

ACTIVE DEPLOYMENT SYSTEM AND METHOD

BACKGROUND OF THE INVENTION

Related Applications

- 5 This Application claims the benefit under Title 35 of United States Code § 119(e) of U.S. Provisional Application No. 60/194,822, filed April 5, 2000.

Technical Field

- 10 This invention relates to the field of lifting/deployment devices capable of maintaining tension on a cable or wire rope line. More specifically, the invention relates to a system and method for maintaining controlled lifting conditions as applied to a mass or load
15 handled from a moving lifting platform, such as an offshore drilling rig.

History of the Related Art

- 20 Under moving sea conditions, a majority of floating marine vessels, such as offshore drilling rigs, find difficulty in deploying sub-sea machinery due to the problems imposed by rig heave. The oscillations of the vessel make it difficult to land heavy equipment using ordinary deployment systems due to the movement imposed on
25 the deployment system by changing wave conditions. Thus, under heaving vessel conditions, the equipment or machinery being deployed may encounter a sudden drop to the ocean floor on the downward heave cycle. Due to this risk, most deployment operations occur in calm seas, and are delayed
30 whenever wave conditions become unfavorable.

- Some passive methods of deployment operate to compensate for the motion of the vessel. However, such passive compensators typically operate to absorb only a small portion of the vessel heave distance. Even with the
35 ability to absorb vessel heave, however, it is still held

to be good practice by those experienced in the art to wait for favorable sea conditions (i.e., calm seas).

Therefore, what is needed is an active deployment system for regulating a distance between deployed equipment and a destination delivery point (e.g., the ocean floor) wherein the equipment is suspended above the destination point from a cable attached to a moving deployment platform. Such a system and method would be even more valuable if the length of the cable could be adjusted in proportion to the movement direction and velocity.

SUMMARY OF THE INVENTION

The active deployment system and method of the invention allow equipment deployment operations to proceed during a wide variety of deployment platform movement. For example, the active deployment system and method can be used to assist in deployment of sensitive scientific instruments to the ocean floor from a heaving vessel.

In essence, the active deployment system comprises a passive cylinder system coupled with an active cylinder system. The passive system, including a pre-charged accumulator, provides load balance for the equipment or other mass/load being deployed. Pressure provided to the blind end of the passive cylinder provides the majority of support for the load, as commonly occurs in conventional pneumatic cylinder arrangements. In the static condition, the passive cylinder is balanced at mid-stroke with the load hanging from a cable. A sheave arrangement, placed at opposite ends of the passive cylinder-active cylinder combination, is used to introduce a cable travel multiplier for cylinder displacement. Thus, when the platform moves, for example, a distance of 16 meters with respect to the delivery point, the cylinder combination needs only to move a distance of 4 meters to compensate so as to allow the

load to remain stationary in space (with respect to the delivery point).

The active cylinder is controlled hydraulically to add or remove loading to/from the passive cylinder system in order to provide a compensating balance. Accelerometers measure platform movement (velocity and direction), sending a signal to a hydraulic power unit which provides hydraulic flow and pressure to extend or retract the system in phase with (and opposite in direction to) the platform movement.

Thus, the active deployment system includes a cable tensioner supporting a cable in reeved engagement with a cable suspending the load, and in mechanical engagement with a supporting platform. The cable tensioner includes a rod assembly adapted to apply tension force to the cable under heaving conditions. The deployment system also includes an accelerometer (to measure platform heave movement) and a stroke sensor for measuring movement of the rod assembly within the cable tensioner. The accelerometer provides a heave movement signal, and the stroke sensor provides a feedback signal in response to movement by the rod assembly. Finally, the deployment system includes a processing means in electrical communication with the cable tensioner, accelerometer, and stroke sensor which monitors the heave movement and feedback signals, and regulates the distance between the load and the destination point by adjusting the tension force applied to the cable.

The cable tensioner typically comprises a passive cylinder system and an active cylinder system in combination. The passive system is pre-charged to support the load, while the active system moves in phase with the support platform heave. The rod assembly within the cable tensioner is moved in proportion to the heave velocity and direction.

The method for regulating the distance between the mass and the destination point makes use of the active

deployment system. Essentially, the method comprises the steps of measuring a heave movement (velocity and direction), and adjusting the tension force applied to the cable upon determining that the heave velocity exceeds a
5 preselected critical velocity. Typically, the tension force is adjusted by adjusting the rate of at least one fluid flow within the cable tensioner, such as the hydraulic fluid flow applied to the active cylinder system.

10 BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the structure and operation of the present invention may be had by reference to the following detailed description when taken in conjunction with the accompanying drawings, wherein:

15 FIGURES 1A and 1B illustrate perspective views of two different embodiments of the system of the present invention;

FIGURE 2 is an operational flow chart for the system of the present invention;

20 FIGURE 3 is a logical block diagram of the system of the present invention;

FIGURES 4A and 4B illustrate perspective, and side, cut-away views of the deployment system cylinder of the present invention, respectively;

25 FIGURES 4C and 4D illustrate section views of the Deployment System Cylinder of the present invention; and

FIGURE 5 is a flow chart illustrating the method of the present invention.

30 DETAILED DESCRIPTION

Referring now to Figures 1A and 1B, two different embodiments of the system **10, 10'** of the present invention can be seen. Numeric designators are used to refer to specific elements of the structure. Those corresponding
35 designators including a prime (') symbol refer to elements

having a similar or identical structure and function to those elements having numeric designators without the prime symbol.

Figure 1A illustrates the active deployment system 10 of the present invention as it might be mounted to, or mechanically engaged with, the rig structure 80 of an offshore drilling rig. Of course, the rig structure 80 may also be described as a "heaving vessel", a "platform", or any other base, framework, or structure to which the system 10 may be fixedly attached. It is assumed throughout this description that the rig structure 80 moves in accord with the wave motion of the sea (or a corresponding medium supporting/surrounding the structure 80).

The active deployment system 10 operates to regulate the distance LD between the mass or load 60 and a destination point 195 toward which the load 60 is being deployed. Typically, the load 60 is suspended above the destination point 195 from the distal end 37 of a cable 30. The proximal end 33 of the cable 30 is in reeved engagement with the cable tensioner or Deployment System Cylinder (DSC) 20, using the rod end sheaves 120 and the blind end sheaves 130.

The system 10 comprises the Deployment System Cylinder (DSC) or cable tensioner 20, an accelerometer 32, a stroke sensor 40, and a processing means 150, such as a central control unit 150. The accelerometer 32 may be embodied as a single, multi-axis accelerometer, which gives directional velocity signal information along the traditional X, Y, and Z axes (commonly known as a "six" axis accelerometer to those skilled in the art, for +X, -X, +Y, -Y, +Z, and -Z acceleration axes). The accelerometer 32 may also be made up of several unitary accelerometers which provide velocity and/or directional heave movement information for the structure 80. The stroke sensor 40 is typically embodied

in the form of a potentiometer, but may also be embodied in an encoder (linear or rotary), or other position measurement devices well known to those skilled in the art. The cable tensioner or DSC 20 is in reeved engagement with the proximal end 33 of the cable 30, and in mechanical engagement, typically fixedly attached, to the heaving vessel structure 80, or other structure, as described above.

The accelerometer 32 provides a vessel heave movement signal in proportion to the velocity and direction (heave velocity and heave direction) of the heaving vessel structure 80. The stroke sensor 40 is used for measuring movement of a rod assembly within the DSC 20, providing a feedback motion signal in proportion to the piston rod movement distance within the rod assembly. As can be seen in Figure 1B, the Heave Velocity (HV) and Heave Direction (HD) are a measure of the heave movement by the base 160 of the system 10' illustrated in Figure 1B as it moves in response to wave motion, for example, as the wave surface 190 moves from a first location L1 to a second location L2. The processing means, such as the central control unit 150, is in electrical communication with the cable tensioner 20 (using the Hydraulic Power Unit (HPU) 50 and the stroke sensor 40). The processing means 150 monitors the heave movement signal produced by the accelerometer and the feedback signal provided by the stroke sensor, and regulates the LD by adjusting the tension force F applied to the cable 30.

As can be seen in Figure 1A, the HPU 50 may also include a HPU control unit 110, for manual control or fine adjustment of the position of the active cylinder assembly 400. There is also a high pressure air supply 100 which is regulated by an air control 90 by way of an air line 180, as is well known to those skilled in the art. The air

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control 90 can be used to pressurize the passive cylinder system to balance the load 60.

The system 10, 10' operates by making use of a passive cylinder system 410, including a pre-charged accumulator, to provide balance for the load 60 to be deployed to the destination point 195. The pressure within the accumulator of the passive cylinder system 410 provides force on the blind end of the cylinder 410 to support the load 60, as occurs in conventional pneumatic cylinder arrangements. The accumulator of the passive cylinder system 410 is sized to manipulate the mechanical stiffness of the system 10, 10'. In the static condition, the cylinder 410 is balanced at mid-stroke with the load 60 hanging from the cable 30 30', which is in turn reeved one or more times around a sheave arrangement placed on the opposite ends of the deployment cylinders, viz, the rod end sheaves 120, 120' and the blind end sheaves 130, 130'. Typically, the reeving arrangement provides about a 4:1 cable line travel ratio with regard to the DSC 20 displacement. Thus, as the load 60 moves 4 meters, the DSC 20 moves only one meter. However, if the passive cylinder system 410 were used alone, acceleration of the load 60 caused by vessel heave would create an unbalanced system. Thus, a single passive cylinder system 410 would be ineffective to provide fully-compensated load 60 movement, as the pressure within the passive cylinder system 410 varies with the stroke of the cylinder, which in turn provides a varying reaction force to the tension on the cable 30 produced by the load 60.

The system 10, 10' of the invention solves the problem of varying pressure within the passive cylinder system 410 by incorporating an active system or active cylinder assembly 400, which is controlled hydraulically (using the HPU 50, 50' and central control unit 150, 150'), to add or

remove tension on the cable 30 in order to provide a fully-compensating balance for vessel heave and the weight of the load 60.

Accelerometers, such as the accelerometer 32, measure the HV and HD, providing signals proportional thereto, and send signals to the HPU 50 (and/or central control unit 150), which controls the hydraulic pump and motor system supplying hydraulic fluid through the hydraulic lines 170 to the active cylinder assembly 400. The stroke sensor 40 provides the feedback motion signal to the HPU 50 (and/or central control unit 150) in a similar fashion, so that the actual motion of the cylinder rod can be monitored as it responds to the hydraulic pump and load 60. Thus, the active system 400 is provided with hydraulic flow and pressure to extend or retract the piston rod within the cylinder 410 as necessary to maintain deployment of the load 60 in phase with the heaving vessel or structure 80, as the winch 140 lowers or raises the load 60 by means of the rod end sheaves 120, blind end sheaves 130, and turn down sheaves 70.

Thus, the Active Deployment System (ADS) 10, 10' maintains nearly constant motion control of the load or mass 60 by controlling the length of cable 30 attached to the load 60 relative to the floating vessel or structure 80, 160. Attaching the cable at the distal end 37 to the load 60, and reeving the proximal end 33 several times around the rod and blind end sheaves 120, 130, affording a travel distance advantage to the DSC 20, allows the ADS 10 to act as a powerful hydro-pneumatic spring. The cable 30 length, measured from the winch 140 to the load 60, is controlled in direct response to the heaving motion of the vessel or structure 80, 160. High pressure air is utilized on the blind end of the passive cylinder system 410 as a load-supporting medium. No adjustment of the air volume on

the blind end side of the cylinder 410 is necessary, once the weight of the load 60 has been established and balanced.

A high-pressure air supply 100 is connected to the cylinder 410 to meet the required load, and hydraulic fluid, carried in the lines 170, is used in the active cylinder assembly 400 to provide constant motion control, as well as speed control of the rod in the event of cable 30 breakage. To understand the operation of the speed control in the active cylinder assembly 400, please refer to co-pending patent application No. 09/733,227, herein incorporated by reference in its entirety. This specially designed and calibrated speed limiting system is provided as an adjunct to the active cylinder assembly 400 to limit the terminal velocity of the active cylinder piston (see piston 420 in Figure 4B).

The ADS 10 is therefore an active device. Signals from the stroke sensor 40, which allow the processing means or central control unit 150 to monitor the motion of the piston 420, and signals from the accelerometer 32, which allows the central control unit to monitor the reaction of the structure 80, 160 in response to movement of the wave surface 190, are processed and sent to the HPU 50 to match the movement of the vessel or structure 80, 160, keeping the load 60 stationary. As the vessel or structure 80, 160 heaves upward or downward on the wave surface 190, the HPU 50, in electronic communication with the central control unit 150, is signaled to stroke the piston 420 in or out of the active cylinder assembly 400 to maintain the desired location of the load 60. Typically, the piston 420 is commanded to move with the same velocity as the heave velocity HV of the structure 80, 160, and in a direction which opposes the heave direction HD (as measured by the accelerometer 32).

Turning now to Figure 2, an abbreviated operational diagram for the system 10 can be seen. After taking the system out of a standby status in step 700, the system 10 heave sensing and compensation systems are disabled, and the winch cable is prepared for stroking the passive cylinder 410 to its mid-point. The cylinder 410 is charged in step 720, and the load 60 is deployed through the splash zone into the water in step 730. At this point, an auto-centering program is activated, and the active cylinder 400 is centered using the hydraulic pump in steps 740 and 750, and the system 10 is placed into the active compensation mode in step 760.

The load 60 is deployed while the active mode is maintained in step 770. If it is determined that the structure 80 will remain attached to the wellhead in step 780, and that the operator desires merely to deploy the load 60 using tension in the cable 30 in step 790, then active compensation, along with auto-centering, and heave sensing, will be turned off in step 800. If the operator decides to deploy the load 60 using the active system in step 790, then the winch cable 30 is slackened in step 810 and the active compensation mode remains enabled. The load 60 is then retrieved in steps 820 and 830 until it is safely clear of the wellhead. The active cylinder 400 is then taken out of the active compensation mode in step 840.

If the operator determines that the structure 80 will not remain attached to the wellhead in step 780, then the active compensation mode remains engaged and the structure 80 is removed from the wellhead. After the removal operation is completed, the active compensation mode is terminated in step 840.

Turning now to Figure 3, a logic block diagram of the system 10 of the present invention may be seen. Each of the components of the diagram may be embodied as

electronic and/or mechanical hardware, software, or a combination of these. Thus, for example, the first adder module 200 may be an integrated circuit, a software program module, a series of operational amplifiers, or even a mechanical assembly capable of summing various mechanical inputs, as are well known to those skilled in the art of control system operation. Any of the other modules 210-370 may likewise exist in the form of the various components.

There are two sets of signal/feedback information which are used to drive the operation of the system 10. The first is provided by the stroke sensor 40, appearing in Figure 3 as the cylinder position feedback module 240 for the active cylinder assembly 400. The second is the heave movement detection system, which measures the heave velocity HV and direction HD, represented by the wave accelerometer module 320. The position of the piston 420 is determined several times a second, and from this, the distance, velocity and acceleration of the piston 420 can be determined.

The heave direction 355 may be fed forward from the accelerometer 320. The adder 200, in turn, feeds into the second adder module 210 and creates a hydraulic pump demand at the adder 210 output, which feeds into the pump motor 220. The pump demand, in turn, causes the swash valve 230 to open, causing the DFC 20 to move. The position information derived from the movement of the DSC 20, as tracked by the cylinder position module 240, is fed back, after combination with a position offset signal 280 if desired, (such as may be derived from movement by the passive cylinder 410 due to changes in the load cable 30 weight, for example) using the third adder module 260 as a DSC position feedback signal 270. The signal 270 is then multiplied by several feedback signals 290, 300, and 310 for input into the first adder module 200.

While the wave accelerometer module 320, combined with the stroke sensor module 240, provides piston position, vertical velocity, and vertical acceleration information, the heave velocity feedforward multiplier module 340, and
5 the heave acceleration feedforward multiplier module 330 are used to tailor the system 10 response with regard to the velocity, and acceleration signals which are fed forward into the first adder module 200.

The KVFF 340 is a velocity feedforward multiplier.
10 The heave velocity information from the heave movement accelerometer input is multiplied by the KVFF factor to allow the DSC 20 to change position faster when ocean waves are in a dynamic state. Thus, the mechanical portions of the system 10 can react faster as the velocity of the wave
15 (and therefore, the HV) changes. As the wave activity subsides, the KVFF plays an increasingly small part in determining the final DFC 20 position. The units for KVFF are in terms of second/meter or second/feet.

The KAFF is an acceleration feedforward multiplier.
20 The heave velocity information is differentiated with respect to time to give the rate of change of heave velocity. The acceleration so derived is multiplied by the KAFF to allow the DSC to react quickly, as soon as heave movement due to wave motion is detected. It is the KAFF
25 signal which enables the system 10 to more immediately respond to the onset of wave activity. The larger the value of the KAFF, the faster the system 10 reacts. However, if the KAFF value is too large, then the DSC 20 will react to mere wave noise, rather than actual waves.
30 The units of operation for the KAFF are second squared/meter or second squared/feet.

The feedback signals KPFB (position feedback), KVFB (velocity feedback), and KAFB (acceleration feedback) are analogs of the feedforward signals. Thus, the DSC position
35 feedback multiplier module 290, the DSC velocity feedback

multiplier module 300, and the DSC acceleration feedback multiplier module 310 act in opposition to the feedforward signals to stabilize the system 10. Typically, the absolute values of the KPFB, KVFB, and KAFB multipliers cannot be determined until the actual system is tested, or at least simulated, to derive reaction time information for the mechanical components activated by operation of the swash valve 230. The swash valve position feedback module 250 provides a simple feedback loop for the swash valve controls to ensure that the swash valve 230 position approximately matches the demand. For example, when the demand is 50%, then the swash valve should be open at approximately 50% of its fully open value. The KPS value is positional feedback only for the swash valve 230. The larger the value of KPS, the longer the swash valve 230 will take to reach its final position; however, larger values also contribute to stability. The value of KPS is dimensionless.

The bias module 370 constitutes a low-priority input to the adder module 200, and serves to maintain the position of the load when minimal or no vessel heave is present. However, when the heave velocity exceeds a predetermined critical heave velocity, the bias signal provided by the module 370 is overridden, and the heave compensation system (actively compensated system) takes over.

Figures 4A and 4B illustrate perspective and side, cut-away views of the DSC 20 of the system 10, respectively. As mentioned above, the DSC 20 includes an active cylinder assembly 400 and a passive cylinder system 410. The piston 420 which moves in and out of the active cylinder assembly 400 is fixedly attached to the rod end sheave support 380, which in turn houses the rod end sheaves 120. As can be most easily seen in Figure 4A, the

stroke sensor 40 is typically mounted to the side of the active cylinder assembly 400, and a stroke wire 390, typically rotatably attached to the stroke sensor 40 and fixedly attached to the rod and sheave support 380, is used to derive the position of the piston 420.

As can be more clearly seen in Figure 4B, the passive cylinder system 410 comprises an annular tube or passive cylinder accumulator 440 used as an air bank to hold a volume of air at the pressure necessary to support the load 60 applied to the passive cylinder system 410, which includes the weight of the piston 420, the load 60, and the cable 30. The accumulator 440 houses the inner barrel 460 of the passive cylinder system 410, which in turn is ported to allow air or other fluid media to move from the accumulator 440 to support the passive cylinder rod 450. Thus, the annulus 490 (accumulator) can be pre-charged to the desired pressure for suspending the load 60 such that the cylinder rod 450 is moved to mid-stroke within the body of the passive cylinder system 410. The annulus 510 serves to retain air as pressure builds against the piston 450.

Directly attached to, and in line with, the passive cylinder system 410 is the active cylinder assembly 400. The passive cylinder rod 450 extends up through the passive cylinder inner barrel 460 into the active cylinder assembly 400, where it is threaded into, or otherwise attached, to the bottom of the active cylinder piston 420. Thus, the passive cylinder rod 450 and the active cylinder piston 420 form an integral unit, called the rod assembly 540. It is the position of the rod assembly 540 which is monitored by the stroke sensor 40 and passed on to the central control unit 150 to determine the position, distance traveled, velocity, and acceleration of the DSC 20. To better understand the operation of the DSC 10 as it operates in an uncompensated environment, reference may be made to U.S.

Patent No. 4,638,978, incorporated by reference herein in its entirety.

When hydraulic fluid is pumped into the active cylinder housing 430, via hydraulic ports 550 (and
5 hydraulic lines 170), hydraulic force is applied to the active cylinder piston 420, and thereby, the rod assembly 540, as hydraulic pressure builds within the annulus 520. The hydraulic force is controlled using the HPU 50, which monitors the displacement of the DSC 20 (directly, or
10 indirectly, via the control unit 150) relative to rig heave movement HV, HD. The HPU 50, as commanded by the central control unit 150, provides flow and pressure using hydraulic fluid, or other fluid media, which may even be air or gas, to the active cylinder piston 420, pushing up
15 and down on the piston 420 as necessary.

Thus, in operation, as can be clearly seen from Figures 1A, 1B, and 4A, after the cable 30 is fed off of the winch 140, it is reeved from the winch 140 through one of the outer sheaves on the blind end sheaves 130 (possibly
20 after passing over an alignment sheave), and then up over one of the rod end sheaves 120 at the top of the active cylinder assembly 400. The cable 30 is then reeved back down through a second sheave in the housing for the blind end sheaves 130, and up again to one of the remaining rod
25 end sheaves 120. The cable 30 is then reeved through the last (empty) sheave of the blind end sheaves 130 (assuming that there are three blind end sheaves 130 and two rod end sheaves 120) to one or more turndown sheaves 70 placed apart from the system 10 on the rig 80 or other structure
30 80. The load 60 is then supported on the distal end 37 of the cable 30, and pressure is applied to the accumulator 440 using the air input port 470 until the rod assembly 540 is stroked at mid-position. The stroke sensor 40, typically mounted at the top portion of the active cylinder

assembly 400, provides position change information for the rod assembly 540 (i.e., the distance MD shown in Figure 1B). The accelerometer 32 provides heave movement information for the structure 80, such as the heave velocity HV and heave direction HD. These signals from the accelerometer 32 and the stroke sensor 40 are provided to the HPU 50 (typically, via the central control unit 150). From the rod positional information MD, the HV and HD, velocity and acceleration can be derived for the movement of the rod assembly 540 and acceleration can be derived for the heaving movement of the rig structure or base 80, 160. The central control unit 150, including the control logic of the system 10 shown in Figure 3, actuates the HPU 50 to provide the correct flow and pressure of hydraulic fluid through the hydraulic lines 170 to the hydraulic ports 550 of the active cylinder assembly 400.

Thus, the active deployment system 10 for regulating a distance LD between a mass/load 60 and a destination point 195, when the mass 60 is suspended above the destination point 195 from the distal end 37 of the cable 30 attached to a heaving vessel (or other moving platform structure) 80 at the proximal end 33 of the cable 30 includes a cable tensioner 20, an accelerometer 32, a stroke sensor 40, and a processing means in electrical communication with the cable tensioner 20, the accelerometer 32, and the stroke sensor 40. The accelerometer 32 and the stroke sensor 40 provide the two signals necessary for system 10 operation: the position (or movement distance) of the rod assembly MD, and the heave movement signal, including HV and HD. The cable tensioner 20, in reeved engagement with the proximal end 33 of the cable 30, and mechanically engaged to the heaving vessel (or other support structure) 80, includes a rod assembly 540 adapted to apply a tension force F to the cable 30 under heaving conditions. The processing means

150, such as the central control unit 150 (which may be a computer or other data processing means well known to those skilled in the art) is adapted to monitor the MD, HD, and HV signals, and to regulate the distance LD by adjusting the tension force F applied to the cable 30.

5 The cable tensioner or DSC 20 includes a passive cylinder system 410 including a passive cylinder rod 450 and an active cylinder assembly 400 housing the rod assembly 540. The rod assembly 540 is formed by fixedly attaching an active cylinder piston 420 to the passive cylinder rod 450.

The passive cylinder system 410 is pre-charged with air (or other fluid media) to a mid-stroke position of the passive cylinder rod 450 so as to suspend the mass 60 at the distance LD, and to balance the weight of the mass 60. The tension force F applied to the cable 30 is adjusted by moving the rod assembly 540 in proportion to the heave velocity (HV), and in the opposite direction to the heave direction (HD). The tension force F on the cable 30 may also be adjusted by moving the rod assembly 540 in opposite proportion to the heave velocity and heave acceleration, as measured by the wave accelerometer module 320.

Figure 5 illustrates the method of the invention. As mentioned previously, the passive cylinder system 410 is pre-charged with air (or other fluid media, such as oil) so that the rod assembly 540 is at a mid-stroke position in step 600. After this operation, active management of the load 60 position with respect to the destination/delivery point 195 begins.

30 The method for regulating the distance LD between the mass 60 and the destination point 195, wherein the mass 60 is suspended by the destination point 195 from the distal end 37 of the cable 30 in reeved engagement with the cable tensioner 20 includes the steps of: measuring the heave

movement (HV and HD) experienced by the heaving vessel (or other moving platform structure) 80, 160, along with the rod assembly 540 movement distance MD, and adjusting the tension force F applied to the cable 30 upon determining
5 that the heave velocity HV exceeds a preselected critical velocity. Thus, the heave velocity/direction and rod assembly movement distance are measured in step 610, the heave velocity is compared with a predetermined critical velocity in step 620. Then, if the critical velocity has
10 been exceeded, the tension force F on the cable 30 is adjusted in step 630. The tension force F can be adjusted by changing or adjusting the rate of at least one fluid flow within the tensioner 20, such as the flow of hydraulic fluid into and out of the hydraulic ports 550. This occurs
15 in step 640, the rod assembly can then be moved in opposite proportion to heave velocity, and/or acceleration, in step 650.

Although the invention has been described with reference to specific embodiments, this description is
20 meant to be construed in a limited sense. The various modifications of the disclosed embodiments, as well as alternative embodiments of the invention, will become apparent to those persons skilled in the art upon reference to the description of the invention. It is, therefore,
25 contemplated that the appended claims will cover such modifications that fall within the scope of the invention, or their equivalents.

What is claimed is:

1. An active deployment system connector for regulating a distance between a mass and a destination point, wherein the mass is suspended above the destination point from a distal end of a cable attached to a moving platform at a proximal end of the cable, the system comprising:

a cable tensioner in reeved engagement with the proximal end of the cable and in mechanical engagement with the moving platform, wherein the cable tensioner includes a rod assembly adapted to apply a tension force to the cable under heaving conditions;

an accelerometer for providing a heave movement signal in proportion to a heave distance of the moving platform;

a stroke sensor for providing a feedback motion signal in proportion to a movement distance of the rod assembly; and

a processing means in electrical communication with the cable tensioner, the accelerometer, and the stroke sensor, wherein the processing means is adapted to monitor the platform movement signal and the feedback motion signal, and to regulate the distance by adjusting the tension force applied to the cable.
2. The active deployment system of claim 1, wherein the cable tensioner comprises a passive cylinder including a passive cylinder rod and an active cylinder including an active cylinder piston, and wherein the passive cylinder rod is attached to the active cylinder piston to form a rod assembly.
3. The active deployment system of claim 2, wherein the passive cylinder system is pre-charged with air to a mid-stroke position of the passive cylinder rod so as to suspend the mass at the distance.
4. The active deployment system of claim 3, wherein the tension force applied to the cable is adjusted by moving the rod assembly in opposite proportion to the heave movement signal.
5. The active deployment system of claim 4, wherein the heave movement signal includes a heave velocity.
6. The active deployment system of claim 5, wherein the heave movement signal includes a heave direction.