Title: AN ARRANGEMENT FOR DRILLING AND WORKOVER OF OIL AND GAS WELLS

Abstract: Arrangement for continuous lowering or hoisting of pipes in pressurized or pressureless wells, wherein a snubbing unit (3) continuously may be fed with pipes while the stepwise hoisting or lowering operation is carried out, such that the snubbing unit does not stop for coupling or de-coupling a new pipe length (17).

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— Before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments.

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
AN ARRANGEMENT FOR DRILLING AND WORKOVER OF OIL AND GAS WELLS

The present invention relates to an apparatus for drilling and workover of oil and gas wells, said wells being pressurized or not. The arrangement may be utilized both on floating and fixed drilling and production installations, as well as on land based installations. The arrangement comprises one or two parallel pipe feeding systems so that the machine does not have to be stopped for coupling of a new pipe length, this making it possible to carry out workovers through continuous lowering of pipe lengths. The connection process is carried out during the actual lowering process.

Prior art

Currently used arrangements for work in living wells are arranged with two sets of suspending wedges, the lower set being fixed and the upper set being hoistable and lowerable as compared to the lower set of wedges by means of cylinders.

NO patent publication no. 153 865 discloses a wedge arrangement that can be placed on to a rotary table or some other device. In order to remove the wedges the arrangement has to be lifted up and opened, i.e. taken out from the drilling string.

NO patent publication no. 300 390 discloses a wedge arrangement where the wedge size can be swapped without removing the holding part, i.e. the drilling string or an other pipe may still be left and extend through the holding part during swapping of the wedge size. This is particularly advantageous when using drilling strings where different string elements have different outer diameters.

NO patent publication no. 301 847 discloses a snubbing device comprising hoisting and lowering means for feeding pipes in or out of a oil or gas well, preferably in the form of one lower and one upper wedge arrangement which
both are arranged to grab around the pipe and carry a vertical load, at least one of the wedges being vertically movable and the snubbing device furthermore being arranged to be feed through a rotary table in a drilling deck and suspended in the rotary table. The snubbing arrangement is provided with securing organs that are arranged to fix the snubbing arrangement to the existing structure in order to transmit vertical forces.

All the known arrangements are feed with pipe lengths from a pipe depot to the top of the arrangement by means of cranes, winches or by means of a pipe handler that feeds individual pipes for coupling to the string. The arrangement therefore has to be stopped while the coupling takes place.

**Short description of the invention**

The aim of the present invention is to provide an arrangement that can carry out operations in pressureless or living production wells such that coupled pipe lengths are continuously feed into a snubbing arrangement, the snubbing arrangement either being placed in a rotary table or a universal snubbing frame when a snubbing unit is utilized outside a drilling tower.

The invention furthermore aims at providing an arrangement for transporting pipe lengths inn and out of above arrangement, as well as showing how the snubbing arrangement disclosed in NO patent 301 847 may carry vertical loads arising between a snubbing arrangement and a production tree with safety valves.

**Short description of the drawings**

Figure 1 shows an embodiment in a 3-D perspective of an arrangement according to the present invention, especially how pipe 17a/b is transported into and out of the arrangement in order to carry out a continuous lowering.
Figure 2 shows in greater detail a 3-D perspective describing the individual embodiments.

Figure 3 is a 3-D perspective of the double pipe handling arrangement showing how two independent top driven pipe manipulators 9a/9b brings pipe 17a/b up to a double pipe feeding mast 4 by means of two independent tension adjusted hoisting systems 10a/b.

Figure 4 is a 2-D section showing how the double pipe handling arrangement of figure 3 is arranged.

Figure 5 is a 3-D perspective of a double pipe feeding frame 5 comprising two pipe feeders 7a/b and two pipe feeding magazines 6.

Figure 6 shows how the top driven pipe manipulators 9a/b move from their respective hoisting positions 33/34 and swing to a common drilling center 11.

Figure 7 shows a snubbing unit 3 as disclosed in NO patent 301 847, the snubbing unit being positioned in a rotary table 2 or a universal snubbing frame 8 with an auxiliary arrangement comprising swivels 21/23 and a rotary tong 20 arranged above the unit 30 and a compensatory frame 19 arranged below the unit 3.

Figure 8 shows a sequential drawing with the snubbing unit in a starting position, the snubbing unit 3 hoisting cylinders 24 being in a lower contracted position and the pipe length 17c clamped in the lower wedge arrangement 25/26, while the pipe length 17b takes on the coupling position in the drilling center 11.

Figure 9 shows a sequential drawing with the snubbing unit 3 being operated such that the movable upper arrangement comprising swivels 21/23, wedges 22a/b and rotary tong 20 is lifted to a upper position by means of hoisting cylin-
ders 24. The pipe lengths 17c and 17b are thereby feed automatically to engagement and may be coupled by means of the rotary tong while continuous lowering of the pipes takes place. The coupling is completed before the snubbing unit reaches its lower starting position. Pipe length 17a is lifted to its vertical starting position.

Figure 10 shows a sequential drawing where the pipe length 17b/c is lowered to its lower starting position while pipe length 17a is waiting in its vertical position on a signal to move from the hoisting position 33 to drilling center 11.

Figure 11 shows a sequential drawing where the top driven pipe manipulator 9b is on its way down to get a new pipe length. In the mean time snubbing unit 3 undergoes stepwise hoisting and lowering operations by means of the stationary lower wedge arrangement 25/26 and the upper movable wedge arrangements 22a/b, thereby continuously lowering (or lifting) the sting out of the well without the usual stops for coupling or de-coupling pipe lengths.

Figure 12 shows a sequential drawing where the top driven pipe manipulator 9a has moved the new pipe length 17a from the hoisting position 34 to the drilling center 11. This takes place before the snubbing unit 3 undergoes its last stepwise hoisting/lowering operation of the string 17b/c down into the pressurized or pressureless well. The top driven pipe manipulator 9b is on its way to get a new pipe length.

**Description of an embodiment**

Figure 1 shows an embodiment of an arrangement according to the invention for work in pressurized wells. Figure 1 particularly shows how pipes are transported to and from the arrangement.
The arrangement differs from prior art in that a snubbing unit 3 constructed for being mounted in a drilling tower on a drilling arrangement deck structure 1, the snubbing unit 3 being constructed for work on pressurized or pressureless wells, may be installed outside the drilling tower on the arrangement in a individual universal snubbing frame 8.

The arrangement furthermore differs from the prior art in that the installation of pipe lengths is arranged such that snubbing operations, i.e. the lowering or hoisting of pipes and tools in pressurized or pressureless wells, may be carried out without having to stop, as normal practice today, the hoisting operations in order to carry out coupling or de-coupling of pipe lengths. By using today's known technology with remotely operated pipe handling systems it is possible to run 20-25 pipe lengths per hour. In contrast, the present invention can run 50-60 pipes per hour.

The arrangement furthermore differs from the prior art in that a compensator frame 19 is arranged between the snubbing unit 3 and the production tree for oil/gas. The compensator frame 19 carries the vertical lifting forces arising from the pressurized well by pushing the pipe lengths 17 up though the wedge arrangements 22/25/26, as well as picking up the vertical displacement that arises between a stationary pressurized well arrangement and a moving vessel. The prior art may only be used on fixed platforms or landbased installations where the snubbing unit 3 is rigidly connected to the production tree 27.

The arrangement is constructed so that pipe lengths continuously are feed between a pipe feeding magazine 6 and a snubbing unit 3 in such a way that lowering of pipe lengths may be carried out continuously. In the following description of an embodiment it is described how the arrangement functions when lowering pipes into a pressurized or pressureless oil/gas wells. By reversing the described steps
the arrangement may be used to hoist pipe lengths out of a pressurized or pressureless well.

The arrangement comprises a pipe feeding magazine 6 that is placed on the drilling arrangement deck structure 1. Between the pipe feeding magazine 6 and the universal snubbing frame 8 there is arranged a single or double pipe feeding frame 5 comprising two side mounted pipe feeders 7a/7b with a centrally positioned skid for other equipment to be transported between the deck of the vessel 1 and the snubbing unit 3. The pipe feeders 7a/7b comprise a frame shaped structure with a feeding wagon that is driven along the frame structure by means of hydraulic or electric power. The pipe feeding magazine 6 is arranged with automatic loading and unloading of pipe lengths between the pipe feeding magazine 6 and the pipe feeders 7a/7b.

A snubbing unit 3 is mounted inside a universal snubbing frame 8 that is placed above a production tree on the deck structure 1 of the arrangement. The snubbing unit is landed on a shoulder in a rotary table 2 and is locked onto the production tree 27 by means of a compensator frame 19. The compensator frame comprises an upper and lower steel frame between which are arranged a set of compensator cylinders 28 that connect with a set of accumulators 29. By pressurising the accumulator system a adjustable but constant pressure makes sure that the snubbing unit has the necessary vertical tension independent of how the vessel moves vertically and which pressure conditions exists in the production tree 27. On top of the snubbing unit 3 there is arranged an upper swivel 21 and a lower swivel 23. The upper swivel is mounted to a rotation tong 20 comprising a rotary unit, coupling unit and a pipe coupler. The rotation tong 20 is vertically guided in rail 14. On top of the universal snubbing frame 8 is arranged a double pipe handling mast 4 comprising a double framelike structure with guiding rails for guiding of two top driven pipe manipulators 9A/9B up and down along the double pipe handling mast. The pipe han-
Dangling mast 4 furthermore comprises support bars 16 and access ladders 15. The arrangement may alternatively be equipped with a single mast comprising a pipe manipulator that has to run twice as fast, thereby ensuring that the coupling of pipe lengths may be undertaken while the step-wise lowering is carried out.

The top driven pipe manipulator 9A/9B comprises a revolving pipe claw 13A/13B, a hydraulic or electric revolving motor, circulation pipes 18A/18B, hydraulic fluid swivels, pipe coupling ends as well as a revolving element 12A/12B that moves a hanging pipe length from the hoisting position 33/34 to the drilling centre 11. The top driven pipe manipulators are hoisted up or lowered along the mast 4 by means of a tension adjusted balance winch system 10A/10B.

The starting position of the functional description is while the pipe lengths are positioned in a pipe feeding magazine 6 and where the arrangement is controlled from two control cabins 30/31.

Pipe length 17B is rolled from the pipe feeding magazine 6 to the pipe feeder 7B whereupon the wagon pushes the pipe to a fixed position by the universal snubbing frame 3. The top driven pipe manipulator 9B is positioned in its lower position with the revolving pipe claw 13B in an angle corresponding to the angle of the pipe feeder 7B. The pipe 17B is pushed directly into the pipe claw 13B by means of the pipe feeder 7B. The pipe claw 13B is locked around the pipe length 17B whereupon the pipe length is hoisted in the double pipe handling mast 4 until the pipe reaches its upper starting position 34 ready for revolving into the drilling centre 11.

The starting position of snubbing unit 3 comprises compressed hoisting cylinders 24 in its lower position. The string is locked in the lower wedge arrangement 25/26. The upper wedge arrangement 22A/B with rotation tong 20 is on
its way up to the upper position in order to carry out the last stepwise lowering of the string. The top driven pipe manipulator 9B has now moved the pipe length 17B from the hoisting position 34 to the drilling centre 11. The pipe length 17B is fed into the rotation tong 20 by means of the hoisting cylinders 24 of the snubbing unit. While the upper wedge arrangement 22A/B grabs onto the string and the lower wedge arrangements 25/26 are released from the string at the same time as the string is lowered, pipe length 17B is coupled to the string by means of the rotation tong 20 or the top driven pipe manipulator 9B. The top driven pipe manipulator 9B moves downwards by means of the tension adjusted hoisting system 10B until the first stepwise lowering is completed and the snubbing unit 3 is in its lower position. The top driven pipe manipulator 9B is released from the top of pipe length 17B in its drilling centre position 11 and revolves out to its hoisting position 34 in order to get a new pipe from the pipe feeder 7B. The top driven pipe manipulator 9A has already fetched a pipe length 17A from the pipe feeder 7A and has positioned it in hoisting position 33 ready for revolving to the drilling centre 11.

The snubbing unit 3 takes stepwise holds on the pipe length 17B until it is in its lower position ready for the last upward position in order to carry out the last stepwise lowering of pipe length 17B. The top driven pipe manipulator 9A will now revolve pipe length 17A from hoisting position 33 to drilling centre 11 by means of the rotating element 12A and the sequence is repeated for coupling of pipe length 17A to pipe length 17B while the last stepwise lowering of the pipe is carried out such that a continuous lowering of pipe lengths is undertaken.
Claims

1. Arrangement for continuous lowering or hoisting of pipes in pressurized or pressureless wells, wherein a snubbing unit (3) continuously may be fed with pipes while the stepwise hoisting or lowering operation is carried out, such that the snubbing unit does not stop for coupling or de-coupling a new pipe length (17).

2. Arrangement for continuous lowering or hoisting of pipes in pressurized or pressureless wells, wherein a universal snubbing frame with a snubbing unit (3) is mounted on the deck of the vessel in order to carry out work in wells through production trees (27).

3. Arrangement for continuous lowering or hoisting of pipes in pressurized or pressureless wells, wherein the upper wedge set (22A/B) comprises swivels (21/23) with a rotation tong (20) for drilling in pressurized or pressureless wells.

4. Arrangement for continuous lowering or hoisting of pipes in pressurized or pressureless wells, wherein the upper wedge set (22A/B) comprises swivels (21/23) with rotation tong (20) for continuous coupling of pipe lengths while the stepwise lowering or hoisting of pipe lengths (17) is carried out.

5. Arrangement for continuous lowering or hoisting of pipes in pressurized or pressureless wells, wherein the top of the universal snubbing frame (8) comprises a single or double pipe handling mast (4) with guid-
ing rails for one or more pipe handling manipulators (9A/B).

6. Arrangement for continuous lowering or hoisting of pipes in pressurized or pressureless wells, wherein the pipe manipulators (9A/B) comprises revolving elements (12A/B) for alternating sideways movement of pipe lengths (17A/B) from hoisting position (33/34) to drilling centre 11.

7. Arrangement for continuous lowering or hoisting of pipes in pressurized or pressureless wells, wherein the pipe manipulators (9A/B) comprise a revolving pipe claw (13A/B) for coupling pipe length (17A/B) to the pipe manipulator (9A/B).

8. Arrangement for continuous lowering or hoisting of pipes in pressurized or pressureless wells, wherein the pipe manipulators (9A/B) comprise a hydraulic or electric rotary motor for coupling of pipe lengths (12A/B).

9. Arrangement for continuous lowering or hoisting of pipes in pressurized or pressureless wells, wherein the pipe manipulators (9A/B) comprise circulation pipes and liquid swivels (18A/B), thereby pumping liquids under pressure through the pipe manipulators (9A/B).

10. Arrangement for continuous lowering or hoisting of pipes in pressurized or pressureless wells, wherein a compensator frame (19) is arranged between the
lower wedge set (25/26) on the snubbing unit (3) and the production tree (27).

11. Arrangement for continuous lowering or hoisting of pipes in pressurized or pressureless wells, wherein the pipe manipulators (9A/B) comprise a locking device between the liquid swivel (18A/B) and the pipe connection for thereby coupling a pipe length to the pipe manipulator pipe connection for circulation of liquid down through the string.

12. Arrangement for continuous lowering or hoisting of pipes in pressurized or pressureless wells, wherein the compensator frame (19) comprises compensator cylinders and accumulators (29) such that snubbing can be carried out from moving vessels (1), with a constant but adjustable tension between the snubbing unit (3) and the stationary production tree (27).
A. CLASSIFICATION OF SUBJECT MATTER

IPC7: E21B 19/08
According to International Patent Classification (IPC) or to both national classification and IPC.

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPDOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents
  - "A" document defining the general state of the art which is not considered to be of particular relevance
  - "E" earlier application or patent but published on or after the international filing date
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"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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Date of mailing of the international search report: 23-03-2001

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Form PCT/ISA/210 (second sheet) (July 1998)
**INTERNATIONAL SEARCH REPORT**

**Box I**  
Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

**Box II**  
Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

The claims are formulated as twelve separate independent claims, defining twelve independent inventions. It is assumed that this is not applicant’s intention and it is also assumed that the claims could be reformulated to comprise one independent claim and a number of dependent claims relating to this independent claim. Therefore, it is not considered meaningful to analyse the independent inventions in detail, stating which technical features are the same or corresponding special technical features.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☒ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:  

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:  

**Remark on Protest**  
☐ The additional search fees were accompanied by the applicant’s protest.  
☐ No protest accompanied the payment of additional search fees.
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