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(54) DERRICK FOR ERECTION ON BOARD A DRILLING SHIP

(71) We, GROUPEMENT POUR LES ACTIVITES ATOMIQUES ET AVANCEES (formerly known as Groupement Atomique Alsacienne Atlantique), a French body corporate, of 20 Avenue Edouard Herriot 92-Le Plessis Robinson, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a derrick for erection on board a drilling ship.

More particularly, the derrick is intended for the transfer of a multiple drill pipe element from a transfer position, into which the element has been transferred from store and in which the element is parallel to the longitudinal axis of a hole to be drilled in the sea bed, into a position directly above the location of the hole and aligned with its longitudinal axis. The derrick is also intended for the reverse procedure after the hole has been drilled.

When using a series of multiple drill pipe elements for drilling at sea, each multiple element consisting of a number of separate elements and the multiple elements being connected together in stages as the drilling depth increases to form a single drilling pipe, it is clearly not possible to handle the multiple elements, and more particularly triple drill pipe elements, within a derrick installed on board a drilling ship in the same conditions as in a derrick installed as a stationary unit on land or on a fixed platform attached to land. The well known influence of wind combines here with the rolling and pitching movements caused by the swell and the waves to draw the triple drill pipe elements, during displacement into the required position for drilling, away from this position. Therefore, equipment designed for moving triple drill pipe elements within a derrick installed on board ship should not merely suspend these drill pipe elements on the end of a cable, but should ensure a constant, rigid, bilateral connection between the derrick and the moving element. It will be appreciated that the bilateral connection is to be ensured from the moment when the triple element is ever released to the moment when it is again fixed, this being applicable whatever its movement, vertical or horizontal. Clearly, the triple drill pipe element is to be held firmly at at least two points, to avoid any accidental rotating movement. Lastly, vertical storage of the elements within a derrick at sea can take place only in exceptional circumstances (when the sea is calm) or accidentally (when the horizontal storage system whereby the elements are normally stored horizontally is defective).

Shifting equipment is therefore required which should be capable of ensuring, during any movement of a triple drill pipe element, a permanent bilateral connection enabling the triple element to be gripped or deposited above the drilling pipe on the tool-joint of the latter, and, during dismantling of the drill pipe, to transfer the triple elements to a transfer position from which a transfer carriage grips them to displace them into a horizontal position for storage purposes. The shifting equipment should enable the drill pipes to be delivered at the transfer position with a view to temporary vertical storage in the derrick, when required.

Moreover, the shifting equipment should be as light as possible, so as not to overload the structure of the derrick.

It can be seen, consequently, that the conditions to which such shifting equipment are to comply appear contradictory: rigidity in the balance of a long and heavy element such as a triple drill pipe element requires great strength in the shifting equipment and a massive structure for the derrick and the capability of performing complex operations at points remote from one another requires equipment having a large

volume. These two factors contradict the imperative necessity of lightness imposed on the shifting equipment.

It is an aim of this invention to provide a derrick which is for erection on board a drilling ship and with which it is possible to meet the above requirements.

According to the invention there is provided a derrick for erection on board a drilling ship and intended for the transfer of a multiple drill pipe element from a transfer position, into which the element has been transferred from store and in which the element is parallel to the drilling axis, into a position aligned with the drilling axis, and also intended for the reverse procedure after the hole has been drilled, the derrick having three shifting units arranged at different distances from the base of the derrick so as to provide lower, middle and upper shifting units respectively nearest to, at an intermediate distance from and furthest away from, the said base, each shifting unit being provided with rotating means for adjusting the orientation of the shifting unit relative to the derrick, an arm for guiding the multiple drill pipe element, shifting means for moving the arm relative to the said shifting unit in a direction perpendicular to the drilling axis, and gripping means mounted on the arm, the middle and upper shifting units each additionally having means for moving the shifting unit relative to the derrick in a direction perpendicular to the drilling axis and means for centring the gripping means about the pipe element, and the middle shifting unit additionally being provided with means for displacing its jaws in a direction in or parallel to the drilling axis.

For a better understanding of the invention and to show how the same may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 shows the location of shifting units included in one form of derrick in accordance with the invention;

Figure 2 is a sectional view on an enlarged scale made at the height of the upper shifting unit and taken on the line A—A of Figure 1;

Figure 3 is an elevation view of the middle carriage;

Figure 4 is a partial sectional view on an enlarged scale taken along the line B—B of Figure 3;

Figure 5 is the complete sectional view of the same shifting unit along the line B—B of Figure 3; and

Figure 6 is a diagram showing the handling of a triple drill pipe element.

Figure 1 shows the outside contour of the derrick (designated 1) and the drilling axis (designated 2) of a well being drilled. From top to bottom, three shifting units can be distinguished 100, 200, 300. The upper shifting unit 100 comprises a horizontal carriage 13 which can be driven normal to the drilling axis in a horizontal longitudinal movement in relation to a frame 14 fixed to the derrick, a rotatable turret supported on the carriage 13, a horizontal arm 11 supported by the turret and a pair of jaws 10 at the end of the arm 11.

The middle shifting unit 200 comprises a main carriage 23, itself radially mobile in relation to a frame 24 connected in a fixed way to the derrick, a turret 22 which can turn to the right and to the left through more than 90° in relation to the carriage 23, a cranked arm 21 whose vertical part is supported by a horizontal part 46, itself driven normal to the drilling axis in a horizontal longitudinal movement in relation to the turret 22, and a pair of jaws 20 mobile along a vertical axis in relation to the arm 21 and parallel to or along the drilling axis.

The lower shifting unit 300 comprises a turret 32, which can rotate in relation to a frame 34 fixed to the derrick, a horizontal arm 31 which is supported by the turret 32 and which can be moved relative to the turret in a horizontal direction and thus perpendicular to the drilling axis, and a pair of jaws 30 mounted on the end of the arm 31.

Figure 2 is a sectional view of Figure 1 along the line A—A. The jaws 10 and the arm 11, as well as the slide rails 15 of the carriage 13 on the frame 14, can be distinguished therein.

Figure 3 (which is an elevational view taken in the opposite direction to that of Figure 1) gives a more accurate idea of the middle shifting unit. The jaws 20 holding a triple drill pipe element 25 below the tool-joint 126 can be distinguished therein. The jaws open and close when rollers 27, 27^1 (Figure 4) move inside a cam 28 under the action of a jack 29.

The jaws 20 are driven in a vertical movement by a vertical carriage 40 with which they are fast. By means of two bearing rollers 41 and 42 which move along a bearing race 43 formed in the vertical portion of the arm 21, the jaws 20 and the carriage 40 are driven in vertical motion under the action of the rod 44 of a jack 45. The arm 21 is a cranked part which comprises the vertical portion which has just been described and the horizontal portion 46.

A movement of the horizontal portion 46 of the arm in relation to the turret 22 sets the triple element, supported by the jaws 20 mounted on the vertical portion of the arm 21, in motion. Such a longitudinal

horizontal movement is effected by means of the bearing rollers 48 and 49 of the arm engaging the turret 22, this movement being guided by the fixed arm-guide roller 50 on the turret. This longitudinal movement is controlled by a jack 51 having its cylinder connected to the arm, and its piston 52 connected to a turret 22 at 53. Lastly, when it moves to grip the triple drill pipe element, the movement of the arm is guided by a centring device 47 extended towards the front of the arm by two symmetrical flanges 26 and 26^1 bearing centring rollers 47 and 47^1 (Figure 4). The turret 22 can be turned on its pivot 54 by means of two rotation jacks 55 and 55^1 (Figure 5), the latter alone being shown in Figure 3. This turret is capable of being set in motion, in its turn, by the movement of the carriage 23 sliding on rollers such as 56 and 57 on a bearing race 58 fixed to the frame 24 connected to the derrick. Ultimately, the various possible movements are as follows:

Opening and closing of the jaws 20 by means of the jack 29;

Lifting and lowering of the jaws 20 along the vertical part of the arm by means of the jack 45;

Horizontal longitudinal movement of the arm in relation to the turret 22 by means of the jack 51;

Rotating of the turret 22 in relation to the horizontal carriage 23 by means of the cylinders 55 and 55^1;

Longitudinal movement of the carriage 23 on the bearing race 58 connected to the frame 24, by means of a motor 59.

The upper shifting unit 100 is essentially the same as the middle shifting unit except that it does not afford vertical displacement of the jaws relative to the derrick. Thus, it comprises jaws 10 analogous to the jaws described above and also centring means analogous to the centring device 47 of the middle shifting unit 200.

The lower shifting unit 300 is essentially the same as the middle shifting unit described hereinabove except that it does not have a carriage corresponding to the main carriage 23, the jaws 30 are not vertically displaceable relative to the derrick as are the jaws 20, and it does not have a centring means corresponding to the centring device 47.

Figure 4 shows an enlarged view of a cross-section of the vertical carriage along the line B—B of Figure 3, as well as the vertical portion of the arm. It makes it possible to understand better the two essential movements consisting of the opening of the jaws 20 and of the vertical longitudinal movement of the vertical carriage in relation to the vertical portion of the arm.

When, before transference of a triple drill pipe element from its vertical position to a horizontal position in which it is stored, the middle shifting unit brings the triple drill pipe element towards a transfer carriage (not shown) for taking up the triple element in a vertical position so as subsequently to store it in a horizontal position, the final movement of the shifting unit is guided by a deflector 65 fast with the transfer carriage. The shifting unit rests against the deflector 65 through the centring rollers 47^1 and 47^{11} mounted on the flanges 26 and 26^1 of the centring device 47.

The flanges of the vertical portion of the arm can be distinguished at 21, the sectional view of the jaws opening and closing control cam jack at 29, and the cam for moving the rollers 27 and 27^1 at 28. When the two rollers 27 and 27^1 contacting the cam move towards each other, the jaws 20 pivot about the axis 60 and move away to leave the triple element 25 free. It can, moreover, be seen that when the jaws grip the triple element, rollers 61, 62, 63 and 64 enable a rotation of the triple element about its longitudinal axis with a view to enabling the screwing and unscrewing of adjoining triple drill pipe elements at the respective tool-joints.

Also, in Figure 4, a cross-section of the flange of the vertical carriage 40 and the roller 41 of the vertical carriage can be distinguished. Opposite the centring device 47 and its rollers 47^1, 47^{11}, the deflector 65 of the transfer carriage has been shown, in discontinuous lines, the transfer carriage effecting the transfer of the triple element from the vertical position to the horizontal position. The rollers 47^1 and 47^{11} come into contact with the profile of the deflector 65 and thus bring the triple drill pipe element into its precise position for its loading onto the transfer carriage.

Figure 5 shows the complete cross-section taken along the line BB. Besides the triple drill pipe 25 held by the jaws 20 and free to rotate due to the rollers such as 61, rollers 27 enabling the opening of the jaws in the vertical carriage 21, the turret 22, and a bearing race of the rollers 48, 49 for the movement of the arm in relation to the turret 22 can be distinguished. To simplify the drawing, the centring device 47 and the rollers 47^1 and 47^{11} of that centring device have not been shown. On the other hand, the pivot 54 of the turret 22, as well as the jacks 55 and 55^1 controlling the rotation of the turret, can be seen. Lastly, the main horizontal carriage 23 and its motor 59 can be distinguished.

Figure 6 is a diagram showing, in a horizontal plane, the various positions taken up by the jaws 20 during the hand-

ling of a triple drill pipe element between the well and the transfer carriage which is to bring the drill pipes out of the derrick into a horizontal storage position. The point 72 is the centre line of the well, and the position 75 is the retracted position of the jaws. The position 74 is the position for the loading of the triple element on the transfer carriage.

This figure makes it easier to understand the sequence of the handling operations for a triple drill pipe element between the well and the transfer carriage by means of the middle shifting unit 200 and of the upper shifting unit 100. Jaws of the lower shifting unit 300 are not required to perform any gripping function except during the transfer of a massive drill pipe element (employed for weighting down the drilling pipe) between the well and a vertical storage point.

The sequence of operations can be divided into sixteen elementary connected operations which are even effected simultaneously in certain cases. These operations are the following:

1. Lifting of the succession of triple elements constituting the drill pipe by a lifting means with which this invention is not concerned.

2. (Simultaneous operation with 1). The two pairs of jaws of the upper and middle shifting units go from the retracted position 75 to the waiting position 71.

3. Supporting the triple element on chocks, leaving a residual tension on the triple element to keep it straight.

4. The pairs of jaws 10, 20 advance at high speed from the waiting position 71 to the position 72 by means of the carriages 23 and 13. The arm 21 and the arm 11 continue the movement at low speed until the moment when the triple element is fully engaged in the pairs of jaws at which time the jaws are slightly beyond the position 72.

5. Closing of the pairs of jaws 10, 20 (very rapid operation).

6. The pairs of jaws 10, 20 return to position 72. This low-amplitude course is effected by withdrawing the arm in a very short time.

7. Releasing the lifting means. The triple element is no longer guided except by the middle and upper shifting units.

8. Withdrawal and lowering of the lifting means. The performance of this operation does not hinder the two following operations which are more often carried out simultaneously.

9. Unscrewing the connection of the triple element with the rest of the drill pipe after installing the lower guide arm 31 preventing the tool-joint from shifting immediately after unscrewing.

10. Making the jaws 20 come into contact with the tool-joint, the jaws of the middle shifting unit effecting that lifting movement in two phases:

101—High-speed lifting until detection of the tool-joint;

102—Low-speed lifting for handling the triple element causing the releasing and lifting of the triple element from the rest of the drill pipe.

11. Rotating of the arms of the shifting units to move the jaws from 72 to 73. This operation is carried out by rotating the turret driven by the jacks 55 and 55^1.

12. Advancing the arms to move jaws 10, 20 from 73 to the transfer position 74. This advancing operation comprises a first part at full power up to the moment when one of the rollers 47^1 or 47^{11} comes into contact with the profile of the deflector 65 of the transfer carriage. A reduction in the oil pressure on the jacks controlling the rotating and the jack controlling the movement of the arm limits the effort exerted on the carriage. Thus, the triple element is brought into a precise position in relation to the transfer carriage, cancelling the influence of the play and of the deformations produced by the effect of the swell on all the assembled elements.

13. Closing the jaws of the transfer carriage after arrival of the triple element at the carriage.

14. Opening the jaws 10, 20 of the shifting units.

15. Withdrawal of the jaws 10, 20 of the shifting units from 74 to 73 by sliding the arms.

16. Putting the jaws of the shifting units 200, 100 in the retracted position 75 to clear the passage for the triple element connected to the transfer carriage during its lowering movement from the vertical position to the horizontal position.

The operations carried out by the shifting units during transporting of the triple drill pipes from their store, in which the element is parallel to the drilling axis of the ship, to the drilling well defining the drilling axis can be clearly understood simply by reversing the above sequence of operations.

With the derrick assembled, it is possible to grip a triple drill pipe element at a desired position relative to the derrick, using short travelling distances and limiting the length of the travel paths which the moved drill pipe elements will take to a minimum, by means of a judicious combination of rotating and longitudinal movements.

To simplify the various manoeuvres of the shifting units, it appears preferable, in certain cases, to make a single shifting unit bear the weight of the triple drill pipe ele-

ment load, the other shifting units merely preventing the rotating of the drill pipe elements about axes other than the axis of symmetry of these latter in this case. For reasons of simplicity, the middle shifting unit often fulfils the former function. Its jaws can then grip the element at the base at one of the two available tool-joints. The jaws of the other shifting units are then provided with the bearing rollers mentioned above. The lower drill pipe of the triple element can then be unscrewed or screwed-up without any inconvenience in relation to the last tool-joint of the drill pipe.

To ensure firm and accurate control during these operations, operation of the derrick is preferably achieved by hydraulically controlled jacks, but it is also possible to use electric motors or any other equivalent means in place of such jacks.

WHAT WE CLAIM IS:—

1. A derrick for erection on board a drilling ship and intended for the transfer of a multiple drill pipe element from a transfer position, into which the element has been transferred from store and in which the element is parallel to the drilling axis, into a position aligned with the drilling axis, and also intended for the reverse procedure after the hole has been drilled, the derrick having three shifting units arranged at different distances from the base of the derrick so as to provide lower, middle and upper, shifting units respectively nearest to, at an intermediate distance from and furthest away from, the said base, each shifting unit being provided with rotating means for adjusting the orientation of the shifting unit relative to the derrick, an arm for guiding the multiple drill pipe element, shifting means for moving the arm relative to the said shifting unit in a direction perpendicular to the drilling axis, and gripping means mounted on the arm, the middle and upper shifting unit relative to the derrick in a direction perpendicular to the drilling axis and means for centring the gripping means about the pipe element, and the middle shifting unit additionally being provided with means for displacing its jaws in a direction in or parallel to the drilling axis.

2. A derrick according to claim 1, wherein each means for moving the shifting unit relative to the derrick comprises a carriage and wherein each rotating means of the middle and upper shifting units consists of a turret pivotally mounted on the carriage and two jacks for rotating the turret about its pivot, whereas the rotating means of the lower shifting unit consists of a turret pivotally mounted on a frame fixed on the derrick and two jacks for rotating the turret about its pivot.

3. A derrick according to claim 2, wherein the shifting means each additionally comprise bearing rollers through which a portion of the arm, orientated in the direction perpendicular to the drilling axis between the shifting units, bears against the turret, and a jack connected to the turret and arranged to displace the arm portion.

4. A derrick according to any preceding claim, wherein each gripping means consists of two jaws which are arranged to pivot about an axis and whose portions for contact with the element are provided with bearing rollers enabling the element to be rotated about its longitudinal axis when it is held by the jaws.

5. A derrick according to any preceding claim, wherein a transfer carriage is provided for transferring the element from its transfer position into a further position for storage purposes, and wherein the centring means, at least in the case of the middle shifting unit, consists of two symmetrical flanges extending outwardly beyond the jaws and provided, at their ends, with rollers designed to come into contact with a guiding element forming a part of the transfer carriage.

6. A derrick according to any preceding claim, wherein the arm of the middle shifting unit is a cranked arm whose vertical portion has a bearing race and is provided with a carriage constituting the means for moving the middle shifting unit relative to the derrick, which carriage bears the jaws and the centring means and which is movable on the bearing race, there being a jack connected to the cranked arm and arranged to effect movement of this carriage.

7. A derrick for erection on board a drilling ship, substantially as hereinbefore described with reference to the accompanying drawings.

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2. A derrick according to claim 1, wherein each means for moving the shifting unit relative to the derrick comprises a carriage and wherein each rotating means of the middle and upper shifting units consists of a turret pivotally mounted on the carriage and two jacks for rotating the turret about its pivot, whereas the rotating means of the lower shifting unit consists of a turret pivotally mounted on a frame fixed on the derrick and two jacks for rotating the turret about its pivot.

3. A derrick according to claim 2, wherein the shifting means each additionally comprise bearing rollers through which a portion of the arm, orientated in the direction perpendicular to the drilling axis between the shifting units, bears against the turret, and a jack connected to the turret and arranged to displace the arm portion.

4. A derrick according to any preceding claim, wherein each gripping means consists of two jaws which are arranged to pivot about an axis and whose portions for contact with the element are provided with bearing rollers enabling the element to be rotated about its longitudinal axis when it is held by the jaws.

5. A derrick according to any preceding claim, wherein a transfer carriage is provided for transferring the element from its transfer position into a further position for storage purposes, and wherein the centring means, at least in the case of the middle shifting unit, consists of two symmetrical flanges extending outwardly beyond the jaws and provided, at their ends, with rollers designed to come into contact with a guiding element forming a part of the transfer carriage.

6. A derrick according to any preceding claim, wherein the arm of the middle shifting unit is a cranked arm whose vertical portion has a bearing race and is provided with a carriage constituting the means for moving the middle shifting unit relative to the derrick, which carriage bears the jaws and the centring means and which is movable on the bearing race, there being a jack connected to the cranked arm and arranged to effect movement of this carriage.

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