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(54) METHOD AND SYSTEM FOR SALVAGE OF VESSELS

SCHIFFSBERGUNGSSYSTEM UND -VERFAHREN

SYSTÈME ET MÉTHODE POUR LA RÉCUPÉRATION DES NAVIRES

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(56) References cited:

US-A- 3 853 345 US-A- 4 872 781

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Description

Technical Field

[0001] The present invention relates to the field of salvage of vessels. More specifically the invention relates to an improved method for salvage and equipment for performing the improved method

Background Art

[0002] Salvage operations directed to shipwrecks are complex operations requiring heavy lifting equipment. The par buckling method is commonly used. Salvage method depends on the size of the shipwreck, the water depth, the position of the shipwreck, and requirements set by the owners, insurance company, authorities etc. Normally, a combination of tugs, large barge cranes and the like are used in such operations.

[0003] A shipwreck has normally has to be both lifted up from the bottom and turned into an upright position, before being transported to a destination for repair or for scrapping. Normally the shipwreck also has to be stabilized by means of pontoons or to be placed onto a floating dock to allow for transport.

[0004] Fastening pontoons for buoyancy to the vessel will often require subsea welding and/or relocation / lifting of the vessel before the pontoons are fastened.

[0005] The strength of a ship is, however, calculated for normal operation and not for salvage operations. Additionally, damages to the vessel resulting in the vessel going under and hitting the sea bed, and the break down resulting from corrosion after sinking, has often resulted in substantial reduction of the original strength of the vessel. Accordingly, the vessel to be salvaged may be further damaged and even disintegrate as a result of a salvage operation. Accordingly, the vessel to be salvaged has to be strengthened or the force exerted to the vessel has to be distributed over a larger part of the vessel to avoid disintegration.

[0006] In some salvage operations, such as in the case of Costa Concordia, environmental regulations set limitations i.a. with regard to creating a necessary stronghold onshore, or to build an underwater platform for supporting the vessel, impossible.

[0007] One object according to the present invention is therefore to provide a method and system for salvaging a vessel making it possible to substantially reduce the forces exerted onto limited areas of the vessel to avoid further damage and possible disintegration.

[0008] Another object is to provide a method and a system to perform a salvage operation with no or minimal impact onshore and to the sea bed, to create no or only a small environmental impact by the salvage operation.

[0009] It is also an object to provide a method and system that makes it possible substantially to reduce the cost of salvage operations.

[0010] It is also an object to provide a method and a

system making it possible to relocate a fully or partly sunken vessel to arrange supporting structures to the vessel before the vessel is brought to its final destination for repair or to be cut up.

[0011] It is also an object to provide a method and means allowing dry welding for fastening of pontoons to a vessel to be salvaged.

[0012] Other objects of the present invention will be clear for the skilled person by reading the present description.

Disclosure of Invention

[0013] According to a first aspect, the present invention provides a method for salvage of a partly or fully sunken vessel, the method comprising:

- a) arranging one of more pontoon(s) being equipped with suction pads onto suitable surface of the vessel;
- b) connecting the one or more pontoon(s) to said surface of the vessel by pumping out water from the suction pad(s) to create a holding force between the pontoon(s) and said surface of the vessel;
- c) relocating the vessel and pontoon(s) to a second position by exerting force onto the pontoon(s).

[0014] According to the invention, a temporary connection between one or more pontoon(s) is provided by means of suction pads. The use of suction pads provides a secure connection between the pontoon and the vessel. By using pontoons designed to withstand the lifting forces for relocation, such as up-righting or lifting by means of cranes, barges or the like, the forces needed for the relocation may be distributed over one or more areas of suction pad(s) to avoid disintegration and collapsing of the vessel to be salvaged.

[0015] According to one embodiment, friction pads are arranged on the pontoon so that the pontoon is forced against the surface of the vessel by the suction force created by the suction pads. Friction pads are arranged to create friction parallel to the surface of the hull of the vessel to avoid or substantially reduce relative movement between the pontoon and the hull and thus stabilize the pontoon relative to the vessel even further than what is obtainable by means of the suction forces only.

[0016] According to one embodiment, the method further comprises the step of securely fastening the one or more of the pontoon(s) to said surface of the vessel.

[0017] According to one embodiment, the securely fastening is done by welding the pontoon(s) to the vessel. Welding is the presently preferred method for securely fastening of the pontoon(s) to the vessel.

[0018] According to one embodiment, the step of securely fastening is performed between step b) and c). At relatively shallow water depths, and if the vessel to be salvaged is lying in a position allowing it, at least a part of the securely fastening, such as welding, may be performed before the vessel is relocated.

[0019] According to another embodiment, the step of securely fastening is performed after step c). If the vessel is located at deep waters or if the position of the vessel does not allow the secure fastening of the vessel to the pontoons to be performed before relocation, the vessel and the pontoons may be relocated, such as up-righting or lifting of the vessel and pontoons before the secure fastening is performed.

[0020] According to one embodiment, a habitat is arranged in a space defined between the pontoon and said surface of the vessel for allowing for dry access to said space. Dry access to a space defined between the vessel and the pontoon allows for access to perform the secure fastening of the pontoon to the vessel by means of e.g. welding. The habitat is fastened to the pontoon(s) and are locked to the unit to be salvaged by seals loaded by forces from the suction pads.

[0021] According to one embodiment, the pontoons, after being connected to the vessel, may be trimmed by substituting water in the pontoons with air to relocate the vessel.

[0022] According to one embodiment, one or more of the pontoon(s) is (are) connected to a barge and that the forces exerted for relocation of the vessel are generated by adjusting the trim of the barge.

[0023] According to another embodiment, one or more of the pontoon(s) is (are) connected to lifting cables for relocation of the vessel.

Brief Description of Drawings

[0024]

Fig. 1 is a perspective view of a vessel in a cradle dock according to the present invention,
 Fig. 2 is a cross section through a vessel and a first cradle dock part,
 Fig. 3 illustrates the present cradle dock including a docked vessel along A-A,
 Fig. 4 illustrates a second cradle dock part seen from the side intended to face the vessel (a), and a side view when facing the vessel (b),
 Fig. 5 is a cross section through a pontoon, a suction pad and a habitat,
 Fig. 6 is a cross section through an alternative embodiment of a pontoon, suction pad and a habitat,
 Figs. 7 to 9 illustrate different stages of exemplified salvage operations, and
 figures 10 and 11 illustrate an alternative embodiment of the invention.

Detailed description of the Invention

[0025] Figure 1 is a perspective view of a vessel 1 in a cradle dock 2 comprising a plurality of buoyancy tanks or pontoons according to the present invention, after the vessel has been up-righted and lifted. The buoyancy tanks or pontoons may be separate tanks or pontoons.

The tanks or pontoons may have their own piping system or they may be connected to a piping system for controlling the buoyancy of the tanks by controlling the water level therein. Preferably the buoyancy is controlled by a computerized control system for controlling the flow of water into and out of the tanks or pontoons, and for substitution of water with air for buoyancy.

[0026] Figure 2 is a cross section through one embodiment according to the invention, an embodiment where the two or more buoyancy tanks or pontoons 5, 6 are connected into a first part 3 of the cradle dock 2. The first part 3 of the cradle dock 2 comprises a side pontoon 5 and a bottom pontoon 6. The bottom and side pontoons comprise tanks. The skilled person will understand that each side pontoon 5, or bottom pontoon 6 may comprise one or more tank(s). Water may be introduced or drained from the tanks and be substituted by air according to the need by means of not shown pumps, valves and pipes. Such pumps and valves are parts of the above mentioned system for controlling the buoyancy of the pontoon(s), and accordingly, the pumps and valves may be manually or automatically controlled. In the event that a pontoon comprises several tanks, the water level of each tank may be adjusted individually to control both the buoyancy volume and the centre of buoyancy and thus control both the buoyancy as such as the position of the pontoon.

[0027] Seen in a cross section as in figure 2, the first part 3 of the cradle dock 2, comprising the side pontoon 5 and bottom pontoon 6, is L-shaped to be arranged along one of the sides, and the bottom of a vessel to be salvaged.

[0028] Suction pads 10 are provided at the bottom pontoon 6 and/ or at the side wall of the side pontoon 5 designed to face the bottom and side, respectively, of the vessel to be salvaged. Presently preferred suction pads 10 are of the type described in US 6,901,977 and US 6,701,981, and are used in connection with an offshore loading system sold under the trademark HiLoad® Attachment System, by Remora ASA, Norway.

[0029] Figures 2, 3, 4 illustrates exemplary arrangements of the suction pads 10. Figures 5 and 6 illustrates cross sections through two different configurations of suction pads and habitats 20 for getting access for safely connection, such as welding, between the pontoon(s) and vessel. As shown in figures 5 and 6, the suction pad(s) 10 comprise friction fenders 11, designed to rest against a surface such as a broad side and/or the bottom of a ship / shipwreck. Sealing elements, such as suction pad gaskets 12, designed to create a substantially water tight seal, are surround the friction fenders 11 to create an enclosed suction chamber. Lipseals 13 are preferably arranged to create an addition seal as an additional barrier against the surrounding sea. The skilled person will understand that suction pads may be arranged at any surface of the pontoons 5, 6 which are designed to rest against a submerged surface of the vessel to be salvaged.

[0030] After the suction pad has been arranged at a

surface with a force sufficient for the sealing elements, such as suction pad gasket 12 and the lipseals 13, to create a substantially watertight seal around the friction fenders 11, water is pumped out from the chamber formed by the sealing elements, such as suction pad gasket 12 and lipseal 13, to create a negative pressure inside of the so formed chamber relative to the ambient pressure at the water depth in question. The friction fenders 11 are arranged so that the friction fenders are forced towards the flat surface when the suction pads 10 are forced against the surface of the vessel, or activated. The surface of the friction fenders 11 prevents sliding of the suction pads along the flat surface when exposed to shear forces, or sideways forces directed in parallel with the surface at which they rest. If no, or very low sideways forces are expected for a certain application, the area of friction fenders 11 may be reduced or even be omitted.

[0031] As mentioned above, the negative pressure inside the suction pad(s) relative to the ambient pressure increases the force with which the suction pads 10, and the thus friction fenders 11, are forced against the surface towards which it is forced. Any initial force used to create the connection between the suction pads 10 and the surface may be released as soon as the suction force is sufficiently high.

[0032] The suction pads are then forced towards the surface with a power dependent on the difference between the pressure inside of the suction pad and the surrounding pressure. A pressure difference of 1 atmosphere will result in a force of 10.000 kg/m². The total suction force obtainable is thus dependent on both the pressure difference over the suction pad and the total area of suction pad(s).

[0033] The water inside the suction pad is preferably substituted with a gas, such as air. If practical in a given situation or at a given water depth, the inside of the suction pads is vented to the atmosphere to allow the pressure difference given by water depth and the atmospheric pressure at the surface to provide the pressure difference creating the suction forces. The force obtainable may be increased by reducing the internal gas pressure inside the suction pad below 1 bar, such as 0.5 bar. The use of vacuum, such as a pressure of 0.5 bar, may give sufficient force between the suction pad and the surface at which it rests, even in shallow waters, or even at the surface.

[0034] Rigid or flexible piping / tubing may be used to connect the inner of the suction pads to the surface air, to lead air for substitution of the water that is pumped out of the suction pads. Alternatively, pumps and or air tanks may be provided to keep the air pressure inside of the suction pad at the required pressure. The skilled person will, however, understand which alternatives in obtaining a reduced pressure inside of the suction pads that is available in a given situation.

[0035] To give a large area of contact for suction pads to a given surface, two or more suction pads are preferably arranged to give a suction surface divided between two or more suction pads. Two or more suction pads will

give a higher degree of control of the forces. If a leakage appears for one suction pad (e.g. due to an uneven surface, perforations in the surface etc, such a leakage will not be damaging for an operation as the other suction pad(s) will be intact.

[0036] A habitat 20 may be arranged at the pontoon(s) such as at the first part 3 of the cradle dock 2. Preferably, the habitat 20 comprises a channel 21 made in a pontoon as illustrated in figures 4, 5, 6. Sealing elements are provided to stop or substantially reduce the water ingress from the surrounding water into the habitat. Figures 5 and 6 illustrate to different arrangements of sealing elements for the habitat 20 and a neighbouring suction pad 10. The two arrangements have in common that there is provided sealing elements both around the suction pad 20 and the habitat 20.

[0037] Figure 5 illustrates a first embodiment where both a suction pad gasket 12 and a lipseal 13 are arranged as a part of the suction pad only, whereas a habitat seal gasket 12' and lipseal 13' are arranged around the edges of the habitat 20, to define a watertight chamber surrounding the channel 21. The gasket 12', lipseal 13 and the channel 21 are arranged so that when the suction tabs(s) 10 of the pontoon in question is(are) resting at a surface and the suction tabs are activated to give suction power to keep the pontoon fastened to the surface, the gasket 12' and the lipseal 13' are also being forced towards the surface to form a watertight connection. The water in the habitat may then be substituted with air at e.g. the same pressure as inside of the suction tabs, i.e. preferably atmospheric pressure. As soon as water is pumped out of the habitat and filled with air at atmospheric pressure, the suction force of the area of the habitat will also add to the suction force of the suction pads and increase the total suction power between the pontoon and the vessel to be salvaged provided that the ambient pressure at the depth in question is at 1 bar or higher. A continuous gasket 22 may be provided along all rims of channel 21 to define a habitat. Alternatively, one gasket 22 may be provided to define a watertight chamber 24 between the flat surface of the vessel and the pontoon, in which watertight chamber 24 one or more channel(s) is(are) provided to give access for personnel to the vessel and the pontoon. The skilled person will understand how to pump water out of the habitat and to substitute the water with air at atmospheric pressure, even though the control system, pumps, and valves are not illustrated of further described. The skilled man will also understand that the pressure inside the habitat(s) and the suction pad(s) may not be the same. Preferably, the pressure inside the habitats is substantially atmospheric pressure, whereas the pressure inside the suction pads may differ dependent on the required suction power, water depth etc.

[0038] The embodiment illustrated in figure 6 is a less complex embodiment than the one illustrated in figure 5. The basis principle is, however, the same.

[0039] Accordingly, features that are not specifically

mention with regard to figure 6 are substantially the same as found in figure 5. The habitat 20 of figure 6 is at least partly integrated with a suction pad 10, as the gasket 12' is only provided at one side of the channel 21 as the lipseal 13 and gasket 12 for the neighbouring suction pad is used to provide a water seal at the other side of the channel 21. The skilled person will also understand that the gasket 12' may be omitted if suction pads are arranged continuously along the rims of the channel 21 to make a watertight connection at at both side and the lower end of the channel 21.

[0040] Alternatively, the habitat 20 is a separate construction that is designed to be arranged to get access for personnel and equipment to the pontoon and hull of the vessel. The habitat is constructed in a solid or partly resilient material being open towards the vessel to be salvaged to enable personnel and/or equipment for performing operations and / or control, to access the compartment defined by the vessel and the walls of the habitat. One or more gasket(s) 12' is (are) arranged to provide a watertight seal to give a watertight chamber 24 around one or more habitat(s) as described above.

[0041] The skilled person will understand that not shown access channels are necessary for personnel to get access to the habitats from the surface. For a pontoon that is partly above sea, the channel 21 may be continued to above sea level to provide access to the habitat. For submerged pontoons access channels may be provided either via a channel 21 in a pontoon that is partly above sea level or via specially provided channels. The skilled person will also understand that access to habitats on totally submerged pontoons may also be provided via submarines, diving bells, or the like.

[0042] The cradle dock 2 also comprises a second part 30 designed to be connected to the opposite broad side to where the first part is arranged, and/or to the bottom of the vessel 1. Figure 3 illustrates a length section A-A in figure 2, through a cradle dock 2 parallel to the bottom of the vessel. The position of the vessel to be salvaged is indicated by the reference sign 1. Suction pads 10 are arranged on the first part 2, comprising a side pontoon 5 and a bottom pontoon 6. As mentioned above, a gasket 22 defines a watertight chamber 24, where one of more habitats 20 may be provided.

[0043] Figure 4 illustrate different views of an exemplary second part 30 and illustrates the suction pads 10 arranged thereon, and two channels 21 arranged in the second part 30, to provide for two habitats 20.

[0044] It is normally required to clean parts of a shipwreck before starting the salvage procedure described below, as fouling and sediments may prevent efficient connection between the cradle dock parts and the vessel. This is especially important as fouling and other irregularities at the surface may cause leakage between the gaskets surrounding the friction fenders of the suction pads. The cleaning of the relevant parts of the wreck may be performed by means of any suitable equipment for the cleaning of a vessel. The choice of cleaning solution

will depend on different variables, such as the depth, the degree of fouling and sedimentation etc. The method may comprise the use of remotely operated equipment, such as e.g. an ROV, or the use of divers, or other known solutions.

[0045] Normally a shipwreck to be salvaged is resting at the bottom in a position different from its upright position. The actual position differs but normally it is far easier to get access to either the starboard or the port side of the vessel. The configuration of the first and second part of the cradle dock may differ dependent on the situation. If the wreck is tilted so that it makes it possible to get easy access to one of the broad sides, and parts of the bottom of the vessel, the first part 3 of the cradle dock 2 has a L-shaped cross section as illustrated in the figures. The first part 3 is then arranged onto the vessel to be salvaged so that the side pontoon 5 is resting on the broad side of the vessel and the bottom pontoon 6 is resting on the bottom of the vessel. The suction pads at the bottom pontoon 6 and / or the side pontoon 5 is then activated by lowering the internal pressure of the suction pads.

[0046] The skilled person will understand that the first part of the cradle dock may be divided in two or more parts in the longitudinal direction of the vessel. A reason to divide the first part longitudinally, is that it is easier to position a shorter part than one long enough to serve as a half floating dock for a vessel. Additionally, obstacles may hinder arranging the first part at parts of the wreck. By dividing the first part in two or more shorter parts, such obstacles may be avoided.

[0047] During the positioning of the first part(s) of the cradle dock, the parts, or the side pontoon and / or the bottom pontoon may be fully or partly filled with water as required for the operation. After connecting the first part 3 of the cradle dock, or two or more longitudinally divided first part sections, to the vessel by means of the suction pads, the wreck and the first part(s) of the cradle dock may be repositioned to allow access to the part of the shipwreck that were inaccessible before the start of the operation. The repositioning may comprise substituting the water in the pontoons with air to create buoyancy to facilitate the repositioning. In addition to the buoyancy created by substituting water in the pontoons with air, lifting equipment, such as cranes, may be used.

[0048] The operation after connecting the first part(s) 3 of the cradle dock to the shipwreck until the next step which comprises connecting second part(s) 30 of the cradle dock as will be described below, is dependent on several factors.

[0049] The water in the habitats 20, i.e. the channels 21 as mentioned above, and any additional habitat areas, i.e. areas where work may be performed, is substituted with air. Personnel may then be allowed access to the habitats to make the connection between the cradle dock first part(s) and the shipwreck more permanent by welding the cradle dock first part to the vessel. The habitat(s) 20 will be ventilated in order to obtain good working con-

ditions for the welders. The skilled person will understand that for all embodiments described herein, the cradle dock part(s) 5, 6, 30 are preferably welded to bulkheads, web frames and decks of the vessel to be salvaged.

[0050] If the vessel to be salvaged is at deeper waters, the vessel may be lifted up by means of the buoyancy of the first cradle part(s) to a depth where the suction pads are at e.g. a minimum of 5, or more preferably 10 meters, to allow for a sufficient suction when venting the inner part of the suction pads to the surroundings, to prevent loosening of the suction pads. When the vessel is at such a depth, the habitats may be filled with air as described above, and personnel may be allowed to enter the habitats to perform the welding as described above.

[0051] After welding the cradle dock first part(s) to the vessel, and if relevant, relocating the vessel to allow access to the opposite side of the vessel to the one connected to the cradle dock first part(s).

[0052] The cradle dock second part(s) 30 may then be lowered into the sea and positioned along the opposite side of the one connected to the first part side pontoon(s). After the cradle dock second part(s) have been put in the required position, the suction pads on the cradle dock second part(s) are activated. So that the second cradle dock part(s) is (are) fastened to said second side of the vessel. The water in the habitat may then, as for the first parts, be substituted with air to allow personnel to work therein to weld the second part to the vessel.

[0053] After welding the cradle dock second part to the vessel, water in the pontoon(s) of the cradle dock second parts is substituted with air to balance the vessel in an upright position. The vessel and the cradle dock are now stable and may be towed to any destination for repair, or scrapping.

[0054] The skilled person will understand that the buoyancy tanks or pontoons may be used as individual tanks or pontoons, each having their own set of suction pads for provisionally fastening the buoyancy tanks or pontoons to the vessel to be salvaged.

[0055] Figures 7 - 9 illustrate a specific embodiment developed for salvage of Costa Concordia which partly sunk after running aground at the Italian coast in January 2012. The more general description above also relates to this specific embodiment, if not specifically indicated otherwise, or if it is clear for the skilled man that it is not relevant.

[0056] Costa Concordia rests mainly at one side (port side), leaving most of the other side (starboard side) above sea level. The hull is filled with water and rock formations at the sea bottom and in-adequate strength of the amidships bilge area prevents or makes tilting the vessel to an upright position difficult using traditional salvage methods using cranes, and other lifting equipment. Figure 7 illustrates a first part 3 of a cradle dock placed against one of the broad sides and the bottom of the hull of a vessel resting at the bottom as Costa Concordia. The first part of the cradle dock, having an L-shaped cross section as illustrated, is brought in position by means of

ship section or barge 40.

[0057] The illustrated barge 40 is made by cutting the aft part of a ship to be scrapped, closing the aft end to avoid uncontrolled/unwanted inflow of water into the hull, and mounting of one or more hinge connectors 41 for pivotally connecting the barge to a buoyancy tank, pontoon, or a part of a cradle dock as described herein. If more than one hinge connector is present, the hinge connectors 41, have a common axis of rotation about which the first cradle part 3 and the barge 40 rotate. The axis of rotation about the hinge connector(s) 41 is substantially parallel with the sea, or horizontal, and substantially perpendicular to the length of the barge 40.

[0058] The top of the side pontoon 5 may be welded to the broad side of the vessel 1 to be salvaged during the positioning operation. In this case the barge 40 is ballasted at the aft end to allow the top of the side pontoon 5 to rest at an acute angle onto the broad side of the vessel 1. The top of the side pontoon is then welded to the vessel 1. Thereafter the barge, and if needed also the top pontoon 5 and bottom pontoon 6, forming the first cradle dock part 3, is (are) trimmed to allow both the side pontoon 5 and the bottom pontoon 6 to rest against the broad side and the bottom of the vessel, respectively. The inside of the suction pads and any habitats, are then vented to the atmosphere and the water therein is pumped out, to form a suction force between the vessel 1 and the suction pads, and the vessel and any habitats.

[0059] The cradle dock first part 3 may then be further connected to the vessel by means of welding. If habitats are present, the welding connections may be made by personnel or robots from the inside of the habitats.

[0060] After welding the cradle dock first part 3 to the vessel 1, the barge is trimmed by emptying ballast tanks in the aft part, and filling ballast tanks in the bow part thereof for lowering the bow, and lifting the aft part of the barge to get the vessel and cradle dock parts in a second, or lifted position, and thereby also the cradle dock first part 3 and the vessel 1 sufficiently to move the connected parts. If the side and/or bottom pontoons 5, 6 are trimmed by fully or partly filling the pontoons with water, the water inside the pontoons 5, 6 the trim of the pontoons may be adjusted co-ordinately with the trimming of the barge 40.

[0061] The skilled person will understand that two or more barges may be needed to work in parallel to obtain the necessary lifting force and at the same time keep the necessary balance in the lifting operation.

[0062] In the lifted or second position, illustrated in figure 8, the second cradle dock part(s) 30 may be fitted onto the vessel 1, and be welded to the vessel as for the first cradle part 3. The second cradle part 30 may also be connected to a second cradle part bottom section 31 to give a L-shaped section, or the second cradle part bottom section may be introduced after the second cradle part is fastened. The second cradle part 30 and the second cradle part bottom section are also provided with suction pads 10 and friction fenders 11 to keep the vessel and the second cradle part together and substantially

reduce the relative movement between the cradle part and the vessel to allow welding.

[0063] After the second cradle part 30 and the second cradle part bottom section are welded to the vessel, the barge 40 may be trimmed to lower the vessel and completed cradle 2 so that the vessel 1 and cradle dock 2 are in their upright position. The skilled person will understand that the pontoons of the cradle 2 have to be trimmed correspondingly to stabilize the vessel and cradle dock in this position. After finishing this welding operation, the aft part of the barge 40 may again be lowered by re-trimming the barge, to a 4th position illustrated in figure 9. At the same time water is pumped out of the tanks of the cradle dock first and second parts to allow the cradle dock 2 and the vessel 1 to float as a separate unit. The cradle dock 2 and the vessel 1 may then be released from the barge(s) by disconnecting at the hinge connector(s) 41.

[0064] When the cradle dock parts are arranged as illustrated in figure 1, and described above, the floating unit comprising the cradle dock 2 and the vessel 1, is a stable unit that may be towed to a final destination. Calculation on an embodiment designed for salvage of Costa Concordia has concluded that the stability of this floating unit is fulfilling the requirements set by relevant authorities to be towed to the destination for the vessel.

[0065] Figures 10 and 11 illustrate an alternative connection process for connecting a pontoon 35 to a vessel 1. The vessel is either stabilized in a non illustrated way at the opposite side, e.g. as illustrated with reference to figure 7, or rests in an upright position at the sea bed. The pontoon is partly filled with water and lowered and oriented relative to the vessel by means of cranes. The pontoon 35 is lowered to the intended depth, and oriented so that a lower edge of the side wall of the pontoon 35 to be arranged towards the hull of the vessel, rests against the lower part of the broad side of the hull and the pontoon attacks the hull at an acute angle, as illustrated in figure 10.

[0066] The top of the pontoon is then pulled by means of the cranes towards the vessel until suction pads arranged on the pontoon rest against the side of the vessel, as illustrated in figure 11. The suction pads are then activated by pumping out water thereof and substituting the water with air at lower than the ambient pressure, such as atmospheric pressure. Habitat(s) 20 arranged at the pontoon 35 is then prepared for use by emptying the habitats for water, and substituting the water with air, preferably at atmospheric pressure. As soon as the habitat(s) 20 is (are) prepared for use, the pontoon 35 is welded to the hull of the vessel to produce a secure connection between the vessel and the pontoon, as described above. The same procedure may then be repeated for additional pontoons at the same side or the opposite side.

[0067] Figure 11 illustrates the vessel after being lifted to the surface, but for the purpose of simplification, only the pontoon 35 at one side is illustrated. The skilled person will, however, understand the pontoons are necessary

at both sides of the vessel to stabilize the floating unit comprising the vessel and pontoons. The skilled person will also understand that bottom pontoons, i.e. pontoons supporting the bottom of the vessel and preferably connecting the side pontoons 35 as illustrated below, may be placed below the bottom of the vessel, and carefully lifted towards the bottom by means of cranes and trimming of the buoyancy of the bottom pontoon(s) after the vessel illustrated in figures 10 and 11 is lifted above the sea bed and at least partly lifted to the surface. Preferably, suction pads and habitats is arranged at the upwards directed surface of bottom pontoon, where the suction pads are arranged to ascertain a stable connection between the pontoon during welding operations performed inside the habitat(s).

[0068] The skilled person will observe that both the first and second cradle dock parts in some of the illustrations are L-shaped, and that only the first cradle dock part is L-shaped in some figures. The skilled person will understand that both L-shaped and straight pontoons are applicable according to the present invention. The configuration of the pontoons is dependent on the vessel to be salvaged, the position thereof, the water depth, and other considerations. The skilled person will also understand that the present method and devices may be mounted at the vessel as separate tanks, or pontoons as described above, and any combination of separate tanks and pontoons without leaving the scope of the invention. Additionally, the skilled person will also understand that the invention may also be applicable for salvage of marine vessels with no or limited flat areas, such as e.g., but not limited to submarines, provided that the pontoons or tanks have a mating surface corresponding to the surface of the vessel in question.

Claims

1. A method for salvage of a partly or fully sunken vessel, the method comprising:
 - a) arranging one or more pontoon(s) (5, 6) being equipped with suction pads (10) onto suitable surface of the vessel (1);
 - b) connecting the one or more (5, 6) to said surface of the vessel (1) by pumping out water from the suction pad(s) (10) to create a holding force between the pontoon(s) (5, 6) and said surface of the vessel (1);
 - c) relocating the vessel (1) and pontoon(s) (5, 6) to a second position by exerting force onto the pontoon(s) (5, 6).
2. The method of claim 1, wherein friction pads (11) are arranged on the pontoon (5, 6) so that the pontoon (5, 6) is forced against the surface of the vessel (1) by the suction force created by the suction pads (10).

3. The method of claim 1 or 2, further comprising the step of securely fastening the one or more of the pontoon(s) (5, 6) to said surface of the vessel (1).
4. The method of claim 3, wherein the securely fastening is done by welding the pontoon(s) (5, 6) to the vessel (1). 5
5. The method of claim 3 or 4, wherein the step of securely fastening is performed between step b) and c). 10
6. The method of claim 3 or 4, wherein the step of securely fastening is performed after step c).
7. The method of any of the preceding claims, wherein a habitat (20) is arranged in a space defined between the pontoon (5, 6) and said surface of the vessel (1) for allowing for dry access to said space. 15
8. The method according to any of the preceding claims, wherein the pontoons (5, 6) after being connected to the vessel (1) may be trimmed by substituting water in the pontoons (5, 6) with air to relocate the vessel (1). 20
9. The method of any of the preceding claims, wherein one or more of the pontoon(s) (5, 6) is (are) connected to a barge (40) and that the forces exerted for relocation of the vessel (1) are generated by adjusting the trim of the barge (40). 25
10. The method of any of the claims 1-8, wherein one or more of the pontoon(s) (5, 6) is (are) connected to lifting cables for relocation of the vessel (1). 30
11. A system for salvage of a partly or fully sunken vessel (1), the system comprising one or more pontoon(s) (5, 6) at which pontoon(s) suction pad(s) (10) is (are) for creating a holding force between the pontoon(s) (5, 6) and surface(s) at the vessel (1). 35
12. The system according to claim 11 wherein one or more habitat(es) (20) is (are) arranged on side of the pontoon (5, 6) adjacent to said surface, for providing a dry subsea environment for welding the pontoon(s) (5, 6) to said surface(s). 40
13. The system according to claim 11 or 12, wherein, the system further comprises one or more lifting devices connected to one or more of the pontoon(s) (5, 6) for relocation of the pontoons (5, 6) and the vessel (1). 45

Patentansprüche

1. Verfahren zum Bergen eines teilweise oder vollständig gesunkenen Schiffs, wobei das Verfahren um-

fasst:

- a) Anordnen eines oder mehrerer Ponton(s) (5, 6), welches mit einem Saugkissen (10) ausgestattet ist, auf einer geeigneten Oberfläche des Schiffs (1);
- b) Verbinden des einen oder der mehreren Ponton(s) (5, 6) mit der Oberfläche des Schiffs (1) durch Auspumpen von Wasser aus dem/den Saugkissen (10), um eine Haltekraft zwischen dem/den Ponton(s) (5, 6) und der Oberfläche des Schiffs (1) zu erzeugen;
- c) Verlagern des Schiffs (1) und des/der Pontons (5, 6) zu einer zweiten Position durch Ausüben einer Kraft auf das/die Ponton(s) (5, 6).
2. Verfahren nach Anspruch 1, wobei Reibkissen (11) auf dem Ponton (5, 6) so angeordnet sind, dass der Ponton (5, 6) durch die durch die Saugkissen (10) erzeugte Ansaugkraft gegen die Oberfläche des Schiffs (1) gezwungen wird.
3. Verfahren nach Anspruch 1 oder 2, weiterhin umfassend den Schritt den einen oder die mehreren Ponton(s) (5, 6) an der Oberfläche des Schiffs (1) sicher zu befestigen.
4. Verfahren nach Anspruch 3, wobei das sichere Befestigen durch Schweißen des/der Ponton(s) (5, 6) an das Schiff gemacht wird.
5. Verfahren nach Anspruch 3 oder 4, wobei der Schritt des sicheren Befestigens zwischen den Schritten b) und c) gemacht wird.
6. Verfahren nach Anspruch 3 oder 4, wobei der Schritt des sicheren Befestigens nach dem Schritt c) gemacht wird.
7. Verfahren nach einem der vorhergehenden Ansprüche, wobei ein Habitat (20) in einem zwischen dem Ponton (5, 6) und der Oberfläche des Schiffs (1) definierten Raum angeordnet ist, um einen trockenen Zugang zu dem Raum zu ermöglichen.
8. Verfahren nach einem der vorhergehenden Ansprüche, wobei die Pontons (5, 6) nach dem Verbinden mit dem Schiff (1) durch Ersetzen von Wasser in den Pontons (5, 6) mit Luft getrimmt werden können, um das Schiff (1) zu verlagern.
9. Verfahren nach einem der vorhergehenden Ansprüche, wobei ein oder mehrere Ponton(s) (5, 6) mit einem Schleppkahn (40) verbunden wird/werden, und dass die zur Verlagerung des Schiffs (1) ausgeübten Kräfte durch Anpassung der Trimmung des Schleppkahns (40) ausgeübt werden.

10. Verfahren nach einem der Ansprüche 1-8, wobei eines oder mehrere der Pontons mit Hubseilen zur Verlagerung des Schiffs (1) verbunden ist/sind.
11. System zum Bergen eines teilweise oder vollständig gesunkenen Schiffs (1), wobei das System umfasst ein oder mehrere Ponton(s) (5, 6), wobei an dem/den Ponton(s) Saugkissen zum Erzeugen einer Haltekraft zwischen dem/den Ponton(s) und der/den Oberfläche(n) des Schiffs (1) sind.
12. System nach Anspruch 11, wobei ein oder mehrere Habitat(s) (20) seitlich des/der Ponton(s) (5, 6) neben der Oberfläche zum Vorsehen einer trockenen unterseeischen Umgebung zum Schweißen des/der Ponton(s) an die Oberfläche(n) angeordnet sind.
13. System nach Anspruch 11 oder 12, wobei das System weiterhin ein oder mehrere mit dem einen oder den mehreren Ponton(s) (5, 6) verbundene Hebevorrichtung(en) zur Verlagerung der Pontons (5, 6) und des Schiffs (1) umfasst.

Revendications

1. Procédé pour le sauvetage d'un navire partiellement ou totalement coulé, le procédé comprenant :
- a) l'agencement d'un ou de plusieurs pontons (5, 6) équipés de ventouses (10) sur une surface appropriée du navire (1) ;
 - b) la liaison du(des) ponton(s) (5, 6) à ladite surface du navire (1) en pompant l'eau de la(des) ventouse(s) (10) afin de créer une force de retenue entre le(s) ponton(s) (5, 6) et ladite surface du navire (1) ;
 - c) le repositionnement du navire (1) et du(des) ponton(s) (5, 6) dans une seconde position en exerçant une force sur le(s) ponton(s) (5, 6).
2. Procédé selon la revendication 1, dans lequel des tampons de frottement (11) sont agencés sur le ponton (5, 6) de telle sorte que le ponton (5, 6) est poussé contre la surface du navire (1) par la force d'aspiration créée par les ventouses (10).
3. Procédé selon la revendication 1 ou 2, comprenant en outre l'étape consistant à fixer de manière sécurisée le ou les pontons (5, 6) à ladite surface du navire (1).
4. Procédé selon la revendication 3, dans lequel la fixation sécurisée est effectuée en soudant le(s) ponton(s) (5, 6) au navire (1).
5. Procédé selon la revendication 3 ou 4, dans lequel l'étape de fixation sécurisée est effectuée entre l'éta-

pe b) et c).

6. Procédé selon la revendication 3 ou 4, dans lequel l'étape de fixation sécurisée est effectuée après l'étape c).
7. Procédé selon l'une quelconque des revendications précédentes, dans lequel un habitat (20) est agencé dans un espace défini entre le ponton (5, 6) et ladite surface du navire (1) pour permettre un accès sec audit espace.
8. Procédé selon l'une quelconque des revendications précédentes, dans lequel les pontons (5, 6), après avoir été reliés au navire (1), peuvent être orientés en remplaçant l'eau dans les pontons (5, 6) par de l'air afin de repositionner le navire (1).
9. Procédé selon l'une quelconque des revendications précédentes, dans lequel un ou plusieurs des pontons (5, 6) est(sont) relié(s) à une barge (40) et les forces exercées pour repositionner le navire (1) sont générées en ajustant l'orientation de la barge (40).
10. Procédé selon l'une quelconque des revendications 1-8, dans lequel un ou plusieurs des pontons (5, 6) est(sont) relié(s) à des câbles de levage pour repositionner le navire (1).

11. Système pour le sauvetage d'un navire partiellement ou totalement coulé (1), le système comprenant un ou plusieurs pontons (5, 6) au niveau duquel(desquels) ponton(s) se trouve(nt) une(des) ventouse(s) pour créer une force de retenue entre le(s) ponton(s) (5, 6) et la(les) surface(s) au niveau du navire (1).
12. Système selon la revendication 11 dans lequel un ou plusieurs habitats (20) sont agencés sur un côté du ponton (5, 6) de manière adjacente à ladite surface, pour fournir un environnement sous-marin sec pour souder le(s) ponton(s) (5, 6) à ladite(auxdites) surface(s).
13. Système selon la revendication 11 ou 12, dans lequel le système comprend en outre un ou plusieurs dispositifs de levage reliés à un ou plusieurs des pontons (5, 6) pour repositionner les pontons (5, 6) et le navire (1).

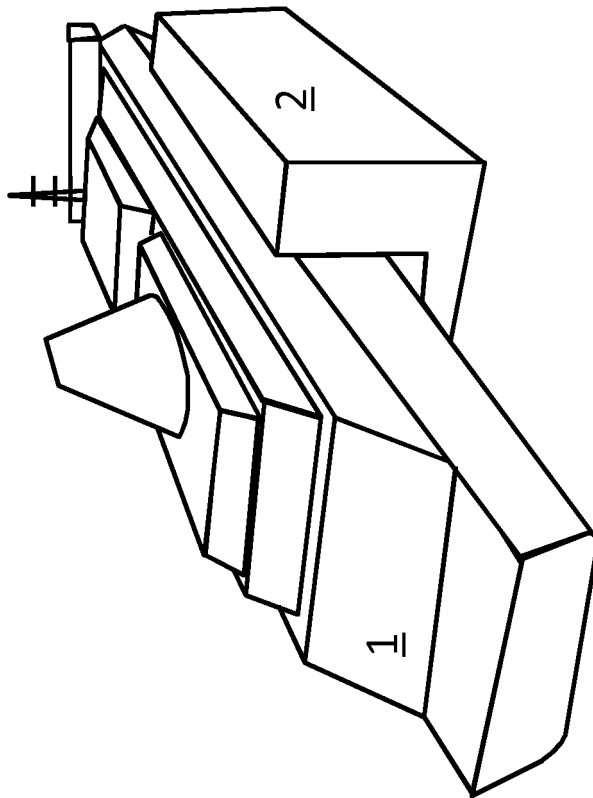


Fig. 1

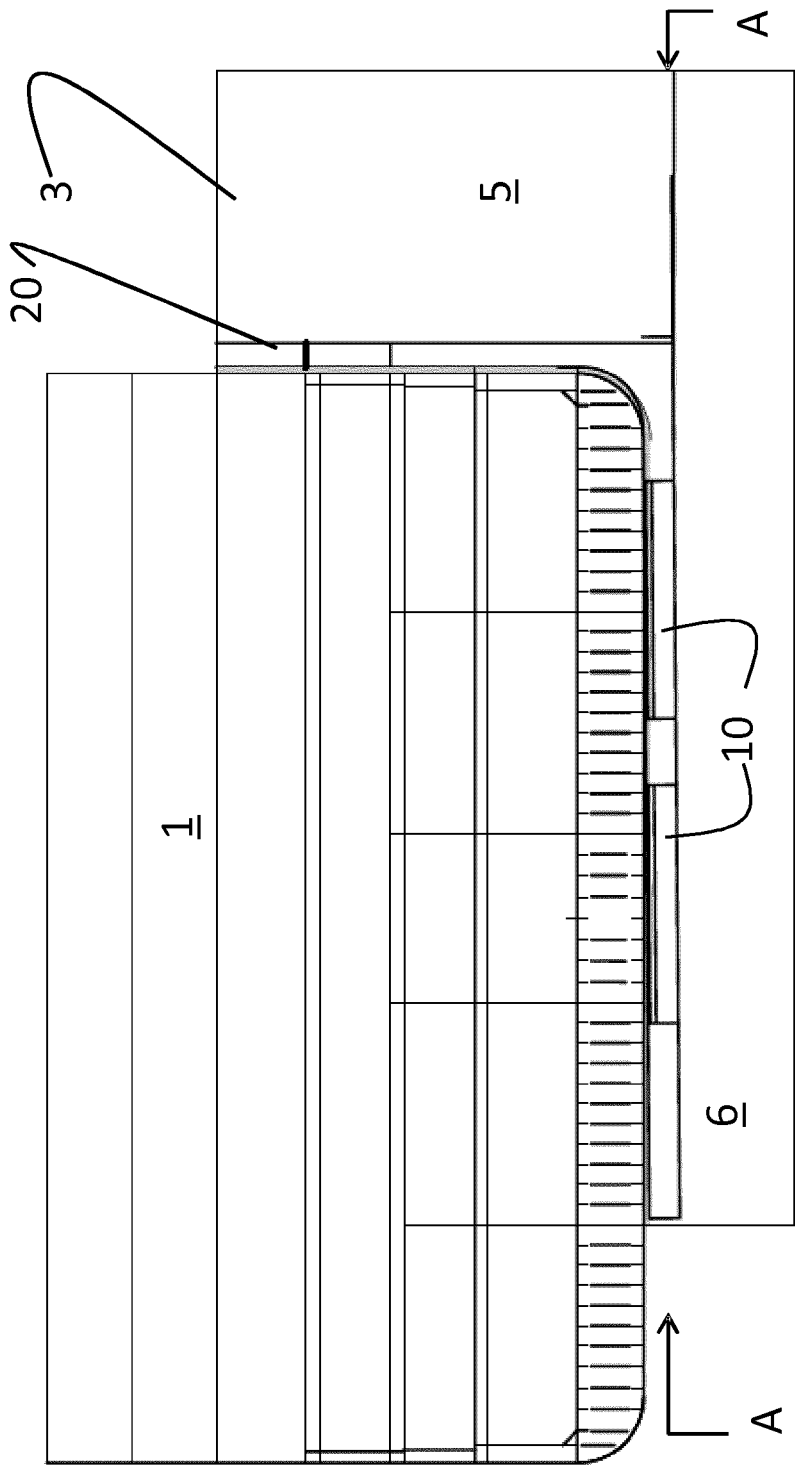


Fig. 2

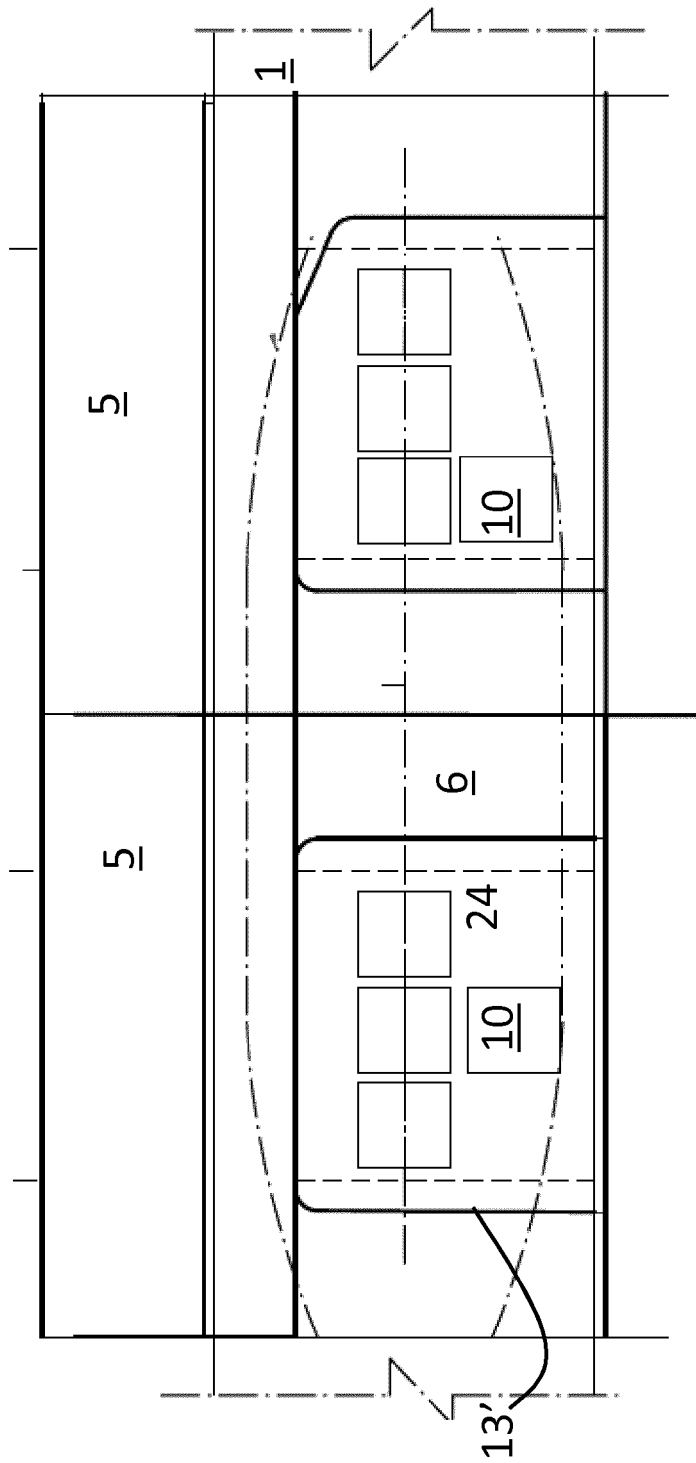
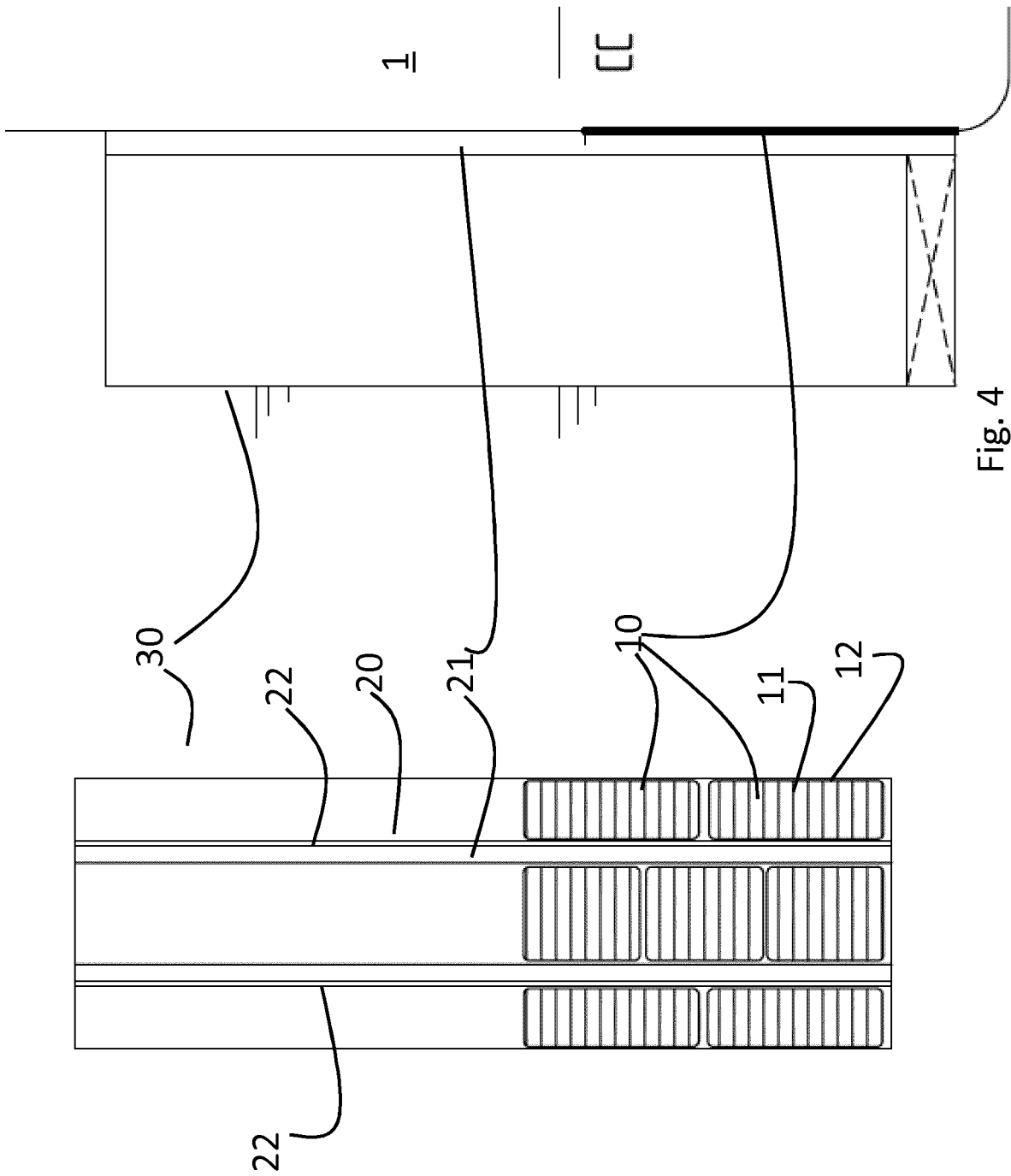


Fig. 3



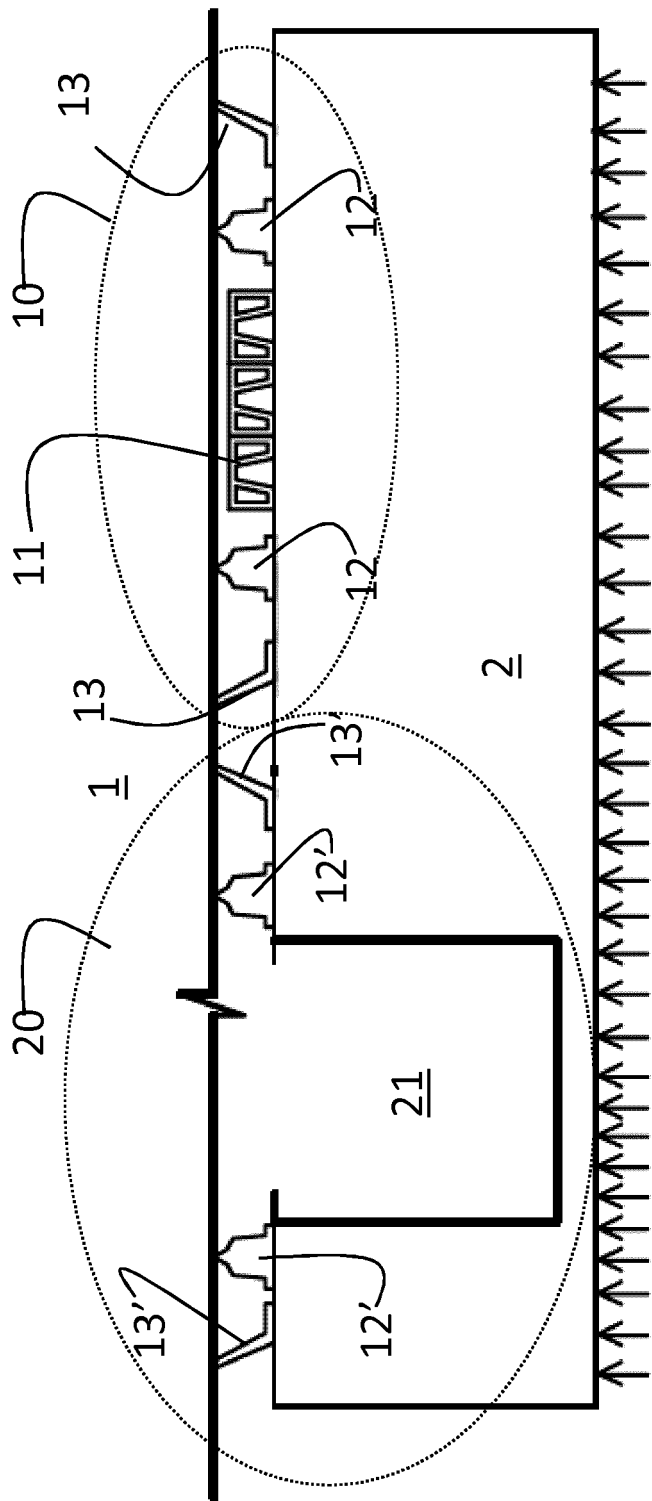


Fig. 5

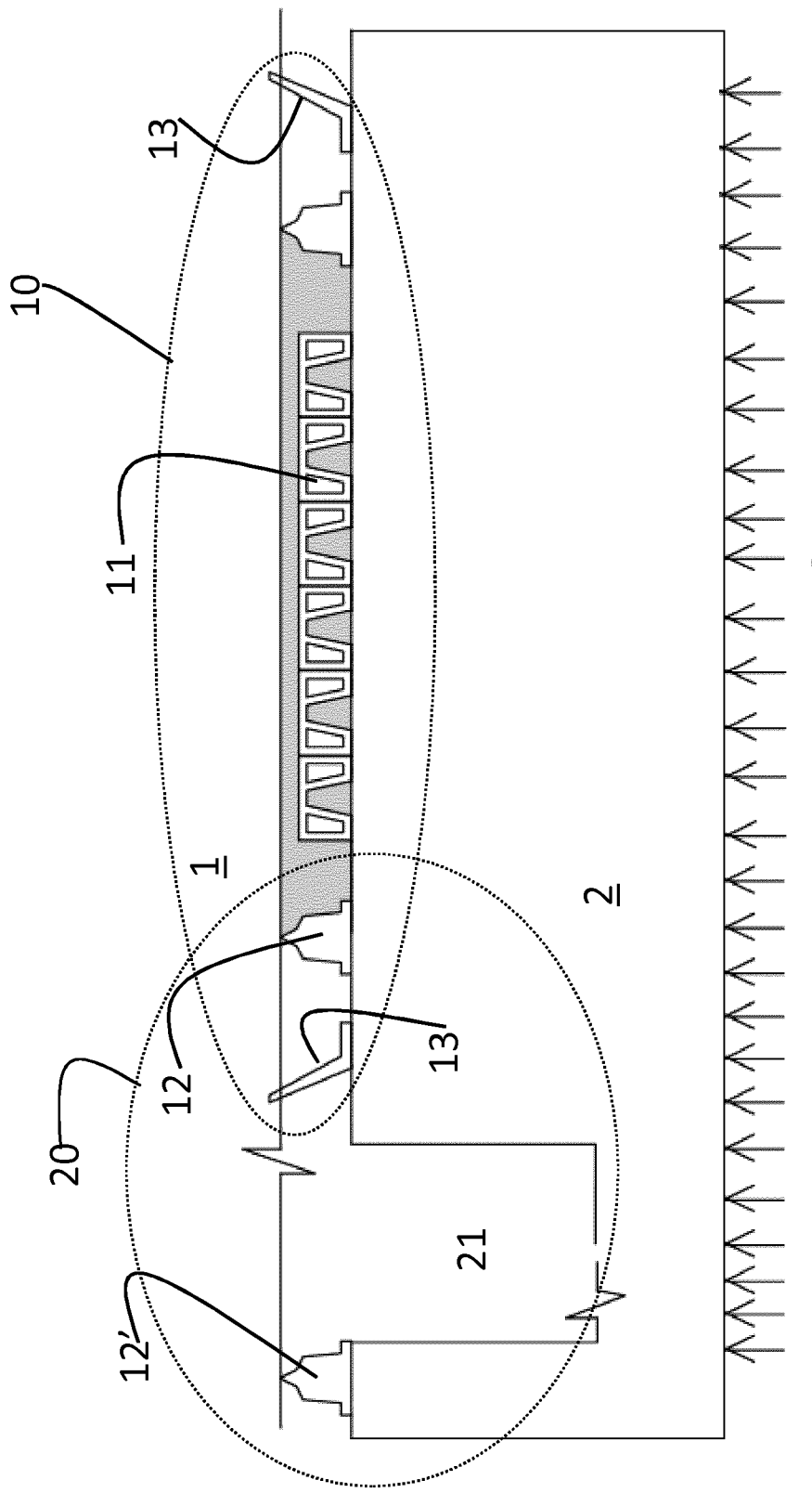


Fig. 6

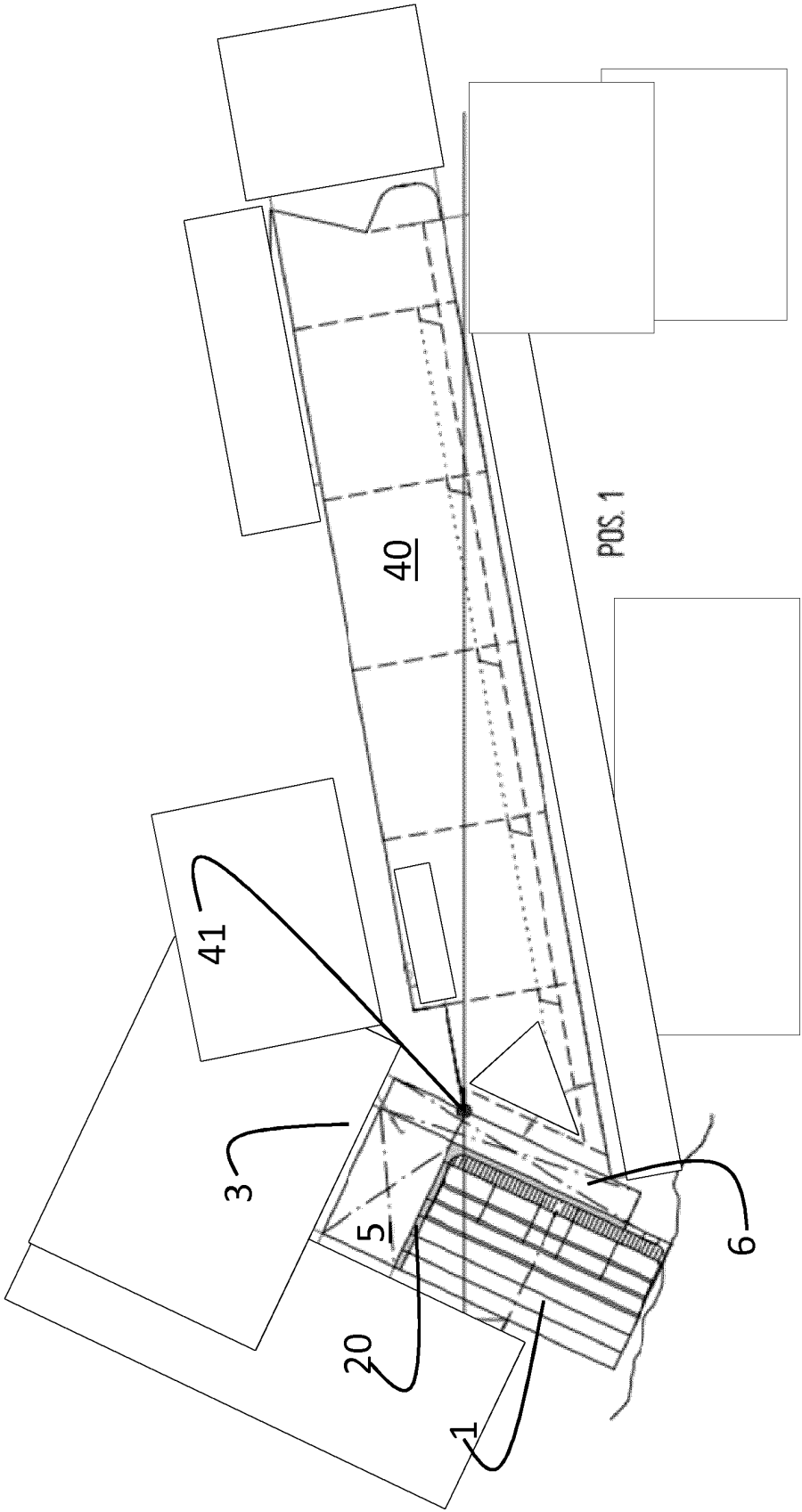
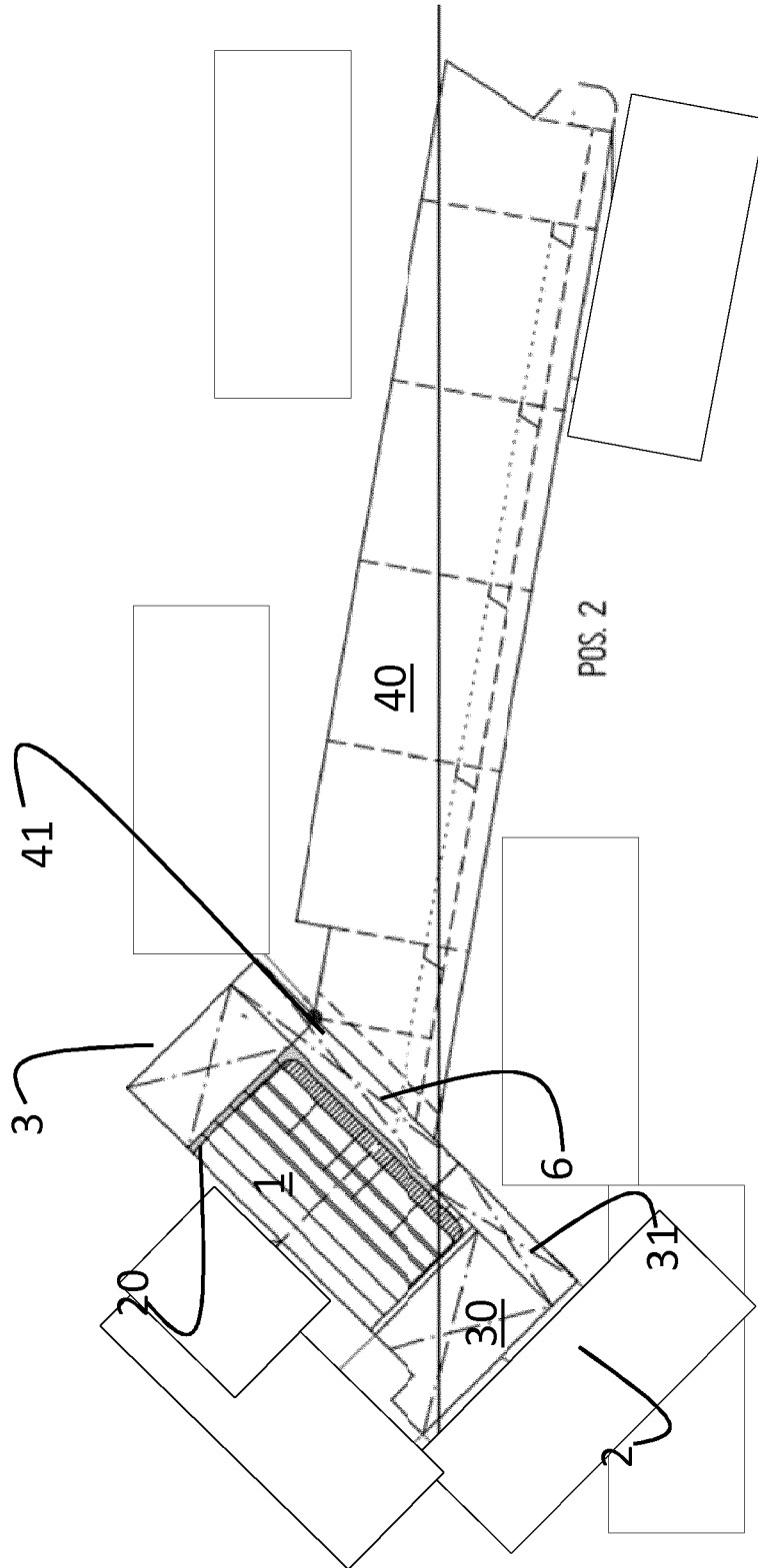
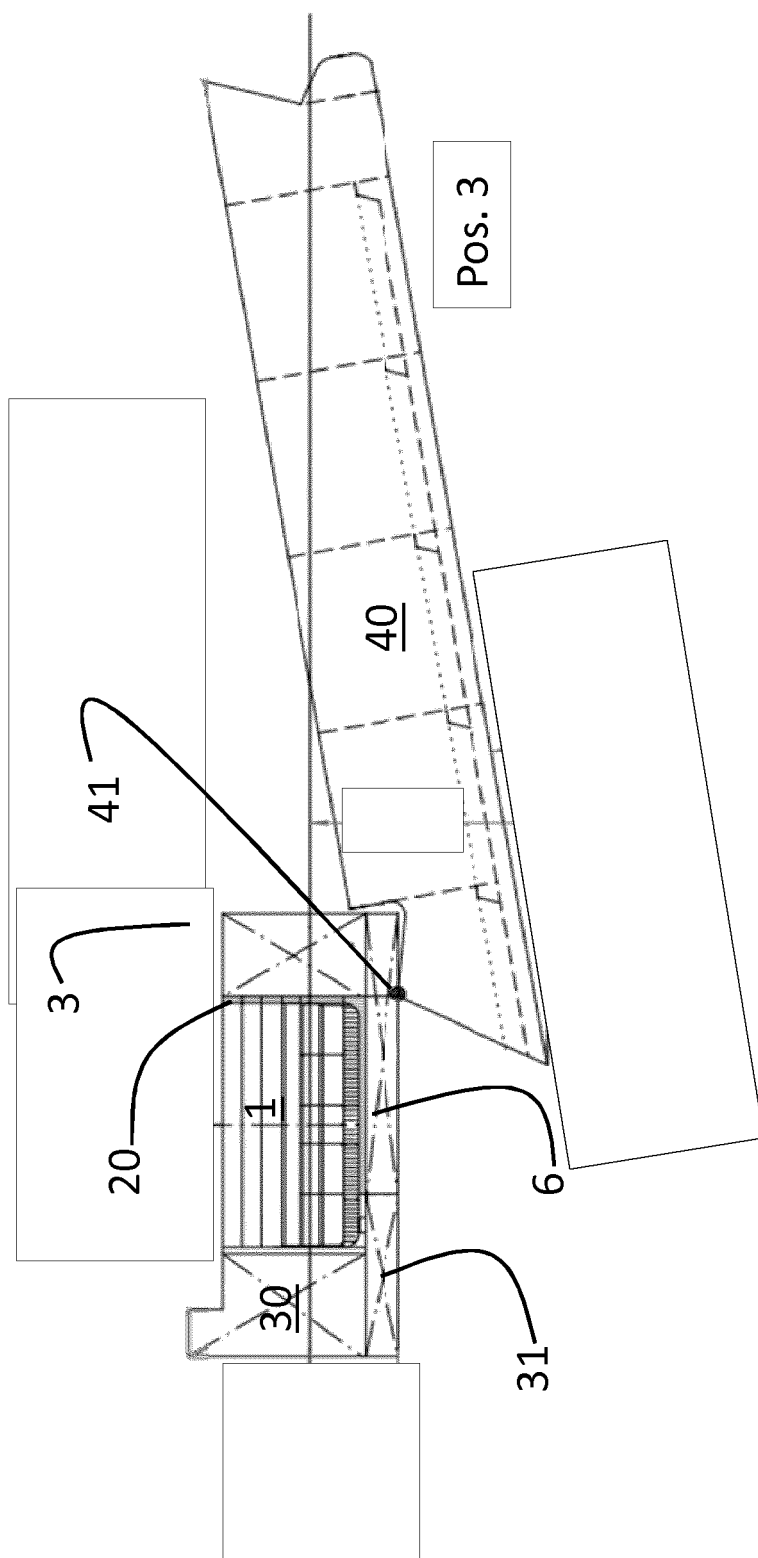


Fig. 7


$$\infty$$



Fi. 9

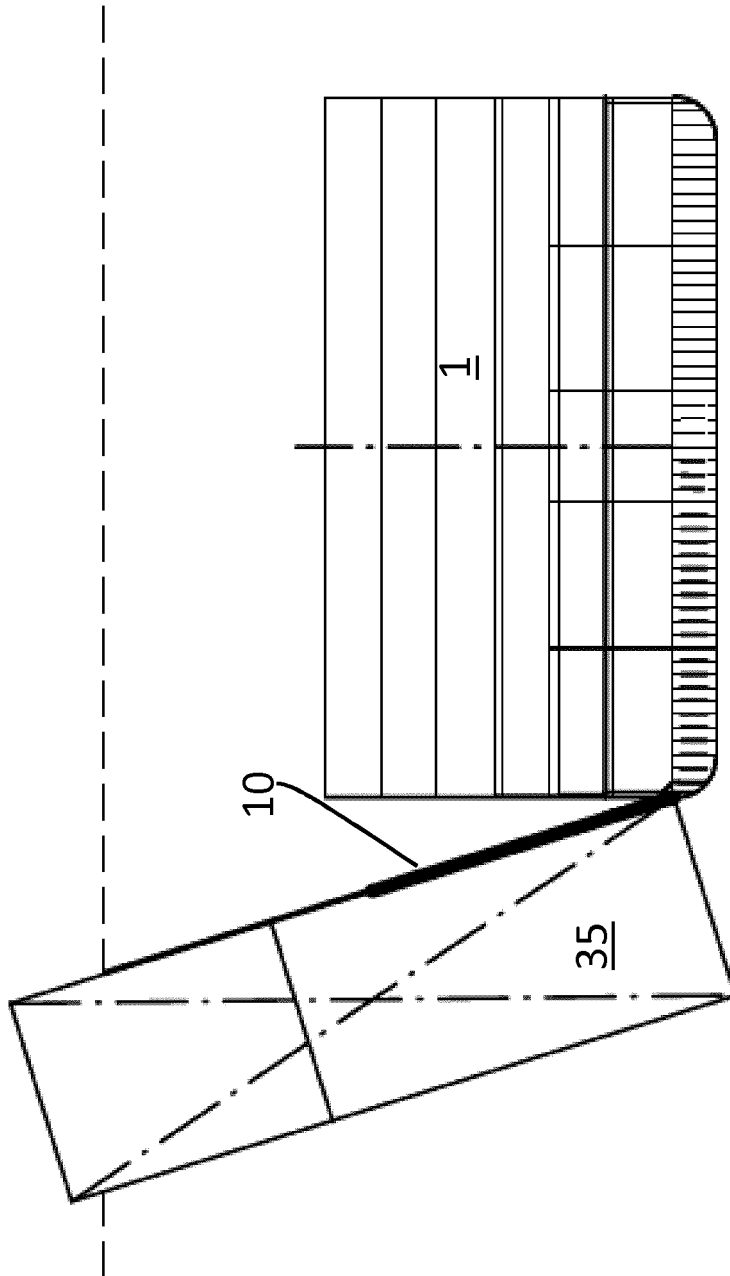


Fig. 10

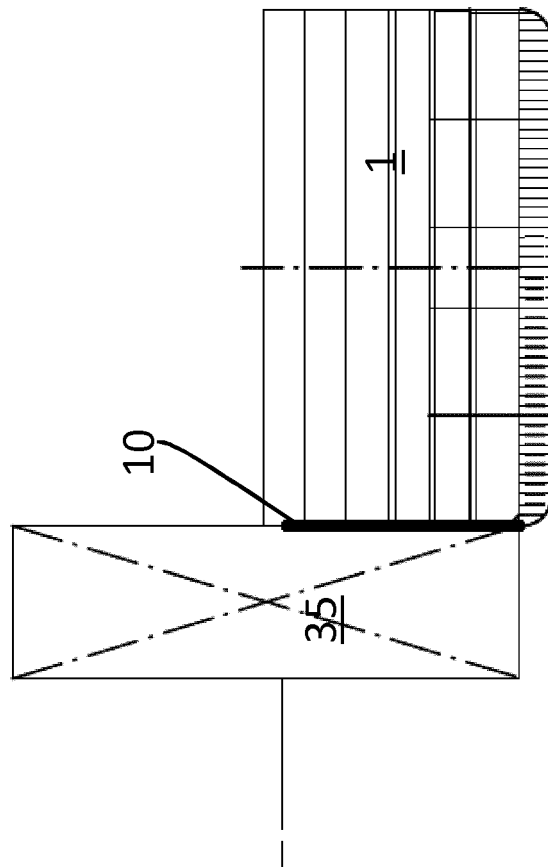


Fig. 11

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 6901977 B [0028]
- US 6701981 B [0028]