

Description

The present invention relates to an improved elastomer seal in which the elastomer is energized in two stages. The improved seal structure of the present invention has particular applications to annular seals between members such as hanger pack-off seals.

U.S. Patent No. 4,008,898 discloses an annular elastomer seal between facing cylindrical surfaces in which the seal follower or actuator is shear held inactive by a shear pin and the seal support ring is also shear pinned so that the initial seal loading results from the movement of the seal follower and then when the seal exerts sufficient load on the seal support ring it moves downward into the tapering annulus to set the seal radially.

In a further embodiment disclosed therein, the actuator, once released by shearing of the shear pin, compresses the seal radially. A sleeve is arranged to abut the upper surface of the seal when it is pressurized by downhole pressure.

U.S. Patent No. 4,138,144 discloses another wellhead annular sealing assembly in which shear pins are used to control the time of movement of the first member 40 and the locking sleeve 50.

U.S. Patent Nos. 4,407,530, 4,408,783 and 4,416,472 are all directed to an annular packoff for a hanger in which the seals are controlled to be set singly and in series.

U.S. Patent No. 3,004,776 discloses a sealing nut for a pipe coupling having a press ring 15 carried by the nut by a thin section which is intended to be sheared so that the press ring and the sleeve both exert sealing force on the resilient sealing ring. Press ring and sleeve coact to contain sealing ring within nut and around the exterior of pipe-end threads 19.

An object of the present invention is to provide an annular resilient seal in which the seal follower can provide substantial seal loadings.

According to the present invention there is provided a sealing arrangement having an annular resilient seal positionable in an annulus between inner and outer cylindrical surfaces to be sealed,

means for supporting said resilient seal in said annulus to be sealed, and

follower means in engagement with said resilient seal, and movable against said seal to urge it into a tightly sealed position, wherein the follower means comprises a first follower in engagement with said resilient seal and a second follower having an extension thereof in engagement with said resilient seal, and

means releasably securing said second follower to said first follower and arranged to be released by the seal setting force reaching a preselected maximum force

the area of engagement of said second follower with said seal being substantially less than the area of engagement of said first follower with said seal, and characterised in that: both the first and second follower engage the same annular face of said seal and wherein

subsequently to said release, said second follower can move further against the annular face of said seal.

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 the improved annular resilient seal of the present invention installed between the exterior of a well hanger and the interior of a well housing.

FIGURE 2 is another partial sectional view of the seal shown in FIGURE 1 after it is partially energized to its set position by the follower assembly.

FIGURE 3 is another partial sectional view of the seal shown in FIGURE 1 and 2 illustrating the completely energized seal by the second portion of the follower assembly.

FIGURE 4 is another partial sectional view of another form of the improved seal of the present invention prior to its energization.

FIGURE 5 is another partial sectional view of the seal of FIGURE 4 in its partially set position.

FIGURE 6 is another partial sectional view of the seal of FIGURES 4 and 5 in its completely energized position by the second portion of the follower assembly.

FIGURE 7 is a partial sectional view taken along line 7 - 7 in FIGURE 4 to illustrate the positioning of the seal engaging extension means of the second follower.

Improved seal structure 10 of the present invention is shown in FIGURE 1 as being positioned within wellhead housing 12 and in surrounding relationship to hanger 14. Wellhead housing 10 includes inner cylindrical sealing surface 16 surrounding hanger 14. Hanger includes lower outer surface 18 which is slightly smaller than housing sealing surface 16, intermediate sealing surface 20 which is smaller in diameter than sealing surface 18 with shoulder 22 between surfaces 18 and 20 and upper surface 24 which is smaller than surface 20 with shoulder 26 between surfaces 20 and 24 and includes external threads 28 thereon.

Seal assembly 30 includes annular resilient seal or ring 32, and follower assembly 34. Follower assembly 34 includes first follower 36, second follower 38 and means 40 releasably securing second follower 38 to first follower 36. First follower 36 includes body 42 having internal threads 44 for engaging with threads 28 on the exterior of hanger 14 and setting rim 46 extending downwardly there-

from and having an inner diameter surface 48 which is slightly larger than the diameter of intermediate sealing surface 20, an outer diameter surface 50 which is smaller than the inner diameter of housing sealing surface 16 and lower seal engaging surface 52 which is in engagement with a substantial portion of upper surface 54 of resilient seal 32. Body 42 includes outer reduced diameter surface 56 with threads 58 thereon. Second follower 38 includes central body 60 having internal threads 62 which engage external threads 58 on body 42, lower rim 64 and upper setting rim 66. Lower rim 64 has inner surface 68 which is slightly larger than outer surface 50 of first follower rim 48 and outer surface 70 which is slightly smaller than inner sealing surface 16 of housing 12 so that lower rim 64 can readily move between the exterior of first follower 36 and the interior of housing 12 and lower end 72 which is in engagement with upper seal surface 54. As shown the area of engagement of upper seal surface 54 by lower end 72 of second follower 38 is substantially less than the area of engagement of upper seal surface 54 by lower end surface 52 of first follower 36. Suitable connecting means 74, such as a J slot, is provided on the upper exterior of second follower 38 for the running and setting of seal assembly 30. Releasably securing means 40 is any suitable means such as the shear pin illustrated.

In operation seal assembly 34 is lowered into the position shown in FIGURE 1 with first follower threaded onto external hanger threads 28 and with resilient seal 32 positioned between sealing surface 16 of housing 12 and sealing surface 20 of hanger 14. The lower ends 52 and 72 of first and second followers 36 and 38 are in engagement with upper surface 54 of resilient seal 32. Rotation of second follower 38 causes first follower 36 to be rotated on threads 28 to move follower assembly 34 downwardly against the upper surface 54 of seal 32 causing it to be compressed axially and to expand radially into engagement with surface 16 and 48 of housing 12 and hanger 14, respectively. When the load on seal 32 reaches a preselected amount releasable securing means 40 releases (shear pin shears) so that further rotation of second follower 38 causes it to move downward on external threads 58 on first follower 36. Because of the smaller area of second follower lower rim 64 in engagement with resilient seal 32, the additional movement of second follower will have the effect of increasing the loading on resilient seal 32 without requiring a commensurate increase in the torque loading of follower assembly 34. The mechanical advantage achieved by the lower area of contact of the second follower provides substantial increases in sealing forces over those which could be achieved by the same torque loading of first follower 36. The continued

rotation of second follower 38 moves it downward relative to first follower 36 to the position illustrated in FIGURE 3. Resilient seal 32 is sufficiently confined that it does not extrude from its sealing position.

FIGURES 4 through 7 illustrate a modified form of seal assembly in which the elements of the assembly which are unchanged are given the same number designation with the prefix "1" and the changed components are provided with new number designations. Improved seal assembly 130 is provided to seal between inner sealing surface 116 of housing 112 and external intermediate sealing surface 120 of hanger 114. Seal assembly 130 includes resilient seal ring 132 and follower assembly 134. Follower assembly 134 includes first follower 136 and second follower 138 with releasable securing means 140, such as a shear pin, for securing followers 136 and 138 into a releasable assembly. First follower 136 is threaded onto external hanger threads 128 and includes lower rim 175 which engages substantially all of the upper surface 154 of resilient seal ring 132. Lower rim 175 of first follower 136 includes a plurality of axially extending openings 176 extending therethrough for receiving lower pin ends 178 of second follower 138 which are in the shape of cylindrical pins. Resilient plugs 180 are positioned within openings 176 in lower rim 175 so that pin ends 178 of second follower engage plugs 180 and the force developed by the movement of second follower 138 after the release of releasable securing means 140 is directed through plugs 180 into resilient seal 132. With the area of pin ends 178 and plugs 180 being relatively small compared to the area of contact with seal ring 132 by the end of lower rim 175, a very considerable increase in sealing pressure is provided by this mechanical advantage without substantial increase in the setting torque.

Seal assembly 130 is illustrated in FIGURE 4 as being installed with seal ring 132 in its desired position without any sealing pressure being exerted thereon. Initial sealing is illustrated in FIGURE 5 which is the result of the rotation of follower assembly 134 up to the preselected load at which releasable securing means 140 releases. Thereafter, further rotation of follower assembly 134 causes the axial movement of second follower 138 on first follower 136 to the position illustrated in FIGURE 6.

In both forms of the present invention, the follower assembly is provided which will provide initial loading of the resilient seal until the securing means releases and thereafter further rotation without substantial increase in the torque of rotation provides substantial increase in the sealing pressure exerted on the resilient seal. This sealing assembly which has been illustrated and described as being applicable to the annular seal between a

well housing and hanger has application to many different annular seals in which it would be advantageous to provide a desired level of seal pressure without commensurate torque loading of the follower.

Claims

1. A sealing arrangement (10) having an annular resilient seal (32) positionable in an annulus between inner and outer cylindrical surfaces (16, 20) to be sealed,

means (22) for supporting said resilient seal (32) in said annulus to be sealed, and

follower means (36, 38) in engagement with said resilient seal (32), and movable against said seal (32) to urge it into a tightly sealed position, wherein the follower means comprises a first follower (36) in engagement with said resilient seal (32) and a second follower (38) having an extension (64) thereof in engagement with said resilient seal (32), and

means (40) releasably securing said second follower (38) to said first follower (36) and arranged to be released by the seal (32) setting force reaching a preselected maximum force

the area of engagement of said second follower (38) with said seal (32) being substantially less than the area of engagement of said first follower (36) with said seal (32), and characterised in that: both the first (36) and second (38) follower engage the same annular face (54) of said seal and wherein

subsequently to said release, said second follower (38) can move further against the annular face (54) of said seal (32).

A sealing arrangement (10) according to claim 1, wherein

said second follower (38) includes a thin lower rim (64) extending around the exterior of said first follower into engagement with said seal (32).

3. A sealing arrangement (10) according to claim 1, wherein

said second follower (138) includes a plurality of pins (178) extending axially through openings (176) in said first follower (136) for exerting a force on said seal (132).

4. A sealing arrangement (10) according to claim 3, including

a resilient plug (180) in each of the openings (176) in said first follower (136);

said pins (178) extending into said first follower openings (176) and engaging said

plugs (180),

said plugs (180) engaging said resilient seal (132) and transmitting the force exerted by said pins (178) of said second follower (138) to said resilient seal (132).

5. A sealing arrangement (10) according to any preceding claim, wherein said outer cylindrical surface (16) is on the interior of a well housing (12) and said inner cylindrical surface (20) is on the exterior of a hanger (14), said hanger (14) is positioned within said well housing (12) and having an upwardly facing shoulder (22) for supporting said seal (32).

6. A sealing arrangement (10) according to claim 5, wherein said first follower (36) is movable by means including

threads (28) on the exterior of said hanger (14) above its sealing surface (20), and

threads (44) on the interior of said first follower (36) engaging within said hanger threads (28) whereby rotations of said first follower (36) threads it against said resilient seal (32) to provide an axial loading thereof.

7. A sealing arrangement (10) according to claim 6, wherein said second follower (38) is movable by means including

second threads (58) on the exterior of said first follower (36), and

internal threads (62) on said second follower (38) in engagement with said second threads (58) on said first follower (36),

rotation of said second follower (38) with respect to said first follower (36) moving said second follower (38) axially on the second threads (58) of said first follower (36).

8. A sealing arrangement (10) according to any preceding claim, wherein said releasable securing means (40) includes

a shear pin (40) connecting between said first follower (36) and said second follower (38) for transmitting rotational movement therebetween until a preselected loading is reached and thereafter allowing independent rotation of said second follower (38).

Patentansprüche

1. Dichtungsanordnung (10) mit einer ringförmigen nachgiebigen Dichtung (32), die in einen Ringraum zwischen den inneren und äußeren abzudichtenden Oberflächen (16, 20) einsetzbar ist, mit einer Vorrichtung (22) zur Halterung der nachgiebigen Dichtung (32) in dem abzudich-



well housing and hanger has application to many different annular seals in which it would be advantageous to provide a desired level of seal pressure without commensurate torque loading of the follower.

Claims

1. A sealing arrangement (10) having an annular resilient seal (32) positionable in an annulus between inner and outer cylindrical surfaces (16, 20) to be sealed,

means (22) for supporting said resilient seal (32) in said annulus to be sealed, and

follower means (36, 38) in engagement with said resilient seal (32), and movable against said seal (32) to urge it into a tightly sealed position, wherein the follower means comprises a first follower (36) in engagement with said resilient seal (32) and a second follower (38) having an extension (64) thereof in engagement with said resilient seal (32), and

means (40) releasably securing said second follower (38) to said first follower (36) and arranged to be released by the seal (32) setting force reaching a preselected maximum force

the area of engagement of said second follower (38) with said seal (32) being substantially less than the area of engagement of said first follower (36) with said seal (32), and characterised in that: both the first (36) and second (38) follower engage the same annular face (54) of said seal and wherein

subsequently to said release, said second follower (38) can move further against the annular face (54) of said seal (32).

A sealing arrangement (10) according to claim 1, wherein

said second follower (38) includes a thin lower rim (64) extending around the exterior of said first follower into engagement with said seal (32).

3. A sealing arrangement (10) according to claim 1, wherein

said second follower (138) includes a plurality of pins (178) extending axially through openings (176) in said first follower (136) for exerting a force on said seal (132).

4. A sealing arrangement (10) according to claim 3, including

a resilient plug (180) in each of the openings (176) in said first follower (136),

said pins (178) extending into said first follower openings (176) and engaging said

plugs (180),

said plugs (180) engaging said resilient seal (132) and transmitting the force exerted by said pins (178) of said second follower (138) to said resilient seal (132).

5. A sealing arrangement (10) according to any preceding claim, wherein said outer cylindrical surface (16) is on the interior of a well housing (12) and said inner cylindrical surface (20) is on the exterior of a hanger (14), said hanger (14) is positioned within said well housing (12) and having an upwardly facing shoulder (22) for supporting said seal (32).

6. A sealing arrangement (10) according to claim 5, wherein said first follower (36) is movable by means including

threads (28) on the exterior of said hanger (14) above its sealing surface (20), and

threads (44) on the interior of said first follower (36) engaging within said hanger threads (28) whereby rotations of said first follower (36) threads it against said resilient seal (32) to provide an axial loading thereof.

7. A sealing arrangement (10) according to claim 6, wherein said second follower (38) is movable by means including

second threads (58) on the exterior of said first follower (36), and

internal threads (62) on said second follower (38) in engagement with said second threads (58) on said first follower (36),

rotation of said second follower (38) with respect to said first follower (36) moving said second follower (38) axially on the second threads (58) of said first follower (36).

8. A sealing arrangement (10) according to any preceding claim, wherein said releasable securing means (40) includes

a shear pin (40) connecting between said first follower (36) and said second follower (38) for transmitting rotational movement therebetween until a preselected loading is reached and thereafter allowing independent rotation of said second follower (38).

Patentansprüche

1. Dichtungsanordnung (10) mit einer ringförmigen nachgiebigen Dichtung (32), die in einen Ringraum zwischen den inneren und äußeren abzudichtenden Oberflächen (16, 20) einsetzbar ist, mit einer Vorrichtung (22) zur Halterung der nachgiebigen Dichtung (32) in dem abzudich-



tenden Ringraum, und einer Mitnahmevorrichtung (36, 38), die mit der elastischen Dichtung (32) in Eingriff steht und auf die Dichtung (32) zubewegt werden kann, um diese in eine feste Dichtstellung zu drücken, wobei die Mitnahmevorrichtung einen ersten Mitnehmer (36) mit Eingriff in die elastische Dichtung (32) und einen zweiten Mitnehmer (38) mit einer Erweiterung (64) mit Eingriff in die elastische Dichtung (32) umfaßt, und mit einer Vorrichtung (40), die den zweiten Mitnehmer (38) mit dem ersten Mitnehmer (36) lösbar fixiert und so angeordnet ist, daß sie durch die Einstellkraft der Dichtung (32) bei Erreichen einer vorgewählten Maximalkraft freigesetzt wird, wobei die Eingriffsfläche des zweiten Mitnehmers (38) mit der Dichtung (32) im wesentlichen geringer ist als die Eingriffsfläche des ersten Mitnehmers (36) mit der Dichtung (32) und **dadurch gekennzeichnet** ist, daß sowohl der erste (36) als auch der zweite Mitnehmer (38) mit der gleichen ringförmigen Fläche (54) der Dichtung zusammenwirkt und wobei nach der Freisetzung der zweite Mitnehmer (38) sich weiter auf die ringförmige Fläche (54) der Dichtung (32) zubewegen kann.

2. Dichtungsanordnung (10) nach Anspruch 1, **dadurch gekennzeichnet**, daß der zweite Mitnehmer (38) einen dünnen unteren Rand (64) enthält, der sich um die Außenseite des ersten Mitnehmers in Eingriff mit der Dichtung (32) erstreckt.

3. Dichtungsanordnung (10) nach Anspruch 1, **dadurch gekennzeichnet**, daß der zweite Mitnehmer (138) eine Anzahl von Stiften (178) enthält, welche sich axial durch Öffnungen (176) in dem ersten Mitnehmer (136) erstrecken, um auf die Dichtung (132) eine Kraft auszuüben.

4. Dichtungsanordnung (10) nach Anspruch 3, **gekennzeichnet durch**, einen nachgiebigen Stößel (180) in jeder der Öffnungen (176) des ersten Mitnehmers (136), wobei die Stifte (178) sich in die Öffnungen (176) des ersten Mitnehmers erstrecken und mit den Stößeln (180) zusammenwirken, und wobei die Stößel (180) mit der nachgiebigen Dichtung (132) zusammenwirken und die von den Stiften (178) des zweiten Mitnehmers (138) ausgeübte Kraft auf die elastische Dichtung (132) übertragen.

5. Dichtungsanordnung (10) nach einem der vorhergehenden Ansprüche, **dadurch gekenn-**

zeichnet, daß die äußere zylindrische Oberfläche (16) sich auf der Innenseite eines Bohrlochgehäuses (12) und die innere zylindrische Oberfläche (20) sich auf der Außenseite einer Aufhängevorrichtung (14) befindet, wobei die Aufhängevorrichtung (14) in das Bohrlochgehäuse (12) eingesetzt wird und eine nach oben gerichtete Schulter (22) zur Halterung der Dichtung (32) besitzt.

6. Dichtungsanordnung (10) nach Anspruch 5, **dadurch gekennzeichnet**, daß der erste Mitnehmer (36) durch eine Vorrichtung beweglich ist, die beinhaltet:

ein Gewinde (28) auf der Außenseite der Aufhängevorrichtung (14) oberhalb ihrer Dichtungsfläche (20), und ein Gewinde (44) auf der Innenseite des ersten Mitnehmers (36), des mit dem Gewinde (28) der Aufhängevorrichtung in Eingriff steht, wobei Drehungen des ersten Mitnehmers (36) diesen auf die elastische Dichtung (32) aufschraubt, so daß diese mit einer axialen Belastung versehen ist.

7. Dichtungsanordnung (10) nach Anspruch 6, **dadurch gekennzeichnet**, daß der zweite Mitnehmer (38) durch eine Vorrichtung beweglich ist, die aufweist:

ein zweites Gewinde (58) auf der Außenseite des ersten Mitnehmers (36), und ein Innengewinde (62) auf dem zweiten Mitnehmer (38), das mit dem zweiten Gewinde (58) auf dem ersten Mitnehmer (36) in Eingriff steht,

wobei die Drehung des zweiten Mitnehmers (38) in bezug auf den ersten Mitnehmer (36) den zweiten Mitnehmer (38) axial auf das zweite Gewinde (58) des ersten Mitnehmers (36) zubewegt.

8. Dichtungsanordnung (10) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet**, daß die lösbare Befestigungsvorrichtung (40) aufweist:

einen Scherstift (40), der den ersten Mitnehmer (36) und den zweiten Mitnehmer (38) verbindet, um die Rotationsbewegung zwischen diesen zu übertragen, bis eine vorgewählte Belastung erreicht ist und wonach eine unabhängige Drehung des zweiten Mitnehmers (38) möglich ist.

Revendications

1. Ensemble (10) d'étanchéité ayant un joint élastique annulaire d'étanchéité (32) destiné à être placé dans un anneau disposé entre les surfaces cylindriques interne et externe (16, 20) qui



doivent coopérer de manière étanche,

un dispositif (22) de support du joint élastique (32) dans l'anneau qui doit être fermé de manière étanche, et

un dispositif suiveur (36, 38) coopérant avec le joint élastique d'étanchéité (32) et mobile contre ce joint d'étanchéité (32) afin qu'il le repousse en position intime d'étanchéité, le dispositif suiveur comprenant un premier organe suiveur (36) placé au contact du joint élastique d'étanchéité (32) et un second organe suiveur (38) ayant un prolongement (64) qui est au contact du joint d'étanchéité (32), et

un dispositif (40) de fixation temporaire du second organe suiveur (38) au premier organe suiveur (36) et disposé afin qu'il soit libéré lorsque la force de positionnement du joint d'étanchéité (32) atteint une force maximale prédéterminée,

la surface de contact du second organe suiveur (38) avec le joint d'étanchéité (32) étant nettement inférieure à la surface de contact du premier organe suiveur (36) avec le joint d'étanchéité (32), et caractérisé en ce que le premier (36) et le second (38) organes suiveurs sont au contact de la même face annulaire (54) du joint d'étanchéité, et dans lequel :

après la libération, le second organe suiveur (38) peut continuer à se déplacer contre la face annulaire (54) du joint d'étanchéité (32).

2. Ensemble d'étanchéité (10) selon la revendication 1, dans lequel le second organe suiveur (38) comporte un mince rebord inférieur (64) disposé autour de la partie externe du premier organe suiveur au contact du joint d'étanchéité (32).

Ensemble d'étanchéité (10) selon la revendication 1, dans lequel le second organe suiveur (138) coopère avec plusieurs tiges (178) passant axialement dans des ouvertures (176) formées dans le premier organe suiveur (136) afin qu'elles appliquent une force sur le joint d'étanchéité (132).

4. Ensemble d'étanchéité (10) selon la revendication 3, comprenant

un bouchon élastique (180) dans chacune des ouvertures (176) du premier organe suiveur (136),

les tiges (178) étant disposées dans les ouvertures (176) du premier organe suiveur et étant au contact des bouchons (180),

les bouchons (180) étant au contact du joint élastique d'étanchéité (132) et transmettant la force appliquée par les tiges (178) du second organe suiveur (138) au joint élastique

d'étanchéité (132).

5. Ensemble d'étanchéité (10) selon l'une quelconque des revendications précédentes, dans lequel la surface cylindrique externe (16) se trouve à l'intérieur du boîtier (12) du puits, et la surface cylindrique interne (20) se trouve à l'extérieur d'un organe de suspension (14), cet organe de suspension (14) étant disposé à l'intérieur du boîtier (12) du puits et ayant un épaulement (22) tourné vers le haut et destiné à supporter le joint d'étanchéité (32).

6. Ensemble d'étanchéité (10) selon la revendication 5, dans lequel le premier organe suiveur (36) est mobile sous l'action d'un dispositif qui comprend :

un filetage (28) formé à l'extérieur de l'organe de suspension (14) au-dessus de sa surface d'étanchéité (20), et

un taraudage (44) formé à l'intérieur du premier organe suiveur (36) et coopérant avec le filetage (28) de l'organe de suspension de manière que la rotation du premier organe suiveur (36) provoque son vissage contre le joint élastique d'étanchéité (32) en appliquant une force axiale à celui-ci.

7. Ensemble d'étanchéité (10) selon la revendication 6, dans lequel le second organe suiveur (38) est mobile sous l'action d'un dispositif comprenant :

un second filetage (58) formé à l'extérieur du premier organe suiveur (36), et

un taraudage (62) formé sur le second organe suiveur (38) et en coopération avec le second filetage (58) du premier organe suiveur (36),

la rotation du second organe suiveur (38) par rapport au premier organe suiveur (36) provoquant le déplacement du second organe suiveur (38) axialement sur le second filetage (58) du premier organe suiveur (36).

8. Ensemble d'étanchéité (10) selon l'une quelconque des revendications précédentes, dans lequel le dispositif de fixation temporaire (40) comporte une goupille de cisaillement (40) assurant le raccordement du premier organe suiveur (36) et du second organe suiveur (38) pour la transmission d'un mouvement de rotation entre eux jusqu'à ce qu'une force prédéterminée soit atteinte, et permettant ensuite la rotation indépendante du second organe suiveur (38).