

Description

The present invention relates to an improved metal-to-metal stem seal for sealing between the exterior of a movable valve stem and the interior of the bore through which the stem extends.

Prior to the present invention there have been many stem seals which have been tried but they have suffered from some disadvantage. For example, some of the prior seals have caused galling of the stem. Others have not provided a continuous seal either due to losing their preferred configuration when exposed to excess pressure either in testing or in service or have worn prematurely so that the metal surfaces no longer were in sealing contact.

An example of a metal-to-metal seal which has been used both in stem sealing applications and in the sealing of the annulus between a casing hanger and the surrounding housing is disclosed in Paper No. OTC 4371 presented at the 14th Annual Offshore Technology Conference in Houston, Texas, May 3-6, 1982 and entitled "Fire Resistant Wellhead Equipment for Statfjord 'B' Platform". The specific metal seal ring which is referred to above is that seal labelled "Primary Seal" in Figure 7 of such paper. The seal has inner and outer legs extending from a midpoint in the seal ring base portion and diverging from each other. The seal legs end in a reverse curve so that their outer end are convergent with respect to each other. The seal ring labelled "Secondary Seal" is a U shaped seal ring having an energizing ring which urges the outer ends of the seal legs into sealing engagement with the walls of the annulus against which they are to seal.

Another similar shaft seal is disclosed in U S-A-4,471,965 in which the seal ring is U-shaped in section and the two legs each have an outer rounded projection which is intended to make the sealing contact with the surface against which it is to seal.

Summary

The present invention relates to an improved metal-to-metal seal for sealing around a moving stem of a valve and includes a U-shaped ring having a base, an inner leg extending from the inner portion of the base and an outer leg extending from the outer portion of the base. The sealing surface of each leg is flattened and in its free position has a slight angle with respect to the axis of the seal. Each of the legs includes a support enlargement on its sealing side at a point toward the base from the sealing surface and preferably at the position of maximum deflection of the leg. The diameter of such supports is preselected so that in its free state they each are spaced a short distance from the walls against which their leg seals. The end of the outer leg is turned inwardly at an angle.

An object of the present invention is to provide an improved valve stem seal which will withstand substantial test pressures without any reduction in the metal-to-metal seal provided by the seal ring.

Another object is to provide an improved valve stem seal which provides a metal-to-metal seal around a moving valve stem without any galling.

A further object is to provide an improved metal valve stem seal which can maintain its sealed position through heightened pressures and movements of the valve stem.

Brief Description of the Drawings

These and other objects and advantages of the present invention are hereinafter set forth and explained with reference to the drawings wherein:

FIGURE 1 is a sectional view through the bonnet and valve stem of a moving stem valve with the improved seal installed around the stem and within the bore through the bonnet.

FIGURE 2 is an enlarged sectional view of the seal shown in FIGURE 1.

FIGURE 3 is a detail sectional view of the improved seal.

FIGURE 4 is an enlarged cross section of the seal ring with the remainder of the ring being omitted for clarity.

Description of the Preferred Embodiment

Valve 10 illustrated in the drawings is a gate valve having a body 12 which defines a gate chamber 14 and having gate 16 positioned therein to control flow through valve 10 in the usual manner. Valve 10 is a rotating stem gate valve and stem 18 is threaded into gate so that rotation causes gate 16 to move in chamber 14 between positions closing flow through valve body 12 or opening flow through valve body 12. Stem threads 20 engage threads 22 within gate 16 so that rotation of stem 18 causes the desired movement of gate. In the position illustrated in FIGURE 1 gate is in its upper position and such position

may either close or open flow through valve body 12 depending on the placement of the opening in gate 16. From this position, the rotation of stem 18 by suitable means (not shown) engaging its outer end causes gate 16 to move away from bonnet 24 to its opposite position. Thereafter, rotation of stem 18 in the opposite direction causes it to return to the illustrated position.

Bonnet 24 includes flange 26 through which suitable connecting means extend, such as studs 28 and nuts 30, to secure bonnet 24 to the exterior of valve body 12 in covering relationship to the opening of chamber 14. Central bore 32 extends through bonnet 24 and counterbore 34 extends into the inner end of bonnet 24 and ends in backseat shoulder 36. The outer interior of bonnet includes inner threads 38, counterbore 40 and counterbore 42 which defines the recess 44 in which improved seal assembly 46 is positioned. Exterior threads 48 surround the outer end of bonnet 24 and enlargement 50 is positioned in surrounding relationship to the sealing area of seal 46. Port 52 extends through enlargement 50 and communicates into central bore 32 immediately below recess 44. Fitting 54 is secured within the opening of port 52 and may be suitable for lubricating the interior within bonnet 24 or for pressure testing.

The outer end of stem 18 includes suitable bearing means 56 providing the rotary mounting of stem 18 and fusible material 58 which provides for the backseating of stem shoulder 60 on backseat shoulder 36 when the valve is subjected to excess heat. Stem extension 62 is secured to the outer end of stem 18 by pin 64 and extends outwardly through cap 66 which is threaded onto external threads 48 on the outer exterior of bonnet 24. Seal assembly 46 is positioned within recess and is held therein by follower ring 68 which is threaded into internal threads 38 of bonnet 24 as shown in FIGURE 1. The outer end of stem extension 62 is provided with a suitable shape to allow connection of a suitable means (not shown) to cause the rotation of stem 18, either manually as with a handwheel or mechanically with a suitable power drive.

Seal assembly 46 which is shown in greater detail in FIGURE 2, includes seal ring 70 as hereinafter described, backup ring 72, which is positioned between the inner end of packing gland 68 and seal ring 70, and locating ring 74. Backup ring 72 is metal and annular in shape with suitable inner and outer diameters so that it fits easily into recess 44. The thickness of backup ring 72 is selected so that when packing gland 68 is threaded completely into threads 38 in bonnet 24, seal ring 70 is positioned within recess 44 so that its sealing portions are in engagement with sealing surface 76 on the interior of bonnet 24 and with sealing surface 78 on the exterior of stem 18. Locating ring 74 is positioned within recess 44 at a position so that its inner end engages the shoulder between the end of recess 44 and bore 32. Locating ring 74 includes a base portion 80 and upstanding rim 82 which extends upwardly between inner leg 84 and outer leg 86 of seal ring 70 and engages the base portion 88 of seal ring 70 to further ensure that seal ring is properly positioned within recess 44.

Seal ring 70 is best seen in FIGURES 3 and 4. It includes base portion 88 from which inner leg 84 and outer leg 86 extend as shown. The diameters of base portion 88 are such that it can be inserted within recess 44 and have a small clearance from the walls of the bonnet interior of the stem exterior. As shown in FIGURE 3, diameter C will always be greater than the outer diameter of stem 18 and diameter F will always be less than the inner diameter of sealing surface 32 within bonnet 24.

Inner leg 84 has its inner surface extending axially from the inner surface of base portion 88 to its approximate mid point where it extends inwardly to support surface 90 which is parallel to the axis and then curves outwardly and back inwardly to sealing surface 92 which is at a slight angle to the axis of the seal ring as hereinafter described. The outer surface of inner leg 84 extends axially to a point beyond support surface 90 and then tapers inwardly to the end 94 of inner leg. Outer leg 86 has its outer surface extending axially from the outer surface of base portion 88 to its approximate mid point where it extends outwardly to support surface 96 which is parallel to the axis of the seal ring and then curves inwardly and outwardly to sealing surface 98 which is at a slight angle outwardly to the axis of the seal ring as hereinafter described and then is curved inwardly as shown. The inner surface of outer leg 86 extends axially to a point beyond support surface 96 and then tapers outwardly to a position near end 100 of outer leg 86 and then tapers inwardly to end 100 as shown. Separate surfaces 90 and 96 preferably are located at the point of maximum deflection of their respective seal legs 84 and 86.

As shown in FIGURES 2, 3, and 4 diameter A of inner sealing surface 92 is preferably less than the diameter of the exterior of stem 18 and diameter D is preferably larger than the diameter of sealing surface 76 on the interior of bonnet 24. Diameter B, which is the diameter of support surface 90, is greater than diameter A and also slightly greater than the diameter of the exterior of stem 18. Diameter E, which is the diameter of support surface 96, is less than diameter D and also is slightly less than the diameter of sealing surface 76 on the interior of bonnet 24. Diameter C, which is the diameter of the interior of base portion 88 and inner leg 84, is larger than the exterior of stem 18. Diameter F, which is the diameter of the exterior of base portion 88 and of outer leg 86, is less than the diameter of the interior of bonnet 24. Sealing surface 92 on inner leg 84 is tapered with respect to the axis inwardly by the angle α and sealing surface 98 on

outer leg 86 is tapered with respect to the axis outwardly by the angle α . The radial difference between support surface 96 and sealing surface 98 on outer leg is dimension d and the radial difference between support surface 90 and sealing surface 92 is dimension c , all as shown in FIGURE 4.

In the following chart suggested relationship of dimensions for a 3 inch (1 inch = 25,4 mm) diameter stem which is positioned within a 3-3/4 inch diameter bore

A	2.992"	B	2.999"	C	3.042"
D	3.762"	E	3.755"	F	3.712"
α	1° 35'	β	1° 35'	γ	0.0035"
d	0.035"	e	15°		

From the foregoing it can be seen that the improved seal provides a positive metal-to-metal seal against the exterior of the stem and the interior of the bonnet bore which is designed so that each of the seal legs is provided with a support surface so that even when they are exposed to test pressures of substantial magnitude, such as 70.10⁶ Pa (10,000 psi), the pressure urging the legs against their sealing surfaces will not cause permanent deformation of the legs.

Claims

1. A seal for sealing between the exterior of a movable valve stem (18) and the interior of the bore (32) through the bonnet through which the stem extends comprising an annular metal U shaped ring (70) having a base (88), an inner leg (84) extending from the inner portion of the base and an outer leg (86) extending from the outer portion of the base, the outer diameter F of said base (88) being smaller than the diameter of said bonnet bore and the inner diameter C of said base (88) being larger than the diameter of said stem, characterised in that said outer leg (86) is longer than said inner leg (84), the end of said outer leg (86) is curved outward to form a sealing portion and the end of said inner leg (84) is curved inward to form a sealing portion, a portion of said outer leg (86) between its end and said base (88) being enlarged in thickness to a diameter E approaching but smaller than the diameter D of the sealing portion of said outer leg (86) to provide support (96) for said outer leg against permanent deformation due to pressure to which it is exposed, a portion of said inner leg (84) between its end and said base (88) being enlarged in thickness to a diameter B approaching but larger than the diameter A of the sealing portion of said inner leg (84) to provide support (90) for said inner leg against permanent deformation due to pressure to which it is exposed, said seal ring (70) being positioned between the stem and the interior of the bonnet bore with its legs extending in the direction toward the source of pressure from the valve.
2. A seal according to claim 1 including means for retaining said seal ring (70) in its desired position between the stem and the bonnet bore.
3. A seal according to claim 2 wherein said retaining means includes means (68) secured to said bonnet and limiting the outward movement of said seal ring (70) from its desired position.
4. A seal according to claim 3 including a back-up ring (72) positioned between the outer surface of said base of said seal ring (70) and said movement limiting means (68).
5. A seal according to claim 4 including a locating ring (74) positioned in the annular space between the stem and the bonnet bore and having a central projection extending into a position engaging the base between the inner and outer legs (84,86) of said seal ring (70).
6. A seal according to claim 1 wherein the sealing surface (98) of said outer leg (86) is flattened and, before installation, tapers outwardly and downwardly at an angle of approximately one and one-half degrees with respect to the surface of the bonnet bore.
7. A seal according to claim 1 wherein the sealing surface (92) of said inner leg (84) which is flattened and, before installation, tapers inwardly and downwardly at an angle of approximately one and one-half degrees with respect to the surface of the stem.

outer leg 86 is tapered with respect to the axis outwardly by the angle α . The radial difference between support surface 96 and sealing surface 98 on outer leg is dimension d and the radial difference between support surface 90 and sealing surface 92 is dimension c, all as shown in FIGURE 4.

In the following chart suggested relationship of dimensions for a 3 inch (1 inch = 25,4 mm) diameter stem which is positioned within a 3-3/4 inch diameter bore

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a	1° 35'	b	1° 35'	c	0.0035"
d	0.035"	e	15°		

From the foregoing it can be seen that the improved seal provides a positive metal-to-metal seal against the exterior of the stem and the interior of the bonnet bore which is designed so that each of the seal legs is provided with a support surface so that even when they are exposed to test pressures of substantial magnitude, such as 70.10⁶ Pa (10,000 psi), the pressure urging the legs against their sealing surfaces will not cause permanent deformation of the legs.

Claims

1. A seal for sealing between the exterior of a movable valve stem (18) and the interior of the bore (32) through the bonnet through which the stem extends comprising an annular metal U shaped ring (70) having a base (88), an inner leg (84) extending from the inner portion of the base and an outer leg (86) extending from the outer portion of the base, the outer diameter F of said base (88) being smaller than the diameter of said stem, characterised in that said outer leg (86) is longer than said inner leg (84), the end of said outer leg (86) is curved outward to form a sealing portion and the end of said inner leg (84) is curved inward to form a sealing portion, a portion of said outer leg (86) between its end and said base (88) being enlarged in thickness to a diameter E approaching but smaller than the diameter D of the sealing portion of said outer leg (86) to provide support (96) for said outer leg against permanent deformation due to pressure to which it is exposed, a portion of said inner leg (84) between its end and said base (88) being enlarged in thickness to a diameter B approaching but larger than the diameter A of the sealing portion of said inner leg (84) to provide support (90) for said inner leg against permanent deformation due to pressure to which it is exposed, said seal ring (70) being positioned between the stem and the interior of the bonnet bore with its legs extending in the direction toward the source of pressure from the valve.
2. A seal according to claim 1 including means for retaining said seal ring (70) in its desired position between the stem and the bonnet bore.
3. A seal according to claim 2 wherein said retaining means includes means (68) secured to said bonnet and limiting the outward movement of said seal ring (70) from its desired position.
4. A seal according to claim 3 including a back-up ring (72) positioned between the outer surface of said base of said seal ring (70) and said movement limiting means (68).
5. A seal according to claim 4 including a locating ring (74) positioned in the annular space between the stem and the bonnet bore and having a central projection extending into a position engaging the base between the inner and outer legs (84,86) of said seal ring (70).
6. A seal according to claim 1 wherein the sealing surface (98) of said outer leg (86) is flattened and, before installation, tapers outwardly and downwardly at an angle of approximately one and one-half degrees with respect to the surface of the bonnet bore.
7. A seal according to claim 1 wherein the sealing surface (92) of said inner leg (84) which is flattened and, before installation, tapers inwardly and downwardly at an angle of approximately one and one-half degrees with respect to the surface of the stem.



Revendications

1. Joint d'étanchéité entre l'extérieur d'une tige mobile (18) de vanne et l'intérieur de l'alésage (32) du chapeau par lequel passe la tige, comprenant un anneau annulaire de métal (70) à profil en étrier comprenant une base (88), une branche intérieure (84) partant de la partie intérieure de la base et une branche extérieure (86) partant de la partie extérieure de la base, le diamètre extérieur F de ladite base (88) étant inférieur au diamètre dudit alésage du chapeau et le diamètre intérieur C de ladite base (88) étant supérieur au diamètre de ladite tige, caractérisé en ce que ladite branche extérieure (86) est plus longue que ladite branche intérieure (84), l'extrémité de ladite branche extérieure (86) est recourbée vers l'extérieur de manière à former une partie d'étanchéité et l'extrémité de ladite branche intérieure (84) est incurvée vers l'intérieur, une partie de ladite branche extérieure (86) comprise entre son extrémité et ladite base (88) comportant une surépaisseur à un diamètre E qui s'approche de, mais qui est inférieur au diamètre D de la partie d'étanchéité de ladite branche extérieure (86) pour constituer un appui (96) de ladite branche extérieure lui évitant une déformation permanente due à la pression à laquelle elle est exposée, une partie de ladite branche intérieure (84) située entre son extrémité et ladite base (88) comportant une surépaisseur à un diamètre B s'approchant de, mais plus grand que le diamètre A de la partie d'étanchéité de ladite branche intérieure (84) pour constituer un appui (90) de ladite branche intérieure lui évitant une déformation permanente due à la pression à laquelle elle est exposée, ledit anneau d'étanchéité (70) étant placé entre la tige et l'intérieur de l'alésage du chapeau de manière que ses branches soient tournées dans le sens allant vers la source de la pression provenant de la vanne.
2. Joint selon la revendication 1, comprenant des moyens pour retenir ledit anneau d'étanchéité (70) à sa position voulue entre la tige et l'alésage du chapeau.
3. Joint selon la revendication 2, dans lequel lesdits moyens de retenue comprennent des moyens (68) fixés audit chapeau et limitant le déplacement vers l'extérieur dudit anneau d'étanchéité (70) à partir de sa position souhaitée.
4. Joint selon la revendication 3, comprenant un anneau de soutien (72) placé entre la surface extérieure de ladite base dudit anneau d'étanchéité (70) et lesdits moyens (68) de limitation du déplacement.
5. Joint selon la revendication 4, comprenant un anneau de positionnement (74) placé dans l'espace annulaire compris entre la tige et l'alésage du chapeau et comportant un prolongement central atteignant une position dans laquelle il est appliqué contre la base entre les branches intérieure et extérieure (84, 86) dudit anneau d'étanchéité (70).
6. Joint selon la revendication 1, dans lequel la surface d'étanchéité (98) de ladite branche extérieure (86) est aplatie et, avant sa mise en place, est inclinée vers l'extérieur et vers le bas en inscrivant un angle d'approximativement un degré et demi avec la surface de l'alésage du chapeau.
7. Joint selon la revendication 1, dans lequel la surface d'étanchéité (92) de ladite branche intérieure (84) est aplatie et, avant mise en place, s'incline vers l'intérieur et vers le bas en inscrivant un angle d'environ un degré et demi avec la surface de la tige.

Patentansprüche

1. Dichtung zur Abdichtung zwischen der Außenseite eines beweglichen Ventilschafts (18) und der Innenseite der Bohrung (32) durch das Ventilgehäuse, durch das sich der Schaft erstreckt, enthaltend einen winkligen, metallischen U-förmigen Ring (70), der eine Basis (88) hat, einen inneren Schenkel (84), der sich von dem inneren Abschnitt der Basis erstreckt, wobei der äußere Durchmesser F der Basis (88) kleiner ist als der Durchmesser der Ventilgehäusebohrung, und wobei der innere Durchmesser C der Basis (88) größer ist als der Durchmesser des Schafts, dadurch gekennzeichnet, daß der äußere Schenkel (86) nach außen gebogen ist, um einen Dichtungsabschnitt zu bilden, und wobei ein Abschnitt des äußeren Schenkels (86) zwischen seinen Enden und der Basis (88) in seiner Dicke vergrößert ist auf einen Durchmesser E, der ähnlich ist, jedoch kleiner als der Durchmesser D des Dichtungsabschnitts des äußeren Schenkels (86), um eine Stütze (98) für den äußeren Schenkel gegen dauerhafte Deformation aufgrund von Druck, dem er ausgesetzt ist, zu erzeugen, wobei ein Abschnitt



des inneren Schenkels (84) zwischen seinen Enden und der Basis (88) in seiner Dicke vergrößert ist auf einen Durchmesser, der ähnlich ist, jedoch größer als der Durchmesser A des Dichtungsabschnitts des inneren Schenkels (84), um eine Stütze (90) für den inneren Schenkel gegen dauerhafte Deformation durch Druck, dem er ausgesetzt ist zu erzeugen, wobei der Dichtungsring (70) zwischen dem Schaft und der Innenseite der Ventilgehäusebohrung positioniert ist, wobei seine Schenkel sich in die Richtung erstrecken entgegen der Druckquelle von dem Ventil.

2. Dichtung nach Anspruch 1, enthaltend Einrichtungen zum Halten des Dichtungsring (70) in seiner gewünschten Position zwischen dem Schaft und der Ventilgehäusebohrung.

3. Dichtungsring nach Anspruch 2, wobei die Halteeinrichtung Einrichtungen (68) enthält, die an dem Ventilgehäuse befestigt sind und die Bewegung nach außen des Dichtungsring (70) von seiner gewünschten Position begrenzen.

4. Dichtungsring nach Anspruch 3, enthaltend einen Stützring (72), der sich zwischen der Außenoberfläche des Basis des Dichtungsring (70) und der Bewegungsbegrenzungseinrichtung (68) befindet.

5. Dichtung nach Anspruch 4, enthaltend einen Feststerring (74), der sich in dem winkligen Raum zwischen dem Schaft und der Ventilgehäusebohrung befindet und einen Mittenvorsprung hat, der sich in eine Position erstreckt, die in die Basis eingreift zwischen den inneren und äußeren Schenkeln (84, 86) des Dichtungsring (79)

6. Dichtungsring nach Anspruch 1, wobei die Dichtungsoberfläche (98) des äußeren Schenkels (86) abgeflacht ist und vor der Befestigung nach außen und nach unten bei einem Winkel von ungefähr $1,5^\circ$ bezüglich der Oberfläche der Ventilgehäusebohrung spitz zuläuft.

7. Dichtungsring nach Anspruch 1, wobei die Dichtungsoberfläche (92) des inneren Schenkels (84), die abgeflacht ist und vor der Installation nach innen und nach unten bei einem Winkel von ungefähr $1,5^\circ$ bezüglich der Oberfläche des Schafts spitz zuläuft.

