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(54) **Subsea wellbore operations vessel.**

(57) A vessel adapted to perform subsea wellbore related operations involving a riser string between the subsea wellbore and the vessel, e.g. drilling and/or wellbore intervention, said vessel comprising a hull having a deck. The vessel comprises a riser storage hold present within said hull below said deck, which riser storage hold comprises storage racks adapted to store therein parallel stacks of multiple riser sections and/or pre-assembled riser stands in horizontal orientation. The vessel has an elongated riser transfer opening between said deck and said roof, said riser transfer opening extending in a direction parallel to said storage racks, said riser transfer opening having a length and a width so as to allow for transfer of a single riser section or a single riser stand in horizontal orientation via said riser transfer opening out of and into the riser storage hold.

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# SUBSEA WELLBORE OPERATIONS VESSEL

The present invention relates to a vessel adapted to perform subsea wellbore related operations involving a riser string between the subsea wellbore and the vessel, e.g. drilling and/or wellbore intervention.

The present invention also relates to a riser string extending between a vessel and a subsea wellbore.

In the prior art it is common to store the multiple riser sections from which the subsea riser string is composed in a riser storage of the vessel.

Commonly a riser section comprises a riser pipe and in many known embodiments additionally one or more satellite or peripheral pipes on the outside of and along the riser pipe. The satellite pipes are e.g. used as fluid lines to a BOP or other subsea equipment, e.g. choke lines, kill lines, hydraulic lines, booster lines, injection lines (e.g. for glycol), etc. Each riser section comprises a connector fitting arrangement at each end thereof. For example the connector fitting arrangement includes a flange having bolt holes, with riser sections being joined by interconnecting flanges by means of bolts and nuts. A satellite pipe may have an individual connector fitting, e.g. a bayonet fitting, or be designed to fit sealingly into the satellite pipe of an adjoining riser section without direct axial securing of the satellite pipes. In many practical embodiments a riser section is provided with one or more buoyancy and/or thermal insulation members, e.g. of foam material, but so-called bare joints are also employed.

Riser sections come in different lengths. Commonly riser sections have lengths between 50 ft. (15.24 meters) and 90 ft. (27.43 meters). A very common length for riser sections is 75 ft. (22.86 meters).

Riser sections are commonly heavy; far heavier than other tubulars used in the offshore drilling industry. For example a single 75 ft. subsea riser section may weigh between 20 and 25 tonnes, which is incomparable to the weight of an equally long drill pipe. Therefore riser handling is subject to different considerations than drill pipe handling, mainly in view of their size (diameter) and weight.

For example WO2009/102196 discloses a mono-hull vessel having a hull and a riser storage hold within the hull. In the riser storage hull riser sections are stacked in their horizontal orientation. A gantry crane is provided to raise and lower the riser sections out of and into the storage hold and to place each individual riser section onto a riser catwalk machine or to pick up a riser section from the catwalk machine. The leading end of the riser section is in practice connected to a riser string lifting tool which connects the riser section to a riser string handling capacity hoisting device of the vessel. By raising the lifting tool and operation of the catwalk machine the riser section is brought into a vertical orientation, or upended, in line with a firing line along which the riser string is suspended into the sea. The already launched portion of the riser string is then temporarily held by a riser string hanger, often referred to as a riser spider, of the vessel. The new riser section is then held in alignment above the launched riser string and the connector fitting arrangements are interconnected to join the new riser section to the riser string. Then the riser string is released by the riser string hanger and lowered over the length of the newly attached section. The riser string is then suspended again from the riser string hanger and the process of joining a new riser section is repeated.

It has been found that this known process to assembly a riser string is time-consuming. In particular a great deal of effort has to be made to properly make up the connections between the connector fitting arrangements of the riser sections. In particular in view of desired or required testing of each connection that has been made up the known process is undesirably slow.

The present invention aims to propose measures that allow for improvements over the known approach, in view of pace with which the riser string can be assembled and/or disassembled, as well as in view of the actual storing and/or handling of riser sections on board a vessel.

The first aspect of the invention proposes a vessel according to claim 1.

Due to the presence of both first length storage racks as well as second length storage racks the vessel can store both single first length riser sections and/or pre-assembled riser stands (62) each having a length of at least 100 ft. (30.48 m), e.g. of 120 ft. (36.57 m) or 150 ft. (45.72 m), and single second length riser sections each having a length of between 50 ft. (15.24 meters) and 90 ft. (27.43 meters), e.g. of 75 ft. (22.86 meters). In a very practical embodiment there are storage racks dedicated to 150 ft. (45.72 m) riser sections and/or pre-assembled riser stands and storage racks dedicated to 75 ft. (22.86 meters) riser sections.

The riser storage may include at opposed ends of the space for storage of pre-assembled riser stands a platform assembly with personnel accessible platforms at multiple levels so as to allow access of personnel to the connector fitting arrangements at the ends of the riser stands.

For example the riser stand transfer opening has a width between 1.5 and 4.0 meters.

The riser transfer opening will have a length at least equal to first length riser section or stand, e.g. a length of about 50 meters for the passage of 150 ft. (45.72 m) riser sections and/or pre-assembled riser stands.

The first, possibly only, overhead travelling beam crane is adapted to transfer a second length riser section between each of the second length storage racks and the transfer station, and to transfer a first length riser section or riser stand between each of the first length storage racks and the transfer station.

In a preferred embodiment two second length storage racks are arranged in line with one another, parallel to the first length storage racks. This allows for efficient use of the volume within the hull of the vessel and efficient access to said second length storage racks by the overhead crane.

In an embodiment the vessel has stored both first length riser sections and/or pre-assembled riser stands each having a length of at least 100 ft. (30.48 m), e.g. of 120 ft. (36.57 m) or 150 ft. (45.72 m), and second length single riser sections each having a length of between 50 ft. (15.24 meters) and 90 ft. (27.43 meters), e.g. of 75 ft. (22.86 meters).

For example, and as preferred, each riser stand consists of two riser sections, preferably equally long single riser sections. Each single riser section comprises a riser pipe and optionally one or more satellite pipes on the outside of and along the riser pipe. Each riser section comprises a connector fitting arrangement at each end thereof. Preferably each riser section comprises one or more buoyancy members.

Through the use of first length riser sections or pre-assembled riser stands stored in the riser storage the time needed for deployment and/or retrieval of a riser string is reduced compared to the present practice wherein second length riser sections are interconnected in the firing line. The use of first length riser sections or pre-assembled riser stands for example allows to bring up the blow-out preventer or a module thereof attached to the lower end of the riser

string without causing undue delay of the drilling process. The blow out preventer or module thereof can then, e.g., be subject to inspection and/or maintenance, which enhances safety of subsea drilling, e.g. in great water depths. Also great progress is made in the deployment process in view of repetitive testing of the leak tightness of the riser string, which is commonly done after three new riser sections have been added to the string. With the use of first length riser sections or pre-assembled riser stands a significant reduction of the number of pressure tests may be required, or testing may be done with less time pressure per test to be performed.

In order to benefit optimally from the invention it is envisaged that the main storage of riser sections onboard the vessel is embodied as storage for first length riser sections or pre-assembled riser stands, so that a majority, e.g. at least 60%, of the riser string length that is stored onboard the vessel, is stored as these first length riser sections or riser stands. For example the storage racks are embodied to store therein at least 6000 ft. in total of first length riser sections or stands, e.g. at least 40 riser sections or stands of 150 ft. each.

The storage racks may also be embodied to store therein at least 1500 ft. in total of second length riser sections, e.g. at least 20 riser sections of 75 ft. each.

Possibly also some so-called pup sections of very limited length that are commonly employed in the industry can be stored onboard, e.g. within the riser storage hold.

Further riser string items like a telescopic joint, hang-off joint, etc. can also be stored onboard the vessel.

It is noted that in non-prepublished PCT/NL2014/050201 a vessel is disclosed having a riser storage hold within the hull below the deck. The riser storage hold comprises storage racks adapted to store therein parallel stacks of multiple riser sections and/or pre-assembled riser stands in horizontal orientation. The vessel is provided with an elongated riser transfer opening between the deck and the roof of the storage hold. This riser transfer opening extends in a direction parallel to the storage racks and has a length and a width so as to allow for transfer of a single riser section or a single riser stand in horizontal orientation via the riser transfer opening out of and into the riser storage hold. The vessel is further provided with a riser transfer station arranged within the riser storage hold below the riser transfer opening. This station is provided with a transfer elevator that is adapted to raise and lower a single riser section or a single riser stand in horizontal orientation thereof so as to pass the riser section or a riser stand through the riser transfer opening. Within the riser storage hold

an overhead travelling beam crane is arranged, which crane is adapted to lift and lower a single riser section or a single riser stand at least allowing for removal of a single riser section or a single riser stand riser stand from a storage rack and for placing a single riser section or a single riser stand into a storage rack respectively. The crane is also adapted for transverse transportation of a single riser section or a single riser stand at least between the transfer station and a position above a storage rack.

In an embodiment the transfer elevator comprises a first elevator unit and a second elevator unit, which units are spaced apart in a direction parallel to the storage racks. Each of the first and second elevator units are adapted to selectively operate stand-alone or in unison. When operating in stand-alone mode each elevator unit is used to raise and lower a second length riser section, e.g. a 75 ft. (22.86 meters) riser section. When operating in unison the first and second elevator units are used to raise and lower a first length riser section or single first length riser stand, e.g. a 150 ft. (45.72 m) riser section and/or pre-assembled riser stand.

Each elevator unit, in an embodiment, comprises a vertical guide structure, preferably stationary mounted in the storage hold, and a telescoping member which is guided by the vertical guide structure. A riser support member is mounted on the telescoping member and is adapted to support a riser section or riser stand thereon.

In an embodiment the elevator unit further comprises a winch and winch driven cable connected to the telescoping member to cause vertical motion thereof. For example, in view of redundant construction, two winches may operate a single winch driven cable, e.g. each winch attached to a different cable end, so that operations can continue in case of winch failure. In an alternative one can envisage a rack-and-pinion drive for the telescoping member or e.g. one or more hydraulic cylinders.

In an embodiment a riser support member is a riser support table having a length of between 20 and 50 ft. The significant length may allow to engage the riser support table directly with one or more buoyancy members fitted on the riser section or riser stand as the load is then distributed over a significant area.

In an embodiment the riser support member is pivotally connected to the telescoping member and tiltable between a horizontal operation position wherein a riser section or riser stand can rest on said riser support member and a vertical inoperative storage position.

In an embodiment a first group of first length storage racks is arranged adjacent one side of the transfer station and a second group of first length storage racks is arranged adjacent another side of the transfer station. This allows for a relative short distance of travel of the first length riser sections or stand between their respective storage rack and the transfer station. This enhances operating speed when handling the long and heavy first length riser sections and/or stands.

In an embodiment a first group of second length storage racks is arranged along the first group of first length storage racks and a second group of second length storage racks is arranged along the second group of first length storage racks.

As will explained below, in an embodiment, it is envisaged that the relative shorter (nowadays common) second length riser sections will be provided with buoyancy members that are to be fitted in a lower part of the riser string, so with buoyancy members that have a high depth rating. Commonly buoyancy members have increasing specific weight and overall mass as the depth rating increases in view of the water pressure to which the buoyancy member is subjected which increases with water depth. It is envisaged that fitting first length riser sections or first length riser stands stored in the storage with high depth rating buoyancy members would result in a total weight of each riser section or riser stand that renders the handling thereof very difficult, e.g. in view of sagging when held horizontally when conveyed by an overhead beam crane. Therefore, in an embodiment, it is envisaged that multiple first length riser sections or riser stands and multiple second length riser sections are each provided with buoyancy modules, wherein the buoyancy modules of the second length riser sections have a greater depth rating than the buoyancy modules of the first length riser sections. So the shorter elements have the relatively heavy buoyancy members and the longer elements of the riser string have the relative light buoyancy members, so that handling of both can be done effectively.

The present invention also envisages a riser string extending between a subsea wellbore and a subsea wellbore operations vessel, wherein the riser string comprises a lower string part composed of interconnected second length riser sections and an upper string part composed of interconnected first length riser sections or riser stand, wherein said first length riser sections or riser stand and said second length riser sections are each provided with buoyancy modules, and wherein the buoyancy modules of the second length riser sections having a greater depth rating than the buoyancy modules of the first length riser sections. It will be appreciated that such riser string can be assembled effectively when using a vessel as described herein.

In an embodiment each storage rack comprises at ends thereof a pair of adjacent riser end support columns that form a vertical slot which is adapted to receive therein an end portion, e.g. a flange, of a riser section or riser stand.

In an embodiment the riser storage hold is provided with at least one elongated riser workshop having a floor, preferably also walls and a possibly also a roof.

The riser workshop is arranged parallel to the storage racks and the workshop is adapted to accommodate at least one riser section or riser stand in horizontal orientation, preferably at least one first length riser section or riser stand, e.g. a 150 ft. length.

The workshop provides a space, preferably an enclosure, for personnel performing work on the riser, e.g. maintenance and/or inspection of the riser and/or assembly of two riser sections to form a pre-assembled riser stand.

In an embodiment the first overhead travelling beam crane is adapted to place a riser in the workshop and remove a riser from the workshop, e.g. the workshop having a roof with a riser transfer opening therein, preferably said opening being provided with a mobile roof cover, e.g. one or more hatches or a tarpaulin.

In a further embodiment a first elongated riser workshop and a second elongated riser workshop are arranged in the riser storage hold, along opposite sides of the storage racks, preferably with the transfer station centrally between storage racks. The arrangement of riser workshops to the sides of the storage racks, e.g. along port and starboard side of the hull in a monohull vessel, allows for effective use of space, reduced crane handling distances, and enhances access to the workshops for personnel.

In an embodiment the riser storage hold is provided, in addition to the first overhead travelling beam crane, with a second overhead travelling beam crane arranged within the riser storage hold. This second crane is also adapted to lift and lower a single riser section or a single riser stand at least allowing for removal of a single riser section or a single riser stand riser stand from a storage rack and for placing a single riser section or a single riser stand into a storage rack respectively. The second crane is also adapted for transverse transportation of a single riser section or a single riser stand at least between said transfer elevator and a position above a storage rack. The second crane comprises:

- a second travelling beam extending in a direction parallel to said storage racks and supported at each end thereof on a crane rail perpendicular to said storage racks, preferably the same crane rail as the first overhead travelling beam crane,
- a second winch trolley provided with one or more winches and displaceable along said travelling beam,
- possibly, an elongated gripper frame suspended by one or more winch driven cables from said winch trolley, said gripper frame being provided with multiple riser grippers adapted to engage on a single riser section or a single riser stand at spaced gripping locations thereof.

The provision of the second crane creates a redundant crane system, which can continue to operate should the first crane have a failure. One can envisage that the gripper frame is then fitted onto the second crane, but also each crane can have its own gripper frame to allow for a rapid changeover to the other crane. The provision of the second crane is in particular advantageous when a first elongated riser workshop and a second elongated riser workshop are arranged in the riser storage hold, at least one of said riser workshop being arranged along a side of the riser storage hold, and when the second travelling beam crane has a parking position above said workshop along the side of the riser storage hold. Most preferred is an embodiment wherein the other workshop is along the opposite side of the riser storage hold so that the crane that is not in use is parked at the side of the hold above the workshop with the other workshop still accessible by means of the operational crane.

In an embodiment the vessel is provided with one or more movable hatches which in a closed position thereof close the transfer opening and in an opened position thereof open the transfer opening, e.g. pivotal hatches.

In an embodiment the gripper frame is provided with two riser grippers that are adapted and arranged to engage on the end portions of second length riser section, e.g. on end portions of a 75 ft. riser section. For example use is made of a riser gripper as disclosed in US 7905529. In another embodiment which is preferred, it is envisaged that the riser grippers are each embodied to cooperate with a hook that is fitted on the riser section or riser stand, e.g. a hook integrated with a collar that is fitted around the riser pipe.

In an embodiment one or more, preferably all, of the first length riser sections or riser stands are provided at intermediate locations along the length thereof with two riser gripper engageable portions, e.g. with a hook at each location, having a spacing the same as the spacing between end portions of a second length riser section so as to allow the two riser grippers to engage on these gripper engageable portions of the first length riser section or

riser stand. So in an embodiment the riser grippers are arranged on the gripper frame to engage end portions, e.g. provided with hooks, of a 75 ft. riser section, with the vessel also storing 150 ft. riser sections or stand that are provided with two gripper engageable portions, e.g. hooks, at the same spacing or at least a spacing that approximates said 75 ft. end portion spacing.

In an embodiment, in particular with the first length riser section having at intermediate locations along the length thereof with two riser gripper engageable portions, the gripper frame is provided, at each end thereof, with a telescoping extender having an extender end, which extender is extensible so that the extender end is adjacent the end of a first length riser section or riser stand. The extender is preferably used to cooperate with the storage racks to guarantee vertical guidance of the gripper frame and riser section or stand held thereby during lifting and lowering.

In an embodiment each first length storage rack comprises at ends thereof a pair of adjacent riser end support columns that form a vertical slot which is adapted to receive therein an end portion, e.g. a flange, of a riser section or riser stand, and wherein the extender end is adapted to be slidingly received between these columns.

In an embodiment substantially horizontal rails extend along opposite longitudinal sides of the riser transfer opening, and the vessel comprises a riser horizontal transport device that is mounted on these horizontal rails and movable there along. The device is adapted to receive and hold a riser section or riser stand that has been raised through the transfer opening by the riser elevator and to horizontally transport the riser section or riser stand so that a leading end thereof is connectable to a riser string lifting tool that is adapted to support the weight of a riser string in a firing line of the vessel.

In an embodiment the riser horizontal transport device comprises a strongback assembly as is disclosed in non-prepublished PCT/NL2014/050201, which disclosure is incorporated herein by reference.

In another embodiment the riser horizontal transport device comprises a catwalk machine having a mobile catwalk machine frame that is movable over said horizontal rails, wherein the catwalk machine frame has a rear end and a front end, and is movable over the horizontal rails at least in a loading position and in a riser upending position. The catwalk machine frame has two parallel and horizontal frame beams, and a skate is supported by said frame beams and travels over the frame beams. The skate comprises a riser end

support to support thereon a rearward end of a riser section or riser stand. The horizontal frame beams of the catwalk machine frame define between them an opening having a width so as to allow for the vertical passing of a single riser section or a single riser stand in horizontal orientation through said opening, preferably by means of the transfer elevator.

In addition to the skate the catwalk machine comprises one or more additional riser support members that are movable between an inactive position allowing for the mentioned vertical passage of the single riser section or single riser stand and an active position wherein the riser section or riser stand is supported on said riser support member.

The frame beams of the catwalk machine are rigidly interconnected by a transverse beam near the rear end of the catwalk machine frame, and the frame beams are interconnected by one or more mobile transverse connectors that are each movable between an inactive position allowing for said vertical passage of the single riser section or single riser stand and an active position wherein the transverse connector interconnects the frame beams, e.g. the catwalk machine frame having a single transverse connector at the front end of the catwalk machine frame. The provision of one or more mobile transverse connectors allows for the length of the catwalk machine frame to be significantly less than the length of the transfer opening and less than the length of the first length riser section or riser stand as the first length element can pass in vertical direction, e.g. by means of the transfer elevator, when the connectors are in their inactive position.

In an embodiment the catwalk machine is provided with a tailing-in arm device that is mounted at the forward end of the catwalk machine frame. For example one tailing-in arm is arranged on each main beam of the frame, with the arms being movable into an operative position to act in unison when tailing-in the riser section or stand during the last stage of the upending process. The mounting on the catwalk machine causes the tailing-in arm device to move along with the catwalk machine, and thus it forms no obstacle near the firing line when the catwalk machine is retracted, e.g. when not in use. In an alternative the tailing-in arm device is supported on the vessel in a different manner, e.g. mobile in the tower.

In an embodiment the vessel is provided with one or more movable hatches which in a closed position thereof close the transfer opening and in an opened position thereof open the transfer opening, e.g. pivotal hatches.

In an embodiment a first set of pivotal hatches is arranged along one longitudinal side of the transfer opening and a second set of pivotal hatches is arranged along the opposed

longitudinal side of the transfer opening, so that with said hatches in horizontal position the transfer opening is closed and with said hatches in upward or downward pivoted position the transfer opening is open.

In an embodiment with upwardly opening pivoting hatches for the transfer opening it is envisaged that with said hatches in upward pivoted position said hatches are to the outside of the horizontal rails at a spacing allowing for the travel of the catwalk machine over said horizontal rails between said upward pivoted hatches.

In an embodiment the vessel is a monohull vessel and the riser storage is embodied to store the riser section and/or riser stands therein parallel to a longitudinal axis of the vessel.

In an embodiment the transfer opening is on the longitudinal midplane of the monohull vessel, preferably with the riser assembly firing line of the vessel also in said midplane.

In an embodiment the vessel has a moonpool and a tower is arranged at the moonpool, e.g. at a side of the moonpool or above the moonpool, e.g. as in WO2009/102196.

In an embodiment the vessel is provided with a riser string hanger that is adapted to suspended therefrom a riser string in a firing line into the sea.

In an embodiment the vessel has a tower, e.g. at a moonpool or above a moonpool, with the riser string assembly firing line e.g. extending through the moonpool, and a firing line hoisting device is provided, the hoisting device comprising a hanger device that is movable up and down relative to the tower. Preferably the hanger device is embodied as a travelling hanger device that is movable up and down along one or more vertical rails mounted on the tower, e.g. a wheeled travelling hanger device having wheels engaging one or more vertical rails. Preferably the hoisting device comprises at least one winch and at least one cable, wherein the hanger device is suspended from the at least one cable.

In an embodiment the moonpool has lateral sides, a front side and a rear side, and the tower is embodied as a hollow construction mast having a top and having a base that is integral with the hull, the base extending between sections of the hull on opposed lateral sides of the moonpool, the base being spaced from each of the front side and the rear side of the moonpool, thereby forming a front moonpool area forward of the mast and a rear moonpool area rearward of the mast, wherein the mast has a front side and an opposed rear side as well as opposed lateral sides. At one of said moonpool areas, preferably the rear moonpool

area, the vessel is provided with a riser string assembly hanger that is adapted to suspended therefrom a riser string in a firing line into the sea during the riser assembly and disassembly process.

In a preferred embodiment the vessel has a riser string handling capacity hoisting device including a riser string lifting tool which is movable up and down relative to the mast and that is adapted to connect to an end of a riser section, preferably of a pre-assembled riser stand, and is embodied to support the weight of a riser string in the firing line when released from the riser string assembly hanger.

In a preferred embodiment the vessel has a second firing hoisting device, having a load attachment device which is movable up and down relative to the mast at a side opposed from the riser firing line, so as to allow for handling of items passing through the other moonpool area along a second firing line distinct and spaced from the first firing line where the riser string assembly takes place. Preferably said second hoisting device is embodied as a drilling drawworks, and is provided with a topdrive suspended from the load attachment device to perform drilling operations.

Preferably the vessel has a moonpool and the vessel is provided with a riser string support cart that is displaceable within the moonpool between the two firing lines allowing to assembly a riser string in a riser string assembly firing line, e.g. at the rear moonpool area, and then to transfer the riser string to a drilling firing line, e.g. at a front moonpool area. For example this cart is embodied as a skid cart that can be skidded over a pair of associated skid rails which extend in longitudinal direction along the moonpool, allowing to displace the cart in longitudinal direction of the moonpool while supporting a riser string (and preferably with a BOP attached to the lower end of the riser string) lowered into the sea, generally between the one moonpool area and the other moonpool area, so underneath the base of the mast.

In an embodiment the riser string support cart is also embodied to support a blow-out preventer or blow-out preventer module thereon, so with the cart underneath the blow-out preventer or module thereof.

Preferably one or both of the riser string handling capacity hoisting devices and – if present - the second firing line hoisting device comprises one or more cables and one or more associated winches.

Preferably one or both of the riser string handling capacity hoisting devices and – if present - the second firing hoisting device comprises a heave compensation mechanism.

It is envisaged that - if present - the riser transfer opening is oriented with its length towards the moonpool, preferably along or parallel to a central axis of the vessel if the vessel is a monohull vessel. E.g. the vessel has a riser storage hold aft of the moonpool.

In an embodiment the vessel has a moonpool. At the moonpool a tower, e.g. a hollow construction mast, is arranged. The vessel is provided with a riser string hanger that is adapted to suspended therefrom a riser string in a firing line through the moonpool into the sea. A hoisting device is provided having a hanger device that is movable up and down relative to the tower, e.g. the hanger device being suspended from a cable connected to one or more winches.

A second aspect of the present application relates to a vessel adapted to perform subsea wellbore related operations involving a riser string between the subsea wellbore and the vessel, e.g. drilling and/or wellbore intervention, said vessel comprising a hull having a deck, said vessel comprising:

- a riser storage hold present within said hull below said deck,

which riser storage hold comprises storage racks adapted to store therein parallel stacks of multiple riser sections and/or pre-assembled riser stands in horizontal orientation,

which riser storage hold has a floor, side walls, and a roof,

wherein the riser storage hold is provided with first length storage racks adapted to store therein single first length riser section and/or pre-assembled riser stands (62) each having a length of at least 100 ft. (30.48 m), e.g. of 120 ft. (36.57 m) or 150 ft. (45.72 m),

and

wherein the riser storage hold is provided with second length storage racks adapted to store therein single second length riser sections each having a length of between 50 ft. (15.24 meters) and 90 ft. (27.43 meters), e.g. of 75 ft. (22.86 meters),

wherein two second length storage racks are arranged in line, parallel to said first length storage racks.

The present invention also relates to a vessel adapted to perform subsea wellbore related operations involving a riser string between the subsea wellbore and the vessel, e.g. drilling and/or wellbore intervention, said vessel comprising a hull having a deck, said vessel comprising:

- a riser storage hold present within said hull below said deck,

which riser storage hold comprises storage racks adapted to store therein parallel stacks of multiple riser sections and/or pre-assembled riser stands in horizontal orientation,

which riser storage hold has a floor, side walls, and a roof,

- a first overhead travelling beam crane arranged within the riser storage hold, said first crane being adapted to lift and lower a single riser section or a single riser stand at least allowing for removal of a single riser section or a single riser stand riser stand from a storage rack and for placing a single riser section or a single riser stand into a storage rack respectively, and said crane being adapted for transverse transportation of a single riser section or a single riser stand at least between said transfer elevator and a position above a storage rack,

wherein said first crane comprises:
- a travelling beam extending in a direction parallel to said storage racks and supported at each end thereof on a crane rail perpendicular to said storage racks
- a winch trolley provided with one or more winches and displaceable along said travelling beam,
- an elongated gripper frame suspended by one or more winch driven cables from said winch trolley, said gripper frame being provided with multiple riser grippers adapted to engage on a single riser section or a single riser stand at spaced gripping locations thereof,

and

wherein the riser storage hold is provided with a second overhead travelling beam crane arranged within the riser storage hold, said second crane being adapted to lift and lower a single riser section or a single riser stand at least allowing for removal of a single riser section or a single riser stand riser stand from a storage rack and for placing a single riser section or a single riser stand into a storage rack respectively, and said second crane (50) being adapted for transverse transportation of a single riser section or a single riser stand at least between said transfer elevator and a position above a storage rack,

wherein said second crane comprises:

- a second travelling beam extending in a direction parallel to said storage racks and supported at each end thereof on a crane rail perpendicular to said storage racks, preferably the same crane rail as the first overhead travelling beam crane,
- a second winch trolley provided with one or more winches and displaceable along said travelling beam,
- possibly, an elongated gripper frame suspended by one or more winch driven cables from said winch trolley, said gripper frame being provided with multiple riser grippers adapted to engage on a single riser section or a single riser stand at spaced gripping locations thereof,

A third aspect of the present invention relates to a vessel adapted to perform subsea wellbore related operations involving a riser string between the subsea wellbore and the vessel, e.g. drilling and/or wellbore intervention, said vessel comprising a hull having a deck, said vessel comprising:

- a riser storage hold present within said hull below said deck,

which riser storage hold comprises storage racks adapted to store therein parallel stacks of multiple riser sections and/or pre-assembled riser stands in horizontal orientation,

which riser storage hold has a floor, side walls, and a roof,

- an elongated riser transfer opening between said deck and said roof, said elongated riser transfer opening extending in a direction parallel to said storage racks, and said elongated riser transfer opening having a length and a width so as to allow for transfer of a single riser section or a single riser stand in horizontal orientation via said riser transfer opening out of and into the riser storage hold,

- a riser transfer station arranged within said riser storage hold and provided with a transfer elevator that is adapted to raise and lower a single riser section or a single riser stand in horizontal orientation thereof so as to pass the single riser section or a single riser stand through the riser transfer opening,

- a first crane arranged within the riser storage hold, said first crane being adapted to lift and lower a single riser section or a single riser stand at least allowing for removal of a single riser section or a single riser stand riser stand from a storage rack and for placing a single riser section or a single riser stand into a storage rack respectively, and said first crane being

adapted for transverse transportation of a single riser section or a single riser stand at least between said transfer elevator and a position above a storage rack,

wherein the riser storage hold is adapted to store therein single first length riser section and/or pre-assembled riser stands (62) each having a length of at least 100 ft. (30.48 m), e.g. of 120 ft. (36.57 m) or 150 ft. (45.72 m),

and

wherein the riser storage hold is adapted to store therein single second length riser sections each having a length of between 50 ft. (15.24 meters) and 90 ft. (27.43 meters), e.g. of 75 ft. (22.86 meters),

wherein the transfer elevator comprises a first elevator unit and a second elevator unit that are spaced apart in a direction parallel to said storage racks, wherein each of said first and second elevator units are adapted to selectively operate stand-alone or in unison, wherein, for operating stand-alone, each elevator unit is adapted to raise and lower a second length riser section, and wherein, for operating in unison, said first and second elevator units are further adapted to raise and lower a first length riser section or single riser stand.

A fourth aspect of the present invention relates to a vessel adapted to perform subsea wellbore related operations involving a riser string between the subsea wellbore and the vessel, e.g. drilling and/or wellbore intervention, said vessel comprising a hull having a deck, said vessel comprising:

- a riser storage hold present within said hull below said deck,

which riser storage hold comprises storage racks adapted to store therein parallel stacks of multiple riser sections and/or pre-assembled riser stands in horizontal orientation,

which riser storage hold has a floor, side walls, and a roof,

- an elongated riser transfer opening extending between said deck and said roof, said elongated riser transfer opening being a parallel to said storage racks, and said elongated riser transfer opening having a length and a width so as to allow for transfer of a single riser section or a single riser stand in horizontal orientation via said riser transfer opening out of and into the riser storage hold,

- a riser transfer station arranged within said riser storage hold and provided with a transfer elevator that is adapted to raise and lower a single riser section or a single riser stand in horizontal orientation thereof so as to pass the single riser section or a single riser stand through the riser transfer opening,

wherein a first elongated riser workshop and a second elongated riser workshop are arranged in the riser storage hold, wherein each riser workshop has a floor, preferably also walls and a possibly also a roof,

the first and second workshop each being arranged along a side of the storage hold, the storage racks being positioned between said first and second workshops,

wherein each riser workshop is arranged parallel to the storage racks and the workshop is adapted to accommodate at least one riser section or riser stand in horizontal orientation, the workshop providing a space, preferably an enclosure, for personnel performing work on the riser, e.g. maintenance and/or inspection of the riser,

wherein the vessel comprises a crane is adapted to place a riser in the workshop and remove a riser from the workshop, e.g. the workshop having a roof with a riser transfer opening therein, preferably said opening being provided with a mobile roof cover, e.g. one or more hatches or a tarpaulin.

wherein, preferably, the transfer station is located centrally between storage racks.

A fifth aspect of the present invention relates to a vessel adapted to perform subsea wellbore related operations involving a riser string between the subsea wellbore and the vessel, e.g. drilling and/or wellbore intervention, said vessel comprising a hull having a deck, said vessel comprising:

- a riser storage,

which riser storage comprises storage racks adapted to store therein parallel stacks of multiple riser sections and/or pre-assembled riser stands in horizontal orientation,

wherein the riser storage is provided with first length storage racks wherein single first length riser section and/or pre-assembled riser stands (62) each having a length of at least 100 ft. (30.48 m), e.g. of 120 ft. (36.57 m) or 150 ft. (45.72 m) are stored,

and

wherein the riser storage is provided with second length storage racks wherein single second length riser sections each having a length of between 50 ft. (15.24 meters) and 90 ft. (27.43 meters), e.g. of 75 ft. (22.86 meters) are stored,

- a first overhead travelling beam crane adapted to lift and lower a single riser section or a single riser stand at least allowing for removal of a single riser section or a single riser stand riser stand from a storage rack and for placing a single riser section or a single riser stand into a storage rack respectively, and said first crane being adapted for transverse transportation of a single riser section or a single riser stand,

wherein said first crane comprises:
- a travelling beam extending in a direction parallel to said storage racks and supported at each end thereof on a crane rail perpendicular to said storage racks,
- a winch trolley provided with one or more winches and displaceable along said travelling beam,
- an elongated gripper frame suspended by one or more winch driven cables from said winch trolley, said gripper frame being provided with two riser grippers,

wherein the first length riser sections or riser stands are each provided at intermediate locations along the length thereof with two riser gripper engageable portions having a spacing the same as the spacing between end portions of a second length riser section so as to allow said two riser grippers to engage on said gripper engageable portions of the first length riser section or riser stand.

A sixth aspect of the present invention relates to a single riser section having a length of at least 100 ft. (30.48 m), e.g. of 120 ft. (36.57 m) or 150 ft. (45.72 m), wherein the riser section is provided at intermediate locations along the length thereof with two riser gripper engageable portions having a spacing corresponding to the spacing between end portions of a 75 ft. (22.86 meters) riser section.

In an embodiment each gripper engageable portion comprises a hook member fitted to the riser section or riser stand, e.g. a hook integrated with a collar that is fitted around the riser pipe.

A seventh aspect of the present invention relates to a set of multiple first length riser sections or pre-assembled riser stands and multiple second length riser sections which are each provided with buoyancy modules, e.g. stored horizontally onboard a vessel, e.g. a vessel as disclosed herein, wherein the buoyancy modules of the second length riser sections having a greater depth rating than the buoyancy modules of the first length riser sections.

An eights aspect of the present invention relates to a riser string extending between a subsea wellbore and a subsea wellbore operations vessel, wherein the riser string comprises a lower string part composed of interconnected second length riser sections and an upper string part composed of interconnected first length riser sections or riser stand, wherein said first length riser sections or riser stand and said second length riser sections are each provided with buoyancy modules, and wherein the buoyancy modules of the second length riser sections having a greater depth rating than the buoyancy modules of the first length riser sections.

Each aspect of the present invention also relates to a method for assembly of a riser string, wherein use is made of a vessel and/or riser sections and/or pre-assembled riser stands as disclosed herein.

The present invention also relates to a riser catwalk machine as described herein. The present invention also relates to a vessel having a deck and a riser storage hold below said deck, wherein first length riser as described herein are stored in horizontal orientation in said storage hold, wherein a riser transfer opening is provided between the hold and the deck and wherein a riser catwalk machine is provided as described herein.

The present invention also relates to a riser handling overhead travelling beam crane as described herein. The present invention also relates to handling first and second length riser sections or pre-assembled riser stands as described herein using said overhead travelling beam crane, e.g. within a riser storage hold of a vessel.

It will be appreciated that any feature described with reference of one aspect of the invention, e.g. described as an optional or a required feature with respect to the first aspect of the invention, may be readily combined with one or more of the other aspects of the invention as described herein.

The invention will now be explained with reference to the drawings. In the drawings:
fig. 1 shows in longitudinal view a vessel according to the invention,

fig. 2 shows a plan view of the aft part of the vessel of figure 1,

fig. 3 shows schematically a step in a riser upending process of the vessel of figure 1,

fig. 4 shows a transverse section of the vessel of figure 1 showing the riser storage hold, the riser transfer elevator, the overhead cranes,

fig. 5 shows a horizontal section of the riser storage hold of the vessel of figure 1,

fig. 6 shows on a larger scale a portion of figure 5,

Fig. 7a illustrates a transfer elevator unit holding a riser section in raised condition,

Fig. 7b illustrates the transfer elevator unit in inoperative condition,

Fig. 8 illustrates the use of two transfer elevator units in unison for handling a first length riser section,

Fig. 9 shows a portion of figure 8 on a larger scale,

Fig. 10 illustrates the use of a single transfer elevator unit in stand-alone mode for handling a second length riser section,

Fig. 11 illustrates the provision of a hook as gripper engageable portion on a first length riser section,

Fig. 12 illustrates the provision of a hook as gripper engageable portion at the end of a second length riser section,

Fig. 13 illustrates an overhead crane handling a first length riser section in the storage hold of the vessel of figure 1,

Fig. 14 shows the overhead crane of figure 13 from above,

Fig. 15a shows the winch trolley and gripper frame of the crane of figure 13 when handling a second length riser section,

Fig. 15b shows the gripper frame of figure 15a from above,

Fig. 16a shows the winch trolley and gripper frame of the crane of figure 13 when handling a first length riser section with the extenders in extended position,

Fig. 16b shows the gripper frame of figure 16a from above,

Fig. 17 illustrates the handling of second length riser sections in the storage hold by means of the crane of figure 13,

Fig. 18 illustrates the catwalk machine, transfer opening and associated hatches of the vessel of figure 1.

Figure 1 shows a mono-hull vessel 1 having a hull 2 with a bow 3, a stern 4, and a moonpool 5 that extends through the hull 1.

The vessel 1 is adapted to perform subsea wellbore related operations involving a riser string between the subsea wellbore and the vessel, in particular drilling operations, e.g. for

exploratory drilling. The vessel can also perform other subsea wellbore related operations, e.g. wellbore intervention.

In this example, the vessel 1 has an accommodation topside 6 at the bow 3, including crew quarters and a bridge.

The vessel 1 has an engine room 7, generally below the accommodation topside, with exhausts 7a extending at the rear of the topside 6, above the topside 6.

The moonpool 5 has, as is preferred, a rectangular shape with opposed lateral sides, a front side and a rear side.

A front main deck 8 extends between the moonpool 5 and the topsides.

A rear main deck 9 extends between the moonpool 5 and the stern of the vessel 4.

The vessel is equipped with a tower 10, which is, as is preferred, embodied as a hollow construction mast having a top 11 and having a base 12 that is integral with the hull 2. The base 12 extends between sections of the hull on opposed lateral sides of the moonpool 5 and the base 12 is spaced from each of the front side and the rear side of the moonpool, thereby forming a front moonpool area 5a forward of the mast 10 and a rear moonpool area 5b rearward of the mast 10.

The mast 10 has a front side and an opposed rear side 10b as well as opposed lateral sides.

In this example, drill pipe racks, here embodied as carrousel type racks 14, are located adjacent the lateral sides of the mast 10, as is known in the art.

At the rear moonpool area, the vessel is provided with a working deck 15 arranged above the rear moonpool area 5b. As is preferred the working deck 15 is a mobile working deck, here liftable along the mast 10 to such a height that a blow-out preventer can be brought and held underneath the working deck 15 in raised position thereof at an elevated position relative to the mast 10. In a lowered, operative position, the working deck 15 preferably, as here, is level with the adjacent main deck area.

In view of assembly and disassembly of a riser string along a firing line 20 through the rear moonpool area 5b the vessel is equipped with a riser string assembly hanger 17 that is

adapted to suspended therefrom a riser string in the firing line 20 into the sea during the riser assembly and disassembly process. As preferred, this hanger 17 is mounted on the working deck 15, e.g. embodied as a riser spider, e.g. provided with a gimballing support so as to allow for angular variation between the riser string and the working deck, e.g. due to sea motion of the vessel.

The vessel 1 has a riser string handling capacity hoisting device including a riser string lifting tool 25 which is movable up and down relative to the mast 10 and that is adapted to connect to an end of a riser section, preferably of a pre-assembled riser stand as will be explained below, and is embodied to support the weight of a riser string in the firing line 20 when released from the riser string assembly hanger 17.

The riser string lifting tool 25 here is suspended from a travelling hanger device 26 that is movable up and down along the rear side of the mast 10 along one or more vertical rails 27.

The hanger device 26 is suspended by one or more cables 28 from a sheave arrangement 29 at the top of the mast, which one or more cables 28 are connected to one or more winches 29a, e.g. arranged within the mast 10.

It is noted that the firing line 20 is outside of the rear side 10b of the mast 10 so that the firing line 20 can be reached without hindrance in the process of upending a riser section or riser stand from the rear of the vessel.

In an alternative embodiment, the mast 10 is replaced by a derrick type tower having a latticed frame with corner posts that forms a frame extending over the moonpool. It is then envisaged that the riser storage is outside of the derrick type tower and the derrick is provided with a V-door or similar to allow passage of a riser section or riser stand into and out of the derrick.

The vessel also has a second hoisting device having a load attachment device 30 which is movable up and down relative to the mast at a side opposed from the riser firing line 20, so as to allow for handling of items passing through the other moonpool area along a second firing line 21 distinct and spaced from the first firing line 20 where the riser string assembly takes place.

The second firing line 21 extends through the front moonpool area 5a. Along this firing line 21 primarily drilling operations are performed.

The second hoisting device is embodied as a drilling drawworks, and is provided with a topdrive 31 suspended from the load attachment device 30 to perform drilling operations. The load attachment device 30 is preferably embodied similar as the travelling hanger device 26.

A working deck 32 is arranged above the moonpool area 5a and may include a rotary table, iron roughneck machine, etc.

The vessel 1 is thus capable of assembly of a riser string in firing line 20. For transfer of the riser string to the other firing line 21 a riser string support cart 35 is provided that is displaceable within the moonpool, e.g. skiddable over rails along the lateral sides of the moonpool 5.

The vessel has a riser storage hold 40, here as is preferred, within the hull 2 aft of the moonpool 5.

The riser storage hold 40 comprises storage racks adapted to store therein parallel stacks of multiple riser sections and/or pre-assembled riser stands in horizontal orientation.

The riser storage hold is provided with first length storage racks 80 adapted to store therein single first length riser sections 85 and/or pre-assembled riser stands each having a length of at least 100 ft. (30.48 m), e.g. of 120 ft. (36.57 m) or 150 ft. (45.72 m). In the example depicted in the figures the first length is 150 ft.

The riser storage hold is provided with second length storage racks 90 adapted to store therein single second length riser sections 95 each having a length of between 50 ft. (15.24 meters) and 90 ft. (27.43 meters), e.g. of 75 ft. (22.86 meters). In the example depicted in the figures the second length is 75 ft.

The second length storage racks 90 are arranged in sets of two arranged, with the two racks 90 being in line with one another and parallel to the adjacent longer first length storage racks 80.
A first group of first length storage racks 80 is arranged adjacent one side of the transfer station 50 and a second group of first length storage racks 80 is arranged adjacent another side of the transfer station 50.

A first group of second length storage racks 90 is arranged along the first group of first length storage racks and a second group of second length storage racks 90 is arranged along said second group of first length storage racks.

Each storage rack 80, 90 comprises at ends thereof a pair of adjacent riser end support columns that form a vertical slot which is adapted to receive therein an end portion, e.g. a flange, of a riser section 85, 95.

The riser storage hold has a floor 40a, port and starboard side walls 40b,c, and a roof 41.

An elongated riser transfer opening 45 is present between the deck 9 and the roof 41.

The riser transfer opening 45 extends in a direction parallel to the storage racks and has a length, here of at least 150 ft., and a width so as to allow for transfer of a single riser section or a single riser stand in horizontal orientation via the riser transfer opening out of and into the riser storage hold.

Within the storage 40 a riser transfer station 50 is arranged below the riser transfer opening 45. The station is provided with a transfer elevator that is adapted to raise and lower a single riser section or a single riser stand in horizontal orientation thereof so as to pass the riser section or a riser stand through the riser transfer opening 45.

In the storage hold 40 a first overhead travelling beam crane 60 is arranged.

The crane 60 is capable of lifting and lowering a single riser section 85,95, either of first length or of second length as described herein, as well as a single pre-assembled first length riser stand as described herein, at least allowing for removal of a single riser section or a single riser stand riser stand from a storage rack and for placing a single riser section 85, 95 or a single riser stand into a storage rack respectively. The crane 60 is also capable of transverse transportation of a single riser section 85, 95 or a single riser stand at least between the transfer station 50 and a position above each of the storage racks 80, 90 in the storage 40.

The first crane 60 comprises:

- a travelling beam 61 extending in a direction parallel to the storage racks and supported at each end thereof on a crane rail 62, 63 perpendicular to the storage racks, here transverse to the hull 2,

- a winch trolley 65 provided with one or more winches 66, 67 and displaceable along the travelling beam 61,
- an elongated gripper frame 68 suspended by one or more winch driven cables 69a, 69b from the winch trolley, 65. The gripper frame 68 is provided with multiple riser grippers 70a, b that are each adapted to engage on a single riser section 85, 95 or a single riser stand at spaced gripping locations thereof.

The gripper frame 68 is provided with two riser grippers 70a, b that are adapted and arranged to engage on the end portions of second length riser section 85, here on end portions of a 75 ft. riser section.

The first length riser sections 95 are provided at intermediate locations along the length thereof with two riser gripper engageable portions, here hooks 140, having a spacing the same as the spacing between end portions of a second length riser section 85 so as to allow said two riser grippers 70a, b to engage on said gripper engageable portions 140 of the first length riser section 95.

The gripper frame 68 is provided, at each end thereof, with a telescoping extender 68a, b having an extender end. Each extender 68a, b is extensible so that the extender end is adjacent the end of a first length riser section 95 or riser stand. The end is dimensioned to be slidable received between two columns of a storage rack in order to guide the gripper frame and riser during vertical travel.

The crane 60 is adapted to transfer a second length riser section 85 between each of the second length storage racks 80 and the transfer station 50, and to transfer a first length riser section 95 or riser stand between each of the first length storage racks 90 and the transfer station 50.

The transfer elevator comprises a first elevator unit 55 and a second elevator unit 55, as is preferred of the same design. These units 55 are spaced apart in direction parallel to the storage racks.

Each of the elevator units 55 is adapted to selectively operate stand-alone or in unison. In stand-alone mode each elevator unit 55 is adapted to raise and lower a second length riser section (fig. 10). When operating in unison the elevator units 55 raise and lower a first length riser section or single riser stand together (fig 8,9).

Each elevator unit 55 comprises a vertical guide structure 56, stationary mounted in the storage hold 40. Further a telescoping member 57 is provided, which is guided by the vertical guide structure 56. The elevator unit further comprises a winch 58 and winch driven cable 59 connected to the telescoping member 57 to cause vertical motion thereof. A riser support member 55a is mounted on the telescoping member 57 and is adapted to support a riser section 85, 95 or riser stand.

The riser support member is a riser support table 55a having a length of between 20 and 50 ft.

The riser support member 55a is pivotally connected to the telescoping member 57 and is tiltable, her by hydraulic cylinder, between a horizontal operation position wherein a riser section or riser stand can rest on said riser support member and a vertical inoperative storage position (see figures 7a, 7b).

The riser storage hold 40 is provided with a first elongated riser workshop 110 and a second elongated riser workshop 120, each having a length at least sufficient to receive therein a first length riser section or stand. Each riser workshop has a floor, and, as is preferred also walls and a roof.

Each riser workshop 110, 120 is arranged parallel to the storage racks and the workshop is adapted to accommodate at least one riser section 85, 95 or riser stand in horizontal orientation. The workshop provides an enclosure for personnel performing work on the riser section, e.g. maintenance and/or inspection of the riser section and/or interconnecting sections to form a pre-assembled stand.

The overhead travelling beam crane 60 is adapted to place a riser section 85, 95 in each of the workshops 110, 120 and remove a riser section from the workshop. In this example it is envisaged that the workshops 110, 120 have a roof with a riser transfer opening therein, preferably said opening being provided with a mobile roof cover, e.g. one or more hatches or a tarpaulin.

As can be seen the workshops 110, 120 are arranged along the port and starboard sides of the hold 40, along opposite sides of the storage racks 80, 90. The transfer station 50 is arranged centrally between storage racks 80, 90.

The riser storage hold is provided with a second overhead travelling beam crane 60' which is provided to obtain a redundant crane system for handling riser sections 85, 95. The crane 60' is preferably of the same design as the crane 60. The travelling beam of crane 60' preferably travels on the same crane rails as the first overhead travelling beam crane 60.

The second travelling beam crane 60'here has a parking position above one of the workshops, here at 120, which workshop 120 preferably is located along a side of the riser storage hold.

The vessel is provided with movable hatches which in a closed position thereof close the transfer opening 45 and in an opened position thereof open the transfer opening. e.g. pivotal hatches 130a, 130b.

Substantially horizontal rails 150 extend along opposite longitudinal sides of the riser transfer opening 45.

The vessel comprises a riser horizontal transport device 200 that is mounted on horizontal rails 150 and is adapted to receive and hold a riser section 85, 95 or riser stand that has been raised through said transfer opening 45 by the riser elevator unit or units 55 and to horizontally transport the riser section 85, 95 or riser stand so that a leading end thereof is connectable to a riser string lifting tool that is adapted to support the weight of a riser string in the firing line 20 of the vessel.

The riser horizontal transport device comprises a catwalk machine having a mobile catwalk machine frame that is movable over the horizontal rails 150. The catwalk machine frame has a rear end and a front end and is movable over the horizontal rails 150 at least in a loading position generally above the opening 45 and in a riser upending position closer to the firing line 20.

The catwalk machine frame has two parallel and horizontal frame beams 201, 202. At the rear end the beams 201, 202 are rigidly and permanently interconnected by a transverse beam 203. The beams 201, 202 are less long than the transfer opening 45 and the first length riser section or stand that is stored in the hold 40. In order to obtain a sturdy frame during transportation of the riser section it is envisaged that, here only at the front end, the frame beams 201, 202 are interconnected by a mobile transverse connector 204 that is movable between an inactive position allowing for vertical passage of the single riser section or single riser stand and an active position wherein the transverse connector 204

interconnects the frame beams 201, 202. When lifting and lowering a section of first length the connector 204 is inactive or opened. A shorter second length may be handled with the connector remaining closed as the opening in the frame of the machine is then large enough.

A skate 205 is supported by the frame beams 201, 202 and travels over the frame beams. As is known in the art the skate 205 comprises a riser end support to support thereon a rearward end of a riser section 85, 95 or riser stand.

As will be appreciated the horizontal frame beams 201, 202 of the catwalk machine frame define between them an opening having a width so as to allow for the vertical passing of a single riser section 85, 95 (equipped with buoyancy members) or a single riser stand in horizontal orientation through said opening, preferably by means of the transfer elevator unit or units 55.

The catwalk machine, in addition to the skate 205, comprises one or more additional riser support members 206 that are movable between an inactive position allowing for said vertical passage of the single riser section 85, 95 or single riser stand and an active position wherein the riser section or riser stand is supported on said riser support member 206.

If desired the catwalk machine 200 is provided with a tailing-in arm device, e.g. with one tailing arm fitted to the front end of each beam 201, 202.

As can be seen in figure 18 a first set of pivotal hatches 130a,b is arranged along one longitudinal side of the transfer opening 45 and a second set of pivotal hatches 130a, b is arranged along the opposed longitudinal side of the transfer opening 45, so that with said hatches 130a, b in horizontal position the transfer opening 45 is closed and with said hatches in upward pivoted position the transfer opening 45 is open.

As can be seen – in upward pivoted position – these hatches 130a, b are to the outside of the horizontal rails 150 at a spacing allowing for the travel of the catwalk machine 200 over said horizontal rails 150 between said upward pivoted hatches.

# CONCLUSIES

1. Vaartuig (1) ingericht om werkzaamheden uit te voeren die verband houden met een onderzees boorgat, waarbij gebruikt wordt gemaakt van een riserstreng tussen het onderzeese boorgat en het vaartuig, bijvoorbeeld boorwerkzaamheden en/of boorgatinterventie, waarbij het vaartuig een romp (2) met een dek (9) omvat, waarbij het vaartuig omvat:

- een riseropslagruim (40) in de romp (2) onder het genoemde dek,

waarbij het riseropslagruim riseropslagrekken omvat die zijn ingericht om daarin evenwijdige stapels van meerdere risersecties en/of voorgeassembleerde risersamenstellen in horizontale oriëntatie op te slaan,

waarbij het riseropslagruim een vloer, zijwanden, en een dak heeft,

- een langwerpige risertransferopening (45) tussen het genoemde dek en het genoemde dak, waarbij de risertransferopening zich in een richting evenwijdig aan de opslagrekken uitstrekt, waarbij de risertransferopening een lengte en een breedte heeft zodanig dat de transfer van een enkele risersectie of een enkel risersamenstel (62) in horizontale oriëntatie via de risertransferopening vanuit het riseropslagruim of daarin naar binnen mogelijk is,

- een risertransferstation (50) dat in het riseropslagruim is aangebracht onder de risertransferopening en is voorzien van een transferlift (55) die is ingericht om een enkele risersectie of een enkel risersamenstel in horizontale oriëntatie daarvan op de tillen of te laten zakken om de risersectie of het risersamenstel door de risertransferopening te doen passeren,

- een eerste bovenloopkraan (60) die in het riseropslagruim (40) is opgesteld, welke eerste kraan (60) is ingericht om een enkele risersectie of een enkel risersamenstel (85, 95) op te tillen en te laten zakken waardoor het ten minste mogelijk is een enkele risersectie of een enkel risersamenstel uit een opslagrek (80, 90) te halen en een enkele risersectie of een enkel risersamenstel in een opslagrek te plaatsen, en waarbij de eerste kraan (60) is ingericht voor het in dwarsrichting transporteren van een enkele risersectie of een enkel risersamenstel ten minste tussen het transferstation en een positie boven een opslagrek,

waarbij de eerste kraan (60) omvat:

- een verplaatsende ligger die zich in een richting evenwijdig aan de opslagrekken uitstrekt en aan elk einde daarvan op een kraanrails is gesteund die zich loodrecht op de opslagrekken uitstrekt,
- een liertrolley die is voorzien van één of meer lieren en verplaatsbaar is langs de verplaatsende ligger,
- een langwerpig grijperframe dat via één of meer door een lier aangedreven kabels van de liertrolley is afgehangen, waarbij het grijperframe is voorzien van meerdere risergrijpers die zijn ingericht om aan te grijpen op een enkele risersectie of een enkel risersamenstel op van elkaar vandaan gelegen grijplocaties daarvan,

waarbij het riseropslagruim is voorzien van eerste lengte opslagrekken (80) die zijn ingericht om daarin individuele eerste lengte risersecties (85) en/of voorgeassembleerde risersamenstellen op te slaan die elk een lengte hebben van ten minste 100 voet (30.48 m), bijvoorbeeld van 120 voet (36.57 m) of 150 voet (45.72 m),

en

waarbij het riseropslagruim is voorzien van tweede lengte opslagrekken (90) die zijn ingericht om daarin individuele tweede lengte risersecties (95) op te slaan die elk een lengte hebben van tussen 50 voet (15.24 m) en 90 voet (27.43 m), bijvoorbeeld van 75 voet (22.86m),

waarbij, bij voorkeur, twee tweede lengte opslagrekken (90) in lijn met elkaar zijn opgesteld, evenwijdig aan de eerste lengte opslagrekken,

en waarbij de eerste bovenloopkraan (60) is ingericht om een tweede lengte risersectie (95) te verplaatsen tussen elk van de tweede lengte opslagrekken (90) en het transferstation, en om een eerste lengte risersectie (85) of risersamenstel te verplaatsen tussen elk van de eerste lengte opslagrekken en het transferstation.

2. Vaartuig volgens conclusie 1, waarbij de transferlift een eerste lifteenheid (55) en een tweede lifteenheid (55) omvat die op een afstand van elkaar zijn geplaatst in een richting evenwijdig aan de opslagrekken, waarbij elk van de eerste en tweede lifteenheden (55) zijn ingericht om selectief in een standalone modus of met elkaar samen te werken, waarbij, voor het standalone werken, elke lifteenheid is ingericht om een tweede lengte risersectie (95) op te tillen en te laten zakken, en waarbij, voor het werken in samenwerking met elkaar,

elk van de eerste en tweede lifteenheden verder zijn ingericht om een eerste lengte risersectie of enkel risersamenstel op te tillen en te laten zakken.

3. Vaartuig volgens conclusie 2, waarbij elke lifteenheid een verticale geleidingsconstructie (56) omvat, bij voorkeur stationair aangebracht in het opslagruim, en een telescopisch orgaan (57) dat door de verticale geleidingsconstructie is geleid, waarbij de lifteenheid verder een lier (58) en een door een lier aangedreven kabel (59) omvat die verbonden is met het telescopische orgaan om verticale beweging daarvan te veroorzaken, en waarbij een riserondersteuningsorgaan (55a) op het telescopische orgaan is aangebracht en is ingericht om een risersectie of risersamenstel te ondersteunen.

4. Vaartuig volgens een van de conclusies 1-3, waarbij een eerste groep van eerste lengte opslagrekken (80) langs één zijde van het transferstation (50) is opgesteld en een tweede groep van eerste lengte opslagrekken (80) is opgesteld langs een andere zijde van het transferstation, en waarbij een eerste groep van tweede lengte opslagrekken (90) is opgesteld langs de eerste groep van eerste lengte opslagrekken en waarbij een tweede groep van tweede lengte opslagrekken (90) is opgesteld langs de tweede groep van eerste lengte opslagrekken.

5. Vaartuig volgens een van de conclusies 1-4, waarbij het riseropslagruim is voorzien van ten minste één langwerpige riserwerkplaats (110, 120) met een vloer, bij voorkeur ook met wanden en mogelijk ook een dak, waarbij de riserwerkplaats evenwijdig aan de opslagrekken (80, 90) is opgesteld en de werkplaats is ingericht om daarin ten minste één risersectie (85, 95) of risersamenstel in horizontale oriëntatie op te nemen, waarbij de werkplaats een ruimte verschaft, bij voorkeur een omsloten ruimte, voor personeel dat werkzaamheden uitvoert aan de riser, bijvoorbeeld onderhoud en/of inspectie van de riser, en waarbij de eerste bovenloopkraan (60) is ingericht om een riser in de werkplaats te plaatsen en een riser uit de werkplaats te halen, waarbij de werkplaats een dak heeft dat is voorzien van een risertransferopening daarin, bij voorkeur waarbij de opening is voorzien van een beweegbare dak afdekking, bijvoorbeeld één of meer luiken of een dekzeil.

6. Vaartuig volgens conclusie 5, waarbij een eerste langwerpige riserwerkplaats (110) en een tweede langwerpige riserwerkplaats (120) in de riseropslagruim (40) zijn opgesteld, langs tegenover elkaar gelegen zijden van de opslagrekken, bij voorkeur met het transferstation (50) in het midden tussen de opslagrekken.

7. Vaartuig volgens een van de conclusies 1- 6, waarbij het riseropslagruim is voorzien van een tweede bovenloopkraan (60') die in het riseropslagruim (40) is opgesteld, waarbij de tweede kraan (60') is ingericht om een enkele risersectie of een enkel risersamenstel op te tillen en te laten zakken waardoor het ten minste mogelijk is een enkele risersectie of een enkel risersamenstel uit een opslagrek te verwijderen en een enkele risersectie of een enkel risersamenstel in een opslagrek te plaatsen, en waarbij de tweede kraan (60') is ingericht voor het in dwarsrichting transporteren van een enkele risersectie of enkel risersamenstel ten minste tussen de transferlift en een positie boven een opslagrek,
waarbij de tweede kraan (60') omvat:

- een tweede verplaatsende ligger die zich in een richting evenwijdig aan de opslagrekken uitstrekt en aan elk einde daarvan op een kraanrail die loodrecht op de opslagrekken staat is gesteund, bij voorkeur dezelfde kraanrail als de eerste bovenloopkraan,
- een tweede liertrolley voorzien van één of meer lieren en verplaatsbaar langs de ligger,
- mogelijk, een langwerpig grijperframe dat via één of meer door een lier aangedreven kabels van de liertrolley is afgehangen, waarbij het grijperframe is voorzien van meerdere risergrijpers die zijn ingericht om aan te grijpen op een enkele risersectie of een enkel risersamenstel op op een afstand van elkaar gelegen grijplocaties daarvan.

8. Vaartuig volgens conclusies 5 en 7, bij voorkeur conclusie 5, 6 en 7, waarbij een eerste langwerpige riserwerkplaats (110) en de tweede langwerpige riserwerkplaats (120) in het riseropslagruim zijn opgesteld, waarbij ten minste één van de riserwerkplaatsen is opgesteld langs een zijkant van de riseropslagruim, en waarbij de tweede bovenloopkraan (60') een parkeerpositie heeft boven die werkplaats langs de zijkant van het riseropslagruim.

9. Vaartuig volgens een van de conclusies 1- 8, waarbij het grijperframe (68) is voorzien van twee risergrijpers (70a, b) die zijn ingericht en opgesteld om op de einddelen, bijvoorbeeld met haken (140), van een tweede lengte risersectie (95) aan te grijpen, bijvoorbeeld op einddelen van een 75 voet risersectie.

10. Vaartuig volgens een van de conclusies 1-9, waarbij één of meer eerste lengte risersecties (85) of risersamenstellen op tussengelegen plaatsen langs de lengte daarvan zijn voorzien van twee door risergrijpers aan te grijpen gedeeltes (140) die een onderlinge afstand hebben die dezelfde is als de onderlinge afstand tussen eindgedeeltes van een tweede lengte risersectie om het mogelijk te maken dat de twee risergrijpers (70a, b) op die door

een grijper aan te grijpen gedeeltes van de eerste lengte risersectie of risersamenstel aangrijpen.

11. Vaartuig volgens een van de conclusies 1-10, waarbij het grijperframe (68), aan elk einde daarvan, is voorzien van een telescopische verlenger (68a, b) met een verlengereinde, waarbij de verlenger uitschuifbaar is zodat het verlengereinde zich nabij het einde van een eerste lengte risersectie of ristersamenstel bevindt, waarbij elk eerste lengte opslagrek (80) aan de einden daarvan een paar naast elkaar gelegen risereindesteunkolommen heeft die een verticale sleuf vormen die is ingericht om daarin een eindgedeelte, bijvoorbeeld een flens, van een risersectie of een risersamenstel op te nemen, en waarbij het verlengereinde is ingericht om schuivend te worden opgenomen tussen die kolommen.

12. Vaartuig volgens een van de conclusies 1-11, waarbij in hoofdzaak horizontale rails (150) zich langs tegenover elkaar gelegen langszijden van de risertransferopening (45) uitstrekken,
en waarbij het vaartuig een riser horizontaal transportinrichting (200) omvat die op die horizontale rails is geplaatst en is ingericht om een risersectie of risersamenstel te ontvangen en vast te houden, welke door de genoemde transferopening is opgetild door de riserlift en om de risersectie of het risersamenstel horizontaal te transporteren zodat een voorste einde daarvan verbonden kan worden met een riserstreng liftgereedschap dat is ingericht om het gewicht van een riserstreng in een vuurlijn (20) van het vaartuig te dragen.

13. Vaartuig volgens conclusie 12, waarbij het riser horizontaal transportinrichting een catwalkmachine (200) omvat met een mobiel catwalkmachineframe dat verplaatsbaar is over de genoemde horizontale rails, waarbij het catwalkmachineframe een achterste einde en een voorste einde heeft, en verplaatsbaar is over de horizontale rails ten minste in een laadpositie en in een riser rechtopzetpositie,
waarbij het catwalkmachineframe twee evenwijdige en horizontale framebalken (201, 202) heeft en waarbij een schaats (205) door de framebalken is ondersteund en over de framebalken verplaatst, waarbij de schaats een risereindesteun omvat om daarop een achterste einde van een risersectie of risersamenstel te dragen,
waarbij de horizontale framebalken (201, 202) van het catwalkmachineframe tussen hen in een opening begrenzen die een zodanige breedte heeft dat verticale passage van een enkele risersectie (85, 95) of een enkel risersamenstel in horizontale oriëntatie daarvan door die opening mogelijk is, bij voorkeur door middel van de transferlift (55),
en waarbij de catwalkmachine, in toevoeging op de schaats, één of meer additionele riserondersteuningsorganen (206) omvat die beweegbaar zijn tussen een inactieve positie die de

genoemde verticale passage van de enkele risersectie of het enkele risersamenstel mogelijk maakt en een actieve positie waarin de risersectie of risersamenstel op de riserondersteuningsorganen is ondersteund.

14. Vaartuig volgens conclusie 13, waarbij de framebalken (201, 202) star met elkaar zijn verbonden door een dwarsbalk (203) nabij het achterste einde van het catwalkmachineframe, en waarbij de framebalken zijn verbonden door één of meer beweegbare dwarsverbinders (204) die elk beweegbaar zijn tussen een inactieve stand die de genoemde verticale passage van de enkele risersectie of het enkele risersamenstel mogelijk maakt en een actieve stand waarin de dwarsverbinder de framebalken met elkaar verbindt, bijvoorbeeld waarbij het catwalkmachineframe een enkele dwarsverbinder heeft nabij het voorste einde van het catwalkmachineframe.

15. Vaartuig volgens conclusie 13, waarbij het vaartuig is voorzien van één of meer beweegbare luiken die in een gesloten stand daarvan de transferopening afsluiten en in een geopende stand daarvan de transferopening openen, bijvoorbeeld scharnierbare luiken, waarbij een eerste set van scharnierbare luiken langs een langszijde van de transferopening is opgesteld en een tweede set van scharnierbare luiken langs de tegenover gelegen langszijde van de transferopening is opgesteld, zodat met de luiken in horizontale stand de transferopening gesloten is en met de luiken in naar boven gekantelde stand de transferopening open is, en waarbij - in naar boven gekantelde stand- de luiken zich buiten de horizontale rails bevinden op een onderlinge afstand die het toelaat dat de catwalkmachine over een horizontale rails verplaatst tussen de naar boven gekantelde luiken.

16. Vaartuig (1) ingericht om werkzaamheden uit te voeren die verband houden met een onderzees boorgat, waarbij gebruikt wordt gemaakt van een riserstreng tussen het onderzeese boorgat en het vaartuig, bijvoorbeeld boorwerkzaamheden en/of boorgatinterventie, waarbij het vaartuig een romp (2) met een dek (9) omvat, waarbij het vaartuig omvat:

- een riseropslagruim in de romp onder het genoemde dek,

waarbij het riseropslagruim opslagrekken omvat die zijn ingericht om daarin evenwijdige stapels van meerdere risersecties en/of voorgeassembleerde risersamenstellen in de horizontale oriëntatie op te slaan,

waarbij het riseropslagruim een vloer, zijwanden en een dak heeft,

waarbij het riseropslagruim is voorzien van eerste lengte opslagrekken die zijn ingericht om daarin enkele eerste lengte risersecties en/of voorgeassembleerde risersamenstellen (62) op te slaan elk met een lengte van ten minste 100 voet (30.48 m), bijvoorbeeld 120 voet (36.57 m) of 150 voet (45.72 m),

en

waarbij het riseropslagruim is voorzien van tweede lengte opslagrekken die zijn ingericht om daarin enkele tweede lengte risersecties op te slaan die elk een lengte hebben van tussen 50 voet (15.24 m) en 90 voet (27.43 m), bijvoorbeeld van 75 voet (22.86 m), waarbij de twee tweede lengte opslagrekken in lijn met elkaar zijn opgesteld, evenwijdig aan de eerste lengte opslagrekken.

17. Vaartuig ingericht om werkzaamheden uit te voeren die verband houden met een onderzees boorgat, waarbij gebruikt wordt gemaakt van een riserstreng tussen het onderzeese boorgat en het vaartuig, bijvoorbeeld boorwerkzaamheden en/of boorgatinterventie, waarbij het vaartuig een romp (2) met een dek (9) omvat, waarbij het vaartuig omvat:

- een riseropslagruim in de romp onder het genoemde dek,

waarbij het riseropslagruim opslagrekken omvat die zijn ingericht om daarin evenwijdig stapels van meerdere risersecties en/of voorgeassembleerde risersamenstellen in de horizontale oriëntatie op te slaan,

waarbij het riseropslagruim een vloer, zijwanden en een dak heeft,

- waarbij een eerste bovenloopkraan (50) in het riseropslagruim (40) is opgesteld, welke eerste kraan (50) is ingericht om een enkele risersectie of een enkel risersamenstel (62) op te tillen en te laten zakken waardoor het ten minste mogelijk is een enkele risersectie of een enkel risersamenstel uit een opslagrek (41) te halen en een enkele risersectie of een enkel risersamenstel in een opslagrek te plaatsen, en waarbij de eerste kraan (50) is ingericht voor het in dwarsrichting transporteren van een enkele risersectie of een enkel risersamenstel ten minste tussen het transferstation en een positie boven een opslagrek,

waarbij de eerste kraan omvat:

- een verplaatsende ligger die zich in een richting evenwijdig aan de opslagrekken uitstrekt en aan elk einde daarvan op een kraanrails is gesteund die zich loodrecht op de opslagrekken uitstrekt,

- een liertrolley die is voorzien van één of meer lieren en verplaatsbaar is langs de verplaatsende ligger,

- een langwerpig grijperframe dat via één of meer door een lier aangedreven kabels van de liertrolley is afgehangen, waarbij het grijperframe is voorzien van meerdere risergrijpers die zijn ingericht om aan te grijpen op een enkele risersectie of een enkel risersamenstel op van elkaar vandaan gelegen grijplocaties daarvan,

en

waarbij het riseropslagruim is voorzien van een tweede bovenloopkraan (60') die in het riseropslagruim (40) is opgesteld, waarbij de tweede kraan (60') is ingericht om een enkele risersectie of een enkel risersamenstel op te tillen en te laten zakken waardoor het ten minste mogelijk is een enkele risersectie of een enkel risersamenstel uit een opslagrek te verwijderen en een enkele risersectie of een enkel risersamenstel in een opslagrek te plaatsen, en waarbij de tweede kraan (50) is ingericht voor het in dwarsrichting transporteren van een enkele risersectie of enkel risersamenstel ten minste tussen de transferlift en een positie boven een opslagrek,

waarbij de tweede kraan omvat:

- een tweede verplaatsende ligger die zich in een richting evenwijdig aan de opslagrekken uitstrekt en aan elk einde daarvan op een kraanrail die loodrecht op de opslagrekken staat is ondersteund, bij voorkeur dezelfde kraanrail als de eerste bovenloopkraan,
- een tweede liertrolley voorzien van één of meer lieren en verplaatsbaar langs de ligger,
- mogelijk, een langwerpig grijperframe dat via één of meer door een lier aangedreven kabels van de liertrolley is afgehangen, waarbij het grijperframe is voorzien van meerdere risergrijpers die zijn ingericht om aan te grijpen op een enkele risersectie of een enkel risersamenstel op op een afstand van elkaar gelegen grijplocaties daarvan.

18. Vaartuig (1) ingericht om werkzaamheden uit te voeren die verband houden met een onderzees boorgat, waarbij gebruikt wordt gemaakt van een riserstreng tussen het onderzeese boorgat en het vaartuig, bijvoorbeeld boorwerkzaamheden en/of boorgatinterventie, waarbij het vaartuig een romp (2) met een dek omvat, waarbij het vaartuig omvat:

- een riseropslagruim in de romp onder het genoemde dek,

welk riseropslagruim opslagrekken omvat die zijn ingericht om daarin evenwijdige stapels van meerdere risersecties en/of voor-geassembleerde risersamenstellen in horizontale oriëntatie op te slaan,

welk riseropslagruim een vloer, zijwanden en een dak heeft,

- een langwerpige risertransferopening (45) tussen het dek en het dak, waarbij de risertransferopening (45) zich in een richting evenwijdig aan de opslagrekken uitstrekt, waarbij de risertransferopening een lengte en een breedte heeft zodanig dat de transfer van een enkele risersectie of een enkel risersamenstel (62) in horizontale oriëntatie via de risertransferopening vanuit het riseropslagruim of daarin naar binnen mogelijk is,

- een risertransferstation dat in het riseropslagruim is aangebracht onder de risertransferopening en is voorzien van een transferlift (55) die is ingericht om een enkele risersectie of een enkel risersamenstel in horizontale oriëntatie daarvan op de tillen of te laten zakken om de risersectie of het risersamenstel door de risertransferopening te doen passeren,

- een eerste kraan (60) aangebracht in het riseropslagruim (40), welke eerste kraan (60) is ingericht om een enkele risersectie of enkel risersamenstel op te tillen en te laten zakken, waardoor het ten minste mogelijk is een enkele eerste risersectie of enkel risersamenstel uit een opslagrek te nemen en een enkele risersectie of enkel risersamenstel in een opslagrek te plaatsen, en waarbij de kraan (60) is ingericht voor het verplaatsen in dwarsrichting van een enkele risersectie of enkel risersamenstel ten minste tussen de transferlift en een positie boven een opslagrek,

waarbij de riseropslagruim is ingericht om daarin enkele eerste lengte risersecties en/of voor-geassembleerde risersamenstellen (62) op te slaan elk met een lengte van ten minste 100 voet (30.48 m), bijvoorbeeld van 120 voet (36.57 m) of 150 voet (45.72 m),

en

waarbij het riseropslagruim is ingericht om daarin enkele tweede lengte risersecties op te slaan die elk een lengte hebben tussen 50 voet (15.24 m) en 90 voet (27.43 m), bijvoorbeeld van 75 voet (22.86 m),

waarbij de riserlift een eerste lifteenheid (55) en een tweede lifteenheid (55) omvat die op een afstand van elkaar zijn geplaatst in een richting evenwijdig aan de opslagrekken, waarbij elk van de eerste en tweede lifteenheden zijn ingericht om selectief in standalone modus of met elkaar samen te werken, waarbij, voor het werken in standalone modus, elke lifteenheid is ingericht om een tweede lengte risersectie op te tillen en te laten zakken, en waarbij, voor het werken in samenwerking met elkaar, de eerste en tweede lifteenheden verder zijn ingericht om een eerste lengte risersectie of enkel risersamenstel op te tillen en te laten zakken.

19. Vaartuig (1) ingericht om werkzaamheden uit te voeren die verband houden met een onderzees boorgat, waarbij gebruikt wordt gemaakt van een riserstreng tussen het onderzeese boorgat en het vaartuig, bijvoorbeeld boorwerkzaamheden en/of boorgatinterventie, waarbij het vaartuig een romp (2) met een dek omvat, waarbij het vaartuig omvat:

- een riseropslagruim in de romp onder het genoemde dek,

welk riseropslagruim opslagrekken omvat die zijn ingericht om daarin evenwijdige stapels van meerdere risersecties en/of voorgeassembleerde risersamenstellen in horizontale oriëntatie op te slaan,

welk riseropslagruim een vloer, zijwanden, en een dak heeft,

- een langwerpige risertransferopening (45) tussen het dek en het dak, waarbij de risertransferopening (45) zich in een richting evenwijdig aan de opslagrekken uitstrekt, waarbij de risertransferopening een lengte en een breedte heeft zodanig dat de transfer van een enkele risersectie of een enkel risersamenstel (62) in horizontale oriëntatie via de risertransferopening vanuit het riseropslagruim of daarin naar binnen mogelijk is,

- een risertransferstation dat in het riseropslagruim is aangebracht onder de risertransferopening en is voorzien van een transferlift (55) die is ingericht om een enkele risersectie of een enkel risersamenstel in horizontale oriëntatie daarvan op de tillen of te laten zakken om de risersectie of het risersamenstel door de risertransferopening te doen passeren,

waarbij een eerste langwerpige riserwerkplaats en een tweede langwerpige riserwerkplaats zijn opgesteld in het riseropslagruim, waarbij elke riserwerkplaats een vloer heeft, bij voorkeur ook wanden en mogelijk ook een dak,

waarbij de eerste en tweede werkplaatsen elk zijn ingericht opgesteld langs een zijkant van het opslagruim, waarbij de opslagrekken tussen de eerste en tweede werkplaatsen zijn opgesteld,

waarbij elke riserwerkplaats evenwijdig aan de opslagrekken is opgesteld en de werkplaats is ingericht om daarin ten minste één risersectie of risersamenstel in horizontale oriëntatie op te nemen, waarbij de werkplaats een ruimte verschaft, bij voorkeur een omsloten ruimte, voor personeel dat werkzaamheden uitvoert aan de riser, bijvoorbeeld onderhoud en/of inspectie van de riser,

waarbij het vaartuig verder een kraan omvat die is ingericht om een riser in de werkplaats te plaatsen en een riser uit de werkplaats te halen, bijvoorbeeld waarbij de werkplaats een dak heeft met een risertransferopening daarin, bij voorkeur waarbij de opening is voorzien van een beweegbare dak afdekking, bijvoorbeeld één of meer luiken en/of een dekzeil,

waarbij, bij voorkeur, het transferstation centraal tussen de opslagrekken is opgesteld.

20. Vaartuig (1) ingericht om werkzaamheden uit te voeren die verband houden met een onderzees boorgat, waarbij gebruikt wordt gemaakt van een riserstreng tussen het onderzeese boorgat en het vaartuig, bijvoorbeeld boorwerkzaamheden en/of boorgatinterventie, waarbij het vaartuig een romp (2) met een dek omvat, waarbij het vaartuig omvat:

- een riseropslag,

welke riseropslag meerdere opslagrekken omvat die zijn ingericht om daarin evenwijdige stapels van meerdere risersecties en/of voorgeassembleerde risersamenstellen in horizontale oriëntatie op te slaan,

waarbij de riseropslag is voorzien van eerste lengte opslagrekken waarin enkele eerste lengte risersecties en/of voorgeassembleerde risersamenstellen (62) zijn opgeslagen die elk een lengte van ten minste 100 voet (30.48 m) bijvoorbeeld van 120 voet (36.57 m) of 150 voet (45.72 m) hebben,

en

waarbij de riseropslag is voorzien van tweede lengte opslagrekken waarin enkele tweede lengte risersecties zijn opgeslagen elk met een lengte van tussen 50 voet (15.24 m) en 90 voet (27.43 m), bijvoorbeeld van 75 voet (22.86 m),

- een eerste bovenloopkraan (60) die is ingericht om een enkele risersectie of een enkel risersamenstel op te tillen en te laten zakken waardoor het ten minste mogelijk is een enkele risersectie of een enkel risersamenstel uit een opslagrek te halen en een enkele risersectie of een enkel risersamenstel in een opslagrek te plaatsen en waarbij de eerste kraan (60) is ingericht voor het in dwarsrichting transporteren van een enkele risersectie of een enkel risersamenstel,

waarbij de eerste kraan omvat:
- een verplaatsende ligger die zich in een richting evenwijdig aan de opslagrekken uitstrekt en aan elk einde daarvan op een kraanrail die loodrecht op de opslagrekken staat is ondersteund,
- een liertrolley voorzien van één of meer lieren en verplaatsbaar langs de ligger,
- een langwerpig grijperframe dat via één of meer door een lier aangedreven kabels van de liertrolley is afgehangen, waarbij het grijperframe is voorzien van twee risergrijpers,

waarbij de eerste lengte risersecties en/of risersamenstellen elk op tussengelegen locaties langs de lengte daarvan zijn voorzien van twee door risergrijpers aangrijpbare gedeeltes die een onderlinge afstand hebben die dezelfde is als de onderlinge afstand tussen eindgedeeltes van een tweede lengte risersectie om het mogelijk te maken dat de twee risergrijpers op de genoemde door een grijper aangrijpbare gedeeltes van de eerste lengte risersectie of risersamenstel aangrijpen.

21. Een enkele risersectie met een lengte van ten minste 100 voet (30.48 m), bijvoorbeeld van 120 voet (36.57 m) of 150 voet (45.72 m), waarbij de risersectie op tussengelegen plaatsen langs de lengte daarvan is voorzien van twee door risergrijpers aangrijpbare gedeeltes die een onderlinge afstand hebben die overeenkomt met de afstand tussen eindgedeeltes van een 75 voet (22.86 m) risersectie.

22. Een enkele risersectie volgens conclusie 21, waarbij elk door een grijper aangrijpbaar gedeelte een haakorgaan omvat dat aan de risersectie of het risersamenstel is aangebracht, bijvoorbeeld een haak die geïntegreerd is met een kraag die om de riserpijp is aangebracht.

23. Een riserstreng die zich uitstrekt tussen een onderzees boorgat en een vaartuig voor het uitvoeren van werkzaamheden aan een onderzees boorgat, waarbij de riserstreng een onderste riserstrenggedeelte omvat dat is samengesteld uit onderling verbonden tweede lengte risersecties en een bovenste strenggedeelte dat is samengesteld uit onderling verbonden eerste lengte risersecties of risersamenstellen, waarbij elke eerste lengterisersectie of risersamenstel en de tweede lengte risersecties elk zijn voorzien van drijfmodules, en waarbij de drijfmodules van de tweede lengte risersecties een grotere dieptecapaciteit hebben dan de drijfmodules van de eerste lengte risersecties.

24. Werkwijze voor het samenstellen van een riserstreng, waarbij gebruik wordt gemaakt van een vaartuig volgens één of meer van de voorgaande conclusies.

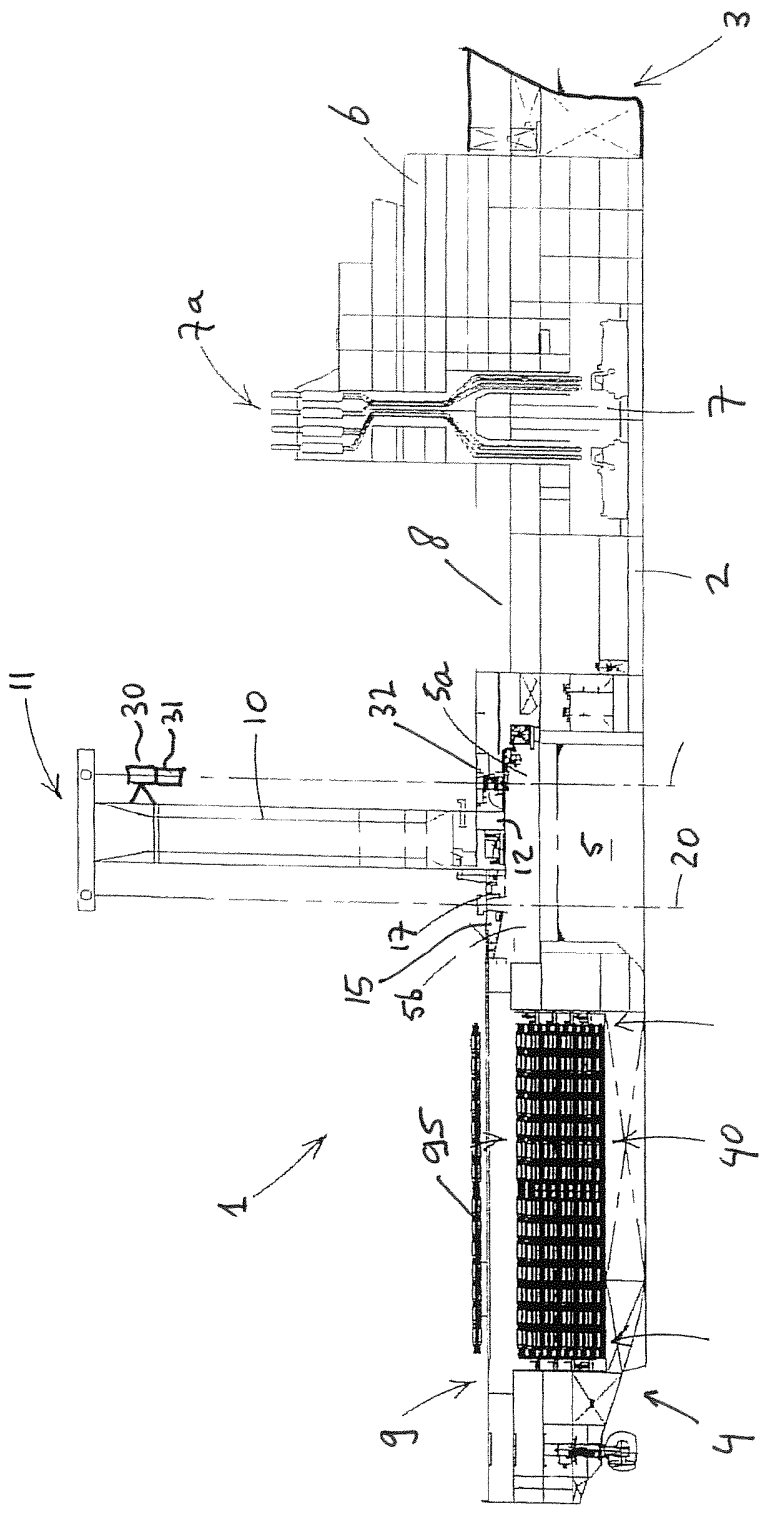



Fig.1

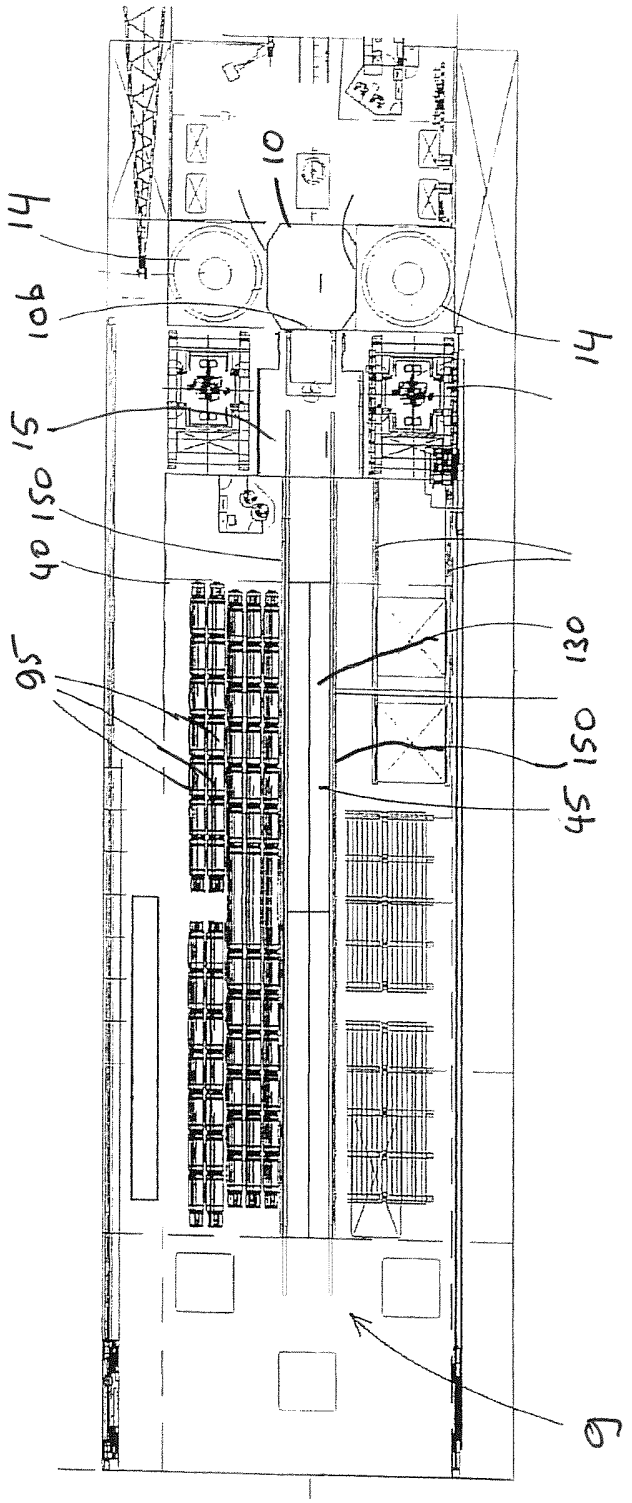
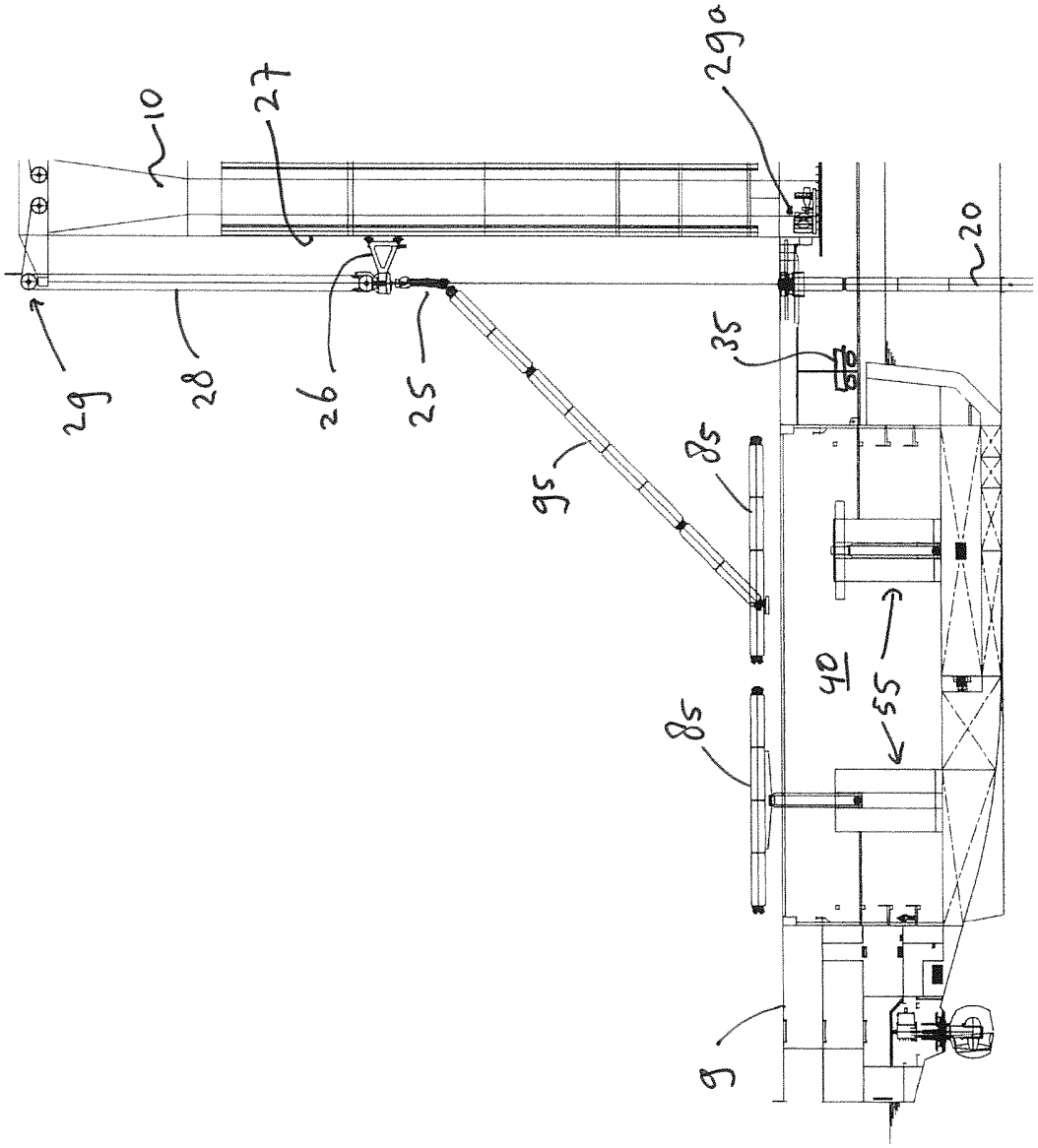



Fig.2

Fig 3



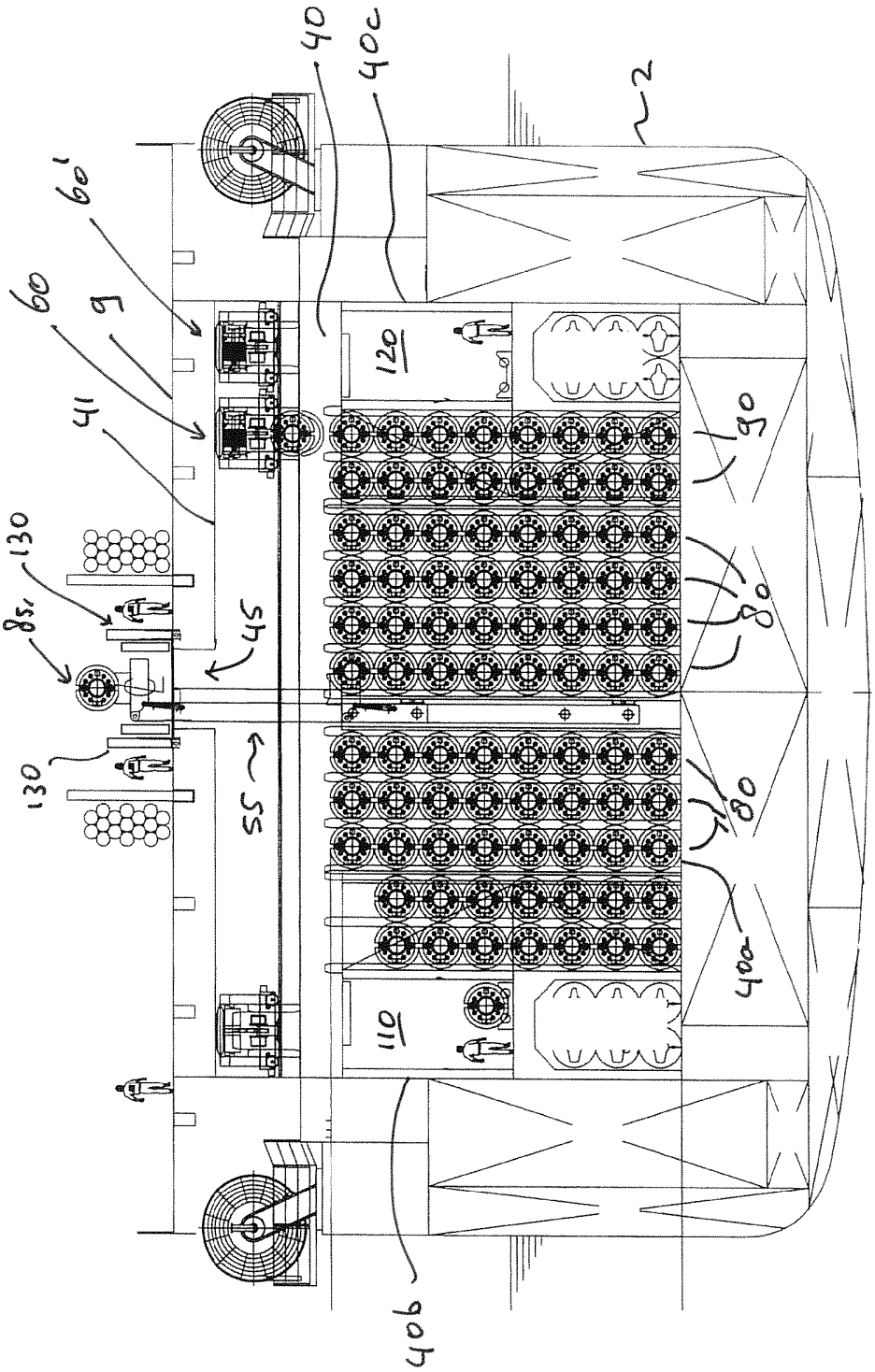



Fig 4

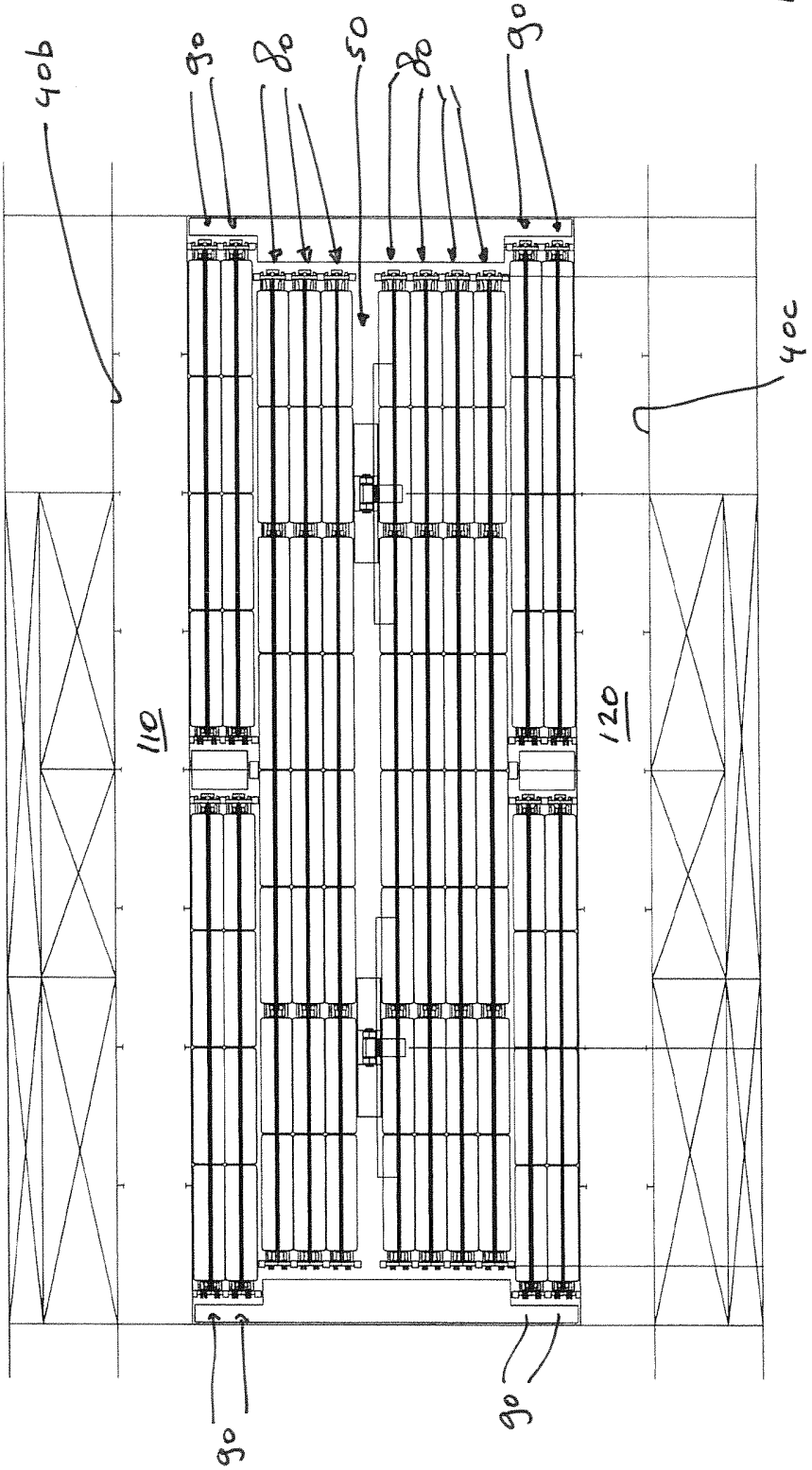



Fig 5

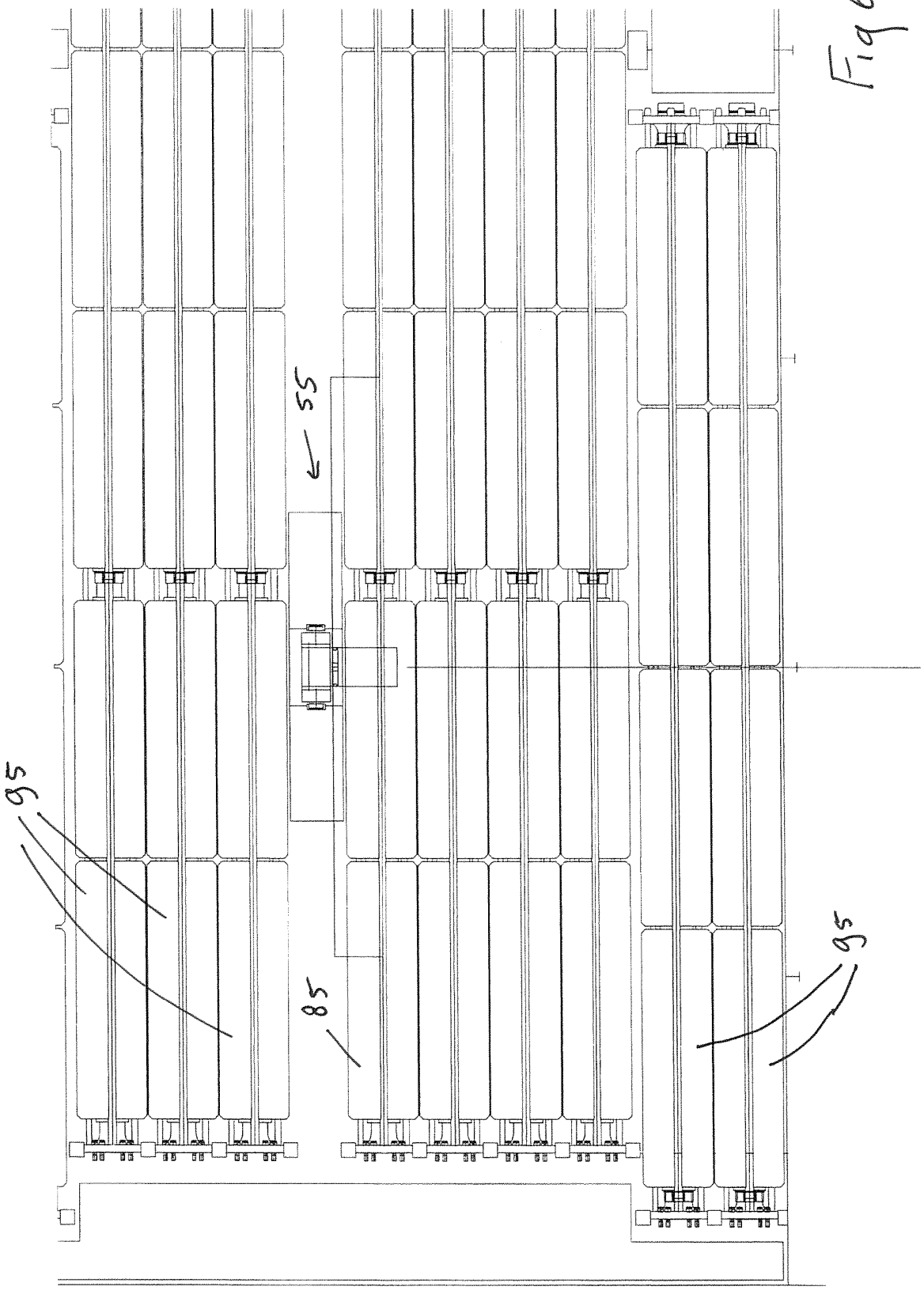



Fig 6

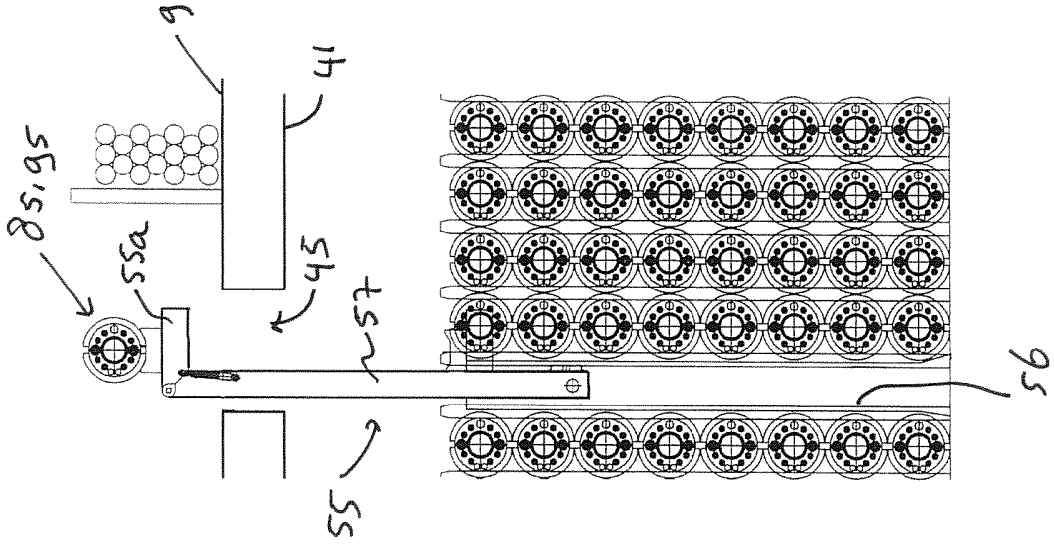



Fig 7a

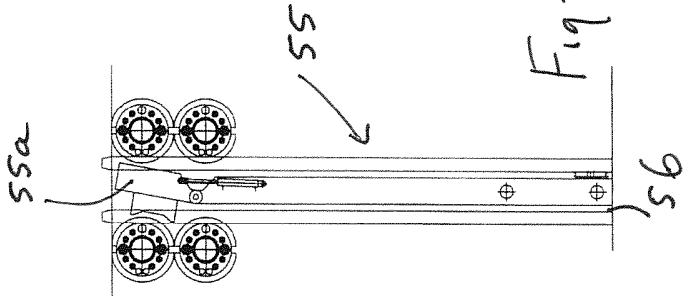



Fig 7b

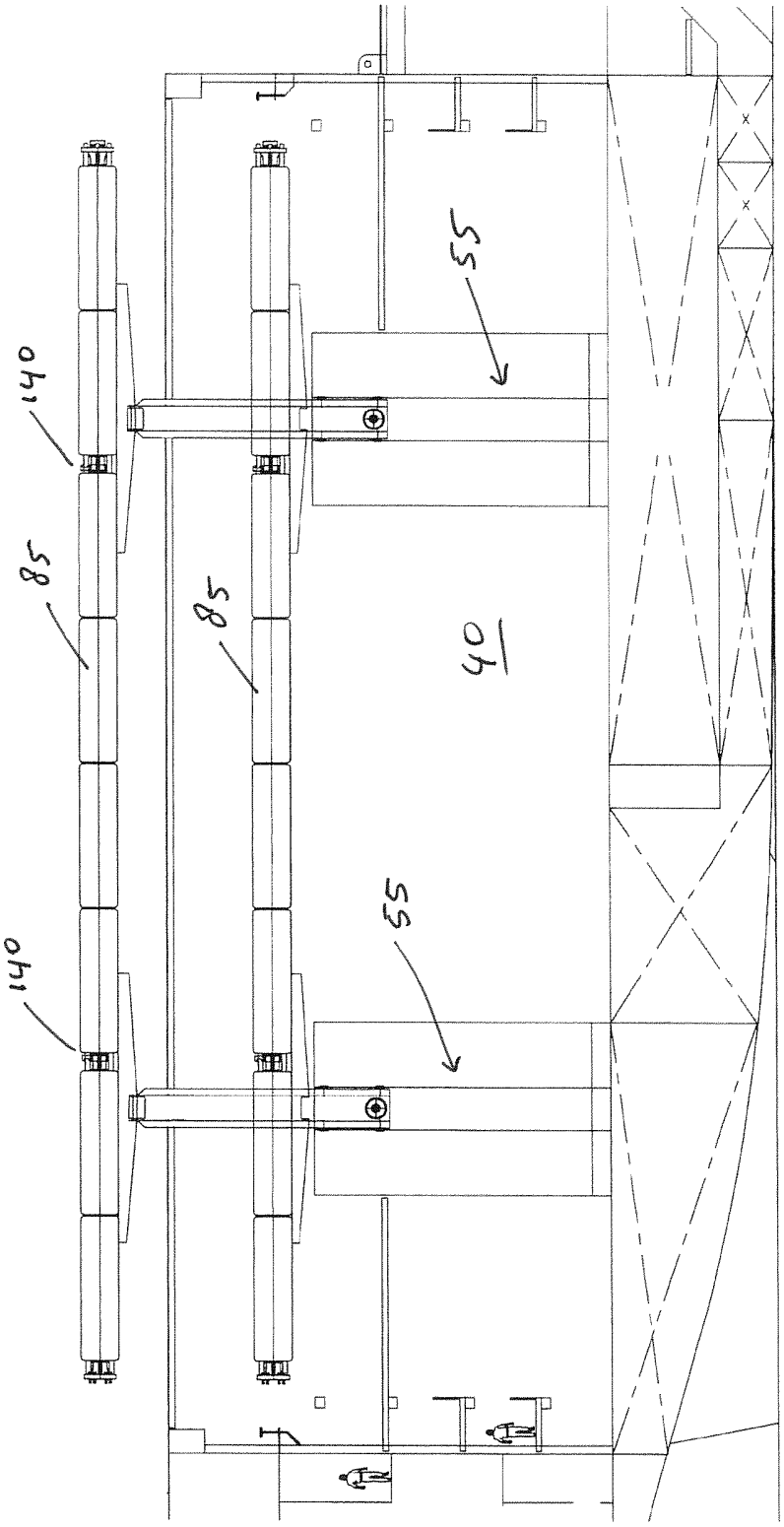



Fig 8

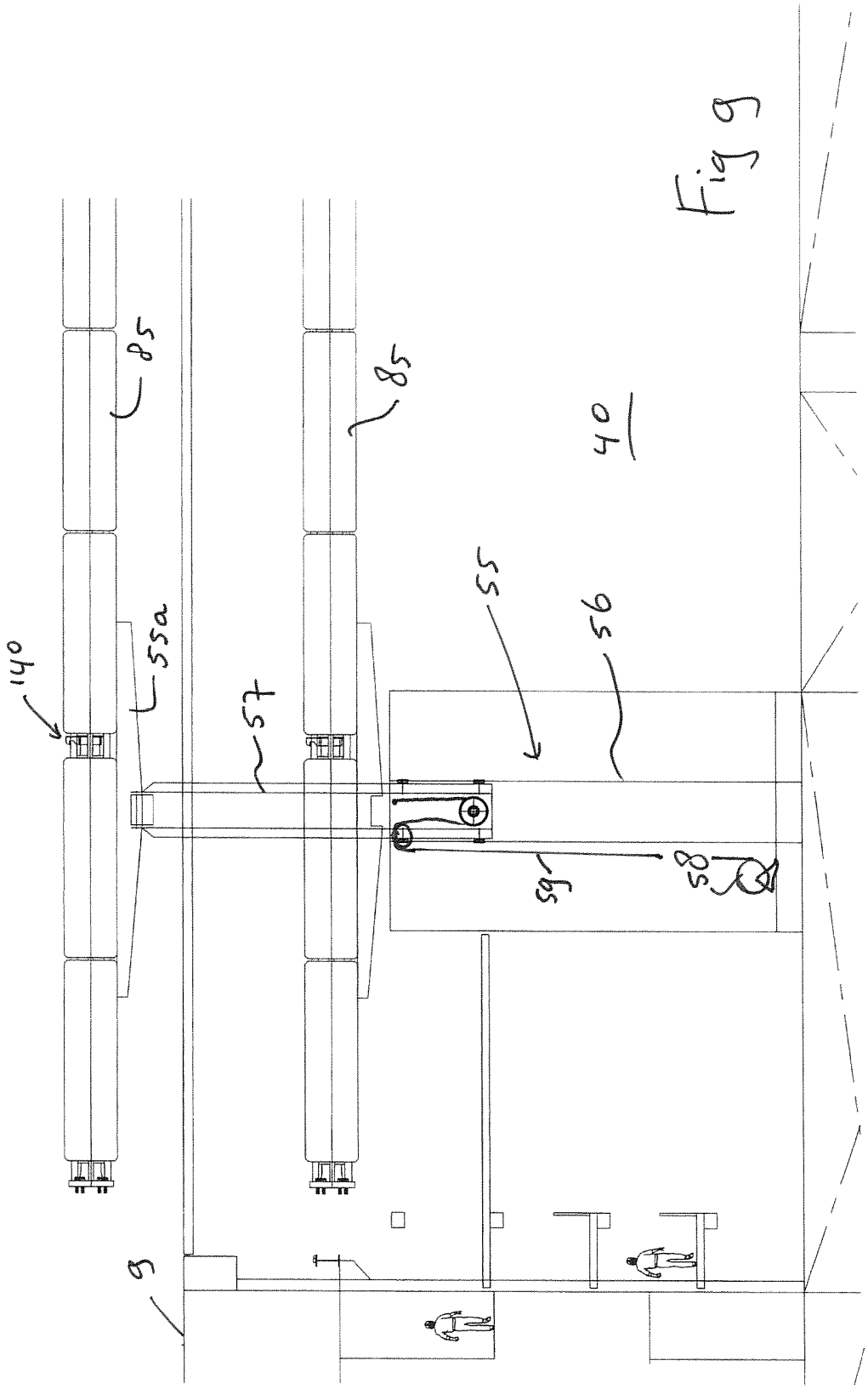



Fig 9

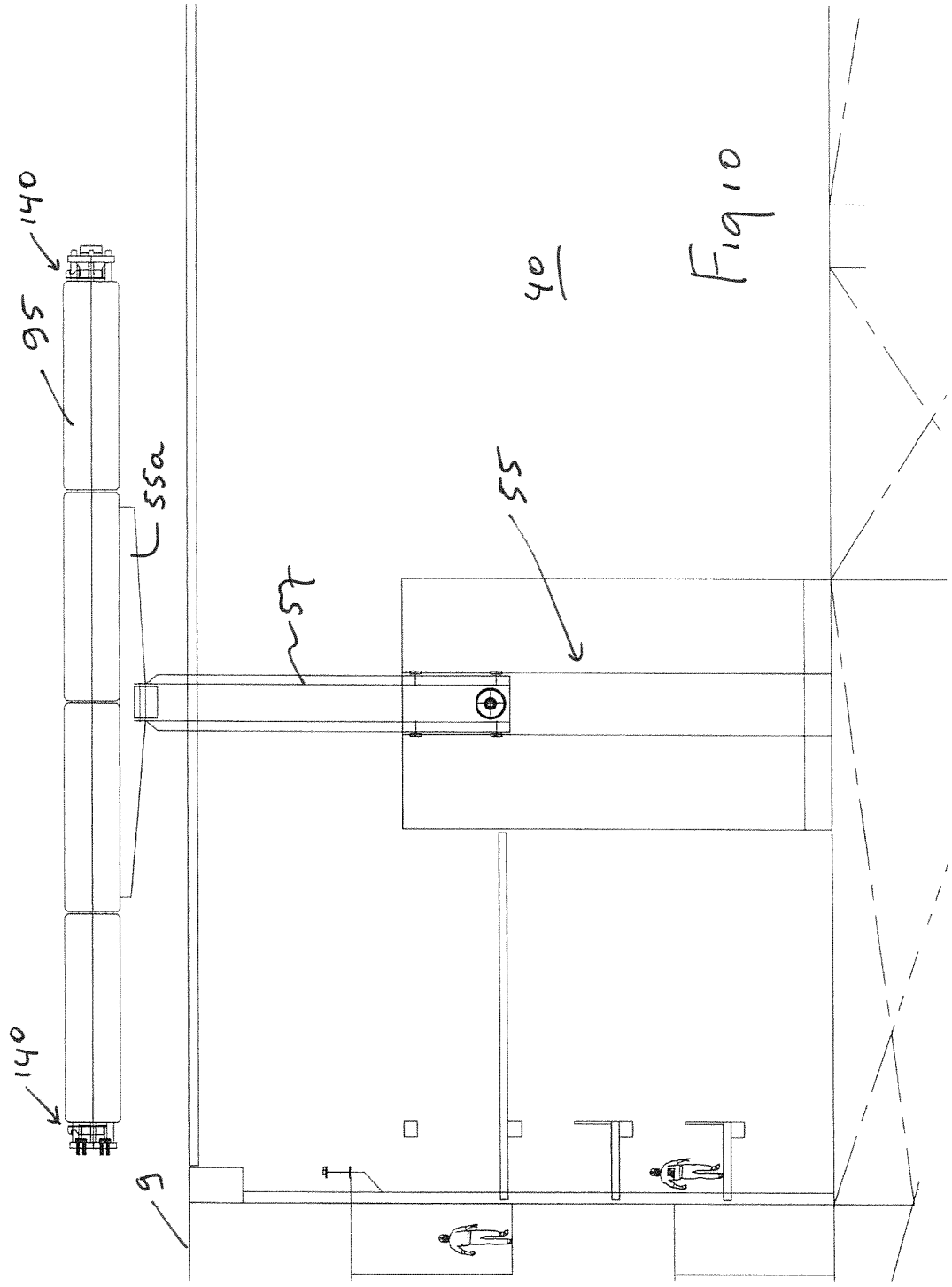



Fig 10

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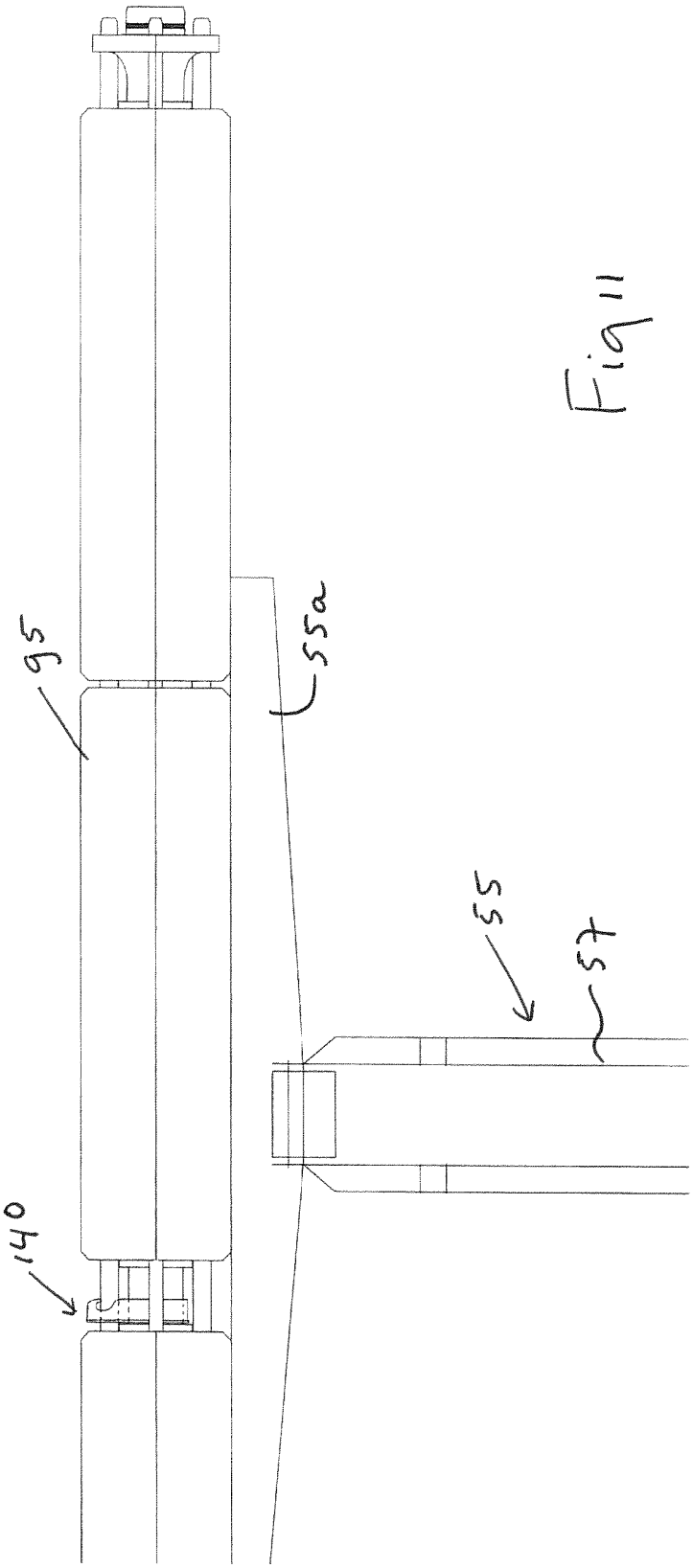


Fig 11

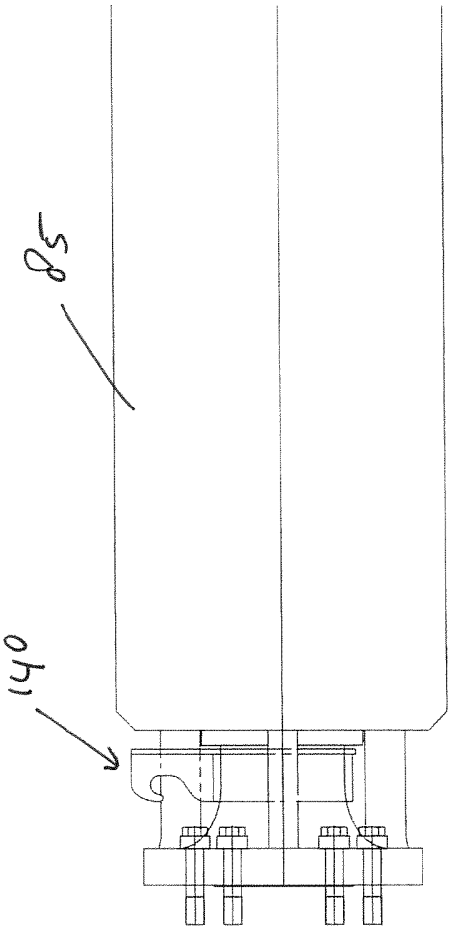


Fig 12

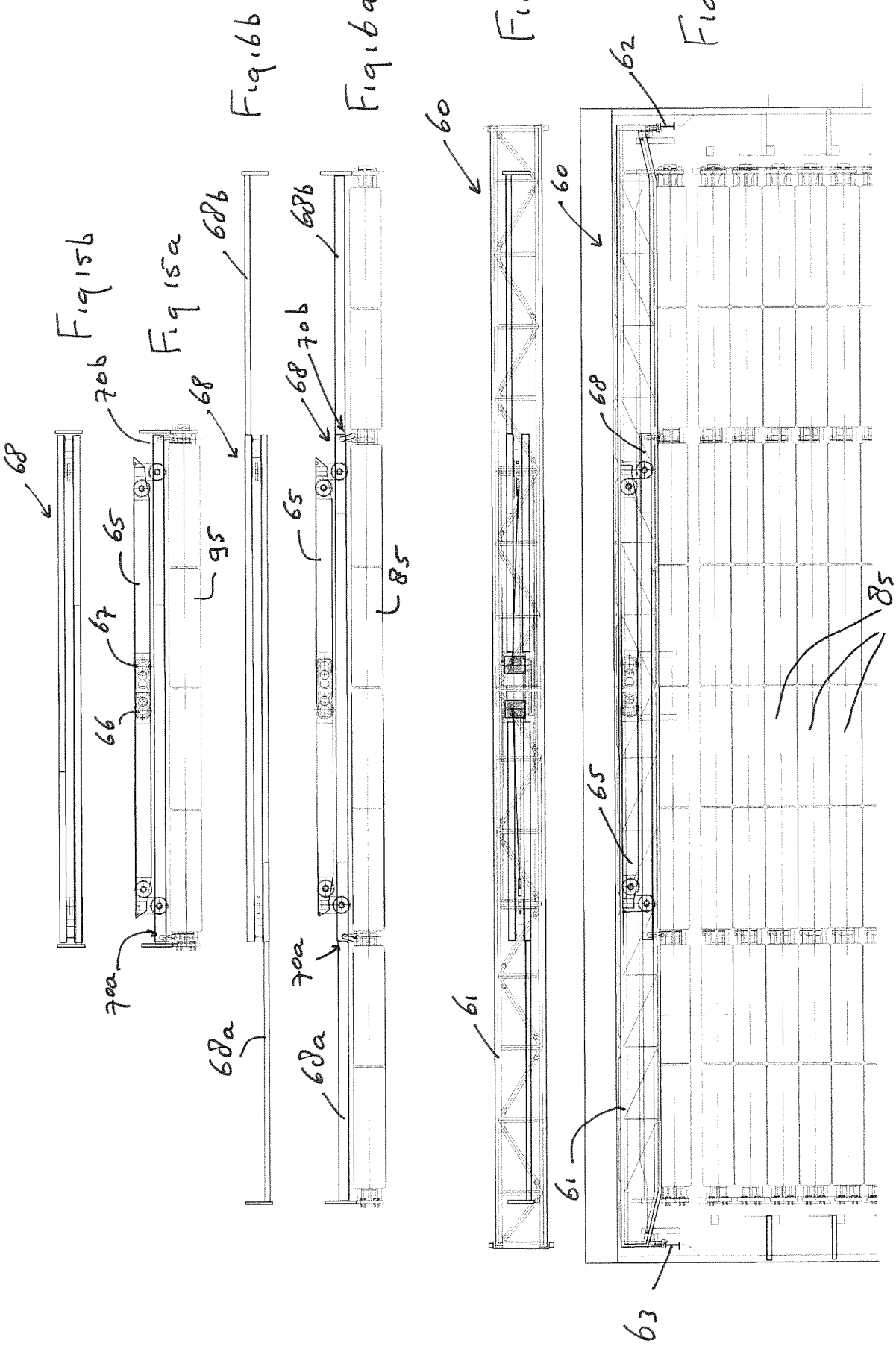
Fig 15b
Fig 15a
Fig 16b
Fig 16a
Fig 14
Fig 13
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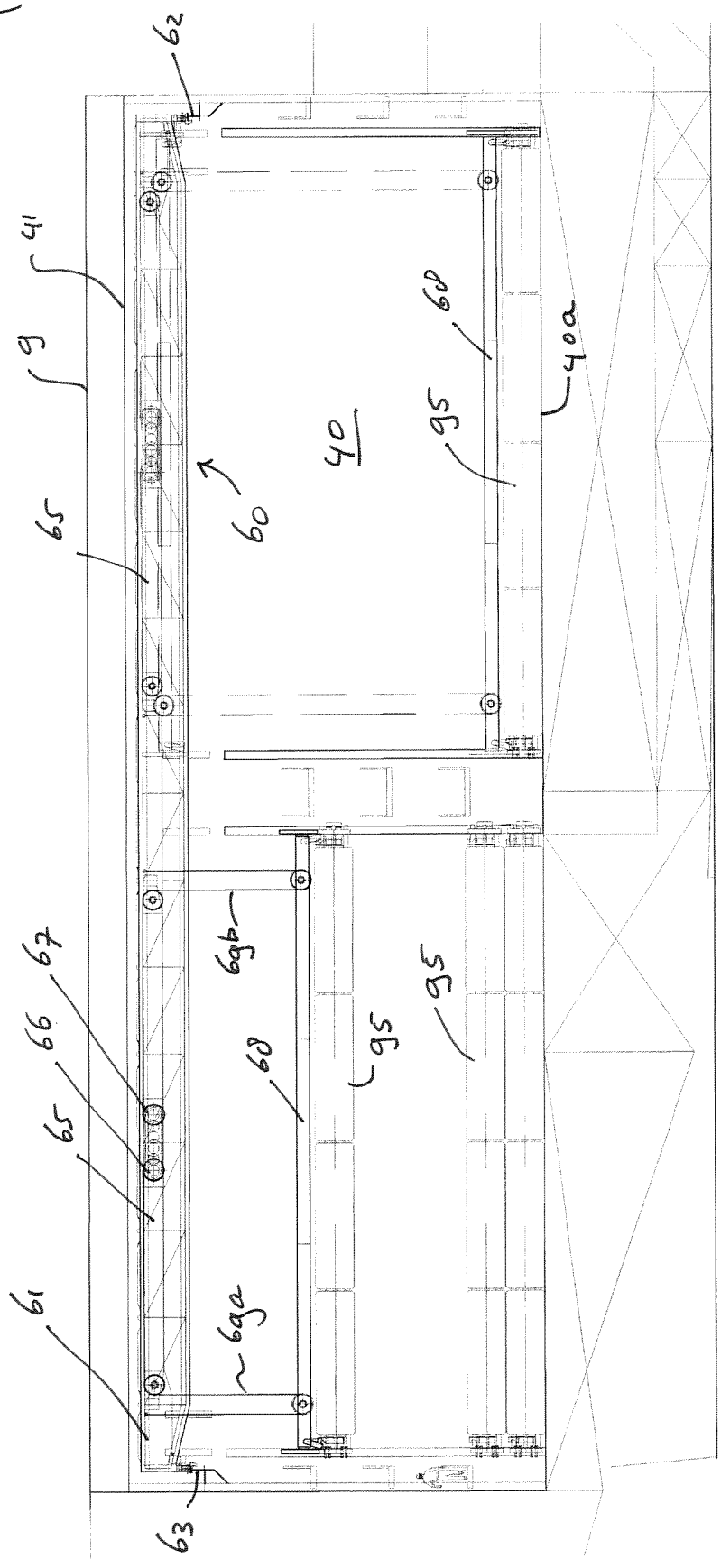
Fig 17



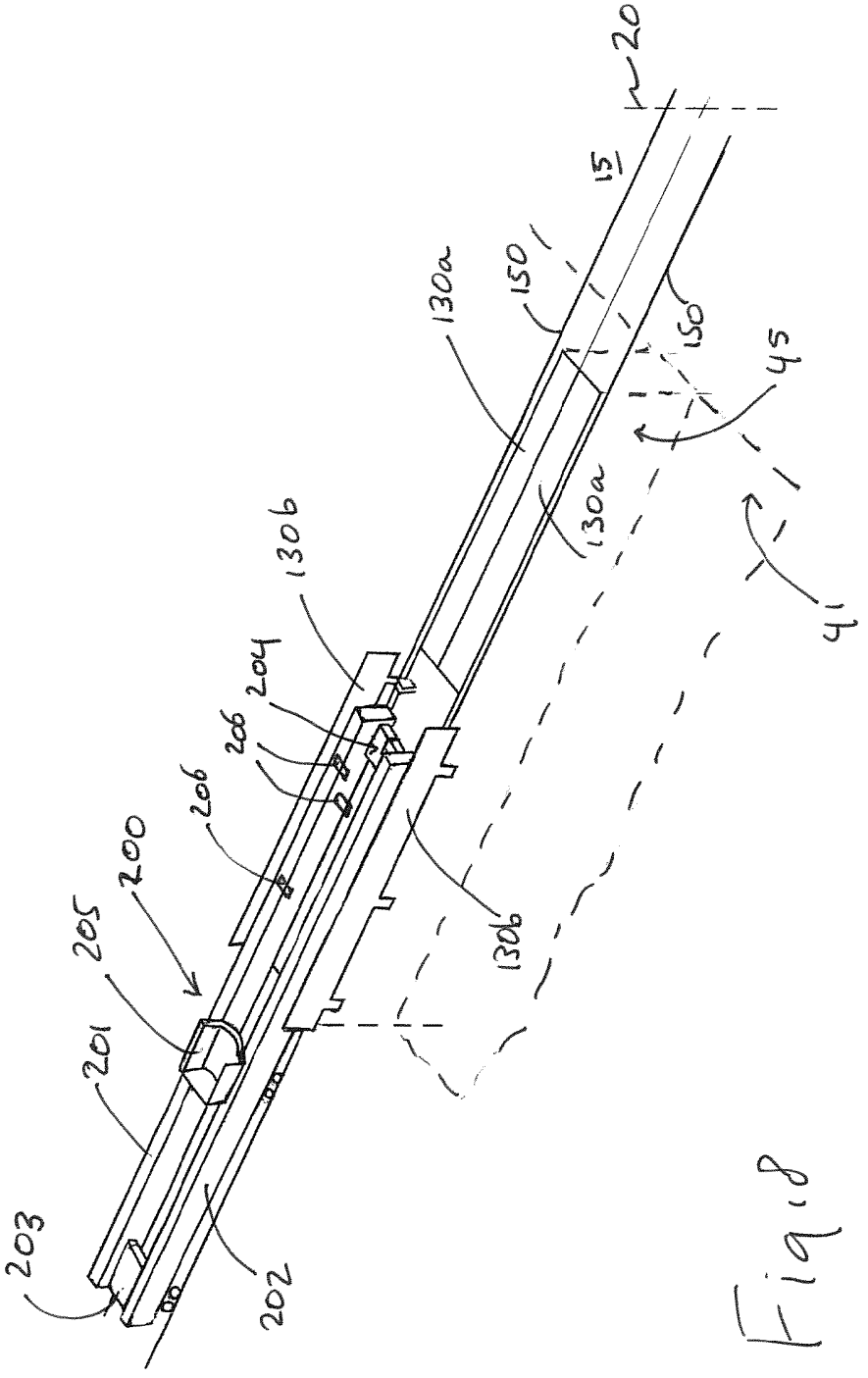

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Fig. 8

A B S T R A C T

A vessel adapted to perform subsea wellbore related operations involving a riser string between the subsea wellbore and the vessel, e.g. drilling and/or wellbore intervention, said vessel comprising a hull having a deck. The vessel comprises a riser storage hold present within said hull below said deck, which riser storage hold comprises storage racks adapted to store therein parallel stacks of multiple riser sections and/or pre-assembled riser stands in horizontal orientation. The vessel has an elongated riser transfer opening between said deck and said roof, said riser transfer opening extending in a direction parallel to said storage racks, said riser transfer opening having a length and a width so as to allow for transfer of a single riser section or a single riser stand in horizontal orientation via said riser transfer opening out of and into the riser storage hold.

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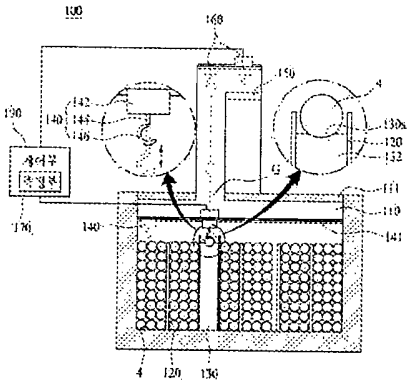
전체 청구항 수 : 총 16 항

(54) 발명의 명칭 **다중 라이저 핸들링 시스템 및 이를 포함한 시추선**

## (57) 요 약

실시예는 저장 공간에 적재된 라이저, 라이저를 인양하여 랜딩 구조물 상부에 배치시키는 제 1크레인, 랜딩 구조물 상부에 배치된 라이저를 인양하여 라이저 캣웍에 이동시키는 제 2 크레인, 미리 설정된 상기 라이저의 위치정보에 따라 상기 제 1 크레인 또는 제 2 크레인 중 적어도 어느 하나의 이동을 제어하는 제어부를 포함하는 라이저 핸들링 시스템 및 이를 포함하는 시추선을 제공한다.

대 표 도 - 도3



## 특허청구의 범위

**청구항 1**

저장 공간에 적재된 라이저;

상기 라이저를 인양하여 랜딩 구조물 상부에 배치시키는 제 1크레인;

상기 랜딩 구조물 상부에 배치된 상기 라이저를 인양하여 라이저 캣웍에 이동시키는 제 2 크레인;

미리 설정된 상기 라이저의 위치정보에 따라

상기 제 1 크레인 또는 제 2 크레인 중 적어도 어느 하나의 이동을 제어하는 제어부를 포함하는 라이저 핸들링 시스템.

**청구항 2**

제 1항에 있어서,

상기 제어부는 상기 라이저의 이동거리를 측정하는 측정부를 포함하는 라이저 핸들링 시스템.

**청구항 3**

제 2항에 있어서,

상기 제어부는 상기 제 1 크레인의 이동거리가 짧을수록 상기 제 2 크레인의 이동속도를 증가하도록 하는 라이저 핸들링 시스템.

**청구항 4**

제 2항에 있어서,

상기 제어부는 상기 제 1 크레인의 이동거리가 길수록 상기 제 1 크레인의 이동속도를 증가하도록 하는 라이저 핸들링 시스템.

**청구항 5**

제 1 항에 있어서,

상기 랜딩 구조물의 양측에 배치되어 상기 랜딩 구조물의 상부면 보다 높게 돌출된 격벽을 더 포함하는 라이저 핸들링 시스템.

**청구항 6**

제 5항에 있어서,

상기 랜딩 구조물의 상부는 상기 라이저가 수용되기 위한 홈을 갖는 라이저 핸들링 시스템.

**청구항 7**

제 6항에 있어서,

상기 랜딩 구조물은 복수개 인 라이저 핸들링 시스템.

**청구항 8**

제 1항 내지 제 7항 중 적어도 어느 한 항의 라이저 핸들링 시스템을 포함하는 시추선.

**청구항 9**

저장 공간에 적재된 라이저;

상기 라이저를 인양하기 위한 제 1 크레인;

인양된 상기 라이저를 라이저 캣웍으로 이송시키는 제2 크레인; 및

상기 제 2 크레인의 이동거리를 줄일 수 있도록 상기 제 1 크레인에 의해 일차로 인양된 상기 라이저를 상기 제 2 크레인 방향으로 미리 리프팅하는 리프트

를 포함하는 라이저 핸들링 시스템.

**청구항 10**

제 9항에 있어서,

상기 리프트와 평행하게 상기 저장 공간에 배치되고, 상기 리프트와 교번적으로 동작하기 위한 보조 리프트와

상기 제 2 크레인과 평행하게 배치되고, 상기 제 2 크레인과 교번적으로 상기 라이저를 상기 라이저 캣웍에 배치시키기 위한 보조 크레인을 더 포함하는 라이저 핸들링 시스템.

**청구항 11**

제 10항에 있어서,

상기 리프트와 상기 보조 리프트는 상기 라이저 캣웍의 중심축을 기준으로 대칭되게 배치되는 라이저 핸들링 시스템.

**청구항 12**

제 9항에 있어서,

상기 리프트는 유압식, 기어식 및 윈치식 중 어느 하나의 라이저 리프트인 라이저 핸들링 시스템.

**청구항 13**

제 9항에 있어서,

상기 리프트는 상기 라이저가 거치되는 받침부, 상기 받침부를 유압에 의해 상승 혹은 하강시키는 실린더 스트로크, 상기 실린더 스트로크를 감싸는 유압 실린더, 상기 유압 실린더의 유압을 작동시키는 유압 장치부를

포함하는 라이저 핸들링 시스템.

**청구항 14**

제 13항에 있어서,

상기 받침부는 상기 라이저가 수용되기 위해 일면에 홈을 갖는 평탄부와 상기 평탄부 양측단에서 상기 평탄부의 일면에 대해 수직방향으로 연장된 가이드부를 포함하는 라이저 핸들링 시스템.

**청구항 15**

제 9항에 있어서,

상기 제 1 크레인 또는 제 2 크레인 중 적어도 어느 하나의 이동을 제어하는 제어부를 포함하는 라이저 핸들링 시스템.

**청구항 16**

제 9항 내지 제 15항 중 적어도 어느 한 항의 라이저 핸들링 시스템을 포함하는 시추선.

## 명 세 서

### 기 술 분 야

[0001] 본 출원은 라이저 핸들링 시스템 및 이를 포함한 시추선에 관한 것으로, 더욱 자세하게는 작업시간을 줄일 수 있는 라이저 핸들링 시스템 및 이를 포함한 시추선에 관한 것이다.

## 배경기술

0002] 일반적으로 종래의 해저 시추는 다른 예인선에 의해서만 항해가 가능하고, 계류 장치를 이용하여 해상의 특정지점에 정박한 상태에서 해저 시추 작업을 하는 해저 시추 전용의 리그선(rig ship)이나 고정식 플랫홈이 주로 사용되었으나, 최근에는 첨단 시추장비를 탑재하고 자체의 동력으로 항해를 할 수 있도록 일반 선박과 동일한 형태로 제작된 소위, 시추선(drillship)이 개발되어 심해 시추에 사용되고 있다.

0003] 이러한 해저의 지하에 존재하는 석유나 가스 등을 시추할 수 있도록 각종 시추장비를 갖춘 리그선 또는 시추선(이하, 시추선)의 중심부에는 해저의 지하에 존재하는 석유나 가스 등을 시추하기 위한 라이저(riser) 또는 드릴 파이프(drill pipe)가 상하로 이동될 수 있도록 문풀(moonpool)이 형성되어 있다.

0004] 도 1은 종래 해수면에서 시추작업을 수행하고 있는 종래의 시추선을 도시한 측면도이다.

0005] 작업자는 라이저(4) 및 드릴 파이프(5)를 시추선(1)의 중앙에 형성된 문풀(3)을 통해 하향 전진시킴으로써 해저바닥(sea bed)(6) 아래의 암반(12)에 위치하는 유정(well)(13)에 저장되어 있는 해저자원을 시추한다.

0006] 상기 라이저(4)는 드릴 파이프(5)를 상기 유정(13)까지 전진시키기 전에 미리 상기 해저바닥(6)까지 전진되는 부재로서 드릴링 머드가 해수에 노출되는 것을 방지한다. 상기 라이저(4)가 설치되면 라이저(4) 내부로 드릴 파이프(5)가 해저지층(11)을 통해 상기 유정(13)까지 하향 전진된다.

0007] 이와 같이 라이저(4)를 해저바닥(6)까지 하향 전진시키거나, 드릴 파이프(5)를 유정(13)까지 전진시킬 경우, 길게 연결된 라이저(4)나 드릴 파이프(5)를 하향 전진시키는 것이 아니라, 짧은 길이의 라이저(4)나 드릴 파이프(5)를 서로 연결하여 하향 전진시킨다. 해저바닥(6)에는 이상 고압이 드릴 파이프(5)를 타고 올라오는 것을 차단하기 위해 비오피(blowout preventer; BOP)(7)가 설치된다. 해저지층(11)에서는 시멘트에 의해 케이싱(8)을 고정한 후, 케이싱 내부로는 드릴비트(10)가 장착된 드릴 파이프(5)를 삽입하여 해저를 시추한다. 드릴비트(10)가 땅을 뚫을 때 발생되는 열에 의해 드릴비트(10)가 과열되는 것을 방지하고 윤활작용을 하여 드릴링을 더욱 쉽게 하기 위해, 드릴 파이프(5) 속으로는 머드(9)가 삽입된다. 시추 작업이 종료되면, 라이저(4)는 문풀(3)을 통해 드릴플로어(drill floor)로 운반되어 해체된 후 적재장소로 운반된다.

0008] 도 2는 종래 시추선에 저장된 라이저를 핸들링하기 위한 라이저 핸들링 시스템을 나타낸 도이다.

0009] 도 2를 참조하면, 라이저 핸들링 시스템(100)은 갑판 하부에 라이저(Riser, 4)가 저장된 저장부(110)와, 상기 라이저(4)를 구획하여 고정 및 지지하는 격벽(120), 상기 라이저(4)를 인양하여 라이저 랜딩 구조물(Riser Landing Structure, 130)에 안착시키는 라이저 핸들링 크레인(Riser Handling Crane, 140), 상기 라이저 랜딩 구조물(130)에 안착된 라이저(4)를 라이저 캣웍(Riser Catwalk, 150)까지 이동시키는 온보드 라이저 핸들링 크레인(Onboard Riser Handling Crane, 160)을 갖는다.

[0010] 이러한 라이저 핸들링 시스템(100)은 먼저, 저장된 라이저(4)를 라이저 핸들링 크레인(140)으로 들어 올린 후, 라이저 랜딩 구조물(130) 상부에 상기 라이저(4)를 옮겨 놓으면, 온보드 라이드 핸들링 크레인(160)은 상기 라이저(4)를 라이저 캣웍(150)까지 이동시키는 공정을 반복한다.

[0011] 한편, 종래 라이저 핸들링 시스템(100)은 온보드 라이저 핸들링 크레인(160) 이나 라이저 핸들링 크레인(140)의 고장이나 기타 다른 이유로 작업을 하지 못할 경우, 상기 장비를 수리할 때까지 대체할 수 있는 설비가 없어 드릴링 작업이 중단되고, 이에 따라 시추선을 운영하는 회사는 막대한 손실을 입는 문제점이 있다.

[0012] 또한, 상기 라이저 저장고(110)내에서 라이저 랜딩 구조물(130)의 상부까지의 라이저 이동 공정과 상기 라이저 랜딩 구조물(130)에서 상기 라이저 캣웍(150)까지의 라이저 이동 공정이 쉼없이 연속 고정이 이루어져야 하는데, 실질적으로 상기 라이저 핸들링 크레인(140)과 상기 온보드 라이저 핸들링 크레인(160)의 이동 경로간 시간 차이로 인해 라이저 인양 또는 하역작업의 연속공정이 이루어지지 못하고 있는 실정이다.

[0013] 이에 따라 라이저 인양 또는 하역시 하나의 공정에서 대기시간이 발생하여 상기 라이저(4)를 이동하여야 하고, 게다가, 라이저 랜딩 구조물(130)위에 배치된 상기 라이저(4)를 상기 온보드 라이저 핸들링 크레인(160)으로 인양시, 작업자의 작업환경이 위험한 실정이다.

## 발명의 내용

### 해결하려는 과제

[0014] 본 출원은 상기한 바와 같은 종래 기술의 문제점을 해결하기 위한 것으로, 라이저 인양시 작업 환경의 안정성 확보, 주 인양 크레인의 고장시 보조 인양 크레인을 통한 대체 및 작업 시간 단축에 따른 비용 절감을 가져올 수 있는 라이저 핸들링 시스템 및 이를 포함한 시추선을 제공하고자 한다.

## 과제의 해결 수단

[0015] 본 발명의 일 측면에 따르면, 라이저 핸들링 시스템 및 이를 포함하는 시추선은 저장 공간에 적재된 라이저, 상기 라이저를 인양하여 랜딩 구조물 상부에 배치시키는 제 1크레인, 상기 랜딩 구조물 상부에 배치된 상기 라이저를 인양하여 라이저 캣웍에 이동시키는 제 2 크레인, 미리 설정된 상기 라이저의 위치정보에 따라 상기 제 1 크레인 또는 제 2 크레인 중 적어도 어느 하나의 이동을 제어하는 제어부를 포함한다.

[0016] 제어부는 상기 라이저의 이동거리를 측정하는 측정부를 포함할 수 있다.

[0017] 제어부는 상기 제 1 크레인의 이동거리가 짧을수록 상기 제 2 크레인의 이동속도를 증가하도록 할 수 있다.

[0018] 제어부는 상기 제 1 크레인의 이동거리가 길수록 상기 제 1 크레인의 이동속도를 증가하도록 할 수 있다.

[0019] 라이저 핸들링 시스템 및 이를 포함하는 시추선은 랜딩 구조물의 양측에 배치되어 상기 랜딩 구조물의 상부면보다 높게 돌출된 격벽을 더 포함할 수 있다.

[0020] 랜딩 구조물의 상부는 상기 라이저가 수용되기 위한 홈을 가질 수 있다.

[0021] 랜딩 구조물은 복수개 일 수 있다.

[0022] 본 발명의 다른 측면에 따르면, 라이저 핸들링 시스템 및 이를 포함하는 시추선은 저장 공간에 적재된 라이저, 상기 라이저를 인양하기 위한 제 1 크레인, 인양된 상기 라이저를 라이저 캣웍으로 이송시키는 제2 크레, 및 상기 제 2 크레인의 이동거리를 줄일 수 있도록 상기 제 1 크레인에 의해 일차로 인양된 상기 라이저를 상기 제 2 크레인 방향으로 미리 리프팅하는 리프트를 포함한다.

[0023] 라이저 핸들링 시스템 및 이를 포함하는 시추선은 리프트와 평행하게 상기 저장 공간에 배치되고, 상기 리프트와 교번적으로 동작하기 위한 보조 리프트와 상기 제 2 크레인과 평행하게 배치되고, 상기 제 2 크레인과 교번적으로 상기 라이저를 상기 라이저 캣웍에 배치시키기 위한 보조 크레인을 더 포함할 수 있다.

[0024] 리프트와 보조 리프트는 상기 라이저 캣웍의 중심축을 기준으로 대칭되게 배치될 수 있다.

[0025] 리프트는 유압식, 기어식 및 원치식 중 어느 하나의 라이저 리프트일 수 있다.

[0026] 리프트는 상기 라이저가 거치되는 받침부, 상기 받침부를 유압에 의해 상승 혹은 하강시키는 실린더 스트로크, 상기 실린더 스트로크를 감싸는 유압 실린더, 상기 유압 실린더의 유압을 작동시키는 유압 장치부를 포함할 수 있다.

[0027] 받침부는 상기 라이저가 수용되기 위해 일면에 홈을 갖는 평탄부와 상기 평탄부 양측단에서 상기 평탄부의 일면에 대해 수직방향으로 연장된 가이드부를 포함할 수 있다.

[0028] 라이저 핸들링 시스템은 제 1 크레인 또는 제 2 크레인 중 적어도 어느 하나의 이동을 제어하는 제어부를 포함할 수 있다.

## 발명의 효과

[0029] 실시예에 따른 라이저 핸들링 시스템 및 이를 포함한 시추선은 크레인의 라이저 인양 이동 거리를 줄여 실질적으로 작업 시간을 줄일 수 있어 작업 시간에 따른 비용을 절감할 수 있다.

[0030] 또한, 메인 라이저 인양 크레인과 보조 라이저 인양 크레인 사용으로 연속공정과 함께, 메인 라이저 인양 크레인의 결함으로 인한 고장 시, 보조 라이저 인양 크레인의 대체 작업으로 예비설비를 갖추게 되어 효율성을 높일 수 있다.

## 도면의 간단한 설명

[0031] 도 1은 종래 해수면에서 시추작업을 수행하고 있는 종래의 시추선을 도시한 측면도이다.

도 2는 종래 시추선에 저장된 라이저를 핸들링하기 위한 라이저 핸들링 시스템을 나타낸 도이다.

도 3은 본 발명의 제 1 실시예에 따른 라이저 핸들링 시스템을 설명하기 위한 도이다.

도 4는 본 발명의 제 1 실시예에 따른 다른 라이저 핸들링 시스템을 설명하기 위한 도이다.

도 5는 본 발명의 제 2 실시예에 따른 라이저 핸들링 시스템을 설명하기 위한 도이다.

도 6은 본 발명의 제 2 실시예에 따른 라이저 핸들링 시스템의 리프트 구조를 설명하기 위한 도이다.

도 7은 본 발명의 제 3 실시예에 따른 라이저 핸들링 시스템을 설명하기 위한 도이다.

## 발명을 실시하기 위한 구체적인 내용

0032] 이하 본 발명의 실시예에 대하여 첨부한 도면을 참조하여 상세하게 설명하기로 한다. 다만, 첨부된 도면은 본 발명의 내용을 보다 쉽게 개시하기 위하여 설명되는 것일 뿐, 본 발명의 범위가 첨부된 도면의 범위로 한정되는 것이 아님은 이 기술분야의 통상의 지식을 가진 자라면 용이하게 알 수 있을 것이다.

0033] 또한, 본 발명의 실시예를 설명함에 있어서, 동일 기능을 갖는 구성요소에 대해서는 동일 명칭 및 동일부호를 사용할 뿐 실질적으론 종래 라이저 핸들링 시스템 및 이를 포함한 시추선의 구성요소와 완전히 동일하지 않음을 미리 밝힌다.

0034] 또한, 본 출원에서 사용한 용어는 단지 특정한 실시예를 설명하기 위해 사용된 것으로, 본 발명을 한정하려는 의도가 아니다. 단수의 표현은 문맥상 명백하게 다르게 뜻하지 않는 한, 복수의 표현을 포함한다. 본 출원에서, "포함하다" 또는 "가지다" 등의 용어는 명세서상에 기재된 특징, 숫자, 단계, 동작, 구성요소, 부품 또는 이들을 조합한 것이 존재함을 지정하려는 것이지, 하나 또는 그 이상의 다른 특징들이나 숫자, 단계, 동작, 구성요소, 부품 또는 이들을 조합한 것들의 존재 또는 부가 가능성을 미리 배제하지 않는 것으로 이해되어야 한다.

0035] 도 3은 본 발명의 제 1실시예에 따른 라이저 핸들링 시스템을 설명하기 위한 도이다.

0036] 본 발명의 제 1실시예에 따르면, 도 3에 도시된 바와 같이, 라이저 핸들링 시스템(100)은 갑판 하부에 라이저(Riser, 4)가 저장된 저장부(110)와, 상기 라이저(4)를 구획하여 고정 및 지지하는 격벽(120), 상기 라이저(4)를 인양하여 라이저 랜딩 구조물(Riser Landing Structure, 130)에 안착시키는 제 1 크레인(140), 상기 라이저 랜딩 구조물(130)에 안착된 상기 라이저(4)를 라이저 캣웍(Riser Catwalk, 150)까지 이동시키는 제 2 크레인(160), 제 1 크레인(140) 또는 상기 제 2 크레인(160)의 이동을 제어하는 제어부(190)을 포함한다.

0037] 갑판 하부엔 라이저(4)가 수용될 수 있는 공간이 마련된 저장부(110)가 설치될 수 있다. 저장부(110)는 갑판 상부에도 설치될 수 있지만, 갑판 하부에 설치됨으로써 갑판 상부에 스키드(Skid)나 컨테이너 박스 등과 같은 부가 설비들의 설치 공간을 확보할 수 있다.

0038] 저장부(110)의 측벽에는 완충재(미도시)나 지지 구조물(미도시)이 설치되어 선체의 모션에 따른 라이저의 유동을 방지할 수 있다.

0039] 선체의 상부 데크(111)는 상기 라이저가 인양되기 위한 개구부(G)가 형성된다. 즉, 저장부(110)에 수용된 라이저(4)는 제 1 크레인과 제 2 크레인에 의해 상기 개구부(G)를 통하여 외부로 인출된다.

0040] 저장부(110)내에는 적어도 하나 이상의 격벽(120)이 설치될 수 있다. 이러한 격벽(120)은 저장부(110)에 저장된 라이저(4)를 분리 및 수용 가능하도록 상기 저장부(110)의 바닥면에서 수직방향으로 설치된다.

0041] 격벽(120)은 시추선의 항해 중 라이저(4)에 전달되는 진동이나 충격을 완충할 수 있고, 외부 충격이나 진동을 더욱 완충할 수 있도록 표면에 탄성력을 갖는 재질이 부가될 수 있다. 따라서 저장부(110) 내에서 라이저(4)의 유동이 최소화 될 수 있어, 라이저(4)를 보다 안정적으로 이송시킬 수 있다.

0042] 랜딩 구조물(130)은 저장부(110)에 수용된 라이저(4)가 임시 거치되었다 외부로 반출되는 곳으로, 저장부(110)의 바닥면에서 상기 격벽(120)의 방향과 동일한 방향으로 설치된다. 라이저(4)가 안착되는 상기 랜딩 구조물(130)의 상부면은 소정의 곡률 반경을 갖는 홈(130a)을 가질 수 있다.

0043] 또한, 랜딩 구조물(130)은 도시된 바와 같이, 소정거리를 두고 이격된 격벽(120) 사이에 구조물(132)을 삽입한 형태로 제작 될 수 있다. 이때, 랜딩 구조물(130)의 상부 양측에는 격벽(120)이 상기 랜딩 구조물의 상부 면보다 높게 돌출되는 형태로 배치될 수 있다. 이에 따라 라이저가 상기 랜딩 구조물(130)의 상부 면에 거치될 때, 외부의 충격이나 진동에 의해 상기 랜딩 구조물 상부에서 라이저가 이탈됨을 방지할 수 있다.

[0044] 실시예에서는 랜딩 구조물(130)이 구조물(132)과 격벽(120)이 함께 결합되어 랜딩 구조물로 형성되는 것으로 설

명 하였지만, 격벽없이 구조물 자체만으로 상부면에 소정의 홈 형성 및 상부면의 양측에서 상기 상부면에 대해 수직방향으로 돌출된 돌출부를 포함하도록 구성될 수 있다. 즉, 랜딩 구조물의 상부면은 평탄한 면을 갖거나, 일부에 소정의 곡률 반경을 갖는 홈이 형성될 수 있고, 상기 랜딩 구조물의 상부면의 양측에는 상기 상부면에 대해 수직방향으로 연장된 돌출부가 형성될 수 있다. 이에 따라 라이저를 안정적으로 거치 시킬 수 있다.

[0045] 이러한 랜딩 구조물(130)은 제 1 크레인(140)이나 제 2 크레인(160)의 인양 이동경로를 줄여 작업 시간을 줄일 수 있도록 상부 데크(111)의 개구부(G)와 대응되는 저장부(110) 내에 설치될 수 있다.

[0046] 또한, 랜딩 구조물(130)은 제 1 크레인(140) 및 제 2 크레인(160) 각각에 대응될 수 있도록 복수개로 구성될 수 있고, 이에 따라 역시 인양 이동경로를 줄일 수 있다.

[0047] 제 1 크레인(140)은 저장부(110) 내에 설치되어, 상기 저장부(110)에 수용된 라이저(4)를 랜딩 구조물(130)로 이송한다. 제 1 크레인(140)은 레일(141)을 따라 이동하는 구동 바디(driving body, 142), 구동 바디(142)로부터 상, 하 방향으로 인출입되는 와이어(wire, 144), 와이어(144)의 단부에 설치되어 저장부(110)에 수용된 라이저(4)를 파지하는 그리퍼(gripper, 146)를 포함한다.

[0048] 이러한 제 1 크레인(140)은 라이저(4)를 그리퍼(146)로 먼저 파지한 후, 와이어(144)의 인입에 따라 저장부(110)의 상측으로 이동한 뒤, 구동 바디(142)가 레일(141)을 따라 이동함에 따라 랜딩 구조물(130)로 이송된다. 이후, 랜딩 구조물 상부에 위치된 라이저(4)는 와이어(144)의 인출에 따라 상기 랜딩 구조물 상면에 놓이게 되고, 그리퍼(146)의 탈거 동작에 의해 상기 라이저(4)는 상기 랜딩 구조물 상에 임시 거치된다.

[0049] 제 2 크레인(160)은 랜딩 구조물(130)에 거치된 라이저(4)를 파지하여 상부 데크(111)의 개구부(G)를 통해 갑판 상부로 반출한 후, 상기 상부 데크의 상부에 설치된 캣웍(Catwalk, 150)으로 이송된다. 캣웍(150)으로 이송된 라이저(4)는 다시 드릴 플로우(Drill Floor, 미도시)로 이송되어, 문풀(Moon Pool, 미도시)로 삽입되도록 수직으로 세워진다.

[0050] 제어부(190)는 미리 설정된 라이저의 위치정보에 따라 제 1 크레인(140) 또는 제 2 크레인(160)의 이동속도를 제어한다.

[0051] 즉, 제어부(190)는 상기 라이저의 위치정보를 인식하여 제 1 크레인(140)이 저장부(110)의 특정 라이저(4)를 인양할 때, 상기 라이저의 위치정보에 기초하여 상기 제 1 크레인(140)의 위치를 이동 거리로 환산하고, 제 1 크레인(140)에 의해 인양된 라이저(4)가 제 2 크레인(160)에 의해 인양될 때 연속공정으로 이루어 질 수 있도록 제 2 크레인(160)의 이동속도를 제어한다. 이때, 제어부(190)는 상기 라이저의 위치정보에 기초하여 상기 제 1 크레인의 이동거리를 측정하는 측정부(170)를 포함할 수 있다.

[0052] 이와 같이 제 1 크레인(140)의 위치를 센싱하여 제 2 크레인(160)의 이동속도를 제어하는 제어부(190)는 종래 저장부에 적재된 라이저를 인양시 저장부의 바닥면쪽으로 갈수록 제 1 크레인의 이동거리가 증가되어, 상기 라이저를 랜딩 구조물에 인양하는데 걸리는 시간이 늘어나게 되고, 이에 따라 제 2 크레인은 제 1 크레인에 의해 상기 라이저가 랜딩 구조물로 이송되기까지 기다림에 따라 작업시간이 늘어남을 방지할 수 있다.

[0053] 도 4는 본 발명의 제 1 실시예에 따른 다른 라이저 핸들링 시스템을 설명하기 위한 도이다.

[0054] 도시된 바와 같이, 라이저 핸들링 시스템은 이미 설명한 도 3의 실시예와 유사함으로, 이에 따른 동일한 기능을 갖는 구성에 대한 설명은 생략하기로 한다.

[0055] 도 4에 따른 라이저 핸들링 시스템은 제 2 크레인(160)의 이동속도가 일정한 경우, 제 1 크레인(140)의 위치에 따라 상기 제 1 크레인(140)의 이동속도를 제어함으로써 연속공정을 가능하게 하도록 한다.

[0056] 제어부(190)는 우선 제 1 크레인(140)에 의해 저장부(110)의 상부에 적재된 라이저(4)가 인양될 때, 제 1 크레인(140)에 의해 라이저(4)가 랜딩 구조물(130)에 이송되고, 시간적인 갭 없이 곧바로 제 2 크레인(160)에 의한 라이저(4)의 인양작업이 이루어질 수 있는 연속공정이 가능하도록 제 1 크레인(140)을 제어한다.

[0057] 이후, 제 1 크레인(140)이 다른 위치에 적재된 라이저(4)를 인양할 때, 제어부(19)에 의해 미리 설정된 라이저의 위치정보에 기초하여 라이저(4)의 위치가 감지된다. 예를 들어, 제 1 크레인(140)이 저장부(110)의 바닥면에 적재된 라이저(4)를 인양하는 방향으로 이동할 수록, 제어부(190)가 인양하고자 하는 라이저의 위치를 감지하고, 이 때, 제어부(190)에 의해 출력된 라이저의 위치정보를 기초로 하여 제 1 크레인(140)의 이동속도가 증가되도록 제어한다.

[0058] 이에 따라, 라이저 인양시 연속공정이 가능하게 된다.

0059] 한편, 본 발명에 따른 제 1 실시예에서 제어부(190)는 제 1 크레인(140)의 위치에 따라 제 1 크레인(140)의 이동속도 혹은 제 2 크레인(160)의 이동속도를 별도로 제어하는 것으로 설명하였지만, 제 1 크레인(140)의 위치에 따라 제 1 크레인(140) 및 제 2 크레인(160)의 이동속도를 동시에 제어하여 연속 인양공정이 가능하게 할 수 있다.

0060] 또한, 제어부(190)는 위와 같이, 라이저(4)의 설정 위치에 따라 상기 라이저의 인양 시 시간적인 갭을 최소화 할 수 있도록 제 1 크레인(140) 또는 제 2 크레인(160)의 이동속도를 제어할 수 있지만, 제 1 크레인(140) 또는 제 2 크레인(160)의 이동속도가 일정한 상태에서, 상기 라이저의 설정 위치에 따라 동작시간 예를 들어, 제 1 크레인(140) 혹은 제 2 크레인(160)의 동작시작시점과 종료시점을 제어하여 제 1 크레인과 제 2 크레인의 연속적인 동작에 따라 인양시간을 최소화 할 수 있다.

0061] 도 5는 본 발명의 제 2 실시예에 따른 라이저 핸들링 시스템을 설명하기 위한 도이다.

0062] 도 5를 참조하면, 제 2 실시예에 따른 라이저 핸들링 시스템은 도 4의 실시예와 마찬가지로, 도 3의 라이저 핸들링 시스템과 유사함으로, 이에 따른 동일한 기능을 갖는 구성에 대한 설명 역시 생략하기로 한다.

0063] 제 2 실시예에 따른 라이저 핸들링 시스템(100)은 라이저(4)가 제 2 크레인(160)에 의해 인양되기 전에 거치되는 랜딩 구조물 대신에 리프트(180)가 설치된다. 리프트(180)는 상부 데크(111)의 개구부(G)에 상응되도록 라이저(4)가 수용된 저장부(110) 내에 설치되고, 라이저(4)는 유압식 혹은 기어식 혹은 윈치식 리프트에 의해 제 2 크레인(160) 방향으로 리프팅 될 수 있다. 리프트의 구조 및 동작에 대한 설명은 다음 도 6에서 하기로 한다.

0064] 이때, 제 1 크레인(140) 및 제 2 크레인(160)의 이동속도는 제 1 및 제 2 실시예에서와 같이 제어부(미도시)에 따라 다르게 제어될 수 있다.

0065] 리프트를 포함하는 라이저 핸들링 시스템의 작동 방법은 다음과 같다.

0066] 먼저, 저장부(110)에 수용된 라이저(4)는 제 1 크레인(140)에 의해 1차적으로 인양되어 리프트(180)까지 이송되어 상기 리프트(180) 상에 거치된다. 거치된 라이저(4)는 리프트 구동에 의해 상부 방향으로 리프팅 되고, 이때, 제 2 크레인(160)이 리프트의 경로 방향으로 이동한다.

0067] 이 후, 상기 리프트(180)가 최대 높이로 리프팅 되면, 제 2 크레인(160)은 상기 리프트(180)에 거치된 라이저(4)를 인양하여 캣웍(150)까지 이송한다. 캣웍(150)에 이송된 라이저(4)는 다시 드릴 플로어(미도시)로 이송되고, 드릴 플로어에서 수직으로 배치된 라이저는 문풀(미도시)을 통해 해저 바닥을 향해 수직하게 삽입된다.

0068] 이와 같이, 리프트(180) 작동에 의해 제 1 크레인(140)에 의해 인양된 라이저(4)를 미리 제 2 크레인(160) 방향으로 리프팅함으로써, 시간적인 갭 없이 제 2 크레인(160)에 의한 라이저의 인양작업을 진행할 수 있어 라이저의 연속 인양작업이 가능하게 된다. 이에 따라 작업 시간을 줄일 수 있다.

0069] 도 6은 본 발명의 제 2 실시예에 따른 라이저 핸들링 시스템의 리프트 구조를 설명하기 위한 도이다.

0070] 도 6을 참조하면, 리프트(180)는 라이저(4)가 거치되는 받침부(181), 상기 받침부(181)를 유압에 의해 상승 혹은 하강시키기 위한 실린더 스트로크(Cylinder Stroke, 183), 상기 실린더 스트로크(183)를 감싸는 유압 실린더(185), 상기 유압 실린더(185)의 유압을 작동시키는 유압 장치부(187)를 포함한다.

0071] 받침부(181)는 라이저(4)가 안착되는 평탄부(181a)와 상기 평탄부(181a) 양측단에서 상기 평탄부(181a)의 일면에 대해 수직방향으로 연장된 가이드부(181c)를 포함할 수 있다.

0072] 평탄부(181a)는 라이저(4)가 안착되어 상부 방향으로 이송될 때, 안정적으로 이송될 수 있도록 일면이 오목한 형태의 홈(181a)을 가질 수 있다. 또한, 라이저(4)와 평탄부(181a)간에 마찰계수를 높여 미끌림이 발생되지 않도록 평탄부 전체 면 혹은 홈 부에 부가물이 부착될 수 있다.

0073] 가이드부(181c)는 평탄부(181a)와 동일한 재질로, 평탄부(181a)에 거치된 라이저(4)가 외부 충격이나 선체의 모션에 의해 상기 평탄부(181a)로부터 이탈되는 것을 방지한다.

[0074] 유압 장치부(187)는 받침부(181)에 라이저(4)가 안착되면, 자동 혹은 수동으로 상기 유압 실린더(185)의 유압을 작동시켜 상기 실린더 스트로크(183)를 상승하게 하고 이에 따라 받침부(181) 역시 상승하게 된다. 유압 장치부(187)는 유압의 크기를 조절하여 상기 받침부(181)의 위치를 달리 제어할 수 있다.

[0075] 본 발명의 실시예에서, 리프트(180)를 유압식 리프트에 대해서만 설명하였지만, 이에 한정되지 않고, 기어식 혹은 윈치식 리프트 등과 같이 리프팅 기능을 할 수 있는 리프트이면 모두 적용 가능하다.

[0076] 도 7은 본 발명의 제 3 실시예에 따른 라이저 핸들링 시스템을 설명하기 위한 도이다.

[0077] 도 7를 참조하면, 제 3 실시예에 따른 라이저 핸들링 시스템은 제 2 실시예의 라이저 핸들링 시스템과 유사함으로, 이에 따른 동일한 기능을 갖는 구성에 대한 설명 역시 생략하기로 한다.

[0078] 제 3 실시예에 따른 라이저 핸들링 시스템은 복수의 제 1 및 제 2 크레인과 복수의 리프트를 포함한다. 즉, 라이저 핸들링 시스템은 저장부(110)에 수용된 라이저(4)를 인양하는 복수의 제 1 크레인(140a, 140b))과 인양된 라이저를 리프팅 하는 복수의 리프트(180a, 180b)와 리프트에 거치된 라이저를 인양하여 켓웍(150)까지 이송하는 복수의 제 2 크레인(160a, 160b)을 구비한다.

[0079] 상기 복수의 리프트는 메인 리프트(180a)와 보조 리프트(180b)를 포함하고, 서로 평행하게 저장공간(110) 내에 배치되어 교번적으로 동작한다. 이때, 메인 리프트(180a)와 보조 리프트(180b)는 데크 상부에 배치된 라이저 켓웍(150)에 가능한 근접거리에 위치하도록 배치된다. 즉, 라이저 켓웍(150)의 중심축을 기준으로 대칭되게 저장공간(110) 내에 배치될 수 있다. 따라서, 리프트에 거치된 라이저를 제 2 크레인을 이용하여 켓웍까지 이동하는데 최단 거리로 이동 시킬 수 있고, 이에 따라 인양 작업 시간을 줄일 수 있다.

[0080] 복수의 제 1 및 2 크레인(140a, 140b, 160a, 160b)은 각각 메인 크레인과 보조 크레인을 포함하고, 메인 크레인과 보조 크레인은 메인 리프트(180a)와 보조 리프트(180b)와 마찬가지로 교번적으로 동작한다. 메인 크레인(140a, 160a)과 보조 크레인(140b, 160b)은 별도의 레일을 이용할 수 있고, 동일 레일을 이용할 수 도 있다.

[0081] 복수의 리프트 및 복수의 제 1 및 제 2 크레인을 포함하는 라이저 핸들링 시스템의 동작방법을 살펴보면 다음과 같다.

[0082] 우선, 저장부(110)에 수용된 라이저(4)는 제 1 메인 크레인(140a)에 의해 1차 인양되어 메인 리프트(180a)로 이송되고, 상기 메인 리프트(180a) 상에 거치된다. 거치된 라이저(4)는 메인 리프트(180a)의 구동에 의해 제 2 메인 크레인(160a)의 이동경로인 상부 방향으로 리프팅되고, 제 2 메인 크레인(160a)은 리프팅 된 라이저(4)를 파지하여 켓웍(150)까지 이송시키는 제 1 라이저 인양작업을 수행한다.

[0083] 이때, 제 1 보조 크레인(140b), 보조 리프트(180b), 제 2 보조 크레인(160b) 역시 제 1 메인 크레인(140a), 메인 리프트(180a), 제 2 메인 크레인(160a)과 같은 방법으로 동시에 교번적으로 라이저를 이송시키는 제 2 라이저 인양작업을 수행한다.

[0084] 이처럼, 제 1 메인 및 보조 크레인, 메인 및 보조 리프트, 제 2 메인 및 보조 크레인을 이용하여 라이저 인양작업을 진행하게 되면, 라이저 인양에 따른 작업 시간을 더욱 효과적으로 줄일 수 있다. 또한, 단일 크레인이나 단일 리프트의 고장으로 작업이 중단 될 때, 보조 크레인이나 보조 리프트는 인양 작업시 대체수단으로 강구될 수 있다.

[0085] 한편, 본 발명의 실시예들의 라이저 핸들링 시스템은 해저 자원을 시추하는 시추선에 적용될 수 있다. 본 발명의 실시예에서의 시추선은 드릴쉽뿐만 아니라 반잠수식시추선을 포함하여 해저자원 시추에 사용되는 부유식 해양구조물을 모두 포함한다. 따라서, 본 발명의 실시예인 라이저 핸들링 시스템은 드릴쉽, 반잠수식시추선을 포함하는 모든 부유식 해양구조물에 적용 가능하다.

[0086] 또한, 본 발명의 실시예들에서, 크레인의 이동 속도 혹은 동작시간을 각각 따로 제어하여 인양시간을 최소화 하였지만, 크레인의 이동 속도 및 동작시간을 동시에 제어하여 인양시간을 최소화 할 수 있다.

[0087] 본 발명은 위에서 설명된 실시예에 한정되지 않고, 청구범위에 기재된 바에 의해 정의되며, 본 발명의 분야에서 통상의 지식을 가진 자가 청구범위에 기재된 권리범위 내에서 다양한 변형과 개작을 할 수 있다는 것은 자명하다.

## 부호의 설명

[0088] 100: 라이저 핸들링 시스템

110: 저장부

120: 격벽

130: 라이저 랜딩 구조물

140: 제 1 크레인

160: 제 2 크레인

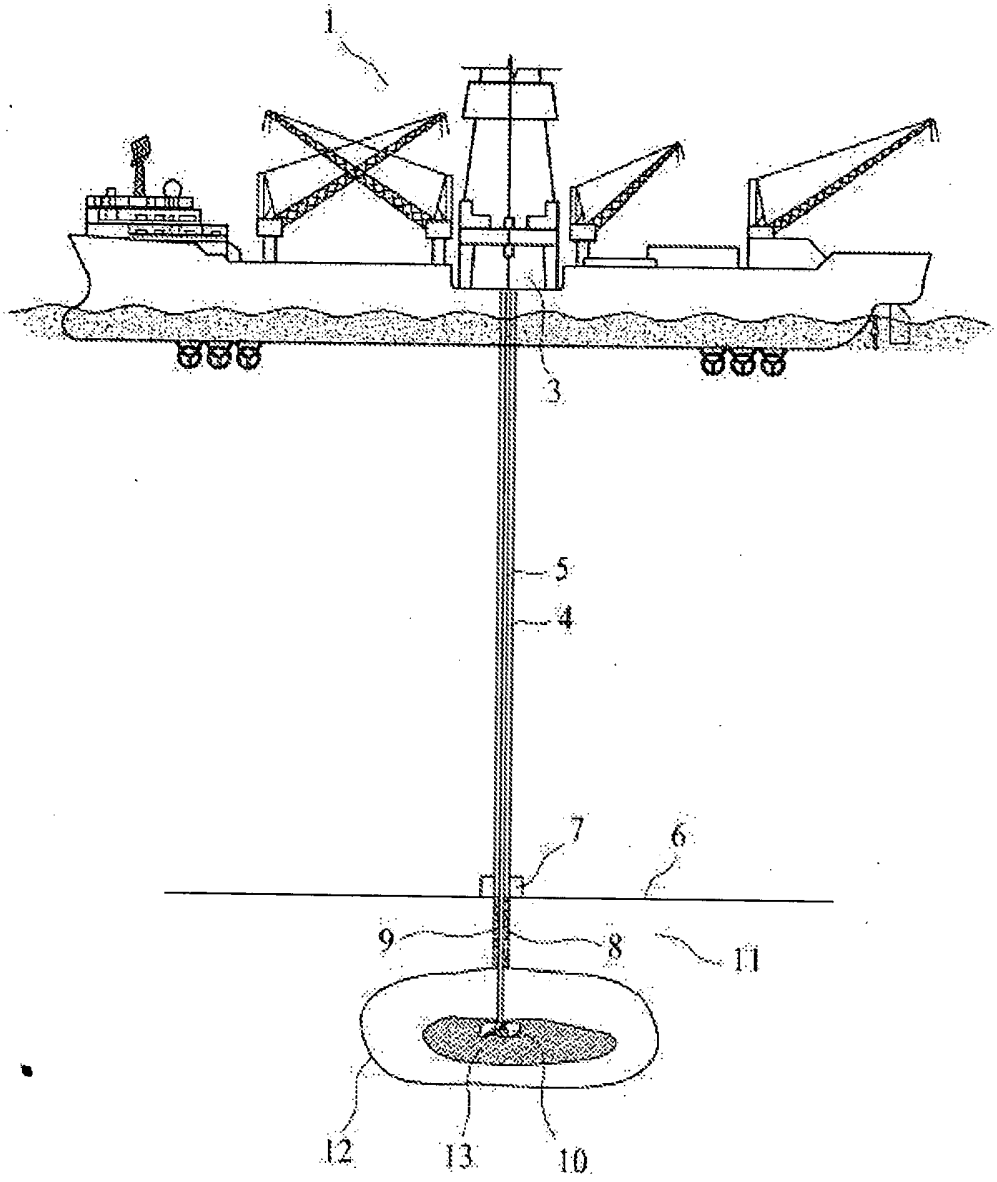
170: 측정부

180: 리프트

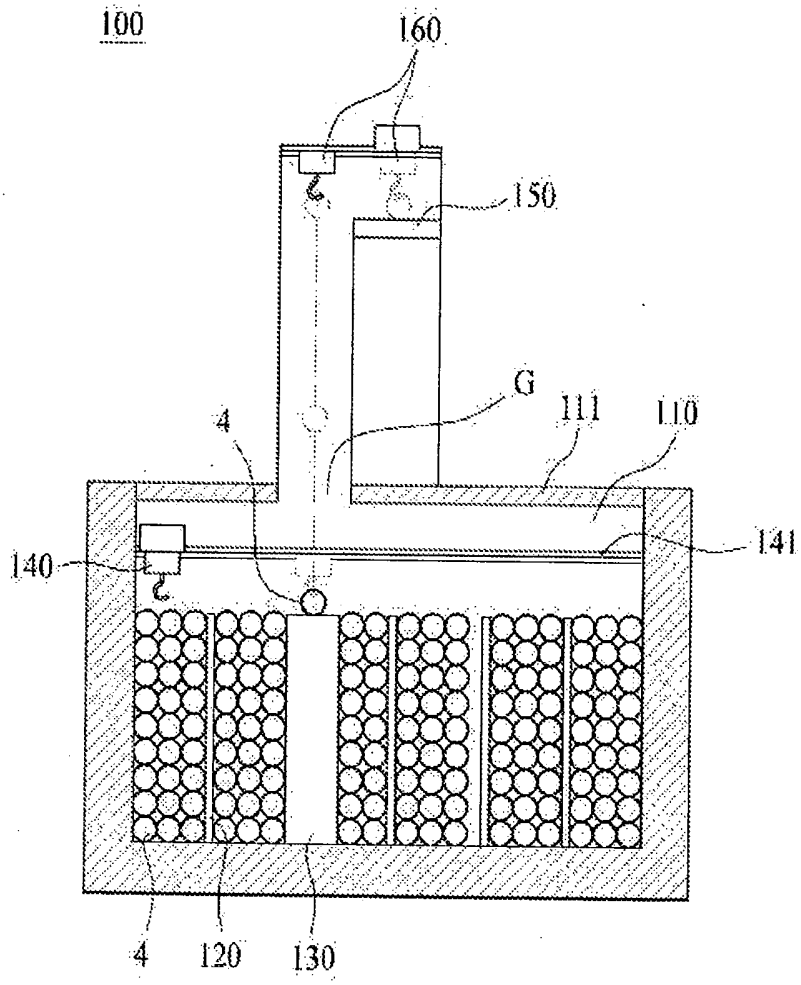
190: 제어부

도면

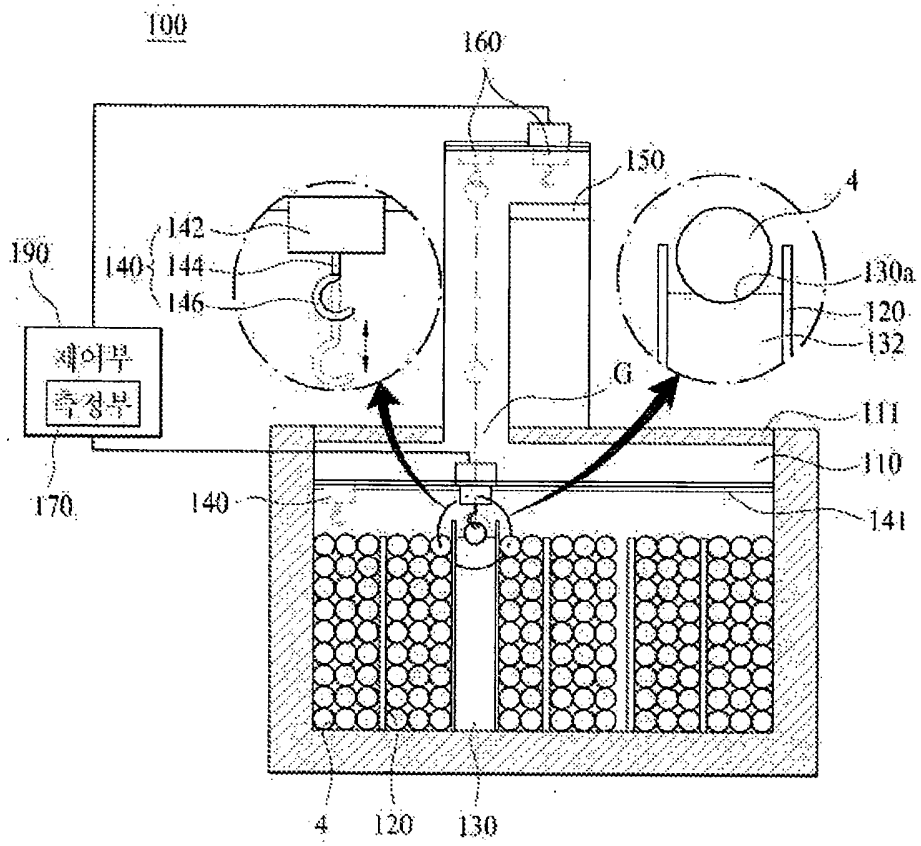
도면1



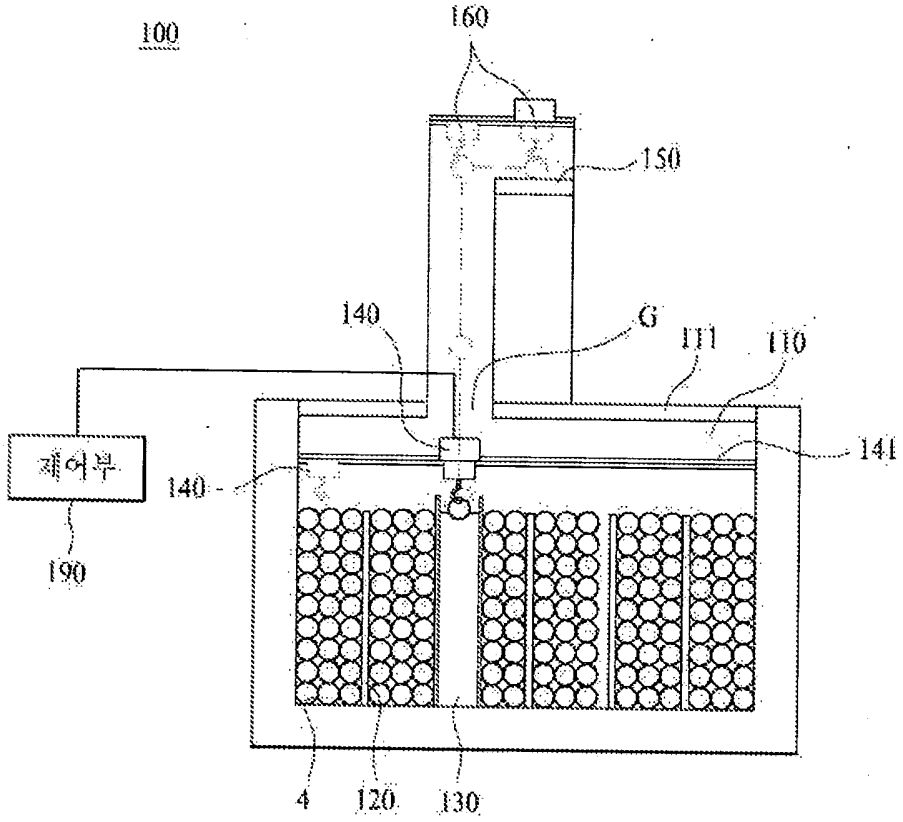
도면2



도면3



도면4



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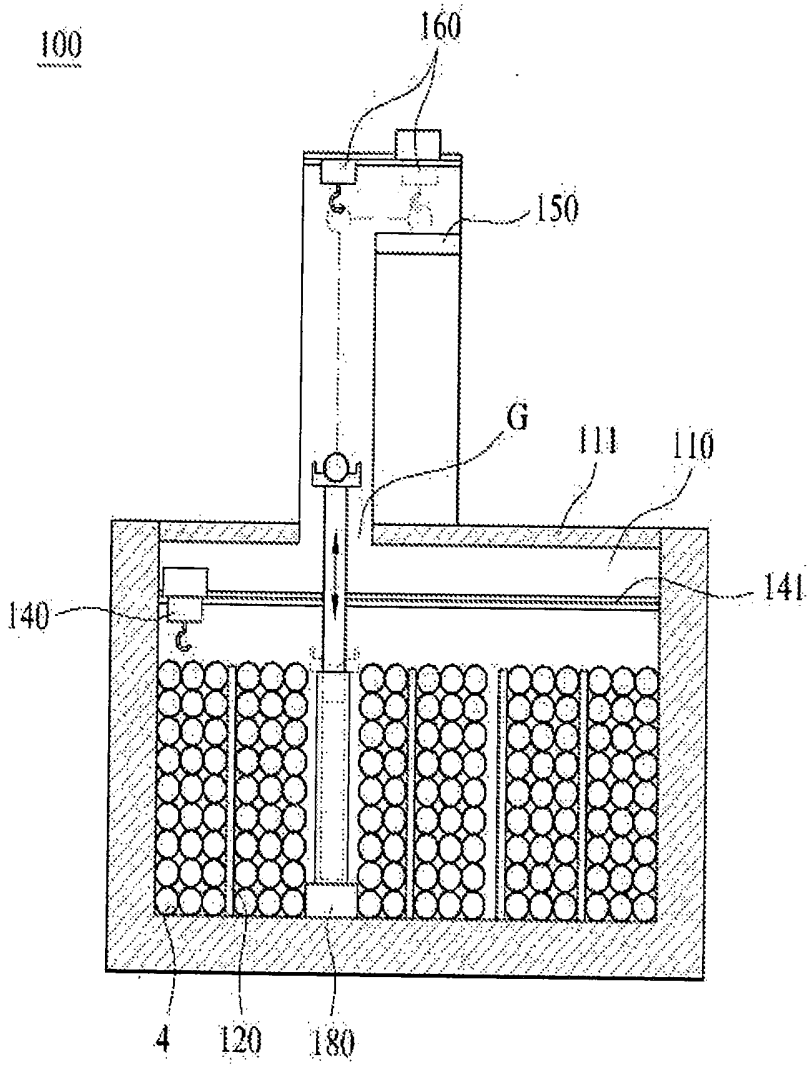
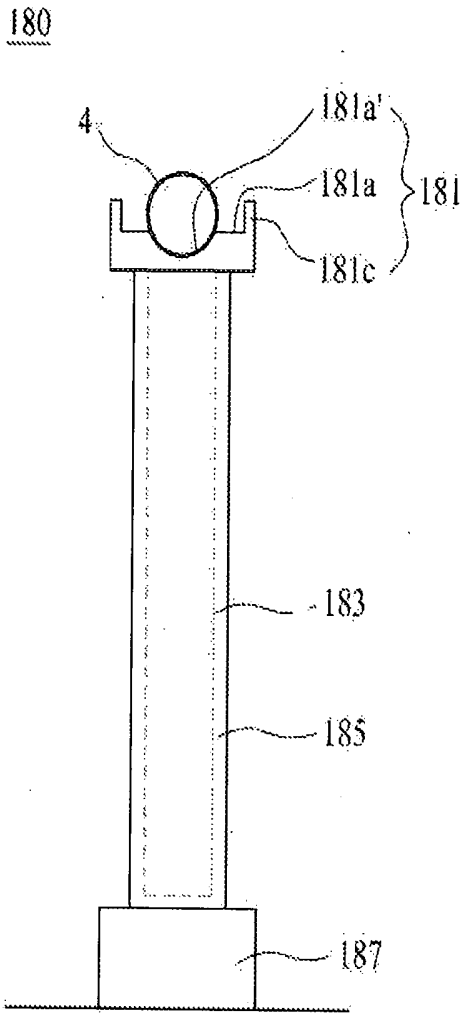


도면6



도면7