CLAIMS

1. An annulus seal ~~(110)~~ for sealing an interface between a wellhead housing ~~(104)~~ and a casing hanger ~~(102)~~, the annulus seal ~~(110)~~ comprising:

a central body portion ~~(114)~~;

a first seal leg ~~(116)~~ extending from the central body portion ~~(114)~~ in a first direction, the first seal leg ~~(116)~~ sealingly engaging the casing hanger ~~(102)~~; and

a second seal leg ~~(118)~~ extending from the central body portion ~~(114)~~ in the first direction across from the first seal leg ~~(116)~~, the second seal leg ~~(118)~~ sealingly engaging the wellhead housing ~~(104)~~;

wherein at least one of the first seal leg ~~(116)~~ or the second seal leg ~~(118)~~ includes at least one of a first cavity ~~(130)~~ at least partially extending into the respective seal leg from the first direction or a second cavity ~~(132)~~ at least partially extending into the respective seal leg from a second direction, wherein fluid pressure pushing on the annulus seal from the first direction causes the first cavity to expand and urge at least one wall of the annulus seal onto the wellhead housing or case hanger.

2. The annulus ~~(110)~~ seal of claim 1, wherein each of the first seal leg ~~(116)~~ and the second seal leg (118) includes a respective first cavity ~~(130)~~ and a respective second cavity ~~(132)~~ formed therein.

3. The annulus seal ~~(110)~~ of claim 1, wherein at least one of the first cavity ~~(130)~~ or the second cavity ~~(132)~~ is elongated and at least partially defined by two walls ~~(154, 156)~~.

4. ~~The annulus seal (110) of claim 1, wherein fluid pressure pushing on the annulus seal (110) from the first direction causes the first cavity (130) to expand and urge at least one wall of the annulus seal (110) onto the wellhead housing (104) or case hanger (102)~~The annulus seal of claim 3, wherein the two walls have wavy profiles with alternating crests and grooves.

5. The annulus seal ~~(110)~~ of claim 1, wherein fluid pressure pushing on the annulus seal ~~(110)~~ from the ~~second~~ first direction causes the ~~second~~first cavity ~~(132)~~ to expand and urge at least one wall of the annulus seal ~~(110)~~ onto the wellhead housing ~~(104)~~ or case hanger ~~(102)~~.

6. ~~The annulus seal (110) of claim 2, wherein the first cavity (130) and the second cavity (132) are positioned at different radial positions and extend past each other without intersecting~~The annulus seal of claim 1, wherein fluid pressure pushing on the annulus seal from the second direction causes the second cavity to expand and urge at least one wall of the annulus seal onto the wellhead housing or case hanger.

7. ~~An annulus seal assembly (100) for sealing the interface between a first wellhead tubular and a second wellhead tubular, the annulus seal assembly comprising:~~

~~an annulus seal (110) comprising:~~

~~a central body portion (114);~~

~~a first seal leg (116) extending from the central body portion (114) in a first direction, the first seal leg (116) sealingly engaging the first wellhead tubular; and~~

~~a second seal leg (118) extending from the central body portion (114) in the first direction across from the first seal leg (116), the first seal leg (116) sealingly engaging the second wellhead tubular; and~~

~~an energizing ring (112) having a nose end (124) for insertion between the first seal leg (116) and the second seal leg (118) of the annulus seal (110) from the first direction to energize~~

~~the first and second seal legs (116, 118) of the annulus seal (110) into a primary sealed~~

~~engagement with the first wellhead tubular and the second wellhead tubular,~~

~~wherein at least one of the first seal leg or the second seal leg (116, 118) includes a cavity~~

~~(130) formed therein, the cavity (130) in fluid communication with an environment external to~~

~~the annulus seal (110) and expandable from pressure in the first environment, the expansion~~

~~energizing the annulus seal (110) into a secondary sealed engagement with the first wellhead~~

~~tubular and the second wellhead tubular~~ The annulus seal of claim 2, wherein the first cavity and the second cavity are positioned at different radial positions and extend past each other without intersecting.

8. ~~The annulus seal assembly (100) of claim 7, wherein the cavity (130) is a first~~

~~cavity (130) and first seal leg (116) or second seal leg (118) includes a second cavity (130),~~

~~wherein the first cavity (130) is in fluid communication with annular space on a first side of the~~

~~annulus seal (110), and the second cavity (132) is in fluid communication with annular space on~~

~~a second side of the annulus seal (110)~~An annulus seal assembly for sealing the interface between a first wellhead tubular and a second wellhead tubular, the annulus seal assembly comprising: an annulus seal comprising:

a central body portion;

a first seal leg extending from the central body portion in a first direction, the first seal leg sealingly engaging the first wellhead tubular; and

a second seal leg extending from the central body portion in the first direction across from the first seal leg, the first seal leg sealingly engaging the second wellhead tubular; and

an energizing ring having a nose end for insertion between the first seal leg and the second seal leg of the annulus seal from the first direction to energize the first and second seal legs of the annulus seal into a primary sealed engagement with the first wellhead tubular and the second wellhead tubular,

wherein at least one of the first seal leg or the second seal leg includes a cavity formed therein, the cavity at least partially extending into the respective seal leg from the first direction

or at least partially extending into the respective seal leg from a second direction which is opposite the first direction, the cavity in fluid communication with an environment external to the annulus seal and expandable from pressure in the first environment, the expansion energizing the annulus seal into a secondary sealed engagement with the first wellhead tubular and the second wellhead tubular.

9. ~~The annulus seal assembly (100) of claim 8, wherein fluid pressure from the first side of the annulus seal (110) causes the first cavity (130) to expand and push the respective leg in which the first cavity (130) is formed against at least one of the first wellhead tubular or second wellhead tubular~~The annulus seal assembly of claim 8, wherein the cavity is a first cavity and first seal leg or second seal leg includes a second cavity, wherein the first cavity is in fluid communication with annular space on a first side of the annulus seal, and the second cavity is in fluid communication with annular space on a second side of the annulus seal.

10. The annulus seal assembly ~~(100)~~ of claim ~~8~~9, wherein fluid pressure from the ~~second~~first side of the annulus seal ~~(110)~~ causes the ~~second~~first first cavity ~~(132)~~ to expand and push the respective leg in which the ~~second~~first cavity is formed ~~(132)~~ against at least one of the first wellhead tubular or second wellhead tubular.

11. ~~The annulus seal assembly (100) of claim 8, wherein each of the first seal leg (116) and the second seal leg (118) includes a respective first cavity (130) and a respective second cavity (132) formed therein~~The annulus seal assembly of claim 9, wherein fluid pressure from the second side of the annulus seal causes the second cavity to expand and push the respective leg in which the second cavity is formed against at least one of the first wellhead tubular or second wellhead tubular.

12. ~~The annulus seal assembly (100) of claim 7, further comprising a third leg (120) extending in a second direction opposite the first direction, wherein the third leg (120) includes a second cavity (132) formed therein, the second cavity (132) in fluid communication with the environment and expandable from pressure in the environment~~ The annulus seal assembly of claim 9, wherein each of the first seal leg and the second seal leg includes a respective first cavity and a respective second cavity formed therein.

13. ~~A method of energizing an annulus seal assembly (100) between a wellhead housing (104) and a casing hanger (102), the method comprising:~~

~~inserting an annulus seal assembly (100) between the wellhead housing (104) and the casing hanger (102), the annulus seal assembly (100) including an annulus seal (110) and an energizing ring (112), the annulus seal (110) comprising two upwardly extending seal legs (116, 118), wherein the seal legs (116, 118) include cavities (132) formed therein extending at least partially into the seal legs (116, 118);~~

~~pushing the energizing ring (112) downward to insert at least portion of the energizing ring (112) between the seal legs (116, 118) of the annulus seal (110), thereby pushing the seal legs (116, 118) away from each other;~~

~~urging the seal legs (116, 118) against the wellhead housing (104) and the casing hanger (102) to form a seal therebetween via the energizing ring (112);~~

~~expanding the cavities (132) formed in the seal legs (116, 118) via pressurized fluid pushing on the annulus seal (110); and~~

~~urging the seal legs (116, 118) against the wellhead housing (104) and the casing hanger (102) from expansion of the cavities (132)~~The annulus seal assembly of claim 8, wherein the cavity is elongated and at least partially defined by two walls having wavy profiles with alternating crests and grooves.

14. ~~The method of claim 13, wherein the cavities (132) extend upwardly into the seal legs (116, 118) and expand due to pressure from below the annulus seal (120)~~The annulus seal assembly of claim 13, wherein the crests and grooves of the two walls are symmetrically arranged, forming a plurality of nodes in fluid communication with each other.

15. ~~The method of claim 14, wherein the annulus seal (110) further comprises additional cavities (130) formed therein extending at least partially downwardly into the seal legs (116, 118)~~The annulus seal assembly of claim 8, further comprising a third leg extending in a second direction opposite the first direction.

16. The annulus seal assembly of claim 15, wherein the third leg includes a second cavity formed therein, the second cavity in fluid communication with the environment and expandable from pressure in the environment.

17. A method of energizing an annulus seal assembly between a wellhead housing and a casing hanger, the method comprising:

inserting an annulus seal assembly between the wellhead housing and the casing hanger, the annulus seal assembly including an annulus seal and an energizing ring, the annulus seal comprising two upwardly extending seal legs, wherein the seal legs include cavities formed therein extending at least partially upwardly or downwardly into the seal legs;

pushing the energizing ring downward to insert at least portion of the energizing ring between the seal legs of the annulus seal, thereby pushing the seal legs away from each other; urging the seal legs against the wellhead housing and the casing hanger to form a seal therebetween via the energizing ring;

expanding the cavities formed in the seal legs via pressurized fluid pushing on the annulus seal; and

urging the seal legs against the wellhead housing and the casing hanger from expansion of the cavities.

18. The method of claim 17, wherein the cavities extend upwardly into the seal legs and expand due to pressure from below the annulus seal.

19. The method of claim 18, wherein the annulus seal further comprises additional cavities formed therein extending at least partially downwardly into the seal legs.

20. The method of claim 19, further comprising: expanding the additional cavities formed in the seal legs via pressurized fluid pushing downwardly on the annulus seal.