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(54) **OFFSHORE DRILLING VESSEL AND INSTALLATION FOR PERFORMING SUBSEA WELLBORE RELATED ACTIVITIES**

OFFSHORE-BOHRSCHIFF UND ANLAGE ZUM DURCHFÜHREN VON AKTIVITÄTEN IM ZUSAMMENHANG MIT UNTERWASSERBOHRLÖCHERN

NAVIRE DE FORAGE EN MER ET INSTALLATION POUR RÉALISER DES ACTIVITÉS ASSOCIÉES À UN Puits DE FORAGE SOUS-MARIN

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Description

[0001] The invention relates to an offshore drilling vessel and installation for performing subsea wellbore related activities.

[0002] In the field some offshore drilling vessels are in use that are provided with a drilling installation that is known under the tradename RamRig, originally developed by the company Maritime Hydraulics AS in Norway.

[0003] For example, US6095501 and US6094910 disclose an offshore drilling vessel with a RamRig drilling installation having tower that is positioned on the floating hull over or adjacent to the moonpool and with a main hoisting device. This main hoisting device comprises:

- a travelling top drive carrier adapted to support a top drive and a drilling tubulars string extending along a firing line through said moonpool;
- a top sheave assembly that is guided vertically relative to an elevated portion of the tower and comprises carrier suspension cable sheaves,
- vertically oriented hydraulic piston-and-cylinder type lift devices, each having a cylinder body and a piston rod, said lift devices each having one of the cylinder and the piston rod thereof fixed in relation to the hull and the other one of the cylinder and the piston rod supporting the top sheave assembly thereon so as to be vertically mobile relative to the tower,
- carrier suspension cables, each carrier suspension cable having one end thereof secured to the travelling top drive carrier and extending over a respective sheave of the top sheave assembly to another end of the carrier suspension cable, said other end being connected to one of an anchor that is fixed in relation to the hull,
- a hydraulic circuit connected to said lift devices and including a hydraulic pump, said hydraulic circuit being configured to lift and lower the travelling top drive carrier by extension and retraction of the one or more lift devices.

[0004] A prior art RamRig embodiment is represented in figures 1a,b and 2a,b of the present document.

[0005] In the operational RamRig installations, a set of hydraulic pumps in the hydraulic circuit to provide a desired hydraulic liquid flow to the lift devices. The heave compensation of the travelling top drive carrier is achieved by means of these lift devices. The hydraulic circuit includes a pressurized gas buffer connected via a piston accumulator to the hydraulic circuit. Active heave compensation is obtained by control of the hydraulic pumps on the basis of a heave sensor, which results in controlled extension and retraction of the lift devices. Passive heave compensation is done on the basis of the pressurized gas buffer as is known in the art. Effectively the piston rods of the lift devices rest on a gas spring. Hoisting and lowering is possible by means of control of the pumps.

[0006] In WO2017/192046, a further development of the RamRig installation is disclosed. Herein, the main difference is that the other ends of the carrier suspension cables are not connected to a respective anchor. Instead, the ends of these cables are connected to a winch that is fixed in relation to the hull. In more detail, all carrier suspension cables are wound on a common drum of the winch, all in a single layer. This document explains that in addition to the carrier suspension cables being connected to the winch, operable anchor devices can be provided that are fixed in relation to the hull and are selectively engageable with these cables to provide an anchor like in US6095501 and US6094910, e.g. allowing when hoisting heavy loads by means of the lift devices only or when performing maintenance on the winch.

[0007] Concerning heave compensation WO2017/192046 discloses that the winch can be embodied as the winch and/or the lift devices can be provided with heave compensation functionality. It is explained that, in an embodiment, the heave compensation as disclosed in US6095501 and US6094910 can be used for the lift devices, e.g. when handling a heavy load, whereas the winch can be operated to provide heave compensation when handling a lighter load.

[0008] In the known vessel having a RamRig installation, as also shown in US6095501, US6094910, and WO2017/192046, a drill floor is stationary arranged above the moonpool, with a slip device being mounted on the drill floor as is common in the field. The slip device is configured to suspend a tubulars string in the firing line, e.g. when tripping in or tripping out a drill string from a subsea wellbore, or during an actual drilling process.

[0009] WO2016/062812 discloses an offshore drilling system wherein heave compensation of the travelling block employs a hydraulic sheave compensator which moves synchronously with a heave compensator of a mobile working deck.

[0010] The present invention aims to provide an enhanced drilling vessel, e.g. in view of enhanced performance in operations that required or would benefit from heave motion compensation.

[0011] The present invention provides an offshore drilling installation configured for mounting on a drilling vessel according to claim 1, and an offshore drilling vessel for performing subsea wellbore related activities according to claim 2, which comprises the offshore drilling installation according to claim 1. The claimed installation is provided e.g. in view of retrofitting existing drilling vessels.

[0012] The installation is characterized in that a vertically mobile working deck is provided, which is vertically movable with respect to the tower and to the hull along the firing line within a motion range including a heave compensation motion range,

wherein the working deck is provided with a slip device that is configured to suspend a tubulars string in said firing line,

wherein the vertically mobile working deck is suspended from at least one working deck suspension cable,

wherein said at least one working deck suspension cable is reeved independent from the one or more lift devices, so that vertical position and vertical motion of the working deck are independent of the operation of said one of more lift devices,

and in that an integrated heave compensation system is provided that is configured to establish, in operation thereof, a heave compensated motion of the vertically mobile working deck relative to the tower and to the hull within said heave compensation motion range and a synchronous heave compensated motion of the travelling top drive carrier in order to obtain synchronous heave compensated motions of the vertically mobile working deck and the travelling top drive carrier,

wherein the integrated heave compensation system comprises a common heave compensation device that acts on both the one or more carrier suspension cables and the one or more working deck suspension cables so that when a load formed by a tubulars string initially suspended from the travelling top drive carrier is transferred to the slip device or vice versa, the load on the common heave compensation device remains substantially the same.

[0013] For example, tripping a drill string into a wellbore can now be performed in full heave compensation mode, avoiding undue vertical motion of the drill string in the wellbore, e.g. thereby avoiding undue pressure variations in the wellbore which may occur when the slip device would not be heave compensated.

[0014] It is noted that, the common heave compensation device is distinct from any heave compensation functionality of the one or more vertically oriented hydraulic piston-and-cylinder type lift devices as the one or more carrier suspension cables are reeved independent from the one or more lift devices, so that vertical position and vertical motion of the working deck are independent of the operation of said one of more lift devices.

[0015] In an embodiment, the common heave compensation device is directly connected to a common anchor for both the end(s) of the one or more carrier suspension cables and for the end(s) of the one or more working deck suspension cables. For example, the common heave compensation device comprises one or more hydraulic piston-and-cylinder type compensator devices, each having a cylinder body and a piston rod, said compensator devices each having one of the cylinder and the piston rod thereof fixed in relation to the hull and the other one of the cylinder and the piston rod supporting the common anchor thereon. These one or more compensator devices are connected to a hydraulic circuit that

includes a pressurized gas buffer as is known in the art.

[0016] In another embodiment, the integrated heave compensation system comprises a first heave compensation sheave assembly, distinct from the top sheave assembly, said first heave compensation sheave assembly comprising one or more sheaves along which the one or more carrier suspension cables pass, and a second heave compensation sheave assembly, comprising one or more sheaves along which the one or more working deck suspension cables pass, wherein the first heave compensation sheave assembly and the second heave compensation sheave assembly are mechanically interconnected and connected to the common heave compensation device so as to allow for synchronous motion thereof.

[0017] In another embodiment, the common heave compensation device is embodied as a winch that is common for all of the ends of the one or more carrier suspension cables and for the ends of the one or more working deck suspension cables. For example, the winch is a single layer drum type winch, wherein all carrier suspension and working deck suspension cables are wound in a single layer, each onto a corresponding section of the drum.

[0018] In an embodiment, each working deck suspension cable has an end portion connected to the working deck that is suspended from a departure sheave that is mounted at a fixed height on the tower, preferably lower than the top sheave assembly.

[0019] In an embodiment, each working deck suspension cable has an end portion connected to the working deck that is suspended from a departure sheave that is mounted in the moonpool, e.g. with the working deck having a vertically extending support structure, e.g. as a hollow tube, that extends upward through the moonpool, e.g. to above the main drilling deck of the installation, with the slip device being mounted on top of said vertically extending support structure.

[0020] It is noted that, in embodiments, the working deck may be rather small, e.g. just big enough to support the slip device thereon. In other, more preferred, embodiments, the working deck simulates a drill floor, e.g. accessible for drilling personnel, e.g. with an iron roughneck device and/or other well center related equipment arranged thereon or arrangeable thereon.

[0021] In an embodiment, the vessel is provided with a heave motion compensating racker system comprising at least one racker device that is adapted to move a tubulars section, e.g. a drill pipe section, between a tubulars storage rack - that is mounted on the hull or tower vessel and subjected to heave motion - and a position wherein the tubulars section is in said firing line and between the vertically mobile working deck and the travelling top drive carrier, wherein said racker device comprises multiple racker assemblies, each of said racker assemblies having a motion arm and a gripper member at an end of said motion arm, said gripper member being adapted to grip a tubulars section, wherein said racker device further com-

prises an associated heave motion synchronization system configured to bring, in operation thereof, said racker assemblies in a heave compensation mode with respect to the tower so that a tubular section that has been retrieved from the storage rack by means of said racker assemblies of said racker device is brought into a vertical motion that is synchronous with the heave motion of the mobile working deck and of the slip device provided on said mobile working deck. For example, a heave motion compensating racker system as disclosed in WO2015/133895 is provided for.

[0022] The present invention also relates to a method for performing a subsea wellbore related activity, wherein use is made of a vessel according to the invention. For example, the activity is one of tripping in or tripping out a tubulars string.

[0023] The invention will now be discussed with reference to the drawings. In the drawings:

- figs. 1a,b show an offshore drilling vessel provided with a drilling installation according to the prior art,
- figs. 2a, b show the prior art offshore drilling vessel of figures 1a, b more schematically,
- figs. 3a, b show an offshore drilling vessel provided with a drilling installation according to the invention,
- figs. 4a, b illustrate the operation of the integrated heave compensation system of the vessel of figures 3a, b,
- figs. 5a, b illustrate a stage of tripping in a drill string with the vessel of figures 3a,b,
- figs. 6a, b illustrate a later stage of tripping in a drill string with the vessel of figures 3a,b,
- figs. 7a, b illustrate a later stage of tripping in a drill string with the vessel of figures 3a,b,
- fig. 8 shows an alternative embodiment of an offshore drilling vessel provided with a drilling installation according to the invention,
- fig. 9 shows another alternative embodiment of an offshore drilling vessel provided with a drilling installation according to the invention.

[0024] With reference to figures 1a,b, and the more schematic figures 2a,b, first a prior art offshore drilling vessel for performing subsea wellbore related activities will be discussed. This vessel is equipped with a prior art RamRig drilling installation.

[0025] The vessel 1 has a floating hull 2 subjected to heave motion during drilling, here a mono-hull, comprising a moonpool 3. In another embodiment, for example, the vessel is a semi-submersible vessel having submergible pontoons (possibly an annular pontoon) with columns thereon that support an above-waterline deck box structure. The moonpool may then be arranged in the deck box structure.

[0026] The figures 1a,b and 2a,b show a cross-section of the vessel 1 across the moonpool 3.

[0027] A drilling tower 10 is positioned on the hull at or near the moonpool 3, so as to perform wellbore related

operation along a firing line 4 through the moonpool 3.

[0028] The vessel is equipped with a drilling tower 10 at or near the moonpool. Here the tower 10 is a gantry structure over the moonpool having two legs 11, 12 on opposite sides of the moonpool 3 and a gantry top over the moonpool 3. The tower 10 is embodied as a lattice-work.

[0029] As shown in, for example, WO2017/192046, the tower could also be embodied as a singular structure along a side of the moonpool. In the WO2017/192046 this embodiment is provided as a latticework tower.

[0030] In another embodiment, the tower is a singular mast having a closed outer wall and having a top and a base. The base of the mast is secured to the hull.

[0031] In the figures 1a,b, and 2a,b it is shown that a drill floor 15 is stationary arranged above the moonpool 3.

[0032] A slip device 20 is mounted on the drill floor 15 as is common in the field. The slip device 20 is configured to suspend a tubulars string in the firing line 4, e.g. when tripping in or tripping out a drill string from a subsea wellbore, or during an actual drilling process.

[0033] The figures 1a,b and 2a,b show a main hoisting device 30 comprising a travelling top drive carrier 35 that is adapted to support a top drive 36 and a drilling tubulars string, e.g. via an elevator that is suspended from the top drive 36 or from the carrier 35 directly. The string extends along the firing line 4 through the moonpool 3.

[0034] The carrier 35 is guided vertically along the tower 10 over one or more vertical guide rails 14, 15, e.g. one guide rail along each leg 11, 12 of the gantry type tower.

[0035] The figures 1a,b and 2a,b show a top sheave assembly 40 that is guided vertically, e.g. on the same guide rails 14,15, relative to an elevated portion of the tower 10. The assembly 40 comprises one or more carrier suspension cable sheaves 41.

[0036] The figures 1a,b and 2a,b show vertically oriented hydraulic piston-and-cylinder type lift devices 50, each having a cylinder body 51 and a piston rod 52. These lift devices 50 each having one of the cylinder and the piston rod thereof fixed in relation to the hull 2 and the other one of the cylinder and the piston rod supports the top sheave assembly 40 thereon so as to be vertically mobile relative to the tower.

[0037] The figures 1a,b and 2a,b show carrier suspension cables 55, each carrier suspension cable having one end 56 thereof secured to the travelling top drive carrier 35. The cables 55 each extend over a respective sheave 41 of the top sheave assembly 40 to another end 57 of the carrier suspension cable. This other end 57 is connected to an anchor 60 that is fixed in relation to the hull, e.g. embodied as an equalizing anchor as described in US6095501.

[0038] As is known in the art, and for example as described in any of US6095501, US6094910, and/or WO2017/192046, a hydraulic circuit 80 is connected to the lift devices 50. This circuit includes a hydraulic pump, e.g. multiple pumps in parallel, and is configured to lift and

lower the travelling top drive carrier 35 by extension and retraction of the lift devices 50.

[0039] The figures 1a, 2a show the lift devices 50 when fully retracted, and the figures 1b, 2b show the lift devices in extended position thereof.

[0040] As is known in the art, and for example as described in any of US6095501, US6094910, and/or WO2017/192046, the lift devices 50 and the hydraulic circuit 80 form also a heave compensation system acting on the carrier suspension cables 55 and configured to provide for heave compensating motion of the travelling top drive carrier 35. In more detail, the lift devices 50 can be operated in passive or active heave compensation mode by suitable operation of the circuit 80, and thereby the assembly 40 is heave compensated, which results in the carrier 35 being heave compensated.

[0041] With reference to figures 3a,b - 7a,b now an offshore drilling vessel for performing subsea wellbore related activities will be discussed. This vessel 1' is equipped with an installation that includes many of the components as discussed above with reference to figures 1a, b and 2a,b. These components have been denoted with the same reference numerals.

[0042] The drilling installation is provided with a vertically mobile working deck 70, which is vertically movable with respect to the tower 10 and to the hull 2 along the firing line 4 within a motion range including a heave compensation motion range. For example, as preferred, the deck 70 is guided by one or more vertical guide rails mounted on the tower and/or the hull, e.g. the same rails 14, 15 that are employed for the carrier 35.

[0043] The slip device 20 is mounted on the working deck 70, e.g. recessed in the deck. For example, multiple slip devices are arranged on the working deck, each displaceable between an operative position in the firing line and a remote, parked position.

[0044] The vertically mobile working deck 70 is suspended from working deck suspension cables 75.

[0045] Each of these working deck suspension cables 75 is reeved independent from the lift devices 50, so that vertical position and vertical motion of the working deck 70 are independent of the operation of the lift devices 50.

[0046] The figures 3a, b show that, as an example, each of the cables 75 has an end portion connected to the working deck 70 that is suspended from a departure sheave 76 that is mounted at a fixed height on the tower 10, preferably lower than the motion range of the top sheave assembly 40.

[0047] An integrated heave compensation system is provided that is configured to establish, in operation thereof, a heave compensated motion of the vertically mobile working deck 70 relative to the tower 10 and to the hull 2 within the associated heave compensation motion range and a synchronous heave compensated motion of the travelling top drive carrier 35 in order to obtain synchronous heave compensated motions of the vertically mobile working deck 70 and the travelling top drive carrier 35.

[0048] The heave compensation system is an integrated heave compensation system which comprises a common heave compensation device 90 that acts on both the carrier suspension cables 36 and the working deck suspension cables 75, so that when a load formed by a tubulars string 100 initially suspended from the travelling top drive carrier 35 is transferred to the slip device 20 or vice versa, the load on the common heave compensation device 90 remains substantially the same.

[0049] In the figures 3a,b - 7a,b the common heave compensation device 90 is embodied as one or more hydraulic piston-and-cylinder type compensator devices 91, 92, each having a cylinder body and a piston rod. These compensator devices 91, 92 each have one of the cylinder and the piston rod thereof fixed in relation to the hull and the other one of the cylinder and the piston rod supporting a common anchor 95 thereon.

[0050] Each common anchor 95 is connected to an end of the one or more carrier suspension cables 36 and to an end of the one or more working deck suspension cables 75.

[0051] As is known in the art the compensator devices 91, 92 are connected to a hydraulic circuit that includes a pressurized gas buffer.

[0052] Figures 4a,b illustrate that the synchronized heave motion compensation of the carrier 35 and of the working deck 70 does not involve the lift devices 50. Figure 4a illustrates a situation wherein the compensator devices 91, 92 are fully extended, and in figure 4b these devices are fully retracted, thereby providing a heave compensation motion range for both of the carrier 35 and the working deck (including the slip device 20 thereon) in synchronicity with one another.

[0053] Figures 5a,b, 6a, b, 7a, b will now be discussed in order to elucidate that this arrangement is such that, e.g. during tripping in of a drilling tubulars string as shown here, the load on the common heave compensation device 90, that is devices 91, 92, remains substantially the same in case of transfer of a load formed by a tubulars string 100 initially suspended from the travelling top drive carrier 35 is transferred to the slip device 20 or vice versa. In this figures, for sake of simplicity, the presence of heave motion is not depicted, yet the operations described herein can be, and will be, performed whilst the device 90 provides for synchronized compensating motions of both the carrier 35 and the working deck 70 with slip device 20 thereon.

[0054] In figure 5a a tubulars string 100 is suspended from slip device 20, e.g. the string 100 passing through a riser into the wellbore. A new section 101, e.g. a multi-joint stand of drill pipes, is to be added to the string 100.

[0055] The new section 101 is presented, see figure 5a, by a racker device into alignment with the firing line 4, above the top end of the string 100 held by the slip device 20. The carrier 35 has been moved, by operation of the lift devices 50, sufficiently high to place the new section 101 between the working deck 70 and the carrier 35 and top drive 36 and/or elevator carried thereby.

[0056] Figure 5b illustrates that the new section 101 has been connected, e.g. screwed, onto the string 100 at its lower end. This may involve the use of a roughneck device as is known in the art, e.g. mounted on the working deck 70.

[0057] Figure 6a corresponds to figure 5b. In a next stage, the carrier 35 is lowered so as to allow the top end of new section 101 to become connected thereto, e.g. to the top drive 36 or to an elevator that is connected to the top drive 36 or that is directly connected to the carrier 35. The lowering of the carrier 35 is done by means of suitable operation of hydraulic circuit 80 so as to retract the lift devices 50. This does not have an effect on the support of the working deck 70.

[0058] Once the top end of new section 101 is connected to the carrier 35, the slip device 20 can be released from the tubulars string 100 to which the new section 101 has been connected, see the figure 7a. In practice this involves transfer of the load of the string 100 from the slip device 20 to the carrier 35, e.g. by means of slightly raising the carrier 35. Once the transfer of load has been done and the slip device 20 disengaged, the lift devices 50 are operated to lower the entire string 100, now including new section 101, along the firing line 4. This is done until the slip device 20 can be brought into engagement with an upper end portion of the string 100. The lowering is shown in figure 7b.

[0059] The above cycle is repeated during tripping in until the string 100 has reached the desired depth.

[0060] As explained herein, the integrated heave compensation system is operable, e.g. in a passive heave compensation mode, during the entirety of the cycle described above, with synchronized heave compensation of the carrier 35 and the working deck 70.

[0061] As the compensator device 91, 92 are each loaded by both the carrier 35 and the working deck 70, and by any vertical load on the carrier 35 and the working deck 70, the moments of transfer of load between the carrier 35 and the working deck 70 do not have a noticeable effect on the load on the compensator devices 91, 92. This is very advantageous, e.g. in view of speed of tripping, e.g. as it avoids the need to adjust settings (e.g. pressure settings) at each time a load transfer is made.

[0062] As preferred, the vessel is provided with a heave motion compensating pipe racker system comprising at least one racker device that is adapted to move a tubulars section 101, e.g. a drill pipe section, between a tubulars storage rack - that is mounted on the hull or tower vessel and subjected to heave motion - and a position wherein the tubulars section is in said firing line and between the vertically mobile working deck 70 and the travelling top drive carrier 35. The racker device comprises multiple racker assemblies, each of said racker assemblies having a motion arm and a gripper member at an end of said motion arm, said gripper member being adapted to grip a tubulars section. The racker device further comprises an associated heave motion synchronization system configured to bring, in operation thereof,

the racker assemblies in a heave compensation mode with respect to the tower so that a tubular section 101 that has been retrieved from the storage rack by means of the racker assemblies of the racker device is brought into a vertical motion that is synchronous with the heave motion of the mobile working deck and of the slip device provided on said mobile working deck. Embodiments hereof are, for example, disclosed in WO2015/133895.

[0063] It will be appreciated that a similar cycle can be performed during drilling or during tripping out a tubulars string from a wellbore.

[0064] Figure 8 illustrates an embodiment, wherein the ends of the cables 55, 70 are connected to a fixedly arranged anchor 60' on the hull, or the tower, of the vessel.

[0065] The depicted integrated heave compensation system comprises a first heave compensation sheave assembly, distinct from the top sheave assembly, said first heave compensation sheave assembly comprising one or more sheaves 96 along which the one or more carrier suspension cables 55 pass, and a second heave compensation sheave assembly, comprising one or more sheaves 97 along which the one or more working deck suspension cables 75 pass. The first heave compensation sheave assembly and the second heave compensation sheave assembly are mechanically interconnected, e.g. one set of sheaves 96 above another set of sheaves 97, and are connected to the common heave compensation device, here devices 91, 92, so as to allow for synchronous motion thereof.

[0066] It will be appreciated that this arrangement, compared to the one shown in figures 3 - 7, doubles the effective heave compensation range of both the carrier 35 and deck 70 with the effective stroke of compensator device 90 being the same.

[0067] Figure 9 illustrates an embodiment, wherein the common heave compensation device is embodied as one or more heave compensated winches 200, e.g. having electronic and/or hydraulic control having heave motion compensation functionality. Herein each of said winches 200 is common for the ends of the one or more carrier suspension cables 55 and for the ends of the one or more working deck suspension cables 70 so that each winch is loaded by both the carrier 35 and the deck 70. As preferred, each winch 200 is embodied as a single layer drum type winch, wherein all carrier suspension and working deck suspension cables are wound in a single layer, each onto a corresponding section of the drum.

[0068] If desired, as explained in WO2017/192046, one or more operable anchoring devices can be combined with the embodiment of figure 9, allowing to retain the cables 55, 75 intermediate the winch 200 and the carrier 35 and deck 70.

[0069] As the winches 200 are each loaded by both the carrier 35 and the working deck 70, and by any vertical load on the carrier 35 and the working deck 70, the moments of transfer of load between the carrier 35 and the working deck 70 do not have a noticeable effect on the

load on the winches 200. This is very advantageous, e.g. in view of speed of tripping, e.g. as it avoids the need to adjust settings (e.g. pressure settings) at each time a load transfer is made.

[0070] The carrier 35 can be raised and lowered independently by operation of the one or more pumps in hydraulic circuit 80. The scope of protection of the present invention is defined by the appended claims.

Claims

1. An offshore drilling installation configured for mounting on a drilling vessel having a floating hull (2) comprising a moonpool (3), wherein the installation comprises:

- a drilling tower (10) configured to be positioned on said hull at or near said moonpool;
- a main hoisting device (30) comprising:

- a travelling top drive carrier (35) adapted to support a top drive and a drilling tubulars string (100) extending along a firing line (4) through said moonpool;

- a top sheave assembly (40) that is guided vertically relative to an elevated portion of the tower and comprises one or more carrier suspension cable sheaves (41),

- one or more vertically oriented hydraulic piston-and-cylinder type lift devices (50), each having a cylinder body (51) and a piston rod (52), said lift devices each having one of the cylinder and the piston rod thereof fixed in relation to the hull and the other one of the cylinder and the piston rod supporting the top sheave assembly (40) thereon so as to be vertically mobile relative to the tower,

- one or more carrier suspension cables (55), each carrier suspension cable having one end (56) thereof secured to the travelling top drive carrier (35) and extending over a respective sheave (41) of the top sheave assembly to another end (57) of the carrier suspension cable, said other end being connectable to one of an anchor (60;90;95) that is fixable in relation to the hull or to a winch (200) that is fixable in relation to the hull,

- a hydraulic circuit (80) connected to said one or more lift devices (50) and including a hydraulic pump, said hydraulic circuit being configured to lift and lower the travelling top drive carrier (35) by extension and retraction of the one or more lift devices (50),

- a heave compensation system acting on the one or more carrier suspension cables

and configured to provide for heave compensating motion of the travelling top drive carrier,

wherein

a vertically mobile working deck (70) is provided, which is vertically movable with respect to the tower (10) and to the hull (2) along the firing line within a motion range including a heave compensation motion range,

wherein the working deck (70) is provided with a slip device (20) that is configured to suspend a tubulars string (100) in said firing line,

wherein the vertically mobile working deck (70) is suspended from at least one working deck suspension cable (75),

wherein said at least one working deck suspension cable (75) is reeved independent from the one or more lift devices (50), so that vertical position and vertical motion of the working deck are independent of the operation of said one of more lift devices (50),

and in that an integrated heave compensation system is provided that is configured to establish, in operation thereof, a heave compensated motion of the vertically mobile working deck (70) relative to the tower and to the hull within said heave compensation motion range and a synchronous heave compensated motion of the travelling top drive carrier (35) in order to obtain synchronous heave compensated motions of the vertically mobile working deck and the travelling top drive carrier,

wherein the integrated heave compensation system comprises a common heave compensation device (90,91,92;200) that acts on both the one or more carrier suspension cables (55) and the one or more working deck suspension cables (75) so that when a load formed by a tubulars string (100) initially suspended from the travelling top drive carrier (35) is transferred to the slip device (20) or vice versa, the load on the common heave compensation device (90,91,92;200) remains substantially the same.

2. An offshore drilling vessel (1,1') for performing sub-sea wellbore related activities, wherein the vessel comprises:

- a floating hull (2) comprising a moonpool (3);
- an offshore drilling installation according to claim 1, installed on the floating hull of the vessel, the drilling tower (10) of the drilling installation being positioned on said hull of the vessel at or near said moonpool of the vessel;

and said other end of the one or more carrier suspension cables (55) being connected to the one of an

anchor (60;90;95) that is fixed in relation to the hull of the vessel or to a winch (200) that is fixed in relation to the hull of the vessel.

3. Offshore drilling vessel according to claim 2, wherein the common heave compensation device (90,91,92) is directly connected to a common anchor (95) for both the end(s) of the one or more carrier suspension cables (55) and for the end(s) of the one or more working deck suspension cables (75), for example wherein the common heave compensation device comprises one or more hydraulic piston-and-cylinder type compensator devices (91,92), each having a cylinder body and a piston rod, said compensator devices each having one of the cylinder and the piston rod thereof fixed in relation to the hull and the other one of the cylinder and the piston rod supporting the common anchor (95). 5 10 15
4. Offshore drilling vessel according to claim 2 or 3, wherein the integrated heave compensation system comprises a first heave compensation sheave assembly, distinct from the top sheave assembly, said first heave compensation sheave assembly comprising one or more sheaves (96) along which the one or more carrier suspension cables (55) pass, and a second heave compensation sheave assembly, comprising one or more sheaves (97) along which the one or more working deck suspension cables pass (75), wherein the first heave compensation sheave assembly and the second heave compensation sheave assembly are mechanically interconnected and connected to the common heave compensation device (91,92) so as to allow for synchronous motion thereof. 20 25 30 35
5. Offshore drilling vessel according to claim 2, the common heave compensation device comprising a heave compensating winch (200) that is common for ends of the one or more carrier suspension cables (55) and for ends of the one or more working deck suspension cables (75), for example wherein the winch is a single layer drum type winch, wherein carrier suspension and working deck suspension cables (55,75) are wound in a single layer, each onto a corresponding section of the drum. 40 45
6. Offshore drilling vessel according to any one of claims 2 - 5, wherein each working deck suspension cable (75) has an end portion connected to the working deck that is suspended from a departure sheave (76) that is mounted at a fixed height on the tower, preferably lower than the top sheave assembly (40). 50
7. Method for performing a subsea wellbore related activity, wherein use is made of a vessel or installation according to any one of claims 1-6, comprising the step of tripping in or tripping out a tubulars string. 55

Patentansprüche

1. Offshore-Bohranlage, ausgelegt zum Montieren auf einem Bohrschiff mit einem schwimmenden Rumpf (2), der einen Moonpool (3) umfasst, wobei die Anlage Folgendes umfasst:
 - einen Bohrturm (10), der dazu ausgelegt ist, auf dem Rumpf an oder in der Nähe des Moonpools positioniert zu werden;
 - eine Haupthubvorrichtung (30), die Folgendes umfasst:
 - einen fahrenden Oberantriebsträger (35), angepasst zum Tragen eines Oberantriebs und eines Bohrrrohrstrangs (100), der sich entlang einer Firing Line (4) durch den Moonpool erstreckt;
 - eine obere Seilscheibenanordnung (40), die relativ zu einem erhöhten Teil des Turms vertikal geführt ist und eine oder mehrere Seilscheiben (41) für die Trägeraufhängung umfasst,
 - eine oder mehrere vertikal ausgerichtete hydraulische Kolben-Zylinder-Hubvorrichtungen (50), die jeweils einen Zylinderkörper (51) und eine Kolbenstange (52) aufweisen, wobei die Hubvorrichtungen jeweils einen Zylinder und eine Kolbenstange aufweisen, die in Bezug auf den Rumpf fixiert sind, und der andere Zylinder und die Kolbenstange die obere Seilscheibenanordnung (40) daran tragen, so dass sie relativ zum Turm vertikal beweglich sind,
 - ein oder mehrere Trägeraufhängungsseile (55), wobei jedes Trägeraufhängungsseil mit einem Ende (56) an dem fahrenden Oberantriebsträger (35) befestigt ist und sich über eine jeweilige Seilscheibe (41) der oberen Seilscheibenanordnung zu einem anderen Ende (57) des Trägeraufhängungsseils erstreckt, wobei das andere Ende mit einem Anker (60;90;95) verbindbar ist, der in Bezug auf den Rumpf fixierbar ist, oder einer Winde (200), die in Bezug auf den Rumpf fixierbar ist,
 - einen Hydraulikkreis (80), der mit der einen oder den mehreren Hubvorrichtungen (50) verbunden ist und eine Hydraulikpumpe umfasst, wobei der Hydraulikkreis dazu ausgelegt ist, den fahrenden Oberantriebsträger (35) durch ein Aus- und Einfahren der einen oder der mehreren Hubvorrichtungen (50) anzuheben und abzusenken,
 - ein Hubausgleichssystem, das auf das eine oder die mehreren Trägeraufhängungsseile wirkt und dazu ausgelegt ist, eine Hubausgleichsbewegung des fahrenden

- den Oberantriebsträgers bereitzustellen,
- wobei ein vertikal bewegliches Arbeitsdeck (70) bereitgestellt ist, das in Bezug auf den Turm (10) und den Rumpf (2) entlang der Firing Line innerhalb eines Bewegungsbereichs, der einen Hubkompensationsbewegungsbereich beinhaltet, vertikal beweglich ist,
- wobei das Arbeitsdeck (70) mit einer Rutschvorrichtung (20) versehen ist, die dazu ausgelegt ist, einen Rohrstrang (100) in der Firing Line aufzuhängen,
- wobei das vertikal bewegliche Arbeitsdeck (70) an mindestens einem Arbeitsdeck-Aufhängungsseil (75) aufgehängt ist,
- wobei das mindestens eine Arbeitsdeck-Aufhängungsseil (75) unabhängig von der einen oder den mehreren Hubvorrichtungen (50) aufgehängt wird, so dass die vertikale Position und die vertikale Bewegung des Arbeitsdecks unabhängig von dem Betrieb der einen oder der mehreren Hubvorrichtungen (50) sind,
- und wobei ein integriertes Hubkompensationssystem bereitgestellt wird, das dazu ausgelegt ist, im Betrieb davon eine Hubkompensationsbewegung des vertikal beweglichen Arbeitsdecks (70) relativ zum Turm und zum Rumpf innerhalb des Hubkompensationsbewegungsbereichs und eine synchrone Hubkompensationsbewegung des fahrenden Verdeckantriebsträgers (35) zu etablieren, um synchrone Hubkompensationsbewegungen des vertikal beweglichen Arbeitsdecks und des fahrenden Oberantriebsträgers zu erhalten,
- wobei das integrierte Hubkompensationssystem eine gemeinsame Hubkompensationsvorrichtung (90,91,92;200) umfasst, die sowohl auf das eine oder die mehreren Trägeraufhängungsseile (55) als auch auf das eine oder 90 die mehreren Arbeitsdeck-Aufhängungsseile (75) wirkt, so dass, wenn eine Last, die durch einen Rohrstrang (100) gebildet wird, der anfänglich an dem fahrenden Oberantriebsträger (35) aufgehängt ist, auf die Rutschvorrichtung (20) übertragen wird oder umgekehrt, wobei die Last auf die Hubkompensationsvorrichtung (90,91,92;200) im Wesentlichen die gleiche bleibt.
2. Offshore-Bohrschiff (1,1') zur Durchführung von Aktivitäten im Zusammenhang mit Unterwasserbohrlöchern, wobei das Schiff Folgendes umfasst:
- einen schwimmenden Rumpf (2), der einen Moonpool (3) umfasst;
 - eine Offshore-Bohranlage nach Anspruch 1, die auf dem schwimmenden Schiffsrumpf installiert ist, wobei der Bohrturm (10) der Bohranlage

auf dem Schiffsrumpf an oder in der Nähe des Moonpools des Schiffes positioniert ist; und wobei das andere Ende des einen oder der mehreren Trägeraufhängungsseile (55) mit einem Anker (60;90;95) verbunden ist, der in Bezug auf den Schiffsrumpf fixiert ist, oder mit einer Winde (200), die in Bezug auf den Schiffsrumpf fixiert ist.

3. Offshore-Bohrschiff nach Anspruch 2, wobei die gemeinsame Hubkompensationsvorrichtung (90,91,92) direkt mit einem gemeinsamen Anker (95) sowohl für das bzw. die Enden des einen oder der mehreren Trägeraufhängungsseile (55) als auch für das bzw. die Enden des einen oder der mehreren Arbeitsdeck-Aufhängungsseile (75) verbunden ist, wobei die gemeinsame Hubkompensationsvorrichtung zum Beispiel eine oder mehrere hydraulische Kolben-Zylinder-Kompensatorvorrichtungen (91,92) umfasst, die jeweils einen Zylinderkörper und eine Kolbenstange aufweisen, wobei die Kompensatorvorrichtungen jeweils eines aus dem Zylinder und der Kolbenstange davon fixiert in Bezug auf den Rumpf aufweisen, und wobei das andere aus dem Zylinder und der Kolbenstange den gemeinsamen Anker (95) trägt.
4. Offshore-Bohrschiff nach Anspruch 2 oder 3, wobei das integrierte Hubkompensationssystem eine erste Hubkompensationsscheibenanordnung umfasst, die sich von der oberen Scheibenanordnung unterscheidet, wobei die erste Hubkompensationsscheibenanordnung eine oder mehrere Scheiben (96) umfasst, entlang denen das eine oder die mehreren Trägeraufhängungskabel (55) verlaufen, und eine zweite Hubkompensationsscheibenanordnung, die eine oder mehrere Scheiben (97) umfasst, entlang denen das eine oder die mehreren Arbeitsdeckaufhängungsseile (75) verlaufen, wobei die erste Hubkompensationsscheibenanordnung und die zweite Hubkompensationsscheibenanordnung mechanisch miteinander verbunden und mit der gemeinsamen Hubkompensationsvorrichtung (91, 92) verbunden sind, um eine synchrone Bewegung davon zu ermöglichen.
5. Offshore-Bohrgefäß nach Anspruch 2, wobei die gemeinsame Hubkompensationsvorrichtung eine Hubkompensationswinde (200) umfasst, die für Enden des einen oder der mehreren Trägeraufhängungsseile (55) und für Enden des einen oder der mehreren Arbeitsdeckaufhängungsseile (75) gemeinsam ist, wobei die Winde beispielsweise eine einlagige Trommelwinde ist, wobei Trägeraufhängungsseile und Arbeitsdeckaufhängungsseile (55,75) einlagig jeweils auf einen entsprechenden Abschnitt der Trommel aufgewickelt sind.

6. Offshore-Bohrschiff nach einem der Ansprüche 2 bis 5, wobei jedes Arbeitsdeck-Aufhängungskabel (75) einen Endabschnitt aufweist, der mit dem Arbeitsdeck verbunden ist und an einer Abgangsscheibe (76) aufgehängt ist, die in einer festen Höhe am Turm, vorzugsweise niedriger als die obere Scheibenanordnung (40), montiert ist. 5
7. Verfahren zum Durchführen einer unterseeischen bohrlochbezogenen Aktivität, wobei ein Schiff oder eine Anlage nach einem der Ansprüche 1 - 6 verwendet wird, umfassend den Schritt des Einlösen oder Auslösen eines Rohrstrangs. 10

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Revendications

1. Installation de forage en mer conçue pour être montée sur un navire de forage comportant une coque flottante (2) comprenant un puits central (3), l'installation comprenant : 20
- une tour de forage (10) conçue pour être positionnée sur ladite coque au niveau ou à proximité dudit puits central ; 25
 - un dispositif de levage principal (30) comprenant :
 - un support d'entraînement supérieur mobile (35) conçu pour supporter un entraînement supérieur et un train de tubes de forage (100) s'étendant le long d'une ligne de tir (4) à travers ledit puits central ; 30
 - un ensemble poulie supérieur (40) qui est guidé verticalement par rapport à une partie élevée de la tour et comprend une ou plusieurs poulies de câble de suspension de support (41), 35
 - un ou plusieurs dispositifs de levage de type piston-cylindre orientés verticalement hydrauliques (50), chacun comportant un corps de cylindre (51) et une tige de piston (52), lesdits dispositifs de levage ayant chacun l'un parmi le cylindre et la tige de piston de celui-ci fixé par rapport à la coque et l'autre parmi le cylindre et la tige de piston supportant l'ensemble poulie supérieur (40) dessus de sorte à être mobiles verticalement par rapport à la tour, 40
 - un ou plusieurs câbles de suspension de support (55), chaque câble de suspension de support ayant une extrémité (56) fixée au support d'entraînement supérieur mobile (35) et s'étendant sur une poulie (41) respective de l'ensemble poulie supérieur jusqu'à une autre extrémité (57) du câble de suspension de support, ladite autre extrémité pouvant être reliée à l'un parmi une 45

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ancres (60 ; 90 ; 95) qui peut être fixée par rapport à la coque ou un treuil (200) qui peut être fixé par rapport à la coque,

- un circuit hydraulique (80) relié audit ou auxdits dispositifs de levage (50) et comprenant une pompe hydraulique, ledit circuit hydraulique étant conçu pour lever et baisser le support d'entraînement supérieur mobile (35) par extension et rétraction du ou des dispositifs de levage (50),
- un système de compensation de pilonnement agissant sur le ou les câbles de suspension de support et conçu pour fournir un mouvement de compensation de pilonnement du support d'entraînement supérieur mobile, un pont de travail (70) mobile verticalement étant fourni, qui est mobile verticalement par rapport à la tour (10) et à la coque (2) le long de la ligne de tir, dans une plage de mouvement comprenant une plage de mouvement de compensation de pilonnement,

le pont de travail (70) étant pourvu d'un dispositif de glissement (20) qui est conçu pour suspendre un train de tubes (100) dans ladite ligne de tir,

le pont de travail (70) mobile verticalement étant suspendu à au moins un câble de suspension de pont de travail (75),

ledit au moins un câble de suspension de pont de travail (75) étant enroulé indépendamment du ou des dispositifs de levage (50), de sorte que la position verticale et le mouvement vertical du pont de travail soient indépendants du fonctionnement dudit au moins un dispositif de levage (50),

et un système de compensation de pilonnement intégré étant fourni qui est conçu pour établir, en fonctionnement, un mouvement compensé de pilonnement du pont de travail (70) mobile verticalement par rapport à la tour et à la coque dans ladite plage de mouvement de compensation de pilonnement et un mouvement compensé de pilonnement synchrone du support d'entraînement supérieur mobile (35) afin d'obtenir des mouvements compensés de pilonnement synchrones du pont de travail mobile verticalement et du support d'entraînement supérieur mobile,

le système de compensation de pilonnement intégré comprenant un dispositif de compensation de pilonnement commun (90, 91, 92 ; 200) qui agit à la fois sur le ou les câbles de suspension de support (55) et sur le ou les câbles de suspension de pont de travail (75) de sorte que lorsqu'une charge formée par un train de tubes (100) initialement suspendu au support d'entraî-

- nement supérieur mobile (35) est transférée au dispositif de glissement (20) ou vice versa, la charge sur le dispositif de compensation de pilonnement commun (90, 91, 92 ; 200) reste sensiblement la même.
2. Navire de forage en mer (1, 1') pour réaliser des activités associées à un puits de forage sous-marin, le navire comprenant :
- une coque flottante (2) comprenant un puits central (3) ;
 - une installation de forage en mer selon la revendication 1, installée sur la coque flottante du navire, la tour de forage (10) de l'installation de forage étant positionnée sur ladite coque du navire au niveau ou à proximité dudit puits central du navire ;
- et ladite autre extrémité du ou des câbles de suspension de support (55) étant reliée à l'un parmi une ancre (60 ; 90 ; 95) qui est fixée par rapport à la coque du navire ou un treuil (200) qui est fixé par rapport à la coque du navire.
3. Navire de forage en mer selon la revendication 2, le dispositif de compensation de pilonnement commun (90, 91, 92) étant directement relié à une ancre commune (95) à la fois pour la ou les extrémités du ou des câbles de suspension de support (55) et pour la ou les extrémités du ou des câbles de suspension de pont de travail (75), par exemple, le dispositif de compensation de pilonnement commun comprenant un ou plusieurs dispositifs compensateurs de type piston-cylindre (91, 92), chacun ayant un corps de cylindre et une tige de piston, lesdits dispositifs compensateurs ayant chacun l'un parmi le cylindre et la tige de piston de celui-ci fixé par rapport à la coque et l'autre parmi le cylindre et la tige de piston supportant l'ancre commune (95).
4. Navire de forage en mer selon la revendication 2 ou 3, le système de compensation de pilonnement intégré comprenant un premier ensemble poulie de compensation de pilonnement, distinct de l'ensemble poulie supérieur, ledit premier ensemble poulie de compensation de pilonnement comprenant une ou plusieurs poulies (96) le long desquelles passent le ou les câbles de support (55), et un second ensemble poulie de compensation de pilonnement comprenant une ou plusieurs poulies (97) le long desquelles passent le ou les câbles de suspension de pont de travail (75), le premier ensemble poulie de compensation de pilonnement et le second ensemble poulie de compensation de pilonnement étant mécaniquement interconnectés et reliés au dispositif de compensation de pilonnement commun (91, 92) de sorte à permettre leur mouvement syn-
- chrone.
5. Navire de forage en mer selon la revendication 2, le dispositif de compensation de pilonnement commun comprenant un treuil de compensation de pilonnement (200) qui est commun aux extrémités du ou des câbles de suspension de support (55) et aux extrémités du ou des câbles de suspension de pont de travail (75), par exemple le treuil étant un treuil du type à tambour à couche unique, les câbles de suspension de support et de suspension de pont de travail (55, 75) étant enroulés en une couche unique, chacun sur une section correspondante du tambour.
6. Navire de forage en mer selon l'une quelconque des revendications 2 à 5, chaque câble de suspension de pont de travail (75) comportant une partie d'extrémité reliée au pont de travail qui est suspendue à une poulie de départ (76) qui est montée à une hauteur fixe sur la tour, de préférence plus basse que l'ensemble poulie supérieur (40).
7. Procédé de réalisation d'une activité associée à un puits de forage sous-marin, utilisation étant faite d'un navire ou d'une installation selon l'une quelconque des revendications 1 à 6, comprenant l'étape consistant à descendre ou à remonter un train de tubes.

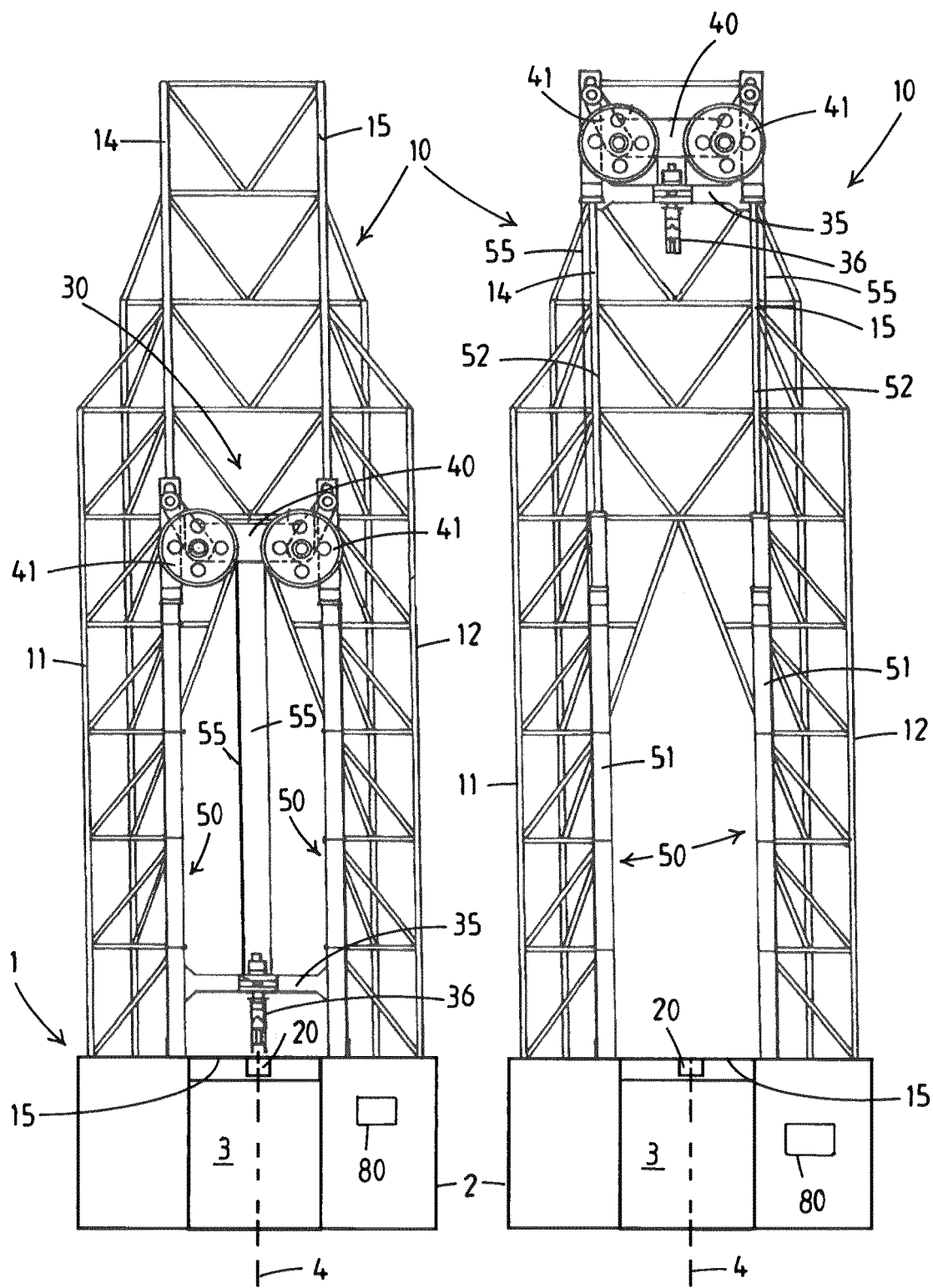


Fig.1a

Fig.1b

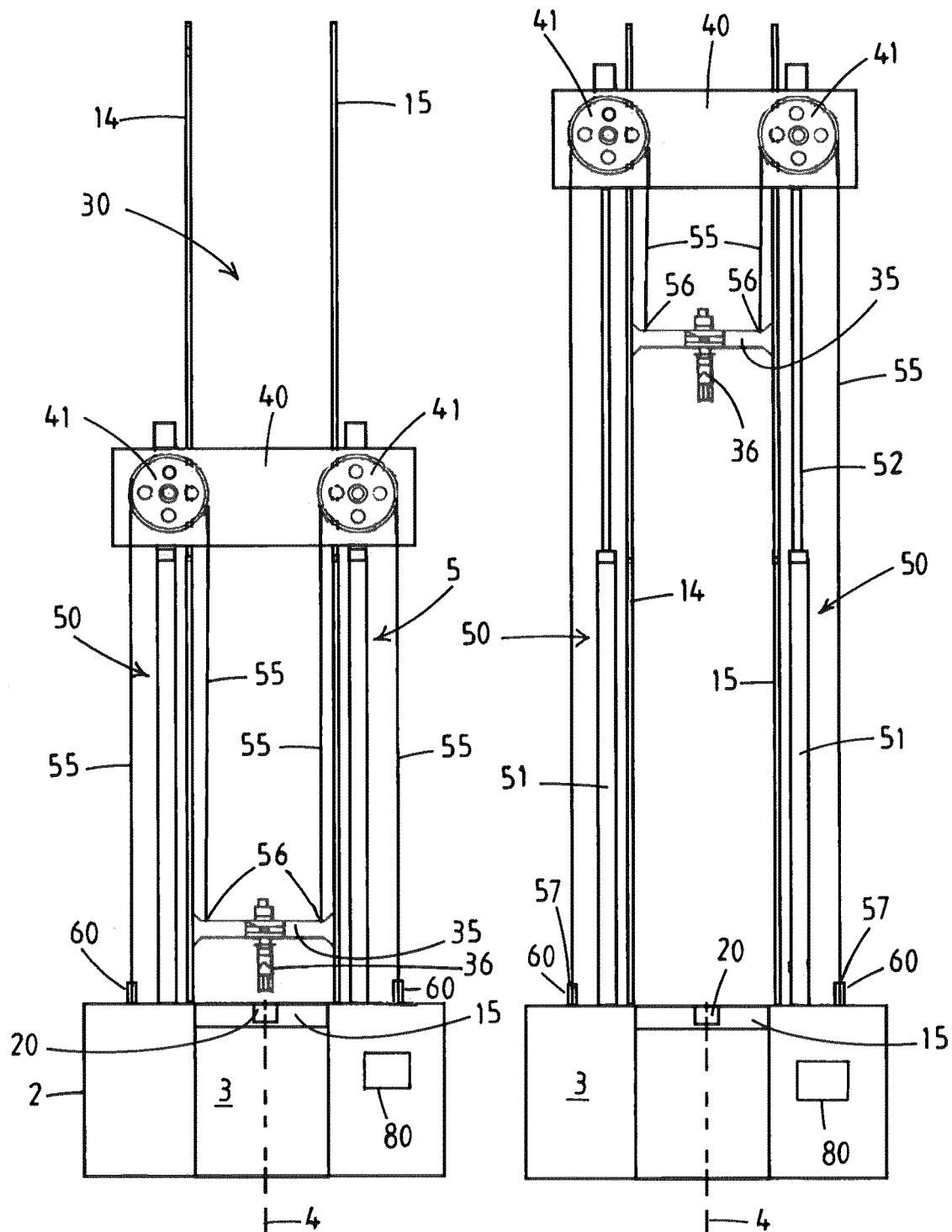


Fig.2a

Fig.2b

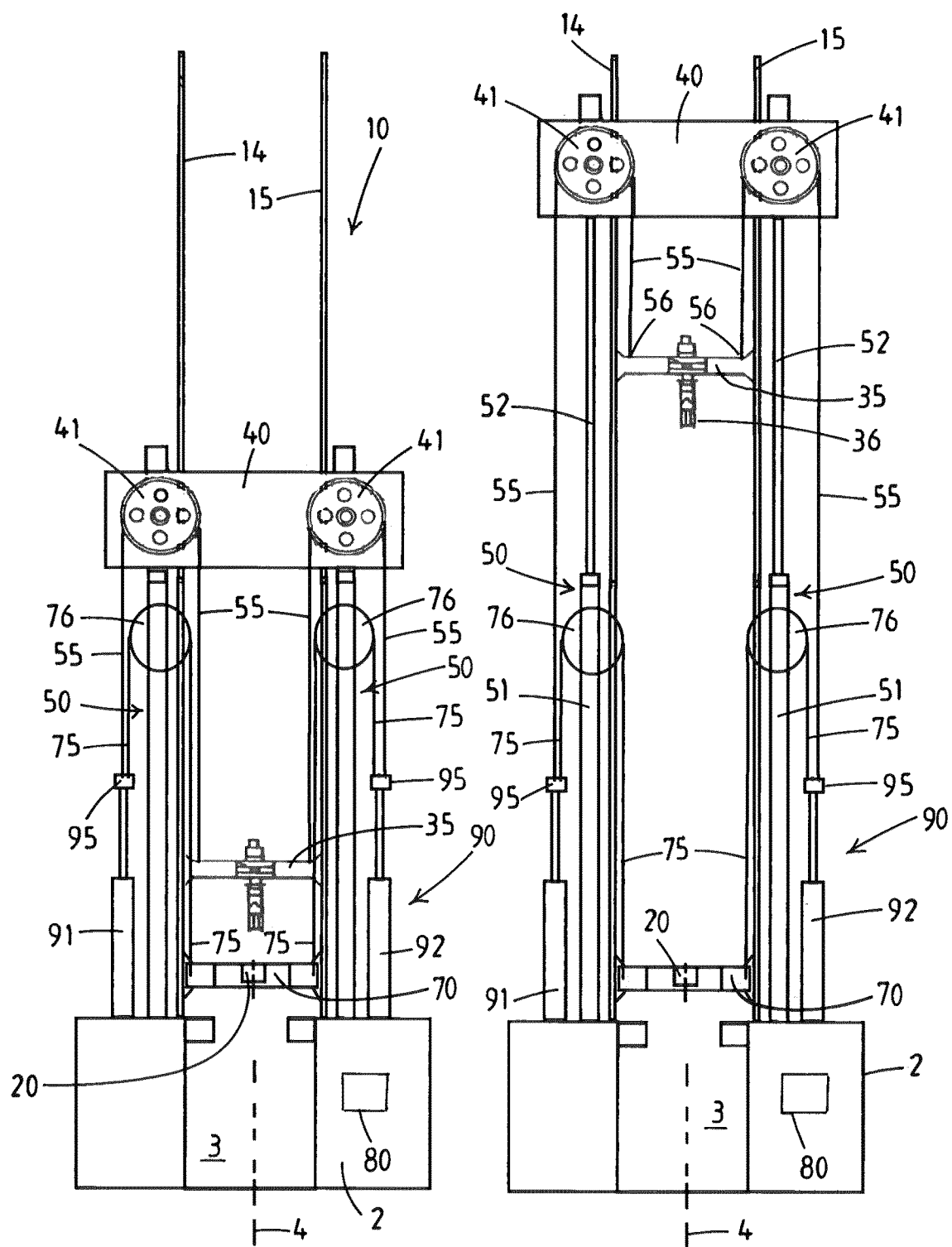


Fig.3a

Fig.3b

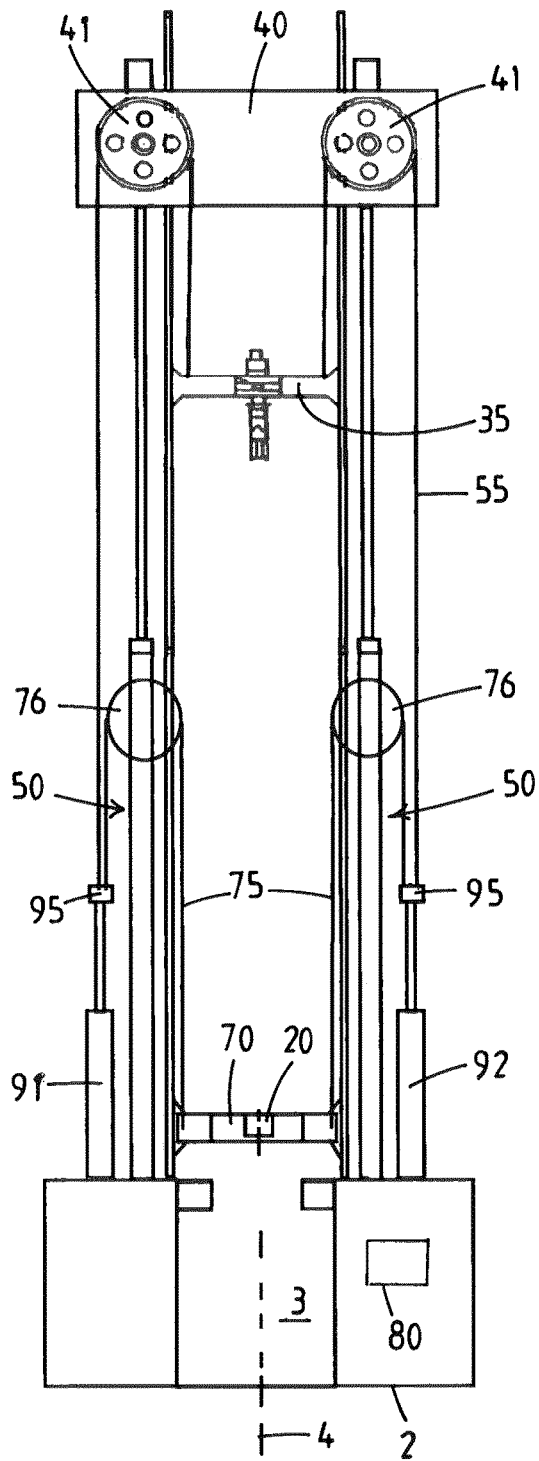


Fig. 4a

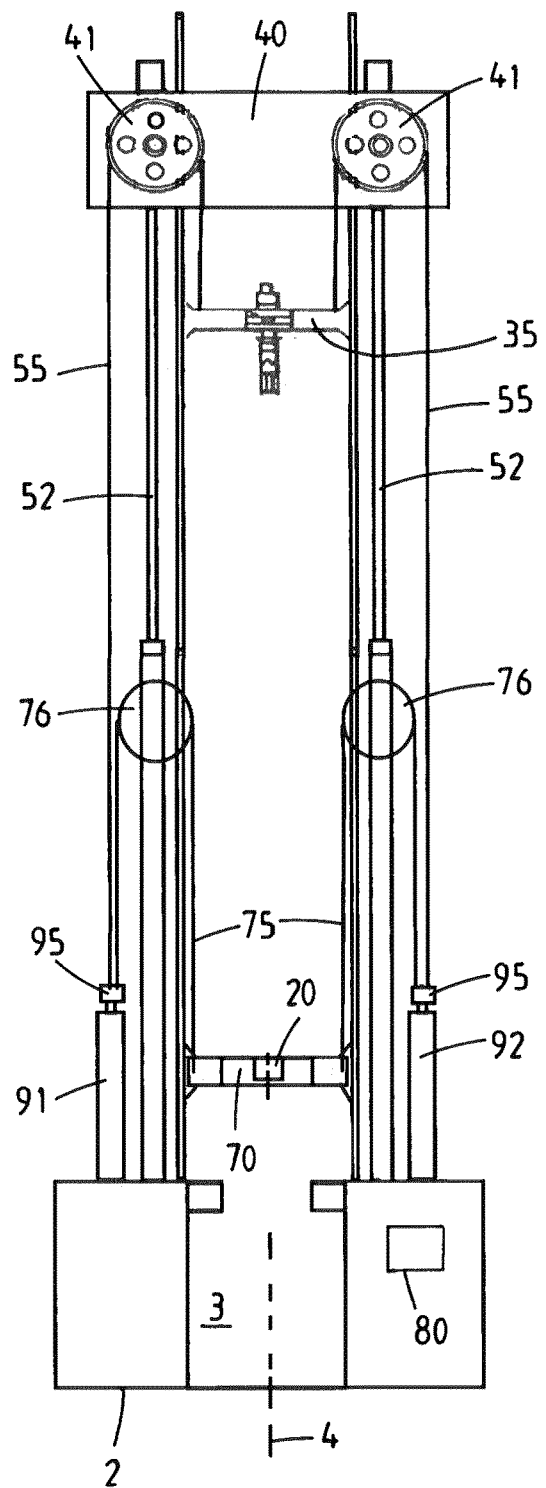


Fig. 4b

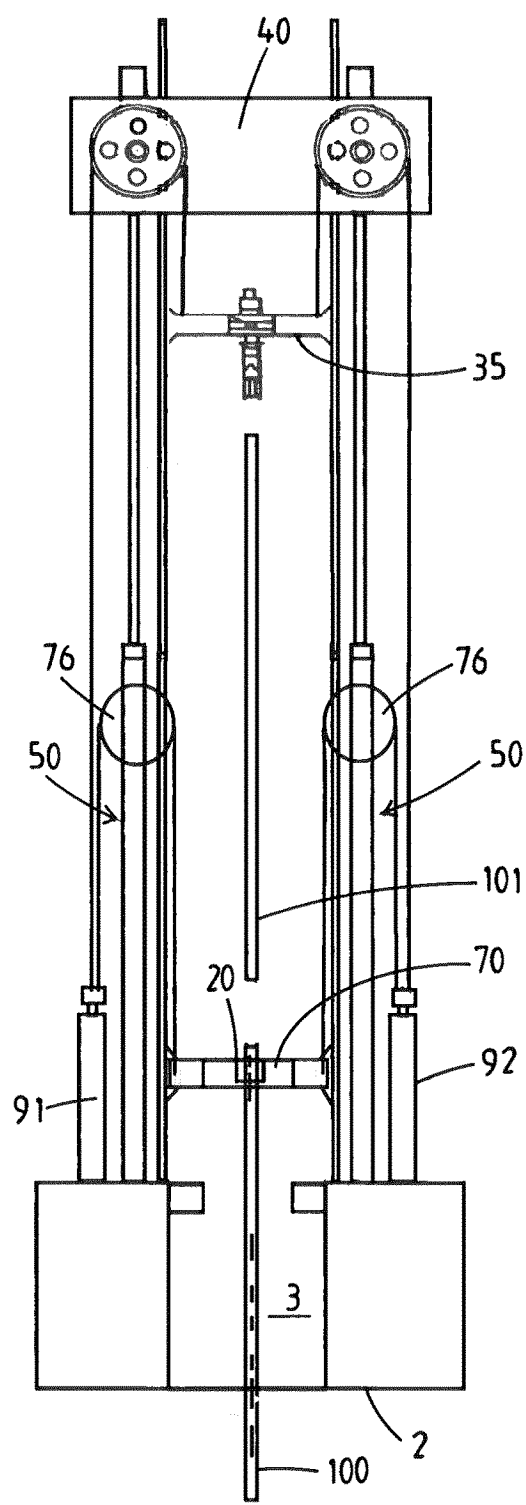


Fig.5a

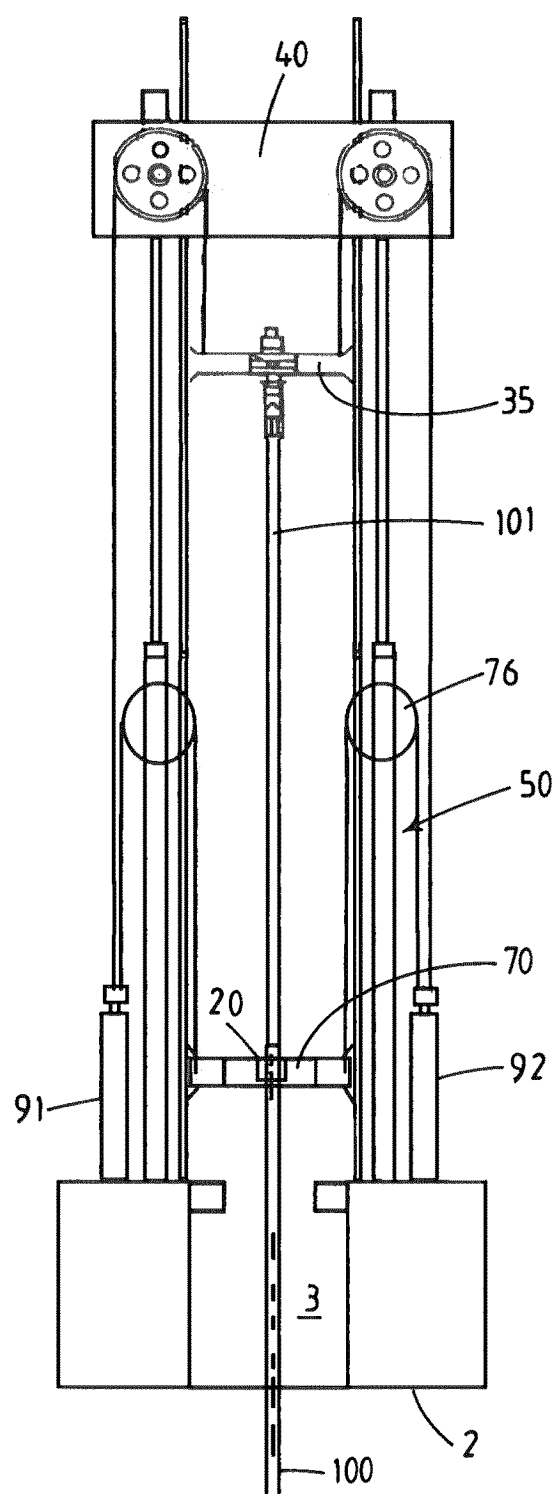


Fig.5b

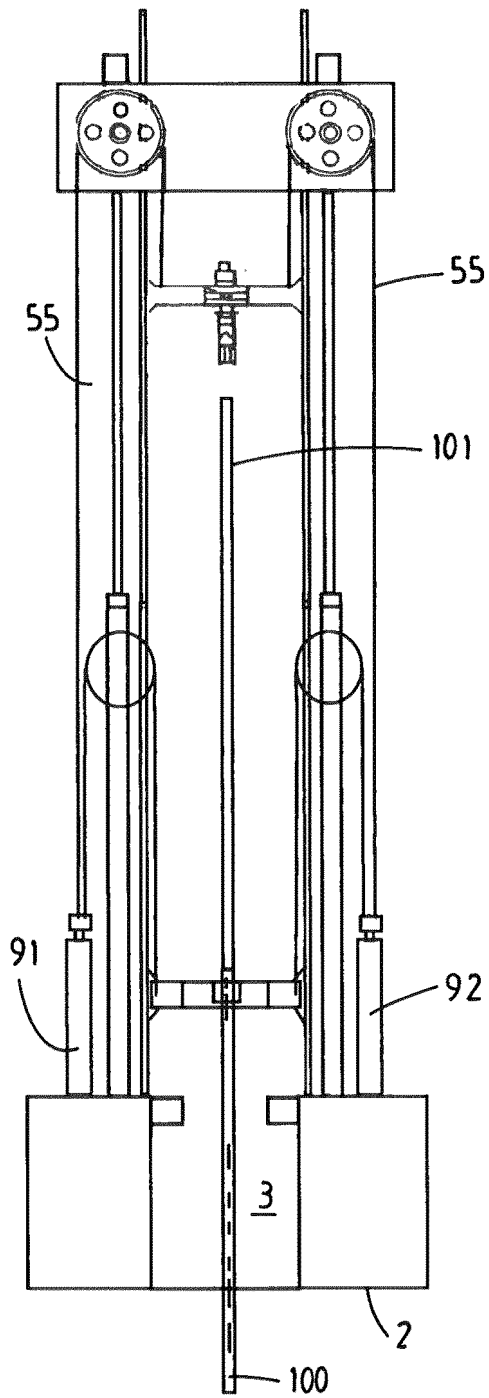


Fig.6a

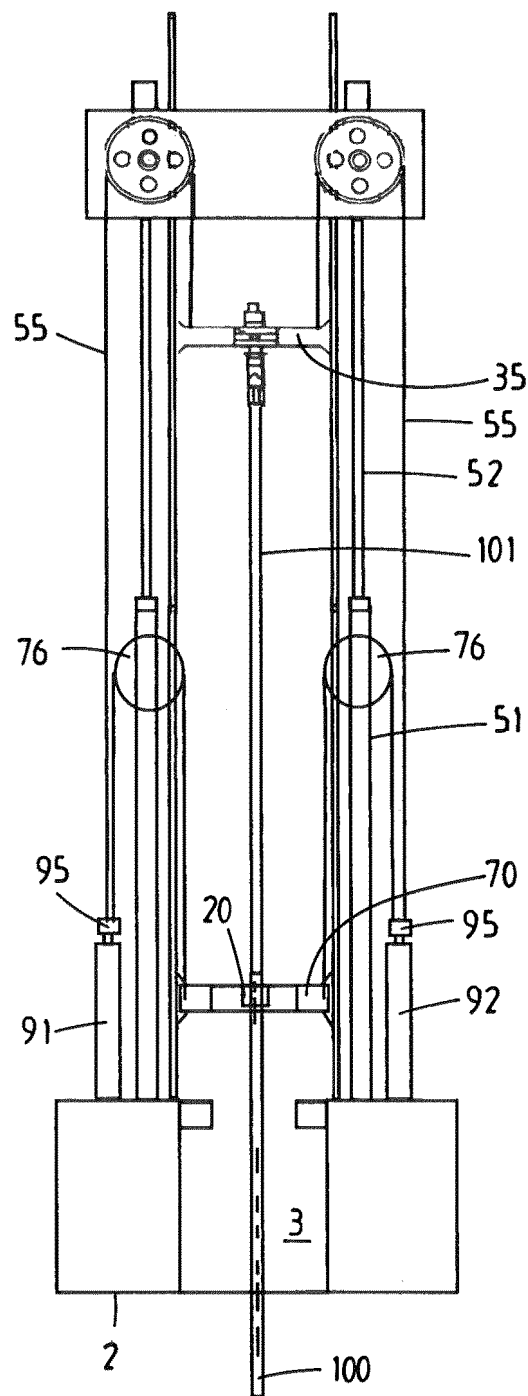


Fig.6b

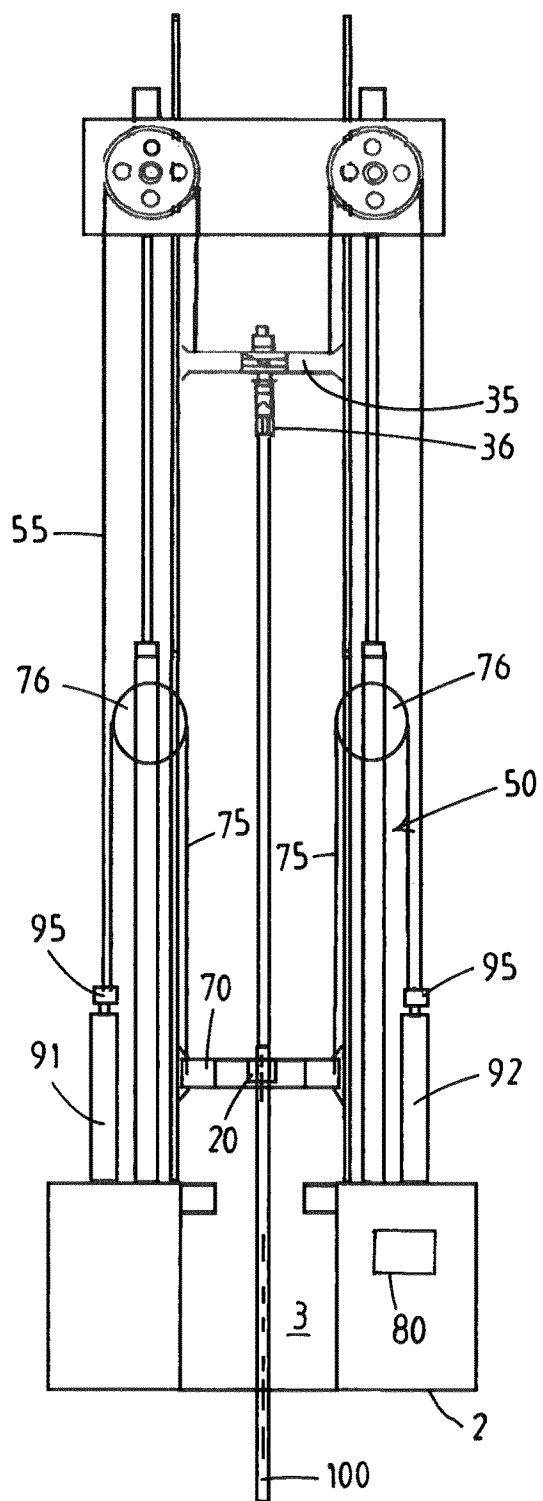


Fig.7a

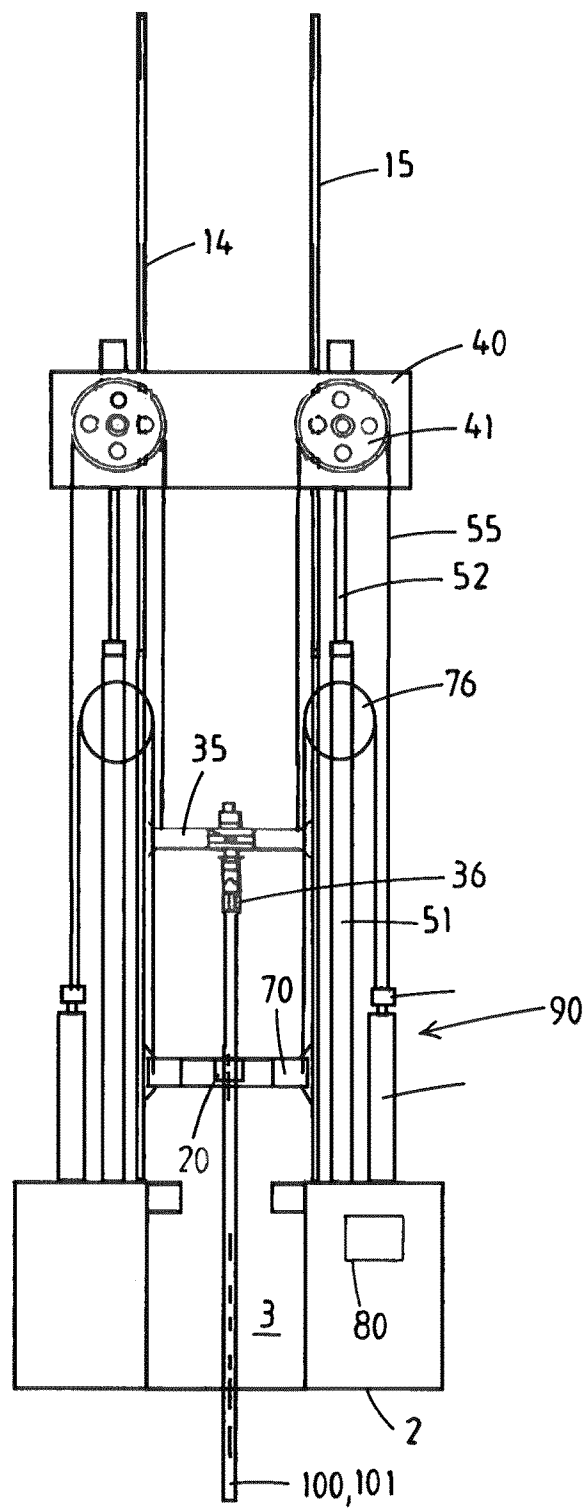


Fig.7b

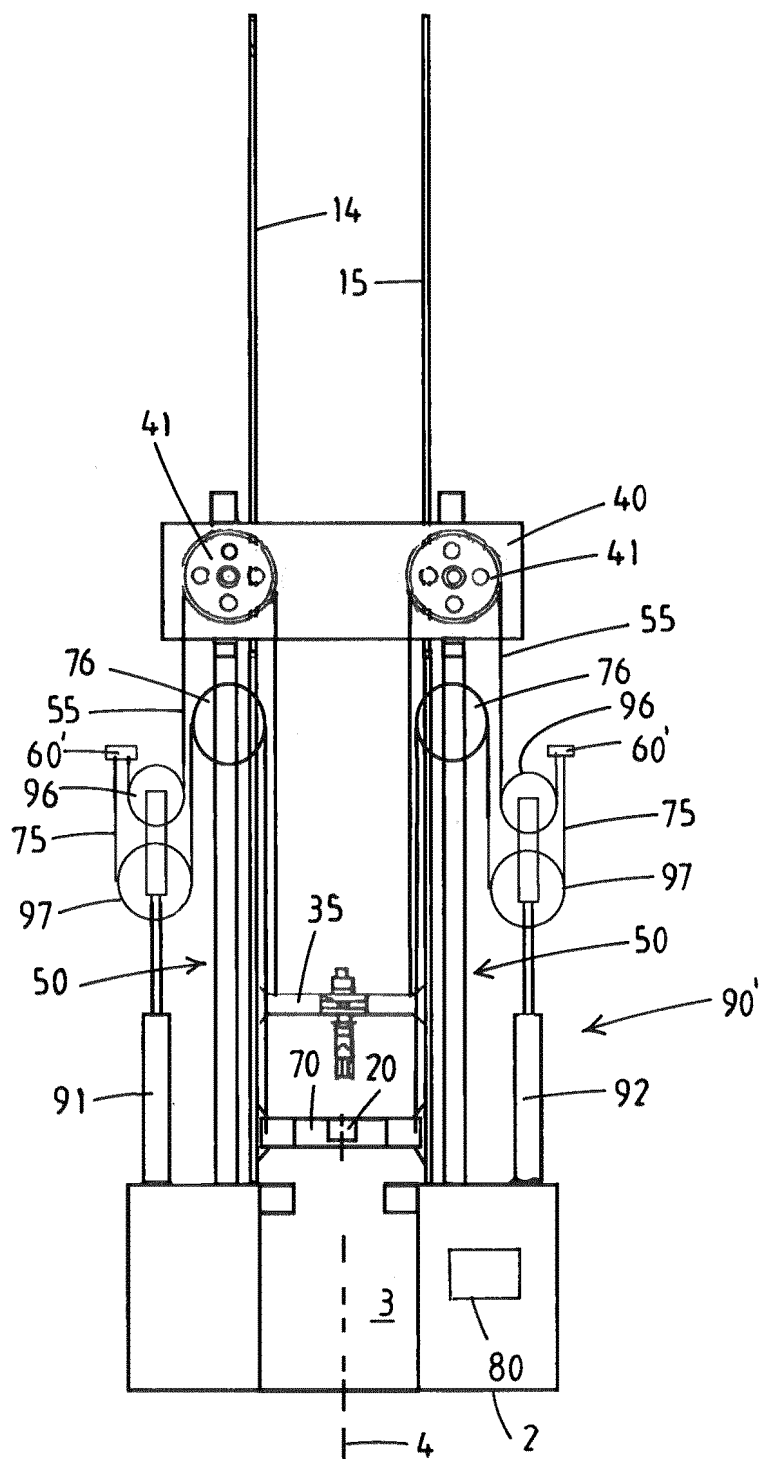


Fig.8

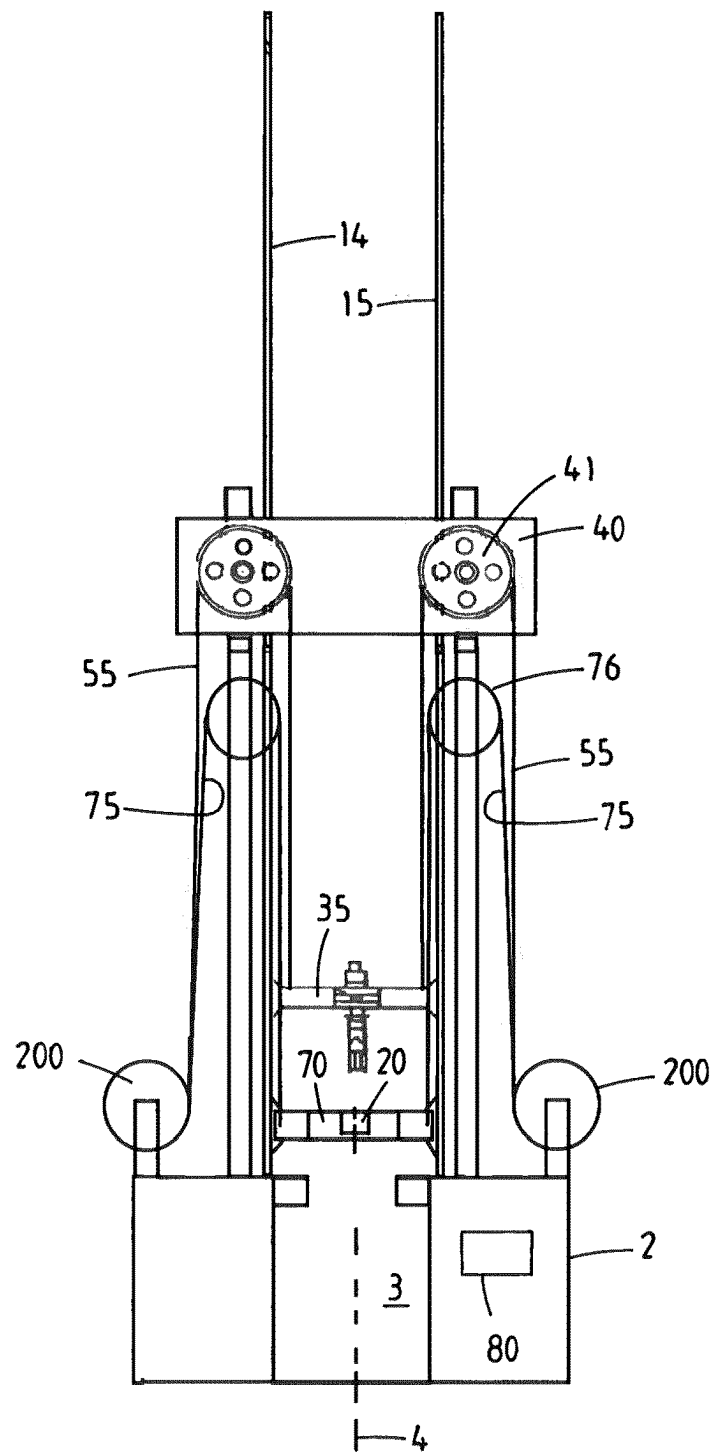


Fig.9

REFERENCES CITED IN THE DESCRIPTION

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