

Description

The present invention relates to an improved device which is positioned within a well bore in surrounding relationship to a tubing string to seal across the annulus between the interior of the well casing and the exterior of the tubing string.

Prior tubing packers have included an annular resilient packer which is positioned between shoulders which can be moved toward each other to compress the packer axially so that it expands radially inward and outward into sealing engagement and also includes anchors which secure the packer structure at a particular level in the casing. An example of such a packer is shown in U. S. Patent No. 2,387,003. Many types of packers have been available. Some packers are set by movement of the tubing string. Others are set by hydraulic pressure transmitted to the packer.

Annular wellhead seals have included seals which seal across the annulus between a housing and a well string. Some of these seal have included seals with legs which are wedged outward toward their respective sealing surfaces as shown in U. S. Patent No. 4,131,287. One seal includes the wedging of the legs into serrations in the sealing surface. This structure is shown in U. S. Patent No. 4,595,053. U. S. Patent No. 4,550,782 discloses an annular ring seal which is wedged into an annular space which it tapered downwardly and outwardly as is the ring seal.

It has been common practice in the past to use multiple camming surfaces to wedge slips outward into sealing engagement with the interior of the casing into which the slips are to be set. These structures are disclosed in U. S. Patent Nos. 2,582,700 and 3,311,168.

When a tubular member is formed outwardly in a liquid environment into a cylindrical fitting having inner grooves into which the tubular member is deformed, U.S. Patent No. 4,662,663 discloses the use of collapsible material positioned within the grooves to eliminate the problems with the grooves being filled with water and limiting the forming of the tubular member.

U.S. Patent No. 4,573,537 discloses a packer/anchor structure which utilizes segmented slips (70) to anchor the structure within the casing string (14) and the sealing means (22) which is used to seal against the interior of the casing string (14). The sealing mechanism includes a plurality of camming surfaces on the interior of the segments (112) and mating camming surfaces on the exterior of the actuating cylinder (136).

U.S. Patent No. 4,588,029 discloses an annular seal to be used within a well. The annular sealing element (20) has an outer pair of projections (24) which are to engage and seal against the interior of

the outer tubular member (14) and a plurality of fingers (28) are used to force sealing element (20) outwardly into sealing position. The projections (24) dig into the casing wall to provide the sealing but do not carry out any gripping function to maintain the sealing assembly in such position.

U.S. Patent No. 4,302,018 discloses a well packer in which a sealing ring (60) is forced outwardly between die surfaces by pressure and engages the interior of the tubular member to which they are to seal. It suggests an aluminum insert (136) in the outer sealing surface of the titanium sealing ring (130) which carried serrations (138). The softer aluminum provided the sealing.

An object of the present invention is to provide an improved downhole tubing packer which provides a metal-to-metal seal against the interior of the casing.

According to the present invention there is provided a downhole tubing packer for sealing against a well string comprising a sleeve having internal multiple camming surfaces and an internal recess, means for closing the recess to define an annular space, a piston movably positioned in said space and having external multiple camming surfaces which can coact with the internal multiple camming surfaces on the sleeve, said piston being movable in response to fluid pressure applied to said annular space,

characterised in that said sleeve has a plurality of external annular groove and a plurality of lands between said grooves, said lands and grooves providing gripping and sealing means for gripping and sealing against the interior of a well string, movement of said piston in response to fluid pressure, forcing said sleeve outwardly so that said lands are urged to dig into the interior surface of a well string so that they are in tight sealing and gripping engagement with said interior surface.

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 partial sectional view of a packer positioned within a well bore at the level at which it is to be set against the interior of the casing.

FIGURE 2 is a partial sectional view of the improved packer set into sealing engagement with the interior of the casing.

FIGURE 3 is an enlarged detail sectional view of two of the grooves and the land between the groove and showing its engagement with the interior of the casing.

As shown in FIGURE 1, improved sealing packer 10 of the present invention is shown positioned within well string 12 at the level at which it is to be set. Sealing packer 10 is run into the well on tubing string 14 which threads into upward facing flange

15 of sleeve 16. Sleeve 16 includes internal annular recess 18 and liner 20 is positioned between upper downwardly facing inner shoulder 22 in the interior of flange 15 and lower upwardly facing shoulder 24 on the closure ring 26 which is threaded into the lower end of sleeve 16. Tubing string 28 below sealing packer 10 is threaded into the interior of closure ring 26. Annular space 30 is formed between the exterior of liner 20 and the interior of sleeve 16 below shoulder 32 at the upper end of recess 18 and the upper surface of closure ring 26. Port 34 extending through the lower portion of liner 20 to provide communication into the lower portion of annular space 30. Annular piston 36 is positioned within annular space 30 and includes inner and outer seals 38 and 40 for sealing against the interior of the lower portion of sleeve 16 and against the exterior of liner 20. The upper end of liner 20 is sealed to flange 15 by O ring 21 and the lower end is sealed to closure ring 26 by O ring 23.

The exterior surface of sleeve 16 includes a plurality of grooves 42 which are at least partially filled with pressure compensating material 43, such as microspheres in an epoxy matrix or in syntatic form. Lands 44 between grooves 42 are best seen in FIGURE 3 wherein it is shown that lands 44 have a pair of shallow grooves 46 which provide upper annular sharp peak 48, lower annular sharp peak 50 and intermediate annular peak 52. The inner surface of sleeve 16 includes multiple inner camming surfaces 54 in the area of sleeve 16 within the area of grooves 42 on the exterior of sleeve 16. Surface 56 immediately above closure ring 26 is smooth to allow sealing of outer seal 40. Ports 58 extend through sleeve 16 at a level above the highest level of seal 40 and is provided to communicate with groove 60 in the lower outer surface of piston 36 to provide for pressure equalization which is needed responsive to the movement of piston 36 to ensure that its movement is not impeded by a pressure lock. Piston 36 includes external multiple outer camming surfaces 62 which mate with camming surfaces 54 on the interior of sleeve 16.

Setting of sealing packer 10 is accomplished by pressuring tubing string 14 so that fluid under pressure flows through ports 34 and into annular space 30 below piston 36. The pressure under piston 36 forces it upwardly causing camming surfaces 54 and 62 to coact forcing sleeve 16 outward into tight gripping and sealing engagement with the interior of well string 12 to create a positive metal-to-metal seal and also an anchoring of sealing packer 10 to well string 12. The engagement of sleeve 16 with the interior of well string 12 is clearly shown in FIGURE 3. As can be seen from the drawing, sharp peaks 48, 50 and 52 of lands 44 actually deform the interior surface of well string 12 by digging therein as shown in the drawing.

With sealing packer 10 set as described above, the relieving of pressure supplied to annular space 30 does not cause the downward movement of piston 36 since it has moved sufficiently far so that its outer cylindrical surfaces 64 are engaged by inner cylindrical surfaces 66 of sleeve 16 so that there no tapered surfaces in the camming surfaces in engagement between piston 36 and sleeve 16 which might cause any reversing forces on piston 36. Thus, improved sealing packer 10 is set into tight gripping and sealing metal-to-metal engagement with the wall of well string 12 within which it is positioned.

Claims

1. A downhole tubing packer for sealing against a well string comprising a sleeve (16) having internal multiple camming surfaces (54) and an internal recess (18), means (20) for closing the recess to define an annular space (30), a piston (36) movably positioned in said space and having external multiple camming surfaces (62) which can coact with the internal multiple camming surfaces on the sleeve (16), said piston being movable in response to fluid pressure applied to said annular space (20),

characterised in that said sleeve (16) has a plurality of external annular grooves (42) and a plurality of lands (44) between said grooves (42), said lands and grooves (42, 44) providing gripping and sealing means for gripping and sealing against the interior of a well string, movement of said piston (36) in response to fluid pressure, forcing said sleeve (16) outwardly so that said lands (44) are urged to dig into the interior surface of a well string so that they are in tight sealing and gripping engagement with said interior surface.

2. A tubing packer (10) according to claim 1 including a pressure compensating material (43) at least partly filling said sleeve grooves (42).
3. A tubing packer (10) according to claim 2 wherein said pressure compensating material (43) comprises microspheres in a suitable matrix.
4. A tubing packer (10) according to claim 3 wherein said matrix is an epoxy.
5. A tubing packer (10) according to claim 3 wherein said matrix is a syntatic foam.
6. A tubing packer (10) according to any preced-

15 of sleeve 16. Sleeve 16 includes internal annular recess 18 and liner 20 is positioned between upper downwardly facing inner shoulder 22 in the interior of flange 15 and lower upwardly facing shoulder 24 on the closure ring 26 which is threaded into the lower end of sleeve 16. Tubing string 28 below sealing packer 10 is threaded into the interior of closure ring 26. Annular space 30 is formed between the exterior of liner 20 and the interior of sleeve 16 below shoulder 32 at the upper end of recess 18 and the upper surface of closure ring 26. Port 34 extending through the lower portion of liner 20 to provide communication into the lower portion of annular space 30. Annular piston 36 is positioned within annular space 30 and includes inner and outer seals 38 and 40 for sealing against the interior of the lower portion of sleeve 16 and against the exterior of liner 20. The upper end of liner 20 is sealed to flange 15 by O ring 21 and the lower end is sealed to closure ring 26 by O ring 23.

The exterior surface of sleeve 16 includes a plurality of grooves 42 which are at least partially filled with pressure compensating material 43, such as microspheres in an epoxy matrix or in syntactic form. Lands 44 between grooves 42 are best seen in FIGURE 3 wherein it is shown that lands 44 have a pair of shallow grooves 46 which provide upper annular sharp peak 48, lower annular sharp peak 50 and intermediate annular peak 52. The inner surface of sleeve 16 includes multiple inner camming surfaces 54 in the area of sleeve 16 within the area of grooves 42 on the exterior of sleeve 16. Surface 56 immediately above closure ring 26 is smooth to allow sealing of outer seal 40. Ports 58 extend through sleeve 16 at a level above the highest level of seal 40 and is provided to communicate with groove 60 in the lower outer surface of piston 36 to provide for pressure equalization which is needed responsive to the movement of piston 36 to ensure that its movement is not impeded by a pressure lock. Piston 36 includes external multiple outer camming surfaces 62 which mate with camming surfaces 54 on the interior of sleeve 16.

Setting of sealing packer 10 is accomplished by pressuring tubing string 14 so that fluid under pressure flows through ports 34 and into annular space 30 below piston 36. The pressure under piston 36 forces it upwardly causing camming surfaces 54 and 62 to coact forcing sleeve 16 outward into tight gripping and sealing engagement with the interior of well string 12 to create a positive metal-to-metal seal and also an anchoring of sealing packer 10 to well string 12. The engagement of sleeve 16 with the interior of well string 12 is clearly shown in FIGURE 3. As can be seen from the drawing, sharp peaks 48, 50 and 52 of lands 44 actually deform the interior surface of well string 12 by digging therein as shown in the drawing.

With sealing packer 10 set as described above, the relieving of pressure supplied to annular space 30 does not cause the downward movement of piston 36 since it has moved sufficiently far so that its outer cylindrical surfaces 64 are engaged by inner cylindrical surfaces 66 of sleeve 16 so that there no tapered surfaces in the camming surfaces in engagement between piston 36 and sleeve 16 which might cause any reversing forces on piston 36. Thus, improved sealing packer 10 is set into tight gripping and sealing metal-to-metal engagement with the wall of well string 12 within which it is positioned.

Claims

1. A downhole tubing packer for sealing against a well string comprising a sleeve (16) having internal multiple camming surfaces (54) and an internal recess (18), means (20) for closing (14) the recess to define an annular space (30), a piston (36) movably positioned in said space and having external multiple camming surfaces (62) which can coact with the internal multiple camming surfaces on the sleeve (16), said piston being movable in response to fluid pressure applied to said annular space (20),

characterised in that said sleeve (16) has a plurality of external annular grooves (42) and a plurality of lands (44) between said grooves (42), said lands and grooves (42, 44) providing gripping and sealing means for gripping and sealing against the interior of a well string, movement of said piston (36) in response to fluid pressure, forcing said sleeve (16) outwardly so that said lands (44) are urged to dig into the interior surface of a well string so that they are in tight sealing and gripping engagement with said interior surface.

2. A tubing packer (10) according to claim 1 including

a pressure compensating material (43) at least partly filling said sleeve grooves (42).

3. A tubing packer (10) according to claim 2 wherein

said pressure compensating material (43) comprises microspheres in a suitable matrix.

4. A tubing packer (10) according to claim 3 wherein said matrix is an epoxy.

5. A tubing packer (10) according to claim 3 wherein

said matrix is a syntactic foam.

6. A tubing packer (10) according to any preced-



ing claim wherein

the lands (44) between said sleeve grooves (42) include sharp projections (48, 50, 52) to dig into the interior surface.

7. A tubing packer (10) according to any preceding claim, wherein
the exterior surface of the lands (4) between said sleeve grooves (42) include a shallow upper annular groove (46) and a lower shallow annular groove (46).
8. A tubing packer (10) according to any preceding claim including
a tubing string (14) connected to the upper end of said sleeve (16), and
a port (34) extending from the interior of the means (20) closing said recess (18) into said annular space (30) provides means for fluid pressure to said annular space.
9. A tubing packer (10) according to any preceding claim, wherein said camming surface (54, 62) on said sleeve (16) and said piston (36) include
cam surfaces which taper with respect to the axes of said sleeve and piston and are alternated with inner and outer cylindrical surfaces.
10. A tubing packer (10) according to any preceding claim, wherein said means closing said internal recess (18) includes
a liner (20) positioned within said sleeve (16).

Patentansprüche

Steigrohrpacker zum Abdichten gegen einen Bohrlochstrang mit einem Zylinder (16) mit inneren Mehrfachnockenflächen (54) und einer inneren Aussparung (18), einer Einrichtung (20) zum Verschließen (14) der Aussparung zur Bildung eines ringförmigen Raums 30, einem Kolben (36), der beweglich in dem Raum positioniert ist und äußere Mehrfachnockenflächen (62) hat, die mit den inneren Mehrfachnockenflächen an dem Zylinder (16) zusammenwirken können, wobei der Kolben entsprechend dem auf den ringförmigen Raum (20) aufgebrachten Fluiddruck bewegbar ist, dadurch gekennzeichnet, daß der Zylinder (16) mehrere äußere ringförmige Nuten (42) und mehrere hervorstehende Teile (44) zwischen den Nuten (42) hat, daß die hervorstehenden Teile und die Nuten (42, 44) eine Greif- und Abdichtungseinrichtung zum Ergreifen und Abdichten gegen das Inne-

re eines Bohrlochzuges aufweisen, daß die Bewegung des Kolbens (36) entsprechend dem Fluiddruck den Zylinder (16) nach außen zwingt, so daß die hervorstehenden Teile (44) gezwungen werden, sich in die Innenfläche eines Bohrrohrzuges einzugraben, so daß sie in abdichtendem und klemmendem Kontakt mit der Innenfläche stehen.

2. Steigrohrpacker (10) nach Anspruch 1, mit einem Druckkompensationsmaterial (43), welches wenigstens teilweise die Zylindernuten (42) füllt.
3. Steigrohrpacker (10) nach Anspruch 10, wobei das Druckkompensationsmaterial (43) Mikroku- geln in einer geeigneten Matrix enthält.
4. Steigrohrpacker (10) nach Anspruch 3, dadurch gekennzeichnet, daß die Matrix ein Epoxidharz ist.
5. Steigrohrpacker (10) nach Anspruch 3, dadurch gekennzeichnet, daß die Matrix ein synthetischer Schaum ist.
6. Steigrohrpacker (10) nach jedem der vorherge- henden Ansprüche, wobei die hervorstehenden Teile (44) zwischen den Zylindernuten (42) scharfe Vorsprünge (48, 50, 52) haben, die sich in die Innenfläche eingraben.
7. Steigrohrpacker (10) nach jedem der vorherge- henden Ansprüche, wobei die Außenfläche der hervorstehenden Teile (44) zwischen den Zy- lindernuten (42) eine flache obere ringförmige Nut (46) und eine flache untere ringförmige Nut (46) aufweisen.
8. Steigrohrpacker (10) nach jedem der vorherge- henden Ansprüche, mit einem Steigrohrzug (14), der mit dem oberen Ende des Zylinders (16) verbunden ist und einer Bohrung (34), die sich von dem Inneren der Einrichtung (20), die die Aussparung (18) verschließt, in den ringfö- rrigen Raum (30) erstreckt und eine Einrich- tung zur Zuführung von Fluiddruck in den ring- förmigen Raum bildet.
9. Steigrohrpacker (10) nach jedem der vorherge- henden Ansprüche, wobei die Nockenflächen (54, 62) an dem Zylinder (16) und dem Kolben (36) Nockenflächen enthalten, die zu den Ach- sen des Zylinders und des Kolbens geneigt verlaufen und sich mit inneren und äußere Zylinderflächen abwechseln.
10. Steigrohrpacker (10) nach jedem der vorherge-



henen Ansprüche, wobei die Einrichtung zum Verschließen der inneren Aussparung (18) ein Futterrohr (20) aufweist, welches innerhalb des Zylinders (16) angeordnet ist.

Revendications

1. Dispositif d'étanchéité de tube de puits destiné à venir en contact d'étanchéité contre un tube de puits, comprenant un manchon (16) présentant de multiples surfaces de came internes (54) et un évidement interne (18), un moyen (20) pour fermer l'évidement afin de définir un espace annulaire (30), un piston (36) disposé de façon coulissante dans ledit espace et présentant de multiples surfaces de came externes (62) qui peuvent venir en contact avec les multiples surfaces de came internes situées sur le manchon (16), ledit piston pouvant se déplacer en réponse à la pression d'un fluide appliquée dans ledit espace annulaire (30), caractérisé en ce que ledit manchon (16) présente une pluralité de gorges annulaires externes (42) et une pluralité d'appuis (44) situés entre lesdites gorges (42), lesdits appuis et lesdites gorges (42, 44) constituant un moyen d'ancrage et d'étanchéité afin de s'ancrer et de venir en contact d'étanchéité sur l'intérieur du tube de puits, le mouvement dudit piston (36) en réponse à la pression du fluide poussant vers l'extérieur ledit manchon (16) de façon à ce que lesdits appuis (44) soient poussés jusqu'à s'engager dans la surface interne d'un tube de puits de telle sorte qu'ils viennent en contact d'étanchéité et d'ancrage avec ladite surface interne.

2. Dispositif d'étanchéité de tube (10) selon la revendication 1, incluant un matériau de compensation de pression (43) qui remplit au moins partiellement lesdites gorges de manchon (42).

3. Dispositif d'étanchéité de tube (10) selon la revendication 2, dans lequel ledit matériau de compensation de pression (43) comprend des microsphères noyées dans une matrice adaptée.

4. Dispositif d'étanchéité de tube (10) selon la revendication 3, dans lequel ladite matrice est un matériau époxy.

5. Dispositif d'étanchéité de tube (10) selon la revendication 3, dans lequel ladite matrice est une mousse synthétique.

6. Dispositif d'étanchéité de tube (10) selon l'une

quelconque des revendications précédentes, dans lequel les appuis (44) situés entre lesdites gorges de manchon (42) comprennent des protubérances en arêtes vives (48, 50, 52) destinées à s'engager dans la surface interne.

7. Dispositif d'étanchéité de tube (10) selon l'une quelconque des revendications précédentes, dans lequel la surface externe des appuis (44) situés entre lesdites gorges de manchon (42) comprend une gorge annulaire supérieure de faible profondeur (46) et une gorge annulaire inférieure de faible profondeur (46).

8. Dispositif d'étanchéité de tube (10) selon l'une quelconque des revendications précédentes, incluant une barre de tubage (14) connectée à l'extrémité supérieure dudit manchon (16) et un orifice (34) s'étendant depuis l'intérieur du moyen (20) qui ferme ledit évidement (18) jusque dans ledit espace annulaire (30), cet orifice amenant le fluide sous pression dans ledit espace annulaire.

9. Dispositif d'étanchéité de tube (10) selon l'une quelconque des revendications précédentes, dans lequel ladite surface de came (54, 62) dudit manchon (16) et dudit piston (36) comprend des surfaces de came qui sont inclinées par rapport aux axes dudit manchon et dudit piston et qui sont alternées avec des surfaces cylindriques interne et externe.

10. Dispositif d'étanchéité de tube (10) selon l'une quelconque des revendications précédentes, dans lequel ledit moyen permettant de fermer ledit évidement interne (18) comprend une chemise (20) disposée à l'intérieur dudit manchon (16).

