Description

The present invention relates to an improved wellhead structure which is particularly adapted to subsea wells. Such structure includes a wellhead housing and an improved hanger and seal assembly which can be landed and set in a single trip. Prior to the present invention many efforts have been made to provide a satisfactory hanger and seal assembly which allows the landing of the hanger, cementing and the setting of the seal in the annulus between the exterior of the hanger and the interior of the housing.

An object of the present invention is to provide an improved hanger seal assembly for use within a wellhead housing with improved metal to metal sealing against the inner and outer surfaces of the hanger housing annulus and which protects the seal assembly sealing surfaces from damage during running.

US-4823871 discloses a metal to metal sealing assembly for sealing between the interior sealing surface of a well housing and the exterior sealing surface of a hanger landed within the well housing, the sealing assembly comprising an annular seal body having an outer seal lip, and a plurality of inner ridges; and energising means for engaging the outer seal lip and urging it outwardly to position the seal lip in sealing engagement with the interior sealing surface of the housing, and, according to the present invention, such an assembly is characterised by the outer seal lip having a first sealing surface and a second protecting surface with the second protecting surface having a larger free diameter than the diameter of the first sealing surface whereby any engagement with the interior surface of the well housing during running occurs at the second protecting surface such that the first sealing surface is protected from being scratched or otherwise damaged by such contact.

In a construction in accordance with the present invention, the hanger is landed within the well housing before the seal assembly is moved into sealing position between the housing and the hanger. The seal assembly is lowered into sealing position between the external hanger sealing surface which is defined on the interior of the well housing and is spaced from the internal housing sealing surface and includes a seal body having external metal sealing lips diverging outward but having an initial free diameter less than the diameter of the housing internal sealing surface and internal metal sealing surfaces on the inner surface of the seal body having a free diameter smaller than the diameter of the hanger external sealing surface, a lower energizer ring movably connected to the seal body and having an upstanding rim which stores the force created by its engaging and moving the lower outer sealing lip to its set position, an upper energizer ring movably connected to the seal body and having a depending rim which stores the force created by its engaging and moving the upper lip to its set position. The lower outer sealing lip includes a first lower sealing surface and a second protecting surface spaced thereabove. The upper sealing lip is the mirror image of the lower sealing lip and includes a first outer sealing surface and a second protecting surface spaced thereabove. During running the second protecting surfaces have larger diameters than the first sealing surfaces so that if the sealing lip comes into contact with the housing through which it is passing the first sealing surfaces do not come into contact with the inner surface of the housing and are thereby protected against scratches and other damage during running. When the sealing lips are moved into set position the first sealing surfaces are moved into sealing engagement with the inner surface of the surrounding housing. Additionally, the surfaces of the lips which may come into contact with the interior of the housing are provided with a coating of a soft, scratch healing material, such as silver plating. The interior projections which provide the interior sealing are spaced along the interior of the seal body by recesses which are either sufficiently deep to avoid problems with liquids trapped therein during setting or have a liquid exclusion material therein. Means for securing or locking the seal assembly and the energizer rings in their set position is included and such securing means includes means for engaging within grooves on the exterior of the hanger and on the interior of the housing. In all forms of the invention there is provided some means for storing the force of the rip setting force and this may include the storing of both axial and radial forces generated for setting the sealing lips.

In the accompanying drawings:

FIGURE 1 is a sectional elevation view of a hanger landed within a well housing and the improved seal assembly of the present invention being in position for lowering into sealing position across the annulus between the hanger external sealing surface and the well housing internal sealing surface.

FIGURE 2 is a partial sectional view illustrating the seal assembly in its landed and set position in the hanger-housing annulus.

FIGURE 3 is a detailed partial sectional view of the seal assembly of the present invention in its unset position.

FIGURE 4 is a partial enlarged sectional view of the lower seal lip and the energizing ring as shown in FIGURE 3.

FIGURE 5 is a detailed partial sectional view of the seal assembly shown in FIGURE 3 after it has been moved to its set position.

FIGURE 6 is a partial enlarged sectional view of the lower seal lip and its energizing ring as shown in FIGURE 5.

Improved seal assembly 10 of the present invention, as shown in FIGURE 1, is illustrated while being lowered within well housing 12 and into annulus 14 between the interior of well housing 12 and the exterior of hanger 16 which has been landed within well housing 12. As shown in FIGURE 1, hangers 16A and 16B have previously been landed within housing 12 and their respective seal

assemblies 10A and 10B have been landed and energized in the respective annuli 14A and 14B. Seal assembly 10 is supported from setting assembly 18 and setting assembly 18 is supported on a suitable tool (not shown) which can move the setting assembly 18 after landing into its set position as hereinafter described.

Seal assembly 10 includes annular body 20, lower energizer ring 22, and upper energizer ring 24 as shown in FIGURES 2 and 3. Lower energizer ring 22 is movably attached to lower rim 26 of body 20 by split ring 28 which is positioned in groove 30 on the interior of energizer ring 22 and in elongated groove 32 in the exterior of lower body rim 26. This allows relative axial movement of energizer ring 22 with respect to body 20. Upper energizer ring 24 is movably attached to upper rim 34 of body 20 by split ring 36 which is positioned in groove 38 on the interior of energizer ring 24 and in elongated groove 40 on the exterior of upper body rim 34. This allows relative axial movement of energizer ring 24 with respect to body 20. Windows 42 are provided in upper energizer ring 24 with exterior latching ring 44 and interior split locking ring 46 positioned around ring 24 and biased inwardly and outwardly respectively. Wedge elements 48 are positioned within windows 42 immediately above exterior latching ring 44 during running and have a lower outer tapered surface 50 which coacts with upper inner tapered surface 52 on exterior latching ring 44. Ring 54 is positioned within energizer rim 66 of ring 24 and is secured by cap screws 56, or other suitable securing means, to wedge elements 48 as shown. Ring 54 includes lower tapered surface 50 which coacts with upper outer tapered surface 60 on split locking ring 46 as hereinafter explained. Ring 54 includes inner flange 62 and upper surface 64 which during running is at approximately the same level as upper surface 66 on upper energizer ring 24.

When seal assembly 10 is landed with the lower end of lower energizer ring 22 on the exterior shoulder 68 provided by hanger 16, setting is accomplished by causing the setting tool to push downwardly on the upper surface 66 of upper energizer ring 24. After setting is complete as hereinafter described, then pushing downwardly on ring 54 causes exterior latching ring 44 to be wedged outwardly into internal housing groove 70 and interior latching ring 46 to be wedged inwardly into hanger groove 72 to lock seal assembly 10 in its landed and set position.

As shown in FIGURES 3 and 4, seal body 20 includes upper annular lip 74 and lower annular lip 76. Upper annular lip 74 extends outwardly from the exterior of body 20 and then extends upwardly to a generally axial upward position. Lower annular lip 76 extends outwardly from the exterior of body 20 and then extends downwardly to a generally axial downward position. The outer end of lips 74 and 76 include sealing lobes or surfaces 74a and 76a respectively at the outer extremity thereof as shown and protecting lobes or surfaces 74b and 76b respectively on the exterior surface of the lips 74 and 76 which extend generally axially and such surfaces 74b and 76b are spaced from surfaces 74a and 76a respectively by grooves 74c and 76c respectively. The diameter of protective surfaces 74b and 76b are larger in their free position than the outer diameter of sealing surfaces 74a and 76a as shown in FIGURES 3 and 4. In running position the exterior diameter of surfaces 74b and 76b is smaller than the inner diameter of housing 12. During running it is hoped that neither the sealing surfaces nor the protecting surfaces will be scratched or damaged by contact with the interior of the well housing 12. In any case even if the protecting surfaces 74b and 76b are scratched or otherwise damaged, they will have protected sealing surfaces 74a and 76a from such damage. Further a coating 77 of a scratch healing soft metal is provided on the surfaces 74a, b and c and 76a, b and c. This coating is preferred to be with a metal such a silver or lead and a silver plating is preferred. With this coating any scratches on the sealing surfaces 74a or 76a will not interfere with the sealing engagement of such surfaces with the interior of the well housing 12 as shown in FIGURES 5 and 6. The coating 77 will be sufficiently soft so that when sealing surfaces 74a and 76a are forced into engagement with the housing interior, the metal of the coating will be sufficiently soft to flow into the scratch and avoid sealing problems.

As best seen in Figure 5, upper energizer ring 24 has its inner surface spaced slightly outward from the exterior surface of upper rim 34 and a lower tapered surface 78 which engages the inner surface of upper lip 74 during setting to move it radially outward to the set position in metal-to-metal sealing engagement with the interior surface of housing 12. Lower energizer ring 22 has its inner surface spaced slightly outward from the exterior surface of lower rim 26 and an upper tapered surface 80 which engages the inner surface of lower lip 76 during setting to move it radially outward to the set position in metal-to-metal sealing engagement with the interior surface of housing 12.

The present invention uses a high yield strength steel for energizer rings 22 and 24 and uses a lower yield strength steel for upper and lower lips 74 and 76. This allows lips 74 and 76 to have sufficient malleability when forced against the interior of housing 12 to flow into the flaws and irregularities of such surface and ensure that there is complete metal-to-metal sealing. With the high yield strength energizer rings 22 and 24, they are subjected to a slight inward elastic deflection at their extremities as shown in FIGURE 6. This effectively stores the setting forces to ensure continued sealing of lips 74 and 76 against the interior of housing 12.

As best seen in Figure 5, the interior of body 20 includes a series of annular ridges 82 separated by grooves 84. The inner diameters of ridges 82 are smaller than the diameter of the exterior portion of hanger 16 against which seal body 20 is to engage and seal. Care should be taken with the depth of grooves 84 to avoid problems with the build-up of pressure in liquids trapped

therein during setting so that the sealing loads of the ridges 82 are not reduced thereby. It is preferred that if the grooves 84 have a radial dimension of approximately 0.005" a water exclusion material or a volume compensating material should be provided in grooves 84 so that the water pressure developed therein does not interfere or lessen the sealing load of the ridges 82 against the exterior surface of hanger 16. If there is some objection to the use of such materials, then it is suggested that the depth of grooves 84 be at least 0.040". This depth of grooves 84 is selected so that the compressibility of the volume of trapped fluid due to its bulk modulus is sufficient to prevent excessive pressure build-up due to flexing of the metal seal. Upper resilient sealing ring 86 is positioned in upper groove 88 and lower resilient sealing ring 90 is positioned in lower groove 92. Sealing rings 86 and 90 provide supplemental sealing between the interior of seal body 20 and the exterior of hanger 16.

It should be noted that in order to'ensure engagement of the ridges 82 with the exterior portion of hanger 16 the interior portions of energizer rings 22 and 24 are provided with inwardly extending projections 94 and 96, respectively, which are positioned immediately outside of lower and upper ridges 82 when seal assembly 10 is set as shown in Figure 5. Projections 94 and 96 have a radial dimension which ensures that upper and lower ridges 82 are in sealing engagement with the exterior portion of hanger 16.

With the configuration of the wedging ends of energizer rings 22 and 24 the forces exerted on sealing lips 74 and 76 are exerted by the axially extending surfaces 98 and 100. This causes only radial forces to be exerted on lips 74 and 76 so that there is no axial force tending to urge the energizer rings axially away from the sealing lips.

Claims

1. A metal to metal sealing assembly for sealing between the interior sealing surface of a well housing (12) and the exterior sealing surface of a hanger (16) landed within the well housing, the sealing assembly comprising an annular seal body (20) having an outer seal lip (76,78), and a plurality of inner ridges (82); and energising means (22,24) for engaging the outer seal lip and urging it outwardly to position the seal lip in sealing engagement with the interior sealing surface of the housing, characterised by the outer seal lip having a first sealing surface (74,76) and a second protecting surface (74b,76b) with the second protecting surface having a larger free diameter than the diameter of the first sealing surface whereby any engagement with the interior surface of the well housing during running occurs at the second protecting surface such that the first sealing surface is protected from being scratched or otherwise damaged by such contact.

2. A sealing assembly according to claim 1, wherein the annular seal body (20) has both outer upper (74) and outer lower (76) ones of the seal lip, each with respective ones of the sealing and protecting surfaces (74a,76a;74b,76b), and with respective ones of the engaging means (22,24).

3. A sealing assembly according to claim 1 or claim 2, wherein the or each first sealing surface (74a,76a) is a rounded surface on the outer end of the outer seal lip (74,76) the or each second protecting surface (74b,76b) is a rounded surface spaced from the first sealing surface towards connection of the outer seal lip (74,76) to the annular seal body (20).

4. A sealing assembly according to any one of the preceding claims, including a coating (77) of a soft scratch healing metal material on the or each first sealing surface (74a,76a), on the or each second protecting surface (74b,76b) and on the surface of the or each outer seal lip between said surfaces.

5. A sealing assembly according to claim 4, wherein the coating (77) is silver.

6. A sealing assembly according to any one of the preceding claims, wherein the inner ridges (82) have grooves (84) therebetween the inner diameter which is smaller than the outer diameter of the exterior sealing surface of the hanger (16).

7. A sealing assembly according to claim 6, including means for preventing excessive pressures being generated in liquids trapped in the grooves (84) between the ridges (82).

8. A sealing assembly according to claim 7, wherein the excess pressure prevention means includes a water exclusion material in the grooves (84).

9. A sealing assembly according to claim 7, wherein the excess pressure prevention means includes having the depth of the grooves (84) being at least 0.040 inches.

10. A sealing assembly according to any one of the preceding claims, wherein the energising means includes means (44,46) for preventing its retraction from its setting engagement with the seal lip (74,76).

11. A sealing assembly according to claim 1, wherein the energising means includes an annular body (22,24) and a wedge (78,80) engaging the or each seal lip (74,76).

therein during setting so that the sealing loads of the ridges 82 are not reduced thereby. It is preferred that if the grooves 84 have a radial dimension of approximately 0.005" a water exclusion material or a volume compensating material should be provided in grooves 84 so that the water pressure developed therein does not interfere or lessen the sealing load of the ridges 82 against the exterior surface of hanger 16. If there is some objection to the use of such materials, then it is suggested that the depth of grooves 84 be at least 0.040". This depth of grooves 84 is selected so that the compressibility of the volume of trapped fluid due to its bulk modulus is sufficient to prevent excessive pressure build-up due to flexing of the metal seal. Upper resilient sealing ring 86 is positioned in upper groove 88 and lower resilient sealing ring 90 is positioned in lower groove 92. Sealing rings 86 and 90 provide supplemental sealing between the interior of seal body 20 and the exterior of hanger 16.

It should be noted that in order to ensure engagement of the ridges 82 with the exterior portion of hanger 16 the interior portions of energizer rings 22 and 24 are provided with inwardly extending projections 94 and 96, respectively, which are positioned immediately outside of lower and upper ridges 82 when seal assembly 10 is set as shown in Figure 5. Projections 94 and 96 have a radial dimension which ensures that upper and lower ridges 82 are in sealing engagement with the exterior portion of hanger 16.

With the configuration of the wedging ends of energizer rings 22 and 24 the forces exerted on sealing lips 74 and 76 are exerted by the axially extending surfaces 98 and 100. This causes only radial forces to be exerted on lips 74 and 76 so that there is no axial force tending to urge the energizer rings axially away from the sealing lips.

Claims

1. A metal to metal sealing assembly for sealing between the interior sealing surface of a well housing (12) and the exterior sealing surface of a hanger (16) landed within the well housing, the sealing assembly comprising an annular seal body (20) having an outer seal lip (76,78), and a plurality of inner ridges (82); and energising means (22,24) for engaging the outer seal lip and urging it outwardly to position the seal lip in sealing engagement with the interior sealing surface of the housing, characterised by the outer seal lip having a first sealing surface (74,76) and a second protecting surface (74b,76b) with the second protecting surface having a larger free diameter than the diameter of the first sealing surface whereby any engagement with the interior surface of the well housing during running occurs at the second protecting surface such that the first sealing surface is protected from being scratched or otherwise damaged by such contact.

2. A sealing assembly according to claim 1, wherein the annular seal body (20) has both outer upper (74) and outer lower (76) ones of the seal lip, each with respective ones of the sealing and protecting surfaces (74a,76a;74b,76b), and with respective ones of the engaging means (22,24).

3. A sealing assembly according to claim 1 or claim 2, wherein the or each first sealing surface (74a,76a) is a rounded surface on the outer end of the outer seal lip (74,76) the or each second protecting surface (74b,76b) is a rounded surface spaced from the first sealing surface towards connection of the outer seal lip (74,76) to the annular seal body (20).

4. A sealing assembly according to any one of the preceding claims, including a coating (77) of a soft scratch healing metal material on the or each first sealing surface (74a,76a), on the or each second protecting surface (74b,76b) and on the surface of the or each outer seal lip between said surfaces.

5. A sealing assembly according to claim 4, wherein the coating (77) is silver.

6. A sealing assembly according to any one of the preceding claims, wherein the inner ridges (82) have grooves (84) therebetween the inner diameter which is smaller than the outer diameter of the exterior sealing surface of the hanger (16).

7. A sealing assembly according to claim 6, including means for preventing excessive pressures being generated in liquids trapped in the grooves (84) between the ridges (82).

8. A sealing assembly according to claim 7, wherein the excess pressure prevention means includes a water exclusion material in the grooves (84).

9. A sealing assembly according to claim 7, wherein the excess pressure prevention means includes having the depth of the grooves (84) being at least 0.040 inches.

10. A sealing assembly according to any one of the preceding claims, wherein the energising means includes means (44,46) for preventing its retraction from its setting engagement with the seal lip (74,76).

11. A sealing assembly according to claim 1, wherein the energising means includes an annular body (22,24) and a wedge (78,80) engaging the or each seal lip (74,76).

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Patentansprüche

1. Metall gegen Metall-Abdichtanordnung zum Abdichten zwischen der inneren Dichtfläche eines Bohrlochgehäuses (12) und der äußeren Dichtfläche eines Aufhängers (16), der innerhalb des Bohrlochgehäuses angeordnet ist, wobei die Abdichtanordnung einen ringförmigen Dichtkörper (20) aufweist, der eine äußere Dichtlippe (76, 78) und eine Vielzahl von inneren Rippen (82) aufweist; und Angriffsmittel (22, 24) zum Angriff an der äußeren Dichtlippe und zum Nachaußendrücken derselben, um die Dichtlippe in Dichteingriff mit der inneren Dichtfläche des Gehäuses zu positionieren, dadurch gekennzeichnet, daß die äußere Dichtlippe eine erste Dichtfläche (74, 76) und eine zweite Schutzfläche (74b, 76b) aufweist, wobei die zweite Schutzfläche einen größeren Durchmesser als die erste Dichtfläche hat, so daß jeder Eingriff mit der Innenfläche des Bohrlochgehäuses während des Betriebes an der zweiten Schutzfläche auftritt, derart, daß die erste Dichtfläche vor einem Zerkratzen oder einer sonstigen Beschädigung infolge einer solchen Berührung geschützt ist.

2. Abdichtanordnung nach Anspruch 1, bei welcher der ringförmige Dichtkörper (20) sowohl eine äußere obere (74) und eine äußere untere (76) Dichtlippe aufweist, die je mit entsprechenden Dicht- und Schutzflächen (74a, 76a; 74b, 76b) und mit entsprechenden Angriffsmitteln (22, 24) versehen sind.

3. Abdichtanordnung nach Anspruch 1 oder 2, bei welcher die bzw. jede erste Dichtfläche (74a, 76a) eine gerundete Fläche am äußeren Ende der äußeren Dichtlippe (74, 76) ist, wobei die bzw. jede zweite Schutzfläche (74b, 76b) eine gerundete Fläche ist, die von der ersten Dichtfläche gegen die Verbindung der äußeren Dichtlippe (74, 76) zum ringförmigen Dichtkörper (20) hin Abstand hat.

4. Abdichtanordnung nach einem der vorhergehenden Ansprüche, mit einer Beschichtung (77) aus einem weichen, Kratzer heilenden Metallmaterial an der bzw. jeder ersten Dichtfläche (74a, 76a), an der bzw. jeder zweiten Schutzfläche (74b, 76b) und an der Oberfläche der bzw. jeder äußeren Dichtlippe zwischen den vorerwähnten Flächen.

5. Abdichtanordnung nach Anspruch 4, bei welcher die Beschichtung (77) aus Silber besteht.

6. Abdichtanordnung nach einem der vorhergehenden Ansprüche, bei welcher zwischen den inneren Rippen (82) Nuten (84) vorgesehen sind, deren Innendurchmesser kleiner ist als der Außendurchmesser der äußeren Dichtfläche des Aufhängers (16).

7. Abdichtanordnung nach Anspruch 6, mit Mitteln, welche die Erzeugung übermäßiger Drücke in Flüssigkeiten verhindern, die in den Nuten (84) zwischen den Rippen (82) eingeschlossen sind.

8. Abdichtanordnung nach Anspruch 7, bei welcher die Mittel zur Verhinderung eines übermäßigen Druckes durch ein Wasserausschlußmaterial in den Nuten (84) gebildet sind.

9. Abdichtanordnung nach Anspruch 7, bei welcher die Mittel zur Verhinderung eines übermäßigen Druckes durch eine Tiefe der Nuten (84) von zumindest 0,040 Zoll gebildet sind.

10. Abdichtanordnung nach einem der vorhergehenden Ansprüche, bei welcher die Angriffsmittel Mittel (44, 46) zur Verhinderung ihres Zurückziehens aus dem Einstelleingriff mit der Dichtlippe (74, 76) aufweisen.

11. Abdichtanordnung nach Anspruch 1, bei welcher die Angriffsmittel einen ringförmigen Körper (22, 24) und einen Keil (78, 80) aufweisen, welcher mit der bzw. jeder Dichtlippe (74, 76) im Eingriff steht.

Revendications

1. Dispositif d'étanchéité métal sur métal destiné à réaliser une étanchéité entre la surface intérieure d'étanchéité d'un carter de puits (12) et la surface extérieure d'étanchéité d'une suspension (16) installée à l'intérieur du carter de puits, le dispositif d'étanchéité comprenant un corps annulaire d'étanchéité (20) qui comporte une lèvre extérieure d'étanchéité (76, 78), et une série de nervures intérieures (82); et un moyen d'actionnement (22, 24) pour mettre en contact la lèvre extérieure d'étanchéité et la pousser vers l'extérieur afin de positionner la lèvre d'étanchéité en contact étanche avec la surface intérieure d'étanchéité du carter, caractérisé par le fait que la lèvre extérieure d'étanchéité comporte une première surface d'étanchéité (74, 76) et une deuxième surface protectrice (74b, 76b), la deuxième surface protectrice étant d'un diamètre libre supérieur au diamètre de la première surface d'étanchéité, grâce à quoi un contact quelconque avec la surface intérieure du carter de puits pendant le fonctionnement se produit à la deuxième surface protectrice, de sorte que la première surface d'étanchéité est protégée vis-à-vis de toute éraflure ou d'autres dommages dus à un tel contact.

2. Dispositif d'étanchéité selon la revendication 1, dans lequel le corps annulaire d'étanchéité (20) comporte des lèvres extérieure supérieure (74) et extérieure inférieure (76) d'étanchéité, chacune étant pourvue de surfaces respectives d'étanchéité

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et de protection (74a, 76a; 74b, 76b), et de moyens respectifs (22, 24) de contact.

3. Dispositif d'étanchéité selon la revendication 1 ou la revendication 2, dans lequel la ou chaque première surface d'étanchéité (74a, 76a) est une surface arrondie située sur l'extrémité extérieure de la lèvre extérieure d'étanchéité (74, 76), la ou chaque deuxième surface protectrice (74b, 76b) est une surface arrondie à une certaine distance de la première surface d'étanchéité en direction de la connexion de la lèvre extérieure d'étanchéité (74, 76) au corps annulaire d'étanchéité (20).

4. Dispositif d'étanchéité selon l'une quelconque des revendications précédentes, incluant un revêtement (77) fait d'un matériau métallique doux qui régénère les éraflures sur la ou chaque première surface d'étanchéité (74a, 76a), ou sur la ou chaque deuxième surface protectrice (74b, 76b) et sur la surface de la lèvre extérieure d'étanchéité ou de chacune d'elles entre lesdites surfaces.

5. Dispositif d'étanchéité selon la revendication 4, dans lequel le revêtement (77) est en argent.

6. Dispositif d'étanchéité selon l'une quelconque des revendications précédentes, dans lequel les nervures intérieures (82) comportent entre elles des rainures (84) dont le diamètre intérieur est inférieur au diamètre extérieur de la surface extérieure d'étanchéité de la suspension (16).

7. Dispositif d'étanchéité selon la revendication 6, incluant un moyen destiné à empêcher que des pressions excessives ne soient engendrées dans des liquides piégés dans les rainures (84) entre les nervures (82).

8. Dispositif d'étanchéité selon la revendication 7, dans lequel les moyens destinés à empêcher une pression excessive incluent une matière d'exclusion d'eau dans les rainures (84).

9. Dispositif d'étanchéité selon la revendication 7, dans lequel les moyens destinés à empêcher une pression excessive incluent d'avoir des rainures (84) d'une profondeur au moins égale à 1,016 mm (0,040 pouce).

10. Dispositif d'étanchéité selon l'une quelconque des revendications précédentes, dans lequel le moyen d'actionnement inclut un moyen (44, 46) destiné à empêcher son retrait à partir de son contact de fixation avec la lèvre d'étanchéité (74, 76).

11. Dispositif d'étanchéité selon la revendication 1, dans lequel le moyen d'actionnement inclut un corps annulaire (22, 24) et un coin (78, 80) qui vient en contact avec la ou chaque lèvre d'étanchéité (74, 76).