Claims:

1. A tie back liner connector assembly for connecting an end of a liner to a wellhead having an external profiled surface and a landing shoulder, comprising:

a tubular housing adapted to be coupled to the end of the liner that defines one or more interior windows;

one or more locking dogs movably coupled to the tubular housing adapted for displacement through corresponding interior windows of the tubular housing;

one or more linking elements pivotally coupled to the tubular housing and operably coupled to corresponding locking dogs; and

an hydraulic actuator operably coupled to the tubular housing for displacing the locking dogs relative to the tubular housing and through the corresponding windows to engage the external profiled surface of the wellhead.

2. The assembly of claim 1, wherein the linking elements are adapted to provide an increasing load angle as the locking dogs are displaced through the corresponding windows into engagement with the external profiled surface of the wellhead.

3. The assembly of claim 1, further comprising a shock absorber assembly coupled to an end of the housing for absorbing shock when the end of the connector assembly engages the wellhead.

4. The assembly of claim 1, wherein the hydraulic actuator comprises a first annular piston operable for displacing the locking dogs relative to the tubular housing and through the

corresponding windows to engage the external profiled surface of the wellhead; and at least one second annular piston operable for displacing the locking dogs relative to the tubular housing and through the corresponding windows to disengage from the external profiled surface of the wellhead.

5. The assembly of claim 1, wherein the hydraulic actuator comprises a first annular piston operable for displacing the locking dogs relative to the tubular housing and through the corresponding windows to engage the external profiled surface of the wellhead; and a plurality of second annular pistons operable for displacing the locking dogs relative to the tubular housing and through the corresponding windows to disengage from the external profiled surface of the wellhead.

6. A method for connecting a lower end of a liner to a wellhead having an external profiled surface and a landing shoulder, comprising:

coupling a tubular housing, an hydraulic actuator and one or more locking elements to the end of the liner;

positioning a lower end of the tubular housing next to an upper end of the wellhead;

engaging the lower end of the tubular housing with the wellhead until a lower end face of the liner is positioned proximate an upper end face of the wellhead; and

displacing the locking elements relative to the lower end of the liner through interior windows defined within the tubular housing and into engagement with the external profiled surface of the wellhead by operating the hydraulic actuator.

7. The method of claim 6, wherein displacing the locking elements relative to the lower end of the liner through interior windows defined within the tubular housing and into engagement with the external profiled surface of the wellhead by operating the hydraulic actuator comprises increasing a load angle of the locking elements as they are displaced in the direction of the external profiled surface of the wellhead.

8. The method of claim 6, further comprising absorbing energy during the engaging of the lower end of the tubular housing with the wellhead.

9. The method of claim 6, wherein the hydraulic actuator comprises a first annular piston for displacing the locking elements relative to the lower end of the liner through interior windows defined within the tubular housing and into engagement with the external profiled surface of the wellhead.

10. The method of claim 9, wherein the hydraulic actuator further comprises at least one second annular piston for displacing the locking elements relative to the lower end of the liner through interior windows defined within the tubular housing and out of engagement with the external profiled surface of the wellhead.

11. A tie back liner connector assembly for connecting an end of a liner to a wellhead having an external profiled surface and a landing shoulder, comprising:

a tubular housing adapted to be coupled to the end of the liner that defines one or more interior windows; and

one or more locking dogs movably coupled to the tubular housing adapted for displacement through corresponding interior windows of the tubular housing for engagement with the external profiled surface of the wellhead.

12. The assembly of claim 11, further comprising:

one or more linking elements pivotally coupled to the tubular housing and operably coupled to corresponding locking dogs.

13. The assembly of claim 12, wherein the linking elements are adapted to provide an increasing load angle as the locking dogs are displaced through the corresponding windows into engagement with the external profiled surface of the wellhead.

14. The assembly of claim 11, further comprising a shock absorber assembly coupled to an end of the housing for absorbing shock when the end of the connector assembly engages the wellhead.

15. The assembly of claim 11, further comprising an hydraulic actuator operably coupled to the tubular housing for displacing the locking dogs relative to the tubular housing and through the corresponding windows to engage the external profiled surface of the wellhead.

16. The assembly of claim 15, wherein the hydraulic actuator comprises a first annular piston

operable for displacing the locking dogs relative to the tubular housing and through the corresponding windows to engage the external profiled surface of the wellhead; and at least one second annular piston operable for displacing the locking dogs relative to the tubular housing and through the corresponding windows to disengage from the external profiled surface of the wellhead.

17. The assembly of claim 15, wherein the hydraulic actuator comprises a first annular piston operable for displacing the locking dogs relative to the tubular housing and through the corresponding windows to engage the external profiled surface of the wellhead; and a plurality of second annular pistons operable for displacing the locking dogs relative to the tubular housing and through the corresponding windows to disengage from the external profiled surface of the wellhead.

18. A method for connecting a lower end of a liner to a wellhead having an external profiled surface and a landing shoulder, comprising:

coupling a tubular housing and one or more locking elements to the end of the liner;

positioning a lower end of the tubular housing next to an upper end of the wellhead;

engaging the lower end of the tubular housing with the wellhead until a lower end face of the liner is positioned proximate an upper end face of the wellhead; and

displacing the locking elements relative to the lower end of the liner through interior windows defined within the tubular housing and into engagement with the external profiled surface of the wellhead.

19. The method of claim 18, wherein displacing the locking elements relative to the lower end of the liner through interior windows defined within the tubular housing and into engagement with the external profiled surface of the wellhead comprises increasing a load angle of the locking elements as they are displaced in the direction of the external profiled surface of the wellhead.

20. The method of claim 18, further comprising absorbing energy during the engaging of the lower end of the tubular housing with the wellhead.

21. The method of claim 18, further comprising displacing the locking elements relative to the lower end of the liner through interior windows defined within the tubular housing and into engagement with the external profiled surface of the wellhead by operating an hydraulic actuator.

22. The method of claim 21, wherein the hydraulic actuator comprises a first annular piston for displacing the locking elements relative to the lower end of the liner through interior windows defined within the tubular housing and into engagement with the external profiled surface of the wellhead.

23. The method of claim 21, wherein the hydraulic actuator further comprises at least one second annular piston for displacing the locking elements relative to the lower end of the liner through interior windows defined within the tubular housing and out of engagement with the external profiled surface of the wellhead.

24. A tie back liner connector assembly for connecting an end of a liner to a wellhead having an external profiled surface and a landing shoulder, comprising:

a tubular housing adapted to be coupled to the end of the liner;

one or more locking dogs movably coupled to the tubular housing adapted for displacement thereto into engagement with the external profiled surface of the wellhead; and

one or more linking elements pivotally coupled to the tubular housing and operably coupled to corresponding locking dogs for transferring loads from the tubular housing to the locking dogs.

25. The assembly of claim 24, further comprising:

an actuator operably coupled to the tubular housing for displacing the locking dogs relative to the tubular housing to engage the external profiled surface of the wellhead; and

a shock absorber assembly coupled to an end of the housing for absorbing shock when the end of the connector assembly engages the wellhead.

26. The assembly of claim 25, wherein the shock absorber assembly comprises a spring element and a damper element.

27. The assembly of claim 25, wherein the shock absorber comprises an annular chamber and a flow passage for controllably permitting fluidic materials to be exhausted from the annular chamber.

28. The assembly of claim 24, wherein the linking elements are adapted to provide an increasing load angle as the locking dogs are displaced through corresponding internal windows defined in the tubular housing into engagement with the external profiled surface of the wellhead.

29. A method for connecting a lower end of a liner to a wellhead having an external profiled surface and a landing shoulder, comprising:

coupling a tubular housing and one or more locking elements to the end of the liner;

positioning a lower end of the tubular housing next to an upper end of the wellhead;

engaging the lower end of the tubular housing with the wellhead until a lower end face of the liner is positioned proximate an upper end face of the wellhead;

displacing the locking elements relative to the lower end of the liner into engagement with the external profiled surface of the wellhead by operating the actuator; and

during the displacement of the locking elements, transferring loads from the tubular housing to the locking elements using one or more pivotal load transfer elements.

30. The method of claim 29, further comprising absorbing energy during the engaging of the lower end of the tubular housing with the wellhead.

31. The method of claim 30, wherein absorbing energy during the engaging of the lower end of the tubular housing with the wellhead comprises preventing shock loading on the lower end of the tubular housing and the wellhead.

32. The method of claim 30, wherein absorbing energy during the engaging of the lower end of the tubular housing with the wellhead comprises limiting a flow rate of fluidic materials out of an annular chamber.

33. A tie back liner connector assembly for connecting an end of a liner to a wellhead having an external profiled surface and a landing shoulder, comprising:

a tubular housing adapted to be coupled to the end of the liner;

one or more locking elements movably coupled to the tubular housing adapted for displacement thereto into engagement with the external profiled surface of the wellhead; and

a shock absorber assembly coupled to an end of the housing for absorbing shock when the end of the connector assembly engages the wellhead.

34. The assembly of claim 33, further comprising:

an actuator operably coupled to the tubular housing for displacing the locking elements relative to the tubular housing to engage the external profiled surface of the wellhead.

35. The assembly of claim 33, wherein the shock absorber assembly comprises a spring element and a damper element.

36. The assembly of claim 33, wherein the shock absorber comprises an annular chamber and a flow passage for controllably permitting fluidic materials to be exhausted from the annular chamber.

37. The assembly of claim 33, further comprising one or more linking elements pivotally coupled to the tubular housing and operably coupled to corresponding locking dogs for transferring loads from the tubular housing to the locking dogs.

38. The assembly of claim 37, wherein the linking elements are adapted to provide an increasing load angle as the locking dogs are displaced through corresponding internal windows defined in the tubular housing into engagement with the external profiled surface of the wellhead.

39. A method for connecting a lower end of a liner to a wellhead having an external profiled

surface and a landing shoulder, comprising:

coupling a tubular housing and one or more locking elements to the end of the liner;

positioning a lower end of the tubular housing next to an upper end of the wellhead;

engaging the lower end of the tubular housing with the wellhead until a lower end face of the liner is positioned proximate an upper end face of the wellhead;

displacing the locking elements relative to the lower end of the liner into engagement with the external profiled surface of the wellhead by operating the actuator; and

absorbing energy during the engaging of the lower end of the tubular housing with the wellhead.

40. The method of claim 39, further comprising during the displacement of the locking elements, transferring loads from the tubular housing to the locking elements using one or more pivotal load transfer elements.

41. The method of claim 39, wherein absorbing energy during the engaging of the lower end of the tubular housing with the wellhead comprises preventing shock loading on the lower end of the tubular housing and the wellhead.

42. The method of claim 39, wherein absorbing energy during the engaging of the lower end of the tubular housing with the wellhead comprises limiting a flow rate of fluidic materials out of an annular chamber.

The invention claimed is:

1. A tie back liner connector assembly, comprising:

a tubular housing having a longitudinal axis and adapted to be coupled to the end of a liner, the tubular housing having at least one interior locking dog window;

a setting chamber in the housing;

an actuator carried in the housing for axial movement, the actuator having a setting piston within the setting chamber, a cam surface, and an actuating sleeve extending from the setting piston;

a retraction chamber in the housing, spaced axially from the setting chamber and having a retracting piston therein;

locking dogs movably coupled to the tubular housing for displacement through the at least one locking dog window of the tubular housing, the locking dogs being axially spaced between the setting chamber and the retraction chamber, the locking dogs being in engagement with the cam surface;

the actuating sleeve having a plurality of linking element windows, the actuating sleeve having a lower end portion extending into the retraction chamber in engagement with the retracting piston;

a plurality of linking elements, each having an inner end in engagement with one of the locking dogs and an outer end in engagement with a load shoulder located in the housing, the inner and outer ends being axially spaced from each other for transferring forces on the locking dogs to the housing, the linking elements extending through the linking element windows in the actuating sleeve; and

wherein applying fluid pressure to the setting chamber moves the setting piston, the actuating sleeve and the retracting piston in one direction to move the dogs radially inward into a setting position in engagement with a profiled surface on a wellhead, and applying fluid pressure to the retraction chamber moves the retracting piston, the actuating sleeve and the setting piston in an opposite direction to release the locking dogs from engagement with the profiled surface on the wellhead.

2. The assembly of claim **1**, wherein the inner end of each of the linking elements comprises a straight conical surface that appears flat when viewed in cross section.

3. The assembly of claim **1**, further comprising a shock absorbing sleeve coupled to an end of the housing for axial movement of the shock absorbing sleeve relative to the housing, the shock absorbing sleeve adapted to land on a landing shoulder of the wellhead; and

a spring located between the shock absorbing sleeve and the housing to absorb shock when the sleeve lands on the landing shoulder of the wellhead.

4. The assembly of claim **3**, wherein:

said end of the housing has a recess that faces an exterior portion of the wellhead when the connector assembly has landed on the wellhead, defining a shock absorbing chamber;

the shock absorbing sleeve has a piston portion carried in the shock absorbing chamber; and

the shock absorbing sleeve has an inner seal on an inner side of the piston portion that is adapted to slidingly engage the exterior portion of the wellhead, and an outer seal on an outer side of the piston portion that slidingly engages the recess.

5. The assembly of claim **4**, further comprising:

a port extending laterally from the shock absorbing chamber to an exterior of the housing to allow trapped fluid in the shock absorbing chamber to be displaced when the housing moves axially relative to the shock absorbing sleeve while the tieback connector is landing on the wellhead.

6. A tie back liner connector assembly, comprising:

a tubular housing having a longitudinal axis and adapted to be coupled to the end of a liner;

a tubular inner sleeve rigidly mounted within the housing, the inner sleeve having a plurality of locking dog windows;

a plurality of locking dogs movably coupled to the tubular housing, within the locking dog windows for engagement with an external profiled surface of a wellhead;

a setting piston chamber located between the inner sleeve and an inner wall of the housing;

a retracting piston chamber located between the inner sleeve and the inner wall of the housing and having a retracting piston;

an axially movable actuator having a setting piston and an actuator sleeve extending therefrom, the setting piston being located in the setting piston chamber, the actuator sleeve having one end extending into the retracting piston chamber into engagement with the retracting piston, the actuator having an intermediate cam portion axially spaced between the setting and retracting pistons and located laterally outward and in contact with outer sides of the locking dogs;

a plurality of linking elements, each having an inner end in engagement with one of the locking dogs and an outer end in engagement with a load shoulder provided in the inner wall of the housing, the inner and outer ends of the linking elements being axially spaced from each other;

a plurality of linking element windows in the actuator sleeve between the setting and retracting pistons; wherein

each of the linking elements extends through one of the linking element windows; and

fluid pressure applied to the setting piston chamber axially moves the setting piston, the actuator sleeve, and the retracting piston in one direction to move the locking dogs inward into engagement with the profiled surface of the wellhead, and fluid pressure applied to the retracting piston chamber moves the retracting piston, the actuator sleeve, and the setting piston in an opposite direction to release the locking dogs from engagement with the profiled surface of the wellhead.

7. The assembly of claim **6**, wherein the inner end of each of the linking elements is a straight conical surface that appears flat when viewed in cross section.

8. The assembly of claim **6**, further comprising a shock absorber sleeve coupled to a lower end of the housing and having a downward facing internal shoulder for landing on a landing shoulder of a wellhead, the shock absorber sleeve being axially movable relative to the housing for absorbing shock when the connector assembly lands on the wellhead; and

a spring between the shock absorber sleeve and the housing for urging the shock absorber sleeve downward relative to the housing.

9. The assembly of claim **8**, wherein the shock absorber sleeve has an outward flared lower end.

10. The assembly of claim **8**, wherein:

a recess is located in the lower end of the housing that defines a shock absorbing chamber when the lower end of the housing is located on the wellhead; and

the shock absorbing sleeve has a piston portion located in the shock absorbing chamber, the piston portion of the shock absorbing sleeve having an inner seal adapted to seal against the wellhead and an outer seal that seals against the recess.

11. The assembly of claim **10**, further comprising a displacement port extending through the housing from the recess to an exterior of the housing.

12. A tie back liner connector assembly, comprising:

a tubular housing having a longitudinal axis and adapted to be coupled to the end of a liner;

an inner sleeve fixedly mounted within the housing, defining an annular space between an exterior side of the inner sleeve and the housing;

a plurality of locking dog windows defined by the inner sleeve;

a plurality of locking dogs movably mounted in the locking dog windows and being movable laterally inward within the locking dog windows into engagement with an external profiled surface of a wellhead;

an actuator carried for axial movement within the annular space between the inner sleeve and the housing, the actuator having a setting piston that seals between the exterior side of the inner sleeve and the housing in the annular space;

a retracting piston sealing between the exterior of the inner sleeve and the housing in the annular space, the locking dog windows being located axially between the setting piston and the retracting piston,

the actuator having an actuator sleeve extending from the setting piston and carried in the annular space, the actuator sleeve having an intermediate portion extending laterally outward from the locking dog windows, the actuator sleeve having a lower end portion in engagement with the retracting piston;

a cam surface on an inner side of the intermediate portion of the actuator sleeve for pushing the locking dogs laterally inward in response to fluid pressure applied to the setting piston moving the setting piston and the actuator sleeve downward;

a retracting sleeve in engagement with the retracting piston and being axially movable upward in response to fluid pressure delivered to the retracting piston for pushing the locking dogs laterally outward;

a plurality of linking elements, each having an inner end that engages one of the locking dogs and an outer end that engages a load shoulder provided in the housing for transferring loads from the locking dogs to the tubular housing; and

wherein the intermediate portion of the actuator sleeve has a plurality of linking element windows through which the linking elements extend.

13. The assembly of claim **12**, wherein the retracting sleeve is located radially inward from the intermediate portion of the actuator sleeve.

14. The assembly of claim **12**, wherein the inner end of each of the linking elements is a straight conical surface that appears flat when viewed in cross section.

15. The assembly of claim **12**, wherein the setting piston and the retracting piston move axially in unison with each other.

16. The assembly of claim **12**, wherein:

the housing has an inner shoulder that defines one end of the annular space that is abutted by the setting piston when the actuator is in a released position; and

the inner sleeve has an outer shoulder that defines an opposite end of the annular space.

17. A tie back liner connector assembly, comprising:

a tubular housing having a longitudinal axis and adapted to be coupled to the end of a liner;

one or more locking elements movably coupled to the tubular housing adapted for displacement thereto into engagement with an external profiled surface of a subsea wellhead; and

a shock absorber assembly coupled to a lower end of the housing, having a shock absorber sleeve with an internal downward facing internal shoulder adapted to land on an external landing shoulder of the wellhead, the shock absorber sleeve being axially movable relative to the housing, and the shock absorber assembly having a spring located between the shock absorber sleeve and the lower end of the housing for absorbing shock when the shock absorber sleeve lands on the landing shoulder of the wellhead.

18. The assembly of claim **17**, further comprising:

an actuator operably coupled to the tubular housing for displacing the locking elements relative to the tubular housing to engage the external profiled surface of the wellhead.

19. The assembly of claim **17**, wherein the shock absorber assembly further comprises:

a damper chamber defined between the housing and the wellhead when the connector is landing on the wellhead, the damper chamber adapted to be in communication with sea water surrounding the wellhead; and wherein

the shock absorber sleeve has a piston portion within the damper chamber to dampen axial movement of the housing after the shock absorber sleeve lands on the landing shoulder.

20. The assembly of claim **19**, further comprising a flow passage extending from the damper chamber for controllably permitting sea water to be exhausted from the damper chamber when the housing moves axially relative to the shock absorber sleeve after the shock absorber sleeve has landed on the landing shoulder.

21. The assembly of claim **19**, wherein the damper chamber is defined on an inner side by the wellhead and on an outer side by the housing.

22. The assembly of claim **21**, wherein the shock absorber sleeve has an inner seal that seals against the wellhead.