

Description

When a casing within a well bore has been lost or cut loose for any reason, a connection to the upper end of the casing is attempted. This type of connection is also used in the event the casing has stuck to adjust the vertical position of the top of the casing. Such connection is referred to herein as a casing patch. It is preferred that the casing patch be made to a hanger or other suitable equipment which can be supported within a wellhead housing and that the casing be held in tension during the making of the patch.

A particularly advantageous manner of providing such casing patch is to provide a cold forging tool which is positioned within the casing and a hanger having a gripping and sealing interior contour positioned around the casing near its upper end. US-A-4892149 discloses a cold forging method, apparatus and tool therefor which can be used to make a casing patch.

EP-A-0218049 describes a method of making a casing patch in which an annular member is positioned around the upper end of the casing, a forging tool is lowered into the upper end of the casing, and the casing is cold forged into gripping and sealing engagement with the annular member. The forging tool is then released and retrieved.

Casing which is in a well bore as a "fish" can be engaged internally by a device commonly referred to as a spear and when the spear has engaged, tension can be exerted on the string in which the spear is engaged to exert a tension on the casing. One disadvantage which has been encountered with the use of spear to tension casing is that considerable radial loading may be necessary on the casing and to prevent slipping of the spear, the spear slips are highly loaded. Also, the tensioning can also increase the loading of the slips against the interior of the casing. Such high slip loading has caused excessive deformation of the casing in the past.

According to one aspect of the present invention there is provided a method of making a casing patch including the steps

positioning an annular member around the the upper end of the casing,

lowering a forging tool into the upper end of the casing,

cold forging the casing into gripping and sealing engagement with the annular member, and

releasing and retrieving the forging tool from within the casing, characterised by the step of providing a spear which is lowered into the upper end of the casing, setting the spear) into gripping engagement with the casing at a position above the forging tool, and lifting the spear to tension the casing so that the cold forging is carried out whilst

the casing is under tension.

According to another aspect of the present invention there is provided an apparatus suitable for making a casing patch within a well bore to a casing fish in accordance with the first aspect, the apparatus comprising

an annular member having an internal contoured recess,

means for lowering the annular member into into a well bore into surrounding relationship to the casing fish,

a forging tool,

means for lowering the forging tool into into said casing fish,

means for actuating said forging tool to forge the casing into gripping and sealing engagement with the internal contoured recess within said annular member, and

means releasing and retrieving the forging tool,

characterised in that the apparatus includes a spear which can be lowered in the casing by said lowering means and means for setting said spear within the upper portion of the casing fish to exert a tensile force on the casing fish so that the casing fish is under tension when it is forged.

In a preferred form of the method and apparatus the casing is protected from excessive formation by surrounding its exterior in the area of spear engagement with a protection collar.

Thus, the present invention provides a method and apparatus for effecting a casing patch in which the unit is tensioned by a spear which engages within the upper end of the casing so that the casing below such spear engagement is under tension as it is cold forged into tight gripping and sealing engagement within an annular member surrounding the casing.

The invention will be described now by way of example only with particular reference to the accompanying drawings. In the drawings:

Figure 1 is a detail sectional view of a well bore showing a casing in the lower portion thereof and an annular member with a protection collar supported within said annular member and a guide sleeve on lower end of the annular member being lowered within the well bore into surrounding relationship to the upper end of the casing fish.

Figure 2 is a view similar to Figure 1 but illustrates the position at which the annular member is supported for subsequent operations.

Figure 3 is another similar view showing the cold forging tool and the spear after they have been lowered to a preselected position within the casing fish.

Figure 4 is another similar view showing the setting of the spear within the upper end of the casing fish.

Figure 5 is another similar view showing the tensioning of the casing fish by lifting of the string supporting the spear and forging tool.

Figure 6 is another similar view illustrating the cold forging connection being made between the casing fish and the contour on the interior of the annular member.

Figure 7 is another similar view showing the release of the cold forging tool from the interior of the casing fish.

Figure 8 is another similar view illustrating the release of the spear.

FIGURE 9 is another similar view illustrating a pressure testing tool positioned within the annular member and the casing to pressure test the cold forged joint between the two.

As shown in FIGURE 1, outer casing 10 is positioned within a well bore and inner casing fish 14 is positioned within outer casing 10. Annular member 16 having an internal contoured recess 18 has guide sleeve 20 secured to its lower end as by threads 22. The lower interior of guide sleeve 20 is tapered so that it will cause the upper end of inner casing fish 14 to move into the interior of guide sleeve 20. Protection collar 24 is positioned on upwardly facing shoulder 26 on the upper end of annular member 16 and within tubular connector 28 which is threaded onto the upper exterior of annular member 16. With the upper end of inner casing fish 14 within guide sleeve 20, guide sleeve 20, annular member 16 and protection collar 24 are lowered until the upper end of inner casing fish 14 is within the upper half of protection collar 24. Connector 28, as shown in FIGURE 2, is secured to the lower end of string 30 on which the outer assembly described is lowered.

With the outer assembly positioned as described above, the inner assembly is lowered through string 30 on drill pipe 32 to position spear 34 within the upper end of casing fish 14 and at a level at which casing fish 14 is surrounded by protection collar 24, forging tool 36 is within casing fish 14 below spear 34 and at least partially below the lower level of contoured recess 18 as shown in FIGURE 3. Pump and instrument pod 38 is positioned above spear 34 on drill pipe 32. Tubing 40 connects from pod 38 through spear 34 into tool 36 to provide the pressure fluid for the actuation of tool 36. Tool 36 is preferred to be a tool such as is disclosed in EP-A-031267. Spear 34 is any suitable available spear which includes outer slips 42 and an inner mandrel 44 which moves axially of the slips 42 to wedge them outward into gripping engagement with the interior of the upper end of casing fish 14. As mentioned above, tool 36 is positioned below its desired position with respect to contour recess 18 by a distance which includes the anticipated elongation of the casing fish 14 and

the distance the spear mandrel 44 is estimated to travel to properly and completely set slips 42.

FIGURE 4 illustrates the relative position of the inner and outer assemblies after the spear mandrel 44 has been moved upwardly within slips 42 causing slips 42 to be moved outward into tight gripping engagement within the upper end of casing fish 14. It should be noted that tool 36 has been moved upwardly within annular member 16 the distance of the setting movement of spear mandrel 44 but tool 36 is still below the upper end of contoured recess 18. The gripping engagement of spear 34 into the interior of casing 14 causes casing 14 to be forced outward into engagement with protection collar 24. Collar 24 is sufficiently thick and strong so that further distortion of casing 14 responsive to the gripping forces of spear 34 is prevented.

FIGURE 5 illustrates the positions of the components after spear 34 has been set and lifted by drill pipe 32 to effect the desired amount of tension in casing fish 14. This has caused casing fish 14 to elongate and inner assembly to be raised so that tool 36 is positioned at the desired level within annular member 16. In this position the forging of casing fish 14 is outward into internal contoured recess 18 of annular member 16. This forging step is illustrated in FIGURE 6. When such forging is completed responsive to the delivery of fluid under pressure from pod 38 through tubing 40 into tool 36 so that the resilient packing is forced outward forcing the portion of casing 14 which it engages outward into tight sealing and gripping engagement with internal contoured recess 18.

With the completion of the forging step as described above, the pressure within tool 36 is relieved and its resilient packing relaxes back to its normal position immediately surrounding the body of tool 36. This position is shown in FIGURE 7. Following the release of tool 36, spear 34 is released by lowering of drill pipe 32 to cause spear mandrel 44 to move out from under spear slips 42 and causing slips 42 to withdraw from engagement with casing 14. In this position, shown in FIGURE 8, inner assembly is recovered from within outer casing 10 and pressure testing tool 46 is lowered on drill string 48 into the interior of annular member 16 and the interior of casing 14. In its set position as shown in FIGURE 9, upper packing seal 50 is set within string 30 above connector 28 and above the upper end of annular member 16. Lower packing seal 52 is set within casing 14 at a position below the portion of casing 14 which has been forged into engagement with contoured recess 18 within annular member 16. To test the sealing of the forged connection, pressure is delivered through drill string 48 and out its central opening 54. Since blind cap 56 is secured to the lower end of string 48, any loss of pressure notice at the

surface in string 48 after it has been fully pressurized will indicate a leakage in the forged connection.

It should be noted that the use of the protection collar with the spear to protect the casing from excessive deformation responsive to the setting of the spear and its tension loading which increases the gripping loading on the casing may be used in applications other than the method and apparatus for providing a casing patch.

Claims

1. A method of making a casing patch including the steps

positioning an annular member (16) around the upper end of the casing (14),

lowering a forging tool (36) into the upper end of the casing,

cold forging the casing (14) into gripping and sealing engagement with the annular member (16), and

releasing and retrieving the forging tool from within the casing, characterised by the step of providing a spear (34) which is lowered into the upper end of the casing, setting the spear (34) into gripping engagement with the casing at a position above the forging tool, and lifting the spear (34) to tension the casing (14) so that the cold forging is carried out whilst the casing is under tension.

2. A method according to claim 1, including the step of

positioning a protective collar (24) around the upper end of the casing (14) at the level of engagement of the spear (34) within the casing to limit the deformation of the casing responsive to the internal gripping of the spear.

3. A method according to claim 1, including the steps of

lowering a testing tool (36) into the casing to span the forged connection, and

applying pressure to the forged connection to test its sealing engagement.

4. An apparatus suitable for making a casing patch within a well bore to a casing fish in accordance with the method according to claim 1, the apparatus comprising

an annular member (16) having an internal contoured recess (18),

means (30) for lowering the annular member into a well bore into surrounding relationship to the casing fish (14),

a forging tool (36),

means (32) for lowering the forging tool

into said casing fish,

means for actuating said forging tool (36) to forge the casing into gripping and sealing engagement with the internal contoured recess within said annular member, and

means releasing and retrieving the forging tool,

characterised in that the apparatus includes a spear (34) which can be lowered into the casing by said lowering means (32) and means (44) for setting said spear within the upper portion of the casing fish to exert a tensile force on the casing fish so that the casing fish is under tension when it is forged.

5. An apparatus according to claim 4, including

means (24) surrounding the casing fish in the area engaged by the spear for protecting the casing fish from excessive deformation responsive to the engagement and tensile forces of the spear (34) on the casing fish (14).

6. An apparatus according to claim 4, including

a testing tool (46) having an upper and a lower packing seal (50, 52) and supported on a hollow member (48) with an opening (54) therein between the upper and lower packing seals, and

means (48) for lowering the testing tool (46) to position the packing seals (50, 52) above and below the forged connection and to deliver fluid under pressure to test the sealing engagement of the forged connection.

7. An apparatus according to claim 4, wherein said protecting means includes a protection collar (24) lowered into surrounding relationship to the upper end of the casing fish (14).

8. An apparatus according to claim 7, wherein said protection collar (24) has sufficient strength and fits sufficiently close around the exterior of the casing fish (14) to limit the deformation of the casing fish responsive to the engagement and lift by the spear (34).

Patentansprüche

1. Verfahren zum Ausbessern eines Casings mit den Schritten Positionieren eines ringförmigen Bauteils (16) um das obere Ende des Casings (14), Absenken eines Verformungswerkzeugs (36) in das obere Ende des Casings, Kaltverformen des Casings (14) in Greif- und Dichtungskontakt mit dem ringförmigen Bauteil (16) und Freigeben und Zurückziehen des Verformungswerkzeugs aus dem Casing, gekennzeichnet durch den Schritt der An-



surface in string 48 after it has been fully pressurized will indicate a leakage in the forged connection.

It should be noted that the use of the protection collar with the spear to protect the casing from excessive deformation responsive to the setting of the spear and its tension loading which increases the gripping loading on the casing may be used in applications other than the method and apparatus for providing a casing patch.

Claims

1. A method of making a casing patch including the steps
 - positioning an annular member (16) around the upper end of the casing (14),
 - lowering a forging tool (36) into the upper end of the casing,
 - cold forging the casing (14) into gripping and sealing engagement with the annular member (16), and
 - releasing and retrieving the forging tool from within the casing, characterised by the step of providing a spear (34) which is lowered into the upper end of the casing, setting the spear (34) into gripping engagement with the casing at a position above the forging tool, and lifting the spear (34) to tension the casing (14) so that the cold forging is carried out whilst the casing is under tension.
2. A method according to claim 1, including the step of
 - positioning a protective collar (24) around the upper end of the casing (14) at the level of engagement of the spear (34) within the casing to limit the deformation of the casing responsive to the internal gripping of the spear.
3. A method according to claim 1, including the steps of
 - lowering a testing tool (36) into the casing to span the forged connection, and
 - applying pressure to the forged connection to test its sealing engagement.
4. An apparatus suitable for making a casing patch within a well bore to a casing fish in accordance with the method according to claim 1, the apparatus comprising
 - an annular member (16) having an internal contoured recess (18),
 - means (30) for lowering the annular member into a well bore into surrounding relationship to the casing fish (14),
 - a forging tool (36),
 - means (32) for lowering the forging tool

into said casing fish,

means for actuating said forging tool (36) to forge the casing into gripping and sealing engagement with the internal contoured recess within said annular member, and

means releasing and retrieving the forging tool,

characterised in that the apparatus includes a spear (34) which can be lowered in the casing by said lowering means (32) and means (44) for setting said spear within the upper portion of the casing fish to exert a tensile force on the casing fish so that the casing fish is under tension when it is forged.

5. An apparatus according to claim 4, including
 - means (24) surrounding the casing fish in the area engaged by the spear for protecting the casing fish from excessive deformation responsive to the engagement and tensile forces of the spear (34) on the casing fish (14).
6. An apparatus according to claim 4, including
 - a testing tool (46) having an upper and a lower packing seal (50, 52) and supported on a hollow member (48) with an opening (54) therein between the upper and lower packing seals, and
 - means (48) for lowering the testing tool (46) to position the packing seals (50, 52) above and below the forged connection and to deliver fluid under pressure to test the sealing engagement of the forged connection.
7. An apparatus according to claim 4, wherein said protecting means includes a protection collar (24) lowered into surrounding relationship to the upper end of the casing fish (14).
8. An apparatus according to claim 7, wherein
 - said protection collar (24) has sufficient strength and fits sufficiently close around the exterior of the casing fish (14) to limit the deformation of the casing fish responsive to the engagement and lift by the spear (34).

Patentansprüche

1. Verfahren zum Ausbessern eines Casings mit den Schritten Positionieren eines ringförmigen Bauteils (16) um das obere Ende des Casings (14), Absenken eines Verformungswerkzeugs (36) in das obere Ende des Casings, Kaltverformen des Casings (14) in Greif- und Dichtungskontakt mit dem ringförmigen Bauteil (16) und Freigeben und Zurückziehen des Verformungswerkzeugs aus dem Casing, gekennzeichnet durch den Schritt der An-



- ordnung eines Greifdorns (34), der in das obere Ende des Casings abgesenkt wird, Festsetzen des Greifdorns (34) in Greifkontakt mit dem Casing an einer Stelle oberhalb des Verformungswerkzeugs und Anheben des Greifdorns (34), um das Casing (14) so zu spannen, daß die Kaltverformung ausgeführt wird, während das Casing unter Spannung steht.
2. Verfahren nach Anspruch 1, einschließlich des Schritts des Positionierens einer Schutzhülse (24) um das obere Ende des Casings (14) in der Höhe des Kontakts mit dem Greifdorns (34) in dem Casing, um die Verformung des Casings entsprechend dem inneren Angreifen des Greifdorns zu beschränken.
 3. Verfahren nach Anspruch 1, einschließlich der Schritte des Absenkens eines Testwerkzeugs (36) in das Casing, um die Verformungsverbindung zu überbrücken, und Aufbringen eines Drucks auf die Verformungsverbindung, um den Dichtungskontakt zu testen.
 4. Vorrichtung zur Herstellung einer Casingausbesserung innerhalb einer Schachtbohrung an einem Casingfisch entsprechend dem Verfahren nach Anspruch 1, wobei die Vorrichtung ein ringförmiges Bauteil (16) mit einer inneren konturierten Aussparung (18), eine Einrichtung (30) zum Absenken des ringförmigen Bauteils in eine Bohrung, so daß dieses den Casingfisch (14) umfaßt, ein Verformungswerkzeug (36), eine Einrichtung (32) zum Absenken des Verformungswerkzeugs in den Casingfisch, eine Einrichtung zur Betätigung des Verformungswerkzeugs (6), um das Casing in Greif- und Dichtungskontakt mit der inneren konturierten Aussparung innerhalb des ringförmigen Bauteils zu verformen, und eine Einrichtung zum Freigeben und Zurückziehen des Verformungswerkzeugs aufweist, dadurch gekennzeichnet, daß die Vorrichtung einen Greifdorn (34), der in das Casing mittels der Absenkeinrichtung (32) abgesenkt werden kann, und eine Einrichtung (44) zum Festsetzen des Greifdorns in dem oberen Teil des Casingfischs aufweist, um eine Spannkraft auf den Casingfisch auszuüben, so daß dieser unter Spannung steht, wenn er verformt wird.
 5. Vorrichtung nach Anspruch 4, mit einer Einrichtung (24), die den Casingfisch in dem Bereich umfaßt, der von dem Greifdorn ergriffen wird, um den Casingfisch gegen eine übermäßige Verformung entsprechend dem Kontakt und den Zugkräften des Greifdorns (34) auf den Casingfisch (14) zu schützen.
 6. Vorrichtung nach Anspruch 4, mit einem Testwerkzeug (46) mit einer oberen und einer unteren Dichtung (50, 52), welches an einem hohlen Bauteil (48) mit einer Öffnung (54) darin zwischen der oberen und unteren Dichtung gehalten ist, und mit einer Einrichtung (48) zum Absenken des Testwerkzeugs (46), um die Dichtungen (50, 52) oberhalb und unterhalb der Verformungsverbindung zu positionieren und um ein Druckfluid zuzuführen, um den Dichtungskontakt der verformten Verbindung zu testen.
 7. Vorrichtung nach Anspruch 4, wobei die Schutzeinrichtung eine Schutzhülse (24) aufweist, die so abgesenkt wird, daß sie das obere Ende des Casingfisch (14) umfaßt.
 8. Vorrichtung nach Anspruch 7, wobei die Schutzhülse (24) eine ausreichende Festigkeit hat und dicht genug um das Äußere des Casingfischs (14) paßt, um die Verformung des Casingfischs entsprechend dem Angriff und Anheben durch den Greifdorn (34) zu begrenzen.

Revendications

1. Procédé de réalisation d'un raccordement de tubage comprenant les étapes de :
 positionnement d'un élément annulaire (16) autour de l'extrémité supérieure du tubage (14),
 descente d'un outil de forgeage (36) jusque dans l'extrémité supérieure du tubage,
 forgeage à froid du tubage (14) afin de le mettre en contact d'ancrage et d'étanchéité avec l'élément annulaire (16), et
 libération et récupération de l'outil de forgeage pour l'amener hors de l'intérieur du tubage,
 caractérisé par les étapes de :
 fourniture d'un relève tubes (34) qui est descendu jusque dans l'extrémité supérieure du tubage,
 mise en place du relève tubes (34) pour l'amener en contact d'ancrage avec le tubage en une position située au-dessus de l'outil de forgeage, et
 remontée du relève tubes (34) afin de mettre en tension le tubage (14) de telle sorte que le forgeage à froid soit effectué tandis que le tubage est en tension.
2. Procédé selon la revendication 1, incluant l'étape de :
 mise en place d'un collier de protection (24) autour de l'extrémité supérieure du tubage



- (14) au niveau du contact du relève tubes (34) avec l'intérieur du tubage afin de limiter la déformation du tubage suite à l'ancrage interne du relève tubes.
3. Procédé selon la revendication 1, incluant les étapes de :
- descente d'un outil de test (36) dans le tubage jusqu'à la connexion forgée, et application d'une pression sur la connexion forgée afin de tester son étanchéité.
4. Appareil pour effectuer un raccordement de tubage à l'intérieur d'un trou de forage sur un tubage de fond selon le procédé selon la revendication 1, l'appareil comprenant :
- un élément annulaire (16) présentant un évidement profilé interne (18),
- un moyen (30) pour faire descendre l'élément annulaire dans le trou de forage afin de l'amener en une position dans laquelle il entoure le tubage de fond (14),
- un outil de forgeage (36),
- un moyen (32) pour faire descendre l'outil de forgeage jusque dans ledit tubage de fond,
- un moyen pour actionner ledit tube de forgeage (36) afin de forger le tubage de façon à le mettre en contact d'ancrage et d'étanchéité avec l'évidement profilé interne situé à l'intérieur dudit élément annulaire, et
- un moyen de libération et de récupération de l'outil de forgeage,
- caractérisé en ce que l'appareil comprend un relève tubes (34) qui peut être descendu dans le tubage à l'aide dudit moyen de descente (32), et
- un moyen (44) pour mettre en place ledit relève tubes à l'intérieur de la partie supérieure du tubage de fond afin d'exercer une force de tension sur le tubage de fond de telle sorte que le tubage de fond soit en tension quand il est forgé.
5. Appareil selon la revendication 4, comprenant un moyen (24) entourant le tubage de fond dans la zone qui est en contact avec le relève tubes afin de protéger le tubage de fond contre une déformation excessive qui résulterait de la mise en contact et des forces de tension du relève tubes (34) sur le tubage de fond (14).
6. Appareil selon la revendication 4, comprenant :
- un outil de test (46) qui comporte des garnitures d'étanchéité supérieure et inférieure (50, 52) et qui est supporté sur un élément creux (48) muni d'une ouverture (54) située entre les garnitures d'étanchéité supérieure et

inférieure, et

un moyen (48) pour faire descendre l'outil de test (46) afin de positionner les garnitures d'étanchéité (50, 52) au-dessus et en-dessous de la connexion forgée et pour délivrer du fluide sous pression afin de tester l'étanchéité de la connexion forgée.

7. Appareil selon la revendication 4, dans lequel ledit moyen de protection comprend un collier de protection (24) qui est descendu de façon à venir entourer l'extrémité supérieure du tubage de fond (14).
8. Appareil selon la revendication 7, dans lequel ledit collier de protection (24) présente une résistance mécanique suffisante et est emboîté autour de l'extérieur du tubage de fond (14) avec un jeu suffisamment faible de façon à limiter la déformation du tubage de fond résultant du contact et du relèvement du relève tubes (34).