Description

In the formation of a well in an oil or gas field, concentric casing strings are successively run down into the well bore through an incomplete wellhead. It sometimes happens that a casing string becomes stuck before it has been run in to its full depth. Provided that it has reached a sufficient depth to be useful, this is accepted, and the lower end of the casing string is cemented into the borehole. However, at that time, the string will not be properly supported at the wellhead, as no hanger or spool fixed to the upper end of the casing string will have achieved a proper landing at the wellhead. In this circumstance an emergency suspension is necessary.

One such prior emergency suspension comprises an annular slip and seal assembly which is formed in two parts which are hinged together so that the assembly can be wrapped around a casing to be supported. The assembly incorporates a slip bowl, and a ring of complementary segmental slips, and, above the slips, an elastomeric seal. In use the assembly is wrapped around a casing and landed on a wellhead support surface near to the bottom of the slip and seal assembly, and the slips are energised, by means of screws or by casing weight, to grip the casing.

Although such an assembly can be set through the blowout preventer (BOP), which is advantageous as compared to some previous emergency suspension systems, one disadvantage of such an arrangement is that the two-part construction of the slip and seal assembly inevitably involves a possibility of failure at the very high pressures to which the seal may be subjected in use, requiring the assembly to be made more robust than might otherwise be necessary. An increase in completion height for that casing string may also be necessary. Modern practice also prefers metal to metal seals rather than elastomeric seals. A further consideration is that there is very little radial clearance in the annulus between a casing and the next outer casing, particularly with large casing sizes of nominal OD 27,3 cm (10 3/4") and above.

In accordance with the present invention, a wellhead suspension device for a casing string comprises a tubular housing which is arranged to be landed at a wellhead; a plurality of axially spaced circumferential grooves in the radially inner surface of the housing, each groove having a depth which tapers axially to form a slip ring bowl; and, captive but axially movable within each groove, a respective rigid, circumferentially continuous, one part, metal sealing and slip ring which projects radially inwardly from the respective groove and which is provided with teeth on its radially inner surface.

The invention also includes a method of suspending at a wellhead a casing string, which has become stuck before being fully run into the well bore, the method comprising, (preferably after cutting off an excess length at the upper end of the casing and bevelling the upper end of the remaining casing), fitting the tubular housing of a novel device according to the invention down over an upper end of the casing by stretching the casing longitudinally and landing the housing in the wellhead so that an interference fit between the slip rings and the casing draws the slip rings axially upwardly in their respective grooves whilst allowing the rings to ride down the casing, and subsequently releasing the casing so that the slip rings are drawn by the casing axially downwards in their respective grooves to positions in which the rings jam between the casing and housing and the teeth on the radially inner surfaces of the rings bite into the casing both to secure the casing and to create a seal between the housing and the casing.

The new support has the advantage of providing metal to metal sealing and automatic energization of the slip sealing rings by the casing string weight in a construction in which the tubular housing and slip rings may be slim enough to be accepted in the narrow annulus around a casing to be supported, so that in spite of the multiple slip ring grooves there is no need for an increase in the height of the completion above the normal height.

The teeth on the radially inner surface of the rings are preferably annular circumferential teeth which are inclined axially upwardly, that is to say axially towards the wider ends of the grooves, so that they will ride down the casing, but bite into the casing when tended to be forced up the casing upon release of the stretched casing.

There are preferably formed on the radially outer surface of each ring annular circumferential teeth finer than those on the radially inner surface. The purpose of these fine teeth is to spread the jamming load between the rings and the tubular housing, upon jamming of the rings in the narrower lower ends of the grooves, to avoid excessive localised radial forces which might distort the casing.

The tubular housing may be a depending portion of a spool, but is preferably a depending portion of a hanger having, on its outer surface, a landing shoulder positioned axially above the grooves. The device may then be provided with an upwardly projecting neck, such as a screw threaded tongue, for carrying of a conventional external sealing assembly and possibly a landing for the hanger of the next inner casing string. The tubular housing may be provided, below the annular grooves, with a guide funnel and centralising fingers for use when the housing is lowered over a

casing to be supported.

The suspension device may be manufactured by machining the tubular housing, with the grooves formed in an internal substantially cylindrical envelope, and advancing the slip rings in an unexpanded state axially into the body into alignment with respective ones of the grooves, and then expanding the rings radially outwardly beyond their elastic limit, using an hydraulic or mechanical tool, until they are captive in the grooves and have the appropriate diameter.

The emergency support of a casing string utilising a suspension device, in accordance with the present invention, is illustrated in the accompanying drawings, in which:

Figure 1 is a part axial section through the device and related parts at the wellhead, the parts to the right of the centre line showing the suspension device being fitted to the casing and the parts on the left hand side of the centre line showing the casing suspended by the device;

Figure 2 is an enlargement of part of the Figure 1 with the casing in a slightly different axial position relatively to the suspension device; and,

Figure 3 is an enlargement of part of the right hand side of Figure 1 but showing the casing suspended by the device.

As illustrated, a casing housing 10 is assumed to be landed in a wellhead and carries a string of 33,97 cm (13 3/8") OD casing 11 in conventional fashion via a screw thread 12. A 27,3 cm (10 3/4") OD casing string 13 is shown having been run into the well bore through the string 11. On the assumption that the string 13 has stuck but deep enough for its lower end to have been cemented into the bore hole, the upper end of the exposed section of casing is cut off at the wellhead with a mechanical casing cutter to provide an upper end 14 of the casing, which is then milled to provide the conventional external bevel 15 as shown in Figure 2.

The casing is then secured in the wellhead by means of an emergency tubular hanger having a body 16 with a landing shoulder 17, and a depending housing portion 18 formed on its inner surface with five axially spaced annular grooves 19. These grooves taper downwardly at the conventional slip angle of 8°, to form slip ring bowls. Initially loosely located within each groove is a tapering sealing and slip ring 20 formed on its radially outer surface with fine annular circumferential teeth 21, and on its radially inner surface with three upwardly inclined circumferential annular teeth 22. These teeth project into a radially inner cylindrical envelope of the housing 18. At its lower end the housing 18 is provided with external centralising fingers 23 and a guide funnel 24. Above the body 16, the hanger has a conventional seal neck 25 having an external screw thread 26, for normal a 27,3 cm (10 3/4") seal assembly.

In order to suspend the prepared upper end of the casing string 13 at the wellhead, the emergency hanger 16 is assembled together with an installation tool 27, which is screwed to the neck 25 and a tool carrier 28, which carries at its lower end a 27,3 cm (10 3/4") casing spear. The tool 27 is sealed by O sealing rings, 29 to the spool 10, and 30 to the tool 28. The assembly is lowered so that the tubular housing 18 enters the annulus 31 between the casings 11 and 13, guided by the funnel 24 and centralised by the fingers 23. Simultaneously the casing spear enters the top of the casing 13. This continues until the shoulder 17 lands on a complementary landing bowl in the housing 10, as shown in Figure 1.

By means of pressure applied downwardly on an upper surface 32 of the tool 27, the emergency hanger is held down on its landing in the spool 10. The casing spear is then pulled upwardly to stretch the casing string 13 and to cause the upper end 14 of the casing to be drawn up through the housing 18 and through the slip sealing rings 20. As shown in Figure 2, the interference between the casing and the rings draws each ring up until it abuts the upper end of its respective groove 19, whereafter the upward movement of the casing causes it to ride through the rings. This is continued until the casing has been drawn up through all five rings. The tension in the casing spear is then slowly released so that the casing string 13 contracts downwardly under its own weight, drawing the five rings 20 simultaneously with it down within their respective grooves 19, until they jam in the narrower bottom parts of the grooves. At this time the teeth 21 spread the load on the groove walls and the teeth 22 bite into the casing to secure the casing, and to form a labyrinth seal at the top of the annulus 31. This secure seal position is shown on the left hand side in Figure 1.

Thereafter the tool 27 and spear are released and withdrawn and a conventional seal assembly is fitted to the neck 25, prior to running in the next casing string.

The housing 16 might be made of 75 K steel and the rings 20 from a hard material such as an inconel alloy.

Claims

1. A wellhead suspension device for a casing string, the device comprising a tubular housing (18) which is arranged to be landed at a wellhead; a plurality of axially spaced circumferential grooves (19) in the radially inner surface of the housing, each groove having a depth which tapers axially to form a slip ring bowl; and,

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casing to be supported.

The suspension device may be manufactured by machining the tubular housing, with the grooves formed in an internal substantially cylindrical envelope, and advancing the slip rings in an unexpanded state axially into the body into alignment with respective ones of the grooves, and then expanding the rings radially outwardly beyond their elastic limit, using an hydraulic or mechanical tool, until they are captive in the grooves and have the appropriate diameter.

The emergency support of a casing string utilising a suspension device, in accordance with the present invention, is illustrated in the accompanying drawings, in which:

Figure 1 is a part axial section through the device and related parts at the wellhead, the parts to the right of the centre line showing the suspension device being fitted to the casing and the parts on the left hand side of the centre line showing the casing suspended by the device;

Figure 2 is an enlargement of part of the Figure 1 with the casing in a slightly different axial position relatively to the suspension device; and,

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As illustrated, a casing housing 10 is assumed to be landed in a wellhead and carries a string of 33,97 cm (13 3/8") OD casing 11 in conventional fashion via a screw thread 12. A 27,3 cm (10 3/4") OD casing string 13 is shown having been run into the well bore through the string 11. On the assumption that the string 13 has stuck but deep enough for its lower end to have been cemented into the bore hole, the upper end of the exposed section of casing is cut off at the wellhead with a mechanical casing cutter to provide an upper end 14 of the casing, which is then milled to provide the conventional external bevel 15 as shown in Figure 2.

The casing is then secured in the wellhead by means of an emergency tubular hanger having a body 16 with a landing shoulder 17, and a depending housing portion 18 formed on its inner surface with five axially spaced annular grooves 19. These grooves taper downwardly at the conventional slip angle of 8°, to form slip ring bowls. Initially loosely located within each groove is a tapering sealing and slip ring 20 formed on its radially outer surface with fine annular circumferential teeth 21, and on its radially inner surface with three upwardly inclined circumferential annular teeth 22. These teeth project into a radially inner cylindrical envelope of the housing 18. At its lower end the housing 18 is provided with external centralising fingers 23 and a guide funnel 24. Above the body 16, the hanger has a conventional seal neck 25 having an external screw thread 26, for normal a 27,3 cm (10 3/4") seal assembly.

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By means of pressure applied downwardly on an upper surface 32 of the tool 27, the emergency hanger is held down on its landing in the spool 10. The casing spear is then pulled upwardly to stretch the casing string 13 and to cause the upper end 14 of the casing to be drawn up through the housing 18 and through the slip sealing rings 20. As shown in Figure 2, the interference between the casing and the rings draws each ring up until it abuts the upper end of its respective groove 19, whereafter the upward movement of the casing causes it to ride through the rings. This is continued until the casing has been drawn up through all five rings. The tension in the casing spear is then slowly released so that the casing string 13 contracts downwardly under its own weight, drawing the five rings 20 simultaneously with it down within their respective grooves 19, until they jam in the narrower bottom parts of the grooves. At this time the teeth 21 spread the load on the groove walls and the teeth 22 bite into the casing to secure the casing, and to form a labyrinth seal at the top of the annulus 31. This secure seal position is shown on the left hand side in Figure 1.

Thereafter the tool 27 and spear are released and withdrawn and a conventional seal assembly is fitted to the neck 25, prior to running in the next casing string.

The housing 16 might be made of 75 K steel and the rings 20 from a hard material such as an inconel alloy.

Claims

1. A wellhead suspension device for a casing string, the device comprising a tubular housing (18) which is arranged to be landed at a wellhead; a plurality of axially spaced circumferential grooves (19) in the radially inner surface of the housing, each groove having a depth which tapers axially to form a slip ring bowl; and,

captive but axially movable within each groove, a respective rigid, circumferentially continuous, one part, metal sealing and slip ring (20) which projects radially inwardly from the respective groove and which is provided with teeth (22) on its radially inner surface.

2. A device according to claim 1, in which the teeth are annular circumferential teeth (22) which are inclined axially upwardly.

3. A device according to claim 1 or claim 2, in which further teeth (21) are provided on the radially outer surface of each ring, the further teeth being annular circumferential teeth, finer than those on the radially inner surface of the ring.

4. A device according to any one of the preceding claims, in which the tubular housing is a depending portion of a hanger (16) having, on its outer surface, a landing shoulder (17) positioned axially above the grooves.

5. A device according to claim 4, which has an upwardly projecting screw threaded neck (25) for carrying a sealing assembly.

6. A device according to any one of the preceding claims, in which the tubular housing is provided, below the annular grooves, with a guide funnel (24) and centralising fingers (23).

7. A method of suspending at a wellhead a casing string (13) which has become stuck before being fully run into the well bore, the method comprising fitting the tubular housing (18) of a device according to any one of the preceding claims down over an upper end of the casing by stretching the casing longitudinally and landing the housing in the wellhead so that an interference fit between the slip rings (20) and the casing draws the slip rings axially upwardly in their respective grooves (19) whilst allowing the rings to ride down the casing, and subsequently releasing the casing so that the slip rings are drawn by the casing axially downwards in their respective grooves to positions in which the rings jam between the casing and the housing and the teeth (22) on the radially inner surfaces of the rings bite into the casing both to secure the casing and to create a seal between the housing and the casing.

8. A method according to claim 7, in which an excess length at the upper end of the casing is cut off and the upper edge of the casing is bevelled (15) before fitting the device to the casing.



Patentansprüche

1. Aufhängungsvorrichtung für eine Verrohrung in einem Bohrlochkopf, **gekennzeichnet durch** ein rohrförmiges Gehäuse (18), das zur Befestigung in einem Bohrlochkopf vorgesehen ist, und eine Vielzahl von am Umfang angeordneten, axial beabstandeten Nuten (19) radial an der Innenfläche des Gehäuses besitzt, wobei sich die Tiefe jeder Nut axial verjüngt, um eine Ausnehmung für einen Gleitring zu bilden, sowie durch einen in jeder Nut eingeschlossenen, jedoch axial beweglichen, entsprechend steifen, am Umfang nicht unterbrochenen, einteiligen Metall-Dichtungs- und Gleitring (20), welcher aus der entsprechenden Nut nach innen vorsteht und welcher an seiner radialen Innenfläche mit Zähnen (22) versehen ist.

2. Vorrichtung nach Anspruch 1, **dadurch gekennzeichnet**, daß die Zähne (22) ringförmig am Umfang und axial nach oben angewinkelt angeordnet sind.

3. Vorrichtung nach Anspruch 1 oder 2, **dadurch gekennzeichnet**, daß weitere Zähne (21) radial an der Außenfläche jedes Ringes vorgesehen sind, wobei die weiteren Zähne ringförmig am Umfang angeordnet und zierlicher als jene sind, die sich radial an der Innenfläche des Ringes befinden.

4. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet**, daß das rohrförmige Gehäuse ein unterer Teil einer Aufhängung (16) ist, der an seiner Außenfläche eine Setzschulter (17) aufweist, die sich axial oberhalb der Nuten befindet.

5. Vorrichtung nach Anspruch 4, **dadurch gekennzeichnet**, daß sie einen nach oben vorstehenden, mit Gewinde versehenen Hals (25) zum Halten einer Dichtungseinrichtung aufweist.

6. Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche, **dadurch gekennzeichnet**, daß das rohrförmige Gehäuse unterhalb der ringförmigen Nuten mit einer Führungskonus (24) und Zentrierfingern (23) versehen ist.

7. Verfahren zur Aufhängung einer Verrohrung in einem Bohrlochkopf (13), welche vor dem vollständigen Absenken im Bohrloch steckenge-

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blieben ist, **gekennzeichnet durch** das Befestigen des rohrförmigen Gehäuses (18) einer Vorrichtung nach einem oder mehreren der vorhergehenden Ansprüche auf dem oberen Ende der Verrohrung durch längsseitiges Strecken der Verrohrung und Festsetzen des Gehäuses im Bohrlochkopf, so daß eine Preßpassung zwischen den Gleitringen (20) und der Verrohrung die Gleitringe (20) in ihren entsprechenden Nuten (19) axial nach oben zieht, wobei es den Ringen möglich ist, an der Verrohrung nach unten zu rutschen und demzufolge die Verrohrung freizugeben, so daß die Gleitringe durch die Verrohrung in ihren entsprechenden Nuten axial nach unten in Positionen gezogen werden, in welchen die Ringe sich zwischen der Verrohrung und dem Gehäuse verklemmen, und die an den radialen inneren Flächen der Ringe befindlichen Zähne (22) sich in die Verrohrung eindrücken, um die Verrohrung sowohl zu befestigen als auch eine Abdichtung zwischen dem Gehäuse und der Verrohrung zu schaffen.

8. Verfahren nach Anspruch 7, **dadurch gekennzeichnet**, daß eine überschüssige Länge am oberen Ende der Verrohrung abgeschnitten wird und die obere Kante der Verrohrung mit einer Schräge (15) versehen wird, bevor die Aufhängungsvorrichtung an der Verrohrung befestigt wird.

Revendications

1. Dispositif de suspension d'une ligne de tubage au niveau d'une tête de puits, le dispositif comportant un boîtier tubulaire (18) qui est agencé pour être en appui au niveau d'une tête de puits, plusieurs gorges circonférentielles (19) axialement espacées situées dans la surface radialement intérieure du boîtier, chaque gorge ayant une profondeur qui diminue axialement pour former une cuvette pour anneau formant coulisse, et, en étant captif mais axialement mobile à l'intérieur de chaque gorge, un anneau correspondant (20) d'étanchéité et formant coulisse, métallique, rigide, continu circonférentiellement, en une seule pièce, qui fait saillie radialement vers l'intérieur à partir de la gorge correspondante et qui est muni de dents (22) sur sa surface radialement intérieure.

2. Dispositif selon la revendication 1 dans lequel les dents sont des dents (22) circonférentielles annulaires qui sont inclinées axialement vers le haut.

3. Dispositif selon la revendication 1 ou 2, dans lequel d'autres dents (21) sont agencées sur la surface radialement extérieure de chaque anneau, les autres dents étant des dents circonférentielles annulaires, plus petites que celles existant sur la surface radialement intérieure de l'anneau.

4. Dispositif selon l'une quelconque des revendications précédentes, dans lequel le boîtier tubulaire est une partie suspendue d'un dispositif de suspension (16) comportant, sur sa surface extérieure, un épaulement d'appui (17) positionné axialement au dessus des gorges.

5. Dispositif selon la revendication 4, qui comporte un col fileté (25) faisant saillie vers le haut pour supporter un ensemble d'étanchéité.

6. Dispositif selon l'une quelconque des revendications précédentes, dans lequel le boîtier tubulaire est muni, en dessous des gorges annulaires, d'un entonnoir de guidage (24) et de doigts de centrage (23).

7. Procédé consistant à suspendre au niveau d'une tête de puits une ligne de tubage (13) qui a été immobilisée avant d'être entièrement descendue à l'intérieur de l'alésage de puits, le procédé consistant à agencer le boîtier tubulaire (18) d'un dispositif selon l'une quelconque des revendications précédentes vers le bas sur une extrémité supérieure du tubage par étirage du tubage longitudinalement et mise en appui du boîtier dans la tête de puits de telle sorte qu'un agencement avec interaction existant entre les anneaux (20) formant coulisse et le tubage tire les anneaux formant coulisse axialement vers le haut dans leur gorge respective (19) tout en permettant aux anneaux de se déplacer vers le bas du tubage, et à ensuite relâcher le tubage de telle sorte que les anneaux formant coulisse sont tirés par le tubage axialement vers le bas dans leur gorge respective vers des positions dans lesquelles les anneaux sont coincés entre le tubage et le boîtier et les dents (22) situées sur les surfaces radialement intérieures des anneaux mordent dans le tubage à la fois pour fixer le tubage et pour créer une étanchéité entre le boîtier et le tubage.

8. Procédé selon la revendication 7, dans lequel une longueur en excès existant au niveau de l'extrémité supérieure du tubage est découpée et le bord supérieur du tubage est biseauté (15) avant d'agencer le dispositif sur le tubage.