

What is claimed is:

1. A well tool (11) comprising:

a tubular body (13) defining a central bore (15) having an axis (17), the tubular body (13) adapted to be connected to and lowered on a running tool string into a well conduit;

a sleeve (33) in the central bore (15), the sleeve (33) selectively moveable from an upper position to a lower position;

the sleeve (33) having at least one bypass port (49) extending from an exterior to an interior of the sleeve (33);

at least one retainer (47) securing the sleeve (33) in the upper position;

a seal (38) on the sleeve (33) that seals the exterior of the sleeve (33) to the bore (15) while the sleeve (33) is in the upper position;

a bypass passage (27) in the tubular body (13) having an upper inlet portion (26) and a lower outlet portion (28) in fluid communication with the bypass ports (49);

a drop member (55) adapted to be lowered through the running tool string and land on the sleeve (33), wherein the inlet portion (26) of the bypass passage (27) is blocked from fluid communication with the central bore (15) when the drop member (55) is located in the sleeve (33) and the sleeve (33) is in the upper position; and

wherein the retainer (47) is adapted to selectively release the sleeve (33) so that the sleeve (33) moves downward to the lower position, the bypass passage (27) being in fluid communication with the central bore (15) when the sleeve (33) is moved to the lower position, allowing fluid communication from above the central bore (15) through the bypass passage (27) via the bypass ports (49) of the sleeve (33).

2. The well tool (11) of Claim 1, wherein:

the central bore (15) defines an upward facing shoulder (29) near a lower end of the central bore (15); and

the sleeve (33) has a downward facing shoulder (35) spaced above the upward facing shoulder (29) while the sleeve (33) is in the upper portion.

3. The well tool (11) of Claim 1, wherein:

the tubular body (13) defines a stop receptacle (31);

at least one stop limiter (41) is formed in a sidewall of the sleeve (33) proximate to the stop receptacle (31); and

the stop limiter (41) is adapted to move axially within the stop receptacle (31) so that axial movement of the sleeve (33) will be limited by upper and lower shoulders (43, 45) of the stop receptacle (31).

4. The well tool (11) of Claim 1, wherein:

the tubular body (13) defines a plurality of windows (31) in a sidewall of the tubular body (13);

the sleeve (33) defines a plurality of threaded bores (39), a bore (39) corresponding to each window (31); and

a limiter screw (41) threads into each bore (39) such that a head of the limiter screw (41) will remain within a corresponding window (31), the limiter screw (41) limiting movement through contact with the edges (43, 45) of the window (31).

5. The well tool (11) of Claim 2, wherein the sleeve (33) further comprises:

a cylindrical protrusion (37) from a lower end of the sleeve (33); and

the cylindrical protrusion (37) extending past the upward facing shoulder (39) of the tubular body (13) while in the upper position.

6. The well tool (11) of Claim 1, wherein the bypass passage (27) comprises an annular recess (27) formed in an inner wall of the tubular body (13).

7. The well tool (11) of Claim 6, wherein:

while the sleeve (33) is in the upper position and the drop member (55) is landed on the sleeve (33), the seal (38) around the sleeve (33) blocks fluid pressure above the drop member (55) from the annular recess (27); and

while the sleeve (33) is in the lower position, fluid pressure above the drop member (55) causes fluid to flow from above the sleeve (33) into the annular recess (27) and from the annular recess (27) through the bypass port (49).

8. The well tool (11) of Claim 1, wherein:

the flow area at the upper end of the annular recess (27) is greater than or equal to the flow area in the bore (15); and

the upper portion of the annular recess (26) extends downward and outward and the upper end (51) of the sleeve (33) tapers downward and outward, defining a uniform flow area while the sleeve (33) is in the lower position.

9. The well tool (11) of Claim 1, wherein the bypass port (49) in the sleeve (33) extends downward and inward from the exterior of the sleeve (33) to the interior of the sleeve (33).

10. The well tool (11) of Claim 1, wherein:

the base of the tubular body (13) below the sleeve (33) while the sleeve (33) is in the lower position has a cross sectional lower bore flow area; and

the at least one bypass port (49) in the sleeve (33) comprises a plurality of bypass ports (49) having a cumulative cross-sectional flow area at least equal to the cross-sectional flow area of the lower portion of the bore (15).

11. A well tool assembly comprising:

a running tool (57) adapted to be coupled to a running string and having at least one hydraulically actuated function;

a receptacle sub (11) coupled to a lower end of the running tool (57) so that when a drop member (55) is landed in the receptacle sub (11), fluid flow through the receptacle sub (11) is blocked and the hydraulically actuated function will actuate; and

the receptacle sub (11) having a bypass passage (27) that is opened in response to increased fluid pressure after the function is performed, the bypass passage (27) extending below the drop member (55) and having a cross-sectional flow area that is at least equal to a flow area cross section through a central passage (61) of the running tool (57).

12. The well tool assembly of Claim 11, wherein the receptacle sub (11) comprises:

a tubular body (13) defining a central bore (15) having an axis (17), the tubular body (13) adapted to be connected to and lowered on a running tool string into a well conduit;

a sleeve (33) in the central bore (15), the sleeve (33) selectively moveable from an upper position to a lower position;

the sleeve (33) having at least one bypass port (49) extending from an exterior to an interior of the sleeve (33);

at least one retainer (47) securing the sleeve (33) in the upper position;

a seal (38) on the sleeve (33) that seals the exterior of the sleeve (33) to the bore (15) while the sleeve (33) is in the upper position;

a bypass passage (27) in the body having an upper inlet portion (27) and a lower outlet portion (28) in fluid communication with the bypass ports (49);

a drop member (55) adapted to be lowered through the running tool string and land on the sleeve (33), blocking downward fluid flow through the sleeve (33) to actuate a hydraulic function in the running tool string;

the inlet portion (26) of the bypass passage (27) being blocked from fluid communication with the central bore (15) while the drop member (55) is located in the sleeve (33) and the sleeve (33) is in the upper position; and

the drop member (55) further adapted to receive a fluid pressure greater than the fluid pressure needed to actuate the hydraulic function, thereby releasing the retainer (47) so that the sleeve (33) moves downward to the lower position, the bypass passage (27) being in fluid communication with the bore (15) when the sleeve (33) is moved to the lower position, allowing fluid communication from above the central bore (15) through the bypass passage (27) and through the bypass ports (49) of the sleeve (33) below the drop member (55).

13. The well tool assembly of Claim 12, wherein:

the tubular body (13) defines a stop receptacle (31);

at least one stop limiter (41) is formed in a sidewall of the sleeve (33) proximate to the stop receptacle (31); and

the stop limiter (41) is adapted to move axially within the stop receptacle (31) so that axial movement of the sleeve (33) will be limited by upper and lower shoulders (43, 45) of the stop receptacle (31).

14. The well tool assembly of Claim 12, wherein the bypass passage (27) comprises an annular recess (27) formed in an inner wall of the tubular body (13).

15. The well tool assembly of Claim 14, wherein:

while the sleeve (33) is in the upper position and the drop member (55) is landed on the sleeve (33), the seal (38) around the sleeve (33) blocks fluid pressure above the drop member (55) from the annular recess (27); and

while the sleeve (33) is in the lower position, fluid pressure above the drop member (55) causes fluid to flow from above the sleeve (33) into the annular recess (27) and from the annular recess (27) through the bypass port (49).

16. The well tool assembly of Claim 12, wherein:

the flow area at the upper end of the annular recess (27) is greater than or equal to the flow area in the bore (15); and

the upper portion (26) of the annular recess (27) extends downward and outward and the upper end (51) of the sleeve (33) tapers downward and outward, defining a uniform flow area while the sleeve (33) is in the lower position.

17. The well tool assembly of Claim 12, wherein:

the base of the tubular body (13) below the sleeve (33) while the sleeve (33) is in the lower position has a cross sectional lower bore flow area; and

the at least one bypass port (49) in the sleeve (33) comprises a plurality of bypass ports (49) having a cumulative cross-sectional flow area at least equal to the cross-sectional flow area of the lower portion of the bore (15).

18. A method for operating a running tool (57), comprising:

(a) providing a well tool assembly, the well tool assembly having:

a running tool (57) adapted to be coupled to a running string and having at least one hydraulically actuated function; and

a receptacle sub (11) coupled to a lower end of the running tool (57);

(b) dropping a drop member (55) in the running string to land in the receptacle sub (11) in an upper position, thereby blocking fluid flow through the receptacle sub (11) and hydraulically actuating the running tool (57);

(c) supplying fluid pressure to the running tool (57) at a first pressure to actuate the running tool (57) to perform a function; then

(d) supplying fluid pressure to the running tool (57) at a second pressure, greater than the first pressure, to drive the receptacle sub (11) to a lower position, thereby opening a fluid flow bypass (27) around the drop member (55).

19. The method of Claim 18, wherein step (b) comprises sealing a bypass passage (27) extending below the drop member (55) to prevent fluid flow past the drop member (55), thereby increasing fluid pressure above the drop member (55) to actuate the running tool (57).

20. The method of Claim 18, wherein the function of step (c) comprises actuating the running tool (57) to set an annular seal (99).

21. The method of Claim 18, wherein step (c) comprises moving a sleeve (33) of the receptacle sub (11) from the upper position to the lower position to open a bypass passage (27) extending below the drop member (55) and having a cross sectional flow area that is at least equal to a flow area cross section through a central passage (61) of the running tool (57).

22. A system for setting an annular seal (99) between a casing hanger (91) and a wellhead, the system comprising:

a running tool (57) adapted to be coupled to a running string and carrying an annular seal (99) for disposal between the casing hanger (91) and the wellhead;

a receptacle sub (11) coupled to a lower end of the running tool (57) so that when a drop member (55) is landed in the receptacle sub (11), fluid flow through the receptacle sub (11) is blocked and the annular seal (99) will energize in response to a resulting increased fluid pressure, sealing an annulus between the wellhead and the casing hanger (91); and

the receptacle sub (11) having a bypass passage (27) that is opened in response to increased fluid pressure after the seal (99) is energized, the bypass passage (27) extending below the drop member (55) and having a cross-sectional flow area that is at least equal to a flow area cross section through a central passage (61) of the running tool (57) so that the running tool (57) may be pulled to the surface.

CLAIMS

1. A well tool comprising:

a hanger for landing in a wellhead;

a hanger seal for sealing between the hanger and the wellhead:

a hanger running tool having a stem for securing, to a running string, a stern flow passage extending axially through the stem relative to a longitudinal axis of the stern, a body releasably connected to the hanger, and a piston releasably connected to the hanger seal, the body and the piston being axially movable relative to each other and to the stem;

a tubular receptacle sub defining a central bore having an upper end that couples to a lower end of the stem of the running tool;

a sleeve in the central bore, the sleeve selectively moveable in the central bore from an upper position to a lower position;

the sleeve having at least one bypass port extending from an exterior to an interior of the sleeve;

at least one retainer securing the sleeve in the upper position;

a sleeve seal on the sleeve above the bypass port that seals the exterior of the sleeve to the bore while the sleeve is in the upper position;

a bypass passage in the bore of the sub having an upper inlet portion and a lower outlet portion in fluid communication with the bypass port, and having a cross-sectional flow area that is at least equal to a cross-sectional flow area of the central bore;

a drop member adapted to be dropped through the running tool string and land on the sleeve, wherein the inlet portion of the bypass passage is blocked from fluid communication with the central bore by the sleeve seal when the drop member is located in the sleeve and the sleeve is in the upper position, enabling fluid to be pumped

down the running string and through the stem at a first pressure level to the piston to set the hanger seal; and

wherein the retainer is adapted to selectively release the sleeve in response to a second and greater pressure level in the stem flow passage so that the sleeve moves downward to the lower position, placing the bypass passage in fluid communication with the bore when the sleeve is moved to the lower position, allowing fluid communication from above the central bore through the bypass passage and the bypass port of the sleeve, enabling fluid in the running string and the stem flow passage to flow into and out the sleeve during retrieval of the running tool.

2. The well tool of claim 1, wherein:

the central bore defines an upward facing shoulder near a lower end of the central bore; and

the sleeve has a downward facing shoulder spaced above the upward facing shoulder while the sleeve is in the upper portion.

3. The well tool of claim 2, wherein the sleeve further comprises:

a cylindrical protrusion extending downward from a lower end of the sleeve; and

the cylindrical protrusion extends below the upward facing shoulder of the sub while the sleeve is in the upper position.

4. The well tool of claim 1, wherein:

the receptacle sub defines a stop receptacle;

at least one stop limiter is formed in a sidewall of the sleeve proximate to the stop receptacle; and

the stop limiter is adapted to move axially within the stop receptacle so that axial movement of the sleeve will be limited by upper and lower shoulders of the stop receptacle.

5. The well tool of claim 1, wherein:

the receptacle sub defines a plurality of windows in a sidewall of the tubular body;

the sleeve defines a plurality of threaded holes, a threaded hole corresponding to each window; and

a limiter screw threads into each threaded hole such that a head of the limiter screw will remain within a corresponding window, the limiter screw limiting movement through contact with the edges of the window.

6. The well tool of claim 1, wherein the bypass passage comprises an annular recess formed in central bore of the sub.

7. The well tool of claim 6, wherein:

while the sleeve is in the upper position and the drop member is landed on the sleeve, the sleeve seal around the sleeve blocks fluid pressure above the drop member from the annular recess; and

while the sleeve is in the lower position, fluid pressure above the drop member causes fluid to flow from above the sleeve into the annular recess and from the annular recess through the bypass opening.

8. The well tool of claim 6, wherein:

the flow area at the upper end of the annular recess is greater than or equal to the flow area in the bore;

an upper portion of the annular recess comprises a conical surface extending downward and outward;

an upper end of the sleeve comprises conical surface that tapers downward and outward at a same taper angle as the upper portion of the annular recess; and

the upper end of the sleeve is located below the upper portion of the annular recess while the sleeve is in the lower position.

9. The well tool of claim 1, wherein the bypass port in the sleeve extends downward and inward from the exterior of the sleeve to the interior of the sleeve.

10. The well tool of claim 1, wherein the sub has a tubular side wall that is free of any flow ports that communicate with the interior of the sleeve in both the upper and lower positions of the sleeve.

11. A method for installing a hanger within a subsea wellhead assembly, comprising:

(a) providing a running tool having a stem with a longitudinal axis and an axial passage, a body carried by the stem for selective axial movement relative to the stem, and a piston carried by the stem for selective axial movement relative to the stem and the body;

(b) connecting a receptacle sub to the stem below the body, the receptacle sub having a central bore with an annular bypass area of greater diameter than the central bore above the bypass area, a sleeve mounted in the central bore for selective axial movement, the sleeve having a side wall with at bypass port therethrough, and positioning the sleeve in an upper position;

(c) connecting an annular hanger seal to the piston, connecting the hanger to the body, connecting the stem to a running string and lowering the hanger into the wellhead assembly;

(d) dropping a drop member in the running string to land in the receptacle sub while the sleeve is in the upper position, thereby blocking fluid flow down the running string through the sleeve and through the bypass port into the sleeve;

(e) while the sleeve remains in the upper position and contains the drop member, supplying fluid pressure to an interior of the running string and to the running tool at a first pressure to cause the piston of the running tool to lower the hanger seal relative to the stem and set the hanger seal between the hanger and an interior wall of the wellhead assembly; then

(f) supplying fluid pressure to the interior of the running string and the piston of the running tool at a second pressure, greater than the first pressure, to drive the sleeve to a lower position, thereby opening a fluid flow bypass around the drop member, into the annular bypass area and from the bypass area through the bypass port into the sleeve, the fluid flow bypass having a cross-sectional flow area that is equal to or greater than a cross-sectional flow area of the central bore of the receptacle sub;

(g) disengaging the running tool from the hanger and the hanger seal; and

(h) retrieving the running tool and the receptacle sub with the running string while the sleeve is in the lower position, thereby draining fluid from the running string and the stem through the sleeve.

12. The method of claim 11, wherein in step (f) all of the fluid flowing into the sleeve flows out a lower end of the sleeve.

13. The method of claim 11, wherein (f) further comprises temporarily sealing the piston to the interior surface of the wellhead assembly to create a sealed void in the

wellhead assembly above the hanger seal, and directing well fluid at a test pressure from the running string to the sealed void to apply fluid pressure to an upper side of the hanger seal to test the hanger seal prior to the sleeve moving to the lower position.

14. The method of claim 11, wherein step (e) further comprises rotating the stem relative to the body to align a flow port in the stem with a flow port in the body leading to the piston.

15. A system for installing casing in a subsea wellhead, the system comprising:
a casing hanger that secures to an upper end of the casing;

a casing hanger seal that seals between the casing hanger and the wellhead;

a running tool having a stem adapted to be coupled to a running string, a body coupled to the casing hanger, and a piston coupled to the casing hanger seal, the stem having a longitudinal axis and an axial stem flow passage;

a receptacle sub coupled to a lower end of the stem, the receptacle sub having an axial central bore with an annular enlarged bypass recess, a sleeve carried in the bore and having a side wall containing a bypass port, the sleeve being axially movable from an upper position to a lower position;

a drop member configured to be lowered, through the running string and landed in the sleeve while the sleeve is in the upper position, thereby blocking an interior of the sleeve and the bypass port from fluid contained in the stem flow passage;

a shear member between the sleeve and the receptacle sub that retains the sleeve in the upper position while fluid pressure at a first pressure level is applied to the stem flow passage and the piston to move the piston and the hanger seal downward into a setting position; and

the shear member being releasable in response to an increase in pressure in the stem flow passage to a second pressure level, enabling the sleeve to move to the lower

position, which positions the bypass port in the annular bypass area, allowing fluid in the running string and the stem flow passage to drain through the bypass port into and out of the sleeve while the running tool is being retrieved.

16. A method for installing a casing hanger within a subsea wellhead, comprising:

(a) providing a running tool having a stem with a longitudinal axis and an axial stem passage, a body carried by the stem for selective axial movement relative to the stem, and a piston carried by the stem for selective axial movement relative to the stem and the body, the piston having an annular test seal on an exterior surface;

(b) connecting a receptacle sub to the stem below the body, the receptacle sub having a central bore with an annular bypass area of greater diameter than the central bore above the bypass area, a sleeve mounted in the central bore for selective axial movement, the sleeve having a side wall with a bypass port therethrough, and positioning the sleeve in an upper position;

(c) connecting a casing hanger seal to the piston below the test seal, connecting the casing hanger to the body, connecting the stem to a running string;

(d) lowering the casing hanger into the wellhead and sealing the test seal to an interior surface of the wellhead; then

(e) lowering a drop member through the running string and landing the drop member in the receptacle sub while the sleeve is in the upper position, thereby blocking fluid flow down the running string through the bypass port into the sleeve; then

(f) supplying setting fluid pressure to an interior of the running string and to the stem passage to cause the piston to lower the casing hanger seal relative to the stem and set the casing hanger seal between the casing hanger and an interior wall of the wellhead; then

(g) supplying test fluid pressure to the interior of the running string and the piston of the running tool and directing the test fluid pressure to a sealed chamber located between the test seal and the casing hanger seal to test whether the casing

hanger seal holds the test fluid pressure while the sleeve is still in the upper position;
then

(h) increasing the test fluid pressure to drive the sleeve to a lower position, thereby opening a fluid flow bypass around the drop member into the annular bypass area and from the bypass area through the bypass port into the sleeve;

(i) disengaging the running tool from the hanger and the hanger seal; and

(j) retrieving the running tool and the receptacle sub with the running string while the sleeve is in the lower position, thereby draining fluid from the running string and the stem through the sleeve.