5 **5.** Unmanned underwater vehicle according to any of the proceeding claims,
characterized in that
the endings (22, 23) of the cross bar (12, 13, 14, 15) comprise auxiliary joints (24, 24', 25, 25'), which are attached to the hulls (2, 3) of the unmanned underwater vehicle.
- 10 **6.** Unmanned underwater vehicle according to claim 5,
characterized in that
the auxiliary joints (24, 24', 25, 25') assigned to the same hull (2, 3) are located in a common plane.
- 15 **7.** Unmanned underwater vehicle according to any of the proceeding claims,
characterized in that
the framework (4) comprises cross bars (12, 13, 14, 15) in different parallel planes, wherein the cross bars (13, 14) located in a larger distance from the longitudinal bar (26) than the other cross bars (12, 15) are attached to the longitudinal bar (26) by means of struts (27, 28).
- 20 **8.** Unmanned underwater vehicle according to any of the proceeding claims,
characterized by
telescoping cross bars (12, 13, 14, 15).
- 25 **9.** Unmanned underwater vehicle according to any of the proceeding claims,
characterized in that
the framework (4) comprises a detachable locking mechanism, which is engaged in an unfolded operating position of the framework (4).
- 30 **10.** Unmanned underwater vehicle according to any of the proceeding claims,
characterized in that
each hull (2, 3) comprises a multibeam sonar (9),
- 35 **11.** Unmanned underwater vehicle according to any of the proceeding claims,
characterized in that
the means for crane deployment and recovery is an eye (29) attached to the longitudinal bar (26).
- 40 **12.** Unmanned underwater vehicle according to any of the proceeding claims,
characterized in that
the vehicle is an autonomous underwater vehicle (1).
- 45 **13.** Unmanned underwater vehicle according to any of the proceeding claims,
characterized in that
the hulls (2, 3) are assemblies of modules comprising modules for propulsion, energy packages or power supplies, communication, payload and/or navigation.

Amended claims in accordance with Rule 137(2) EPC.

- 50 **1.** Unmanned underwater vehicle comprising two or more hulls (2, 3) and a framework (4) coupling the hulls (2, 3), wherein the framework (4) comprises a means for crane deployment and recovery,
characterised in that
the framework (4) comprises at least one cross bar (12, 13, 14, 15) connected to the hulls (2, 3) at its endings (22, 23), said cross bar (12, 13, 14, 15) comprising two pivotable levers (16, 17) connected to each other by a main joint (18, 19, 20, 21), wherein the main joint (18, 19, 20, 21) of the cross bar (12, 13, 14, 15) is attached to the means for crane deployment and recovery.
- 55 **2.** Unmanned underwater vehicle according to claim 1,
characterized in that

the main joint (18, 19, 20, 21) is located in the centre of the cross bar (12, 13, 14, 15).

**3. Unmanned underwater vehicle according to any of the proceeding claims,
characterized by**

two or more cross bars (12, 13, 14, 15) with their main joints (18, 19, 20, 21) attached to a longitudinal bar (26), wherein said longitudinal bar (26) comprises the means for crane deployment and recovery.

**4. Unmanned underwater vehicle according to any of the proceeding claims,
characterized in that**

the endings (22, 23) of the cross bar (12, 13, 14, 15) comprise auxiliary joints (24, 24', 25, 25'), which are attached to the hulls (2, 3) of the unmanned underwater vehicle.

**5. Unmanned underwater vehicle according to claim 4,
characterized in that**

the auxiliary joints (24, 24', 25, 25') assigned to the same hull (2, 3) are located in a common plane.

**6. Unmanned underwater vehicle according to any of the proceeding claims,
characterized in that**

the framework (4) comprises cross bars (12, 13, 14, 15) in different parallel planes, wherein the cross bars (13, 14) located in a larger distance from the longitudinal bar (26) than the other cross bars (12, 15) are attached to the longitudinal bar (26) by means of struts (27, 28).

**7. Unmanned underwater vehicle according to any of the proceeding claims,
characterized by**

telescoping cross bars (12, 13, 14, 15).

**8. Unmanned underwater vehicle according to any of the proceeding claims,
characterized in that**

the framework (4) comprises a detachable locking mechanism, which is engaged in an unfolded operating position of the framework (4).

**9. Unmanned underwater vehicle according to any of the proceeding claims,
characterized in that**

each hull (2, 3) comprises a multibeam sonar (9),

**10. Unmanned underwater vehicle according to any of the proceeding claims,
characterized in that**

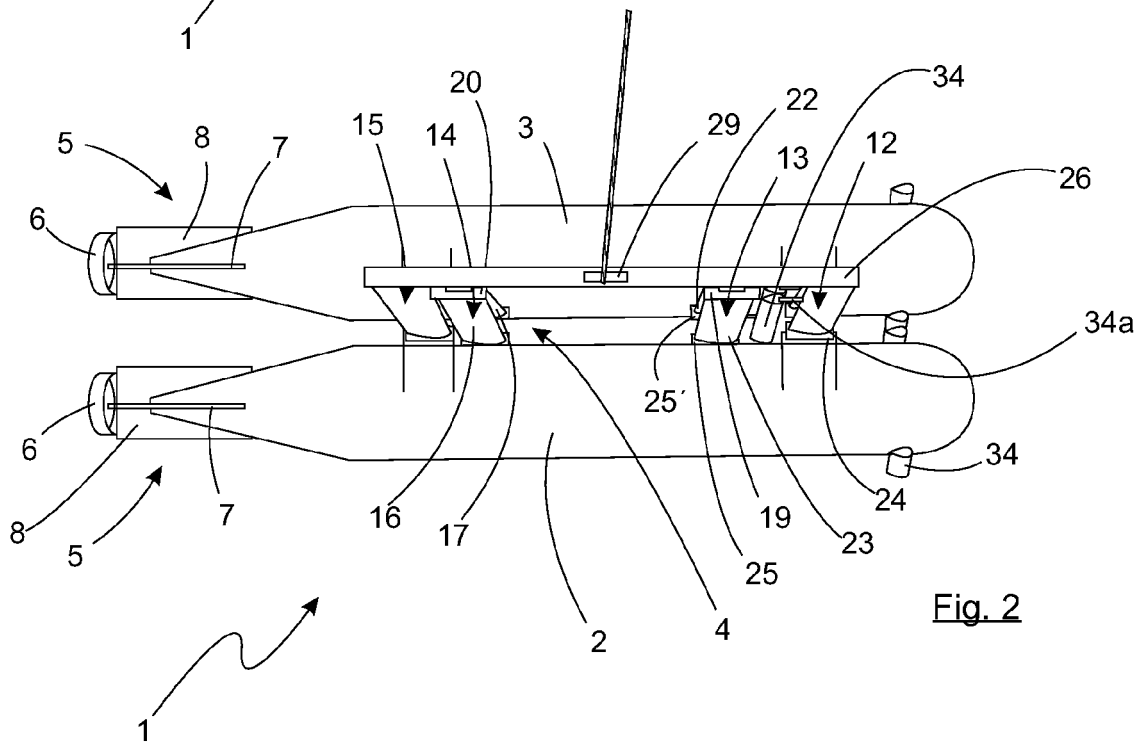
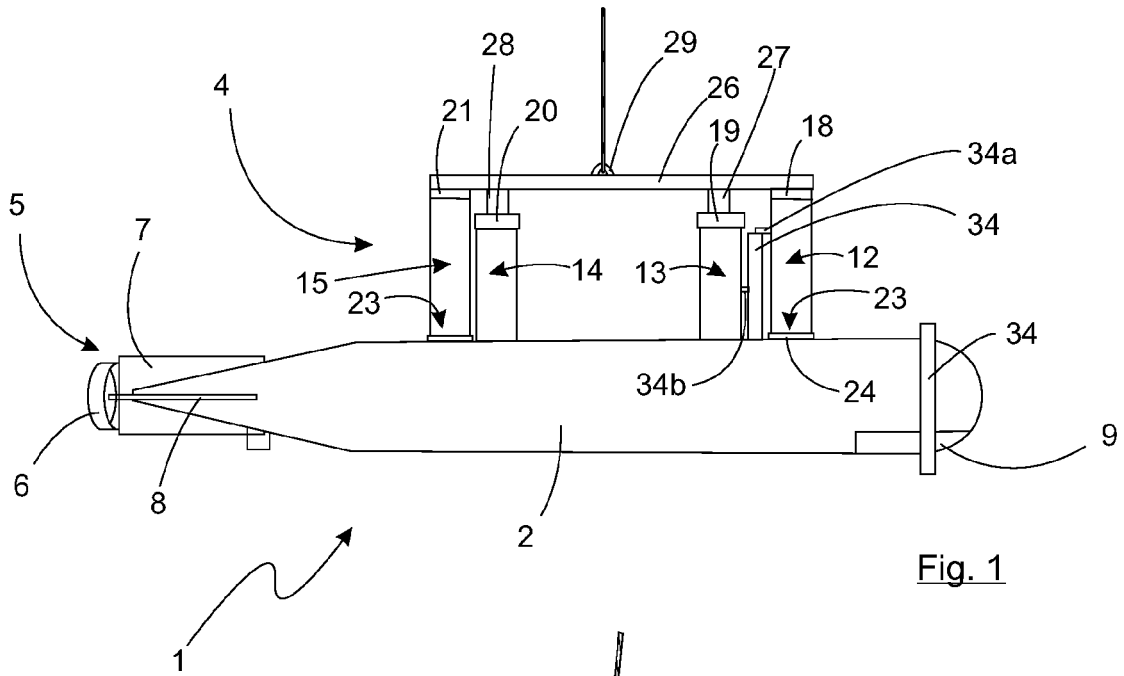
the means for crane deployment and recovery is an eye (29) attached to the longitudinal bar (26).

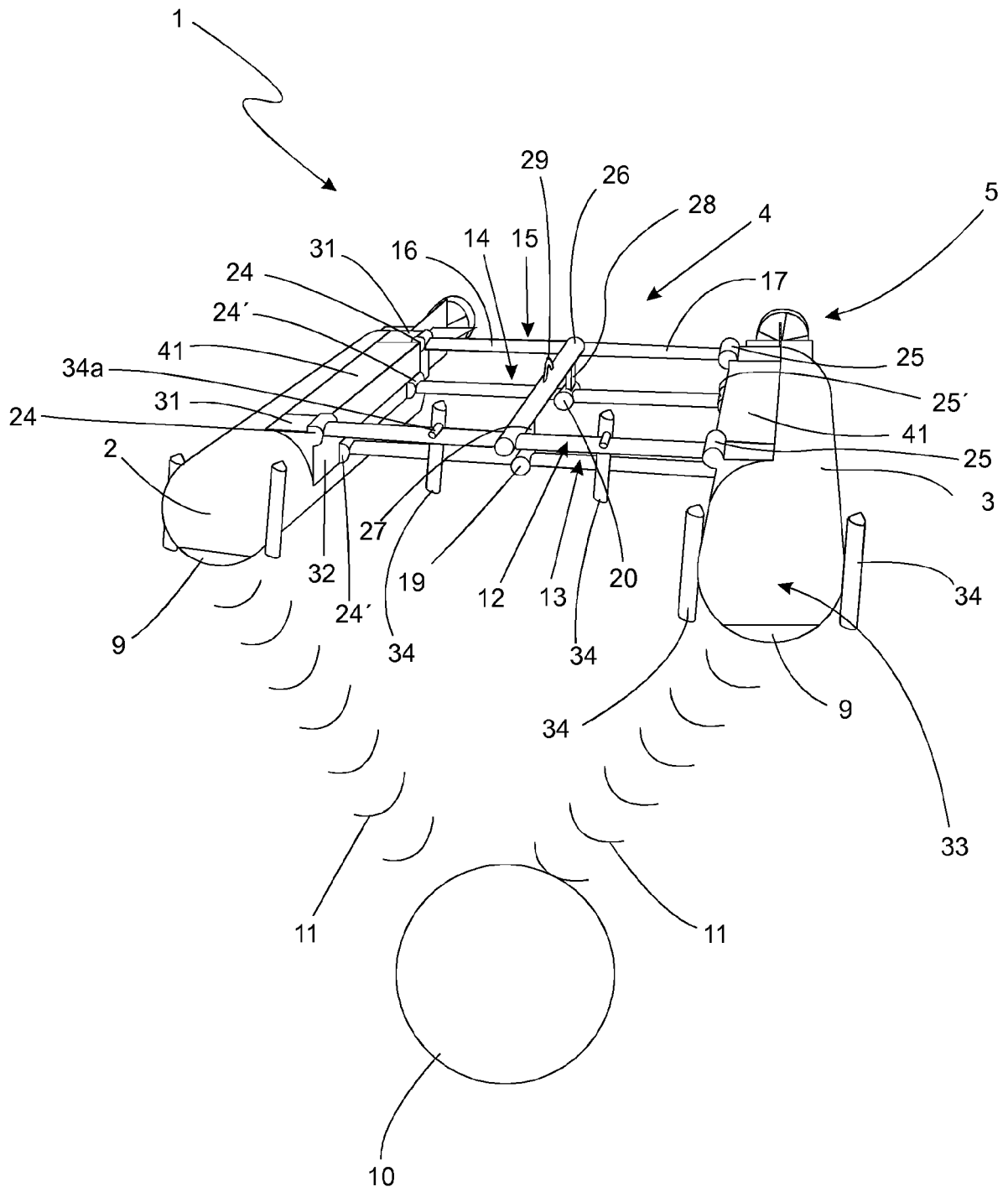
**11. Unmanned underwater vehicle according to any of the proceeding claims,
characterized in that**

the vehicle is an autonomous underwater vehicle (1).

**12. Unmanned underwater vehicle according to any of the proceeding claims,
characterized in that**

the hulls (2, 3) are assemblies of modules comprising modules for propulsion, energy packages or power supplies, communication, payload and/or navigation.





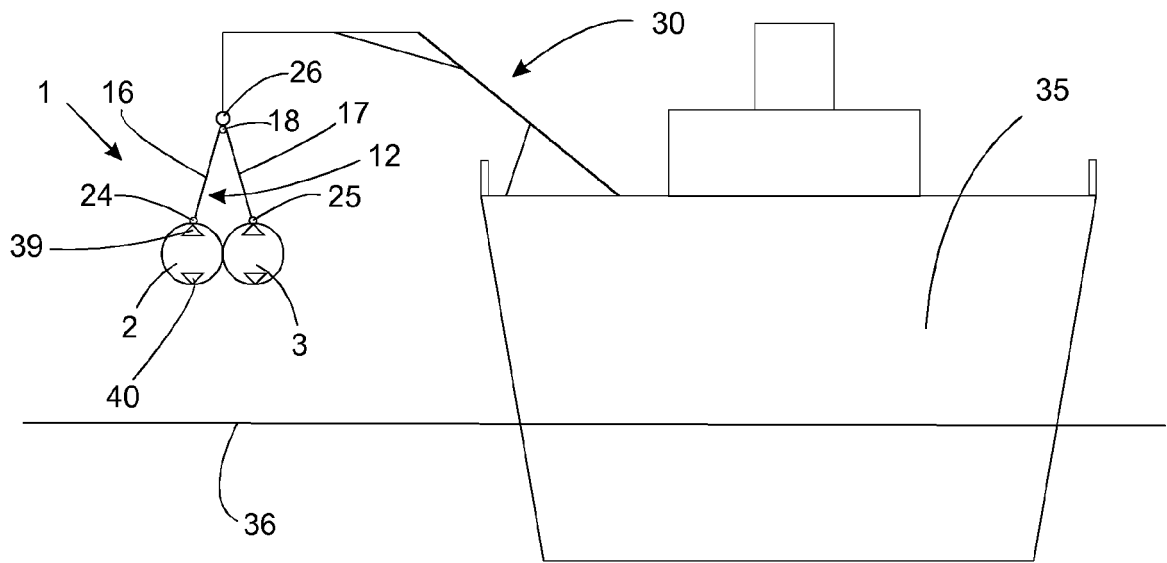


Fig. 4

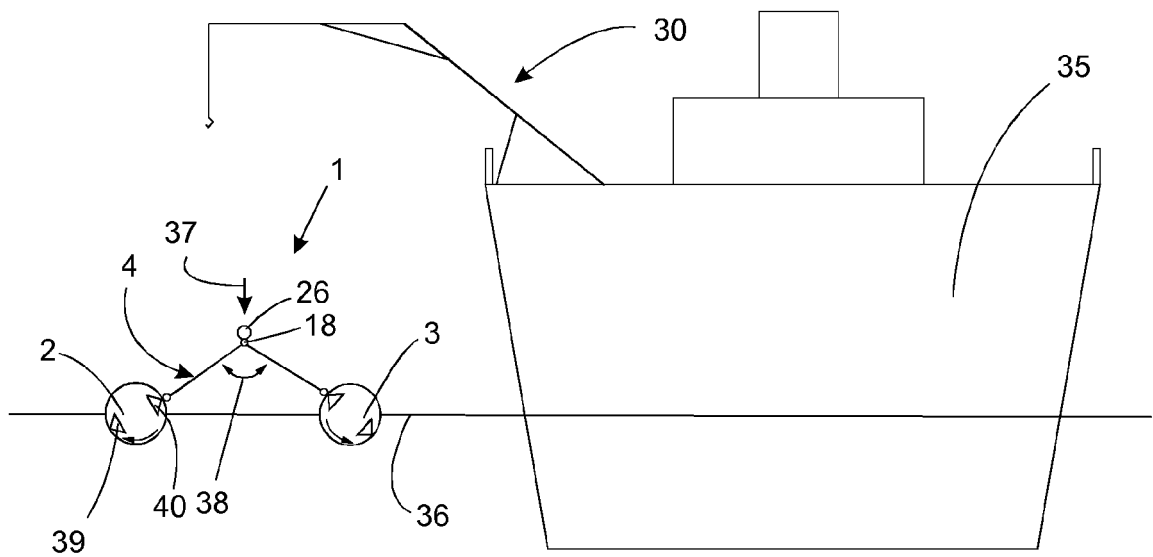


Fig. 5



EUROPEAN SEARCH REPORT

 Application Number
 EP 10 19 0895

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2010/269675 A1 (LARKIN LOUIS J [US] ET AL) 28 October 2010 (2010-10-28)	1-4,9,12,13	INV. B63B27/16
Y	* the whole document *	5-8,10,11	
Y	----- WO 85/02157 A1 (INGS TERRY CLIFFORD) 23 May 1985 (1985-05-23)	5-7	
A	* the whole document *	1	
Y	----- US 2008/203216 A1 (APELOIG JULIEN [FR] ET AL) 28 August 2008 (2008-08-28)	8	
A	* figure 11 *	1	
Y	----- US 3 943 875 A (SANDERS RAYMOND J) 16 March 1976 (1976-03-16)	10	
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A	* column 4, line 14 *	1	
A	----- US 4 841 896 A (FURY TOMMY J [US]) 27 June 1989 (1989-06-27)	1-13	TECHNICAL FIELDS SEARCHED (IPC)
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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 6 May 2011	Examiner Lindner, Volker
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

 1
 EPO FORM 1503 03/82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 10 19 0895

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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06-05-2011

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