Title of the Invention: **Orientation pin actuation assembly**
Abstract Title: **Orientation pin actuation assembly**

A retractable orientation pin actuation assembly (10) of a blowout preventer (5) of a subsea well assembly. The orientation pin being retractable using a primary actuation piston rod (21) connected to a primary actuation piston (19) in a primary hydraulic chamber (23). The orientation pin also being connected to a secondary actuation piston rod (29) connected to a secondary actuation piston (25) in a secondary hydraulic chamber (27) which is offset form the primary actuation piston rod. Multiple secondary actuators may be included and the range of motion of the primary and secondary actuators may overlap. The primary and secondary actuators may also be run on separate and independent hydraulic circuits.
Orientation pin actuation assembly
The present invention relates to an orientation pin actuation assembly, used for moving an orientation pin into and out of engagement with an orientation sleeve. In particular, the assembly is adapted for attachment to a blowout preventer, used during installation or retrieval of a tubing hanger.

Background
Within the field of subsea wells, such as a hydrocarbon production or an injection well, it is known to land a tubing hanger at the top of the well. A tubing extends into the well from the tubing hanger. When landing and locking the tubing hanger, the operator needs to ensure that the tubing hanger has the correct orientation. That is, it needs to be rotated into one specific, predetermined position. Such correct orientation makes it possible to connect lines to the tubing hanger, such as hydraulic, electric or optic lines. Such lines can typically communicate with downhole sensors, or a downhole pump or valve.

To ensure such correct orientation, an orientation joint is used as a part of the landing string when lowering the tubing hanger. The orientation joint is provided with a helix shoulder engaging an orientation pin. The orientation pin is adapted to be extended into the bore of a blowout preventer (BOP) when engaging the helix shoulder.

Publication US2011278013 describes such a solution. In this solution, the orientation pin engages the helix shoulder when the orientation joint moves downwards. This engagement rotates the landing string, and thereby ensures proper orientation.

The operator must be able to extend the orientation pin into and out of the BOP bore. I.e. he needs to retract the orientation pin from the bore so that it does not interfere for instance with the tubing hanger being lowered. When the orientation joint is in the correct position within the BOP bore, the operator extends the orientation pin for engagement. The present invention relates to an orientation pin actuation assembly for such retraction and extension of the orientation pin.
Such an assembly needs to have a primary and a secondary movement means, the secondary being a backup for the primary means.

An object of the present invention is to provide such an assembly which is reliable. Another object is to provide an assembly which is relatively small.

The invention
According to the present invention, there is provided an orientation pin actuation assembly of the type intended for connection to a blowout preventer of a subsea well assembly. The orientation pin assembly has a primary actuation piston rod which is connected to a primary actuation piston in a primary hydraulic chamber. A secondary actuation piston rod is connected to a secondary actuation piston in a secondary hydraulic chamber. Moreover, the primary actuation piston rod and the secondary actuation piston rod are mechanically connected to each other and to an actuation pin. According to the invention, the axial center axis of the secondary actuation piston rod is offset from the axial center axis of the primary actuation piston rod.

When in use, the actuation pin will be connected to the orientation pin, or alternatively, be the orientation pin itself.

The primary and secondary actuation piston rods being connected to the actuation pin may regard a direct connection of the piston rods to the actuation pin, or an indirect connection. For instance, the primary actuation piston rod can advantageously be connected directly to the actuation pin, while the secondary actuation piston rod may be connected to the actuation pin via the primary actuation piston rod. The primary and secondary actuation piston rods, as well as the orientation pin, do all move simultaneously.

Offsetting the axial center axes of the primary and secondary actuation piston rods, respectively, makes it possible to reduce the overall axial extension of the orientation pin actuation assembly.
In an embodiment of the assembly according to the invention, the axial extension
of the secondary actuation piston rod can overlap with the axial extension of the
primary actuation piston rod. Alternatively, or in addition, the axial extension of
the secondary hydraulic chamber may overlap with the axial extension of the
primary hydraulic chamber.

In a preferred embodiment, the assembly comprises two secondary actuation
piston rods and two secondary hydraulic chambers. Furthermore, in such an
embodiment, two secondary actuation piston rods can be arranged on opposite
sides of the primary actuation piston rod. Advantageously, the two secondary
piston rods are also arranged symmetrically about the primary piston rod. Such a
distribution of the piston rods will ensure an advantageous force distribution in
the assembly.

The primary and secondary hydraulic chambers can advantageously be in a
common main body and the primary and secondary actuation piston rods can be
connected to a connection body which is separate from the main body. One can
also imagine other embodiments, however, where instead of one main body, the
hydraulic chambers may be accommodated in separate bodies which are
connected together in a fixed fashion (not mutually movable).

The primary hydraulic chamber is advantageously in fluid communication with a
primary hydraulic fluid source with at least two hydraulic lines, namely one line for
extending the orientation pin, and another for retracting it. Moreover, the second-
dary hydraulic chamber is in fluid communication with a secondary hydraulic fluid
source with at least two hydraulic fluid lines. In such an embodiment, the primary
hydraulic fluid source can preferably be separate and independent from the
secondary hydraulic fluid source.

Furthermore, an interlocking valve can be arranged in at least one of said
hydraulic lines. In this manner, the operator will be able to hydraulically lock the
hydraulic piston arranged in the chamber to which the hydraulic line
communicates. Thereby, he may lock the entire assembly, preventing it from
moving the orientation pin inadvertently.
Example of embodiment
While various features of the present invention have been presented in general terms above, a more detailed and non-limiting example of embodiment is given in the following with reference to the accompanying figures, in which

Fig. 1 is a perspective, cross section view through a portion of a BOP having an orientation joint at the position of the orientation pin;
Fig. 2 is a perspective view of an orientation pin actuation assembly according to the present invention;
Fig. 3 is a perspective cross section view through the orientation pin actuation assembly shown in Fig. 2;
Fig. 4 is a cross section top view through the assembly shown in Fig. 2, depicted in a retracted mode;
Fig. 5 is a cross section top view corresponding to Fig. 4, however showing the assembly in an extended mode; and
Fig. 6 is a schematic view of two hydraulic fluid sources.

Fig. 1 illustrates an orientation pin 1 extending through a wall 3 of a blowout preventer (BOP) 5. Within the bore of the BOP 5 there is an orientation joint 7 having a helix shoulder 9. With the orientation pin 1 extended into the BOP bore, the helix shoulder 9 will engage the orientation pin 1 when the orientation joint 7 is elevated. This engagement makes the orientation joint 7 rotate until the orientation pin 1 enters an axially extending guide slot 11 in the orientation joint 7. With the orientation pin 1 engaged in the guide slot 11, the orientation joint 7 is lowered. A tubing hanger (not shown) is arranged below the orientation joint 7, and is landed and locked with the correct orientation. The orientation pin is then retracted out from the BOP bore, and the orientation joint 7 is pulled up, while the tubing hanger remains locked in its position.

The extension and retraction of the orientation pin is accomplished by actuating an orientation pin actuation assembly 10 which connects to the orientation pin 1. The orientation pin actuation assembly 10 is attached to the BOP 5.
Fig. 2 to Fig. 4 depict an embodiment of an orientation pin actuation assembly 10 according to the invention. Fig. 2, Fig. 3 and Fig. 4 show the orientation pin actuation assembly 10 in an retracted mode, while the cross section view of Fig. 5 shows it in an extended mode.

The orientation pin actuation assembly 10 has a main body 13. At an end portion of the main body 13 there is a flange 15 for connection to the BOP 5. Extending in an axial direction beyond the flange 15 is an actuation pin 17. The actuation pin 17 is adapted to be connected to the orientation pin 1 (cf. Fig. 1) when the orientation pin actuation assembly 10 is installed on the BOP 5. Hence, the actuation pin 17 can be moved axially back and forth.

As visible in Fig. 3, Fig. 4 and Fig. 5, the actuation pin 17 is part of a component that includes a primary actuation piston 19 and a primary piston rod 21. The actuation pin 17, primary piston 19, and the primary piston rod 21, could alternatively be separate parts connected together. The primary piston 19 is arranged in a primary hydraulic chamber 23 within the main body 13. By supplying hydraulic fluid at respective sides of the primary piston 19, the operator may move the actuation pin 17 in both axial directions. That way, he may move the orientation pin 1 when connected to the actuation pin 17.

If, for some reason, the operator is not able to move the orientation pin 1, the consequences may be severe. For instance, if he cannot orient the tubing hanger correctly, he will not be able to connect to various types of lines extending into the well, as discussed above. Moreover, if he is not able to retract the orientation pin 1, it will collide with the tubing hanger and possibly other equipment when pulling it.

Thus, to ensure that the operator will be able to move the orientation pin also if the primary function, i.e. the primary actuation piston 19, should fail, there is arranged two secondary actuation pistons 25. In alternative embodiments, one could have only one secondary piston, or more than two, for instance three or four.
The secondary pistons 25 are arranged in secondary hydraulic chambers 27. In this embodiment, the secondary pistons 25 are integrated in the same component as secondary actuation piston rods 29. The secondary piston rod 29 connected to the secondary piston 25 extends axially on both sides of the piston. The secondary piston rods 29 may extend out from the main body 13 at opposite sides of the main body 13, as shown in Fig. 4 and Fig. 5.

The primary piston rod 21 and the two secondary piston rods 29 are retained with retaining members 31 that are bolted to the main body 13.

All the piston rods, i.e. the primary piston rod 21 and the two secondary piston rods 29, protrude out of the main body 13 opposite of the position of the flange 15 with their rearwards ends. Moreover, they all connect to a connection body 33. Since all the piston rods, 21, 29 are connected to the connection body 33, they are not able to move independently.

Under normal operation, the operator will only apply hydraulic pressure to the primary hydraulic chamber 23, either to extend the orientation pin 1 or to retract it. However, should he not be able to move the orientation pin 1, he may apply hydraulic pressure in the two secondary hydraulic chambers 27.

Reasons for the primary moving means (primary piston and piston rod) not to move may for instance be that the hydraulic supply is damaged. Or, the orientation pin 1 may be stuck for some reason.

In order to apply a large retracting force on the orientation pin 1, the operator may provide hydraulic pressure to all three hydraulic chambers 23, 27 simultaneously.

Referring again to Fig. 2, on the main body 13 are six hydraulic ports 35. Each of the three hydraulic chambers 23, 27 communicate with two hydraulic ports 35, on respective sides of the hydraulic piston 19, 25. Thus, all piston rods 21, 29 and pistons 19, 25 can be actuated in both axial direction by application of hydraulic pressure to the correct hydraulic ports 35.
As shown in Fig. 2 to Fig. 5, the two secondary hydraulic chambers 27 are arranged symmetrically about the primary hydraulic chamber 23. This also applies to the secondary pistons 25 as well as the secondary piston rods 29. By such symmetrical distribution of the piston rods 21, 29, one will substantially avoid forces on the pistons and piston rods that are directed transverse to the axial direction of the piston rods or the hydraulic chambers.

Fig. 6 schematically illustrates the hydraulic fluid supply to the primary and secondary hydraulic chambers 23, 27. Notably, in this embodiment, the primary hydraulic chamber 23 is connected to a primary hydraulic fluid source 37, while the two secondary hydraulic chambers 27 are connected to a secondary hydraulic fluid source 39. The primary hydraulic fluid source 37 is separate and independent from the secondary hydraulic fluid source 39.

The primary hydraulic fluid source 37 can typically comprise hydraulic supply lines extending to surface operated BOP control modules (not shown), making the operator able to remotely operate the orientation pin actuation assembly 10.

The secondary hydraulic fluid source 39 can be for instance an ROV interface for receiving hydraulic fluid from an ROV (remotely operated vehicle). However other sources can also be used, as will be appreciated by the person skilled in the art.

From each of the primary and secondary hydraulic fluid sources 37, 39 there are two hydraulic lines 41 extending to the orientation pin actuation assembly 10. In this shown embodiment, in one of the hydraulic lines 41 extending from the secondary hydraulic fluid source 39, there is arranged an interlocking valve 43. When moving actuation pin 17, and hence all the piston rods 21, 29, the interlocking valve 43 will be in an open position, so that hydraulic fluid may enter or exit the secondary hydraulic chambers 27. When the orientation pin 1, and thus the actuation pin 17 has been moved into the desired position, the interlocking valve 43 is closed, so that the secondary pistons 25 are retained from moving. The secondary pistons 25 will be hydraulically locked. Thus, if hydraulic pressure is inadvertently applied to the primary hydraulic chamber 23,
the connection body 33, being connected to all the piston rods 21, 29, will prevent the actuation pin 17 from moving.

Advantageously, the interlocking valve 43 may be operated with an ROV, or remotely operated from the surface installation. In similar embodiments, one may include such an interlocking valve also in the hydraulic lines 41 extending from the primary hydraulic fluid source 37, either in one or both of the hydraulic lines 41.
Claims

1. An orientation pin actuation assembly (10) of the type intended for connection to a blowout preventer (5) of a subsea well assembly, the orientation pin assembly (10) comprising

   - a primary actuation piston rod (21) connected to a primary actuation piston (19)
     in a primary hydraulic chamber (23);
   - a secondary actuation piston rod (29) connected to a secondary actuation
     piston (25) in a secondary hydraulic chamber (27);

wherein the primary actuation piston rod (21) and the secondary actuation piston rod (29) are mechanically connected to each other and to an actuation pin (17), characterized in that the axial center axis of the secondary actuation piston rod (29) is offset from the axial center axis of the primary actuation piston rod (21).

2. The orientation pin actuation assembly (10) according to claim 1, characterized in that the axial extension of the secondary actuation piston rod (29) overlaps with the axial extension of the primary actuation piston rod (21).

3. The orientation pin actuation assembly (10) according to claim 1 or claim 2, characterized in that the axial extension of the secondary hydraulic chamber (27) overlaps with the axial extension of the primary hydraulic chamber (23).

4. The orientation pin actuation assembly (10) according to one of the preceding claims, characterized in that it comprises two secondary actuation piston rods (29) and two secondary hydraulic chambers (27).

5. The orientation pin actuation assembly (10) according to claim 4, characterized in that the two secondary actuation piston rods (29) are arranged on opposite sides of the primary actuation piston rod (21).

6. The orientation pin actuation assembly (10) according to one of the preceding claims, characterized in that the primary and secondary hydraulic chambers (23, 27) are in a common main body (13) and that the primary and secondary actuation piston rods (21, 29) are connected to a connection body (33) which is separate from the main body (13).
7. The orientation pin actuation assembly (10) according to one of the preceding claims, characterized in that the primary hydraulic chamber (23) is in fluid communication with a primary hydraulic fluid source (37) with at least two hydraulic lines (41), the secondary hydraulic chamber (27) is in fluid communication with a secondary hydraulic fluid source (39) with at least two hydraulic fluid lines (41), and that the primary hydraulic fluid source (37) is separate and independent from the secondary hydraulic fluid source (39).

8. The orientation pin actuation assembly (10) according to claim 7, characterized in that an interlocking valve (43) is arranged in at least one of said hydraulic lines (41).
Amendment to the claims have been filed as follows

**Amended Claims**

1. An orientation pin actuation assembly (10) of the type intended for connection to a blowout preventer (5) of a subsea well assembly, the orientation pin assembly (10) comprising
   - a primary actuation piston rod (21) connected to a primary actuation piston (19) in a primary hydraulic chamber (23);
   - a secondary actuation piston rod (29) connected to a secondary actuation piston (25) in a secondary hydraulic chamber (27);

   wherein the primary actuation piston rod (21) and the secondary actuation piston rod (29) are mechanically connected to each other and to an actuation pin (17), and wherein the primary actuation piston rod (21) constitutes a primary function for actuating the actuation pin (17), while the secondary piston rod (29) constitutes a redundant, secondary function for actuation the actuation pin,

   **characterized in** that the axial center axis of the secondary actuation piston rod (29) is offset from the axial center axis of the primary actuation piston rod (21).

2. An orientation pin actuation assembly (10) according to claim 1, **characterized in** that the primary hydraulic chamber (23) connects to a primary hydraulic fluid source (37) and that the secondary hydraulic chamber (27) connects to another, secondary hydraulic fluid source (39).

3. The orientation pin actuation assembly (10) according to claim 1 or 2, **characterized in** that the axial extension of the secondary actuation piston rod (29) overlaps with the axial extension of the primary actuation piston rod (21).

4. The orientation pin actuation assembly (10) according to claim 1, 2 or 3, **characterized in** that the axial extension of the secondary hydraulic chamber (27) overlaps with the axial extension of the primary hydraulic chamber (23).

5. The orientation pin actuation assembly (10) according to one of the preceding claims, **characterized in** that it comprises two secondary actuation piston rods (29) and two secondary hydraulic chambers (27).
6. The orientation pin actuation assembly (10) according to claim 5 characterized in that the two secondary actuation piston rods (29) are arranged on opposite sides of the primary actuation piston rod (21).

7. The orientation pin actuation assembly (10) according to one of the preceding claims, characterized in that the primary and secondary hydraulic chambers (23, 27) are in a common main body (13) and that the primary and secondary actuation piston rods (21, 29) are connected to a connection body (33) which is separate from the main body (13).

8. The orientation pin actuation assembly (10) according to one of the preceding claims, characterized in that the primary hydraulic chamber (23) is in fluid communication with a primary hydraulic fluid source (37) with at least two hydraulic lines (41), the secondary hydraulic chamber (27) is in fluid communication with a secondary hydraulic fluid source (39) with at least two hydraulic fluid lines (41), and that the primary hydraulic fluid source (37) is separate and independent from the secondary hydraulic fluid source (39).

9. The orientation pin actuation assembly (10) according to claim 8 characterized in that an interlocking valve (43) is arranged in at least one of said hydraulic lines (41).
Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

<table>
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<tr>
<th>Category</th>
<th>Relevant to claims</th>
<th>Identity of document and passage or figure of particular relevance</th>
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<tr>
<td>Y</td>
<td>1-8</td>
<td>EP1519003 A1 (HOPPER) Hydraulic retractable orientation pin for a blowout preventer, see Figures 1 and 2B and paragraphs 26 and 27.</td>
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<tr>
<td>Y</td>
<td>1-8</td>
<td>US7770650 B2 (YOUNG) Shows a hydraulically actuated retractable orientation pin, see Figures and paragraphs 22 and 23.</td>
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<td>Y</td>
<td>1-8</td>
<td>CN201250639 Y (ZHANWEI) A blowout preventer ram with secondary offset hydraulic pistons.</td>
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<td>Y</td>
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<td>US2011/0012311 A1 (MCCLANAHAN) A seal ring actuated by 3 hydraulic pistons, see Figures.</td>
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<td>GB2475986 A (WHITBY) Actuation of a blowout preventer ram with two hydraulic pistons, see Figures.</td>
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<td>A</td>
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<td>US9303465 B2 (PARE) A mule shoe assembly with a spring biased engaging pin, see Figure 2.</td>
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<td>A</td>
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<td>US8720578 B2 (ALLENSWORTH) A telescoping mule shoe assembly with an orientation pin, see paragraph 14 and Figure 2B.</td>
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<td>US5975210 A1 (WILKINS) A mule shoe assembly with a fixed orientation pin, see Figure 1.</td>
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Categories:

- X Document indicating lack of novelty or inventive step
- Y Document indicating lack of inventive step if combined with one or more other documents of same category
- & Member of the same patent family
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- E Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:
Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^: 
Worldwide search of patent documents classified in the following areas of the IPC  
E21B

The following online and other databases have been used in the preparation of this search report  
EPODOC, WPI

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