

## **Device for launching and recovering a marine craft, and associated launching and recovery method**

The present invention concerns the field of handling submarine or marine craft, and in particular a device for launching and recovering such a craft.

One particularly interesting application of the invention concerns launching and recovering a submersible craft connected to a traction cable.

This device is used, in particular, for launching and recovering an autonomous submersible craft named "AUV" (Autonomous Underwater Vehicle)) and generally comprises winch means fixed to a naval surface vehicle and a mobile part for receiving the craft.

The mobile part, generally referred to as the "cage", more particularly comprises a chassis defining a housing into the inside of which the craft may penetrate in order to be recovered.

Reference can be made to the document GB 2 160 156 which describes a launching structure for submersible vehicles.

Accordingly, reference can be made to the document WO 00171415, which describes a craft recovering device comprising a cage having at the entrance blades forming a frustoconical ring through which the submersible craft passes to penetrate into the cage. However, it is necessary to align the craft properly with the cage in order for it to be able to penetrate properly.

Such devices are not suitable in a rough sea, because of movements of the cage generated by the swell that would prevent the submersible craft from entering into the cage properly without being damaged.

French patent application FR 2 904 287 (IFREMER) proposes a marine craft recovering device enabling to overcome these drawbacks

To this end, the recovery device comprises a chassis defining a housing for the craft and conical receiving means for receiving the front part of the craft, called the "nose". These conical receiving means have enough movement freedom relative to the chassis to damp

the swell and are able to slide along the housing in order to draw the craft into the housing. However, the above document proposes a launching and recovering device for use on the surface of the sea. Moreover, the chassis is connected by two lifting cables to a winch  
5 fixed to the naval surface vehicle, with the result that the chassis is not locked properly and is able to oscillate in the event of a rough sea. Finally, the marine craft is immobilized in the cage only by two vertical rods.

The operation of immersing a submersible craft to a depth of  
10 several metres below the surface of the sea from a platform of a naval vehicle is rendered difficult by vertical, longitudinal swaying and rolling movements of the naval surface vehicle caused at the surface of the water by the swell and conventionally referred to as "pounding". Vertical movements caused by the swell are attenuated by the depth at  
15 which the cage is located. However, the recovery and launching device being fixed to the naval vehicle by means of a cable, it is moved vertically by the naval vehicle subjected to the vertical movements of the swell. The relative movements of the submersible craft and the launching and recovery device may damage the craft and the naval  
20 vehicle.

The aim of the present invention is to overcome the drawbacks of the prior art.

The aim of the invention is to propose a device for launching and recovering a submersible craft comprising means for securing  
25 transportation of the cage on the naval vehicle as well as enabling attenuation of vertical movements caused by swell.

The invention consists in a device for launching and recovering a marine craft comprising a cage for receiving the craft with docking means adapted to receive the front part of the craft and a traction cable  
30 connected to the cage and capable of being hitched to the craft.

The device comprises a handling structure adapted to be fixed to a naval vehicle and means for locking the cage to the structure. The cage is connected to the structure by lifting cables.

Thus the cage is mechanically secured to the structure during its transportation with or without the marine craft in order to prevent oscillation caused by movement of the naval vehicle. Moreover, the marine craft is launched and recovered when immersed between the hulls of the naval vehicle. Recovery when immersed enables reduction of the effects of the swell.

The cage advantageously comprises mobile arms pivoting between an open position and a closed position for locking the craft. The arms of the cage enable effective immobilization of the marine craft in the cage without damaging it.

The lifting cables may be supported by wheels including at least one mobile wheel tensioned by at least one actuator. The actuators and the wheels serve as swell compensation means.

For example, the swell compensation means comprise hydraulic actuators.

The structure preferably comprises a guiding frame sliding vertically between a low position for receiving the cage and a high position for locking the cage. Thus when the cage is situated at the level of the surface of the sea, it is surrounded by the guide frame enabling attenuation of oscillations of the cage and preventing damaging the naval vehicle and the marine craft.

The device advantageously comprises means providing a data link and an electrical power supply to the cage.

Another aspect of the invention concerns a method of launching and recovering a marine craft accommodated in a cage supported by a fixed structure on a naval vehicle. The method comprises the following steps:

- the means locking the cage to the structure are unlocked, and
- the cage equipped with the marine craft is lowered vertically by means of lifting cables of the structure to the required depth of immersion.

Advantageously, during the step of launching the craft:

- pivoting mobile arms are positioned in an open position for unlocking the craft,

- the docking means are caused to slide to the entrance of the cage,
- the traction cable to which the craft is hitched is paid out,
- the vehicle is hitched to the traction cable,
- 5       - the craft is drawn into and docked with the docking means of the cage by means of a winch fixed to the cage,
- the pivoting mobile arms are positioned in a closed position for locking the craft, and
- the cage equipped with the craft is raised vertically until it is
- 10       locked in the structure thanks to the locking means.

Other aims, features and advantages of the invention will become apparent on reading the following description, which is given by way of nonlimiting example only and with reference to the appended drawings, in which:

- 15       - Figure 1 is a general view in perspective of a device of the invention for launching and recovering a craft;
- Figure 2 is a detail view of the device from Figure 1;
- Figure 3 is a general view of a gantry of the invention;
- Figures 4a and 4b are views from below and from above of a
- 20       cage of the invention;
- Figure 5 is a diagrammatic view of a naval surface vehicle on which is mounted the device from Figure 1; and
- Figures 6 to 9 are perspective views of a launching and recovery device according to Figure 1 during a phase of launching the
- 25       craft.

As shown in Figure 1, the device 1 for launching and recovering a marine or submarine craft comprises a structure such as a handling gantry 2 and a cage 3 for receiving a marine or submarine craft 4. The device 1 is adapted to be mounted on a vessel or a naval surface vehicle 5 represented diagrammatically in Figures 5 to 7. In particular, the device 1 enables the craft 4 to move between a stowed position shown in Figure 5 and a launching position shown in Figure 7.

The handling gantry 2, shown in detail in Figure 3, comprises two gantries 6, 7 of welded steel construction, for example. Each

gantry 6, 7 is constituted of two vertical uprights 6a, 6b, 7a, 7b connected at one end by a transverse structural section 6c, 7c. Each vertical upright 6a, 6b, 7a, 7b comprises a fixing base 6d, 7d adapted to be fixed to the naval vehicle 5 and stiffener means 6e, 7e forming a bracket one end of which is fixed to a vertical upright 6a, 6b, 7a, 7b and the other end of which is fixed to the naval vehicle 5. The transverse structural sections 6c, 7c comprise handling means in the form of lifting rings 6f, 7f used to position the handling gantry 2 on a vessel or a naval surface vehicle 5.

The handling gantry 2 also comprises two horizontal crossmembers 8, 9 connecting the two gantries 6, 7 together. The horizontal crossmembers 8, 9 are of welded steel construction, for example, constituted of structural sections and plates. Each horizontal crossmember 8, 9 accommodates swell compensation means 10, 11 including two wheels or pulleys 10a, 10b and 11a, 11b cooperating with a set of cables 12, 13 forming means for lifting the receiving cage 3, and a hydraulic actuator 10c, 11c connecting the two wheels 10a, 10b and 11a, 11b together. One of the wheels 10a, 11b is mounted by a pivot connection on the horizontal crossmember 8, 9 and one of the wheels 10b, 11a is mounted on a carriage 10d, 11d sliding along the crossmember 8, 9 on rollers 10e, 11e so as, on the one hand, to demultiply the forces necessary for lifting the cage 3 and, on the other hand, to attenuate vertical accelerations transmitted to the cage 3 by movements of the naval vehicle 5 caused by the swell. The assembly constituted by the two wheels 10a, 10b, 11a, 11b is generally referred to as a "pulley block". The pulley blocks and the lifting cables constitute a system referred to as a reeving system.

The lifting cables 12, 13 are connected to a lifting winch 14 situated on one of the gantries 7 and equipped with two synchronized winding drums 15, 16 driven by a hydraulic motor-gearbox (not shown). The lifting cables 12, 13 depart from the respective winding drums 15, 16 and then pass over a plurality of pulleys (no reference numbers) and wheels 10a, 10b, 11a, 11b. The pulleys are in particular connected by compensation actuators (not shown) fed by hydraulic

accumulators and damping movements of the naval vehicle 5 induced by the surface swell. A second system of pull-up actuators 15a, 16a fed by hydraulic accumulators (not shown) rapidly moves everything out of the reach of the swell.

5           The handling gantry 2 also comprises an umbilical winch 17 situated on the gantry 6, opposite the lifting winch 14 and connected to an umbilical cable 18 fixed to the cage 3 and providing a data link and an electrical power supply to the receiving cage 3.

10           The handling gantry 2 comprises a guide frame 19 sliding vertically between the gantries 6, 7 between a low position for receiving the cage 3 visible in Figure 1 and a high position at the level of the horizontal crossmembers 8, 9 visible in Figure 3. The guide frame 19 comprises a parallelepiped-shaped frame 19a and two sets of guide means 19b for guiding the lifting cables 12, 13 and limits  
15           movements of the cage 3 relative to the hull of the naval vehicle 5 when the cage 3 is suspended by the lifting cables 12, 13. The guide frame 19 slides vertically in the handling gantry 2 thanks to a pulley and belt system 19c cooperating with guide lugs 19d of the guide frame 19, visible in Figures 1 and 3, and forming a guide carriage for  
20           the guide frame 19 in each of the gantries 6, 7.

          The receiving cage 3, connected to the handling gantry 2 by the lifting means constituted by two sets of lifting cables 12, 13, and seen in detail in Figures 4a and 4b, has a welded stainless steel general structure constituted of two lateral rails 20 and a horizontal central  
25           crossmember 21 connected together by a set of arches 22 defining a housing for receiving the submersible craft 4. A set of floats 23, four in number, for example, is disposed at the sides of the cage 3. The front part 3a of the cage 3 comprises a traction winch 24 for pulling a traction cable 25, visible in Figure 9, the free end of which is adapted  
30           to be hitched to the submersible craft 4, and docking means 26 of conical shape matching the shape of the front part of the craft 4. The docking means 26 comprise a circular base 26a from which extends an armature 26b defining a hollow cone for receiving the front part of the craft 4. The armature 26b comprises a grid 26c in order to prevent any

particles present in the sea from damaging the front part of the craft 4. The base 26a also comprises rolling members 26d enabling the craft to be received into the cone without damaging it. The docking means 26 slide along the cage 3 thanks to a guide carriage 26e comprising, for example, rollers 26f rolling on a guide rail 26g, via a notched transmission belt 26h, between a docking position of the craft 4 at the level of the rear part 3b of the cage 3 and a final position at the level of the front part 3a of the cage 3. In the final position, the craft 4 is drawn entirely into the cage 3. The traction cable 25 passes through the centre of the docking means 26. The cage 3 comprises translation locking means 22a enabling prevention of the docking means 26 leaving the cage 3.

The cage 3 comprises, in its lower part, two identical mobile arms 27 pivotally mounted on the lateral rails 20 to pivot between a closed position holding the craft 4, visible in Figure 1, and an open position, visible in Figure 8, and actuated by actuators 27a. Each mobile arm 27 comprises pads 27b enabling handling of the craft 4 without damaging it. The cage 3 comprises in particular a hydraulic generator set (not shown) for actuating, for example, the drive means of the carriage, the winch 24 or the pivoting mobile arms 27.

The central crossmember 21 of the cage 3 includes two rings 28 adapted to cooperate with locking means 29 on the handling gantry 2. The receiving cage 3 protects and holds the submersible craft 4 when the naval surface vehicle 5 is in transit and during launching and recovery operations during which the cage 3 is immersed to a depth of 15 m, for example.

As shown in Figure 2, the handling gantry 2 comprises mechanical means 29 for locking the cage 3 to the handling gantry 2 disposed on each gantry 6, 7. The locking means 29 each comprise two plates 29a, 29b and a pin 30 cooperating with the ring 28 disposed on the cage 3. The ring 28 is positioned between the two plates 29a, 29b, the pin 30 then cooperating with the hole bored in the ring 28, enabling it to be held in position. The pin 30 is actuated by an actuator and a spring. The actuator commands unlocking and the spring ensures

automatic locking as soon as the bored hole in the ring 28 is aligned with the axis of the pin 30.

5 The craft 4 may be a floating or submersible submarine vehicle, for example, designed, for example, for submarine surveillance and/or inspection.

10 As shown in Figure 5, the device 1 for launching and recovering a craft 4 is mounted on a naval surface vehicle 5. The naval vehicle 5 comprises, in particular, two floats 5a, 5b delimiting a trench 5c. There could instead be provided a hole produced in the hull of the vehicle. The naval vehicle 5 may be a ship or an autonomous vehicle. Each gantry 6, 7 is fixed to one of the floats 5a, 5b, on either side of the trench 5c, so that the transverse crossmembers 8, 9 are disposed over the trench 5c.

15 The operation of the launching and recovery device 1 is described in detail next with reference to Figures 6 to 9.

20 The process for launching the craft 4 from the naval surface vehicle 5 is as follows. In a first step, the means 29 on the handling gantry 2 for unlocking the cage 3 are commanded to unlock the cage 3 mechanically. Actuation of the lifting winch 14 is then commanded to enable driving of the winding drums 15, 16 and thus the lifting cables 12, 13 connected to the cage 3 in order to lower the cage 3 vertically between the vertical uprights 6, 7 until it is totally immersed. The cage is immersed via the trench 5c situated between the floats 5a, 5b of the naval vehicle 5 and is guided by the guide frame 19 as far as the level of the surface of the sea.

25 The launching position of the cage is shown more clearly in Figures 6 and 7.

30 The cage is immersed until it reaches a particular immersion depth. It will be noted that the umbilical winch 17 is also actuated to synchronize the length of the umbilical cable with the lifting cables 12, 13.

In a second step, seen in Figure 8, once the immersed cage 3 has been stabilized, the pivoting mobile arms 27 are pivoted into an open position in order to the release the craft 4. The notched means

26h are then actuated to cause the carriage 26e to slide as far as the stop 22a. The traction winch 24 is actuated simultaneously in order to enable the craft 4 to move away from the cage 3, as seen in Figure 9.

5       Conversely, during the recovery operation, the craft 4 is drawn by the winch 24 into the cage 3 in order to position the front, also known as the "nose", of the craft 4 in the docking means 25, to be more precise in the mobile receiver cone. The notched means 26h are then actuated to cause the carriage 26e to slide on the guide rail 26g toward the front 3a of the cage 3.

10       Once the carriage 26e has reached the end of its travel, the craft 4 is positioned properly in the cage 3 and held in position by actuation of the mobile arms 27 pivoted into a closed position for holding the craft 4.

15       The craft 4 housed in the cage 3 in this way is then raised to the surface by actuation of the lifting cables 12, 13. Once raised, the cage 3 is then locked to the gantry 2 to ensure secure transportation. The operation of raising the cage 3 is not described further and comprises the reverse steps to the immersion operation.

20       During the steps of recovering the craft 4, the naval surface vehicle 5 follows the carriage 26e at a low forward speed in order to align its trajectory with the trajectory of the cage and to facilitate penetration of the craft 4 into the receiver cage 3.

25       Thanks to the invention, during a phase of recovering the craft, the introduction of the craft into the docking means enables alignment of the axis of the craft with the axis of said docking means to be achieved. It is thus possible to be sure that, in the holding position of the mobile arms, the articulation axis of the arms is parallel to the longitudinal axis of the craft so that the craft is held properly. Moreover, the cage is mechanically secured to the gantry during its transportation with or without the marine craft in order to prevent any  
30       oscillation caused by the movement of the naval vehicle. Finally, thanks to the invention, the marine craft is launched and recovered when immersed between the floats of the naval vehicle. Recovery when immersed enables the effects of the swell to be reduced.

## CLAIMS

1. Device (1) suitable for launching and recovering a marine craft (4) such as an autonomous submersible craft, comprising a cage (3) for receiving said marine craft (4) with docking means (26) adapted to receive the front part of said marine craft (4), a traction cable (25) connected to the cage (3) and able to be hitched to said marine craft (4), a handling structure (2) adapted to be fixed to a naval vehicle (5) and means (29) for locking the cage (3) to the structure (2), the cage (3) being connected to the structure (2) by lifting cables (12, 13), characterized in that the cage (3) comprises mobile arms (27) pivoting between an open position and a closed position of locking said marine craft (4).

2. Launching and recovery device according to Claim 1, wherein the lifting cables (12, 13) are supported by wheels (10a, 10b, 11a, 11b) including at least one mobile wheel tensioned by at least one actuator (10c, 11c).

3. Launching and recovery device according to Claim 2, wherein the actuators (10c, 11c) are hydraulic actuators.

4. Launching and recovery device according to any one of the preceding claims, wherein the structure (2) comprises a guide frame (19) sliding vertically between a low position for receiving the cage (3) and a high position for locking the cage (3).

5. Launching and recovery device according to any one of the preceding claims, comprising means (18) providing a data link and an electrical power supply to the cage (3).

6. Method of launching and recovering a marine craft (4) such as an autonomous submersible craft accommodated in a cage (3) supported by a structure (2) fixed to a naval vehicle (5), comprising the following steps:

- the means (29) for locking the cage (3) to the structure (2) are unlocked, and

- the cage (3) equipped with the marine craft (4) is lowered vertically by means of the lifting cables (12, 13) of the structure (2) to the required depth of immersion, characterized in that during the step of launching the marine craft (4):

- pivoting mobile arms (27) are positioned in an open position for unlocking the marine craft (4),

- the docking means (26) are caused to slide to the entrance (3b) of the cage (3),

- the traction cable (25) to which the craft (4) is hitched is paid out.

7. Launching and recovery method according to Claim 6, characterized in that during the step of recovering the craft (4):

- the marine craft (4) is drawn into and docked with the docking means (26) of the cage (3) by means of a winch (24) fixed to the cage (3),

- the pivoting mobile arms (27) are positioned in a closed position for locking the marine craft (4), and

- the cage (3) equipped with the craft (4) is raised vertically until it is locked in the structure (2) thanks to the locking means (29).