

What is claimed is:

1. A subsea wellhead assembly, comprising:
 - a subsea wellhead (77) having a bore containing a grooved profile (79);
 - a casing hanger (75) landed in the bore below the profile (79);
 - a wear bushing (11) that retrievably lands in the bore, shielding the profile (79) and an inner part of the casing hanger (75) from drilling tools that pass through the wear bushing (11);
 - an impression block (47) of a deformable material carried by the wear bushing (11); and
 - an actuator (39) moveable in response to landing of the wear bushing (11) that forces the impression block (47) into the profile (79) to cause the impression block (47) to form an impression of the profile (79) for subsequent inspection when the wear bushing (11) is retrieved.
2. The subsea wellhead assembly of Claim 1, wherein the wear bushing (11) further comprises:
 - a first tubular member (13) having an axis (12);
 - a second tubular member (15) coaxial with the first tubular member (13) and axially moveable between run-in and set positions relative to the first tubular member (13); and
 - wherein movement of the second tubular member (15) to the set position causes the actuator (39) to force the impression block (47) into the profile (79) to cause the block (47) to form an impression of the profile (79) for subsequent inspection when the wear bushing (11) is retrieved.
3. The subsea wellhead assembly of Claim 2, wherein
 - the actuator (39) is housed within a window (29) in a tubular wall of the first tubular member (13); and
 - the second tubular member (15) is disposed axially above the first tubular member (13) and has a lower end that inserts within a bore (17) of the first tubular member (13) when

moving to the set position to move the actuator (39) and force the impression block (47) into the profile (79).

4. The wear bushing (11) of Claim 2, wherein:

the first tubular member (13) defines a plurality of vertical slots (35) on an inner diameter surface (23) of the bore (17);

a plurality of ribs (69) are formed on an exterior surface (24) of a lower end of the second tubular member (15);

each rib (69) substantially fills a corresponding one of the slots (35) when the lower end of the second tubular member (15) is inserted into the central bore (17) of the first tubular member (13);

wherein a plurality of shear elements (73) hold the second tubular member (15) in the run-in position relative to the first tubular member (13) during a running operation;

a guide slot (37) is formed in each slot (35) of the plurality of vertical slots (35) in the first tubular member (13);

a plurality of guide pins (71) are mounted to the second tubular member (15), each guide pin (71) having an exterior end adapted to fit within a corresponding guide slot (37) of the first tubular member (13); and

wherein the guide pins (71) are further adapted to support the axial weight of the first tubular member (13) during running and retrieval of the wear bushing (11).

5. The subsea wellhead assembly of Claim 2, wherein:

the first tubular member (13) defines a plurality of windows (29) extending from an inner diameter of the first tubular member (13) to an outer diameter of the first tubular member (13); and

the actuator (39) comprises a plurality of lead impression assemblies (39), each corresponding to and positioned within a separate window (29) of the plurality of windows (29).

6. The subsea wellhead assembly of Claim 5, wherein the lead impression assembly (39) comprises:

a piston (45) adapted to move radially within each window (29) of the first tubular member (13), the piston (45) biased to the retracted position;

a spring (43) mounted to the piston (45) and exerts a spring force radially inward on the piston (45);

the piston (45) having an interior end adapted to be slidably engaged by an exterior surface (24) of the second tubular member (15) when the second tubular member (15) moves from the run-in to the set position; and

the impression block (47) is coupled to an outer end of the piston (45).

7. A wear bushing (11) for disposition within a wellhead (77) comprising:

a first tubular member (13) having an axis (12);

at least one impression assembly (39) housed within the first tubular member (13) and radially moveable between a retracted and an extended position relative to the first tubular member (13);

a second tubular member (15) coaxial with the first tubular member (13) and axially moveable between run-in and set positions relative to the first tubular member (13);

wherein movement of the second tubular member (15) to the set position causes the impression assembly (39) to move from the retracted to the extended position into engagement with a wellhead member profile (79), the impression assembly (39) having a permanently deformable block (47) for creating an imprint of the profile (79);

a latch (87) mounted to one of the tubular members to latch the first and second tubular members (13, 15) in the wellhead (77);

a seal (85, 89) mounted to one of the tubular members to seal the first and second tubular member (15) to the wellhead (77); and

wherein the first and second tubular member (13, 15) have bores sized for the passage of drilling tools.

8. The wear bushing (11) of Claim 7, wherein:

the lead impression assembly (39) is housed within a window (29) in a tubular wall of the first tubular member (13); and

the second tubular member (15) is disposed axially above the first tubular member (13) and has a lower end that inserts within the bore (17) of the first tubular member (13) when moving to the set position.

9. The wear bushing (11) of Claim 8, wherein:

the first tubular member (13) defines a plurality of vertical slots (35) on an inner diameter surface (23) of the bore (17);

a plurality of ribs (69) are formed on an exterior surface (24) of a lower end of the second tubular member (15); and

each rib (69) substantially fills a corresponding one of the slots (35) when the lower end of the second tubular member (15) is inserted into the central bore (17) of the first tubular member (13).

10. The wear bushing (11) of Claim 9, wherein a plurality of shear elements (73) hold the second tubular member (15) in the run-in position relative to the first tubular member (13) during a running operation.

11. The wear bushing (11) of Claim 9, wherein:

a guide slot (37) is formed in each slot (35) of the plurality of vertical slots (35) in the first tubular member (13); and

a plurality of guide pins (71) are mounted to the second tubular member (15), each guide pin (71) having an exterior end adapted to fit within a corresponding guide slot (37) of the first tubular member (13).

12. The wear bushing (11) of Claim 11, wherein the guide pins (71) are further adapted to support the axial weight of the first tubular member (13) during running and retrieval of the wear bushing (11).

13. The wear bushing (11) of Claim 8, wherein the impression assembly (39) comprises:

a piston (45) adapted to move radially within each window (29) of the first tubular member (13), the piston (45) biased to the retracted position;

the piston (45) having an interior end adapted to be slidingly engaged by an exterior surface of the second tubular member (15) when the second tubular member (15) moves from the run-in to the set position; and

the block (47) is coupled to an outer end of the piston (45).

14. The wear bushing (11) of Claim 13, wherein a spring (43) is mounted to the piston (45) and exerts a spring force radially inward on the piston (45).

15. The wear bushing (11) of Claim 7, wherein:

the first tubular member (13) defines a plurality of windows (29) extending from an inner diameter of the first tubular member (13) to an outer diameter of the first tubular member (13); and

the impression assembly (39) comprises a plurality of lead impression assemblies (39), each corresponding to and positioned within a separate window (29) of the plurality of windows (29).

16. A method for performing operations through and in a subsea wellhead (77), comprising:
- (a) mounting an impression block (47) in a wear bushing (11); then
 - (b) running the wear bushing (11) subsea and landing the wear bushing (11) within the wellhead (77) such that the impression block (47) is adjacent a selected profile (79) within the wellhead (77);
 - (c) moving the impression block (47) outward and deforming the impression block (47) against the profile (79) in the wellhead (77);
 - (d) lowering a drill string through the wear bushing (11) and wellhead (77) and rotating the drill string to perform drilling activities;
 - (e) retrieving the wear bushing (11) along with the deformed impression block (47); and
 - (f) inspecting the impression block (47) to ascertain a location of the profile (79).
17. The method of Claim 16, wherein step (c) comprises applying weight to the wear bushing (11), which causes an upper portion (15) of the wear bushing (11) to move downward relative to a lower portion (13).
18. The method of Claim 16, wherein step (c) occurs in response to the landing of the wear bushing (11) in the wellhead (77).
19. The method of Claim 16, wherein step (c) further comprises pressure testing the wear bushing (11).
20. The method of Claim 16, wherein step (b) comprises landing the wear bushing (11) on a casing hanger (75) located in the subsea wellhead (77).

What is claimed is:

1. A subsea wellhead assembly, comprising:
 - a subsea wellhead having a bore containing a grooved profile;
 - a casing hanger landed in the bore below the profile;
 - a wear bushing that retrievably lands in the bore, shielding the profile and an inner part of the casing hanger from drilling tools that pass through the wear bushing;
 - an impression block of a deformable material carried by the wear bushing;
 - an actuator moveable in response to landing of the wear bushing that forces the impression block into the profile to cause the impression block to form an impression of the profile for subsequent inspection when the wear bushing is retrieved;wherein the wear bushing further comprises:
 - a first tubular member having an axis;
 - a second tubular member coaxial with the first tubular member and axially moveable between run-in and set positions relative to the first tubular member: andwherein movement of the second tubular member to the set position causes the actuator to force the block into the profile to cause the impression block to form an impression of the profile for subsequent inspection when the wear bushing is retrieved.
2. The subsea wellhead assembly of claim 1, wherein
 - the actuator is housed within a window in a tubular wall of the first tubular member; and
 - the second tubular member is disposed axially above the first tubular member and has a lower end that inserts within a bore of the first tubular member when moving to the set position to move the actuator and force the impression block into the profile.
3. The wear bushing of claim 1, wherein:
 - the first tubular member defines a plurality of vertical slots on an inner diameter surface of the bore;
 - a plurality of ribs are formed on an exterior surface of a lower end of the second tubular member;

each rib substantially fills a corresponding one of the slots when the lower end of the second tubular member is inserted into the central bore of the first tubular member;

wherein a plurality of shear elements hold the second tubular member in the run-in position relative to the first tubular member during a running operation;

a guide slot is formed in each slot of the plurality of vertical slots in the first tubular member;

a plurality of guide pins are mounted to the second tubular member, each guide pin having an exterior end adapted to fit within a corresponding guide slot of the first tubular member; and

wherein the guide pins are further adapted to support the axial weight of the first tubular member during running and retrieval of the wear bushing.

4. The subsea wellhead assembly of claim 1, wherein:

the first tubular member defines a plurality of windows extending from an inner diameter of the first tubular member to an outer diameter of the first tubular member; and

the actuator comprises a plurality of lead impression assemblies, each corresponding to and positioned within a separate window of the plurality of windows.

5. The subsea wellhead assembly of claim 4, wherein the lead impression assembly comprises:

piston adapted to move radially within each window of the first tubular member, the piston biased to the retracted position;

a spring mounted to the piston and exerts a spring force radially inward on the piston;

the piston having an interior end adapted to be slidingly engaged by an exterior surface of the second tubular member when the second tubular member moves from the run-in to the set position; and

the impression block is coupled to an outer end of the piston.

6. A wear bushing for disposition within a wellhead comprising:

a first tubular member having an axis;

at least one impression assembly housed within the first tubular member and radially moveable between a retracted and an extended position relative to the first tubular member;

a second tubular member coaxial with the first tubular member and axially moveable between run-in and set positions relative to the first tubular member;

wherein movement of the second tubular member to the set position causes the impression assembly to move from the retracted to the extended position into engagement with at wellhead member profile, the Impression assembly having a permanently deformable block for creating an imprint of the profile;

a latch mounted to one of the tubular members to latch the first and second tubular members in the wellhead;

a seal mounted to one of the tubular members to seal the first and second tubular member to the wellhead; and

wherein the first and second tubular members have bores sized for the passage of drilling tools.

7. The wear bushing of claim 6, wherein:

the lead impression assembly is housed within a window in a tubular wall of the first tubular member; and

the second tubular member is disposed axially above the first tubular member and has a lower end that inserts within the bore of the first tubular member when moving to the set position.

8. The wear bushing of claim 7, wherein:

the first tubular member defines a plurality of vertical slots on an inner diameter surface of the bore;

a plurality of ribs are formed on an exterior surface of a lower end of the second tubular member; and

each rib substantially fills a corresponding one of the slots when the lower end of the second tubular member is inserted into the central bore of the first tubular member.

9. The wear bushing of claim 8, wherein a plurality of shear elements hold the second tubular member in the run-in position relative to the first tubular member during a running operation.

10. The wear bushing of claim 8, wherein:
a guide slot is formed in each slot of the plurality of vertical slots in the first tubular member; and

a plurality of guide pins are mounted to the second tubular member, each guide pin having an exterior end adapted to fit within a corresponding guide slot of the first tubular member.
11. The wear hushing of claim 10, wherein the guide pins are further adapted to support the axial weight of the first tubular member during running and retrieval of the wear bushing.
12. The wear bushing of claim 7, wherein the impression assembly comprises:
a piston adapted to move radially within each window of the first tubular member, the piston biased to the retracted position;

the piston having an interior end adapted to be slightly engaged by an exterior surface of the second tubular member when the second tubular member moves from the run-in to the set position; and

the block is coupled to an outer end of the piston.
13. The wear bushing of claim 12, wherein a spring is mounted to the piston and exerts a spring force radially inward on the piston.
14. The wear bushing of claim 6, wherein:
the first tubular member defines a plurality of windows extending from an inner diameter of the first tubular member to an outer diameter of the first tubular member: and

the impression assembly comprises a plurality of lead impression assemblies, each corresponding to and positioned within a separate window of the plurality of windows.
15. A method performing operations through and in a subsea wellhead, comprising:
(a) mounting an impression block in a wear bushing; then

(b) running the wear bushing subsea and landing the wear bushing within the wellhead such that the impression block is adjacent a selected profile within the wellhead:

(c) moving the impression block outward and deforming the impression block against the profile in the wellhead;

(d) lowering is drill string through the wear bushing and wellhead and rotating the drill string to perform drilling activities;

(e) retrieving the wear bushing along, with the deformed impression block;

(f) inspecting the impression block to ascertain a location of the profile; and

wherein step (c) occurs in response to landing of the wear bushing in the wellhead.

16. The method of claim 15, wherein step (c) comprises applying weight to the wear bushing, which causes an upper portion of the wear bushing to move downward relative to a lower portion.

17. The method of claim 15, wherein step (c) further comprises pressure testing the wear bushing.

18. The method of claim 15, wherein step (b) comprises landing, the wear bushing on a casing hanger located in the subsea wellhead.