Claims

What is claimed is:

1. A seal assembly for use between wellbore tubulars comprising:

an inner seal ring having an outer radial surface profiled oblique to an axis of the tubulars; and

an outer seal ring having an inner radial surface profiled oblique to the axis of the tubulars and in sliding contact with the inner seal ring outer radial surface, so that when the seal assembly is set in an annular space between the tubulars and opposing axial forces are applied to lateral ends of the outer seal ring and inner seal ring, sealing surfaces are formed where an inner radius of the seal assembly contacts an inner tubular and an outer radius of the seal assembly contacts an outer tubular.

2. The seal assembly of claim 1, further comprising a spring assembly for applying an axial force on one of the lateral ends of the outer seal ring or inner seal ring.

3. The seal assembly of claim 2, wherein the spring assembly comprises a resilient member selected from the group consisting of a Belleville washer, a stack of Belleville washers, wave spring washers, coiled springs, and combinations thereof.

4. The seal assembly of claim 1, wherein the inner and outer seal rings include an inelastic substance comprising a material selected from the group consisting of graphite, a fluoropolymer, and combinations thereof.

5. The seal assembly of claim 1, further comprising lateral rings provided on distal surfaces of the inner ring and outer ring.

6. The seal assembly of claim 1, further comprising an intermediate ring disposed between at least a portion of the inner radial surface of the outer ring and the outer radial surface of the inner ring.

7. The seal assembly of claim 6, wherein the intermediate ring has a hardness greater than a hardness of the inner and outer rings.

8. The seal assembly of claim 6, wherein the intermediate ring comprises a coating on each of the inner radial surface of the outer ring and the outer radial surface of the inner ring.

9. A wellhead assembly comprising:

an outer tubular;

an inner tubular inserted within the outer tubular;

an annular space defined between the inner and outer tubulars;

a seal assembly in the annular space and between axial supports coupled with at least one of the inner or outer tubular, the seal assembly comprising:

an inner seal ring having an inner radial surface in selective contact with a portion of an outer radial surface of the inner tubular and an outer radial surface profiled at an angle oblique to an axis of the wellhead assembly;

an outer seal ring having an outer radial surface in selective contact with a portion of an inner radial surface of the outer tubular and an inner radial surface profiled at an angle oblique to an axis of the wellhead assembly and that corresponds to the outer radial surface of the inner seal ring, so that when the inner tubular is inserted into the outer tubular and axial forces are applied to the seal assembly, the inner and outer seal rings slide into respective positions and a sealing interface is formed between the inner radius of the inner ring and a portion of an outer radius of the inner tubular and a sealing interface is formed between the outer radius of the outer ring and a portion of an inner radius of the outer tubular.

10. The wellhead assembly of claim 9, wherein at least one of the supports comprises a resilient member.

11. The wellhead assembly of claim 9, further comprising a groove formed in the outer radius of the inner tubular, wherein the seal assembly is disposed in the groove and upper and lower edges of the groove comprise supports for the seal assembly.

12. The wellhead assembly of claim 9, wherein the inner and outer seal rings are each comprised of a compliant material, so that when the axial forces are applied to distal ends of the inner and outer seal rings, the inner radius of the inner seal ring bulges radially inward to form the sealing interface with the inner tubular and the outer radius of the outer seal ring bulges radially outward to form the sealing interface with the outer tubular.

13. The wellhead assembly of claim 9, wherein the inner and outer tubulars are selected from the group consisting of a hanger and a production tree.

14. A method of sealing an annular space between wellbore tubulars comprising:

(a) providing a seal assembly comprising an inner seal ring having an outer radial surface profiled oblique to an axis of the wellbore tubulars, and an outer seal ring having an inner radial surface profiled oblique to the axis of the wellbore tubulars and in sliding contact with the inner seal ring outer radial surface;

(b) disposing the seal assembly between the wellbore tubulars; and

(c) maintaining an axial length of the seal assembly by applying axial loads to opposing lateral ends of the seal assembly thereby bulging out at least one of an inner radial surface on the inner seal ring and an outer radial surface of the outer seal ring to form a sealing surface between the seal assembly and at least one of the tubulars.

15. The method of claim 14, wherein prior to step (b), a width of the seal assembly taken along a radius of the seal assembly exceeds a width of a space between the wellbore tubulars, wherein during step (b), the inner and outer seal rings axially slide a designated distance in opposite directions along the inner and outer radial profiles.

16. The method of claim 15, wherein the designated distance is defined by the position of where the axial loads are applied to the seal assembly.

17. The method of claim 14, wherein the inner and outer seal rings include an inelastic substance comprising a material selected from the group consisting of graphite, a fluoropolymer, and combinations thereof.

18. The method of claim 14, wherein the wellbore tubulars comprise inner and outer wellbore tubulars, and a groove is formed on an outer radial surface of the inner wellbore tubular, and wherein the seal assembly is provided in the groove.

What is claimed is:

1. A seal assembly for use between wellbore tubulars comprising:
an inner seal ring having an inner radial surface and an outer oblique surface profiled oblique to an axis of the tubulars and that intersects the inner radial surface;

an outer seal ring having an inner oblique surface profiled oblique to the axis of the tubulars and in sliding contact with the inner seal ring outer oblique surface, so that when the seal assembly is set in an annular space between the tubulars and opposing axial forces are applied to ends of the outer seal ring and inner seal ring, sealing surfaces are formed where an inner radius of the seal assembly contacts an inner tubular and an outer radius of the seal assembly contacts an outer tubular;

an anti-extrusion ring assembly on one of the ends of one of the seal rings, the anti-extrusion ring assembly comprising inner and outer members with mating oblique surfaces that slidingly engage each other such that an axial force causes a width of the anti-extrusion ring assembly to expand, the inner and outer members having a lesser axial dimension than an axial dimension of the inner and outer seal rings; and

a spring assembly in engagement with an end of the anti-extrusion ring assembly opposite the seal rings for applying an axial force to the anti-extrusion ring assembly.

2. The seal assembly of claim 1, wherein the oblique surfaces of the inner and outer members are at a greater angle relative to the axis of the seal assembly than the oblique surfaces of the seal rings.

3. The seal assembly of claim 1, wherein the anti-extrusion ring assembly comprises an upper anti-extrusion ring assembly on an upper end of the seal rings and a lower anti-extrusion ring assembly on a lower end of the seal rings.

4. The seal assembly of claim 1, wherein the inner and outer seal rings include an inelastic substance comprising a material selected from the group consisting of graphite, a fluoropolymer, and combinations thereof.

5. The seal assembly of claim 1, wherein the inner and outer members of the anti-extrusion ring assembly are symmetrical with each other.

6. The seal assembly of claim 1, further comprising an intermediate ring disposed between at least a portion of the inner radial surface of the outer ring and the outer radial surface of the inner ring.

7. The seal assembly of claim 6, wherein the intermediate ring has a hardness greater than a hardness of the inner and outer rings.

8. The seal assembly of claim 6, wherein the intermediate ring comprises a coating on each of the inner radial surface of the outer ring and the outer radial surface of the inner ring.

9. A wellhead assembly comprising:
an outer tubular;

an inner tubular inserted within the outer tubular;

an annular space defined between the inner and outer tubulars and a downward facing shoulder on the inner tubular member;

an inner seal ring having an inner radial surface in selective contact with a portion of an outer radial surface of the inner tubular and an outer oblique surface profiled at an angle oblique to an axis of the wellhead assembly;

an outer seal ring having an outer radial surface in selective contact with a portion of an inner radial surface of the outer tubular and an inner oblique surface profiled at an angle oblique to an axis of the wellhead assembly that intersects the outer radial surface and that corresponds to the outer oblique surface of the inner seal ring, so that when the inner tubular is inserted into the outer tubular and axial forces are applied to the inner and outer seal rings, the inner and outer seal rings slide into respective positions and a sealing interface is formed between the inner radius of the inner ring and a portion of an outer radius of the inner tubular and a sealing

interface is formed between the outer radius of the outer ring and a portion of an inner radius of the outer tubular;

a metal seal mounted in the annular space below the inner and outer seat rings, the metal seal having inner and outer legs separated by a slot;

an energizing ring that inserts into the slot to force the inner and outer legs inward and outward into sealing engagement with the inner and outer tubulars, respectively;

a retainer ring secured to the inner tubular member for forcing the energizing ring upward to apply an upward force to the metal seal; and

wherein the metal seal and inner and outer seal rings are mounted in the annular space so that the upward force is transmitted through the inner and outer seal rings to the shoulder.

10. The wellhead assembly of claim 9, further comprising a spring located between the shoulder and the inner and outer seal rings.

11. The wellhead assembly of claim 9, further comprising a pair of anti-extrusion rings between the inner and outer seal rings and the shoulder, the anti-extrusion rings having mating oblique surfaces that slidingly engage each other, such that the upward force causes a width of the anti-extrusion rings to expand, and wherein an axial dimension of the anti-extrusion rings is less than an axial dimension of the inner and outer seal rings.

12. The wellhead assembly of claim 9, wherein the inner and outer seal rings are each comprised of a compliant material, so that when the axial forces are applied to distal ends of the inner and outer seal rings, the inner radius of the inner seal ring bulges radially inward to form the sealing interface with the inner tubular and the outer radius of the outer seal ring bulges radially outward to form the sealing interface with the outer tubular.

13. The wellhead assembly of claim 9, further comprising upper anti-extrusion rings between the inner and outer seal rings and the shoulder, and lower anti-extrusion rings between the metal seal

and the inner and outer seal rings, the upper anti-extrusion rings having mating oblique surfaces that slidingly engage each other, and the lower anti-extrusion rings having mating oblique surfaces that slidingly engage each other, wherein the upward force causes a width of the lower and the upper anti-extrusion rings to expand.

14. A method of sealing an annular space between wellbore tubulars comprising:
providing a seal assembly comprising an inner seal ring having an inner radial surface and an outer oblique a surface profiled oblique to an axis of the wellbore tubulars that intersects the inner radial surface, and an outer seal ring having an inner oblique surface profiled oblique to the axis of the wellbore tubulars and in sliding contact with the inner seal ring outer radial surface;

providing an anti-extrusion ring assembly on one of the ends of one of the seal rings, the anti-extrusion ring assembly comprising inner and outer members with mating oblique surfaces that slidingly engage each other, the inner and outer members having at lesser axial dimension than an axial dimension of the inner and outer seal rings;

providing a spring assembly in engagement with an end of the anti-extrusion ring assembly opposite the seal rings for applying an axial force the anti-extrusion assembly;

(a) disposing the seal assembly, the anti-extrusion ring assembly, and the ring assembly between the wellbore tubulars; and

(b) maintaining an axial length of the seal assembly by applying an axial load to an end of the seal assembly opposite the spring assembly, thereby bulging out at least one of an inner radial surface on the inner seal ring and an outer radial surface of the outer seal ring to form a sealing surface between the seal assembly and at least one of the tubulars and increasing a width of the anti-extrusion ring assembly.

15. The method of claim 14, wherein prior to step (b), a width of the seal assembly taken along a radius of the seal assembly exceeds a width of a space between the wellbore tubulars, wherein during step (b), the inner and outer seal rings axially slide a designated distance in opposite directions along the inner and outer radial profiles.

16. The method of claim 15, wherein the designated distance is defined by the position of where the axial loads are applied to the seal assembly.

17. The method of claim 14, wherein the inner and outer seal rings include an inelastic substance comprising a material selected from the group consisting of graphite, a fluoropolymer, and combinations thereof.

18. The method of claim 14, wherein the wellbore tubulars comprise inner and outer wellbore tubulars, and a groove is formed on an outer radial surface of the inner wellbore tubular, and wherein the seal assembly is provided in the groove