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Seal arrangement with low drag seal gland

Abstract

A seal arrangement is provided having a first part with a seal gland, and a seal located in the seal gland. The seal has an outer sealing surface and an inner support surface that is supported on a bottom support surface of the seal gland. A second part having a sealing surface is provided against which the outer sealing surface of the seal is pressed. A relief area is formed in a portion of the bottom support surface of the seal gland, with the relief area being configured to receive a resiliently deflected portion of the inner support surface of the seal during assembly. A method of assembling a sealing arrangement is also provided.

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References Cited

U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
2462596	12/1948	Bent	N/A	N/A
2553222	12/1950	Wallgren	285/918	F16J 15/0881
2690360	12/1953	Young	N/A	N/A
3214182	12/1964	Herbruggen	277/465	F16J 15/32
4165882	12/1978	Crow	405/104	F16J 15/32
4298204	12/1980	Jinkins	277/910	F16J 15/062
4544049	12/1984	Shellhause	N/A	N/A
4732550	12/1987	Suzuki	418/57	F01C 1/0215
5482297	12/1995	Burns et al.	N/A	N/A
6361052	12/2001	Farinella	277/626	F16L 17/06
8269104	12/2011	Choraku	277/630	H05K 5/061
8388232	12/2012	Lida	277/641	F16C 27/066
9167876	12/2014	Yamaguchi	N/A	H05K 5/061
9844157	12/2016	Spencer	N/A	G06F 1/1656
10066881	12/2017	Hruza	N/A	F28F 9/0226
10415728	12/2018	Raper	N/A	F16L 21/035
2007/0175172	12/2006	Sousa	52/741.1	F16J 15/062

FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
1113200	12/2000	EP	F16J 15/062
9424466	12/1993	WO	N/A

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Background/Summary

TECHNICAL FIELD

(1) The disclosure relates to a seal arrangement between two parts, and more particularly to a seal gland to reduce drag and or damage to the seal during assembly.

BACKGROUND

(2) Conventional seal devices or radial seals form a seal between inner and outer lateral surfaces. The seal prevents material on one side of the seal from entering an opposite of the area being

sealed. This can be, for example, to maintain lubricating or hydraulic fluid on one side of a seal, or to prevent the ingress of dirt and debris.

(3) During assembly of the parts carrying the surfaces being sealed, the seal body is resiliently compressed into a seal gland, for example formed as a groove, that retains the seal in position on one of the parts. The compression provides an elastic sealing force to press the seal against the walls of the seal gland and the opposing surface contacted by the seal. The amount of seal compression varies depending on a number of factors, including the seal size and material, clearance of the seal in a nominal position in the gland, the gland size, the clearance between the surfaces being sealed, and the desired force being applied by the seal against the surfaces, among others. Depending on the assembly and the size of the seal and the gland, it is possible for the seal to roll during installation, which can result in seal leakage under pressurization, particularly with seals having a shaped cross-section—such as a D-seal.

(4) It would be desirable to provide a seal arrangement that reduced the possibility of assembly defects that can reliably provide the desired sealing properties.

SUMMARY

(5) In one aspect, a seal arrangement is provided having a first part with a seal gland, and a seal located in the seal gland. The seal has an outer sealing surface and an inner support surface that is supported on a bottom support surface of the seal gland. A second part having a sealing surface is provided against which the outer sealing surface of the seal is pressed. A relief area is formed in a portion of the bottom support surface of the seal gland, with the relief area being configured to receive a resiliently deflected portion of the inner support surface of the seal during assembly.

(6) The seal gland is configured to reduce compression and the overall force required during installation of the seal. This is accomplished by bottom surface of the seal gland being provided with an extra expansion volume formed by the relief area during installation while still maintaining the seal gland properties for compression and gap from the seal gland to the sealing surface.

(7) In one embodiment, the first and second parts are generally circular or cylindrical, at least in an area of the seal arrangement, and the seal is ring-shaped.

(8) In the exemplary embodiment, the relief area is formed in a medial area of bottom support surface of the seal gland. Here, the inner support surface of the seal extends on both sides of the relief area on the bottom support surface.

(9) In the exemplary embodiment, the relief area that is configured to receive the resiliently deflected portion of the inner support surface of the seal during assembly has a parabolic form in cross-section. This reduces stress concentration points on the seal as it resiliently deflects into the relief area during assembly.

(10) In one embodiment, the second part includes a lead-in area configured to compress the seal during assembly of the first and second parts.

(11) The relief area can be formed as a machined cut in the bottom support surface. Alternatively, it can be formed by other means.

(12) In one embodiment, the relief area has a volume that is less than about 15% of a volume of the seal, and more preferably less than about 10%.

(13) In another aspect, a method of forming a seal arrangement is disclosed. The method includes: (a) providing a first part having a seal gland; (b) forming a relief area in a portion of a bottom support surface of the seal gland; (c) installing a seal in the seal gland, the seal having an outer sealing surface and an inner support surface that is supported on the bottom support surface of the seal gland; (d) installing a second part having a sealing surface against the outer sealing sur-face of the seal by sliding the first and second parts together relative to one another; and (e) compressing the seal during the installing step such that a resiliently deflected portion of the inner support surface of the seal expands into the relief area during assembly.

(14) In one aspect, the relief area is formed in a medial area of bottom support surface of the seal gland. Here, the inner support surface of the seal can extend on both sides of the relief area on the

bottom support surface.
(15) In one aspect, the relief area has a parabolic form in cross-section. This reduces stress concentration points on the seal as it resiliently deflects into the relief area during assembly.
(16) In one aspect, the second part includes a lead-in area, and the method further includes the lead-in area compressing the seal during assembly of the first and second parts.
(17) The method may also comprise machining the relief area in the bottom support surface. However, the relief area can be formed by other means.
(18) In one aspect, the relief area may have a volume that is less than about 15% of a volume of the seal, and more preferably less than about 10%.
(19) Various features of the invention can be used alone or in combination in order to achieve one or more of the benefits described herein.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) The foregoing Summary and the following detailed description will be better understood when read in conjunction with the appended drawings, which illustrate preferred embodiments according to the disclosure. In the drawings:
(2) FIG. **1** is a cross-section through a seal arrangement according to one exemplary embodiment.
(3) FIG. **2** is a flow chart illustrating a method of forming a seal arrangement.
DETAILED DESCRIPTION
(4) Certain terminology is used in the following description for convenience only and is not limiting. The words “inwardly” and “outwardly” refer to directions toward and away from the parts referenced in the drawings. “Axially” refers to a direction along the axis of a shaft. “Radially” refers to a direction normal to an axis. A reference to a list of items that are cited as, for example, “at least one of a or b” (where a and b represent the items being listed) means any single one of the items a or b, or a combination of a and b thereof. This would also apply to lists of three or more items in like manner so that individual ones of the items or combinations thereof are included. The terms “about” and “approximately” encompass + or −10% of an indicated value unless otherwise noted. The terminology includes the words specifically noted above, derivatives thereof and words of similar import.
(5) Referring now to FIG. **1**, an exemplary embodiment of a seal arrangement **10** is shown. The seal arrangement **10** includes a first part **12** having a seal gland **14**, which can be formed as a circumferentially extending groove. The seal gland **14** has side walls **16***a*, **16***b* as well as a bottom support surface **18**. A seal **22** is located in the seal gland **14**, and the seal **22** has an outer surface **24** and an inner support surface **26** that is supported on the bottom support surface **18** of the seal gland **14**. A second part **28** having a sealing surface **30** is provided against which the outer sealing surface **24** of the seal **22** is pressed. In the exemplary embodiment, the first and second parts **12**, **28** are generally circular or cylindrical at least in an area of the seal arrangement **10**, and the seal **22** is ring-shaped. In the exemplary embodiment, the seal **22** has a D-shape in cross-section, and can be a D-ring seal. The body of the seal **22** except for the extending D-shape that forms the outer sealing surface **24** is preferably located between the outside diameter OD at the surface of the first part and the inside diameter ID of the seal gland **14**.
(6) In order to reduce the chance of the seal **22** rolling during assembly, a relief area **20** is formed in a portion of the bottom support surface **18** of the seal gland **14**. The relief area **20** is configured to receive a resiliently deflected portion of the inner support surface **26** of the seal **22** during assembly. By providing the relief area **20** that is configured to receive a resiliently deflected portion of the inner support surface **26** of the seal **22** during assembly, the overall compression and force required to install the first and second parts **12**, **28** together with the seal **22** is reduced and rolling

of the seal **22** during assembly is avoided. This is due to the relief area **20** providing extra expansion volume in which the seal **22** is compressed or deflects which is important during installation, but still allows the seal glad properties for compression and gap from the seal gland **14** to the sealing surface **30** of the second part **28** to be maintained.

(7) As shown in FIG. **1**, the relief area **20** can be formed in a medial area of the bottom support surface **18** of the seal gland **14**. This allows the inner support surface **26** of the seal **22** to extend on both sides of the relief area **20** on the bottom support surface **18**, providing support for the seal in order to maintain the sealing properties of the outer sealing surface **24** against the sealing surface **30** of the second part **28**.

(8) The relief area **20** that is configured to receive the resiliently deflected portion of the inner support surface **26** of the seal **22** during assembly can have a parabolic form in cross-section. This form allows for easier resilient deflection of the seal **22** into the relief area **20** without stress concentration points forming on the seal **22** that could result in plastic deformation of the seal **22**. This is important for maintaining the sealing function of the seal **22** in the seal arrangement **10**.

(9) As shown in FIG. **1**, the second part **28** may include a lead-in area **32** configured to compress the seal **22** during assembly of the first and second parts **12**, **28**.

(10) In one embodiment, the relief area **20** is formed as a machine cut in a bottom of the support surface **18**. However, it could be formed by other methods.

(11) While the specific compression of the seal and the size of the seal gland **14** are case specific, in the exemplary embodiment the relief area **20** has a volume that is less than about 15% of a volume of the seal **12**, and more preferably less than about 10%.

(12) Referring to FIG. **2**, a method of forming a seal arrangement **10** is indicated as **40**. As shown in FIG. **2**, the method includes providing a first part **12** having a seal gland **14**, as indicated at **41**. The method further includes forming a relief area **20** in a portion of a bottom support surface **18** of the seal gland **14**, as indicated at **42**. The method further includes installing a seal **22** in the seal gland **14**, with the seal **22** having an outer sealing surface **24** and an inner support surface **26** that is supported on the bottom support surface **18** of the seal gland **14**, as noted at **43**. The method further includes installing a second part **28** having a sealing surface **30** against the outer sealing surface **24** of the seal **22** by sliding the first and second parts **12**, **28** together relative to one another, as indicated at **44**. Further, the method includes compressing the seal **22** during the installing steps such that a resiliently deflected portion of the inner support surface **26** of the seal **22** expands into the relief area **20** during assembly, as indicated at **45**.

(13) As discussed above, the relief area **20** is preferably formed in a medial area of the bottom support surface **18** of the seal gland **14**. The method preferably includes the inner support surface **26** of the seal **22** extending on both sides of the relief area **20** on the bottom support surface **18** of the seal gland **14**.

(14) As discussed above, preferably the relief area **20** has a parabolic form in cross-section.

(15) Further, the method further includes providing the second part **28** with a lead-in area **32** and the method further includes the lead-in area **32** compressing the seal **22** during assembly of the first and second parts **12**, **28**.

(16) The method may further include machining the relief area **20** in the bottom support surface **18** of the seal gland **14**. However, the relief area can be formed by other means.

(17) Additionally, the method can further include providing the relief area **20** with a volume that is less than about 15% of a volume of the seal **22**, and more preferably less than about 10%. However, the specific size of the relief area **20** relative to the volume of the seal **22** can vary depending upon the particular application and the overall size of the seal gland.

(18) Having thus described the presently preferred embodiments in detail, it is to be appreciated and will be apparent to those skilled in the art that many physical changes, only a few of which are exemplified in the detailed description, could be made without altering the inventive concepts and principles embodied therein. It is also to be appreciated that numerous embodiments incorporating

only part of the preferred embodiment are possible which do not alter, with respect to those parts, the inventive concepts and principles embodied therein. The present embodiments and optional configurations are therefore to be considered in all respects as exemplary and/or illustrative and not restrictive, the scope that is indicated by the appended claims rather than by the foregoing description, and all alternate embodiments and changes to this embodiment which come within the meaning and range of equivalency of said claims are therefore to be embraced therein.

LIST OF REFERENCE SYMBOLS

(19) **10** seal arrangement **12** first part **14** seal gland **16***a*,*b* side walls **18** bottom support surface **20** relief area **22** seal **24** outer surface **26** inner support surface **28** second part **30** sealing surface **32** lead-in area **40** method **41**-**45** method steps OD outside diameter ID inside diameter

Claims

1. A seal arrangement, comprising: a first part having a seal gland including a first side surface, a second side surface, and a bottom support surface; a seal located in the seal gland between the first side surface and the second side surface, the seal having an outer sealing surface and an inner support surface that is supported on the bottom support surface of the seal gland, the inner support surface being flat from a first lateral side to a second lateral side of the seal; a second part having a sealing surface against which the outer sealing surface of the seal is pressed; wherein the second part includes a lead-in area configured to compress the seal during assembly of the first and second parts; and a relief area formed in a portion of the bottom support surface of the seal gland, the relief area being configured to receive a resiliently deflected portion of the inner support surface of the seal during assembly, wherein the relief area has a parabolic form in cross-section; wherein the first side surface of the seal gland is positioned adjacent and non-contacting a first side of the seal, the second side surface of the seal gland is positioned adjacent and non-contacting a second side of the seal, and the bottom support surface of the seal gland is positioned adjacent and contacting the inner support surface of the seal.

2. The seal arrangement of claim 1, wherein the relief area is formed in a medial area of the bottom support surface of the seal gland.

3. The seal arrangement of claim 1, wherein the inner support surface of the seal extends on both sides of the relief area on the bottom support surface.

4. The seal arrangement of claim 1, wherein the second part includes a lead-in area configured to compress the seal during assembly of the first and second parts.

5. The seal arrangement of claim 1, wherein the relief area is formed as a machined cut in the bottom support surface.

6. The seal arrangement of claim 1, wherein the relief area has a volume that is less than about 15% of a volume of the seal.

7. A method of forming a seal arrangement, the method comprising: providing a first part having a seal gland; forming a relief area in a portion of a bottom support surface of the seal gland; installing a seal in the seal gland, the seal having an outer sealing surface and an inner support surface that is supported on the bottom support surface of the seal gland; installing a second part having a sealing surface against the outer sealing surface of the seal by sliding the first and second parts together relative to one another; and compressing the seal during the installing step such that a resiliently deflected portion of the inner support surface of the seal expands into the relief area during assembly; wherein the second part includes a lead-in-area that compresses the seal during the installing and compressing steps, the lead-in-area is free from contact with the seal after installing the second part on the first part, and the lead-in-area is orientated at a non-perpendicular and non-parallel angle with respect to the sealing surface of the second part; wherein a first side surface of the seal gland is positioned adjacent and non-contacting a first side of the seal, a second side surface of the seal gland is positioned adjacent and non-contacting a second side of the seal, and the

bottom support surface of the seal gland is positioned adjacent and contacting the inner support surface of the seal.
8. The method of claim 7, wherein the relief area is formed in a medial area of the bottom support surface of the seal gland.
9. The method of claim 7, wherein the inner support surface of the seal extends on both sides of the relief area on the bottom support surface.
10. The method of claim 7, wherein the relief area has a parabolic form in cross-section.
11. The method of claim 7, further comprising machining the relief area in the bottom support surface.
12. The method of claim 7, wherein the relief area has a volume that is less than about 15% of a volume of the seal.
13. The method of claim 7, wherein the lead-in-area is axially offset from the seal gland after the second part is installed on the first part.
14. The seal arrangement of claim 1, wherein the seal is a D-ring seal.
15. The method of claim 7, wherein the seal is a D-ring seal.
16. The seal arrangement of claim 1, wherein the inner support surface of the seal is located radially between an outside diameter and an inside diameter of the seal gland, and the outer sealing surface is located radially outside the outside diameter of the seal gland.
17. A seal arrangement comprising: a first part having a seal gland including a first side surface, a second side surface, and a bottom support surface; a seal located in the seal gland between the first side surface and the second side surface, the seal having an outer sealing surface and an inner support surface that is supported on the bottom support surface of the seal gland, the inner support surface being flat from a first lateral side to a second lateral side of the seal; a second part having a sealing surface against which the outer sealing surface of the seal is pressed; and a relief area formed in a portion of the bottom support surface of the seal gland, the relief area being configured to receive a resiliently deflected portion of the inner support surface of the seal during assembly; wherein the first side surface of the seal gland is positioned adjacent and non-contacting a first side of the seal, the second side surface of the seal gland is positioned adjacent and non-contacting a second side of the seal, and the bottom support surface of the seal gland is positioned adjacent and contacting the inner support surface of the seal.