CLAIMS

1. A method for setting an inner wellhead member in a bore of a subsea wellhead housing having an axis, the inner wellhead member having a radially expansible locking element and an axially movable member for engaging a profile in the wellhead housing, the method comprising:

providing a running tool with an axially movable latch sleeve having a latch sleeve piston and an axially movable actuation sleeve having an actuation sleeve piston;

releasably connecting the inner wellhead member to the running tool by moving the latch sleeve into engagement with the inner wellhead member;

running the running tool and the inner wellhead member on a running string through a riser assembly to the wellhead housing, the running string having a first flow passage, the riser assembly defining a second flow passage in an annulus surrounding the running string; then

expanding the locking element into engagement with the profile by increasing fluid pressure in one of the first and second flow passages, which applies fluid pressure to the actuation sleeve piston to move the actuation sleeve and the axially movable member axially relative to the locking element; then

releasing the latch sleeve of the running tool from the inner wellhead member by increasing fluid pressure in the other of the first and second flow passages, which applies fluid pressure to the latch sleeve piston to move the latch sleeve from engagement with the inner wellhead member; and

withdrawing the running tool on the running string.

2. The method according to claim 1, wherein:

the running tool further comprises a setting piston and a release piston, the setting piston separating fluid in the first flow passage from a liquid in a setting chamber between the setting piston and the actuation sleeve piston, the release piston separating fluid in the second flow passage from a liquid in a release chamber between the release piston and the latch sleeve piston;

applying fluid pressure to the actuation sleeve piston comprises applying fluid pressure to the setting piston, which in turn transmits the fluid pressure through the liquid in the setting chamber to the actuation sleeve piston; and

applying fluid pressure to the latch sleeve piston comprises applying fluid pressure to the release piston, which in turn transmits the fluid pressure through the liquid in the release chamber to the latch sleeve piston.

3. The method according to claim 2, wherein:

the setting chamber also extends between the setting piston the latch sleeve piston; and

applying fluid pressure to the setting piston also applies fluid pressure through the liquid in the setting chamber to the latch sleeve piston in a direction that urges the latch sleeve to remain engaged with the inner wellhead member.

4. The method of claim 3, wherein:

the release chamber also extends between the release piston and the actuation sleeve piston; and

applying fluid pressure to the release piston also applies fluid pressure through the liquid in the release chamber to the actuation sleeve piston in a direction that urges the actuation sleeve piston to move the actuation sleeve away from the axially movable member.

5. The method according to claim 4, wherein:

applying fluid pressure to the setting piston applies the fluid pressure to a first side of the actuation sleeve piston, and liquid in the setting chamber on the second side of the actuation sleeve piston expels to the release chamber; and

applying fluid pressure to the release piston applies the fluid pressure to a first side of the latch sleeve piston, and liquid in the release chamber on the second side of the latch sleeve piston expels to the setting chamber.

6. The method according to claim 4, wherein applying fluid pressure to the setting piston results in the liquid in the setting chamber applying pressure to an upper side of the actuation sleeve piston and an upper side of the latch sleeve piston.

7. The method according to claim 4, wherein applying fluid pressure to the release piston results in the liquid in the release chamber applying pressure to a lower side of the actuation sleeve piston and a lower side of the latch sleeve piston.

8. A method for setting an inner wellhead member in a subsea wellhead housing, the method comprising:

(a) providing a running tool having a setting piston, a release piston, an actuation sleeve with an actuation sleeve piston, and a latch sleeve with a latch sleeve piston, the setting, release, actuation sleeve and latch sleeve pistons each being in communication with a closed-loop hydraulic system;

(b) providing the inner wellhead member with a locking element that moves between inner and outer positions, the locking element being in engagement with the actuation sleeve;

(c) latching the running tool to the inner wellhead member with a latching element of the running tool and moving the latch sleeve from a release position to a latched position;

(d) running the running tool and the inner wellhead member on a running string through a riser assembly until the inner wellhead member lands in the wellhead housing, an inner fluid passage being defined by the running string and the running tool and an outer fluid passage being defined by an annulus of the riser assembly and the running tool, the closed-loop hydraulic system containing a liquid that is isolated from the fluid passages by the setting piston and the release piston; then

(e) locking the inner wellhead member to the wellhead housing by applying fluid pressure through one of the fluid passages to the setting piston, which increases a fluid pressure in the liquid in the closed loop hydraulic system between the setting piston and the actuation sleeve piston and moves the actuation sleeve to cause the locking element to move to the outer position; and then

(f) applying fluid pressure through the other of the fluid passages to the release piston, which increases a fluid pressure in the liquid in the closed loop hydraulic system between the release piston and the latch sleeve piston and moves the latch sleeve out of engagement with the latching element so that the latching element can unlatch from the inner wellhead member.

9. The method of claim 8, wherein each of the setting piston and the release piston are separated from the actuation sleeve piston and the latch sleeve piston by portions of the closed-loop hydraulic system.

10. The method of claim 8, wherein each of the setting piston and the release piston are in communication with a single reservoir of liquid in the closed-loop hydraulic system so that movement of the setting piston to move the actuation sleeve piston causes movement of the release piston in a direction away from the latch sleeve piston.

11. The method of claim 8, wherein step (e) is performed by applying fluid pressure through the inner fluid passage.

12. The method of claim 8, wherein step (f) comprises applying fluid pressure through the outer fluid passage.

13. The method of claim 8, wherein:

applying fluid pressure through one of the fluid passages to the setting piston causes fluid pressure in the closed-loop hydraulic system to be applied to an upper side of the actuation sleeve piston and an upper side of the latch sleeve piston; and

applying fluid pressure through the other of the fluid passages to the release piston causes fluid pressure in the closed-loop hydraulic system to be applied to a lower side of the latch sleeve piston and a lower side of the actuation sleeve piston.

14. A running tool for setting an inner wellhead member in a subsea wellhead housing, the running tool comprising:

a setting pistol, a release piston, an actuation sleeve piston, and a latch sleeve piston, each piston comprising a first end and a second end;

a closed-loop hydraulic system having a setting portion located between the second end of the setting piston and the first end of the actuating piston, the closed-loop hydraulic system having a release portion located between the second end of the release piston and the first end of the latch sleeve piston;

an actuation sleeve joined to the actuation sleeve piston for movement therewith, the actuation sleeve moving from an unlocked position to a locked position in response to movement of the setting piston in a direction that increases fluid pressure in the setting portion of the closed-loop hydraulic system, the actuation sleeve urging a locking member of the inner wellhead member into engagement with the subsea wellhead housing when moving from the unlocked position to the locked position;

a latch sleeve joined to the latch sleeve piston for movement therewith, the latch sleeve moving from latched position to unlatched position in response to movement of one of the release piston in a direction that increases fluid pressure in the release portion of the closed-loop hydraulic system, the unlatched position releasing the running tool from the inner wellhead member;

a running tool body having an inner flow passage for receiving fluid pumped down a running string;

an inner flow passage port extending from the inner flow passage for delivering fluid from the inner flow passage to the first end of one of the setting and release pistons; and

an external flow passage port in the running tool for delivering fluid from an outer flow passage surrounding the running tool to the first end of the other of the setting and release pistons.

15. The running tool according to claim 14, wherein:

the setting portion of the closed-loop hydraulic system also extends to a second end of the latch sleeve piston; and

the release portion of the closed-loop hydraulic system also extends to a second end of the actuation sleeve piston.

16. The running tool according to claim 15, wherein:

one of the setting and release pistons prevents fluid within the inner flow passage from entering the closed-loop hydraulic system; and

the other of the setting and release pistons prevents fluid within the outer flow passage from entering the closed-loop hydraulic system.

17. The running tool according to claim 14, wherein a volume of fluid in the closed-loop hydraulic system does not change in response to movement of the pistons.

18. The running tool according to claim 14, wherein movement of one of the setting and release pistons urges the other one of the setting and release pistons to move.

19. The running tool according to claim 14, wherein:

the second ends of the setting, release, actuation, and latch sleeve pistons are on a lower side of each of the setting, release, actuation and latch sleeve pistons.

20. The running tool according to claim 14, wherein the latch sleeve moves to the latched position in response to the application of fluid pressure to the first side of the setting piston.