

TENSION LOCK MULTIBOWL WELLHEAD

The present invention relates to a device for ensuring simply and accurately the tensioning of a cylindrical body, such as a rod or a casing, which can elongate elastically when it is made to undergo a 5 tensile force. Although the use described below relates essentially to the tensioning of a casing for an oil well, the invention can be used for tensioning and maintaining this tension in any body capable of undergoing elastic elongation.

The suspension of the casings on the wellhead in an oil-well 10 installation is usually obtained by means of a wedge mechanism which, bearing on an inner conical surface of the wellhead, highly compresses the outside of the casing in order to obtain the suspension of the latter. In most cases, in order to install this wedge mechanism, it is necessary to remove the blow-out preventer 15 block and use a wellhead with stacked receptacles, each of them being associated with each casing, in such a way as to make it easier to cut the casing above the wedge mechanism. After the casing has been cut and chamfered, a sealing element is slipped between the bore in the receptacle of the wellhead and the casing 20 in order to isolate the annular space present between the casing and the wellhead.

The development of underwater wellheads has given rise to integral wellheads possessing a suspension collar for the casing. In this case, the casing is connected by screwing to a collar which has a 25 substantially radial bearing shoulder, thus avoiding the need to use a wedge mechanism and eliminating the annular compression stresses generated in the casing by this wedge mechanism. An annular sealing element can then be installed remotely between the suspension collar. This arrangement makes it possible to avoid 30 disconnecting the blow-out preventer, and the latter can then ensure the protection of the operations of suspension, cementing and sealing the casing. Because the casing does not have to be

cut, receptacles for each casing dimension can be connected in one piece to form an integral wellhead.

This arrangement with a suspension collar and an integral wellhead is not suitable when tension must be introduced into the casing after cementation. It is then necessary to return to the mechanism with locking wedges.

According to the invention there is provided a device for adjusting the position of a cylindrical body in relation to a stationary support as set out in Claim 1.

10 The present invention is thus intended to avoid the need to resort to the wedge mechanism, by providing a suspension device capable of adjustment of locking of the tension introduced into the cylindrical body. This device greatly reduces the circular compression stresses in the cylindrical body and avoids the need to cut the latter.

15 With the above angular relationships, the resultants of the forces to which the intermediate element is subjected may have a radial component directed outward when the cylindrical body is actuated axially in the direction of its elongation, and directed towards the axis when the cylindrical body is subjected to the installed axial
20 tension prestressing force.

In a preferred embodiment, the angle of each face of the inner grooving is equal to 45 degrees, while the angle of the first

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conical bearing surface is equal to 70 degrees and the angle of the second conical bearing surface is equal to 30 degrees.

In the preferred version of this invention, the intermediate element is an elastic split ring of which the mean diameter of the inner grooving corresponds to the mean diameter of the outer grooving of the cylindrical body. In this case, the depth of the above mentioned grooves is of the order of the possible elastic increase in the radius of the split ring. In an alternate embodiment, the intermediate element comprises a plurality of dogs and corresponding elastic restoring members.

An important use of the device according to the invention involves the use of a suspension head for the tensioning of an oil-well casing, possessing a stack of suspension collars. Thus, the wellhead forms the said outer support, and the cylindrical body is formed by the stack of the suspension collars of the casing which are grooved on the outside and the last of which has an upper flange. The split ring is retained under the upper flange by means of a fastening breakable under the effect of a specific force. The ring is located opposite an annular receptacle made on the said collar so as to be capable of contracting during its introduction into the part of the bore of the wellhead located above the receptacle made in the wellhead.

Advantageously, the annular receptacle made in the upper suspension collar is divided by means of an inner circular partition perpendicular to the axis of the casing. The partition, together with a lower edge of the receptacle, each have a cylindrical bearing surface of a diameter equal to that measured at the bottom of the grooves, where those made in the suspension collar are concerned, and to that measured at the top of the grooves, where those carried by the split ring when the latter is in its position of rest are concerned.

A suspension head embodying the invention also possesses a second annular receptacle made on a lower suspension collar. In the event that the casing is raised, the split ring can once again contract radially and thus come away from the receptacle of the wellhead and
 5 rise together with the casing in the bore of the wellhead.

Finally, the split ring has a double pair of inverted conical supports. The receptacle of the ring in the wellhead likewise has a corresponding double pair of supports. That part of the bore of the wellhead located above this receptacle has grooves for the
 10 installation of a metal sealing joint above the split ring.

A device embodying the invention is hereinafter described, by way of example, with reference to the accompanying drawings.

Figures 1A and 1B are diagrams illustrating essential elements of the invention;

15 Figures 2 to 6 illustrate, in views in axial section, the different sequences for installing the device according to the invention used for an oil wellhead;

Figure 7 illustrates, in a view in axial section, on the left a wellhead supporting a casing during the cementation of the
 20 latter and on the right a wellhead supporting the casing tensioned after cementation and equipped with a sealing joint.

Referring to the drawings, Figures 1A and 1B show, in an axial half-section, a cylindrical body 1 of longitudinal axis 1a accommodated in a bore 2a of a stationary support 2 coaxial
 25 relative to the body 1 and retained in this support by means of an intermediate piece or element 3.

The cylindrical body 1 has peripheral grooves 5, each of which has a conical upper flank 6a and a conical lower flank 6b, and therefore are of triangular profile. Each flank 6a, 6b is located
 30 at an angle 7a, 7b, respectively, of 45 degrees relative to long-

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itudinal axis 1a.

Support 2 is equipped with an annular receptacle 8, delimited by a downward facing conical upper surface 9 and an upward facing conical lower surface 10. The angle 4a of the downward-facing surface 9 is 70 degrees, and the angle 4b of the upward-facing surface 10 is 30 degrees, measured relative to longitudinal axis 1a.

The intermediate element 3 is delimited by an inner cylindrical surface having grooves 11, forming a grooving capable of interacting with the grooves 5 of the body 1. Intermediate element 3 has an outer surface 12 comprising two conical bearing surfaces 13 and 14, the profile of which is identical to the profile of the receptacle 8.

The radial thickness of the intermediate element 3 and the depth of the receptacle 8 are such that, when the element 3 is shifted radially inside the receptacle 8, the grooving 11 is no longer in engagement with the grooves 5 of the piece 1. Furthermore, these dimensions are such that, when the grooves 11 are in engagement with the grooves 5, the piece 3 cannot escape from the receptacle 8 axially.

The intermediate piece 3 can comprise a split ring arranged in the receptacle 8 with a radial play allowing an increase in its outer radius corresponding to the depth of the grooves 5, 11. The mean diameter of the grooves 11 of the ring is, in the free state, equal to the mean diameter of the grooves 5 of the body 1. It will therefore be appreciated that the variations in diameter of the ring 3 occur counter to its elasticity which tends to return to its position of rest.

As an alternative to a split ring, the body 3 can comprise a plurality of radial dogs (not shown) arranged in receptacles

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likewise distributed in the same plane of the support and subjected to the action of radial elastic members for the restoring of the dogs to their position of rest corresponding to the coincidence of the mean diameter of their grooving with that of the grooving of the cylindrical body 1. It will be seen, in this respect, that in the alternative embodiment of the intermediate piece 3 in the form of dogs, the body 1 can be of polygonal cross-section, the grooved inner surface of each of the dogs being substantially plane and corresponding to the sides of the polygon of the cross-section of the body 1.

Returning to Figures 1A and 1B, it can be seen that, when a pull is exerted axially on the central body 1 in the direction A, the support 2 being assumed to be stationary, a set of forces is generated on the piece 3 designated by the arrow F1. The direction of this force is between the direction A and the perpendicular to the face 6b of the grooves 5 of the central body 1, somewhat in the vicinity of this perpendicular, because of the friction existing between the central body 1 and intermediate piece 3 (of the order of 0.1 for lubricated metal surfaces).

The reaction of the support 2 on the piece 3 results in a set of forces symbolized at F2, the direction of which is between the perpendicular to the surfaces 9, 13, and the axial direction, and somewhat nearer to this perpendicular because of the friction between these surfaces. The force F1 is directed upwards, while the force F2 is directed downwards. Because of the values of the slopes of the faces 6b and 9, 13, and a coefficient of friction assumed to be equal to 0.1 on each of the contacting surfaces (corresponding to a difference in the forces F1 and F2 in relation to the perpendiculars to the faces on which they are exerted of the order of $5\frac{1}{2}$ degrees), the direction of the forces F1 and F2 form an angle of approximately 14 to 15 degrees between them. Moreover, since it is the force F1 which is the most inclined relative to the axial direction, the resultant of these forces is a radial force R1

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directed opposite to the axis 1a. The element 3 is therefore subjected to a force which tends to open it, where a split ring is concerned, or to cause it to penetrate inside its receptacle against the restoring member, where a dog is concerned. The element 3 can therefore move aside in order to allow the central body 1 to rise.

Conversely, as shown in Figure 1B, if the element 1 is subjected to a force B directed downwards, corresponding to the installed tension in this element or to its weight, the piece 3 undergoes forces represented by F3, F4. The force F3 is directed downwards and outwards and is inclined at approximately 40 degrees relative to the axis 1a (in view of the numerical values of the angles of the coefficients of friction mentioned above). The F4 force is a force directed inwards and upwards and is inclined at an angle of approximately 65 degrees relative to the axis 1a, for the same reasons regarding numerical values. The outcome of this is that the resultant R2 of these forces is horizontal and directed towards the axis 1a, therefore tending to grip the body 1 and thus preventing the latter from descending.

It will be seen that the intensity of the said horizontal resultants R1 directed outwards or R2 directed towards the axis is relatively low, especially with regard to that R2 directed towards the axis (as shown in Figure 1B), although added to this is the elastic reaction of the ring or of the restoring member for the dog 3. The circular compression stress generated as a result of R2 is therefore reduced.

The numerical values given in the above example constitute a preferred embodiment of the invention, but the latter can encompass other values which will depend, in particular, on the coefficients of friction or of slip and therefore on the materials in contact, as well as on the mechanical characteristics required for the coupling. It will be seen, for example, that the number of

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successive axially adjacent grooves and the number of receptacles in the support will be a function of the forces to be absorbed and of the characteristics of shearing resistance of the materials used.

5 Figures 2 to 7 illustrate a use of the device according to the invention, described diagrammatically in Figures 1A and 1B, for the suspension of a casing in an oil wellhead. The casing 21 is equipped in a known way with a stack of suspension collars 22a, 22b, 22c, 22d screwed into one another and equipped on the outside
10 with grooves 5, as described with reference to the preceding Figures. The tool 23 for installing the casing is fixed to the upper suspension collar 22d for installing the casing in the bore 24a of the wellhead 24. The upper collar 22d for installing the suspension has a receptacle 25 divided into two parts 25a, 25b by
15 means of an annular partition 26. It also has, above this receptacle 25, a flange 27 equipped with substantially radially slotted orifices 27a, through which is fastened a shearing screw 28 capable of being broken beyond a specific tensile force. The screw 28 is screwed into a split ring 29, the inner surface of which has
20 grooves 11. The ring 29 has a receptacle 30 for the partition 26. The ring 29 has an outer surface of which has two inverted conical bearing surfaces 13a, 14a and 13b, 14b for interacting with conical bearing surfaces 9a, 10a and 9b 10b of an annular receptacle made in the wellhead 24.

25 In Figure 2, the ring 29 is illustrated contracted into the receptacle 25 of the suspension collar 22d as a result of the containing effect of the walls of the bore 24a. The casing 21 is shown being lowered inside the wellhead 24. When the ring 29 comes opposite the receptacle defined by the conical surfaces 9a, 9b;
30 10a, 10b of the wellhead 24, it seats itself partially in this receptacle under the effect of its own elasticity. The ring 29 reaches its "free state" position and is maintained centered on the axis of the assembly by means of an inner bearing surface 27b of

the flange 27, which interacts with an upper cylindrical part of the ring (as shown in Figure 3).

Figure 4 illustrates the phase in which a pull is exerted on the upper collar 22d by means of the tool 23 in the direction A in order to shear the screws 28. Since the end of the partition 26 and the lower end of the receptacle 25 have a cylindrical bearing surface 31a, 31b, the diameter of which is equal to the diameter at the top of the grooves 11 of the ring 29 in its position of rest, the positioning of the bearing surfaces 31a and 31b in front of the grooves 11 prevents the ring 29 from contracting once again as a result of the cam effect which the conical bearing surfaces 9a and 9b could exert on it.

If the upward pull exerted on the casing is continued, forces of the type described with reference to Figure 1A are generated, thus allowing the casing to rise along the ring 29, the screw 28 having been severed beyond a specific tensile force. This sequence is illustrated in Figures 5 and 6, Figure 5 showing the position of the ring 29 when the tops of the grooves 5, 11 are opposite one another. Figure 6 shows the position of the ring 29 when the latter is in its position of rest, that is to say interpenetrating the grooves 5 of the suspension collars 22. The inner grooves 11 on ring 29 ratchet past the grooves 5 on suspension collar 22c. This operation is continued until the entire axial length of the ring 29 has been placed opposite the grooves 5 of the stack of suspension collars.

In the left-hand part of Figure 7, the casing is shown in its position in which cementation begins. The casing is suspended by means of the ring 29 which retains it against the effect of gravity, as explained with reference to Figure 1B.

If it is necessary to raise the casing in the wellhead at this stage for any reason, a pull is exerted on the casing according to

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arrow C, so that the ring 29 comes opposite a lower receptacle 34 made in or under the lower suspension collar 22a. A continuation of the pull on the casing in the direction C causes a contraction of the ring 29 into the receptacle 34 as a result of the play of
5 the surfaces 9a, 9b on the surfaces 13a, 13b of this ring and the driving of the ring by the shoulder 35 provided at the base of the suspension collars. The ring 29 can then be raised along the bore 24a in the wellhead 24.

After cementation, a tensioning of the casing is carried out, and
10 when the value (arrow B) for the desired stress is reached, the ring 29 is in a position similar to that illustrated in Figure 1B for the intermediate element 3, and the casing is maintained in this position, as illustrated in the right-hand part of Figure 7. It will be seen that the upper suspension collar 22d has been
15 removed, and a metal sealing joint 33 known per se has been installed between the auxiliary grooving 32 made in the bore of the wellhead.

The invention is used in an especially useful way in the sector of oil drilling. The suspension device allows for adjustment and
20 locks tension introduced into the casing. The device greatly reduces circular compression stresses in the casing and avoids the need to cut the latter.



CLAIMS:

1. A device for adjusting the position of a cylindrical body in relation to a stationary support, the cylindrical body having a longitudinal axis and a plurality of triangular grooves on its outer surface, the stationary support having at least one recess the or each recess having a conical upward and a conical downward facing bearing surface, the device comprising an intermediate element whose inner side contains a plurality of inner grooves of the same longitudinal section as and for interacting with the grooves of the cylindrical body and
10 whose outer side has conical upward and downward bearing surfaces capable of bearing on the bearing surfaces of the stationary support, the intermediate element being elastically expansible from a position wherein its inner grooves engage the grooves of the cylindrical body, the downward facing flanks of the inner grooves having an angle of
15 inclination relative to the longitudinal axis that is less than the inclination of the upward facing bearing surface of the intermediate element and the upward facing flanks of the inner grooves being inclined at a greater angle than the angle of the downward facing bearing surface of the intermediate element so that when the
20 cylindrical body is subjected to an upward force, the resultant reaction has a radial component directed outwardly from said longitudinal axis and when the cylindrical body is subject to a downward force, the resultant reaction has a radial component directed inwardly towards said longitudinal axis.
- 25 2. A device as claimed in Claim 1 wherein the upward and downward facing flanks of the inner grooves of the cylindrical body have equal inclinations to the longitudinal axis.
3. A device as claimed in Claim 1 or Claim 2 wherein the intermediate element comprises a split ring.
- 30 4. A device as claimed in Claim 3 wherein the cylindrical body



is formed with an annular receptacle on its exterior above said plurality of grooves, the split ring being adapted to be carried in said annular receptacle, the outward facing bearing surface of the outer support being positioned so as to be landed on by the downward facing bearing surface of the intermediate element while it is located in said receptacle, the angle of the upward facing bearing surface of the outer support causing the intermediate element to expand outward into the recess of the outer support upon downward force applied to the cylindrical body, the difference in the angles of the downward facing flanks of the inner grooves of the intermediate element and the upward facing bearing surface of the intermediate element resulting in an outward radial force component on the intermediate element upon application of an upward force on the cylindrical body, allowing the cylindrical body to be moved upward relative to the intermediate element after the intermediate element has landed on the upward facing bearing surface of the outer support to position the grooves on the cylindrical body adjacent the inner grooves ratcheting past the grooves on the cylindrical body during said upward movement, and the difference in the angles of the upward facing flanks of the inner grooves and the downward facing bearing surface of the intermediate element resulting in an inward radial force component on the intermediate element upon application of a downward force on the cylindrical body to support the cylindrical body on the outer support.

5. A device as claimed in Claim 4 wherein the annular receptacle is formed directly below a flange extending radially from the exterior of the cylindrical body.

6. A device as claimed in Claim 5 comprising a shearable pin extending through an elongated slot in the flange and connected to the intermediate element, for retaining the intermediate element in the receptacle until a sufficient tensile force is applied, for allowing the intermediate element to expand without shearing the shear pin upon landing on the upward facing bearing surface of the outer support, then for shearing the pin to allow upward movement of the cylindrical member



relative to the intermediate element.

7. A device as claimed in any one of the preceding Claims wherein the intermediate element comprises a pair of vertically spaced said upward and downward facing conical bearing surfaces for engagement 5 with a corresponding pair of recesses located in the outer support.

8. A device as claimed in any of the preceding Claims comprising an annular slot formed in the inner side of the intermediate element.

9. A device as claimed in Claim 8 comprising a partition having a circular outer diameter extending outward from the receptacle 10 dividing it into two compartments, the partition initially receiving the slot of the intermediate element, the outer diameter of the partition being equal to the diameter of the inner grooves of the intermediate element measured at the apex, the outer diameter of the partition being equal to the diameter of the grooves of the cylindrical 15 body measured at the bottom.

10. A device for adjusting the position of a cylindrical body in relation to a stationary support substantially as herein described with reference to the accompanying drawings.
