

Title: Spud carriage biasing system, spud carriage, apparatus for accommodating a working spud of a vessel, and vessel

5 The invention relates to a spud carriage biasing system for biasing a spud carriage of a vessel, for instance a dredging vessel, especially a cutter suction dredging vessel, and for absorbing at least a portion of a moment on the spud carriage.

 During use, dredging vessels are often exposed to conditions such
10 as for instance wind, waves and/or water flows, for example when they are used on unsheltered waters. Therefore, and due to the fact that dredging action can cause a vessel to move with respect to the bed or bottom of the water, a dredging vessel is normally kept substantially in place by means of a working spud inserted partly into the bed during use. Generally, the
15 working spud is accommodated in a spud carriage which is normally mounted to the hull of the vessel in a manner that it can be moved backward and forward with respect to the hull, such that the vessel can be relocated to some extent without pulling the working spud out of the bed and relocating said spud. Hence, dredging action can for example start when
20 the working spud is placed partly in the bed and the spud carriage is temporarily fixed in its front working position. After a while, the vessel may be moved forwardly, e.g. by pushing the spud carriage rearwardly, and the spud carriage may then be temporarily fixed in a second working position, such that dredging work can be performed at a bed or bottom area located
25 further forward than the initial working area. Since relatively large forces can be exerted on a fixing coupling between the spud carriage and the vessel, the spud carriage is during use normally not rigidly fixed in its working position in which it is fixed temporarily. Normally, the spud carriage is mounted in such a manner that it can rotate to some extent
30 around a substantially horizontal axis, which axis extends substantially transverse to the longitudinal direction of the vessel and/or the direction in

which the spud carriage can be moved forward and rearward. Hence, the vessel can pitch to some extent around said horizontal axis. Further, the vessel can have a spud carriage biasing system for biasing the spud carriage in a neutral position and for absorbing at least a portion of a moment on the
5 spud carriage.

For example, European patent publication EP 1 888 849 describes a spud carriage biasing system. Said publication describes an apparatus for accommodating a substantially vertical spud of a dredging vessel with a longitudinal direction, comprising a spud carriage which is mounted for
10 limited rotation around a horizontal transverse axis, wherein a first and a second steel wire are arranged under bias between vessel and spud in the longitudinal direction for the purpose of absorbing a moment on the spud carriage, which first and second steel wires compensate each other in the non-loaded situation of the spud, and wherein the wires are connected to the
15 vessel at least partly by means of respectively a first and second hydraulic cylinder for the purpose of applying bias. Said European patent publication EP 1 888 849 further describes that the pistons of the first and second hydraulic cylinder are provided with a respective tensioning cylinder, and that each of said tensioning cylinders is connected to a respective co-acting
20 accumulator in order to work as a spring tensioning means for the respective steel wire, thereby counteracting that a respective wire becomes slack when said wire loses tension due to pitching, or so-called tilting, of the vessel, while the other wire tensions.

A disadvantage of such conventional spud carriage biasing system
25 may be formed by the tensioning cylinders provided in the pistons of the hydraulic cylinders. For example, such an arrangement, including a cylinder within a cylinder, can be relatively vulnerable, relatively difficult to maintain, and/or relatively complex.

An object of the present disclosure is to provide an alternative
30 spud carriage biasing system. It is an alternative object of the present

invention to alleviate or solve at least one disadvantage of prior art systems. In embodiments, the invention aims at providing a spud carriage biasing system which is relatively invulnerable, relatively easily to maintain, and/or of relatively simple or uncluttered design. In particular, the invention may
5 aim at providing a spud carriage biasing system arranged for counteracting that a respective wire – of two wires compensating each other in a non-loaded situation of the spud – becomes slack when said wire loses tension due to pitching of the vessel, while another wire tensions, preferably without providing pistons of hydraulic cylinders of the system with
10 tensioning cylinders within said hydraulic cylinders.

In a first aspect of the present disclosure, the disclosure provides for a spud carriage biasing system for biasing a spud carriage of a vessel in a position in which the spud carriage accommodates a working spud of the vessel in a substantially vertical direction and for absorbing at least a
15 portion of a moment on the spud carriage, comprising: a first hydraulic tensioning cylinder; a first low pressure tensioning accumulator in fluid communication with a first pressure chamber comprised in the first cylinder; a second hydraulic tensioning cylinder; and a second low pressure tensioning accumulator in fluid communication with a second pressure
20 chamber comprised in the second cylinder; wherein the biasing system further comprises two sets of two connected hydraulic cylinders, the first set comprising a third hydraulic cylinder and a fourth hydraulic cylinder, wherein a piston rod of the third hydraulic cylinder is connected with a piston rod of the fourth hydraulic cylinder, the second set comprising a fifth
25 hydraulic cylinder and a sixth hydraulic cylinder, wherein a piston rod of the fifth hydraulic cylinder is connected with a piston rod of the sixth hydraulic cylinder, wherein a third pressure chamber, which is part of the third hydraulic tensioning cylinder, and a fifth pressure chamber, which is part of the fifth cylinder are in fluid communication with the first pressure
30 chamber, which is part of the first cylinder, and wherein a fourth pressure

chamber, which is part of the fourth cylinder and a sixth pressure chamber, which is part of the sixth cylinder are in fluid communication with the second pressure chamber, which is part of the second cylinder, wherein the third cylinder comprises a seventh pressure chamber provided with a pressure fluid for biasing a piston of the third cylinder toward the third pressure chamber, and wherein the sixth cylinder comprises a eighth pressure chamber provided with a pressure fluid for biasing a piston of the sixth cylinder toward the sixth pressure chamber.

By providing the arrangement with the two sets of two connected hydraulic cylinders, pressure fluid can be pushed from the fourth pressure chamber toward the second pressure chamber when the coupled piston rods of the third and fourth hydraulic cylinder moves as a result of pressure fluid of the first cylinder being pushed into the third cylinder when the pressure in the fluidly interconnected first and third pressure chambers exceeds the initial counter pressure of the pressure fluid provided in the seventh pressure chamber due to an increased pressure which a first wire is exerting onto the piston of the first cylinder. As a result of the pressure fluid which is pushed from the fourth pressure chamber toward the second pressure chamber, the second cylinder can then exert additional pressure to a wire connected to said second cylinder. Hence, the arrangement with the two sets of two connected hydraulic cylinders may not only counteract that the pressure in the pressure chamber of the first cylinder, and thus the pressure in a connected first wire, will exceed a certain value when the vessel pitches to a relatively large extent with respect to its working spud, but will also counteract that the second wire becomes slack, because said arrangement also counteracts that the pressure in the pressure chamber of the second chamber will drop too low. Hence, the spud carriage biasing system having said arrangement with the two sets of two connected hydraulic cylinders can provide that a respective wire becomes slack when said wire loses tension due to pitching of the vessel, while another wire – of two wires

compensating each other in a non-loaded situation of the spud – tensions, without providing tensioning cylinders within the pistons of the first and second hydraulic cylinders of the system.

In embodiments, the pressure fluid of the seventh and/or eighth
5 pressure chamber can be formed by a substantially compressible fluid, e.g. a gas or gas mixture.

However, in preferred embodiments, the pressure fluid of the seventh and/or eighth pressure chamber may be a substantially non-compressible hydraulic fluid, especially oil. The system can then be
10 arranged to allow the fluid of the seventh pressure chamber to be pressed out of the seventh pressure chamber at least partly when the pressure in the third pressure chamber reaches a predetermined upper threshold value. Further, the system can be arranged to push at least part of said fluid back into the seventh pressure chamber when the pressure in the third pressure
15 chamber drops below said upper threshold value. Additionally, or alternatively, the system can further be arranged to allow the fluid of the eighth pressure chamber to be pressed out of the eighth pressure chamber at least partly when the pressure in the sixth pressure chamber reaches a predetermined upper threshold value, wherein said system can further be
20 arranged to push at least part of said fluid back into the eighth pressure chamber when the pressure in the sixth pressure chamber drops below said upper threshold value. As a result, the system may be arranged to bring the piston of the third cylinder or the piston of the sixth cylinder, respectively, back toward its respective initial position, while it pushes pressure fluid out
25 of the third or sixth pressure chamber toward the first or second pressure chamber, respectively, when the pressure in said first or second pressure chamber, respectively, drops due to the vessel pitching back toward its initial substantially horizontal position.

In preferred embodiments, the seventh and/or eighth pressure
30 chambers can be in fluid communication with a respective high pressure

limitation accumulator or said pressure chambers can both be in fluid communication with a shared high pressure limitation accumulator, especially one or multiple compressed gas accumulators or so-called hydro-pneumatic accumulators. By providing a high pressure limitation
5 accumulator, a substantially passive system may be provided which does not need to be actively controlled, which system may therefore be relatively simple and/or reliable.

Advantageously, the seventh pressure chamber can be in fluid connection with the eighth pressure chamber, such that the seventh and
10 eighth pressure chamber can then thus be in fluid communication with the same high pressure limitation accumulator. As a result, the system can be relatively simple and/or can be balanced relatively easily because the counter pressure provided to the pressure fluid in the fourth and fifth pressure chamber, respectively, can be practically the same. By connecting
15 the first high pressure limitation accumulator and/or a further high pressure limitation accumulator to a respective pump, the system can be arranged to adjust the counter pressure provided by the pressure fluid in the seventh and/or eighth pressure chamber in a relatively easy manner.

The present disclosure also relates to a spud carriage for
20 accommodating a working spud.

Further, the disclosure relates to an apparatus for accommodating a working spud of a vessel, such as a dredging vessel.

The disclosure also relates to a vessel, preferably a dredging vessel, especially a cutter suction dredging vessel.

25 Advantageous embodiments of the disclosure and the invention are described below and in the appended claims.

By way of non-limiting examples only, embodiments of the present invention will now be described with reference to the accompanying figures in which:

Figure 1a shows a schematic side view of an embodiment of a vessel according to an aspect of the invention;

Figure 1b shows a schematic top view of the dredging vessel shown in Figure 1a;

5 Figure 2 shows a schematic view of a wire system for biasing a spud carriage;

Figure 3 shows a schematic view of an embodiment of a spud carriage biasing system according to an aspect of the invention in a first position;

10 Figure 4 shows a schematic view of the spud carriage biasing system of Figure 3 in a second position; and

Figure 5 shows a schematic view of the spud carriage biasing system of Figures 3 and 4 in a third position.

15 The embodiments disclosed herein are shown as examples only and should by no means be understood as limiting the scope of the claimed invention in any way. In this description the same or similar elements have the same or similar reference signs.

20 Figures 1a and 1b show schematic side and top views of an embodiment of a vessel 100, e.g. a ship, boat or pontoon, according to an aspect of the invention. For instance, the vessel can be a dredging vessel 100, especially a cutter suction dredging vessel provided with a cutter suction head 101.

25 During dredging action, the vessel 100 may be kept substantially in place by means of a working spud 3, which can be lowered partly into a so-called bed 102, such as a seabed or riverbed. The working spud 3 can be accommodated in a spud carriage 2. Preferably, the carriage 2 may be mounted to the hull 103 of the vessel 100 in a manner that it can be moved with respect to the hull, preferably moved backward and forward with respect to the hull 103. For instance, the spud carriage 2 and/or the hull 103
30 can therefore be provided with guiding means, preferably corresponding

guiding means, such as for example slide shoes or wheels guided through or along a corresponding rail or guide beam. Additionally or alternatively, one or more driving means 8, such as one or more driving cylinder 8, for moving the spud carriage 2 with respect to the hull, preferably in a substantially horizontal direction, may be provided, such as for instance can be seen in Figure 2.

The vessel can be relocated to some extent by relocating the spud carriage with respect to the hull, and thus without pulling the working spud 3 out of the bed 102 and relocating said spud 3 with respect to the bed before starting dredging action at an adjacent working location. For example, dredging action can start when the working spud 3 is inserted in the bed 102 and the spud carriage 2 is temporarily fixed in its front working position 2a as shown in Figs. 1a and 1b. For example when dredging action is finished at the first working location, the vessel can be moved forward, e.g. by pushing the spud carriage 2 rearward with respect to the hull 103. Subsequently, the spud carriage 2 may be temporarily fixed in a second working position 2b, as is shown in Fig. 1b by means of a dotted line, such that dredging work can be performed at a bed or bottom area 104b located further forward than the initial working area 104a.

Further, the vessel 100 may be provided with an auxiliary spud 105, which can be inserted partly into the bed before hoisting the working spud 3. Subsequently, the spud carriage 2 may be moved from a rearmost working position 2c back to its initial or front working position 2a in which it can be temporarily fixed, at least in the longitudinal direction 106 of the vessel 100, and in which position of the carriage 2 the working spud 3 can be inserted into the bed 102. Subsequently, the auxiliary spud 105 can be hoisted before moving the vessel 100 further forward by pushing the spud carriage 2 rearward.

When the spud carriage 2 is temporarily fixed in a respective working position 2a, 2b, 2c, it is not rigidly fixed, but is fixed in a manner in

which it can at least move to some extent around a rotation axis 108 extending substantially transverse to a substantially vertical direction in which the working spud 3 extends during use and substantially transverse to a direction 107 in which the spud carriage 2 can be moved with respect to the hull 103 when it is not fixed, which direction of movement 107 may be substantially parallel and/or in line with the longitudinal direction 106 of the vessel 100. As a result, the vessel can pitch to some extent around said axis 108, without skewing the working spud 3 placed in the bed 102 or at least while counteracting that the working spud 3 skews.

Figure 2 shows a schematic view of a wire system 5 for biasing the spud carriage 2. Said system 5 and/or the spud carriage 2 may be provided at the vessel 100 of Figs. 1a and 1b. Here in Fig. 2, only one wire system 5 is shown, but in preferred embodiments, the spud carriage 2 may be provided with at least two of such wire systems 5, e.g. one located at a starboard side and one provided at a port side of the spud carriage 2.

For example, as shown in Figure 2, the wire system 5 may comprise a first wire 6 and a second wire 7, which wires may compensate each other in a neutral or non-loaded situation of the spud carriage 2, which situation may correspond with a substantially vertical position of the working spud 3 and/or the spud carriage 2 accommodating it.

The first wire 6 may be attached with a first end portion 6a to the vessel at a position located at the rearward side of the spud carriage 2 and may extend, e.g. at least partly laterally and/or substantially horizontally, toward a first wire guide 71, e.g. a wire guiding wheel, attached to the spud carriage 2. Said first wire 6 may then be guided around said guide 71 and extend, e.g. at least partly laterally and/or substantially horizontally, toward at least one second wire guide 72 located at the vessel 100 behind the spud carriage 2. Subsequently, said first wire 6 may be guided around the second guide 72 and extends – for instance via an intermediate wire guide 73a – toward a third wire guide 73b attached to the vessel at a

location in front of the spud carriage 2. The first wire can be guided around said third wire guide 73b and can extend backward toward a fourth wire guide 74 attached to the spud carriage 2, for instance in a substantially horizontal manner. The first wire can then be guided around said fourth
5 guide 74 and can be attached with a second end portion 6b to the vessel 100 at a position located at the front side of the spud carriage 2. The second wire 7 may be provided in a substantially mirrored manner. For example, the second wire 7 may be attached with a first end portion 7a to the vessel at a position located at the front side of the spud carriage 2 and may extend, e.g.
10 at least partly laterally and/or substantially horizontally, toward a fifth wire guide 75 attached to the spud carriage 2. Said second wire 7 may then be guided around said guide 75 and extend, e.g. at least partly laterally and/or substantially horizontally, toward at least one sixth wire guide 76 located at the vessel 100 in front of the spud carriage 2. Subsequently, said
15 second wire 7 can be guided around the sixth guide 76 and extends – for instance via an intermediate wire guide 77a – toward a seventh wire guide 77b attached to the vessel at a location behind the spud carriage 2. The second wire 7 can be guided around said seventh wire guide 77b and can extend backward toward an eighth wire guide 78 attached to the spud
20 carriage 2, for instance in a substantially horizontal manner. The second wire 7 can then be guided around said eighth guide 78 and can be attached with a second end portion 7b to the vessel 100 at a position located at the rear side of the spud carriage 2.

For example, wire guides can be formed by guiding discs,
25 preferably rotatably mounted guiding discs. In embodiments, such as for instance shown in Fig. 2, the first and fifth wire guide 71, 75 may be integrated, e.g. being integrated into a double guiding disc 71, 75, and/or may be provided at a single rotation axis. Additionally or alternatively, the fourth and eighth wire guide 74, 78 may be integrated, e.g. being integrated

into a double guiding disc 74, 78, and/or may be provided at a single rotation axis.

Preferably, the wires 6, 7 can be steel wires and/or may be stretchable to some extent, e.g. by providing them with an integrated spring element. Hence, by stretching, the respective wire 6, 7 can absorb at least a part of a moment the vessel 100 is exerting on the spud carriage.

During use, the working spud 3 and the carriage 2 housing it may tend to tilt with respect to the longitudinal direction 106 of the vessel 100, e.g. due to waves, wind and/or dredging action. For example, if the front side of the vessel tends to pitch or tilt upwardly, the carriage 2 tends to tilt around its rotation axis 108 with respect to the vessel 100 in a clockwork motion when seen from the right side or so-called port side of the vessel 100, as shown in Fig. 2. On the other hand, as can be understood when observing Fig. 2, the first guide 71 will then tend to move away from the second guide 72, and the fourth guide 74 will tend to move away from the third wire guide 73b. Hence, the first wire 6 will tend to stretch. On the other hand, the fifth guide 75 will then tend to move toward the sixth guide 76, and the eighth guide 78 will tend to move toward the seventh wire guide 77b. Hence, the second wire 7 will tend to slack. It will be apparent that in case the spud carriage 2 will tend to tilt the other direction, the first wire 6 will tend to slack and the second wire 7 will tend to stretch.

In an aspect, the present disclosure also relates to a spud carriage biasing system 1 suitable for holding the wires 6, 7 under bias and/or for limiting tension in the respective wire, preferably by moving at least one 72, 76 of the wire guides in order to reduce the length of the path along which the respective wire 6, 7 extends, when said path length tends to increase due to tilting of the spud carriage 2 with respect to the vessel's hull 103.

As can be seen in Fig. 2, the wires 6, 7 may be held under bias by means of respectively a first and second hydraulic tensioning cylinder 10, 20. The first cylinder 10, preferably its piston rod 13, may engage a first

tensioning guide 72, which can be the second wire guide 72, which is associated with the first wire 6. The second cylinder 20, preferably its piston 23, may engage a second tensioning guide 76, which can be the sixth wire guide 76, which sixth guide 76 is associated with the second wire 7. For
5 example, distal ends of the first and second piston rod 13, 23 may extend from the cylinder head of the respective cylinder and may be connected to and/or being arranged to be connected to respectively the first and the second tensioning guide 72, 76 around which the respective first and second
10 biasing wire 6, 7 can be guided during use.

Here, the first and second cylinders 10, 20 are located between the respective guide and the spud carriage, and may thus be arranged to bias the guides in an outward direction away from the spud carriage 2, by means of a pressure fluid provided in a pressure chamber 11, 21 located at a cylinder base side of the respective cylinder 10, 20. However, in alternative
15 embodiments, the cylinders 10, 20 may be directed substantially oppositely, i.e. with a distal end engaging the respective guide 72, 76 pointing toward the spud carriage 2. In that case, the cylinders 10, 20 may for instance be arranged to bias the respective guides 72, 76 in an outward direction by pulling the piston rods 13, 23 into the cylinder barrels.

Figures 3-5 show schematic views of an embodiment of a spud carriage biasing system 1 according to an aspect of the invention in three different positions. The spud carriage biasing system 1 may be arranged for biasing a spud carriage 2 of a vessel 100 in a position in which the spud carriage 2 accommodates a working spud 3 of the vessel 100 in a
20 substantially vertical direction and/or for absorbing at least a portion of a moment which during use may be working on the spud carriage 2. Said spud carriage biasing system 1 comprises a first hydraulic tensioning cylinder 10 having a first pressure chamber 11 in fluid communication with a first low pressure tensioning accumulator 15 and a second hydraulic tensioning
25

cylinder 20 having a second pressure chamber 21 in fluid communication with a second low pressure tensioning accumulator 25.

Preferably, said first pressure chamber 11 may be located at the cylinder base side of the first hydraulic tensioning cylinder 10, e.g. in case
5 when the first tensioning guide 72, e.g. formed by the second wire guide 72, is biased in an outward direction with respect to the spud carriage 2.

Besides, said second pressure chamber 21 may be located at the cylinder base side of the second hydraulic tensioning cylinder 20 e.g. in case when the second tension guide 76, e.g. being formed by the sixth wire guide 76, is
10 biased in an outward direction with respect to the spud carriage 2.

It is noted that the pressure fluid in the first and second pressure chambers 11, 21 and in the connected first and second low pressure tensioning accumulators 15, 25, respectively, may be a substantially non-compressible hydraulic fluid, preferably oil.

15 The spud carriage biasing system 1 further comprises two sets of two connected hydraulic cylinders 30, 40; 50, 60. The first set 30, 40 comprises a third hydraulic cylinder 30 and a fourth hydraulic cylinder 40, wherein a piston rod 33 of the third hydraulic cylinder 30 is connected with a piston rod 43 of the fourth hydraulic cylinder 40. The second set 50, 60
20 comprises a fifth hydraulic cylinder 50 and a sixth hydraulic cylinder 60, wherein a piston rod 53 of the fifth hydraulic cylinder 50 is connected with a piston rod 63 of the sixth hydraulic cylinder 60. The respective piston rods may be connected in such a way that when the piston of one cylinder moves in a direction from the cylinder base side toward the cylinder head side of
25 said cylinder, the piston of a connected or so-called coupled cylinder moves in a direction from the cylinder head side toward the cylinder base side of said coupled cylinder. Preferably, the respective piston rods 33, 43; 53, 63 and/or pistons can be rigidly coupled together, e.g. by integrating the third and fourth piston rod 33, 43 and/or by integrating the fifth and sixth piston
30 rod 53, 63.

Further, a third pressure chamber 31, which is part of the third hydraulic tensioning cylinder 30, and a fifth pressure chamber 51, which is part of the fifth cylinder 50 are in fluid communication with the first pressure chamber 11, which is part of the first cylinder 10. Additionally, a
5 fourth pressure chamber 41, which is part of the fourth cylinder 40 and a sixth pressure chamber 61, which is part of the sixth cylinder 60 are in fluid communication with the second pressure chamber 21, which is part of the second cylinder 20. Furthermore, the third cylinder 30 comprises a seventh pressure chamber 32 provided with a pressure fluid for biasing a piston 34
10 of the third cylinder 30 toward the third pressure chamber 31, and the sixth cylinder 60 comprises a eighth pressure chamber 62 provided with a pressure fluid for biasing a piston 64 of the sixth cylinder 60 toward the sixth pressure chamber 61.

In embodiments, the fluid of the seventh pressure chamber 32
15 and/or the fluid of the eighth pressure chamber 62 is formed by a substantially compressible fluid, e.g. a gas or gas mixture. However, in preferred embodiments the fluid of the seventh and eighth pressure chamber is formed by a substantially non-compressible hydraulic fluid, e.g. oil.

Advantageously, especially in case when the fluid of the seventh
20 pressure chamber 32 is formed by a substantially non-compressible hydraulic fluid such as oil, the spud carriage biasing system 1 can further be arranged to allow the fluid of the seventh pressure chamber 32 to be pressed out of the seventh pressure chamber 32 at least partly when the pressure in the third pressure chamber 31 reaches a predetermined upper threshold
25 value, and can also be arranged to push at least part of said fluid back into the seventh pressure chamber 32 when the pressure in the third pressure chamber 31 drops below said upper threshold value. For example thereto, the seventh pressure chamber 32 can be in fluid communication with a high pressure limitation accumulator 80. However, in alternative embodiments,
30 the system 1 may comprise alternative means for allowing fluid to be

pressed out of and into the seventh pressure chamber 32. For example, the seventh pressure chamber 32 may be in fluid communication with a catching reservoir for catching fluid pressed out of the seventh pressure chamber 32, preferably through a pressure relief valve, and the system may
5 further comprises a pump for pumping fluid back from said catching reservoir toward the seventh pressure chamber, e.g. when the pressure in the third pressure chamber 31 drops below said upper threshold value.

Additionally or alternatively, especially in case when the fluid of the eighth pressure chamber 62 is formed by a substantially
10 non-compressible hydraulic fluid such as oil, the spud carriage biasing system 1 may further be arranged to allow the fluid of the eighth pressure chamber 62 to be pressed out of the eighth pressure chamber at least partly when the pressure in the sixth pressure chamber 61 reaches a predetermined upper threshold value, and may be arranged to push at least
15 part of said fluid back into the eighth pressure chamber 62 when the pressure in the sixth pressure chamber 61 drops below said upper threshold value. For example thereto, the eighth pressure chamber 62 can be in fluid communication with said high pressure limitation accumulator 80 and/or in fluid communication with a further high pressure limitation accumulator.
20 However, in alternative embodiments, the system 1 may comprise alternative means for allowing fluid to be pressed out of and into the eighth pressure chamber 62. For instance, the eighth pressure chamber 62 may be in fluid communication with the catching reservoir for catching fluid of the seventh pressure chamber or in fluid communication with a further catching
25 reservoir, the respective reservoir can be arranged for catching fluid pressed out of the eighth pressure chamber, and the system 1 can further be arranged such that said pump of the first reservoir or a further pump associated with the further catching reservoir can pump fluid back from the respective catching reservoir toward the eighth pressure chamber 62, e.g.

when the pressure in the sixth pressure chamber 61 drops below said upper threshold value.

In embodiments, such as for instance in the exemplary embodiment of Figs. 3, 4 and 5, the seventh pressure chamber 32 can be in fluid connection with the eighth pressure chamber 62, and the seventh and eighth pressure chamber can thus be in fluid communication with the same high pressure limitation accumulator 80. Hence, the counter pressures provided by the fluid in the seventh and eight pressure chamber can be substantially equally.

Preferably, the high pressure limitation accumulator 80 and/or the further high pressure limitation accumulator, and/or the first and/or second low pressure tensioning accumulators 15, 25 can be formed by a compressed gas accumulator, or a so-called hydro-pneumatic accumulator. In alternative embodiments, other high pressure limitation accumulators can be used. For instance, the substantially non-compressible hydraulic fluid in the third pressure chamber 31 and/or sixth pressure chamber 61 can be held under pressure by a spring or a raised weight.

Although one or more compressed gas accumulators may preferably be formed by a respective membrane accumulator, one or more compressed gas accumulators may alternatively be formed by a piston accumulator.

As shown in the exemplary embodiment of Figs. 3-5, the gas volume of the high pressure limitation accumulator 80 may be increased by coupling it to a gas reservoir 81, e.g. formed by one or more gas bottles 81. It is apparent that one or both low pressure accumulators may alternatively or additionally be coupled to a respective gas reservoir.

Advantageously, the first high pressure limitation accumulator 80 and/or the further high pressure limitation accumulator 80 can be connected to one or more pumps 82. As a result, the counter pressure provided by the gas side of the respective high pressure limitation accumulator 80 may be

adjusted. It is apparent that one or both low pressure accumulators may alternatively or additionally also be coupled to a respective pump for setting or adjusting the system.

Preferably, a neutral or so-called non-loaded situation of the wire system 5 of the spud carriage 2, e.g. such as shown in Fig. 2, may correspond with a substantially vertical position of the working spud 3 and/or the spud carriage 2 accommodating it. In said non-loaded situation, the first and second wire 6, 7 of the wire system 5 may compensate each other, and/or said wires 6, 7 may be substantially equally biased, especially outwardly. Said non-loaded situation of the wire system 5 may correspond with an initial, neutral or non-loaded situation of the spud carriage biasing system 1, as shown in Fig. 3. Preferably, the high pressure limitation accumulator 80 provides for counter pressure in the seventh and eighth pressure chambers 32, 62 which is so high that the pistons 34, 64 of the corresponding third and sixth cylinder 30, 60 are pushed to their outermost positions in the initial position of the spud carriage biasing system 1, as shown in Fig. 3, wherein the pistons limit the volume of the corresponding third and sixth pressure chambers 31, 61 to their minimum in said outermost positions. Preferably, in the initial position of the biasing system 1, the first and second low pressure tensioning accumulators 15, 25 provide for a relatively low pressure, wherein said relatively low pressure is not high enough to move the respective pistons 34, 64 of the two sets of two connected hydraulic cylinders against the counter pressure provided by the fluid of the seventh and eighth pressure chamber, e.g. pressurized by means of the high pressure limitation accumulator 80, but wherein said relatively low pressure can be high enough to provide for a biasing force pre-tensioning the wires 6, 7 of the wire system 5.

During use of the spud carriage biasing system 1, the spud carriage 2 may be temporarily fixed in a working position 2a, 2b, 2c such that it can temporarily not be moved substantially forwardly or rearwardly.

As described above, the respective wire 6, 7 can be stretchable and may absorb at least a part of forces associated with a moment working on a coupling between a vessel's hull 103 and the spud carriage 2, when said spud carriage 2 tilts with respect to the hull 103 around its substantially vertical rotation axis 108. When forces working on the working spud 3 and/or working on the spud carriage 2 increase, a force the respective wire 6 exerts on the respective hydraulic tensioning cylinder 10, e.g. via a respective wire guide 72, may increase to such extent that said force becomes greater than a force exerted by the hydraulic fluid in the first pressure chamber 11 located in said first cylinder 10. As a result, as shown in Figure 4, a portion of the fluid is pushed out of said first chamber 11 toward the associated first low pressure tensioning accumulator 15, thereby absorbing at least a part of the increased forces and/or moment working on the spud carriage 2 and/or spud 3. At the same time, as described above, the other wire 7 tends to slack. When the first low pressure tensioning accumulator 15 is absorbing a part of the forces exerted on the first wire 6, the second low pressure tensioning accumulator 25 can cause that the second wire 7 is kept under enough tension by pushing additional hydraulic fluid into the second pressure chamber 21 as the tension the second wire 7 exerts on the second cylinder 20 decreases.

When the force exerted on the respective hydraulic tensioning cylinder 10 by the respective wire, e.g. the first wire 6, decreases, the pressure exerted by the respective low pressure tensioning accumulator 15 will cause that the piston of the first cylinder 12 will be moved back toward its initial position, thereby counteracting that the first wire 6 will slack or slack too much. Simultaneously, when the force exerted on the respective first tensioning cylinder 10 by the first wire 6 decreases, the force exerted by the second wire 7 on the second tensioning cylinder 20 will increase, thereby pushing the piston 24 of the second cylinder back toward its initial position. When the moment exerted on the coupling between the vessel and spud

carriage disappears, the spud carriage biasing system 1 will thus move back to its initial position as shown in Fig. 3.

On the other hand, when the force exerted on the respective hydraulic tensioning cylinder 10 by the respective wire, e.g. the first wire 6, increases further, e.g. due to an increasing moment, the pressure in the respective pressure chamber, e.g. the first pressure chamber 11, and the hydraulic fluid side of the respective low pressure tensioning accumulator 15 fluidly connected therewith increases. At a certain point, said fluid pressure exceeds the counter pressure applied by the fluid in the seventh pressure chamber 32. Then, the fluid in the third pressure chamber 21 moves the piston 34 of the third cylinder 30 toward the seventh pressure chamber 32 until the pressures in the third cylinder 30 are balanced, as can be seen in Figure 5. By moving the piston 34 of the third cylinder 30, the coupled piston 44 of the fourth cylinder moves as well, thereby increasing the fluid pressure in the fourth pressure chamber 41 and the interconnected second pressure chamber 21. As a result, the increased force exerted on the first hydraulic tensioning cylinder 10 by the first wire 6 causes the second hydraulic tensioning cylinder 20 to exert a greater force on the second wire 7, thereby counteracting that said second wire 7 can slack too much.

When the increased force exerted on the first cylinder 10 by the first wire 6 decreases, the pressure fluid in the seventh pressure chamber 32 can cause the third piston 34 to move back to at least some extent, thereby pushing fluid back from the third pressure chamber 31 toward the first pressure chamber 11, thereby causing that the first tensioning guide 72, e.g. formed by the second wire guide 72, can keep enough tension on the first wire 6. Simultaneously, the movement of the third piston 34 causes the connected piston 44 of the fourth pressure cylinder to move, thereby increasing the volume of the fourth pressure chamber and decreasing the fluid pressure in the second pressure chamber, such that can be counteracted that second tensioning guide 76, e.g. formed by the sixth wire

guide 76, tensions the second wire 7 to a too great extent. When the force exerted on the first cylinder 10 by the first wire 6 decreases even further, the interconnected pistons 34, 44 of the third and fourth cylinder can be moved back into their initial positions, as shown in Fig. 4. When said force
5 decreases further, the wires 6, 7 can mainly be tensioned by means of the first and second low pressure tensioning accumulators 15, 25 and the first and second cylinders 10, 20 connected with the respective accumulators 15, 25.

On the other hand, in case the force exerted by the first wire 6 on
10 the first hydraulic tensioning cylinder increases even further with respect to the situation shown in Figure 5, the first low pressure tensioning accumulator 15 and the high pressure limitation accumulator 80 may absorb at least a part of said additional force. It is noted that the spud carriage biasing system can advantageously comprise one or multiple safety
15 valves, which may counteract that pressures in the system 1 reaches critical values. For example, a first safety valve 16 may be provided in fluid communication with the first pressure chamber 11 and/or a second safety valve 26 in fluid communication with the second pressure chamber 21. Preferably, the respective pressure valve can be fluidly connected to a
20 storage container, e.g. in order to counteract that pressure fluid pollutes the water and/or environment.

The invention is not restricted to the embodiments described above. It will be understood that many variants are possible.

For the purpose of clarity and a concise description features are
25 described herein as part of the same or separate embodiments, however, it will be appreciated that the scope of the invention as defined by the claims may include embodiments having combinations of all or some of the features shown and/or described.

These and other embodiments will be apparent to the person skilled in the art and are considered to lie within the scope of the invention as formulated in the following claims.

Claims

1. Spud carriage biasing system (1) for biasing a spud carriage of a vessel in a position in which the spud carriage accommodates a working spud of the vessel in a substantially vertical direction and for absorbing at least a portion of a moment on the spud carriage, comprising:
- 5 a first hydraulic tensioning cylinder (10);
a first low pressure tensioning accumulator (15) in fluid communication with a first pressure chamber (11) comprised in the first cylinder (10);
a second hydraulic tensioning cylinder (20); and
10 a second low pressure tensioning accumulator (25) in fluid communication with a second pressure chamber (21) comprised in the second cylinder (20);
wherein the biasing system (1) further comprises:
two sets of two connected hydraulic cylinders (30, 40, 50, 60), the
15 first set comprising a third hydraulic cylinder (30) and a fourth hydraulic cylinder (40), wherein a piston rod (33) of the third hydraulic cylinder (30) is connected with a piston rod (43) of the fourth hydraulic cylinder (40), the second set comprising a fifth hydraulic cylinder (50) and a sixth hydraulic cylinder (60), wherein a piston rod (53) of the fifth hydraulic cylinder (50) is
20 connected with a piston rod (63) of the sixth hydraulic cylinder (60), wherein a third pressure chamber (31), which is part of the third hydraulic tensioning cylinder (30), and a fifth pressure chamber (51), which is part of the fifth cylinder (50) are in fluid communication with the first pressure chamber (11), which is part of the first cylinder (10), and wherein a fourth
25 pressure chamber (41), which is part of the fourth cylinder (40) and a sixth pressure chamber (61), which is part of the sixth cylinder (60) are in fluid communication with the second pressure chamber (21), which is part of the

- second cylinder (20), wherein the third cylinder (30) comprises a seventh pressure chamber (32) provided with a pressure fluid for biasing a piston (34) of the third cylinder (30) toward the third pressure chamber (31), and wherein the sixth cylinder (60) comprises a eighth pressure chamber (62) provided with a pressure fluid for biasing a piston (64) of the sixth cylinder (60) toward the sixth pressure chamber (61).
2. Spud carriage biasing system (1) according to claim 1, wherein the system (1) is further arranged to allow the fluid of the seventh pressure chamber (32) to be pressed out of the seventh pressure chamber (32) at least partly when the pressure in the third pressure chamber (31) reaches a predetermined upper threshold value, and wherein the system is arranged to push at least part of said fluid back into the seventh pressure chamber (32) when the pressure in the third pressure chamber (31) drops below said upper threshold value.
3. Spud carriage biasing system (1) according to claim 1 or 2, wherein the system (1) is further arranged to allow the fluid of the eighth pressure chamber (62) to be pressed out of the eighth pressure chamber at least partly when the pressure in the sixth pressure chamber (61) reaches a predetermined upper threshold value, and wherein the system (1) is arranged to push at least part of said fluid back into the eighth pressure chamber (62) when the pressure in the sixth pressure chamber (61) drops below said upper threshold value.
4. Spud carriage biasing system (1) according to any of the preceding claims, wherein the seventh pressure chamber (32) is in fluid communication with a high pressure limitation accumulator (80).
5. Spud carriage biasing system (1) according to claim 4, wherein the eighth pressure chamber (62) is in fluid communication with said high pressure limitation accumulator (80) and/or in fluid communication with a further high pressure limitation accumulator.

6. Spud carriage biasing system (1) according to claim 4 and 5,
wherein the seventh pressure chamber (32) is in fluid connection with the
eighth pressure chamber (62), and wherein the seventh and eighth pressure
chamber are thus in fluid communication with the same high pressure
5 limitation accumulator (80).
7. Spud carriage biasing system according to claim 1 or 2, wherein
the first high pressure limitation accumulator (80) and/or the further high
pressure limitation accumulator is connected to a respective pump (82).
8. Spud carriage biasing system according to any one of claims 1-3,
10 wherein the seventh pressure chamber (32) is in fluid communication with a
catching reservoir for catching fluid pressed out of the seventh pressure
chamber (32) and the system (1) further comprises a pump for pumping
fluid back from the catching reservoir toward the seventh pressure chamber
(32), and/or wherein the eighth pressure chamber (62) is in fluid
15 communication with the catching reservoir or a further catching reservoir
for catching fluid pressed out of the eighth pressure chamber (62) and the
system (1) is arranged such that said pump or a further pump can pump
fluid back from the first catching reservoir or the further catching reservoir
toward the eighth pressure chamber (62).
- 20 9. Spud carriage biasing system (1) according to any of the preceding
claims, the system comprising a first safety valve in fluid communication
with the first pressure chamber.
10. Spud carriage biasing system (1) according to any of the preceding
claims, the system comprising a second safety valve in fluid communication
25 with the second pressure chamber.
11. Spud carriage biasing system (1) according to any of the preceding
claims, wherein the first and second cylinder (10, 20) comprise respectively
a first and second piston rod (13, 23) having a distal end extending from a
cylinder head of the respective cylinder, the distal ends being connected to
30 and/or being arranged to be connected to respectively a first and a second

tensioning guide (72, 76) around which a respective first and second biasing wire (7) can be guided during use.

12. Spud carriage (2) for accommodating a working spud (3), wherein the carriage is provided with spud carriage biasing system (1) according to
5 any one of the preceding claims.

13. Spud carriage (2) according to claim 12, wherein the spud carriage is mounted to a vessel, especially a dredging vessel, in such a manner that the spud carriage can rotate to some extent around a substantially
horizontal axis, preferably wherein said axis extends substantially
10 transverse to a longitudinal direction of the vessel and/or a direction in which the spud carriage can be moved, especially forward and/or rearward, in order to move it from one working position into another working position of said spud carriage.

14. Apparatus (4) for accommodating a working spud (3) of a vessel
15 (100), such as a dredging vessel, comprising:
a spud carriage (2) for accommodating a working spud (3); and
a spud carriage biasing system (1) according to any one of
claims 1-11.

15. Vessel (100), preferably a dredging vessel, especially a cutter
20 suction dredging vessel, wherein the vessel (100) is provided with a spud carriage biasing system (1) according to any one of claims 1-11, a spud carriage(2) according to claim 12 or 13, and/or an apparatus (4) according to claim 14.