stable. In such a condition, radial seal 408 may not be able to effectively seal between body 402 and bonnet 404.

[0011] Accordingly, there exists a need for a sealing assembly to seal between surfaces under high pressure without sacrificing sealing capabilities under low pressure.

SUMMARY OF INVENTION

[0011a] In accordance to a first aspect of the present invention, there is provided a seal assembly disposed within a radial seal groove to sealingly engage a bonnet within a bore, the seal assembly comprising: a radial seal surface; an axial seal surface; a vent surface opposite to the radial seal surface, the vent surface having a first recessed area and a first raised area; an axial preload surface having a second recessed area and a second raised area, the axial preload surface being opposite to the axial seal surface; and a backup ring at least partially bonded adjacent to the axial seal surface, wherein at least one vent of the bonnet is configured to allow communication between a high-pressure zone and the first recessed area but not the first raised area of the vent surface, wherein the radial seal surface sealingly engages against the bore and the axial seal surface sealingly engages against a longitudinal wall of the radial seal groove, wherein the seal assembly is thrust towards the longitudinal wall and away from a radial wall of the radial seal groove when pressure in the high-pressure zone increases, and wherein the first raised area is adjacent to the second raised area.

[0012] E~~In one aspect, e~~mbodiments disclosed herein relate to an apparatus to isolate a high-pressure zone from a low-pressure zone. The apparatus comprises a bonnet engaged within a bore along an axis, a radial seal groove located in one of the bonnet and the bore wherein the radial seal groove comprises a radial wall and a longitudinal wall, and a seal assembly disposed in the radial groove. The seal assembly comprises a radial seal surface, an axial seal surface, a vent surface, an axial preload surface, and a backup ring adjacent to the longitudinal wall and at least partially bonded to the seal assembly. At least a portion of the vent surface and the radial seal surface are radially preloaded, and at least a portion of the axial preload surface and the axial seal surface are axially preloaded.

[0013] ~~In another aspect, e~~Embodiments disclosed herein relate to a seal assembly disposed within a radial seal groove to sealingly engage a bonnet within a bore. The seal assembly comprises a radial seal surface, an axial seal surface, a vent surface, an axial preload surface, a backup ring at least partially bonded adjacent to the axial seal surface, and at least one vent to allow communication between a high-pressure zone and the vent surface. The radial seal surface sealingly engages against the bore and the axial seal surface sealingly engages against a longitudinal wall of the radial seal groove. Further, the seal assembly is thrust towards the longitudinal wall and away from a radial wall of the radial seal groove when pressure in a high-pressure zone increases.

[0014] ~~In another aspect, e~~Embodiments disclosed herein relate to a seal assembly disposed within a radial seal groove to sealingly engage a bonnet within a bore. The seal assembly comprises a seal carrier, a radial seal surface, an axial seal surface, a vent surface, an axial preload surface, a sealing element disposed on the radial seal surface, and a sealing element disposed on the axial seal surface. The sealing

element disposed on the radial seal surface sealingly engages against the bore and the sealing element disposed on the axial seal surface sealingly engages against a longitudinal wall of the radial seal groove. Further, the seal assembly is thrust towards the longitudinal wall and away from a radial wall of the radial seal groove when pressure in a high-pressure zone increases.

[0015] Other ~~aspects and~~ advantages of the invention will be apparent from the following description and the appended claims.

BRIEF DESCRIPTION OF DRAWINGS

[0016] Figure 1 is a perspective view of a prior art ram-type blowout preventer.

[0017] Figure 2 is a cross-sectional view of a prior art high-pressure seal carrier disposed between a bonnet and a BOP body of a ram-type blowout preventer.

[0018] Figure 3A is a cross-sectional view of a prior art high-pressure seal disposed in a groove about a shaft.

[0019] Figure 3B is a cross-sectional view of prior art high-pressure seal with a ring to seal about a shaft.

[0020] Figure 4 is a cross-sectional view of a prior art seal disposed between a bonnet and a BOP body of a ram-type blowout preventer.

[0021] Figure 5A is a cross-sectional view of a seal assembly in accordance with an embodiment of the present disclosure.

[0022] Figure 5B is a perspective view of a seal assembly in accordance with an embodiment of the present disclosure.

[0023] Figure 6 is a cross-sectional view of a seal assembly disposed in a radial seal groove in accordance with an embodiment of the present disclosure.

[0024] Figure 7 is a cross-sectional view of a seal assembly disposed in a radial seal groove in accordance with an embodiment of the present disclosure.

[0025] Figure 8 is a cross-sectional view of a seal assembly disposed in a radial seal groove under low-pressure in accordance with an embodiment of the present disclosure.

CLAIMS

What is claimed is:

1. An apparatus to isolate a high-pressure zone from a low-pressure zone, the apparatus comprising:

a bonnet engaged within a bore along an axis;

a radial seal groove located in one of the bonnet and the bore, wherein the radial seal groove comprises a radial wall and a longitudinal wall; and

a seal assembly disposed in the radial seal groove, the seal assembly comprising:

a radial seal surface, an axial seal surface, a vent surface, an axial preload surface, and a backup ring adjacent to the longitudinal wall and at least partially bonded to the seal assembly;

wherein at least a portion of the vent surface and the radial seal surface are radially preloaded; and

wherein at least a portion of the axial preload surface and the axial seal surface are axially preloaded.

2. The apparatus of claim 1, further comprising at least one high-pressure vent to allow fluid to communicate between the high-pressure zone and the vent surface of the seal assembly.

3. The apparatus of claim 1, wherein under high operating pressure, the seal assembly is thrust against the longitudinal wall and away from the radial wall in the radial seal groove.

4. The apparatus of claim 1, wherein the seal assembly comprises at least one biasing mechanism.

5. The apparatus of claim 4, wherein the at least one biasing mechanism is selected from the group consisting of springs, elastomers, and rubbers.

6. The apparatus of claim 1, further comprising a seal retainer removably secured to one of the bonnet and the bore.

7. The apparatus of claim 1, wherein the bonnet rotates about the axis with respect to the bore.

8. The apparatus of claim 1, wherein the bonnet reciprocates along the axis with respect to the bore.

9. The apparatus of claim 1, wherein the seal assembly comprises a seal carrier and a plurality of sealing elements.

10. The apparatus of claim 1, wherein the seal assembly comprises at least one of the group consisting of elastomers, synthetic rubber, and natural rubber.

11. The apparatus of claim 10, wherein the seal assembly comprises multiple compounds.

12. The apparatus of claim 10, wherein the seal assembly is a multi-durometer compound.

13. The apparatus of claim 10, wherein the seal assembly further comprises fabric reinforcement.

14. The apparatus of claim 1, wherein the vent surface comprises a relief groove.

15. The apparatus of claim 1, wherein the axial preload surface comprises a relief groove.

16. The apparatus of claim 1, wherein the backup ring comprises one of a continuous ring, a segmented ring, and a rolled spring.

17. A seal assembly disposed within a radial seal groove to sealingly engage a bonnet within a bore, the seal assembly comprising:

a radial seal surface;

an axial seal surface;

a vent surface;

an axial preload surface;

a backup ring at least partially bonded adjacent to the axial seal surface; and

at least one vent to allow communication between a high-pressure zone and the vent surface;

wherein the radial seal surface sealingly engages against the bore and the axial seal surface sealingly engages against a longitudinal wall of the radial seal groove; and

wherein the seal assembly is thrust towards the longitudinal wall and away from a radial wall of the radial seal groove when pressure in the high-pressure zone increases.

18. The apparatus of claim 17, wherein the seal assembly comprises biasing mechanisms.

19. The apparatus of claim 17, further comprising a seal retainer removably secured to one of the bonnet and the bore to retain the seal assembly within the radial seal groove.

20. The apparatus of claim 17, wherein the seal assembly comprises a seal carrier and a plurality of sealing elements.

21. The apparatus of claim 17, wherein the seal assembly comprises at least one of the group consisting of elastomers, synthetic rubber, and natural rubber.

22. The apparatus of claim 21, wherein the seal assembly comprises multiple compounds.

23. The apparatus of claim 21, wherein the seal assembly is a multi-durometer compound.

24. The apparatus of claim 21, wherein the seal assembly comprises fabric reinforcement.

25. The apparatus of claim 17, wherein the vent surface comprises a relief groove.

26. The apparatus of claim 17, wherein the preload surface comprises a relief groove.

27. The apparatus of claim 17, wherein the backup ring comprises one of a continuous ring, a segmented ring, and a rolled spring.

28. A seal assembly disposed within a radial seal groove to sealingly engage a bonnet within a bore, the seal assembly comprising:

a seal carrier;

a radial seal surface;

an axial seal surface;

a vent surface;

an axial preload surface;

a sealing element disposed on the radial seal surface; and

a sealing element disposed on the axial seal surface;

wherein the sealing element disposed on the radial seal surface sealingly engages against the bore and the sealing element disposed on the axial seal surface sealingly engages against a longitudinal wall of the radial seal groove; and

wherein the seal assembly is thrust towards the longitudinal wall and away from a radial wall of the radial seal groove when pressure in a high-pressure zone increases.

29. The seal assembly of claim 28, wherein a modulus of elasticity of a material of the seal carrier is lower than a modulus of elasticity of the bore.

30. The seal assembly of claim 29, wherein the seal carrier is comprised of titanium.

31. The seal assembly of claim 28, further comprising at least one vent to allow communication between the high-pressure zone and the vent surface.

32. The seal assembly of claim 28, further comprising at least one biasing mechanism.

33. The seal assembly of claim 28, wherein at least one of the sealing elements is molded rubber.

CLAIMS

What is claimed is:

1. A seal assembly disposed within a radial seal groove to sealingly engage a bonnet within a bore, the seal assembly comprising:

a radial seal surface;

an axial seal surface;

a vent surface opposite to the radial seal surface, the vent surface having a first recessed area and a first raised area;

an axial preload surface having a second recessed area and a second raised area, the axial preload surface being opposite to the axial seal surface; and

a backup ring at least partially bonded adjacent to the axial seal surface, wherein at least one vent of the bonnet is configured to allow communication between a high-pressure zone and the first recessed area but not the first raised area of the vent surface,

wherein the radial seal surface sealingly engages against the bore and the axial seal surface sealingly engages against a longitudinal wall of the radial seal groove, wherein the seal assembly is thrust towards the longitudinal wall and away from a radial wall of the radial seal groove when pressure in the high-pressure zone increases, and

wherein the first raised area is adjacent to the second raised area.

2. The seal assembly of claim 1, further comprising a seal retainer removably secured to one of the bonnet and the bore to retain the seal assembly within the radial seal groove.

3. The seal assembly of claim 1, wherein the seal assembly comprises at least one of the group consisting of elastomers, synthetic rubber, and natural rubber.

4. The seal assembly of claim 1, wherein the seal assembly comprises multiple compounds.

5. The seal assembly of claim 1, wherein the seal assembly is a multi-durometer compound.

6. The seal assembly of claim 1, wherein the vent surface comprises a relief groove.

7. The seal assembly of claim 1, wherein the preload surface comprises a relief groove.

8. The seal assembly of claim 1, wherein the backup ring comprises one of a continuous ring, a segmented ring, and a rolled spring.