What is claimed is:

1. A wellhead assembly (11), comprising:

a wellhead (13) having a bore (7) having a grooved profile (63);

one or more casing hangers (21) landed in the bore (7) below the grooved profile (63); and

an annular lockdown bushing (25) coaxially inserted into the bore (7);

a locking ring (41) set in an annulus between the lockdown bushing (25) and the grooved profile (63) and selectively moveable from a running position spaced radially inward from the grooved profile (63) to a set position in contact with the grooved profile (63);

an energizing ring (43) having an annular portion in contact with over fifty percent of the surface of the locking ring (41) facing the lockdown bushing (25) when the locking ring (41) is in the running position and in contact with about eighty percent of the surface of the locking ring (41) facing the lockdown bushing (25) in the set position.

2. The wellhead assembly (11) of Claim 1, further comprising a profile (30) on an inner surface of the locking ring (41) that is substantially similar to a profile on an inner surface of the casing hanger (21) so that a running tool used for landing the casing hanger (21) can be used to land the locking ring (41).

3. The wellhead assembly (11) of Claim 1, further comprising a limiter ring (47) coupled to the lockdown bushing (25) and projecting radially outward into a lower portion of a groove (51) in an inner surface of the energizing ring (43) when the locking ring (41) is in the running position and into an upper portion of the groove (51) when the locking ring (41) is in the set position.

4. The wellhead assembly (11) of Claim 1, wherein the energizing ring (43) contacts the locking ring (41) to define a mating tapered surface (53, 59) that is offset about four degrees from an axis of the wellhead assembly (11).

5. The wellhead assembly (11) of Claim 1, wherein the energizing ring (43) is moved a distance of up to about one third a height of the locking ring (41) to move the locking ring (41) from a running position to a set position.

6. The wellhead assembly (11) of Claim 1, wherein a locking ring cam surface (59) and an energizing ring cam surface (53) have mating detents (71, 73) formed on lower ends of each cam surface (53, 59), the detents (71, 73) adapted to engage when the locking ring cam surface (59) and the energizing ring cam surface (53) fully engage to secure the energizing ring (43) and the locking ring (41) in the set position.

7. The wellhead assembly (11) of Claim 1, wherein the locking ring (41) includes a saw cut (4) extending from an upper rim of the locking ring (41) to a lower rim of the locking ring (41) to form a split ring.

8. The wellhead assembly (11) of Claim 1, wherein the locking ring (41) includes one or more saw cuts (40) extending from at least one of an upper rim (44) and a lower rim (42) of the locking ring (41), the saw cuts (40) circumferentially spaced about the locking ring (41).

9. The wellhead assembly (11) of Claim 1, wherein the locking ring (41) includes a plurality of saw cuts (40) extending from an upper rim (44) and a lower rim (42) of the locking ring (41), the saw cuts (40) circumferentially spaced about the locking ring (41).

10. A lockdown bushing (25) adapted for use with a subsea wellhead assembly (11) comprising:

a tubular body (27) having an axis (9) and a central bore (7), the tubular body (27) having a lower end (31) adapted to land on a hanger (21) and an upward facing shoulder (39) on an outer diameter portion of the tubular body (27);

a locking ring (41) positioned on the upward facing shoulder (39) and circumscribing the tubular body (27), the locking ring (41) having an inner diameter with an annular locking ring cam surface (59); and

an energizing ring (43) circumscribing the tubular body (27) and adapted to engage the locking ring (41) with an inner diameter surface of a wellhead (13), the energizing ring (43) including a lower portion (45) interposed between the tubular body (27) and the locking ring (41) in an unset position, the lower portion (45) having an outer diameter cam surface (53) in sliding contact with the annular locking ring cam surface (59) along an interface offset up to about seven degrees from an axis (9) of the wellhead assembly (11) so that when the energizing ring (43) moves axially downward a distance of up to about one-third the height of the locking ring (41), the outer diameter cam surface (53) of

the energizing ring (43) engages the annular locking ring cam surface (59) to move the locking ring (41) into engagement with the inner diameter of the wellhead (13) to a set position increasing lockdown capacity.

11. The lockdown bushing (25) of Claim 10, further comprising a limiter ring (47) interposed between the energizing ring (43) and an upper portion (29) of the tubular body (27), the limiter ring (47) adapted to engage an upward facing shoulder (65) and a downward facing shoulder (69) of a groove (51) formed in an upper portion of the energizing ring (43) to limit axial movement of the energizing ring (43).

12. The lockdown bushing (25) of Claim 10, wherein the interfacing cam surfaces (53, 59) are offset from the axis at about 4 degrees.

13. The lockdown bushing (25) of Claim 13, wherein the energizing ring cam surface (53) and the locking ring cam surface (59) form a friction lock to secure the energizing ring (43) and the locking ring (41) in the set position.

14. The lockdown bushing (25) of Claim 10, wherein the cam portion (45) of the energizing ring (43) overlaps the locking ring (41) along at least two-thirds a height of the locking ring (41) in the unset position and overlaps up to ninety-five percent of the locking ring (41) in the set position.

15. The lockdown bushing (25) of Claim 10, wherein a plurality of shear elements (67) hold the energizing ring (43) in the running position relative to the tubular body (27) during a running operation.

16. The lockdown bushing (25) of Claim 10, wherein the locking ring (41) includes one or more saw cuts (40) extending from at least one of an upper rim (44) and a lower rim (42) of the locking ring (41), the saw cuts (40) circumferentially spaced about the locking ring (41).

17. A method to run and set a lockdown bushing (25) in a wellhead, the method comprising:

(a) providing a lockdown bushing (25) having a locking ring (41) disposed on an upward facing shoulder (39) of the lockdown bushing (25) and an energizing ring (43) secured to an upper portion (29) of the lockdown bushing (25) so that a cam portion (45) of the energizing ring (43) extends between the lockdown bushing (25) and the

locking ring (41) and overlaps the locking ring (41) along at least fifty percent of the height of the locking ring (41);

(b) running the lockdown bushing (25) to a casing hanger (21) landed and set in a bore (7) of the wellhead (13);

(c) actuating the running tool to move the energizing ring (43) axially downward to engage an energizing ring cam surface (53) on the cam portion (45) of the energizing ring (43) with a locking ring cam surface (59) on an inner diameter of the locking ring (41), the energizing ring (43) overlapping the locking ring (41) along at least eighty percent of the height of the locking ring (41); and

(d) moving the locking ring (41) radially outward into engagement with an inner diameter of the wellhead (13) in response to the downward axial movement of the energizing ring (43), thereby setting the lockdown bushing (25).

18. The method of Claim 17, wherein step (c) further comprises shearing one or more shear elements (67) holding the energizing ring (43) in an upward axial position relative to the lockdown bushing (25).

19. The method of Claim 17, further comprising engaging a pair of matching detents (71, 73) on the energizing ring cam surface (53) and the locking ring cam surface (59) to secure the energizing ring (43) and the locking ring (41) in the set position.

20. The method of Claim 17, wherein step (a) further comprises positioning the energizing ring (43) so that the energizing ring (43) overlaps the locking ring (41) along at least two-thirds of the height of the locking ring (41).

CLAIMS:

1. A wellhead assembly, comprising:

a wellhead having a bore having a grooved profile;

one or more casing hangers landed in the bore below the grooved profile; and

an annular lockdown bushing coaxially inserted into the bore;

a locking ring set in an annulus between the lockdown bushing and the grooved profile and selectively moveable from a running position spaced radially inward from the grooved profile to a set position in contact with the grooved profile; and

an energizing ring having an annular portion in contact with over fifty percent of the surface of the locking ring facing the lockdown bushing when the locking ring is in the running position and in contact with about eighty percent of the surface of the locking ring facing the lockdown bushing in the set position.

2. The wellhead assembly of Claim 1, further comprising a profile on an inner surface of the locking ring that is substantially similar to a profile on an inner surface of the casing hanger so that a running tool used for landing the casing hanger can be used to land the locking ring.

3. The wellhead assembly of Claim 1 or Claim 2, further comprising a limiter ring coupled to the lockdown bushing and projecting radially outward into a lower portion of a groove in an inner surface of the energizing ring when the locking ring is in the running position and into an upper portion of the groove when the locking ring is in the set position.

4. The wellhead assembly of any preceding claims, wherein the energizing ring contacts the locking ring to define a mating tapered surface that is offset about 3 to 7 degrees from an axis of the wellhead assembly.

5. The wellhead assembly of any preceding Claim, wherein the energizing ring contacts the locking ring to define a mating tapered surface that is offset about four degrees from an axis of the wellhead assembly.

6. The wellhead assembly of any preceding Claim, wherein the energizing ring is moved a distance of up to about one third a height of the locking ring to move the locking ring from a running position to a set position.

7. The wellhead assembly of any preceding Claim, wherein the locking ring cam surface and the energizing ring cam surface have mating detents formed on lower ends of each cam surface, the detents adapted to engage when the locking ring cam surface and the energizing ring cam surface fully engage to secure the energizing ring and the locking ring in the set position.

8. The wellhead assembly of any preceding Claim, wherein the locking ring includes a saw cut extending from an upper rim of the locking ring to a lower rim of the locking ring to form a split ring.

9. The wellhead assembly of any preceding Claim, wherein the locking ring includes one or more saw cuts extending from at least one of an upper rim and a lower rim of the locking ring, the saw cuts circumferentially spaced about the locking ring.

10. The wellhead assembly of any preceding Claim, wherein the locking ring includes a plurality of saw cuts extending from an upper rim and a lower rim of the locking ring, the saw cuts circumferentially spaced about the locking ring.

11. The wellhead assembly of claim 1, wherein the lockdown bushing comprises a tubular body having an axis and a central bore, the tubular body having a lower end adapted to land on a hanger and an upward facing shoulder on an outer diameter portion of the tubular body;

the locking ring is arranged to be positioned on the upward facing shoulder and circumscribing the tubular body, the locking ring having an inner diameter with an annular locking ring cam surface; and

the energizing ring is arranged to circumscribe the tubular body and adapted to engage the locking ring with an inner diameter surface of the wellhead, the energizing ring including a lower portion interposed between the tubular body and the locking ring in an unset position, the lower portion having an outer diameter cam surface in sliding contact with the annular locking ring cam surface along an interface offset up to about seven degrees from an axis of the wellhead assembly so that when the energizing ring moves axially downward a distance of up to about one-third the height of the locking ring, the outer diameter cam surface of the energizing ring engages the annular locking ring cam surface to move the locking ring into engagement with the inner diameter of the wellhead to the set position increasing lockdown capacity.

12. The lockdown bushing of Claim 11, further comprising a limiter ring interposed between the energizing ring and an upper portion of the tubular body, the limiter ring adapted to engage an upward facing shoulder and a downward facing shoulder of a groove formed in an upper portion of the energizing ring to limit axial movement of the energizing ring.

13. The lockdown bushing of Claim 11 or Claim 12, wherein the interfacing cam surfaces are offset from the axis at about 4 degrees.

14. The lockdown bushing of any of Claims 11 to 13, wherein the energizing ring cam surface and the locking ring cam surface form a friction lock to secure the energizing ring and the locking ring in the set position.

15. The lockdown bushing of any of Claims 11 to 14, wherein the cam portion of the energizing ring overlaps the locking ring along at least two-thirds a height of the locking ring in the unset position and overlaps up to ninety-five percent of the locking ring in the set position.

16. The lockdown bushing of any of Claims 11 to 15, wherein a plurality of shear elements hold the energizing ring in the running position relative to the tubular body during a running operation.

17. The lockdown bushing of any of Claims 11 to 16, wherein the locking ring includes one or more saw cuts extending from at least one of an upper rim and a lower rim of the locking ring, the saw cuts circumferentially spaced about the locking ring.

18. A method to run and set a lockdown bushing in a wellhead, the method comprising:

(a) providing a lockdown bushing having a locking ring disposed on an upward facing shoulder of the lockdown bushing and an energizing ring secured to an upper portion of the lockdown bushing so that a cam portion of the energizing ring extends between the lockdown bushing and the locking ring and overlaps the locking ring along at least fifty percent of the height of the locking ring;

(b) running the lockdown bushing to a casing hanger landed and set in a bore of the wellhead;

(c) actuating the running tool to move the energizing ring axially downward to engage an energizing ring cam surface on the cam portion of the energizing ring with a locking ring cam surface on an inner diameter of the locking ring, the energizing ring overlapping the locking ring along at least eighty percent of the height of the locking ring; and

(d) moving the locking ring radially outward into engagement with an inner diameter of the wellhead in response to the downward axial movement of the energizing ring, thereby setting the lockdown bushing.

19. The method of Claim 18, wherein step (c) further comprises shearing one or more shear elements holding the energizing ring in an upward axial position relative to the lockdown bushing.

20. The method of Claim 18 or Claim 19, further comprising engaging a pair of matching detents on the energizing ring cam surface and the locking ring cam surface to secure the energizing ring and the locking ring in the set position.

21. The method of any of Claims 18 to 20, wherein step (a) further comprises positioning the energizing ring so that the energizing ring overlaps the locking ring along at least two-thirds of the height of the locking ring.