DESCRIPTION

SYSTEM AND METHOD FOR LIFTING PACKAGES

TECHNICAL FIELD OF THE INVENTION

[0001] The present invention relates to the technical field of package lifting.

[0002] More particularly, it relates to a system and a method for lifting packages in the presence of a relative movement between the lifting system and the zone where the package is located or is to be deposited, for example due to the swell.

BACKGROUND ART

[0003] Sea package lifting systems are commonly used for loading and unloading vessels, barges and offshore platforms.

[0004] In this context, a lifting machine such as a crane or a gantry is usually used, equipped with at least one cable whose end is suitable for winding onto a winch and whose other end carries the package.

[0005] In the specific field of offshore lifting, the main difficulty encountered concerns the relative speeds between the reference frame of the lifting machine and the reference frame on which the package is or must be placed.

[0006] Traditionally, winches in offshore lifting systems have high lifting speeds so that experienced crane operators can follow movements of the swell through actions of so-called heaving in and paying out the hoist line (vire and dévire in French respectively).

[0007] The package is first lifted off the deck by always giving more slack in the lifting straps, then recovering slack during a package rise phase in order to accompany natural movement of the package imposed by the swell.

[0008] To assist crane operators, there are now active swell compensation cranes that automatically compensate for relative movements between the two reference frames.

[0009] This active compensation aims to keep the cables taut at all times so as to avoid a slack take-up shock.

[0010] In practice, however, this technical solution is heavy, expensive and highly sensor-dependent.

[0011] Another solution is shock-absorbing cranes: a shock-absorbing device, usually hydraulic, filters out as dynamically as possible any force exceeding a pre-set threshold.

[0012] However, this type of solution is not able to recover large shocks due to very high relative speeds.

[0013] Given the above, it would be interesting to provide alternative solutions adapted to package lifting in the presence of a relative movement due to the swell.

[0014] In particular, it would be interesting to provide a mechanical solution that is not only aimed at treating effects of shocks but at making them impossible, or at least limiting them.

DISCLOSURE OF THE INVENTION

[0015] In this context, the present invention provides a system for lifting a package, preferably between two reference frames having at least one relative vertical movement, for example for lifting the package in the presence of a relative movement due to the swell, which lifting system comprises at least one lifting point which comprises a framework including:

- at least one lifting cable associated with:

¤ a winch, for maneuvering said lifting cable, in heaving in and paying out the hoist line,

¤ reeving means comprising:

° a fixed block of sheaves, secured to said framework, and

° a movable block of sheaves, cooperating with said framework by means of slider means defining a translational degree of freedom orthogonally to axes of rotation of said blocks of sheaves, the distance dimension of said movable block of sheave(s) with respect to said fixed block of sheaves being variable,

- controlled braking means, cooperating with said movable block of sheave(s) and controllable between two preferably bistable configurations:

¤ an inactive configuration, in which said controlled braking means allow said movable block of sheave(s) to move freely in translation according to said translational degree of freedom, especially adapted to a passive compensation of the swell, and

¤ an active configuration, in which said controlled braking means allow the movable block of sheave(s) to move in a single direction according to said translational degree of freedom, corresponding to an increase in said distance dimension,

- control means, for actuating said winch and said controlled braking means, especially during the launching or recovery operation of said package,

- first maneuvering means which cooperate with said movable block of sheave(s) and which are configured to restore potential energy to said movable block of sheave(s) so as to:

¤ when said controlled braking means are in the inactive configuration, tend to keep constant tension in said at least one lifting cable and,

¤ when said controlled braking means are in the active configuration, tend to increase said distance dimension.

[0016] According to the invention, said slider means comprise a sliding rod which carries the movable block of sheave(s), which is translationally guided coaxially to said translational degree of freedom and which cooperates with said controlled braking means, while said controlled braking means comprise:

- at least two jaws which are distributed about said sliding rod, which jaws each include a friction face adapted to cooperate with said sliding rod, and

- second bistable maneuvering means adapted to move each jaw between two positions:

¤ a distal position, at a distance from said sliding rod, corresponding to said inactive configuration of said controlled braking means, and

¤ a proximal position, bearing against said sliding rod, corresponding to said active configuration of the controlled braking means.

[0017] Consequently, the controlled braking means are adapted, in the inactive configuration, to allow the reeving means to take up or give slack to the lifting cable. This configuration is particularly useful when the package must remain on a reference frame moving relative to the one on which the lifting system is located. These controlled braking means are further adapted, in the active configuration, to allow the reeving means to take up slack to the lifting cable but to prohibit them from giving slack. This configuration is particularly useful when the package must be pulled off the moving reference frame.

[0018] The solution provided by the invention, using jaws, then proves to be particularly interesting in various respects.

[0019] Firstly, it relies essentially or even exclusively on mechanical means (advantageously by limiting the number of sensors and actions of an automaton, in real time), making it particularly robust and reliable, even in the harsh marine and offshore environmental conditions. Indeed, it is possible to envisage that only the winch and the bistable maneuvering means are controlled. It would even be possible to contemplate that the bistable maneuvering means take the form of a simple lever.

[0020] This solution also makes it possible to lift and rest packages as gently as possible, regardless of the relative speeds of the reference frames, even when the latter exceed the recommendations (typically if a particularly high and unpredictable wave occurs).

[0021] Finally, it is inexpensive, lightweight and of low overall size.

[0022] Other advantageous and non-limiting characteristics of the lifting system according to the invention, taken individually or according to any technically possible combinations, are as follows:

- the friction faces of the jaws extend in parallel to said translational degree of freedom;
- said second maneuvering means guide the displacement of each jaw along an arc-of-circle trajectory in which said friction face moves in parallel to itself, between said two distal and proximal positions;
- the second maneuvering means comprise an actuator and, for each jaw, a deformable parallelogram structure which includes said jaw, a base, and at least two pivoted links each assembled in free rotation with said base and with said jaw about two distinct pivot axes, which deformable parallelogram structure cooperates with said actuator for maneuvering said jaw between its distal position and its proximal position;
- at least two pivoted links, belonging to two distinct deformable parallelogram structures, cooperate together through gears, so as to ensure synchronization of the associated jaws;
- in the proximal position, the angle between the plane passing through the pivot axes of each pivoted link and the normal to the friction face is between 6 and 9° if the coefficient of static friction between each friction face and said sliding rod is between 0.08 and 0.16;

- at each jaw, given a resultant angle, corresponding to an angle formed by the resultant of the forces applied between said jaw and said sliding rod, and a half angle of a static friction cone, corresponding to the maximum angle with respect to a contact normal oriented perpendicularly to said sliding rod in which a force can be applied to said sliding rod according to said translational degree of freedom without generating translation of said sliding rod, said lifting system is configured so that, when the jaws are in the active configuration, said resultant angle is less than said half angle of the static friction cone;

- the controlled braking means include mechanical stops to define an end-of-travel position for the jaws which is located beyond said proximal position and which is such that, in the end-of-travel position, all components of the controlled braking means are elastically deformed only;

- the slider means are configured such that said sliding rod, and its translational degree of freedom, are oriented horizontally;

- the slider means are configured such that said sliding rod, and its translational degree of freedom, are oriented vertically;

- when said translational degree of freedom is oriented horizontally, said sliding rod is carried by support rollers;

- when said translational degree of freedom is oriented vertically, the controlled braking means include means for compensating the weight of the jaws, for example a spring member or a counterweight;

- the first maneuvering means, configured to return potential elastic energy or potential gravitational energy on said movable block of sheave(s), comprise an elastically deformable member such as a spring or an elastic, and/or a counterweight;

- the controlled braking means comprise safety means which are configured to prevent control from the inactive configuration to the active configuration during a translation of the sliding rod corresponding to a decrease in said distance dimension;

- the safety means comprise a safety ring which encircles said sliding rod so as to move between two positions, namely an active position, during a translation of the sliding rod corresponding to a decrease in said distance dimension, to cooperate with the jaws in the inactive configuration and prevent control from the inactive configuration to the active configuration, and an inactive position, during a translation of the sliding rod corresponding to an increase in said distance dimension, to move away from the jaws in the inactive configuration and to allow control from said inactive configuration to said active configuration;

- the lifting system consists of a crane including a lifting point, the framework of which includes a post and a boom, or a gantry including at least two lifting points.

[0023] The invention also provides a method for lifting a package, between two reference frames preferably having at least one relative vertical movement, for example for lifting the package in the presence of a relative movement due to the swell, by implementing a lifting

system as aforementioned, which lifting method comprises:

- for switching from the proximal position to the distal position of the jaws:

¤ controlling the second maneuvering means to move the jaws from the proximal position to the distal position, and then,

¤ if a force exerted on the sliding rod coaxially to said translational degree of freedom in a direction corresponding to a decrease in said distance dimension is less than a predetermined threshold, executing said control, otherwise

¤ suspending said control until said force decreases below said predetermined threshold, and then executing said control,

- for switching from the distal position to the proximal position of the jaws:

¤ controlling the second maneuvering means to move the jaws from the distal position to the proximal position, and then,

¤ if said distance dimension increases, executing said control, otherwise

¤ suspending said control until said distance dimension increases.

[0024] Preferably, this lifting method comprises the following operations:

(i) during an operation of launching said package from the reference frame of the lifting system to a destination reference frame:

- a step of suspending said package from said lifting cable, wherein the jaws are in the distal position and said movable block of sheave(s) is in an average position centered over an available travel,

- a hoist line heave-in and then pay-out step over a travel for positioning the safety ring in the inactive position,

- a step of controlling closing of the jaws towards the proximal position,

- a hoist line heave-in step to lift the package and place it above the destination reference frame,

- a step of lowering said package in proximity to the highest wave crests of the swell,

- when the package is placed on a wave crest or in proximity to a wave crest at the end of the rising edge, a hoist line pay-out step, preferably to become tangent to said wave crest, and of switching from the proximal position to the distal position of the jaws, so that when said package transfers its weight from said lifting cable to said destination reference frame, said lifting system ensures passive compensation of the swell,

and/or

(ii) during an operation of recovering said package located on the destination reference frame, the jaws being in the distal position, said lifting system ensuring passive compensation of the swell,

- preferably when said package is in an upward movement, a step of switching the jaws to the proximal position so that said movable block of sheave(s) continues its movement by increasing said distance dimension, this up to a wave crest where said movable block of sheave(s) is

translationally blocked,

- as soon as the jaws reach the proximal position, a heave-in step to lift the package and place it above the reference frame of the lifting system,

- a step of lowering said package onto the reference frame of the lifting system.

[0025] Of course, the different characteristics, alternatives and embodiments of the invention may be associated with one another according to various combinations to the extent that they are not incompatible with or exclusive of one another.

DETAILED DESCRIPTION OF THE INVENTION

[0026] The following description with reference to the appended drawings, given as non-limiting examples, will explain the scope of the invention and how it could be carried out.

[0027] In the appended drawings:

[0028] [Fig. 1] is a general and perspective schematic view of a lifting system according to the invention, according to a first embodiment (vertical), in the form of a crane including a lifting point;

[0029] [Fig. 2] is a schematic and perspective view of the lifting system according to Figure 1, on which the framework is hidden and which illustrates in particular reeving means and braking means for this lifting system;

[0030] [Fig. 3] is a schematic and perspective view of controlled braking means that cooperate with the reeving means of Figure 2, viewed in a first direction;

[0031] [Fig. 4] is a schematic plan view of the controlled braking means of Figure 3, seen in a second direction opposite to Figure 3;

[0032] [Fig. 5] is a schematic and perspective view of a safety ring equipping the controlled braking means of Figure 3;

[0033] [Fig. 6] illustrates different configurations that can be taken by the controlled braking means of Figure 3;

[0034] [Fig. 7] is a schematic perspective view of the lifting system according to a second (horizontal) embodiment;

[0035] [Fig. 8] is a cross-section view in the plane A-A of Figure 7.

Lifting system

[0036] It should be noted that, in these figures, the structural and/or functional elements common to the various alternative embodiments may have the same references.

[0037] As shown in Figure 1, the present invention relates to a lifting system 1 designed for lifting a package C.

[0038] This lifting system 1 is in particular adapted for lifting a package C in the presence of a relative movement due to the swell, in particular for an offshore or sea application.

[0039] More generally, the lifting system 1, for example a crane or a gantry, is adapted for handling a package C between two reference frames that have a relative movement due to the swell.

[0040] By “swell”, it is meant the oscillation of the sea surface, in particular due to waves.

[0041] In general, the highest point of a swell is called the crest; the lowest point is called the trough. The size of the swell is determined by the gap between the crest and the trough. The period is the time elapsed between two crests.

[0042] As discussed hereinafter, a “highest crest” advantageously corresponds to the highest crest during a given period of time.

[0043] “Package” encompasses any object (or load) intended to be handled by the lifting system 1. Such a package C may have various shapes and sizes. For example, it can be a man basket for the transhipment of people (figure 1 for example), a container or a boat.

[0044] “Reference frames” advantageously encompasses any surface which, for one of them, supports the lifting system 1 and, which, for the other of them, is intended to receive package C. In the following, the origin reference frame Ro and the destination reference frame Rd will be referred to respectively. This could be, for example, the deck of a vessel or platform, or the surface of the water.

[0045] Generally and according to the invention, the lifting system 1 comprises at least one lifting point 1a, that is a system by which it can independently lift a package. Alternatively, the lifting system 1 may include at least two lifting points 1a, for lifting several distinct packages or for lifting a same package by several points.

[0046] According to the invention, this lifting point 1a comprises a framework 2 equipped with:

- at least one lifting cable 3 associated with a winch 4 and reeving means 5,
- controlled braking means 6, cooperating with the reeving means 5,
- first maneuvering means 8 that cooperate with the reeving means 5 and that are configured to return potential energy, in particular to keep the reeving means tensioned and ensure passive compensation of the swell, and
- control means 7, for actuating the winch 4 and possibly also the controlled braking means 6, in particular during operations of launching or recovering the package C.

Lifting cable

[0047] The lifting cable 3 is conventional per se.

[0048] For example, it consists of a cable made of synthetic material or metal material.

[0049] This lifting cable 3 is capable of undergoing a tensile force which is generated by the package C suspended from said lifting cable 3.

[0050] In other words, the package C is intended to be suspended from one end of the lifting cable 3 when the other end is wound onto the winch 4. When it is suspended, this package C is thus intended to exert a tensile load, or a tensile force, on the lifting cable 3.

[0051] By “suspended”, it is meant a configuration in which the package C is located at height and at a distance from the reference frames.

Winch

[0052] The winch 4 is conventional per se.

[0053] This winch 4 is adapted for maneuvering the lifting cable 3:

- in hoist line heave-in, to exert a force on the lifting cable 3 by winding on a drum of the winch 4, and advantageously to generate ascent of the package C from the destination reference frame, and

- in hoist line pay-out, to release the force on the lifting cable 3 by unwinding from the winch 4, and advantageously to generate a descent of the package C towards the destination referential.

Reeving means

[0054] The reeving means 5, more visible in Figure 2, comprise:

- a fixed block of sheaves 51, secured to the framework 2, and

- a movable block of sheave(s) 52, translationally movably mounted to the framework 2 by means of slider means 53 defining a translational degree of freedom T.

[0055] In particular, the movable block of sheave(s) 52 preferably comprises a single sheave 52 or two sheaves 52.

[0056] Preferably, the sheaves 51, 52 (also known as “pulleys”) have respective axes of rotation 51', 52', which extend in planes orthogonal to the translational degree of freedom T (also known as “slider axis”), which are parallel to each other and which define a distance dimension D to each other.

[0057] Advantageously, the distance dimension D is measured according to the translational degree of freedom T, described below.

[0058] The slider means 53 define a translational degree of freedom for the movable block of sheave(s) 52. This is preferably the only degree of freedom between the two blocks of sheaves.

[0059] This translational degree of freedom T extends along an axis, hereinafter also referred to as “slider axis T”, which can be oriented vertically (Figures 1 to 6) or horizontally (Figures 7 and 8). Of course, this slider axis T could extend obliquely.

[0060] As further developed, the aforementioned distance dimension D (corresponding to the distance between the axis of rotation 52' of the movable block of sheave(s) 52 and the axis of rotation 51' of the fixed block of sheaves 51, measured over the translational degree of freedom) is variable.

[0061] For example, the possible travel of the movable block of sheave(s) 52, according to the translational degree of freedom, is for example from 1 m to 2 m, for example from 1.5 m (i.e. from 6 m at the hook).

[0062] In general, the slider means 53 comprise for example a sliding beam 531 (also called “sliding rod”), forming a slider, which carries the movable block of sheave(s) 52.

[0063] If present, the sliding beam 531 extends coaxially to the slider axis T. This sliding beam 531 is movable along this slider axis T.

[0064] The movable block of sheave(s) 52 is advantageously carried at one of the ends 531a,

531b of the sliding beam 531.

[0065] As developed hereinafter, this sliding beam 531 cooperates with the controlled braking means 6. The latter thus make it possible to brake or block sliding of the sliding beam 531 and the movable block of sheave(s) 52. Here, they also make it possible to translationally guide this sliding beam 531 along the slider axis T.

Controlled braking means

[0066] According to the invention, the controlled braking means 6 are controllable between two configurations, advantageously bistable: an inactive configuration and an active configuration.

[0067] By “bistable”, it is advantageously meant that the inactive configuration and the active configuration constitute stable configurations. Preferably, these controlled braking means 6 cannot be controlled in another configuration; the controlled braking means 6 thus advantageously switch between the inactive configuration and the active configuration. However, they may possibly have a different configuration, especially when switching from one to the other of the two stable configurations.

[0068] In the inactive configuration, the controlled braking means 6 allow free translation of the movable block of sheave(s) 52 along the slider axis T, in both directions (for example according to an oscillating movement).

[0069] As developed hereinafter, such an inactive configuration is especially adapted for passive compensation of the swell. In this case, the movable block of sheave(s) 52 and the sliding beam 531 can freely oscillate with respect to the fixed block of sheaves 51, especially depending on the relative movement between the two reference frames. This is typically the case when the package C is placed on the destination reference frame Rd and the two reference frames Ro, Rd rise and fall relative to each other due to the waves.

[0070] In the active configuration, the controlled braking means 6 allow the movable block of sheave(s) 52 to move in one direction only along the slider axis T, corresponding to an increase in the aforementioned distance dimension D. In other words, in the active configuration, the reeving means 5 can recover slack of the lifting cable 3, but they remain blocked when a tensile force is exerted on this lifting cable 3 (when the package C is suspended from the end of this lifting cable 3). For example, in Figures 1 and 2, only the downward movement of the movable block of sheave(s) 52 is allowed, to ensure ascent of the package C, its descent being blocked. This is typically the case when the package C was placed on the destination reference frame Rd and it is desired to pull it off or when the package C rises with respect to the lifting system 1.

[0071] In other words, in the active configuration, the controlled braking means 6 are structured to:

- allow the movable block of sheave(s) 52 to move in a first direction along the slider axis T, corresponding to an increase in the distance dimension D, and
- prevent the movable block of sheave(s) 52 to move in a second direction along the slider axis

T, corresponding to a decrease in the distance dimension D.

[0072] Such an active configuration is particularly interesting to allow continuation of a movement increasing the distance dimension D, for example when the package C follows an upward trajectory up to a wave crest, and for preventing it from subsequently descending back towards the trough of the wave since it is desired to lift it.

Jaws

[0073] According to the invention, the controlled braking means 6 essentially comprise mechanical means, movably mounted with respect to one another to define the aforementioned active and inactive configurations.

[0074] More precisely, according to an example illustrated in Figure 3, the controlled braking means 6 first comprise a base 61, in this case a case 61, which is attached to the framework 2 and which houses jaws 631, 632.

[0075] These jaws 631, 632 are preferably located on either side of the sliding rod 531 so as to be able to sandwich it. Preferably, these jaws 631, 632 are for this purpose movably mounted along an inclined direction relative to the slider axis T in order to bear against this sliding rod 531 or to move away from it, depending on the direction of travel.

[0076] The jaws 631, 632 furthermore each include a friction face 631a, 632a, these faces facing one another and towards the sliding rod 531. These friction faces 631a, 632a are intended to cooperate with the sliding rod 531 to ensure braking thereof.

[0077] The sliding rod 531 is so-called profiled, in that it has, over at least part of its length (that which slides in the case 61), a cross-section of invariable shape and size.

[0078] The friction faces 631a, 632a of the jaws 631, 632 have shapes complementary, negatively, to those of the parts of the sliding rod 531 against which they bear.

[0079] Here, and preferably, the sliding rod 531 has a circular cross-section. Consequently, the friction faces 631a, 632a of the jaws 631, 632 are curved, in that they have arc-of-circle cross-sections (in planes orthogonal to the slider axis T), extending over angular sectors less than or equal to 180°.

[0080] Of course, alternatively, the sliding rod 531 could have a rectangular cross-section, in which case the friction faces 631a, 632a of the jaws 631, 632 would be planar or dihedral. Other forms would still be contemplatable.

[0081] In practice, the jaws 631, 632 are advantageously in the form of parallelepiped blocks, one of the six faces of which forms the friction face 631a, 632a.

[0082] The jaws 631, 632 could be manufactured from a wide variety of materials. They are here formed of a single piece and from a single metal material, for example of soft stainless steel (while the sliding rod 531 is manufactured from hard stainless steel). Of course, alternatively, it would be possible to manufacture them from another material or from several different materials (for example to coat their friction faces 631a, 632a with a particular material dedicated to braking the sliding rod 531).

[0083] The controlled braking means 6 further comprise second bistable maneuvering means 60 adapted to move the jaws 631, 632 so that the latter can move closer to or away from the sliding rod 531.

[0084] These bistable maneuvering means 60 are shaped to enable the jaws 631, 632 to be moved between two positions, namely:

- a distal position in which the jaws 631, 632 extend at a distance from the sliding rod 531, and

- a proximal position in which the jaws 631, 632 bear against said sliding rod 531.

[0085] By “at a distance”, it is meant that the jaws 631, 632 are in a position apart from the sliding rod 531 relative to the proximal position, and such that they do not prevent the sliding rod 531 from sliding according to its translational degree of freedom, in both directions. In practice, in this position, it will be preferred that no contact between the jaws 631, 632 and the sliding rod 531 occurs. However, as an alternative, partial sliding bearing could be contemplatable, on the model of brake disks of automobile vehicles.

[0086] When the jaws 631, 632 are in the distal position (advantageously spaced apart with respect to the sliding rod 531), they therefore do not block sliding of the sliding rod 531 according to its translational degree of freedom. Consequently, this distal position corresponds to the inactive configuration of said controlled braking means 6.

[0087] When the jaws 631, 632 are in the proximal position (advantageously bearing against the sliding rod 531), they block sliding of the sliding rod 531 along the slider axis T in one direction only, for the reason that will be described below. Therefore, this proximal position corresponds to the active configuration of the controlled braking means 6.

[0088] Different systems could be contemplated so that, when the jaws are in the proximal position, they block sliding of the sliding rod 531 in one direction only.

[0089] Here, the second maneuvering means 60 are in practice shaped to guide displacement of the jaws 631, 632 along arc-of-circle trajectories, such that the friction faces 631a, 632a move in parallel to one another, between both distal and proximal positions.

[0090] More precisely, they are arranged so that, when the jaws 631, 632 move from the distal position to the proximal position, these jaws 631, 632 move along the slider axis T, in a direction corresponding to a reduction in the distance dimension D.

[0091] These second maneuvering means 60 are further shaped so that the arc-of-circle trajectories of the friction faces 631a, 632a of the jaws 631, 632 are not tangent to the sliding rod 531. Thus, in the proximal position (when the jaws come to bear against the sliding rod 531), the displacement of the sliding rod 531 in one direction (that corresponding to a reduction in the distance dimension D) will tend, given the friction of the jaws 631, 632 on this sliding rod 531, to tighten the jaws 631, 632 against the sliding rod 531. On the contrary, the displacement of the sliding rod 531 in the opposite direction will tend to move the jaws 631, 632 away from this sliding rod 531. It is this aspect that makes it possible here to prevent displacement of the

sliding rod 531 in only one direction.

[0092] In practice, this so-called “rotary translation” movement of the jaws 631, 632 is carried out by two deformable parallelogram structures.

[0093] For each jaw 631, 632, the deformable parallelogram structure includes:

- said jaw 631, 632,
- the base 61, and
- at least two pivoted links 602, 603, 604, 605, each assembled in free rotation with said base 61 and with said jaw 631, 632 about two distinct pivot axes.

[0094] As shown in Figure 3, these structures each include, for example, two pivoted links 602, 604; 603, 605 which are hinged, here at their ends, on the one hand to the case 61, and on the other hand to the jaw 631; 632 considered. In other words, each jaw 631, 632 cooperates with a pair of pivoted links 602, 604; 603, 605.

[0095] For this, the case comprises a bottom wall 610 from which four first cylindrical studs 612, 613, 614, 615 of revolution about axes parallel and orthogonal to the slider axis T rise.

[0096] Each pivoted link 602, 603, 604, 605 has a shape of a plate perforated at both ends by openings, one of which is engaged on one of these first studs 612, 613, 614, 615. The first studs 612, 613, 614, 615 thus allow guiding each associated pivoted link 602, 603, 604, 605 according to pivot movements about respective pivot axes corresponding to the axes of the studs.

[0097] Similarly, each jaw 631, 632 carries two second studs, not visible in Figure 3, being cylindrical of revolution about axes parallel to the axes of the first studs 612, 613, 614, 615. The second opening of each pivoted link 602, 603, 604, 605 is then engaged on one of these second studs.

[0098] In general, the first and second studs are positioned such that the two pivoted links 602, 604; 603, 605 (also hinged to each jaw 631; 632) are elongated along parallel axes. Here, the longitudinal axis of a pivoted link will be defined as the axis that passes through half the thickness of the pivoted link and intersects the axes of the first and second studs to which this pivoted link is hinged.

[0099] Each deformable parallelogram structure thus includes:

- a fixed side, formed by the case and two of its first studs,
- two sides rotatably movable about the axes of these first studs, formed by the pivoted links, and
- a rotary translationally movable side formed by the jaw.

[0100] It is necessary that the two deformable parallelogram structures act together on the sliding rod 531, that is that the jaws exert symmetrical stresses on this sliding rod 531.

[0101] For this, the movements of the two jaws 631, 632 are symmetrical and synchronized, here by means of gears 602a, 603a, 604a, 605a.

[0102] Different gear systems could be used for this purpose. In the example illustrated in

Figure 4, the solution consists in forming teeth adapted to mesh on the ends of the pivoted links 602, 603, 604, 605.

[0103] The two pivoted links 602, 604 of one of the jaws then include several teeth respectively meshing with teeth of the two pivoted links 603, 605 of the other of the jaws. In this way, when a movement is imparted to one of the jaws 631, 632, this movement is mechanically transmitted to the other of the jaws.

[0104] Alternatively, other transmission means could have been used with the same intention. Typically, it would be possible to use a pivoted link that would force the two jaws to move up or down together (along the slider axis T).

Actuator

[0105] To move the jaws 631, 632 between their distal and proximal positions, the second maneuvering means 60 advantageously comprise an actuator 601a, advantageously a bistable actuator, preferably associated with a delay member 601b, for example a spring box 601b.

[0106] The actuator 601a could include a manual maneuvering lever.

[0107] In this case, it is rather a controlled actuator.

[0108] This controlled actuator 601a preferably includes a linear actuator. It may be an electric or pneumatic linear actuator, or a hydraulic linear actuator.

[0109] In any case, it is a double-acting linear actuator, for displacing the jaws 631, 632:

- from the distal position to the proximal position, and
- from the proximal to the distal position.

[0110] In practice, this linear actuator has a cylinder that is mounted to a framework.

[0111] Moreover, the spring box 601b is in practice hinged to the case 61 via a ball-and-socket type connection.

[0112] The spring box 601b includes a free end that is coupled:

- to one of the jaws or
- to one of the pivoted links housed in this case 61.

[0113] This free end is herein hinged to one of the pivoted links 605 via a ball-and-socket type connection.

[0114] Thus, the second maneuvering means 60 are secured to only one of the deformable parallelogram structures, the other being actuated by the aforementioned gear system.

[0115] In general and advantageously, the bistable actuator 601a translates instructions from the operator (package in lifting mode or package in passive swell compensation mode), which is “memorized” by the delay member 601b.

[0116] The execution, corresponding to the actual movement of the jaws, is conditioned by the safety conditions of the lifting operation:

- the controlled braking means 6 do not set the package in free fall even if the operator wants to switch to passive compensation; the controlled braking means 6 wait until the selfweight has been taken up by the destination reference frame so that the jaws open at this precise moment,

“passively” pushed by the delay member which has been pre-stressed by the position change of the control;

- the controlled braking means 6 do not instantly block the lowering movement of the package even if the operator requests it; the jaws close, but on the safety ring which remains between the jaws until reaching the low point; once the package begins to rise, the safety ring is pushed out of the jaws and these rest on the sliding rod which is not blocked in the direction of the package rising; when the package arrives at its peak and the latter wants to start descending, the jaws block movement of the sliding rod and thus the package rests at a theoretical zero speed on the lifting cable(s).

[0117] In other words and advantageously, the controlled braking means 6 do not execute commands from the operator in real time but wait for the appropriate times (those that ensure safety of the operation) to do so. This is done passively, purely mechanically, that is by dispensing with the management of sensors and actuators in real time, by the automaton or operator. This approach makes it a solution where useful actions occur naturally at the right times and therefore inherently safe and reliable.

Static friction cone

[0118] At this stage, how the second maneuvering means 60 are designed can be defined more precisely in order to ensure that, in the proximal position, the jaws 631, 632 can block the sliding rod 531 if the latter tends to slide in one direction and that they allow it to slide if it tends to slide in the opposite direction.

[0119] For this, a “resultant angle” must be defined for each jaw.

[0120] This angle corresponds to the angle formed by the resultant of the forces applied by the jaw 631, 632 considered to the sliding rod 531. This resulting is composed of the force of the jaw bearing against the sliding rod, which is oriented in parallel to the longitudinal axis of the pivoted links of this jaw, and the friction force of the jaw on the sliding rod, which is oriented in parallel to the slider axis T.

[0121] A half angle of a static friction cone, also called “adhesion angle” or “friction angle”, should also be defined.

[0122] The static friction cone is formed by the boundary between the space in which the resultant of the forces are such that the sliding rod does not slide relative to the jaw 631, 632 (considering that the two jaws apply symmetrical forces to the sliding rod), and the space in which the resultant of the forces are such that the sliding rod 531 slides relative to the jaw 631, 632. Therefore, the static angle corresponds to the maximum angle with respect to a normal of contact of the jaw on the sliding rod 531 in which a force can be applied by the jaw to the sliding rod 531 along the slider axis T without generating translation of said sliding rod 531.

[0123] And the second maneuvering means 60 are then configured such that, when the jaws 631, 632 are in a proximal position, said resultant angle is less than the friction angle, which blocks the sliding rod 531 in a fixed position in one direction.

[0124] Still in other words, the lifting system 1 is configured such that, when the jaws 631, 632 are in the active configuration, said resultant angle is less than the half angle of the static friction cone, advantageously minus a safety margin. For example, at 0.15 friction/static coefficient, the minimum requirement is 9°. The effortless angle is taken at 8° and will decreasingly change as the load increases.

[0125] Several parameters can be varied for this purpose.

[0126] A first parameter is the force exerted by the actuator 601a on the jaws. However, here, this force is intended to remain restricted compared to the other forces involved.

[0127] A second parameter, at least as important as the first, is the angle α (Figure 4) formed, in the proximal position, between the longitudinal axis of any one of the pivoted links and the normal to the jaw (in particular normal to its friction face 631a, 632a) to which this pivoted link is hinged. The smaller this angle α when the jaws 631, 632 are in the proximal position, the more the pivoted links 602, 603, 604, 605 are perpendicular to the friction faces of the jaws.

[0128] The objective is then to adjust this angle α according to the can be defined more precisely between the friction faces 631a, 632a of the jaws and the sliding rod 531.

[0129] Here, the jaws 631, 632 being manufactured from soft stainless steel (for example of the 316 L type) and the sliding rod 315 being manufactured from hard stainless steel (for example of the Super-Duplex X2CrNiMoN 25-7-4 type), the coefficient of static friction between these two materials is between 0.15 and 0.2. Therefore, an angle α of 8° makes it possible to retain the sliding rod 531 when the load C has a substantially zero weight. As has been set out above, when the weight of the load C increases, the sliding rod 531 tends to slide towards decreasing the distance dimension D, which causes the jaws 631, 632 to be tightened by friction so that the rod remains blocked despite this increase in load.

[0130] Thus, by geometrically imposing an angle α lower than that of the natural static friction cone that exists between the jaws and the sliding rod at zero load, the load C will remain retained when the jaws are closed, regardless of its mass. It is a virtuous system because it is the very presence of load C that creates its retention. Conversely, this system allows free movement of the sliding rod 531 in the other direction, when the load C rises. Indeed, in this case, the jaws are pushed by friction to open.

[0131] Of course, materials of the jaws and the sliding rod could be different, in which case the angle α would have to be modified according to the coefficient of static friction between the materials chosen.

[0132] For example, it may be considered that, for a coefficient of static friction between 0.08 and 0.16, the angle may be between 5° and 9°.

[0133] Of course, for a higher value coefficient (for example if the jaws are coated with rubber), the angle α may have a higher value.

Mechanical stops

[0134] When the jaws 631, 632 have been closed in the proximal position and the weight of

the load C is high, the sliding rod 531 causes displacement of the jaws beyond their proximal position (relative to the distal position), by elastic compliance of the parts in compression (pivoted links, jaws, bearing) and in tension (case).

[0135] All the controlled braking means 6 could be oversized to withstand loads greater than the maximum recommended, so as to withstand shocks and unexpected stresses. However, this solution would prove to be much less interesting technically and economically.

[0136] Instead, it is sought here to avoid that if the weight of the load C exceeds a recommended load threshold (for example including dynamic effects such as maximum accelerations imposed on the lifting machine or shock effects due to the recovery of the load lifted at too high a relative speed (accidental presence of slack), stresses exerted by the sliding rod 531 on the different components of the controlled braking means 6 (case, pivoted links and jaws) are too high and cause damage to one of these components.

[0137] For this, as shown in Figure 3, the controlled braking means 6 include mechanical stops 641, 642 for defining an end-of-travel position for the jaws 631, 632.

[0138] This end-of-travel position is chosen so that, when the jaws are in this position, the angle α remains strictly greater than 0. Thus, this angle α varies here from a value strictly greater than 8° in the distal position, up to a value between 0 and 8° (bounds excluded) in the end-of-travel position.

[0139] Here, these mechanical stops 641, 642 are settable, which makes it possible to adjust in situ the end-of-travel position and thus the limit force capable of being retained by the jaws. This is a precise, passive force limiting system with a very good level of repeatability. When it reaches the hard stop, the direction of the resultant of the forces of the jaws on the sliding rod is very significantly affected. Initially imposed by the direction of the pivoted links, the path of the forces being much steeper by the stops, the slightest increase in force on the sliding rod, tends to lay the resultant towards the axis of the sliding rod, which very quickly causes it to exit the static friction cone and thus initiates sliding of the sliding rod under the jaws which stops naturally as soon as the force has returned below the pre-set threshold. This solution thus acts as a force limiter, such as a mechanical safety valve.

[0140] In the embodiment illustrated in Figure 3, these are screws, having the advantage of being able to perform recalibration if necessary. It could also be a simple fixed-height stop (calculated in advance).

[0141] As is illustrated in this figure, these screws may be screwed into the jaws 631, 632, in order to come into contact with the case 61 when the jaws reach the end-of-travel position.

[0142] Alternatively, these screws could be screwed into the case 61, to form stops upon which the jaws would come into contact when the latter would reach the end-of-travel position.

[0143] Other structures could be contemplated.

[0144] Typically, the stop means could include only one screw placed on any one of the jaws, the gears ensuring symmetrical stopping of the other of the jaws in the end-of-travel position.

[0145] It is understood that if the weight of the load C is very high, the jaws will bear against these mechanical stops 641, 642, so that the resultant of the forces will exit the static friction cone. Thus, in this case, the jaws 631, 632 are no longer able to retain the sliding rod 531 towards reducing the distance dimension D.

[0146] Therefore, in the event of a shock causing a sudden and limited increase in the weight of the load C over time, the load C may drop somewhat, which will prevent all the stresses from being transmitted to the controlled braking means 6 and plastically deforming them.

Safety ring

[0147] Preferably, safety means are also provided to prevent the jaws 631, 632 from coming into the proximal position in a particular situation:

- the jaws are in the distal position, and
- the jaws are controlled to come to the proximal position while the forces applied to the sliding rod 531 tend to decrease the distance dimension D.

[0148] Stated otherwise, the safety means prevent the jaws from pressing against the sliding rod 531 when a load C is retained by the cable and the load C undergoes a lowering movement (for example when the destination reference frame Rd on which the load is placed descends with respect to the original reference frame Ro). Such a technical characteristic avoids suspending the load C at half-wave on the falling slope (where the relative speed is maximum, which would generate a potentially destructive dynamic force), and that the load is hit shortly afterwards by the destination reference frame Rd when the latter rises on the next wave.

[0149] Preferably, these safety means are designed to interpose automatically between the jaws 631, 632 when the latter are in the distal position and the distance dimension D decreases.

[0150] Here, as shown in Figure 3, these safety means comprise a safety ring 65 which encircles the sliding rod 531.

[0151] This safety ring 65 is housed inside the case 61 and is threaded (or fitted) on the sliding rod 531 so as to be able to slide thereon between two distinct extreme positions, called the active position and inactive position.

[0152] According to the embodiment illustrated, it is located here opposite the stop means 641, 642 with respect to the jaws 631, 632.

[0153] In the active position, the safety ring 65 is provided to interpose between the jaws in order to prevent the actuator 601a from bringing these jaws back into the proximal position.

[0154] In the inactive position, the safety ring 65 is located at a distance from the jaws so as not to hinder their movement.

[0155] The safety ring 65 is mounted to the sliding rod 531 so as to:

- on the one hand, be retained in a fixed position on the latter when no force is exerted on this ring, and
- on the other hand, to be able to slide along the sliding rod 531 when the sliding rod 531 slides and the ring comes to a stop against the case 61 or against the jaws.

[0156] The safety ring 65 then has a defined oscillation travel between the case 61 and the jaws.

[0157] As shown in Figure 3, the jaws 631, 632 each have a notch on the side of the safety ring 65. These notches together delimit a cavity 650 open towards the sliding rod 531 and on the opposite side of the sliding ring 65.

[0158] Then, the safety ring 65 is provided to be able to be housed in this cavity 650 only when the jaws are in the distal position and the sliding rod 531 has a movement tending to decrease the distance dimension D.

[0159] If the jaws are in the proximal position and the rod slides in this same direction (for example because the load C is too high and the jaws are in the end-of-travel position), the safety ring 65 comes to bear against the edges of the jaws so that it cannot come to be housed in the cavity 650. As a result, it remains inoperative.

[0160] If the sliding rod 531 has a movement tending to increase the distance dimension D, the safety ring 65 comes to bear against a side wall of the case 61. As a result, it remains still inoperative.

[0161] This safety ring 65 is represented in detail in Figure 5.

[0162] It has substantially cylindrical inner and outer faces about an axis of revolution A1, and extends over a height less than the distance separating the jaws and the aforementioned side wall of the case 61.

[0163] According to a particular embodiment, it advantageously includes three substantially identical sections 651, each extending over an angular sector of 120°. These three sections 651 are hinged to each other, about pivot axes parallel to the axis of revolution A1.

[0164] A first of the sections 651 is further secured to a second of these sections via an elastically deformable connection, which makes it possible to slightly move away these two sections so as to modify the diameter of the safety ring 650.

[0165] In practice, this first section has a hollow cavity 652 in its outer face, and a hole that opens on one side into this cavity, and on the other side at the end of the first section that faces the corresponding end of the second section. A screw 653 is engaged in this hole so that its head is housed in the cavity 652 and its threaded body is screwed into a tapped bore provided in the second section. A compression spring 654, which is sandwiched between the head of the screw 653 and the edge of the hole, makes it possible to elastically return the safety ring in a tightened configuration where its diameter is minimal.

[0166] Thus, the safety ring 65 can have a variable diameter, between the aforementioned tightened configuration and an enlarged configuration in which its diameter is maximum.

[0167] The inner face of the safety ring 65 has, in the tightened configuration, a diameter strictly smaller than that of the sliding rod 531, and in the enlarged configuration, a diameter strictly larger than that of the sliding rod 531.

[0168] Thus, the safety ring 65 remains bearing around the sliding rod 531, which allows it to

slide with the latter as long as it is in contact with neither the case 61 nor the jaws 631, 632. The stiffness of the compression spring 654 is sufficiently low so that the friction between this ring and the rod remains restricted and that, when the safety ring 65 comes to bear (for example against the case 61), it does not hinder sliding of the sliding rod 531.

[0169] In summary, the bistable control executed by the actuator 601a makes it possible to place the jaws 631, 632 in three positions, namely:

- the proximal position, in which the jaws 631, 632 are bearing against the sliding rod 531, controlled by the second maneuvering means 60,
- the distal position, in which the jaws are at a distance from the sliding rod 531, controlled by the second maneuvering means 60, and
- an intermediate position, in which the jaws 631, 632 are controlled to move proximally from a distal position but the safety ring 65 blocks these jaws in an intermediate position between the distal position and the proximal position.

[0170] In other words, in the intermediate position, the jaws do not reach the proximal position. The sliding rod 531 is able to slide within the controlled braking means 6.

[0171] Furthermore, preferably, the safety ring 65 is ejected relative to the jaws 631, 632 in the intermediate position when these jaws are controlled from the intermediate position to the distal position.

[0172] In other words, once the jaws are placed on the safety ring:

- in the direction of descent of the package (decrease in the distance D), the safety ring remains between the jaws, sucked by sliding of the sliding rod,
- in the direction of rise of the package (increase in the distance D), the safety ring is naturally ejected from the jaws (aided by a conical shape given to the jaw/safety ring interface) which then fall on the sliding rod.

Maneuvering means

[0173] The first maneuvering means 8 cooperate with said movable block of sheave(s) 52.

[0174] These first maneuvering means 8 are configured to restore potential energy to the movable block of sheave(s) 52 so as to:

- in the inactive configuration, endeavor to maintain a constant tension in said at least one lifting cable (hence performing passive compensation of the swell), and
- in the active configuration, endeavor to increase the distance dimension D.

[0175] More precisely, these maneuvering means 8 are configured to accumulate potential energy from the movable block of sheave(s) 52 when the distance dimension D decreases.

[0176] In other words, the maneuvering means 8 are intended to return a return force, corresponding to the potential energy returned.

[0177] The maneuvering means 8 are adapted to maintain a tension sufficient to tension said at least one lifting cable 3, in the inactive configuration and in the active configuration of the controlled braking means 6.

[0178] Without being limiting, this tension advantageously depends on the maximum length of said at least one lifting cable 3 which hangs during the passive compensation of the swell, on the linear density of said at least one lifting cable 3 and on the value of the destabilizing forces (e.g. winds, accelerations of the reference frames) which tend to push said at least one lifting cable 3 out with respect to its ideal natural straightness position(s) between the sheaves 51, 52 and the fixed points.

[0179] Preferably, this tension must also be greater than the force exerted by the controlled braking means 6 in the active configuration, towards increasing the distance dimension D.

[0180] “Potential energy” preferably encompasses:

- elastic potential energy, for example in the form of a spring member (not represented), advantageously mechanical or pneumatic, and/or
- potential gravitational energy (so-called gravity energy), for example in the form of a counterweight.

[0181] For example, a spring member accumulates elastic potential energy (for example by putting it under stress) when the distance dimension D decreases.

[0182] Similarly, a counterweight accumulates potential gravitational energy (for example by its displacement in height) when the distance dimension D decreases.

[0183] In general, the counterweight may be possible formed by:

- the sliding beam 531, and/or
- an offset counterweight 85, suspended from one end of the sliding beam 531 (for example at a proximal end, on the side of the winch 4), directly (figure 3) or via a cable/pulley assembly, and advantageously exerting a tensile force on the sliding beam 531.

[0184] Conversely, potential energy is here returned in the form of a return force, by increasing the distance dimension D.

[0185] In general and taking the maneuvering means 8 exerting a potential energy on the movable block of sheave(s) 52 into account, the distance dimension D is especially variable according to the tensile force exerted by the package C via the lifting cable 3:

- the distance dimension D tends to increase as the tensile force exerted by the package C decreases, and
- the distance dimension D tends to decrease as the tensile force exerted by the package C increases.

[0186] In other words, movements of the movable block of sheave(s) 52 are determined by:

- the tensile force exerted by the package C on the lifting cable 3,
- the return force corresponding to potential energy returned by the maneuvering means 8,
- the friction forces exerted by the jaws 631, 632, and
- and, where applicable, the hoist line heave-in and pay-out maneuvers exerted on the lifting cable 3 via the winch 4.

Control means

[0187] The control means 7 are configured for actuating the winch 4 and possibly the controlled braking means 6, in particular during the operation of launching or recovering the package C.

[0188] Such control means 7 comprise for example a computer program implemented by a computer, for example in the form of an Programmable Logic Controller or PLC. This computer program advantageously comprises instructions which, when the program is executed by a computer, cause the same to control the winch 4 and/or the controlled braking means 6 (preferably according to an algorithm).

[0189] Preferably, the control means 7 advantageously comprise a centering module 71 which, in the inactive configuration of the controlled braking means 6, is configured to control the winch 4 so as to position the movable block of sheave(s) 52 in a centered position, advantageously an average position centered over an available travel.

[0190] This centering module 71 advantageously comprises an initial centering module 71a, which aims to position the movable block of sheave(s) 52 in a centered position prior to an operation of launching the package C from a reference frame.

[0191] The centering module 71 further advantageously comprises a slow centering module 71b which is configured so as, in the inactive configuration of the controlled braking means 6, to tend to hold the movable block of sheave(s) 52 in a centered position, advantageously an average position centered on an available travel.

[0192] Preferably, the slow centering module 71b cooperates with means for instantaneous and averaged measurement of the position of the movable block of sheave(s) 52 over a period of time (period of 30 s to 90 s for example), in particular when the controlled braking means 6 are in the inactive configuration.

[0193] The means for instantaneous and averaged measurement of the position of the movable block of sheave(s) 52 consist, for example, of a cable or laser position sensor.

[0194] This slow centering module 71b is configured to control the winch 4 (in hoist line heave-in and pay-out) when the average position of said movable block of sheave(s) 52 reaches either of two actuation thresholds along the slider axis T.

[0195] Preferably, the control means 7 advantageously comprise a safety end-of-travel module 72, which is configured to actuate the winch 4 (in hoist line heave-in and pay-out) when the movable block of sheave(s) 52 reaches one or the other of two end-of-travel thresholds along the slider axis T.

[0196] Preferably, an increasing speed order is imposed by this safety module at the end of travel 72 to avoid arrival at the end of travel of the movable block of sheave(s) 52.

[0197] Still preferably, the control means 7 comprise an automatic recovery module 73 and/or an automatic launching module 74, configured to automatically control the winch 4 and the controlled braking means 6 during recovery operation and/or launching operation of the

package C, as described hereinafter.

[0198] The automatic recovery module 73 and/or the automatic launch module 74 is preferably associated with at least one measurement sensor 75 (for example a laser or a radar, illustrated in Figure 1) configured to measure the relative vertical distance between a reference frame of the framework 2 and a destination reference frame, for example in the case where the average distance between the reference frame of the framework 2 and the destination reference frame is not known or variable.

[0199] Preferably, said at least one measurement sensor 75 makes it possible to measure the relative vertical position of the destination reference frame with respect to the lifting system 1, among:

- the average position,
- the highest position,
- the lowest position.

[0200] From these measurements, it is possible to determine:

- the instantaneous vertical speed (by $\Delta U/\Delta t$ derivation),
- the maximum speed when ascending and descending (over the last 1 to 5 minutes, for example),
- the average absolute speed (over the last 1 to 5 minutes, for example),
- the length to be paid out by the winch 4 to obtain centering of the movable block of sheave(s) 52 in the theoretical centered position.

First Embodiment

[0201] As illustrated in Figure 1, the lifting system 1 consists of a crane including a single lifting point 1a.

[0202] In this case, the framework 2 includes a post 2a and a boom 2b.

[0203] In general, the winch 4, the reeving means 5, the controlled braking means 6 and the maneuvering means 8 are advantageously carried by the framework 2.

[0204] According to the embodiment illustrated in Figures 1 and 2, the winch 4 and the reeving means 5 are carried by the post 2a. In particular, the fixed block of sheaves 51 is hinged at the top of the post 2a, and the slider means 53 define a translational degree of freedom having a vertical slider axis T, along this post 2a, so that the movable block of sheave(s) 52 extends under the fixed block of sheaves 51, at a distance therefrom corresponding to the distance dimension D.

[0205] The lifting cable 3 then extends from the winch 4 to the reeving means 5, then returns horizontally to a pulley carried by the boom to descend back towards the load C.

[0206] The first maneuvering means 8, cooperating with the movable block of sheave(s) 52, use herein potential gravitational energy. In this mode, they include a counterweight formed partly by the sliding beam 531 and partly by a mass attached to this sliding beam 531.

[0207] Alternatively, these maneuvering means 8 could include an offset counterweight (not

represented), exerting downward tension on the sliding beam 531.

[0208] Of course, alternatively, a spring member could have been used.

[0209] As shown in Figure 3, in this first embodiment, the pivot axes of the pivoted links 602, 603, 604, 605 thus extend horizontally, while the friction faces 631a, 632a of the jaws 631, 632 rise vertically.

[0210] Due to this orientation, it is necessary to compensate the weight of the jaws 631, 632. This compensation could be carried out actively, by the actuator 601a. But preferably, it is carried out passively, here by a spring 80 that pushes the jaws upwards (the force exerted by the spring counteracting the weight of the two jaws). Alternatively, a counterweight system could be used.

[0211] In this first embodiment, the case 61 has two opposite openings through which the sliding rod 531 passes. To ensure proper sliding of this rod, these openings can be equipped with sliding rings, such as bronze or aluminum bronze rings.

Second embodiment

[0212] In a second embodiment illustrated in Figures 7 and 8, the slider means 53 define a translational degree of freedom with horizontal slider axis T.

[0213] In practice, in this mode, the lifting system 1 could consist of a crane, in which case the winch 4 and the reeving means 5 would be carried by the boom. It will be considered here that it consists rather of a gantry with at least two identical lifting points (one of which is represented in the figures). In this mode, the winch 4 and the reeving means 5 are carried by a horizontal cross member 2b of the gantry.

[0214] Either way, as shown in Figure 7, the winch 4 (here including two counter-rotating motors), the reeving means 5, and the controlled braking means 6 are advantageously supported by the horizontal cross member 2b.

[0215] As illustrated in Figure 7, the fixed block of sheaves 51 is located at a distance from the winch 4, and the movable sheave block 52 is located between the fixed block of sheaves 51 and the winch 4. Of course, the opposite would be contemplatable.

[0216] The controlled braking means 6 are located on the other side of the winch 4 with respect to the reeving means 5.

[0217] As shown in Figure 8, the sliding rod 531 therefore passes through the fixed block of sheaves 51 so as to be able to be attached to the movable block of sheaves 52 and to be able to pass through the case 61 of the controlled braking means 6. This sliding rod 531 is carried by support rollers 532, so as to be able to slide horizontally (as freely as possible, advantageously without friction). Here, one roller is located on one side of the case 61 (the side opposite the sheaves) and the other roller is located on the other side of the movable block of sheave(s) 52. These rollers can be formed by rollers mounted to bearings or by any other ad hoc system.

[0218] Thus, in this second embodiment, the lifting cable 3 extends from the winch 4 to the reeving means 5, then descends back towards the load C directly from the fixed block of

sheaves 51.

[0219] The maneuvering means 8, cooperating with said movable block of sheave(s) 52, here still use potential gravitational energy, for example in the form of an offset counterweight (not represented) intended to exert a tensile force on the horizontally oriented sliding beam 531, for example via a cable and pulley system.

[0220] In this embodiment, the pivot axes of the pivoted links 602, 603, 604, 605 of the controlled braking means 6 extend vertically, while the friction faces of the jaws extend horizontally. Due to this orientation, it is not necessary to compensate for the weight of the jaws.

Lifting method

[0221] At this stage, the operation of the lifting system 1 can be described in detail with reference especially to Figure 6.

- Passive swell compensation

[0222] “Passive swell compensation” is referred to when the lifting system 1 and the package C rest on two different reference frames (the original reference frame Ro and the destination reference frame Rd).

[0223] In this configuration illustrated by the tile V1 in Figure 6, the control means actuate the controlled braking means 6 in the inactive configuration. In practice, the actuator 601a exerts a force F1 on the jaws 631, 632 to maneuver them in the distal position.

[0224] The movable block of sheave(s) 52 is then subjected to two reverse forces:

- the tensile force exerted by the package C via the lifting cable 3, and
- the return force corresponding to the potential energy returned by the first maneuvering means 8.

[0225] The resultant F2 of these forces varies as follows.

[0226] If the height difference between the reference frames decreases (for example, a wave causes the package C to rise), the tension in the lifting cable 3 decreases and, naturally, the distance dimension D increases under the action of the first maneuvering means 8.

[0227] Conversely, if the height difference between the reference frames increases (for example, a wave lowers the package C), the tension in the lifting cable 3 increases and, naturally, the distance dimension D decreases.

[0228] Passively, the lifting cable 3 is advantageously held at an average tension (i.e. preferably a force exerted by the maneuvering means 8 divided by the number of strands of the reeving means 5).

[0229] Preferably, in passive compensation of the swell, the method comprises a step of controlling the winch 4 to attempt to hold the movable block of sheave(s) 52 in an average position.

[0230] This centering of the movable block of sheave(s) 52 is ensured here by the aforementioned slow centering module 71b.

[0231] In practice, if an actuation threshold is reached by increasing the distance dimension D,

the slow centering module 71b controls the winch 4 in sheave-in so as to tend to return, advantageously on average, the movable block of sheave(s) 52 to a central position.

[0232] Conversely, if an actuation threshold is reached by decreasing the distance dimension D, the slow centering module 71b controls the winch 4 in pay-out so as to tend to return, advantageously on average, the movable block of sheave(s) 52 to a central position.

[0233] In general, if an end-of-travel threshold is reached, the end-of-travel safety module 72 is executed to actuate the winch 4, in hoist line sheave-in or pay-out as the case may be, so as to actively push back the movable block of sheave(s) 52 with respect to said end-of-travel threshold.

- Launching

[0234] The present invention further relates to the method for lifting a package C, in particular for lifting a package C in the presence of a relative movement due to the swell, by implementing a lifting system 1 according to the invention.

[0235] Thus, it relates firstly to an operation of launching the package C from the origin reference frame Ro to the destination reference frame Rd, in which case the lifting method advantageously comprises several successive steps.

[0236] These steps can be controlled one after the other manually (using a human-machine interface, for example) or, on the contrary, fully automatically. Alternatively, it would also be possible to provide for semi-automated control, in which some steps would be implemented manually while others would be carried out automatically. Here, this launch operation is ensured by the automatic launch module 74.

[0237] Initially, the package is placed on the original reference frame Ro and is attached to the lifting cable 3. The operation is then initiated by an operator who presses an ad hoc button connected to the automatic launch module 74 to that end.

[0238] The first step consists in ensuring that the jaws are in the distal position and placing, using the winch, the movable block of sheave(s) 52 in an average position centered over an available travel.

[0239] According to a preferred embodiment, during a second step, the winch 4 is controlled to perform a heave-in and then pay-out movement, in order to place the safety ring 65 in the inactive position, against the wall of the case 61, outside the cavity 650 delimited by the jaws.

[0240] During a third step, the controlled braking means 6 are controlled in the active configuration. In practice, the actuator 601a exerts a force F1 on the jaws 631, 632 to bring them into a proximal position and hold them therein. In this step, the safety ring 65 does not prevent the jaws 631, 632 from bearing against the sliding rod 531.

[0241] Then, during a fourth step, the winch 4 is controlled in heave-in to lift the package C above the destination reference point Rd (tile V2 in Figure 6). The force exerted by the jaws on the rod will then be all the greater as the weight exerted by the package C on the lifting cable 3 will be significant, which is illustrated by the resultant of the forces F2.

[0242] At the end of this step, the lifting system can then optionally be controlled to transfer the package C to the destination reference frame Rd.

[0243] During a fifth step, the package C was lowered in proximity to the destination reference frame Rd, preferably so that the package reaches this reference frame when the difference in heights between the reference frames is minimal (for example in proximity to the highest wave crests of the swell).

[0244] Thus, the winch 4 is controlled in pay-out, for example in proximity to a wave crest at the end of the rising edge, preferably so that the package C rests on the destination reference frame Rd and descends at the same speed as the latter (to become tangent to the wave crest). Thus accompanying a downward movement of the destination reference frame Rd allows minimizing shocks (i.e. accelerations) perceived by the package C.

[0245] A sixth step of controlling the controlled braking means 6 in the inactive configuration is then provided. In practice, this sixth step may be implemented during, or even before, the fifth step (but after the fourth step). Its implementation is therefore not time-constrained.

[0246] Indeed, this sixth step of switching the controlled braking means 6 to inactive configuration is not necessarily executed immediately: it is executed only when a condition is met. This is known as suspending (or memorizing). The suspensive condition is relative to the force applied by the package C on the sliding rod 531. When this force is greater than a predetermined threshold (relative to the presence of a package suspended from the cable from which it is desired to prevent it from falling freely), the step is inhibited. Indeed, as shown in the tile V3 of Figure 6, the resultant F2 of the forces applied to the sliding rod 531 cannot be counteracted by the force F1 exerted by the actuator 601a to open the jaws, so that the latter remain closed in the proximal position. This sixth step, on the other hand, is executed as soon as the resultant F2 decreases below a threshold (which reflects the fact that the package C is now placed on the destination reference frame Rd). Indeed, as shown in the tile V1 of Figure 6, the resultant F2 of the forces then applied to the sliding rod 531 can be counteracted by the force F1 exerted by the actuator 601a to open the jaws, so that the latter open in the distal position.

[0247] Thus, the jaws 631, 632 only open when the weight of the package C has transferred to the destination reference frame Rd.

[0248] When said package C thus transfers its weight from the lifting cable 3 to the destination reference frame Rd, said lifting system 1 ensures passive compensation of the swell, as set out above.

- Recovery

[0249] The present invention also relates to an operation of recovering the package C in order to return it from the destination reference frame Rd to the original reference frame Ro, in which case the lifting method advantageously comprises several successive steps.

[0250] Again, these steps can be controlled one after the other manually or, on the contrary,

fully automated or semi-automated. Here, this recovery operation is ensured by the automatic recovery module 73.

[0251] Initially, the package is placed on the destination reference frame Rd and is attached to the lifting cable 3. The operation is then initiated by an operator who presses an ad hoc button connected to the automatic recovery module 73 to this end.

[0252] Starting from an inactive configuration as aforementioned in which said lifting system 1 ensures passive compensation of the swell, the lifting method first comprises a step of controlling the controlled braking means 6 to switch them to active configuration, so that the jaws sandwich the sliding rod 531.

[0253] In practice, as shown by the tile V4 in Figure 1, the actuator 601a exerts a force F1 on the jaws 631, 632 to bring them to the proximal position.

[0254] The step of switching the controlled braking means 6 to active configuration is not necessarily executed immediately: it is executed only when a condition is met. It is said to be suspended (or “memorized”). The suspensive condition is this time relating to the direction of displacement of the package C. When the distance dimension D decreases (the package is descending), the step is inhibited. On the other hand, the control is executed as soon as the distance dimension D increases. It is therefore possible that it is executed immediately if this dimension increased when controlling.

[0255] This suspension could be carried out by the control means. However, here, it is advantageously carried out by the safety ring 65 which, when the jaws are in the distal position and the distance dimension D decreases, is placed between the jaws 631, 632, in the cavity 650. Controlling the jaws in the proximal position cannot therefore be executed since the jaws come to abut against this safety ring 65. On the other hand, as soon as the distance dimension D increases, the safety ring 65 is ejected which allows the jaws to reach the proximal position.

[0256] It will be noted that when the safety ring 65 interposes between the jaws 631, 632, it exerts low-intensity friction forces on the pull rod 531, which do not prevent the latter from sliding in the case 61 provided that the weight of the package C is not zero.

[0257] Stated differently, the control is not executed as long as package C follows a downward movement because this would have a possible double consequence, in the worst case, at the maximum relative speed, in the middle of the wave:

- at the moment, to generate a dynamic effect potentially generating damage to the lifting machine and the package, and
- in the next wave, to generate a collision of the destination reference frame Rd under the package, if an immediate and high-speed sheave-in action was not initiated, potentially damaging to the package (but not damaging to the lifting machine).

[0258] When the control is executed (tile V5 in Figure 6), the jaws 631, 632 bear against the sliding rod 531. Since the package C follow an upward movement, the jaws do not block the sliding rod 531 and the movable block of sheave(s) 52 continues its movement by increasing

the distance dimension D. Once it reaches the wave crest, the controlled braking means 6 on the other hand prohibit decrease in the distance D. The start of lowering of the next wave then gradually deposits the package C on the lifting cable 3. At the end, the package C hangs at the end of the lifting cable 3, above and away from the destination reference frame Rd.

[0259] Then, or even before the wave crest, the winch 4 is controlled in heave-in. Preferably, it is controlled in heave-in as soon as the jaws 631, 632 reach their proximal position, with constant acceleration up to a predetermined speed setpoint. The movement of the sliding rod 531 will then follow the difference in speed between what the environment imposes (slack recovery) and what the winch 4 will absorb (which, on the contrary, will tend to reduce the distance dimension D). Thus, for example, during the “mid-wave” phase where the speeds imposed by the environment are greater than the lifting speed by the winch alone 4, the sliding rod 531 will continue to recover slack but, when it arrives at the wave crest, the rewinding speed of the winch 4 will exceed the raising speed of the package C and therefore the sliding rod 531 will be blocked by the jaws 631, 622 and the package C will therefore gradually transfer its weight to the lifting cable 3.

[0260] In all cases, the relative speed of the package C with respect to the original reference point Ro at the time of load transfer from the destination reference point Rd to the lifting cable 3 is absolutely zero. This is a major advantage of the lifting system 1 and its control method since it minimizes the dynamic lifting coefficient (unlike a conventional lifting machine which will necessarily experience a shock with a relative speed much greater than 0 m/s at a time of its operation). As the stresses exerted on the system are thus reduced, it is possible to dimension it accordingly, in favor of its weight, its overall size and its cost.

[0261] If a higher wave crest arrives later, package C may rest on the destination reference frame and rise again under the effect of this wave. In this event, the sliding rod 531 remains free to slide between the jaws, so that the package C does not descend again and is blocked at a new maximum level.

[0262] The package C is then brought back above the original reference frame Ro, then lowered using the winch 4 to the original reference frame Ro.

[0263] At this stage, some observations can be made about this recovery operation.

[0264] The first observation is that if the waves are very small in size, the safety ring 65 may not move to the active position. To avoid this, a slight pay-out setpoint could be applied at the same time as the jaws 631, 632 closing setpoint. In this case, the relative speed of package C with respect to the original reference Ro at the time of load transfer may reach at most the value of the pay-out speed.

[0265] The second observation is that the lifting system 1 as designed makes it possible to control closing of the jaws 631, 632 in the proximal position at any time during the recovery operation, due to the presence of the safety ring 65. Of course, to make the system capable of continuing operations after a fault, it remains preferable to start the recovery operation in a

“wave trough”. But if the operation starts accidentally at another time, this will not affect the safety of the operation thanks to the safety ring.

[0266] The third observation is that slack in the lifting cable 3 and “external play” may appear not due to the lifting system 1 itself, but due to the load C. To understand this, it can be considered that the lifting system 1 includes four lifting points 1a, and therefore four lifting cables 3 that carry straps in pairs for lifting a floating machine. This machine, typically a boat, is then controlled to position itself above the two straps, and these straps are then provided to be raised by the four lifting points. Then, when the jaws 631, 632 close, the cradle formed by the two straps is at zero speed and the floating machine must sit in the straps before being lifted. Thus, the cradle will be recovered and will gain speed relative to the floating machine, so that a residual shock will occur when the boat sits in the straps. Minimizing slack and external play will minimize the relative speed and hence the related dynamic effects.

[0267] The fourth observation is that the end-of-travel stops having a force limiter function, in the event of malfunction or exit from the specified environmental conditions (or in the event of significant external play), the rod will slide between the jaws, which will crest the dynamic effects induced beyond a threshold. In this way, none of the components of the lifting system 1 will be damaged.

[0268] The fifth observation is that if power supply is interrupted:
- in swell compensation: the lifting system 1 being passive, it continues to operate normally;

- in lifting: if package C is in proximity to a reference frame and this reference frame comes back in contact with package C, then the latter rises to the new highest point, which will prevent it from hitting this reference frame several times.

[0269] The sixth observation is that the lifting system 1 set forth, due to its simple and highly mechanized architecture, has a very low reaction time. This reaction time will preferably be less than 4 tenths of a second when it comes to opening or closing the jaws (i.e. less than one tenth of the minimum wave period).

Alternative

[0270] Of course, various other modifications may be made to the invention within the scope of the appended claims.

[0271] Typically, the lifting system 1 could include several pairs of jaws housed in the same case, preferably all controlled by the same actuator. These pairs of jaws could be distributed as a cross around the sliding rod, or overlapping along the sliding rod.

[0272] According to another alternative, maneuvering means different from those described and represented could be contemplated (deformable parallelogram systems) but allowing them, when the jaws are in the proximal position, to block sliding of the sliding rod 531 in one direction only. Typically, the sliding rod and the jaws could be coated with sawtooth notches which would push the jaws outward when the sliding rod tends to move in one direction and which, on the

contrary, would compress the jaws against the sliding rod when the latter tends to move in the opposite direction. According to another alternative embodiment, the jaws could be pushed against the sliding rod by linear actuators inclined relative to the axis of the rod.

[0273] According to another alternative of the invention, the safety means could include, instead of the safety ring 65, a sensor for detecting the direction in which the sliding rod moves and to control the jaws accordingly. However, the solution illustrated in the figures is more robust than a solution based on such a sensor.

CLAIMS

[Claim 1] A lifting system (1) for a package (C), preferably between two reference frames (Ro, Rd) having at least one relative vertical movement, for example for lifting the package (C) in the presence of a relative movement due to the swell, which lifting system (1) comprises at least one lifting point (1a) which comprises a framework (2) including:

- at least one lifting cable (3) associated with:

-- a winch (4), for maneuvering said lifting cable (3), in hoist line heave-in and pay-out,

-- reeving means (5) comprising:

--- a fixed block of sheaves (51), secured to said framework (2), and

--- a movable block of sheave(s) (52), cooperating with said framework (2) by means of slider means (53) defining a translational degree of freedom orthogonally to axes of rotation (51', 52') of said blocks of sheaves, the distance dimension (D) of said movable block of sheave(s) (52) with respect to said fixed block of sheaves (51) being variable,

- controlled braking means (6), cooperating with said movable block of sheave(s) (52) and controllable between two preferably bistable configurations:

-- an inactive configuration, in which said controlled braking means (6) allow said movable block of sheave(s) (52) to move freely in translation according to said translational degree of freedom, especially adapted to a passive compensation of the swell, and

-- an active configuration, in which said controlled braking means (6) allow the movable block of sheave(s) (52) to move in a single direction according to said translational degree of freedom, corresponding to an increase in said distance dimension (D),

- control means (7), for actuating said winch (4) and said controlled braking means (6), especially during the operation of launching or recovering said package (C),

- first maneuvering means (8) that cooperate with said movable block of sheave(s) (52) and which are configured to restore potential energy to said movable block of sheave(s) (52) so as to:

-- when said controlled braking means (6) are in the inactive configuration, tend to keep constant tension in said at least one lifting cable (3) and,

-- when said controlled braking means (6) are in the active configuration, tend to increase said distance dimension (D),

characterized in that said slider means (53) comprise a sliding rod (531) which carries the movable block of sheave(s) (52), which is translationally guided coaxially to said translational degree of freedom and which cooperates with said controlled braking means (6), and

in that said controlled braking means (6) comprise:

- at least two jaws (631, 632) which are distributed about said sliding rod (531), which jaws (631, 632) each include a friction face (631a, 632a) adapted to cooperate with said sliding rod (531),

- second bistable maneuvering means (60) adapted to move each jaw (631, 632) between two

positions:

-- a distal position, at a distance from said sliding rod (531), corresponding to said inactive configuration of said controlled braking means (6), and

-- a proximal position, bearing against said sliding rod (531), corresponding to said active configuration of the controlled braking means (6).

[Claim 2] The lifting system (1) for a package (C) according to claim 1, characterized in that the friction faces (631a, 632a) of the jaws (631, 632) extend parallel to said translational degree of freedom,

and in that said second maneuvering means (60) guide displacement of each jaw (631, 632) according to an arc-of-circle trajectory in which said friction face (631a, 632a) moves in parallel to itself, between said two distal and proximal positions.

[Claim 3] The lifting system (1) for a package (C) according to claim 2, characterized in that the second maneuvering means (60) comprise an actuator (601a) and, for each jaw (631, 632), a deformable parallelogram structure which includes:

- said jaw (631, 632),
- a base (61), and
- at least two pivoted links (602, 603, 604, 605) each assembled in free rotation with said base (61) and with said jaw (631, 632) about two distinct pivot axes,

which deformable parallelogram structure cooperates with said actuator (601a) for maneuvering said jaw (631, 632) between its distal position and its proximal position.

[Claim 4] The lifting system (1) for a package (C) according to claim 3, characterized in that at least two pivoted links (602, 603, 604, 605), belonging to two distinct deformable parallelogram structures, cooperate together through gears (602a, 603a, 604a, 605a), so as to ensure synchronization of the associated jaws (631, 632).

[Claim 5] The lifting system (1) for a package (C) according to any one of claims 3 or 4, characterized in that, in the proximal position, the angle between the plane passing through the pivot axes of each pivoted link and the normal to the friction face (631a, 632a) is between 5° and 9° if the coefficient of static friction between each friction face (631a, 632a) and said sliding rod (531) is between 0.08 and 0.16.

[Claim 6] The lifting system (1) for a package (C) according to any one of claims 1 to 5, characterized in that, at each jaw (631, 632), said lifting system (1) has the following parameters:

- a resultant angle, corresponding to an angle formed by the resultant of the forces applied between said jaw (631, 632) and said sliding rod (531),
- a half angle of a static friction cone, corresponding to the maximum angle with respect to a contact normal oriented perpendicularly to said sliding rod (531) in which a force can be applied to said sliding rod (531) according to said translational degree of freedom without generating

translation of said sliding rod (531) and

in that said lifting system (1) is configured such that, when the jaws (631, 632) are in the active configuration, said resultant angle is less than said half angle of the static friction cone.

[Claim 7] The lifting system (1) for a package (C) according to any one of claims 1 to 6, characterized in that the controlled braking means (6) include mechanical stops (641, 642) to define an end-of-travel position for the jaws (631, 632) which is located beyond said proximal position and which is such that, in the end-of-travel position, all components of the controlled braking means (6) are only elastically deformed.

[Claim 8] The lifting system (1) for a package (C) according to any one of claims 1 to 7, characterized in that the slider means (53) are configured so that said sliding rod (531), and its translational degree of freedom, are oriented horizontally or vertically,

and in that, when said translational degree of freedom is oriented vertically, the controlled braking means (6) include means for compensating the weight of the jaws (631, 632).

[Claim 9] The lifting system (1) for a package (C) according to any one of claims 1 to 8, characterized in that the controlled braking means (6) comprise safety means which are configured to prevent control from the inactive configuration to the active configuration during a translation of the sliding rod (531) corresponding to a decrease in said distance dimension (D).

[Claim 10] The lifting system (1) for a package (C) according to claim 9, characterized in that the safety means comprise a safety ring (65) which encircles said sliding rod (531) so as to move between two positions:

- an active position, during a translation of the sliding rod (531) corresponding to a decrease in said distance dimension (D), to cooperate with the jaws (631, 632) in the inactive configuration and prevent control from the inactive configuration towards the active configuration, and
- an inactive position, during a translation of the sliding rod (531) corresponding to an increase in said distance dimension (D), to move away from the jaws (631, 632) in the inactive configuration and to allow control of said jaws (631, 632) from said inactive configuration to said active configuration.

[Claim 11] The lifting system (1) for a package (C) according to any one of claims 1 to 10, characterized in that it consists of:

- a crane including a lifting point, the framework of which includes a post and a boom, or
- a gantry including at least two lifting points.

[Claim 12] A method for lifting a package (C), between two reference frames (Ro, Rd) preferably having at least one relative vertical movement, for example for lifting the package (C) in the presence of a relative movement due to the swell, by implementing a lifting system (1) according to any one of claims 1 to 11,

which lifting method comprises:

- for switching from the proximal position to the distal position of the jaws (631, 632):

-- controlling the second maneuvering means (60) to move the jaws (631, 632) from the proximal position to the distal position, and then,

-- if a force exerted on the sliding rod (531), coaxially to said translational degree of freedom along a direction corresponding to a decrease in said distance dimension (D), is less than a predetermined threshold, executing said control, otherwise

-- suspending said control until said force decreases below said predetermined threshold, and then executing said control,

- for switching from the distal position to the proximal position of the jaws (631, 632):

-- controlling the second maneuvering means (60) to move the jaws (631, 632) from the distal position to the proximal position, and then,

-- if said distance dimension (D) increases, executing said control, otherwise

-- suspending said control until said distance dimension (D) increases.

[Claim 13] The lifting method according to claim 12, characterized in that it comprises the following operations:

(i) during an operation of launching said package (C) from the reference frame (Ro) of the lifting system (1) to a destination reference frame (Rd):

- a step of suspending said package (C) from said lifting cable (3), wherein the jaws (631, 632) are in the distal position and said movable block of sheave(s) (52) is in an average position centered over an available travel,

- optionally, in combination with claim 10, a hoist line heave-in and then pay-out step over a travel for positioning the safety ring (65) in the inactive position,

- a step of controlling closure of the jaws (631, 632) towards the proximal position,

- a heave-in step to lift the package (C) and place it above the destination reference frame (Rd),

- a step of lowering said package (C) in proximity to the highest wave crests of the swell,

- when the package (C) is placed on a wave crest or in proximity to a wave crest at the end of the rising edge, a hoist line pay-out step, preferably to become tangent to said wave crest, and of switching from the proximal position to the distal position of the jaws (631, 632), so that when said package (C) transfers its weight from said lifting cable (3) to said destination reference frame (Rd), said lifting system (1) ensures passive compensation of the swell,

and/or

(ii) during an operation of recovering said package (C) located on the destination reference frame (Rd), the jaws (631, 632) being in the distal position, said lifting system (1) ensuring passive compensation of the swell,

- preferably when said package (C) is in an upward movement, a step of switching the jaws (631, 632) to the proximal position so that said movable block of sheave(s) (52) continues its movement increasing said distance dimension (D), this up to a wave crest where said movable

block of sheave(s) (52) is translationally blocked,

- as soon as the jaws (631, 632) reach the proximal position, a hoist line heave-in step to lift the package (C) and place it above the reference frame (Ro) of the lifting system (1),
- a step of lowering said package (C) onto the reference frame (Ro) of the lifting system (1).