960263-5
IPOS 3

REPLACED SHEETS SG
☑ Description : paged ...1.... to paged ..10.....
☑ Claim(s) : paged ..11.... to paged ..14.....
☑ Drawing(s) : paged ..15.... to paged ..15.....
☑ Abstract : paged ..16.... to paged ...2.....
DATE OF RECEIPT .....

This Sheet Has Been Replaced

ANNULAR SEALING ASSEMBLY

The present invention relates to an improved annular seal which has particular application to sealing across annular spaces between facing cylindrical surfaces, such as the annular seal between the exterior of a hanger and the surrounding housing in a well. The prior annular seals have used annular seals having a U-shaped section with expander rings positioned in the space between the two legs of the ring to either mechanically or responsive to pressure urge the expander ring inwardly of the legs to wedge them outward into sealing engagement with the facing cylindrical surfaces to effectively seal across the annulus between such surfaces.

U. S. Patent No. 3,288,472 to B. J. Watkins discloses a metal seal which includes a U-shaped ring having legs extending axially away from an annular base and tapering outwardly at an angle preferred to be approximately 2°. This provides an interference fit for the legs of the seal ring with respect to the surfaces against which they are to seal. U. S. Patent Nos. 3,378,269; 4,766,956; and 5,031,923 all disclose similar metal seals which include annular metal seal rings having a U-shaped section and having an interference fit with the surfaces against which they are to seal.

U. S. Patent No. 2,075,947 discloses a pipe joint which includes a soft metal seal ring having a pair of upwardly extending spaced legs and a pair of downwardly extending spaced legs with an annular hard metal wedging member positioned between each pair of legs and energized by the nut to be forced between the legs to urge the legs radially into sealing engagement with the outer and inner annular cylindrical surfaces against which they are to seal. Other prior art patents disclosing similar

structures include U. S. Patent Nos. 3,915,462; 2,766,956; 4,900,041; and 5,044,672.

U. S. Patent No. 3,326,560 to N. D. Trbgovich discloses an adjustable annular seal which has a V shape and includes a split ring expander positioned between the diverging legs of the seal ring with suitable shoulders containing and urging the seal ring and expander together so that the expander urges the legs of the seal ring radially into sealing engagement with the annular walls against which it is to seal. The expander is described as being substantially coextensive in length with the sealing ring and being resiliently compressible for urging the walls (legs) apart to compensate for wear of the sealing portions. It is stated that the expander should be constrained from moving into engagement with the sealing surfaces and thus should not act as a sealing element itself. It should be noted that this patent specifically suggests the use of a split ring as the expander, it does not suggest any particular advantages. It could be that the advantage was that it was easier to install than a solid ring since it had to be assembled within the seal ring and in the space bounded by the sealing surfaces and the shoulders which urge the expander into the seal ring so that its sealing legs are urged toward the sealing surfaces.

The Lee Company manufactures hydraulic inserts or plugs which are adapted to be inserted into an opening to close and seal the opening. The Lee plug is cylindrical with a tapered reamed hole part way through its center and numerous small grooves in its exterior surface. It is used with a tapered pin which is driven into the reamed hole until the plug and pin are flush with each other. The pin wedges the tapered sides of the plug into biting engagement with the surrounding material forming independent seals and retaining rings. This plug does not have any use for sealing across an annulus.

This Sheet Has Been Replaced



The improved seal of the present invention is adapted to provide a seal across the annular space between a first member and a second member. The improved seal includes an improved seal ring assembly which has an annular metal sealing ring with a U-shaped section and a plurality of segments positioned within the legs of the seal ring. The one of the legs has a taper sufficient to provide an interference fit with the surface against which it is to seal and the other leg extends generally perpendicularly to its base. The legs are connected with an annular base. The metal sealing ring is made of a soft steel and the insert segments are made from a ring of steel which is cut into segments by a suitable cutting method which has a minimum kerf. When assembled the segments are positioned between the legs of the sealing ring and the ring is then installed between the surfaces against which it is to seal. On installation between the surfaces against which it is to seal, one leg that is tapered is forced toward the segments and the segments transmit this force to the other leg so that they are both in sealing engagement with their respective sealing surfaces. The transmission of this force by the segments is not dependent on overcoming hoop tension in a ring since the ring has been cut into segments. The segments are cut from the ring with a minimum kerf at each cut so that they substantially fill the space between the legs completely around the annulus of the sealing ring.

An object of the present invention is to provide an improved sealing assembly for sealing across an annulus which requires a minimum amount of setting load and provides improved sealing.

Another object of the present invention is to provide an improved annular sealing assembly for sealing across the annulus between the interior of a well member and the exterior of another well member in a well.

This Sheet Has Been Replaced



This Sheet Has Been Replaced



A further object of the present invention is to provide an improved annular sealing assembly for sealing across the annular space between the exterior of a well hanger and the interior of the well member into which the well hanger is landed.

Still another object is to provide an improved annular sealing assembly for sealing between two spaced apart sealing surfaces in which improved metal-to-metal sealing is provided and initial sealing is sufficient to retain sealing when pressure is supplied to the open end of the sealing ring.

These and other objects and advantages of the present invention are hereinafter shown and explained with respect to the drawings wherein:

FIGURE 1 is a partial sectional view of the improved sealing ring assembly positioned between two tubular well members and showing its position immediately prior to being moved into its sealing position.

FIGURE 2 is a partial sectional view of the apparatus shown in FIGURE 1 but illustrating the sealing position of the sealing ring assembly against the sealing surfaces of the two tubular well members. The inner member which has an external taper has been moved downward with respect to the outer member and the sealing ring assembly.

FIGURE 3 is a partial sectional view of another form of the improved sealing ring assembly positioned between two tubular members immediately prior to being moved into its sealing position. In this form of the invention the sealing ring assembly is carried by the inner member and is moved downwardly within the outer member which has a tapered inner surface which moves the sealing ring assembly into set position.

FIGURE 4 is a partial sectional view of the form of the invention shown in FIGURE 3 after it has been moved to the set position of the sealing ring assembly.

This Sheet Has Been Replaced



FIGURE 5 is a partial sectional view of another form of the present invention which provides a seal between opposing faces of joined flanges.

FIGURE 6 is a sectional view of a sealing ring assembly having a modified U-shaped portion of a double sealing ring assembly.

FIGURE 7 is another sectional view of the U-shaped portion of another form of double sealing ring assembly.

FIGURE 8 is a partial sectional view of the preferred U-shaped sealing ring.

FIGURE 9 is a partial sectional view of the sealing ring shown in FIGURE 8 but enlarged to illustrate greater detail in its specific structure.

FIGURE 10 is a schematic sectional view to illustrate the position of the sealing ring assembly of the present invention as it enters the annulus between two surfaces.

FIGURE 11 is another schematic sectional view of the sealing ring assembly illustrated in FIGURE 10 after it has been moved into its original set position by the tapered surface of one of the surfaces.

FIGURE 12 is another schematic sectional view of the sealing ring assembly illustrated in FIGURES 10 and 11 but illustrating the position of the sealing ring assembly with respect to the two sealing surfaces after the ring has been exposed to pressure.

In FIGURE 1 the preferred form of the sealing ring assembly 10 of the present invention is shown carried between lower support ring 12 and upper sleeve 14. Inner member 16 is lowered into the interior of outer member 18 with sealing ring assembly supported thereon as shown. Upper sleeve 14 is releasably secured to inner member 16 by shear pins 20. Lower support ring 12 is supported on snap ring 22 mounted in groove 24 in the exterior of the portion of inner member 16 which is illustrated. inner member has a lower surface 26 extending above snap ring 22

This Sheet Has Been Replaced



to downwardly facing shoulder 28. The lower outer corner of shoulder 28 is bevelled at 30 to allow ease of assembly of sealing ring assembly 10 thereon and surface 32 above bevel 30 is tapered upwardly and outwardly. Surface 32 thus provides the wedging surface to cause the setting of sealing assembly 10 as it reaches sealing inner member outer sealing surface 34 above surface 32. In its set position sealing ring assembly 10 provides a metal-to-metal seal against sealing surface 34 on the exterior of inner member 16 and sealing surface 36 on the interior of outer member 18. Lower support ring 12 has an external diameter to slide easily within surface 36 of outer member 18 and a lower tapered outer surface 38 which is adapted to engage upwardly facing tapered seat 40. The interior of the lower portion of lower support ring 12 fits easily around the exterior of inner member 16 and has internal upwardly facing shoulder 42 with rim 44 extending thereabove to engage the lower portion of sealing ring assembly 10 and having a radial thickness to fit around sealing surface 34 of inner member 16.

When lower support ring 12 lands on seat 40, the further downward movement of inner member 16 moves downward within the interior of rim 44 and tapered surface 32 moves downwardly through sealing ring assembly 10 to cause it to move to set position as shown in FIGURE 2, the details of which are more clearly set forth with respect to the description of the structure of sealing ring assembly.

In a modified form of the present invention shown in FIGURES 3 and 4, sealing ring assembly 50 is supported on inner member 52 between lower support ring 54 and upper support ring 56. Snap ring 58 is positioned in groove 60 on the lower exterior of inner member 52 to prevent lower support ring 54 from moving downward on inner member and snap ring 62 positioned in groove 64 on the upper exterior of inner member 52 to prevent upper support ring 56 from being forced upwardly on inner member 52. Outer member 66 includes lower central bore 68 with outwardly and upwardly

This Sheet Has Been Replaced



tapered setting bore 70 thereabove, outwardly and upwardly tapered bore above bore 70 and upper straight bore 72 extending thereabove.

The downward movement of sealing ring assembly 50 within outer member 66 is shown in the positions in FIGURES 3 and 4. In FIGURE 3 inner member 52 is moving downward within outer member 66 with sealing ring assembly 50 approaching tapered setting bore 70. In FIGURE 4, inner member has moved downwardly to the point that sealing ring assembly 50 is in sealing engagement with lower central bore 68 and thus provides a metal-to-metal sealing engagement against the exterior of inner member 52 and against the interior of outer member 66. This sealing engagement is hereinafter explained in detail.

Another form of the present invention wherein the improved sealing ring assembly may be used is illustrated in FIGURE 5 wherein sealing ring assembly 80 is positioned in face groove 82 in flange 84. Flange 84 is secured by cap screws or other suitable fastening means 86 to a structure having a bore therethrough, such as flange 88. Sealing ring assembly 80 is initially positioned within groove 82 and as means 86 are tightened it is brought to its set position in sealing engagement between the face of flange 88 and the bottom of groove 82.

In the foregoing described installations of the improved sealing ring assembly of the present invention two rings have been used with the open ends of the U- shaped portions of the sealing ring were in facing opposed positions. As shown in FIGURES 6 and 7, the sealing ring may be used in other combinations, such as the double U-shaped ring 90 shown in FIGURE 6 and the two rings 92 facing in the same direction illustrated in FIGURE 7.

Improved sealing ring assembly 100 of the present invention includes a ring having a base 102 and a pair of legs 104 and 106 extending generally perpendicular to the base, together with a plurality of segments 108 (not shown in FIGURES 8 and 9) but as hereinafter shown in detail in

This Sheet Has Been Replaced



the drawings of FIGURES 8 through 12. Inner leg 106 extends from the inner portion of base 102 and outer leg 104 extends from the outer portion of base 102. Outer leg 104 extends substantially axially from base 102 as best seen in FIGURE 9 having its inner surface and its outer surfaces generally parallel to the centerline 110 of ring 101. Leg 106 is angled slightly with respect to centerline 110 so that it extends inwardly at an angle designated "a" in FIGURE 9 which is preferred to be approximately 4°. The outer surface 112 of leg 106 and inner surface 114 of leg 104 extend from rounded corners on base 102. Outer surface 112 of leg 106 is at an angle to centerline 110 as stated and ends in axial surface 115 which extends to tapered surface 116 which tapers toward leg 104 and ends at point A in outer surface 118 which extends to end surface 120 of leg 106. Inner surface 114 of leg 104 extends parallel to centerline 110 and terminates in tapered surface 124. Tapered surface ends at point B in axial surface 126 which extends to end surface 128 of leg 104. Exterior surface 130 of leg 104 extends from base 102 as surface 132 which is angled approximately 30° and rounded corner 134 to point A. Surface 130 is interrupted by grooves 136 and 138, both of which are formed by tapered surfaces and a flat base surface. Surface 140 extends from point C to end surface 128 as shown. Interior surface 142 of leg 106 extends from base 102 as surface 144 which is angled approximately 30°and rounded corner 146 to point D. Surface 142 is set at an angle to centerline 110 of approximately 4° and is broken by grooves 148 and 150 both of which are formed by tapered surfaces and a flat base surface as shown. Axial surface 152 extends from point D to point E and tapered surface 154 extends from point E to end surface 120.

As shown in FIGURE 10, improved sealing ring assembly 100 is positioned between two generally parallel walls of members 160 and 162. As hereinafter described, sealing ring assembly 100 is to provide an improved metal-to-metal seal between facing surfaces of such members. In the

This Sheet Has Been Replaced

position illustrated in FIGURE 10, sealing ring assembly 100 has not been set in its sealing position but is ready to be moved on tapered surface 164 into its set position.

FIGURE 11 shows sealing ring assembly 100 has been positioned between sealing surface 166 on member 160 and sealing surface 168 on member 162. This may be done by movement of assembly 100 across tapered surface 164 to the position shown in FIGURE 11 or member 160 may be moved with respect to assembly 100. It should be noted that the tapered leg 106 of sealing ring 101 is the leg which engages the tapered surface for sealing. This is the arrangement by which either the inner or outer leg is tapered depending on whether the inner or outer member has the setting tapered surface. With sealing ring 100 assembly in set position, it is exposed to pressure from the open end of its legs and such pressure has the effect of moving sealing ring 101 to the position illustrated in FIGURE 12 wherein both legs 104 and 106 are held against their respective sealing surfaces 168 and 166 and segments 108 are generally centered within the space between legs 104 and 106.

With segments 108 positioned in the space between the legs of the sealing rings 101, segments 108 transmit loading between the legs but without having hoop tension to limit this transmission which would occur if the segments were a complete ring or a partial ring which might limit the transmission of the loading forces by a any hoop tension.

In the forms of the present invention the improved sealing is provided without dramatic increases in the loading of the sealing assembly. The use of the ring segments between the inner and outer legs provides adequate load transmission between the sealing ring legs without having to overcome the hoop tension which would be present if rings were used. The end loading on the segments is to ensure that they are properly positioned between the legs

but not to wedge the legs apart as can be seen from FIGURE 12. The wedging for setting is provided by the tapered surfaced leading into one of the sealing surfaces which causes the leg having an angular position with respect to the other leg to be wedged toward the other leg cause the segments to transmit this to the other leg so that it is also initially loaded into sealing engagement with the sealing surface against which it is to seal. The amount of loading is thus only that loading which causes the sealing ring to move across the tapered setting surface so that the angled leg is moved sufficiently so that its movement is transmitted through the segments to the other leg to cause it to move into sealing engagement.

As described above, the points of contact between the legs and their sealing surfaces and the legs and their segments are offset a different distance from the ends of the legs, i. e., points A and B are closer to the ends of their legs than are points E and C. This creates a moment in the legs when they have been set into sealing engagement before they are exposed to pressure and establishes an indirect load path which makes the seal less sensitive to variations in seal bore diameter, finished dimensions and thermal expansion and contraction. It further makes them open to the pressure so that it will further uniformly urge each leg into sealing engagement with its sealing surface as best shown in FIGURE 12.

This Sheet Has Been Replaced



This Sheet Has Been Replaced

CLAIMS

1. An annular sealing ring assembly for sealing across the annular space between an internal member having an outer cylindrical surface and an external member having an inner cylindrical surface comprising

an annular metal seal ring having an annular base with a pair of spaced apart legs extending from said annular base in one direction and including a first leg and a second leg with an annular space between said legs,

a plurality of segments positioned in the annular space between said legs,

said segments substantially filling said annular space between said legs,

said segments all being sufficiently short whereby they are not subject to hoop tension, and

means for retaining said segments within said annular space between said legs.

2. An annular sealing ring assembly according to claim 1 wherein

said annular base has a centerline, and

said legs extend from the edges of said annular base in a direction generally parallel to said centerline.

3. An annular sealing ring assembly according to claim 1 wherein

said annular base is cylindrical, and

said legs extend generally perpendicularly from the edges of said annular base.

4. An annular sealing ring assembly according to claim 1 including

at least one groove on the interior of said first leg, and

at least one grooves on the exterior of said second leg.

5. An annular sealing ring assembly according to claim 2 wherein

said first leg is positioned to extend slightly radially inward at an angle with respect to said annular

* C L M S *

This Sheet Has Been Replaced





base centerline so that it provides an interference fit with the surface against which it is to seal when it is installed thereon and so that it urges the segments radially away from said first leg to move the second leg radially into sealing engagement with the sealing surface against which said second leg is to seal.

6. An annular sealing ring assembly according to claim 1 including

a pair of sealing rings and segments assembled with their open ends in facing relationship to each other and with the segments in each ring in engagement with the segments of the other ring.

7. An annular sealing assembly comprising

a first sealing ring assembly and a second sealing ring assembly according to claim 1,

said first sealing ring assembly positioned to have its legs extending from their base in a first axial direction,

said second sealing ring assembly having its legs extending from their base in a second axial direction which is toward the first sealing assembly, and

a portion of the segments in each of said sealing assemblies abuts the same portion of the segment from the other sealing assembly so that force on the sealing assemblies urges them toward each other and also urges their segments into the annular space between their legs.

8. A sealing assembly according to claim 7 wherein

said sealing ring assemblies are positioned within a well and adapted to seal across an annulus between an inner cylindrical surface of an outer well member and an outer cylindrical surface of an inner well member.

9. A sealing assembly according to claim 8 including

means for urging the first and second sealing ring assemblies toward each other to ensure proper positioning of the segments in the two sealing assemblies.

10. A sealing assembly according to claim 8 including

wedging means on one of said well members to wedge one

This Sheet Has Been Replaced



of said legs toward the other leg so that said segments transmit the wedging force to said other leg to set it in sealing engagement with the surface of the member against which it is to seal.

11. An annular sealing assembly comprising

a first sealing ring assembly and a second sealing ring assembly according to claim 3,

said first sealing ring assembly positioned to have legs extending from their base in a radial direction,

said second sealing ring assembly having its legs extending from their base in a radial direction, and

means for retaining the segments for each of the sealing ring assemblies in their desired positions between the legs of their sealing ring.

12. An annular sealing assembly according to claim 11 wherein

the segments of one of said sealing rings are in engagement with the segments of the other sealing ring to provide said retaining means.

13. An annular sealing assembly according to claim 11 wherein

the sealing ring of one of said sealing ring assemblies sharing the base with the other of said sealing ring of said sealing ring assemblies with the legs of each sealing ring extending from the edges of said base in opposite directions to the other sealing ring.

14. An annular sealing assembly according to claim 11 wherein

both sealing rings have their legs extending radially in the same direction of the legs of the other sealing ring.

15. An annular sealing assembly according to claim 1 wherein

the legs of the metal sealing ring each have inner points of contact with the segments positioned between the legs and points of contact with their respective sealing surfaces, the points of contact of each leg with its



This Sheet Has Been Replaced

sealing surface being offset a greater distance from the end of the leg than the point of contact with the point of contact with the segment to provide a moment in the legs which ensures that the sealing force between each of the legs and its sealing surface are balanced after loading both before and after the sealing ring assemblies are subjected to pressure.

* C L M S *