

HOISTING CRANE AND OFFSHORE VESSEL

The invention relates to a hoisting crane comprising:

- a substantially hollow vertical column with a foot which is or can be fixed to a support, and with a top,
- a jib,
- an annular bearing structure, which extends around the vertical column and guides and carries a jib connection member, so that the jib connection member can rotate about the column, the jib connection member forming a substantially horizontal pivot axis so that the jib can be pivoted up and down,
- topping means for pivoting the jib up and down.

Hoisting cranes of this type have already been commercially available from the applicant for decades, in particular for installation on a vessel, such as for example a cargo vessel, a tender ship used in the offshore industry, etc. NL 192 679 has disclosed a hoisting crane of this type, in which a cable guide mechanism is provided in the interior of the hollow vertical column, ensuring that the hoisting cable follows the correct path in every angular position of the jib with respect to the column.

It is an object of the invention to propose an improved hoisting crane. To this end, the invention provides a hoisting crane according to claim 1.

Further advantageous embodiments of the hoisting crane according to the invention are described in the following description with reference to the drawing.

In the drawing:

Fig. 1 diagrammatically depicts an offshore vessel which is

suitable, inter alia, for laying a pipeline on the seabed,
Fig. 2 shows the hoisting crane at the rear side of the vessel shown in Fig. 1, partially in the form of a cut-away view,
Fig. 3 shows the hoisting crane from Fig. 2 from a different direction,
Fig. 4 shows a view of the hoisting crane shown in Figs. 2 and 3 from above,
Fig. 5 shows the rear side of the vessel illustrated in Fig. 1, with the stinger in various positions,
Fig. 6 shows the column of the crane and the stinger from Fig. 5,
Fig. 7 shows a plan view of the stinger and part of the vessel,
Fig. 8 shows a possible layout of hoisting cables of the crane,
Fig. 9 shows a crane block, jib and block catcher device,
Fig. 10 shows a preferred embodiment of the annular bearing assembly of the crane,
Fig. 11 shows a preferred embodiment of electrical contact rings of the crane,
Fig. 12 shows an alternative support structure for the stinger,
Fig. 13 shows the use of the stinger as counterweight in a lifting operation.

Figure 1 shows an offshore vessel 1 which is suitable, inter alia, for laying a pipeline on the seabed.

The vessel 1 has a hull 2 with a working deck 3 and, at the front of the hull 2, a superstructure 4 for crew accommodation, etc.

The vessel 1 is provided with a pipeline-laying installation of the S-lay type, with one or more welding stations on the working deck 3, for coupling pipeline sections 9a in a substantially horizontal orientation. On the working deck 3 there are also what are known as tensioners 8 for carrying the weight of the pipeline 9 which is hanging downwards from the vessel 1.

Furthermore, the vessel 1 has a stinger 5 which projects outside the hull 2 of the vessel 1 at the rear side of the vessel 1, engages on the hull 2 at an engagement point such that it can pivot about a substantially horizontal pivot structure 6 and forms a downwardly curved support for pipeline moving towards the seabed.

Furthermore, the vessel 1 has a hoisting crane 20, disposed in the vicinity of the same side of the hull as the stinger 5, which hoisting crane 20 has a vertical structure fixed to the hull 2. The hoisting crane 20 will be described in more detail below. Here, the crane 20 is disposed above the location where the pipeline 9 leaves the working deck 3, on the longitudinal axis of the vessel 1.

The hoisting crane 20, which is illustrated in detail in Figures 2-4, has a substantially hollow vertical column 21 with a foot 22, which in this case is fixed to the hull 2 of the vessel 1. Furthermore, the column 21 has a top 23.

The hoisting crane 20 has a jib 24, which is illustrated in two different positions in Figure 1. An annular bearing structure 25 extends around the vertical column 21 and guides and carries a jib connection member 26, so that the jib connection member 26, and therefore the jib 24, can rotate about the column 21.

In this case, the jib connection member 26 forms a substantially horizontal pivot axis, so that the jib 24 can also be pivoted up and down. There is at least one drive motor 27 for displacing the jib connection member 26 along the annular bearing structure 25. By way of example, the annular bearing structure 25 comprises one or more guide tracks which extend around the column 21 and on which an annular component 28 of the jib connection member 26 is supported via running wheels. Jib securing supports 29 are arranged on the component 28 at two positions. The drive motor 27 may, for example, drive a pinion which engages with a toothed track around the column 21.

To pivot the jib 24 up and down, there is a topping winch 30 provided with a topping cable 31 which engages on the jib 24.

Furthermore, the hoisting crane 20 comprises a hoisting winch 35 for raising and lowering a load, with an associated hoisting cable 36 and a hoisting hook 37. At the top 23 of the column 21 there is a top cable guide 40 provided with a cable pulley assembly 41 for the topping cable 31 and with a cable pulley assembly 42 for the

hoisting cable 36.

One or more cable pulley assemblies 43 for the hoisting cable 36 and a cable pulley assembly 44 for the topping cable 31 are arranged on the jib 24. The number of cable parts for each cable can be selected as appropriate by the person skilled in the art.

The winches 30 and 35 are in this case disposed in the foot 22 of the vertical column 21, so that the topping cable 31 and the hoisting cable 36 extend from the associated winch 30, 35 upward, through the hollow vertical column 21 to the top cable guide 40 and then towards the cable guides 43, 44 on the jib 24.

The top cable guide 40 has a rotary bearing structure, for example with one or more running tracks around the top of the column 21 and running wheels, engaging on the running tracks, of a structural part on which the cable pulley assemblies are mounted. As a result, the top cable guide can follow rotary movements of the jib about the vertical column 21 and adopt substantially the same angular position as the jib 24.

The top cable guide 40 may have an associated drive motor assembly which ensures that the top cable guide 40 follows the rotary movements of the jib 24 about the column 21, but an embodiment without drive motor assembly is preferred.

The winches 31 and 35 are arranged on a movable winch support 50, which is mounted movably with respect to the vertical column 21. The winch support 50 here is located in the vertical crane structure, preferably in the region of the foot 22 under the circular cross section part of the column 21, and is mechanically decoupled from the top cable guide 40. The support 50 could e.g. also be arranged in the hull of the vessel below the column, e.g. the foot could have an extension which extends into the hull.

In the example shown, the winch support 50 is a substantially circular platform which at its circumference is mounted in an annular bearing 51, with the winches 31, 35 arranged on the platform. The annular bearing 51 is in this case such that the

platform can rotate about a vertical axis which coincides with the axis of rotation of the top cable guide. The bearing can have any appropriate design including trolleys running along a circular track.

The rotatable winch support 50 has an associated drive motor assembly 52 for moving the winch support 50, in such a manner that the winch support 50 maintains a substantially constant orientation with respect to the jib 24 in the event of rotary movements of the jib 24 about the vertical column 21. The orientation of the winch support 50 with respect to the top cable guide 40 likewise remains substantially constant, since its movements are once again the consequence of rotary movements of the jib 24.

In the embodiment shown, there is an angle sensor 60 for detecting the position of the component 28 of the jib connection member 26 with respect to the vertical column 21, the drive motor assembly 52 of the winch support 50 having associated control means 53 which are in operative contact with the angle sensor 60.

The winches 31, 35 each have an associated electrical (or electro-hydraulic) winch drive motor assembly 38, 39 which is disposed on the movable winch support 50. The electrical energy required is supplied by generators disposed elsewhere on the vessel, at a distance from the movable winch support 50. One or more sliding contacts (not shown) are provided in the electrical connection between these generators and the winch drive motor assemblies 38, 39.

In a variant which is not shown, the winch support 50 can rotate about a vertical shaft, this shaft being provided with one or more sliding contacts.

Via the one or more sliding contacts, a power current supply is preferably fed to the electrical equipment on the winch support 50.

The hoisting crane 20 is provided with a cab 70 for a hoisting crane operator, which cab 70 is in this case carried by the annular bearing structure 25 to which the jib 24 is secured, so that the cab

70 can rotate with the jib about the vertical column 21.

In the cab 70 there are at least control members (not shown) for operating the winch 35 of the hoisting cable 36 and for operating the winch 31 of the topping cable 31. The winch drive motor assemblies 38, 39 have associated control means (not shown) which are in wireless communication with the associated control members in the cab 70. By way of example, a plurality of wireless transmission/reception units are disposed around the vertical column, in or in the vicinity of the path of the cab 70 around the vertical column.

The control means, for example electronic control equipment, for the one or more winches on the winch support 50 are preferably also positioned on this winch support 50.

It can be seen from the figures that, as is preferred, the vertical column 21 has a substantially continuous outer wall. In this case, the horizontal section through the vertical column is substantially circular from the jib connection member to the top 23, with the cross section gradually decreasing towards the top of the column. The foot 22 of the column 21 is substantially rectangular, which has the advantage that the foot 22 can easily be secured (by welding or using bolts) to the longitudinal and cross bulkheads of the hull 2 of the vessel 1. In a variant which is not shown, the vertical column is partly or completely a framework of bars.

It can be seen from Figure 1 and Figures 5, 6 that a load-bearing connecting structure 80, which holds the stinger in a desired position, extends between the vertical structure of the hoisting crane 20 at a location above the point of engagement 6 of the stinger 5 on the vessel hull 2 (in this case in the vicinity of the annular bearing structure for the jib 24), and the stinger 5, at a location remote from the point of engagement 6 of the stinger 5 on the vessel hull 2.

Using the vertical structure, here the foot 22, of the hoisting crane 20 as a point of engagement for the structure 80 makes it possible to dispense with additional structural components for

holding the stinger in place, such as cantilevers projecting outside the hull 2.

This structure 80 is in this case formed by a cable system with winches 83, 84 in the vicinity of lower end of the foot of the crane 20 and with cable pulley assemblies 84-90 on the upper end of the foot 22 of the crane 20 and on the stinger 5. As a result, the length of the load-bearing connecting structure 80 is adjustable for the purpose of adjusting the position of the stinger 5 thereof.

As an alternative for the cable system a system including (hydraulic) adjusters could be arranged between the crane column 21 and the stinger 5, e.g. including hydraulic jacks. Such a system is shown in Figure 12, wherein a telescopic boom 801 is arranged between the stinger 5 and the column 21, in this example the upper end of the foot. One or more hydraulic jacks can be provided to slide the boom 801 in and out.

The vessel 1 can be used to lay a pipeline 9, but also for hoisting work, such as the hoisting work carried out, for example, in the offshore industry when installing platforms, underwater installations, etc.

In embodiment depicted in Figure 13 it is envisaged that the stinger 5 of the vessel is employed as a counterweight in a lifting operation using crane 20. For this purpose the stinger could be connected also to the slewable component 28 of the crane. In this example a topping cable 5a is arranged between said stinger and the top 40 of the crane. It is noted that this method could be employed on other types of S-lay pipelaying vessels which have a crane and a stinger. It can also be envisaged that a further weight, e.g. a barge, is suspended from the stinger 5 to effectively increase the counterweight.

In figure 8 a preferred layout of the hoisting cables of the crane 20 is shown.

In this preferred crane a first winch 35a and a second winch 35b, preferably both arranged on a common rotatable platform as explained

above, are employed for hoisting a load suspended from crane hook 37 which includes crane hook block 37a.

A first hoisting cable 36a (here shown in solid line) is associated with said first winch 35a and a second hoisting cable 36b (here shown in dashed line) with said second winch 35b.

The cables 36a,b here extend from the winches 35a,b upward through the foot 22 and the column 21 and then arrive at top cable guide 40 of the crane 20. In this drawing the top cable guide 40 is schematically depicted.

The top cable guide 40 has a left side provided with a first hoisting cable pulley assembly 42a for said first hoisting cable 36a and a right side provided with a second hoisting cable pulley assembly 42b for said second hoisting cable 36b.

Figure 8 further schematically depicts the hoisting cable guide 43 on the jib of the crane, which guide 43 has a left side provided with a first hoisting cable pulley assembly 43a for said first hoisting cable 36a and a right side provided with a second hoisting cable pulley assembly 43b for said second hoisting cable 36b.

The first hoisting cable 36a extends here between the assemblies 42a and 43a, the assemblies 42a, 43a having three and two pulleys, respectively in this example.

The second hoisting cable 36b extends here between the assemblies 42b and 43b, the assemblies 42b, 43b having three and two pulleys, respectively in this example.

From the innermost pulley of assembly 42a the first hoisting cable 36a then extends diagonally to a first hoisting cable pulley 101 mounted on the right side of the hoisting cable guide 43 on the jib.

From the innermost pulley of the assembly 42b the second hoisting cable 36b extends diagonally to a second hoisting cable pulley 102 mounted on said left side of the hoisting cable guide 43 on said jib.

The first hoisting cable 36a and second hoisting cable 36b then each extend from said first and second hoisting cable pulley 101, 102 of said cable guide 43 on said jib to a first hoisting cable crane hook pulley assembly 103 and a second hoisting cable crane hook pulley assembly 104 on the right and left side of a crane hook block 37a respectively.

Above said crane hook pulley assemblies 103, 104 associated jib pulley assemblies 105, 106 are mounted on the jib, here such that the first and second hoisting cables 36a, 36b extend in a multiple fall arrangement between the assemblies 103 and 105 and between 104 and 106.

The first and second hoisting cable 36a,b each further extend between the associated jib pulley assembly 105, 106 and the right side and left side of the top cable guide 40, respectively.

A first hoisting cable pulley 107 is mounted on said right side of the top cable guide 40 and a second hoisting cable pulley 108 is mounted on the left side of the top cable guide 40. The hoisting cables each extend around the pulley 107, 108 and then return to the jib head, where the first and second hoisting cable 36a,b each have a terminal end at the right side and left side of the jib respectively.

In the example shown here the crane hook 37 includes additional cable pulley assemblies 109, 110, which can be connected to the crane hook block 37a when desired or be held against the jib head (see figure 8). For the additional cable pulley assemblies 109,110 associated cable pulley assemblies 111, 112 are mounted on the jib head.

The layout of the hoisting cables shown in figure 8 is in particular advantageous for high capacity cranes, more importantly when the top cable guide 40 is arranged in a freely rotatable manner, wherein the guide 40 follows the motions of the jib around the column 21. In case of a failure of one of the winches 35a,b the layout shown here causes the guide 40 to maintain its position, which is highly

desirable.

A further advantage of the layout shown here is that the hoisting winches 35a,b can assist in the topping of the jib, which allows for a reduction of the capacity of the topping winch.

In figure 9 the crane block 37a is shown, and also the cable pulley assemblies 103, 104 mounted on said crane block, each having multiple pulleys arranged adjacent each other. Also the additional pulley assemblies 109, 110 are shown here, releasably attached to the crane block 37a at the outer ends thereof. Also visible is the jib cable guide 43, including numerous cable pulleys, including the assemblies 105, 106 and 110, 111 in this example. It is shown that the pulleys of the guide 43 are mounted here on aligned shafts 115.

The crane block 37a is in this example intended for extreme loads and the total weight of the crane block including the crane hook (not depicted here) could be tens of tonnes, up to 100 tonnes. This can be considered e.g. from the diameter of the shafts 115, which could e.g. have a diameter of 280 mm being made of high quality steel.

A problem associated with such heavy crane blocks, is that the block will sway with respect to the jib, e.g. as the jib is slewed. To counter this problem figure 9 shows a preferred embodiment of a block catcher device which is provided between the crane block and the jib to secure the block with respect to the jib when the crane block is fully raised.

In this example the block catcher device comprises a pin 120, e.g. a pin 120 having a diameter of at least 100 mm, in this example 310 mm, and a receiver 125 for the pin 120.

The pin 120 is mounted on the crane block 37a, upwardly directed towards the jib and the receiver 125 is mounted on the jib. Here the receiver 125 is suspended from a bearing assembly 126 at its top end, freely pivotable about a horizontal axis, here about the shafts 115.

To ensure introduction of the pin 120 into the receiver 125, the pin 120 has a pointed head and the receiver has a reception cone 128 at its receiving end. The receiver 125 could include internal rollers to guide the pin 120.

The pin 120 is arranged centrally between the assemblies 103 and 104. The pin 120 here is interconnected to the block 37a via a shaft 129, extending transversely to the pin 120. The body of the pin 120 extends till below the block 37a, where an eye 130 is provided for attaching the crane block (not shown).

It is noted that the crane block including the block catcher can be used on any type of crane, e.g. a mast crane without rotatable winch platform but also for other types of cranes.

Figure 10 shows a preferred embodiment of the annular bearing structure 25 for the component 28 which supports the jib. Around the column 21 of the crane a radial support flange 25a is fitted. Beneath this flange 25a a support cone 25b is fitted, whereof the internal rim is welded to the column 21, so that a triangular structure is obtained with a high stiffness.

On top of the support flange 25a a guide track structure 25c is mounted, which provides running surfaces for rollers mounted on the component 28.

In this example the track structure 25c includes a bottom part and an upper part interconnected via bolts 131. These bolts are readily accessible for fastening as shown in figure 10.

It is noted that the annular bearing structure of triangular cross section can also be used on any type of crane, e.g. a mast crane without rotatable winch platform, e.g. a crane comprising:

- a substantially hollow vertical column with a foot which is or can be fixed to a support, and with a top,
- a jib,
- an annular bearing structure, which extends around the vertical column and guides and carries a jib connection member, so that the jib connection member can rotate about the column, the jib

connection member forming a substantially horizontal pivot axis so that the jib can be pivoted up and down,

- topping means for pivoting the jib up and down,
- the hoisting crane also comprising:
 - a winch;
 - an associated hoisting cable for hoisting a load;
 - a top cable guide at the top of the vertical column;
 - a hoisting cable guide on the jib of the hoisting crane;
 - the winch being disposed in the column, preferably in the vicinity of the foot of the vertical column, so that the hoisting cable extends from the winch through the hollow vertical column to the top cable guide and then to the hoisting cable guide on the jib,
 - the top cable guide comprising a rotary bearing structure, so that the top cable guide can follow rotary movements of the jib about the vertical column and adopts substantially the same angular position as the jib.

Figure 11 depicts schematically a preferred embodiment of the provision of electrical power to electrical equipment mounted rotatably on the column, e.g. in the cab 70. For this purpose a set of electrically conductive contact rings 140 are mounted around the column 21, here above the bearing structure 25. Electrically conductive sliders 141 are mounted to move along said rings 140 and provide electrical contact. In order to access the rings, e.g. for repair, the set of rings 140 is arranged movable in vertical direction to a raised access position as shown in dashed lines in figure 11. For this purpose the rings 140 are mounted on a common frame 142, which is slidable with respect to associated guides 143 placed along the column. One or more actuators, e.g. vertically arranged screw spindels or hydraulic jacks, could be provided to raise the frame 142 with the rings. One or more of the rings could serve to transmit signals instead of electrical power, e.g. of the open-coax type.

CLAIMS

1. Hoisting crane (20), comprising:
 - a substantially hollow vertical column (21) with a foot (22) which is or can be fixed to a support, and with a top (23),
 - a jib (24),
 - an annular bearing structure (25), which extends around the vertical column and guides and carries a jib connection member (26), so that the jib connection member can rotate about the column (26), the jib connection member forming a substantially horizontal pivot axis so that the jib can be pivoted up and down,
 - topping means (30,31) for pivoting the jib up and down,
 - a hoisting cable guide (43) on the jib of the hoisting crane,
 - a top cable guide (40) at the top (23) of the vertical column, the top cable guide (40) comprising a rotary bearing structure, so that the top cable guide can follow rotary movements of the jib about the vertical column and adopts substantially the same angular position as the jib,
 - a first and a second winch (35a,b), and
 - a first and second hoisting cable (36a,b) associated with said first and second winch respectively for hoisting a load,
- in which the first and second winch (35a,b) are disposed in the column, preferably in the vicinity of the foot of the vertical column (21), so that the first and second hoisting cable (36a,b) extend from the first and second winch through the hollow vertical column to the top cable guide and then to the hoisting cable guide on the jib,
- wherein said top cable guide (40) has a left side provided with a first hoisting cable pulley assembly (42a) for said first hoisting cable (35a) and a right side provided with a second hoisting cable pulley assembly (42b) for said second hoisting cable (35b),
- and wherein said hoisting cable guide (43) on said jib has a left side provided with a first hoisting cable pulley assembly (43a) for said first hoisting cable (36a) and a right side provided with a second hoisting cable pulley assembly (43b) for said second hoisting cable (36b),
- and wherein said first hoisting cable (36a) extends diagonally to a first hoisting cable pulley (101) mounted on said right side of the

hoisting cable guide (43) on said jib,
and wherein said second hoisting cable (36b) extends diagonally to a second hoisting cable pulley (102) mounted on said left side of the hoisting cable guide (43) on said jib,
wherein said first hoisting cable and second hoisting cable (36a,b) extend from said first and second hoisting cable pulley (101,102) of said cable guide on said jib to a first hoisting cable crane hook pulley assembly (103) and a second hoisting cable crane hook pulley assembly (104) on the right and left side of a crane hook block (37a) respectively,
and from there in a one or more cable fall arrangement between each of said crane hook pulley assemblies (103,104) and an associated jib pulley assembly (105,106) on said jib,
wherein said first and second hoisting cable (36a,b) further each extend between the associated jib pulley assembly (105,106) and the right side and left side of the top cable guide (40), respectively.

2. Hoisting crane according to claim 1, in which additional cable pulley assemblies (109,110) are provided, which can be releasably attached to the crane hook block (37a) or be held against the hoisting cable guide (43), and in which associated cable pulley assemblies (111,112) are mounted on the hoisting cable guide (43), wherein said first and second hoisting cable (36a,b) each extend between the additional cable pulley assemblies (109,110) and the associated cable pulley assemblies (111,112), respectively.

3. Hoisting crane according to claim 1 or 2, in which the first and second winch (35a,b) are arranged on a moveable winch support (5), which is mounted moveable with respect to the vertical column (21,22) the winch support having an associated drive motor assembly (52) for moving the winch support (5), in such a manner that the winch support maintains a substantially constant orientation with respect to the jib (24) in the event of rotary movements of the jib about the vertical column (21,22).

4. Hoisting crane according to claim 3, in which an angle sensor (60) is provided for detecting the position of the jib connection member (26) with respect to the vertical column, and in which the drive motor assembly (52) of the winch support (50) has associated

control means (53) which are in operative contact with the angle sensor.

5. Hoisting crane according to one or more of the preceding claims, wherein a block catcher device (120,125) is provided between the crane hook block (37a) and the jib to secure the crane hook block (37a) with respect to a jib, at least to prevent swaying of the crane hook block (37a) with respect to the jib, when the crane hook block is fully raised.

6. Offshore vessel (1) provided with a hoisting crane according to one or more of claims 1-5.