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Bourree et al.

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[45] **Nov. 25, 1975**

[54] **MOVEMENT COMPENSATING APPARATUS FOR FLOATING DRILLING**

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[21] Appl. No.: **438,045**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 208,106, Dec. 15, 1971, abandoned.

[30] **Foreign Application Priority Data**

Dec. 15, 1970 France 70.45175

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[51] **Int. Cl.²** **E21B 19/00**

[58] **Field of Search** ..... 214/2.5, 1 P, 1 BD, 1 B, 214/1 BB; 175/85

[56] **References Cited**

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Primary Examiner—Frank E. Werner

Attorney, Agent, or Firm—Sughrue, Rothwell, Mion, Zinn & Macpeak

[57] **ABSTRACT**

A derrick mounted on a ship has three automatic pipe shifting units that compensate for the sway of the vessel during a drilling operation at sea. Both rotary and reciprocal movement are provided by jack members and turrets. Gripping jaws permit the rotation of the held pipe, while aligning flanges insure precise location. The middle shifting unit provides a vertical jack member for elevating its respective gripping jaw.

2 Claims, 6 Drawing Figures

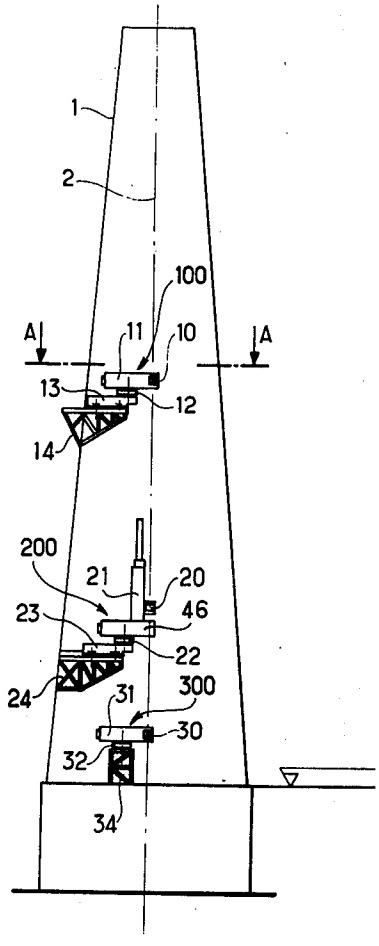


FIG. 1

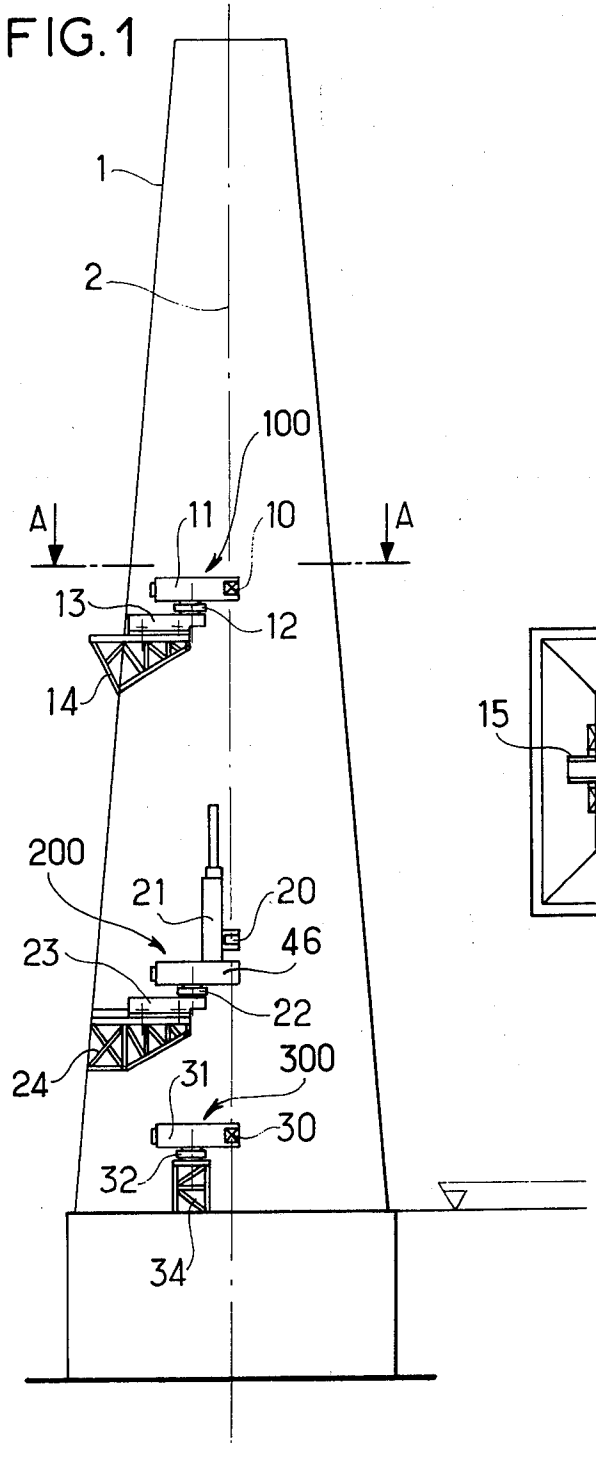

1
2
100
A
11
10
A
13
12
14
200
21
20
46
23
22
24
31
300
30
32
34

FIG. 2

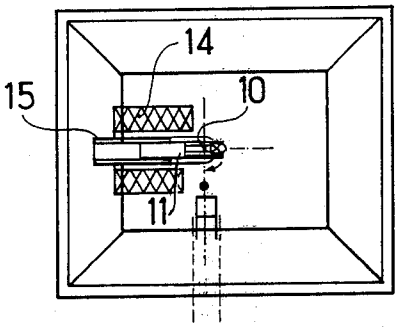

14
15
10
11

FIG. 3

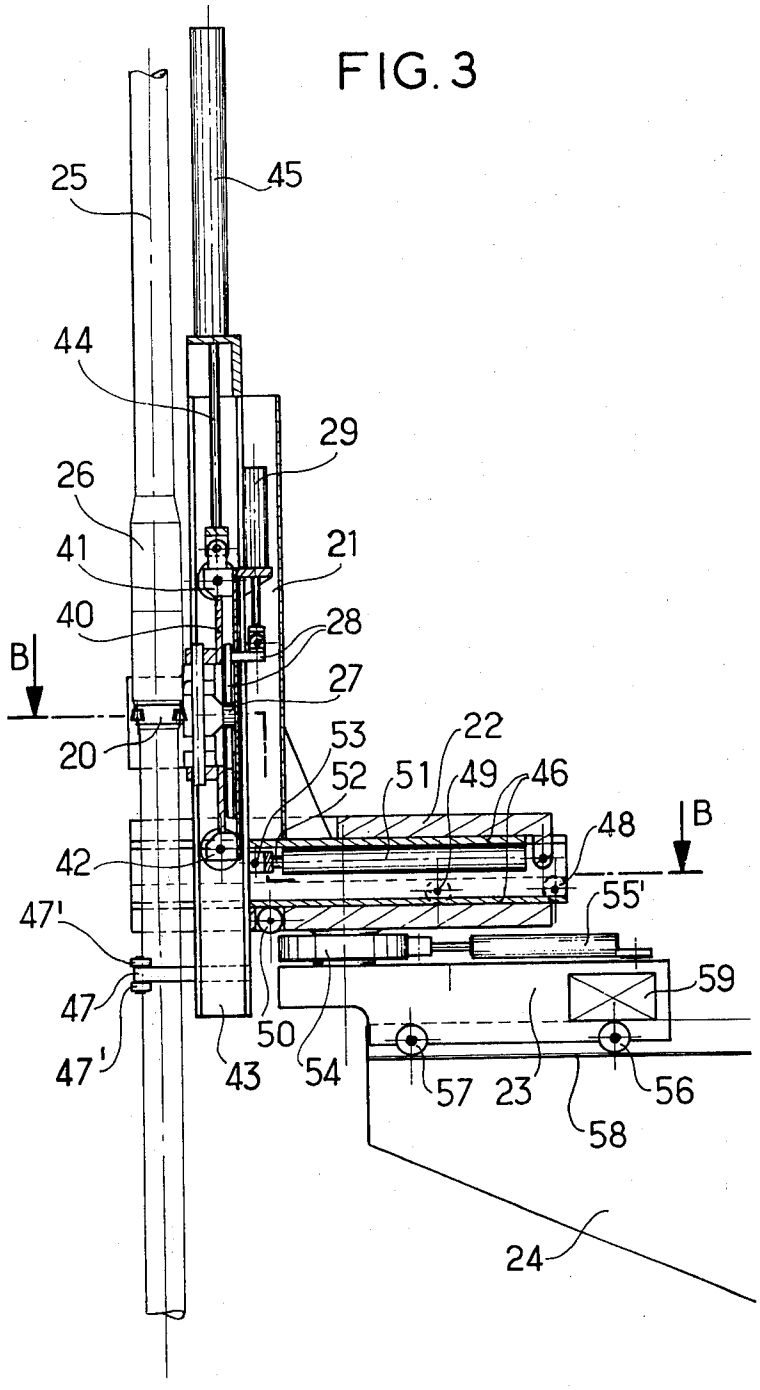

25
45
44
29
26
41
21
40
28
B
27
20
53
22
52
51
49
46
48
B
42
55'
47'
59
47
50
54
47'
43
57
23
56
58
24

FIG. 4

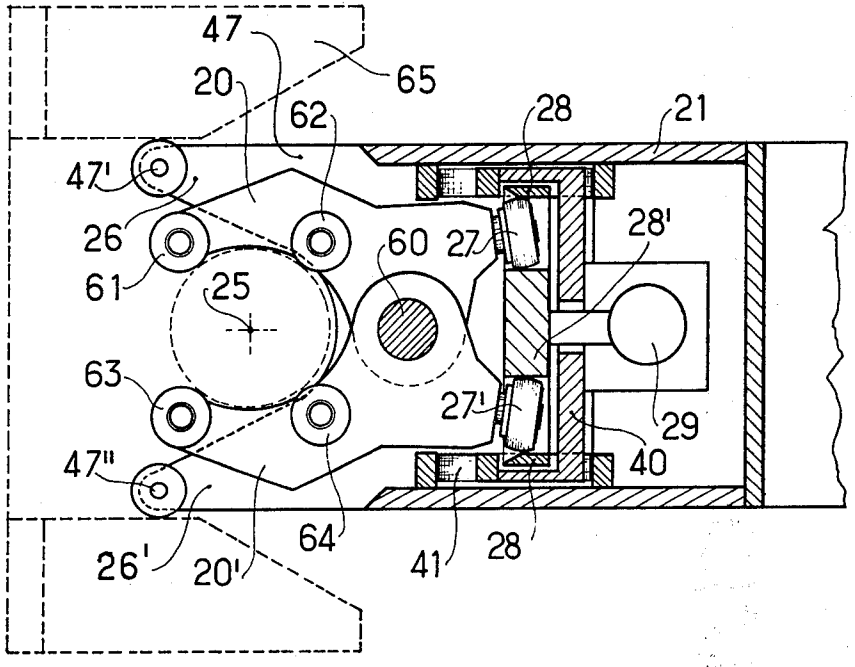

47
20
65
62
28
21
47'
26
60
27
28'
61
25
63
27'
29
47''
40
64
41
28
26'
20'

FIG. 5

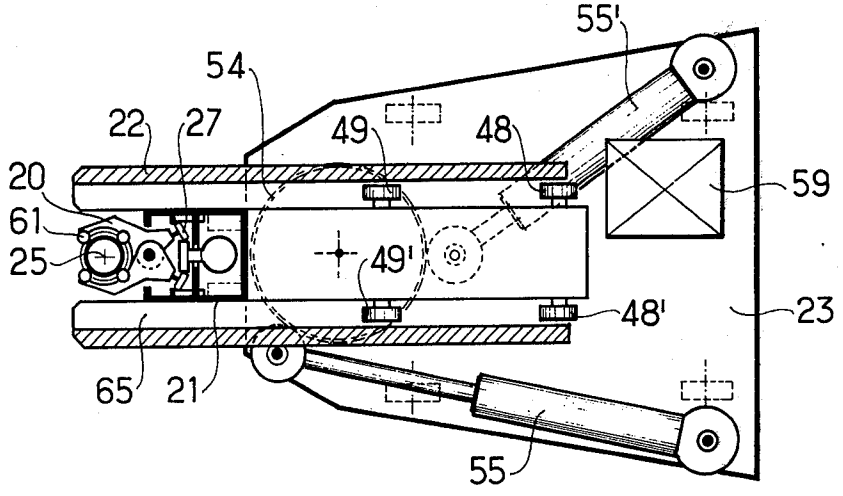
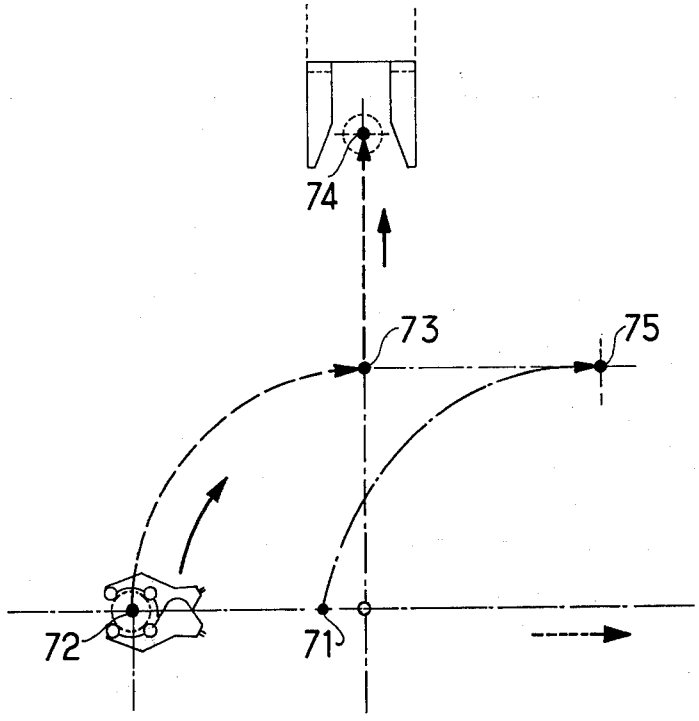

55'
54
22
27
49
48
20
59
61
25
49'
48'
23
65
21
55

FIG. 6



MOVEMENT COMPENSATING APPARATUS FOR FLOATING DRILLING

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of application Ser. No. 208,106, filed Dec. 15, 1971, and abandoned upon the filing of the present application.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a shifting assembly intended for handling drill pipes mounted on a derrick. It is particularly well suited for such derricks located on board a ship performing drilling operations at sea.

2. Description of the Prior Art

It has not been possible to handle drill pipes, and more particularly, triple drill pipes, within a derrick installed on board a ship during drilling operations at sea in the same manner 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 with the rolling and pitching movements caused by the swell and the waves to move all triple drill pipe elements during displacement away from their intended destination.

Generally, equipment designed for moving triple drill pipe elements within a derrick installed on board a ship must not merely suspend these drill pipes on the end of a cable, but must ensure a constant rigid bilateral connection between the derrick and the moving element. The bilateral connection must be ensured from the moment when the triple element is released to the moment when it is again fixed, this being applicable whatever its movement, vertical or horizontal. The triple drill pipe element must be held firmly at least by two points, to avoid any accidental rotating movement.

Shifting equipment must therefore be provided which is capable of ensuring, during any movement of a triple drill pipe element, a permanent bilateral connection enabling the drill pipes to be gripped or deposited above the drill pipe string on the tool-joint of the latter, and to remove the drill pipes normally at the point from which a transfer carriage grips them to deliver them in a horizontal position; in addition, the shifting assembly must enable the drill pipes to be delivered at a takeup point with a view to temporary vertical storage in the derrick. Moreover, such a device must be as light as possible, so as not to overload the structure of the derrick.

SUMMARY OF THE INVENTION

It can be seen, consequently, that the conditions to which such a shifting assembly must comply are contradictory: rigidity in the balance of a long and heavy element such as a set of three drill pipes requires great strength in the shifting unit and a massive structure, the capability of performing complex operations at points remote from one another requires a device having great volume; these two factors contradict the imperative necessity of lightness imposed on the device. The present invention has nevertheless sought to conciliate these different factors by reverting to a compound motion.

The object of the invention is therefore an automatic shifting assembly for a derrick erected on board a ship for drilling at sea, enabling the movement, inside the derrick, of a multiple drill pipe element held in a substantially vertical position, from the well to a transfer

carriage or to a take-up point for possible vertical storage and vice-versa, by successive connected upward or downward, longitudinal and rotating movements during which the handled element is held permanently by at least two collets. This assembly comprises three shifting units arranged respectively one above another, the lower shifting unit, the middle shifting unit and the upper shifting unit, characterized in that the three shifting units are each provided with a rotating turret. In the middle shifting unit and in the upper shifting unit, the rotation turrets can be driven in a radial longitudinal movement by a carriage installed on a fixed frame connected to the derrick. In the middle shifting unit, the collet is further supported by a carriage sliding vertically along an arm provided on the carriage having a radial longitudinal movement.

With such an assembly of shifting units, it is possible to grip a triple drill pipe element at any useful point of the derrick, using short travelling distances and limiting the length of the travel paths which the moved elements will take to a minimum, by means of a judicious combination of rotating and longitudinal movements.

Finally, the arm supporting the collet can slide in relation to its rotation turret.

To simplify the various maneuvers and the production of the shifting units, it is preferable, in certain cases, to make a single shifting unit bear the weight of the triple drill pipe element load, the other shifting units merely preventing the rotation of the drill pipe elements about axes other than the axis of symmetry. For reasons of simplicity, the middle shifting unit often fulfills that function; the collet can then grip the element at the base of one of the two available tool-joints. The jaws of the collets are then provided with bearing rollers. The lower drill pipe of the triple element can then be unscrewed or screwed without any inconvenience in relation to the last tool-joint of the drill pipe string.

To ensure firm and accurate control during these operations, the devices implemented are preferably hydraulically controlled jacks, but it is obviously possible, without going beyond the scope of the invention, to use electric motors or any other equivalent means.

BRIEF DESCRIPTION OF THE PRIOR ART

The invention will be better understood on referring to an embodiment described by way of a non-limiting example, in which:

FIG. **1** shows the location of the shifting units;

FIG. **2** is a sectional view along line AA in FIG. **1** of the upper shifting unit;

FIG. **3** is an elevational view of the middle carriage;

FIG. **4** is a partial sectional view along line BB in FIG. **3** of the middle shifting unit;

FIG. **5** is the complete sectional view of the same shifting unit along line BB in FIG. **3**, and

FIG. **6** is a diagram describing the handling of a triple drill rod element.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** shows the outside contour of the derrick **1** and the center line **2** of the well. From top to bottom, the three shifting units can be distinguished as follows: the upper shifting unit **100** comprises a collet **10** at the end of a horizontal arm **11** supported by a turret **12**, itself mobile on a horizontal carriage **13** which can be driven

in a longitudinal movement in relation to a frame **14** connected to the derrick.

The middle shifting unit **200** comprises a collet **20** mobile along an axis vertical in relation to a cranked arm whose horizontal part **46** is itself driven in a horizontal longitudinal movement in relation to a turret **22.** The turret can turn to the right and to the left through more than 90° in relation to a main carriage **23,** itself radially mobile in relation to the frame **24** connected in a fixed way to the derrick.

The lower shifting device **300** comprises a collet **30** on the end of a horizontal arm **31,** supported, itself, by a turret **32** which can rotate in relation to a frame **34.**

FIG. **2** is a sectional view of FIG. **1** along AA; the collet **10** and the arm **11,** as well as the slide rails **15** of the carriage **13** on the frame **14** can be distinguished therein.

FIG. **3** gives a more accurate idea of the middle shifting unit. The collet **20** holding a triple drill pipe element **25** below the tool-joint can be distinguished therein. The jaws of the collet open and close when a roller **27** moves inside a cam **28** under the action of a jack **29.**

The collet **20** is driven in a vertical movement by a vertical carriage **40** 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 collet **20** and the carriage **40** are driven in motion under the action of the rod **44** of a jack **45.** The arm is a cranked part which comprises a vertical portion **21** which has just been described and a horizontal portion **46.**

A movement of the horizontal portion **46** of the arm in relation to the turret **22** sets the triple element **25** supported by the collet **20** with the vertical portion of the arm **21,** in motion. Such a longitudinal movement is effected by means of the bearing rollers **48** and **49** of the arm in relation to the turret **22,** this movement being guided by the fixed armguide roller **50.** This longitudinal movement is controlled by the jack **51** connected to the arm, whereas its piston **52** rests against a fixed point **53** connected to the turret **22.** Lastly, when it moves to grip the triple drill pipe elements, the movement of the arm is guided by the centering device **47** extended towards the front by two symmetrical flanges **26** and **26'** bearing centering rollers **47'** and **47''** (see FIG. **4**).

The turret **22** can be turned on its pivot **54** by means of two rotation jacks **55** and **55',** the latter alone being shown in FIG. **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:

1. opening and closing of the jaws by means of the jack **29;**

2. lifting and lowering of the collet **20** along the vertical part of the arm by means of the jack **45;**

3. horizontal longitudinal movement of the arm in relation to the turret **22** by means of the jack **51;**

4. rotating of the turret **22** in relation to the horizontal carriage **23** by means of the cylinders **55** and **55';** and

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

The purpose of designing the apparatus to have capability (**3**) as well as capability (**5**) may be explained as follows. Capability (**5**) is needed to bring the collets **10,** 20, and **30** close to a pipe element **25** in the waiting position. This motion typically takes place at high speed. Then, capability (**3**) is needed because the engaging of the pipe element **25** in the collets **10, 20,** and **30** requires a short movement of the collets in the direction of the pipe element at a low speed until the pipe element is gripped by the collets. Once the pipe element has been gripped, the cranked arms can be retracted at a much higher speed than they were extended, and then the turrets can be moved themselves as units. This two-step process is explained in more detail hereinafter.

The upper shifting unit **100** comprises a collet analogous to the collet described above. It can also comprise a centering means analogous to the centering device **47** of the middle shifting unit **200.**

FIG. **4** shows an enlarged view of a cross-section of the vertical carriage along BB, 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 collet and of the vertical longitudinal movement of the vertical carriage in relation to the vertical portion of the arm.

When the middle shifting unit brings the triple drill pipe element towards the transfer carriage taking up the triple element in a vertical position to store it in a horizontal position, the final movement of the shifting unit is guided by a deflector **65** connected with the carriage. The shifting unit then rests against the deflector **65** through the centering rollers **47'** and **47''** mounted on the flanges **26** and **26'** of the centering device **47.**

The flanges of the vertical portion of the arm can be seen at **21,** the sectional view of the collet opening and closing control cam jack at **29,** and the cam for moving the rollers **27** and **27'** at **28** and **28'.** When the two bearing races of the rollers **27** and **27'** move towards each other, the jaws **20** and **20'** pivot about the axis **60** and move away to leave the triple element **25** free. It can, moreover, be seen that the 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 the end of the tube on the tool-joint of the drill pipe string.

Also, in FIG. **4,** a cross-section of the flange of the vertical carriage **40** and the roller **41** of the vertical carriage can be seen. Opposite the centering device **47** and its roller **47',** the deflector **65** of the carriage has been shown, in discontinuous lines, effecting the transfer of the triple element from the vertical position to the horizontal position. The rollers **47'** and **47''** 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 carriage effecting the transfer.

FIG. **5** shows the complete cross-section along view BB. The triple drill pipe **25** held by the jaw **20** is free to rotate due to the rollers such as **61,** rollers **27** enabling the opening of that jaw in the vertical carriage **21,** the turret **22,** the bearing race of the rollers **48, 48', 49, 49'** of the movement for the arm in relation to the turret **22,** can be distinguished. To simplify the drawings, the centering device **47** and the rollers **47'** and **47''** of that centering device have not been shown. On the other hand, the pivot **54** of the turret **22,** as well as the jacks **55** and **55'** controlling the rotation of the turret can be seen. Lastly, the main horizontal carriage **23** and its motor **59** can be discerned.

FIG. 6 is a diagram showing, in a horizontal plane, the various positions taken up by the collet **20** during the handling 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 center line of the well, and the position **75** is the retracted position of the collet. 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.** The lower shifting unit **300** is, indeed, used only in the transfer operation for a casing between the well and a vertical storage point. In that case, it is provided with a collet analogous to the collet of the middle shifting unit described above.

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

1. Lifting of the drill pipe string fixed to a lifting means (which is not an object of this patent).

2. (Simultaneous operation). The two collets of the upper and middle shifting units go from the retracted position **75** to the waiting position **71.**

3. Laying of the triple element on chocks, leaving a residual tension with a view to keeping the triple element in the extended position.

4. The collets 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 engaged in the collet.

5. Closing of the collets (very rapid operation).

6. The collet returns to position **72.** This low-amplitude course is effected by withdrawing the arm in a very short time.

7. Opening of the lifting means; whereby the triple element is no longer guided except by the middle shifting unit.

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 after installing the lower guide arm preventing the tool-joint from shifting immediately after unscrewing.

10. Making the collets **20** come into contact with the tool-joint. The collets of the middle shifting unit effecting the 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;

11. Rotating of the arm from **72** to **73.** This operation is carried out by rotating the turret driven by the jacks **55** and **55'**.

12. Advancing the arms from **73** to **74.** This advancing operation comprises a first part at full power up to the moment when one of the rollers **47'** and **47''** 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 carriage, cancelling the influence of the play and of the deformations produced by the effect of any motion on all the assembled elements.

13. Closing the collets of the carriage around the triple element.

14. Opening the collets of the shifting unit.

15. Withdrawal of the collets from **74** to **73** by sliding the arm.

16. Putting the shifting assembly 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 reverse operations carried out by the shifting units during transporting of the triple drill pipes from their storage to the drilling well can be clearly understood without their having to be described.

While the above describes the preferred embodiment, it should be clear that various modifications can be accomplished within the scope of the present invention and accordingly, the present invention should be determined from the following claims.

What is claimed is:

1. Apparatus for automatically shifting sections of pipe back and forth between operational and storage positions in a derrick which is part of a floating drilling rig, said apparatus comprising at least two shifting units arranged vertically in the derrick, each of said shifting units comprising:

a. a carriage movably mounted for horizontal movement on a frame fixedly connected to the derrick;

b. means for radially moving said carriage;

c. a turret rotatably mounted on said carriage;

d. means comprising at least one rotation jack for rotating said turret on said carriage;

e. an arm movably mounted on said turret, said arm comprising a horizontal part and a vertical part;

f. means comprising a jack for effecting horizontal movement of said arm on said turret;

g. gripping means mounted on the vertical part of said arm; and

h. means comprising a jack mounted on said arm for controlling the opening and closing of said gripping means.

2. Apparatus as claimed in claim **1** wherein said gripping means is movably counted on the vertical part of said arm and further comprising means for effecting vertical movement of said gripping means on the vertical part of said arm.

* * * * *