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A SUBMARINE VEHICLE****Publication Classification**

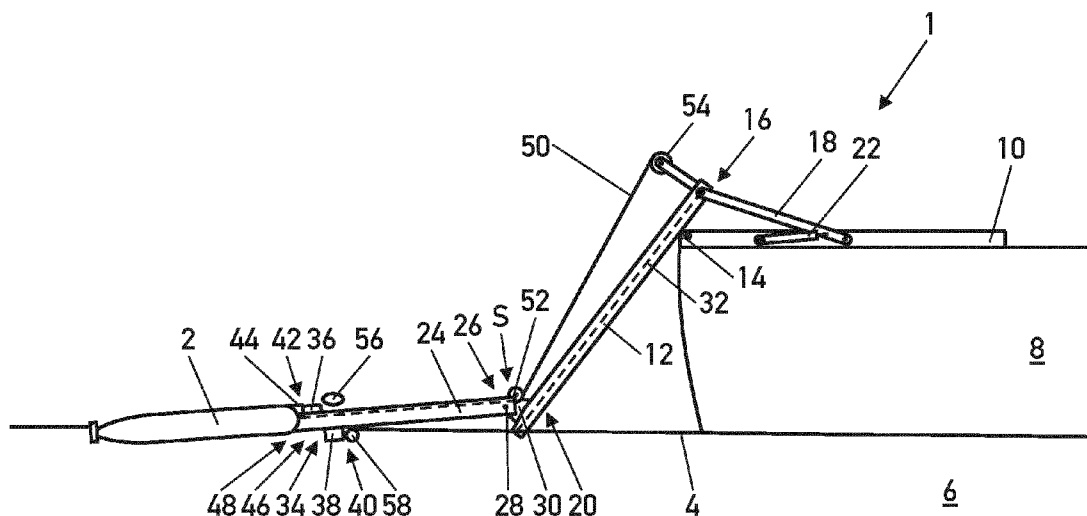
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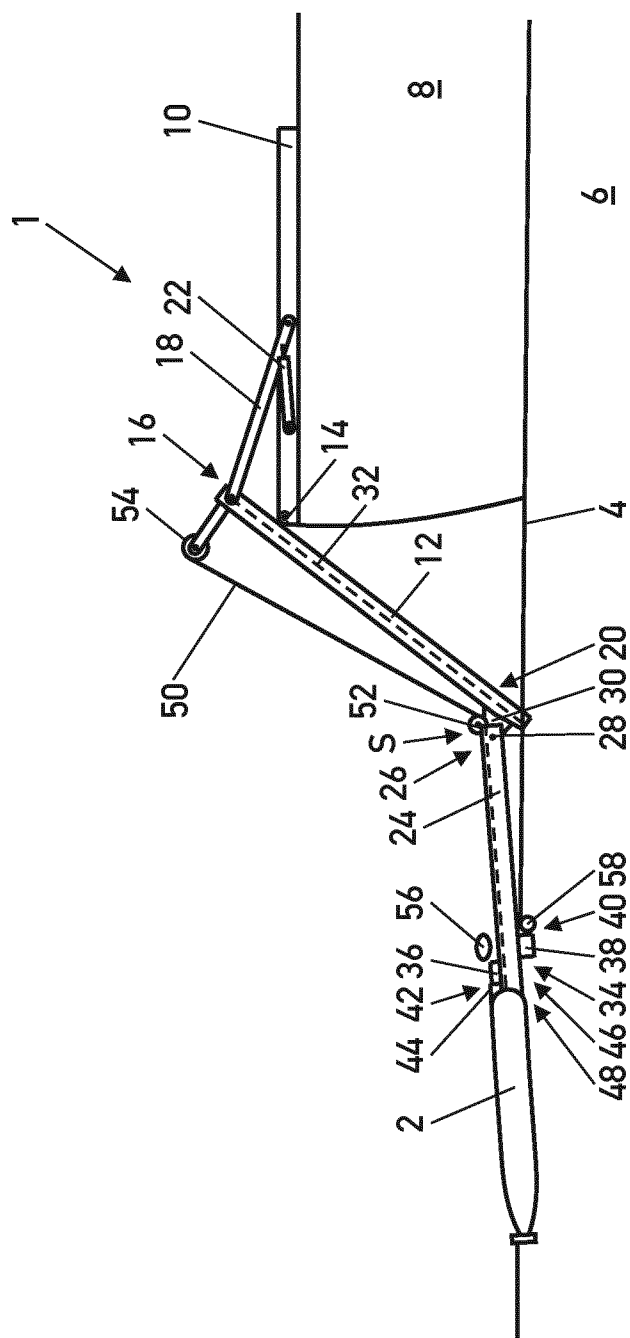
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ABSTRACT

The invention relates to a system and a method for recovering a submarine vehicle. The submarine vehicle is pulled by a rope and hauled by means of the rope and a recovery ramp from the body of water on board a ship or onto land. The system comprises the recovery ramp and a wave equalization ramp. The wave compensation ramp can be rotated relative to the recovery ramp about a swivel axis S and is supported by a floating body. The watercraft is picked up by means of the recovery ramp. The wave compensation ramp is hauled together with the picked-up submarine vehicle by means of the recovery ramp. The invention permits the recovery of a submarine vehicle, even in moderate or heavy seas, with less risk of damage to the submarine vehicle.





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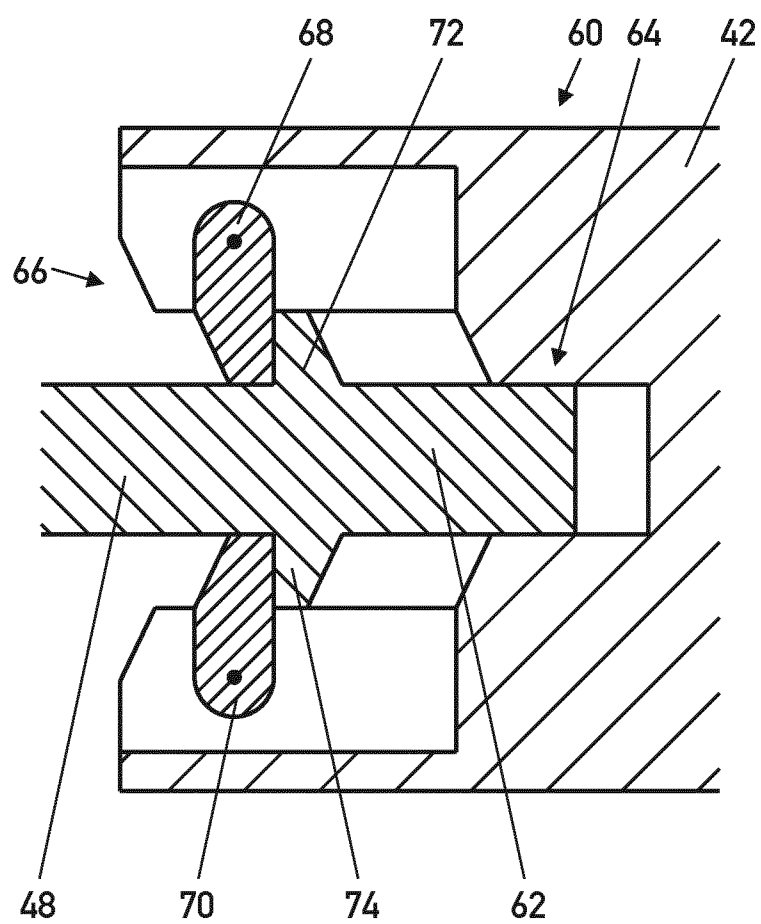


Fig. 2

Fig. 3

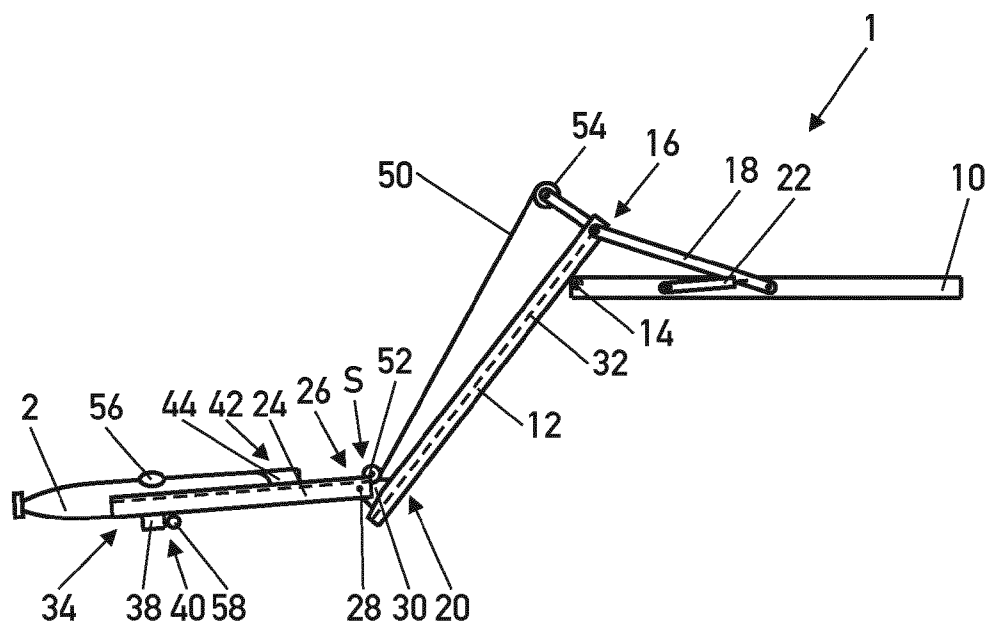


Fig. 4

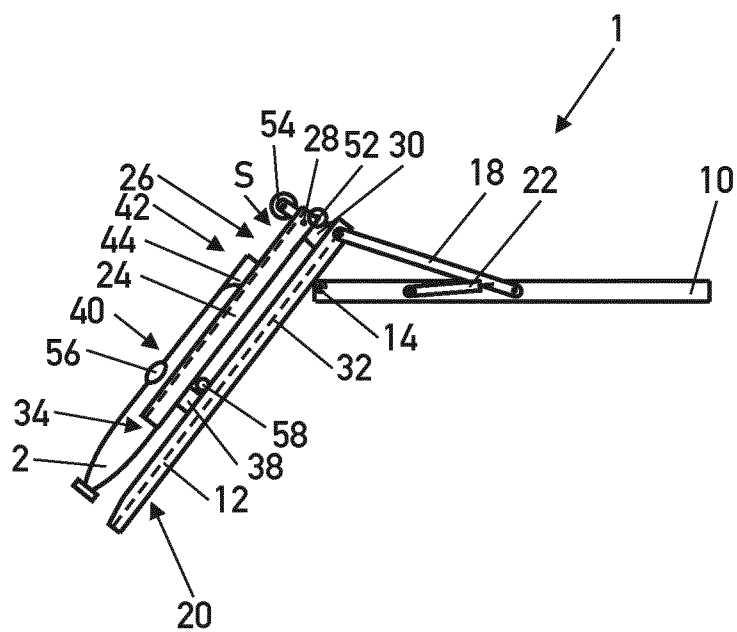


Fig. 5

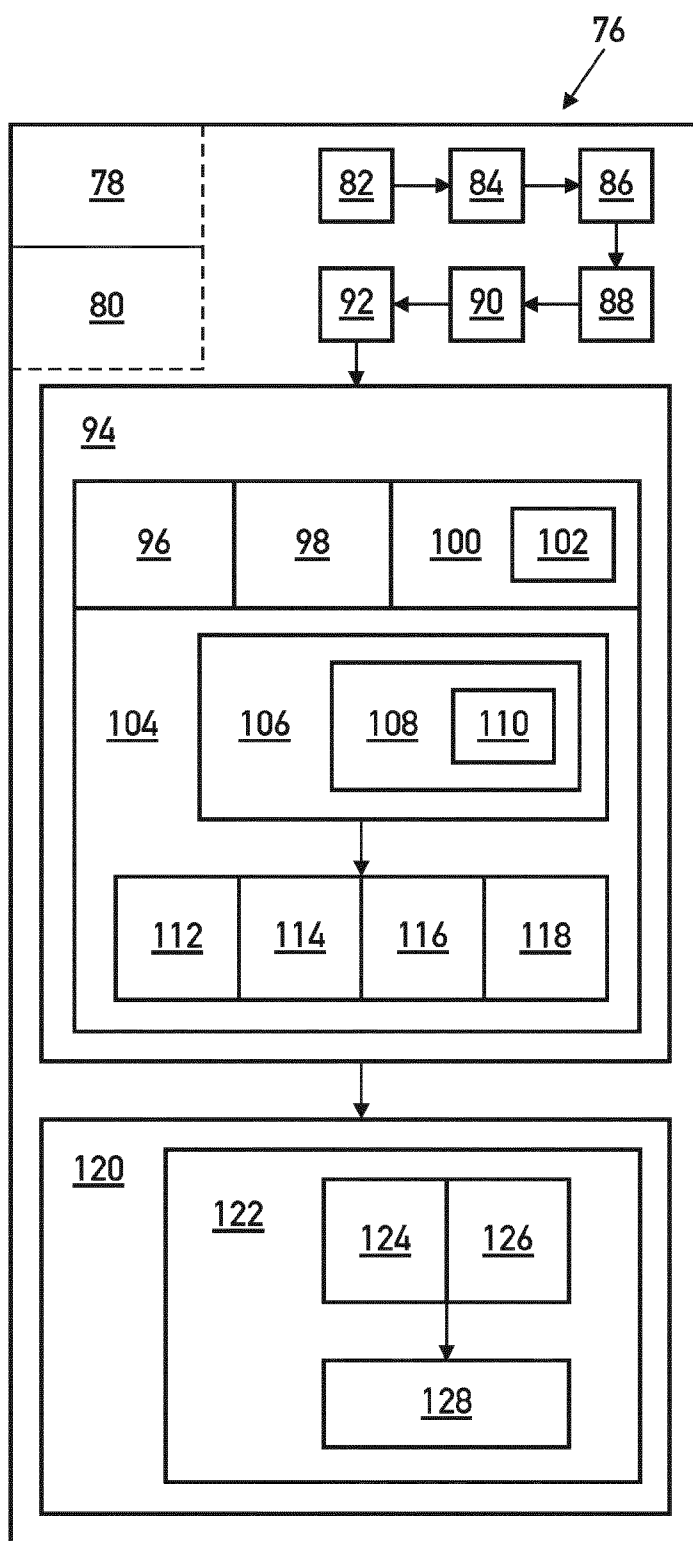


Fig. 6

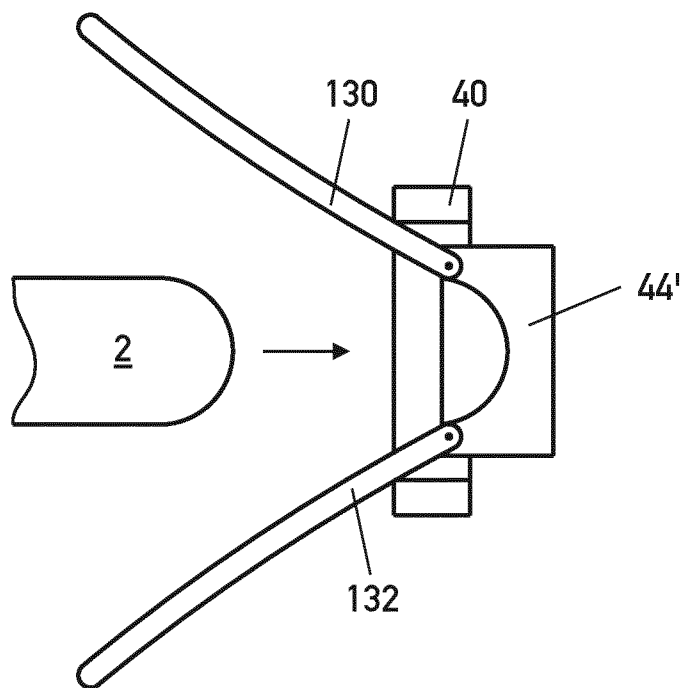


Fig. 7

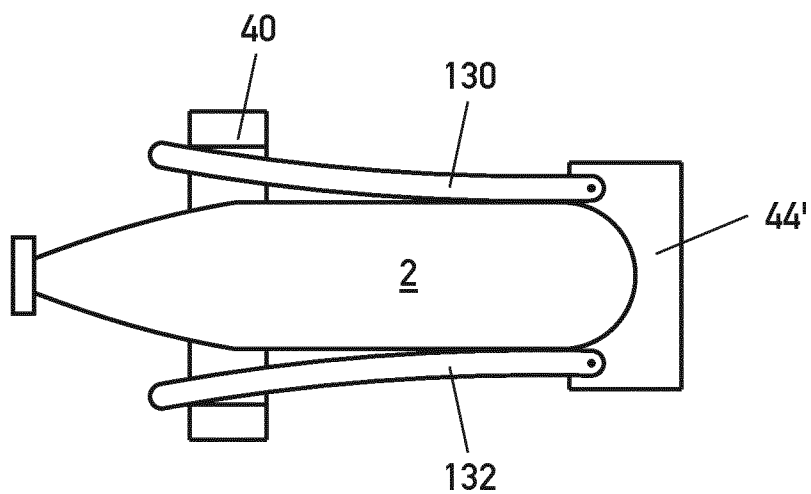


Fig. 8

SYSTEM AND METHOD FOR RECOVERING A SUBMARINE VEHICLE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present invention is the US national stage under 35 U.S.C. §371 of International Application No. PCT/EP2012/064152, which was filed on Jul. 19, 2012 and which claims the priority of application DE 10 2011 109 092.8 filed on Aug. 1, 2011 the content of which (text, drawings and claims) are incorporated here by reference in its entirety.

FIELD

[0002] The invention relates to a system and a method for recovering a submarine vehicle, in particular an unmanned submarine vehicle. The submarine vehicle can be an autonomous submarine vehicle (AUV=Autonomous Underwater Vehicle), but alternatively can also be a submarine vehicle operated by cable (ROV=Remotely Operating Vehicle).

BACKGROUND

[0003] Such a submarine vehicle is generally transported by means of a marine vessel to a place of use and at that point let into the water from on board the marine vessel or from the land, for example from a jetty. After carrying out its mission, the submarine vehicle has to be recovered again. To this end, it is known to reel in the free end of a rope fastened to the submarine vehicle and to pull in and retrieve the submarine vehicle onto the marine vessel by means of the rope. A known system for recovering a submarine vehicle comprises a recovery ramp, by means of which the submarine vehicle is retrieved on board the marine vessel from the body of water. The recovery ramp is fixed relative to the marine vessel for recovering the submarine vehicle, such that the recovery ramp protrudes obliquely into the water from the deck of the marine vessel so that the submarine vehicle is able to be pulled onto the recovery ramp by means of the rope in the region of the waterline and/or water surface of the body of water.

[0004] The marine vessel comprising the recovery ramp has a considerably greater volume and a considerably greater mass relative to the submarine vehicle. The position of the marine vessel in the water, therefore, is substantially influenced by heavy seas and/or waves of relatively long wavelength. However, the submarine vehicle follows comparatively small waves which leave the marine vessel substantially unaffected. As a result, in moderate and/or heavy seas this leads to a vertical relative movement of the submarine vehicle relative to the recovery ramp. The recovery ramp crashes up and down, in particular relative to the submarine vehicle, and thus can hit the submarine vehicle hard and damage said submarine vehicle during the recovery procedure, in particular in the front part of the submarine vehicle. In addition, the recovery ramp itself can be damaged thereby. Even if the recovery ramp is arranged in a fixed manner, for example on the jetty, the submarine vehicle can hit the recovery ramp hard due to the waves.

[0005] Devices for picking up watercraft and/or boats are disclosed in DE 195 00 182 C2, U.S. Pat. No. 2,371,461 A, WO 2008/025345 A1 and U.S. Pat. No. 4,242,768 A, in each case the devices not being pulled by means of a rope. DE 38 34 174 C2 and EP 1 216 918 A8 also propose such devices for picking up submerged objects. DE 41 40 201 C2 discloses a

device for retrieving a trailing body pulled underwater on a trailing cable via a carriage, which is displaceable on vertically arranged guide rails, with a pivotable support arm.

SUMMARY

[0006] The object of the invention is to improve the recovery of a submarine vehicle, in particular to configure the recovery process to be safer for the submarine vehicle.

[0007] In various embodiments, the invention achieves this object by a system for recovering a submarine vehicle according to Claim 1 and by a method for recovering a submarine vehicle according to Claim 8. The system of the type mentioned in the introduction has a wave compensation ramp pivotably mounted on the recovery ramp about a pivot axis relative to the recovery ramp and supported by a floating body for receiving the submarine vehicle and for retrieving the wave compensation ramp together with the received submarine vehicle by means of the recovery ramp, in particular on board the marine vessel or on land, in particular on a jetty. The wave compensation ramp has an end which opposes the pivot axis and/or which is free, the floating body can be arranged on the free end. In various embodiments, the system also comprises the rope for pulling the submarine vehicle.

[0008] Due to the floating body, the wave compensation ramp is adapted to the position of the waterline and/or water surface and/or to the waves. In particular the wave compensation ramp at its free end is adapted to the movement of the submarine vehicle so that the submarine vehicle and the free end of the recovery ramp are both located approximately in the region of the waterline. A front and/or rear floating body can be provided as floating bodies. Alternatively or additionally, further floating bodies can be provided.

[0009] The pivot axis can be arranged in the region, in particular up to half a meter, above an average waterline and/or just above the region in which the waterline is located in calm seas. The recovery ramp, therefore, only needs to extend down almost as far as the average waterline and not be immersed further into the water. As a result, the recovery ramp can be configured to be shorter relative to the known recovery ramp cited in the introduction. The recovery ramp of the system according to various embodiments of the invention can be accommodated, therefore, in a space-saving manner on board the marine vessel or on land, for example on a truck or in a container. According to various embodiments of the method, the submarine vehicle is received by means of the wave compensation ramp and subsequently the wave compensation ramp together with the received watercraft are retrieved by means of the recovery ramp.

[0010] The system according to various embodiments of the invention is also suitable and provided for launching the submarine vehicle. According to various embodiments of the method, the wave compensation ramp is lowered together with the submarine vehicle over the recovery ramp so that the submarine vehicle slides over the recovery ramp into the water. To this end, the wave compensation ramp remains fully mounted on the recovery ramp and/or does not need to be extended or does not need to be fully extended.

[0011] According to various embodiments, the system comprises a guide carriage which is displaceable in a linear manner on the recovery ramp, with a joint for mounting the wave compensation ramp. The joint thus provides the pivot axis. By displacing the guide carriage, the height at which the wave compensation ramp is mounted can be altered. By means of the guide carriage, the wave compensation ramp can

be lifted up or lowered onto the recovery ramp. According to various embodiments of the method, the guide carriage is displaced in a linear manner on the recovery ramp, the joint mounting the wave compensation ramp.

[0012] In various embodiments, the system comprises a hydraulically driven belt drive for displacing the guide carriage. The belt drive provides the tensile force for lifting and lowering the wave compensation ramp, in particular together with the submarine vehicle received by the wave compensation ramp. According to various embodiments of the method, the belt drive displaces the guide carriage.

[0013] According to various embodiments, the system comprises a front receiver device which is displaceable in a linear manner on the wave compensation ramp, for guiding the rope and for guiding, and can also be for mounting, the submarine vehicle. According to various embodiments of the method, the front receiver device is displaced in a linear manner on the recovery ramp, the front receiver device guiding the rope and/or the submarine vehicle. In particular, the rope is threaded through the front receiver device for retrieving the submarine vehicle. Subsequently, the submarine vehicle is pulled towards the front receiver device and onto the wave compensation ramp, in particular by means of a winch, the front receiver device being displaced on the wave compensation ramp and guiding the submarine vehicle.

[0014] According to various embodiments, the system comprises coupling means for coupling to a front attachment fastened to the submarine vehicle. Thus, the submarine vehicle is coupled via the front attachment to the receiver device, according to various embodiments of the method the coupling means being coupled to the front attachment.

[0015] According to various embodiments, the system comprises the front floating body for retaining the front receiver device in the region of the waterline of the body of water during the coupling procedure. According to various embodiments of the method, the front floating body retains the front receiver device in the region of the waterline of the body of water. Thus, the vertical relative movements of the coupling means are minimized relative to the submarine vehicle. The coupling is simplified.

[0016] According to various embodiments, the coupling means comprise a snap connection device for engaging and retaining the front attachment. The snap connection device can be designed with a locking pawl. The snap connection engages the front attachment and subsequently fixedly retains the front attachment and thus the submarine vehicle so that the submarine vehicle is able to be guided by means of the front receiver device and mounted by the front receiver device. The snap connection device permits automatic engagement, with subsequent secure retention of the front attachment and/or the submarine vehicle.

[0017] Advantageously, the front receiver device comprises a negative shell for centering the submarine vehicle. The negative shell centers the submarine vehicle, in particular relative to the front receiver device and thus, relative to the longitudinal axis of the wave compensation ramp. Thus, the negative shell assists the engagement by means of the snap connection device and also the retention and mounting of the front attachment and/or the submarine vehicle.

[0018] According to various embodiments, the negative shell comprises two, or more than two, guide strips when moving the negative shell to the free end of the wave compensation ramp, in particular forming a guide funnel, for guiding the submarine vehicle during the coupling procedure,

in particular for guiding the front attachment to the front receiver device and/or for guiding the front attachment to the coupling means and for retaining the submarine vehicle in position. According to a variant, the guide strips are arranged in a plane, for example in the horizontal plane, and thus, spread apart to the side. As a result, a two-dimensional guide funnel is formed for the submarine vehicle. The guide strips can be flexible and comprise floating bodies, in particular where the guide strips are spread apart to the side in the horizontal plane. As a result, the guide strips are adapted to the surface of the body of water.

[0019] According to various embodiments the guide strips, in particular more than two guide strips, are arranged in a radial and/or rotationally symmetrical manner about an axis, along which the front receiver device is displaceable on the wave compensation ramp so that the spread-apart guide strips form a three-dimensional guide funnel. In any case, the spread-apart guide strips guide the submarine vehicle through the rear receiver device and at the same time center the submarine vehicle. In this case, the guide strips are passed through the rear receiver device. When the front receiver device is located in the region of the rear receiver device and/or in the region of the free end of the wave compensation ramp, the guide strips are spread apart. If, however, the front receiver device is retracted, the guide strips are held together by the rear receiver device in a more compact manner relative thereto. When extending the front receiver device with the negative shell, the guide strips spread apart, for example by means of the force of springs. The guide funnel is opened. However, when retracting the front receiver device, in particular together with the submarine vehicle coupled thereto, the guide funnel is closed and retains the submarine vehicle in position, in particular relative to the front receiver device.

[0020] According to various embodiments, the system comprises a rear receiver device fastened to the wave compensation ramp, in particular for guiding and mounting the submarine vehicle. In various implementations, the rear receiver device comprises the rear floating body for retaining the free end of the wave compensation ramp in the region of the waterline of the body of water. In particular, the rear floating body of the rear receiver device and the front floating body of the front receiver device jointly ensure that the front receiver device and the wave compensation ramp together adopt an advantageous position for coupling and for pulling onto the wave compensation ramp.

[0021] According to various embodiments, the rear receiver device comprises wheels for guiding and mounting the submarine vehicle. The wheels can be arranged such that they come into contact with robust portions of the submarine vehicle and do not come into contact with or damage sensors. In various implementations, the rear receiver device comprises four wheels or alternatively a different number of wheels which limit the freedom of movement of the submarine vehicle along the longitudinal axis of the wave compensation ramp.

[0022] According to various embodiments, the system comprises a guide pulley mounted on the guide carriage or on the wave compensation ramp in the region of the pivot axis for deflecting the rope from the wave compensation ramp to the recovery ramp. In particular, the guide pulley is arranged above the pivot axis and/or the joint, when the recovery ramp is in a position for retrieving the submarine vehicle and/or when the guide carriage is positioned at the free end of the recovery ramp and/or in the region of the average waterline.

In particular, the guide pulley is arranged such that when the submarine vehicle is guided on the wave compensation ramp the lifting of the wave compensation ramp is assisted by pulling on the rope. Pulling on the rope thus has a lifting effect on the wave compensation ramp. As a result, a lowering of the wave compensation ramp below the waterline and/or water surface is counteracted. According to various embodiments of the method, the guide pulley accordingly bears the rope.

[0023] According to various embodiments, the system comprises a marine bearing assembly for mounting the recovery ramp on the marine vessel or on land. Moreover, the system can have a tilting roller and a rocker for lifting the recovery ramp via the rocker onto the marine bearing assembly. In various implementations, a plurality of tilting rollers and rockers are provided. As a result, the recovery ramp can be mounted together with the wave compensation ramp and the submarine vehicle on board the marine vessel or on land and lowered by tilting the rocker toward the water or can be lifted on board and/or onto land by means of the rocker via the tilting roller. In various implementations, the marine bearing assembly has a hydraulic cylinder for driving the rocker. The hydraulic cylinder drives the rocker and/or causes the lowering and/or lifting of the recovery ramp by hydraulic means.

[0024] According to various embodiments of the invention, the system comprises an auxiliary rope, by pulling on the auxiliary rope a lowering moment being able to be effected on the wave compensation ramp so that the wave compensation ramp can optionally be lowered counter to the lifting moment effected by means of the rope.

[0025] According to various embodiments, the system on the submarine vehicle comprises the front attachment fixedly connected to the submarine vehicle. Moreover, the rope can be fixedly connected at its first end to the front attachment.

[0026] According to various embodiments, the system comprises a buoy which can be connected and/or is connected to the second end of the rope at least when the rope is not fastened at the second end to a winch of the marine vessel.

[0027] For reeling in the submarine vehicle, the submarine vehicle can launch the buoy, which is retrieved by means of a rope or boat hook from the marine vessel and/or from the land. On board the marine vessel and/or on land, the second end of the rope is threaded through the rear receiver device and through the front receiver device and placed around the guide pulley and fastened to the cited winch on board the marine vessel and/or on land. The winch, which can form part of the system, winds up the rope and/or parts of the rope and thus pulls the submarine vehicle towards the wave compensation ramp and up onto the wave compensation ramp and/or into the wave compensation ramp.

[0028] According to various embodiments, the front receiver device or the rear receiver device or the wave compensation ramp has at least one folding mechanism, but can have two lateral folding mechanisms, and a lower folding mechanism for protecting external sensors of the submarine vehicle. Upon contact of the submarine vehicle with the folding mechanism, the folding mechanism is folded away and/or yields so that a hard impact of the submarine vehicle and/or of sensors of the submarine vehicle against the wave compensation ramp is counteracted.

DRAWINGS

[0029] Further embodiments are revealed from the claims and from the exemplary embodiments described in more detail with reference to the drawings.

[0030] FIG. 1 shows a system mounted on a marine vessel for recovering a submarine vehicle according to various embodiments of the invention with a submarine vehicle coupled thereto in a side view.

[0031] FIG. 2 shows a coupling means of the system according to FIG. 1 with a front attachment coupled thereto for fastening to a submarine vehicle in a sectional view, in accordance with various embodiments of the invention.

[0032] FIG. 3 shows the system according to FIG. 1 with a retrieved recovery ramp and wave compensation ramp and with the mounted submarine vehicle in a side view, in accordance with various embodiments of the invention.

[0033] FIG. 4 shows the system according to FIG. 1 with the extended recovery ramp, extended wave compensation ramp and the submarine vehicle mounted on the wave compensation ramp in a side view, in accordance with various embodiments of the invention.

[0034] FIG. 5 shows the system according to FIG. 1 with the extended recovery ramp, retrieved wave compensation ramp and the mounted submarine vehicle in a side view, in accordance with various embodiments of the invention.

[0035] FIG. 6 shows a block diagram for illustrating a method for recovering a submarine vehicle according to various embodiments of the invention.

[0036] FIG. 7 shows a negative shell according to various embodiments with the guide strips spread apart.

[0037] FIG. 8 shows the negative shell according to FIG. 7 with a retained submarine vehicle.

DETAILED DESCRIPTION

[0038] The FIG. 1 shows a system 1 configured, in particular, as a recovery device for the recovery of a submarine vehicle 2 according to various exemplary embodiments of the invention. The submarine vehicle 2 can be, for example, an autonomous unmanned submarine vehicle which is provided with sensors and is used for carrying out tests below the water surface and/or waterline 4 of a body of water 6 or for carrying out tests on the bed of the body of water 6.

[0039] The system 1 comprises a marine bearing assembly 10 which is arranged on board the marine vessel 8, in particular at the stern of the marine vessel 8. The marine bearing assembly 10 is, for example, fixedly screwed to the deck of the marine vessel 8 by means of screws. Alternatively, the marine bearing assembly 10 is arranged and/or mounted, for example, in a movable manner on the deck of the marine vessel 8. Alternatively, the marine bearing assembly 10 can also be a bearing assembly arranged on land, for example on a jetty.

[0040] A recovery ramp 12 is mounted on the marine bearing assembly 10, the recovery ramp bearing against a tilting roller 14 fastened to the marine bearing assembly 10. The tilting roller 14 faces the stern of the marine vessel 8 and/or the water. When the marine bearing assembly 10 is alternatively arranged on land, the tilting roller 14 also faces the water and/or a jetty wall. The recovery ramp 12 is connected by a first end 16 via a rocker 18 to the marine bearing assembly 10. The rocker 18 is pivoted toward the stern of the marine vessel 8 and/or toward the water such that a second end and/or free end 20 of the recovery ramp 12 is arranged in the region of the average waterline 4 of the body of water 6. The recovery ramp 12 is thus lowered toward the body of water 6. The recovery ramp 12 is lifted by pivoting the rocker 18 via the tilting roller 14 and, depending on the pivoting direction, thus lowered to the waterline 4 and/or the water or retrieved on

board the marine vessel 8 and/or onto land. To this end, the rocker 18 is driven by a hydraulic cylinder 22. The rocker 18 is, for example, mounted on the side of the marine bearing assembly 10 facing the water or, alternatively to the arrangement according to FIG. 1, on the side remote from the water.

[0041] A wave compensation ramp 24 is pivotably mounted on the recovery ramp 12 about a pivot axis S relative to the recovery ramp 12. In particular, the wave compensation ramp 24 is indirectly connected to the recovery ramp 12 by a first end 26 via a joint 28 providing the pivot axis S. The joint 28 is arranged on a guide carriage 30 which is able to be displaced in a linear manner on the recovery ramp 12 by means of a belt drive 32 indicated in dashed lines. The belt drive 32 can be hydraulically driven. By displacing the guide carriage 30, therefore, the wave compensation ramp 24 can be lowered or the recovery ramp 12 lifted up and/or retrieved.

[0042] A second and/or free end 34 of the wave compensation ramp 24 opposing the first end 26 of the wave compensation ramp 24 is supported by a front floating body 36 and by a rear floating body 38. A rear receiver device 40 fastened to the wave compensation ramp 24 comprises the rear floating body 38. The rear floating body 38 retains the free end 34 of the wave compensation ramp 24, in particular with the aid of the front floating body, in the region of the waterline 4 of the body of water 6. The waterline 4 changes in moderate and/or heavy seas, the wave compensation ramp 24 adapting its position to the current waterline 4 in the region of the wave compensation ramp 24, in particular in the region of the rear floating body 38 and/or the front floating body 36.

[0043] A front receiver device 42 comprises the front floating body 36 which retains the front receiver device 42, in particular with the aid of the rear floating body 38, in the region of the waterline 4 of the body of water 6. The front receiver device 42 has a negative shell 44 in relation to the bow of the submarine vehicle 2 which defines a positive shape. The shape of the front receiver device 42 is thus adapted to the shape of the bow of the submarine vehicle 2. Furthermore, the front receiver device 42 comprises coupling means 46, by means of which the front receiver device 42 can be coupled to the submarine vehicle 2. The coupling is implemented either directly on the submarine vehicle 2 but can be indirectly via a front attachment 48 fastened to the submarine vehicle 2. The front attachment 48 and/or the submarine vehicle 2 are in turn directly connected to a rope 50 which is shown in dashed lines in the region of the wave compensation ramp 24. The rope 50 is guided through the front receiver device 42 and through the rear receiver device 40. Moreover, the rope 50 extends along the wave compensation ramp 24 towards a guide pulley 52 which is mounted above the pivot axis S on the guide carriage 30 and which deflects the rope 50 from the wave compensation ramp 24 to the recovery ramp 12. The rope 50 extends further along the recovery ramp 12, optionally via one or more further guide pulleys, not shown, as far as a winch 54 which is able to wind or even unwind the rope 50 by electrical drive means.

[0044] In the position of the system 1 and of the submarine vehicle 2, shown in FIG. 1, the submarine vehicle 2 has either been let into the water and can now be decoupled or, for example after carrying out a mission, the submarine vehicle 2 has been coupled to the front receiver device 42 and can now be recovered and/or pulled on board the marine vessel 8.

[0045] Prior to the decoupling, generally a buoy is launched from the submarine vehicle 2, to which the free end of the rope 50 is fastened, which in the view according to FIG. 1 is

fastened to the winch 54. The buoy is reeled in by means of a ship's hook, pulled on board the marine vessel 8 and detached from the rope 50. On the deck of the marine vessel 8, the free end of the rope 50 is subsequently threaded through the front receiver device 42 and the rear receiver device 40, placed around the guide pulley 52 and finally fastened to the winch 54. The winch 54 now winds up the rope 50 and, as a result, pulls the submarine vehicle 2 for coupling to the front receiver device 42. Optionally, in a development of the exemplary embodiment shown, folding mechanisms are arranged on the front receiver device 42 or on the wave compensation ramp 24, the folding mechanisms counteracting damage to sensors of the submarine vehicle 2 when approaching the front receiver device 42.

[0046] As soon as the underwater vehicle 2 is coupled by means of the coupling means 46 to the front receiver device 42, the rope 50 is hauled in further by means of the winch 54 which causes the front receiver device 42 to be displaced along the wave compensation ramp and at the same time, together with the bow and subsequent parts of the submarine vehicle 2, to be pushed through the rear receiver device 40. In this case, the submarine vehicle 2 is guided and mounted both by the front receiver device 42 and by the rear receiver device 40. To this end, the rear receiver device 40 comprises wheels 56, four wheels 56 which guide and mount the submarine vehicle 2 can be provided. The wheels 56 can have a flexible roller material for effective damping. Moreover, the wheels 56 can be adjustable in height. By the arrangement of the guide pulley 52 above the pivot axis S and/or by the arrangement which is displaced relative to the pivot axis S in the direction of the first end 16 of the recovery ramp 12, by the tensile force produced by means of the rope 50, a lifting moment is produced for the wave compensation ramp 24 and/or for the free end 34 of the wave compensation ramp 24.

[0047] Finally, the wave compensation ramp 24 comprises a wheel and/or wheels 58 which support the wave compensation ramp 24 and/or the free end 34 of the wave compensation ramp 24 on the recovery ramp 12 when the wave compensation ramp 24 is lifted onto the recovery ramp 12.

[0048] FIG. 2 shows a snap connection device 60 in a sectional view together with a part of the front attachment 48 which is engaged in the snap connection device 60. The coupling means 46 have the snap connection device 60, the snap connection device 60 being configured for engaging and retaining the front attachment 48 and thus for coupling the front attachment 48 to the front receiver device 42.

[0049] The front attachment 48 has a spike and/or pin 62 which is guided by means of a guide 64. The coupling means 46 are configured in the region of the snap connection device 60 in the shape of a guide funnel 66. The snap connection device 60 comprises pivotable snap connections 68 and 70.

[0050] By means of the rope 50, not shown here, the pin 62 is guided through the guide funnel 66 and the guide 64 onto the snap connection device 60. The rope 50 can optionally be passed through the pin 62 and through the snap connection device 60 and/or the top end of the guide 64. Projections 72 and 74 on the pin 62 and/or a peripheral projection which has the portions 72 and 74, when guiding and/or threading in the pin 62, effect a pivoting of the snap connections 68 and 70, the snap connections 68 and 70 snapping back after the projections 72 and 74 have passed the snap connections 68 and 70. Subsequently, the pin 62 and thus the front attachment 48 are coupled by means of the snap connection device 60 to the front receiver device 42.

[0051] The snap connection device 60 can be configured such that the snap connections 68 and 70 open again and open up the passage for the projections 72 and 74 when the pin 62 is pushed in the direction of the front receiver device 42. This can take place, for example for decoupling the submarine vehicle 2, by the submarine vehicle 2 being moved by means of its drives in the direction of the front receiver device 42.

[0052] FIG. 3 shows the system 1 according to the embodiments of FIG. 1 with the recovery ramp 12 retrieved, the wave compensation ramp 24 retrieved and the submarine vehicle 2 retrieved. The same reference numerals in all the figures denote the same components. The recovery ramp 12, the wave compensation ramp 24 and the submarine vehicle 2 are positioned above the marine bearing assembly 10. The rocker 18 is pivoted such that the recovery ramp 12 is mounted in the region of the second and/or free end 20 of the recovery ramp 12 on the tilting roller 14. This arrangement according to FIG. 3 is produced before the submarine vehicle 2 is let into the water and/or when the submarine vehicle 2 is completely recovered. Moreover, the recovery ramp 12 and the wave compensation ramp 24 can adopt the same position when the submarine vehicle 2 carries out its mission and when the rope 50 is reeled in, in particular at least as long as the rope 50 is fastened to the winch 54.

[0053] FIG. 4 shows the system 1 according to embodiments of FIG. 1 in an arrangement which substantially equates to the arrangement according to FIG. 1, but with the submarine vehicle 2 being received by the wave compensation ramp 24. The submarine vehicle 2 in this case is mounted by the front receiver device 42 and the rear receiver device 40, amongst other things the negative shell 44 centering the bow of the submarine vehicle 2.

[0054] In the illustration according to FIG. 4, the front receiver device 42 has reached its outermost position in the direction of the first end 26 of the wave compensation ramp 24. Subsequently, the wave compensation ramp 24 is pulled up onto the recovery ramp 12 by means of the belt drive 32, optionally assisted by pulling on the rope 50.

[0055] The exemplary arrangement according to FIG. 4 is also achieved when the submarine vehicle 2 is to be let into the water, namely when the guide carriage 30 has reached its final position in the region of the second or free end 20 of the recovery ramp 12 or in the region of the average waterline 4.

[0056] FIG. 5 shows the system 1 of FIG. 1 in an arrangement in which the submarine vehicle 2, as in the arrangement according to FIG. 4, is received by the wave compensation ramp 24. In contrast to the arrangement according to FIG. 4, however, the wave compensation ramp 24 with the submarine vehicle 2 is also fully received by the recovery ramp 12. The guide carriage 30 is positioned at the first end 16 of the recovery ramp 12 and retains the wave compensation ramp 24 at that point with the submarine vehicle 2. In this case, the wave compensation ramp 24 is additionally mounted on the wheel and/or the wheels 58.

[0057] The system 1 is suitable for recovering and launching the submarine vehicle 2. Proceeding from the arrangement according to FIG. 3, the launching takes place via the arrangements according to FIGS. 5, 4 and 1. The recovery and/or retrieval of the submarine vehicle takes place, proceeding from the arrangement according to FIG. 1, via the arrangements according to FIGS. 4, 5 and 3. Alternatively, however, the submarine vehicle can be displaced into the body of water 6 from the marine vessel 8 in a different manner, as the launching of the submarine vehicle 2 generally

involves relatively less risk of damage to the submarine vehicle 2 compared to the recovery. For example, the submarine vehicle 2 can be let into the body of water 6 by means of a crane.

[0058] FIG. 6 shows a block diagram for illustrating a method 76 for recovering a submarine vehicle and/or the submarine vehicle 2 in accordance with the various exemplary embodiments of FIG. 1.

[0059] The method 76 always comprises the mounting 78 of the recovery ramp 12 on the marine bearing assembly 10 and/or by means of the marine bearing assembly 10, in particular on the marine vessel 8. Moreover, the method 76 always comprises the mounting 80 of the wave compensation ramp 24 on the recovery ramp 12 in a pivotable manner about the pivot axis S relative to the recovery ramp 12. The wave compensation ramp 24 is thus to be regarded as movable during the recovery procedure, whereas although the recovery ramp 12 can be lowered or lifted on board, during the recovery procedure in the narrower sense and/or when the submarine vehicle is coupled thereto, it is to be regarded as stationary.

[0060] After the submarine vehicle 2 has carried out its mission, its energy reserves are generally exhausted so that the submarine vehicle 2 does not actively control the recovery procedure, but according to a step 82 launches a buoy which is fixedly connected by means of the rope 50 to the front attachment 48 of the submarine vehicle 2. Subsequently, according to a step 84 the buoy is reeled in by means of a ship's hook, for example. The buoy is removed from the free end of the rope 50. Subsequently according to a step 86, the free end of the rope 50 is threaded through the front receiver device 42 and through the rear receiver device 40 and according to a step 88 fastened to the winch 54. Subsequently, according to a step 90, the recovery ramp 12 which is located above the marine bearing assembly 10 is lifted above the tilting roller 14 and lowered in the direction of the waterline 4. The free end 20 of the recovery ramp 12 is now located in the region of the average waterline 4. Subsequently, according to a step 92, the wave compensation ramp 24 is extended by means of the guide carriage 30. The wave compensation ramp 24 is now located with its free end 34 in the region of the actual waterline 4 and rocks up and down with the waves.

[0061] Subsequently, according to a step 94 the submarine vehicle 2 is pulled by means of the rope 50. The winch 54 at the same time produces a tensile force on the rope 50. Whilst the submarine vehicle 2 according to step 94 is pulled, according to a step 96 the rear receiver device 40 is retained in the region of the water surface and/or waterline 4, in particular by means of the rear floating body 38. Moreover, the rope 50 according to a step 98 is guided by means of the front receiver device 42. Additionally, according to a step 100 the rope 50 is deflected by means of the guide pulley 52 from the wave compensation ramp 24 to the recovery ramp 12. The step 100 contains a step 102 according to which the lifting of the wave compensation ramp 24 is assisted by means of the tensile force of the rope which is achieved by the arrangement of the guide pulley 52 above the pivot axis S. As a result, a lifting moment is produced on the wave compensation ramp 24.

[0062] The submarine vehicle 2 according to a step 104 is received by means of the wave compensation ramp 24. In this case according to a step 106, the front receiver device 42 is retained, in particular by means of the front floating body 36, in the region of the water surface and/or waterline 4. In the

meantime, according to a step 108 the coupling means 46 are coupled to the front attachment 48. Thus, the submarine vehicle 2 is fixedly docked to the front receiver device 42. The coupling in step 108 comprises an engagement of the front attachment 108 by means of the snap connection 60 according to a step 110.

[0063] The centering of the submarine vehicle 2 by means of the negative shell 44 according to a step 112 and the guidance of the submarine vehicle 2 by means of the front receiver device 42 according to a step 114 follow hereinafter as further components of the receiving procedure according to step 104, the submarine vehicle 2, in particular, also being mounted by means of the front receiver device 42. Moreover, the step 104 comprises the guidance and mounting of the submarine vehicle 2 by means of the rear receiver device 40, in particular by means of the wheels 56 of the rear receiver device 40 according to a step 116. Finally, a linear displacement of the front receiver device 42 on the wave compensation ramp 24 according to a step 118 forms part of a receiving procedure for the submarine vehicle 2 by means of the wave compensation ramp 24 according to the step 104. The displacement takes place by means of the tensile force exerted by the winch 54 via the rope 50.

[0064] If the submarine vehicle 2 is pulled up to the final designated position onto the wave compensation ramp 24, after the step 94, according to a step 120 the submarine vehicle 2 is retrieved by means of the recovery ramp 12 on board the marine vessel 8 and/or to a position above the marine bearing assembly 10. In particular, according to a step 122 the wave compensation ramp 24 together with the received submarine vehicle 2 are retrieved and/or moved on board the marine vessel 8 and/or above the marine bearing assembly 10. To this end, according to a step 124 the guide carriage 30 is displaced, in particular by means of the belt drive 32, and thus the wave compensation ramp 24 is lifted according to a step 126. Subsequently, the wave compensation ramp 24 bears fully against the recovery ramp 12. Then, according to a step 128, the recovery ramp 12 is lifted by means of the rocker 18 via the tilting roller 14, in particular by means of the hydraulic cylinder 22. Thus, the submarine vehicle 2 is finally located above the wave compensation ramp 24, above the recovery ramp 12 and above the marine bearing assembly 10 and/or recovered on board the marine vessel 8.

[0065] The system 1 can also be used for launching the submarine vehicle 2. The method steps required therefor are in part similar to the method steps for recovering the submarine vehicle 2 in reverse sequence. In this case, however, the rope 50 can be not fastened to the winch 54 but is located on the submarine vehicle 2 together with the buoy fastened to the rope 50. In particular, the launching of the submarine vehicle 2 takes place by the recovery ramp 12 being lowered by means of the rocker 18 via the tilting roller 14 together with the wave compensation ramp 24 located thereon and the submarine vehicle 2 located thereon. Subsequently, the submarine vehicle 2 slides over the recovery ramp 12 into the water.

[0066] Alternatively, the guide carriage 30 is moved down the recovery ramp 12 and thus the wave compensation ramp is lowered. Finally, by means of the coupling means 46, the coupling of the submarine vehicle 2 and/or the front attachment 48 to the front receiver device 42 is released. In this case, the front receiver device 42 is either secured by means of a retaining means in the region of the first end 26 of the wave

compensation ramp 24 or has previously moved to the second and/or free end 34 of the wave compensation ramp.

[0067] FIG. 7 shows a negative shell 44' in a sectional view from above with two guide strips 130 and 132 spread apart to the side. Alternatively, the guide strips 130 and 132 can also be spread apart in other directions, for example the guide strip 130 upwards and the guide strip 132 downwards, according to this alternative example, FIG. 7 being a sectional view of a side view. Moreover, as an alternative to the exemplary embodiment shown, further guide strips can be provided, the guide strips being spread apart in several directions and together forming a three-dimensional funnel.

[0068] For spreading apart the guide strips 130 and 132, the negative shell 44' and/or the front receiver device 42, not shown here, with the negative shell 44' are displaced from the first end 26 of the wave compensation ramp 24, not shown here, to the second and/or free end 34 of the wave compensation ramp 24, the guide strips 130 and 132 being spread apart and finally as shown in FIG. 7 being spread apart when the negative shell 44' is arranged in the region of the rear receiver device 40 connected fixedly to the wave compensation ramp 24. The submarine vehicle 2, the bow thereof being shown in FIG. 7, can move in the direction of the negative shell 44' and/or be pulled by means of the rope 50, not shown here, the submarine vehicle 2 being guided securely to the negative shell 44' by means of the guide strips 130 and 132, even in the case of potential lateral currents, and being able to be coupled there. In particular, the guide strips 130 and 132 prevent the submarine vehicle 2 from striking against the rear receiver device 40. The guide strips 130 and 132 comprise floating bodies and are mounted flexibly and/or movably such that the guide strips 130 and 132, which are spread apart to the side, are also arranged locally in the region of the water surface of the body of water 6. The submarine vehicle 2 and the local portions of the guide strips 130 and 132, towards which the submarine vehicle 2 moves, are thus located approximately at the same height so that the submarine vehicle 2 is not able to reach a position above or below a guide strip, in which it might run the risk of being struck vertically by the respective guide strip 130 and/or 132.

[0069] FIG. 8 shows the negative shell 44' of FIG. 7 with the mounted submarine vehicle 2, in accordance with various embodiments. The submarine vehicle 2 is retained by the guide strips 130 and 132 in position. The negative shell 44' and/or the front receiver device 42 with the negative shell 44' are located in this case in the region of the first end 26 of the wave compensation ramp 24, not shown here, so that the submarine vehicle 2 is mounted on the wave compensation ramp 24.

[0070] Proceeding from the view according to FIG. 7, the view according to FIG. 8 is achieved by the submarine vehicle 2 being pulled onto the wave compensation ramp 24 after being coupled to the front receiver device 42 and/or to the negative shell 44', the negative shell 44' being displaced from the free end 34 of the wave compensation ramp 24 in the direction of the first end 26 of the wave compensation ramp 24 and/or the negative shell 44' being retracted. In this case, the guide strips 130 and 132 slide partially through the rear receiver device 40, so that the guide strips 130 and 132 are forced together by means of the rear receiver device 40 and/or forced in the direction of the submarine vehicle 2.

[0071] The invention prevents a hard impact of the submarine vehicle 2 against the recovery ramp 12, both when launching and when recovering the submarine vehicle 2, even

in moderate and/or heavy seas. Submarine vehicles **2** can be launched and recovered by means of the system **1** according to the invention and/or by means of the method **76** according to the invention with reduced risk of damage to the submarine vehicle **2**, even in moderate and heavy seas.

[0072] All features cited in the above description and in the claims are able to be used individually and in any combination. The disclosure of the invention is therefore not limited to the described and/or claimed combinations of features. On the contrary, all combinations of features should be considered as being disclosed.

1.-14. (canceled)

15. A system for recovering a submarine vehicle, said system comprising:

a recovery ramp for retrieving the submarine vehicle from a body of water by means of a rope for pulling the submarine vehicle and by means of the recovery ramp, on board a marine vessel or onto land; and

a wave compensation ramp pivotably mounted on the recovery ramp about a pivot axis (S) relative to the recovery ramp and supported by a floating body for receiving the submarine vehicle and for retrieving the wave compensation ramp together with the received submarine vehicle by means of the recovery ramp.

16. The system according to claim **15**, further comprising: a guide carriage that is displaceable in a linear manner on the recovery ramp;

a joint for mounting the wave compensation ramp; and a hydraulically driven belt drive for displacing the guide carriage.

17. The system according to claim **16**, further comprising a front receiver device that is displaceable in a linear manner on the wave compensation ramp for guiding the rope and the submarine vehicle, the front receiver device comprising:

a coupling means for coupling to a front attachment fastened to the submarine vehicle; and

a front floating body for retaining the front receiver device in the region of the waterline of the body of water during the coupling procedure.

18. The system according to claim **17**, wherein the coupling means comprises a snap connection device for engaging and retaining the front attachment and the front receiver device comprises a negative shell for centering the submarine vehicle.

19. The system according to claim **18**, further comprising a rear receiver device fastened to the wave compensation ramp, the rear receiver device comprising:

a rear floating body for retaining the free end of the wave compensation ramp in the region of the waterline of the body of water; and

at least one wheel for guiding and mounting the submarine vehicle.

20. The system according to claim **19**, further comprising a guide pulley mounted on one of the guide carriage and the wave compensation ramp in the region of the pivot axis (S) for deflecting the rope from the wave compensation ramp to the recovery ramp, such that the lifting of the wave compensation ramp when the submarine vehicle is guided on the wave compensation ramp is assisted by pulling on the rope.

21. The system of claim **20**, wherein the guide pulley is mounted above the pivot axis (s).

22. The system according claim **20**, further comprising:

a marine bearing assembly for mounting the recovery ramp;

a rocker for lifting the recovery ramp via a tilting roller onto the marine bearing assembly; and

a hydraulic cylinder for driving the rocker.

23. A method for recovering a submarine vehicle, the submarine vehicle being retrieved from a body of water, by means of a rope, by means of which the submarine vehicle is pulled, and by means of a recovery ramp, on board a marine vessel or onto land, said method comprising:

receiving the submarine vehicle by means of wave compensation ramp pivotably mounted on the recovery ramp about a pivot axis (S) relative to the recovery ramp and supported by a floating body; and

retrieving the wave compensation ramp together with the received submarine vehicle by means of the recovery ramp.

24. The method according to claim **23**, further comprising displacing a guide carriage in a linear manner on the recovery ramp via a hydraulically driven belt, wherein a joint of the guide carriage is mounted the wave compensation ramp.

25. The method according to claim **24**, wherein coupling means on a front receiver device are coupled to a front attachment fastened to the submarine vehicle, the method further comprising:

retaining the front receiver device in the region of the waterline of the body of water, via a front floating body of the front receiver device, and

displacing the front receiver device in a linear manner on the wave compensation ramp, the front receiver device guiding at least one of the rope and the submarine vehicle.

26. The method according to claim **25**, further comprising: engaging and retaining the front attachment, via a snap connection device of the coupling means; and centering the submarine vehicle, via a negative shell of the front receiver device.

27. The method according to claim **26**, further comprising: retaining the free end of the wave compensation ramp in the region of the waterline of the body of water, via a rear floating body of a receiver device fastened to the wave compensation ramp; and

guiding and mounting the submarine vehicle, via wheels of the rear receiver device.

28. The method according of claim **27**, further comprising deflecting the rope from the wave compensation ramp to the recovery ramp, via a guide pulley mounted on one of the guide carriage and the the wave compensation ramp in the region of the pivot axis (S), such that when the submarine vehicle is guided on the wave compensation ramp the lifting of the wave compensation ramp is assisted by pulling on the rope.

29. The method of claim **28**, wherein the the guide pulley is mounted above the pivot axis (S).

30. The method according to claim **28**, further comprising: lifting the recovery ramp, via a rocker and tiling roller, onto a marine bearing assembly, wherein a hydraulic cylinder drives the rocker; and

mounting the recovery ramp, via the marine bearing assembly.

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