27 APR 1999 9901957-2
reference copy

TITLE: **PRELOADING TYPE CONNECTOR**

INVENTOR: GERALD BAKER

FIELD OF THE INVENTION

The field of this invention relates to connectors which hold two components together with a preload and more particularly a subsea choke using such a connection for a removable insert.

BACKGROUND OF THE INVENTION

Oilfield applications involve high pressures as well as fluctuating flows and pressures. Thus, when connections need to be made, they need to be able to withstand a variety of different conditions. In the past, various designs incorporating preload into connections have been used. Generally speaking, these connections would involve a tapered ring powered by a hydraulic cylinder or cylinders which would be pulled down on collets having a tapered exterior so as to force the collets against the two pieces being joined. The two pieces would have flanges which would be held together by an internal groove in the collets. Typical of such designs are the model 70 and the high-capacity (HC) collet connectors offered by Cooper Cameron. The high-capacity connector would allow for a preload of 7 million lbs. for 18¾" connections having a 15,000 psi working pressure. One of the drawbacks of such connectors is that they are expensive to construct and their large size makes their assembly in the field more cumbersome. Additionally, such designs require the use of tapered locking surfaces which depend on friction to remain locked. Lubricating components which can appear on the taper of the lock ring or on

the outer surface of the collet segments can act to undermine the connection, causing a potential for leakage.

Other designs involving preload in a connection in oilfield use are illustrated in U.S. patents 5,066,048 and 5,247,996. Other connections for subsea use involving the use of dogs in grooves are shown in U.S. patents 5,273,117; 5,163,514; and 4,712,621.

Subsea chokes have been designed with retrievable inserts. The choke body is generally mounted to the christmas tree or manifold and the insert is a unitized trim cartridge and actuator assembly which can be retrieved to the surface, leaving the choke body subsea. A crown-type connector has been used in such subsea chokes. This design involves a single-piece cylindrical collet with slots machined to form locking fingers. The insert would be pushed into a receptacle and the collet fingers would then move outwardly into an internal groove in the choke body. The operating principle for obtaining the preload in these subsea chokes was similar to the principles relied upon in U.S. patent 5,066,048. However, the drawback of this design for a retrievable subsea choke was that it was very expensive to manufacture and its large size made it difficult to manipulate it into position in the choke body which remained subsea.

What is desirable is a connection which could provide the requisite preload in subsea choke while being small and cheaper to manufacture. The preload requirement functionally eliminated in the past the use of dog-in-window or groove-type designs, split rings or other types of connectors that didn't have a tapered fit between a locking piston and a locking element.

What was desired and is an objective of the present invention is to provide a simple connection which can give the necessary amount of preload, while combining that design into a compact assembly which would significantly reduce costs compared to previous designs and greatly facilitate installation. Thus, the compactness of the design becomes significant in some instances where room for the connector and actuator for a removable choke insert assembly is in limited supply. Additionally, a more lightweight connector can be more easily manipulated subsea for connection or removal. Another objective was to mount the moving components of the connection on the actuator assembly so that such components do not remain subsea when the connection is undone and the choke insert is removed. While the various configurations of connections are illustrated in this application specifically for a choke with a removable insert, those skilled in the art will appreciate that the objective of the present invention is to provide a connection which can be used in well operations or other applications in the oil and gas industry. Those and other objectives of the present invention will become apparent to those skilled in the art from a review of the description of the preferred embodiment below.

SUMMARY OF THE INVENTION

A connection for oilfield use is disclosed. It features male and female components held together by dogs actuable through one of the members and into the other. Different configurations of the connections envision a built-in preload to the connection when made-up. This is accomplished by a cantilevered component at the extremity of one of the components of the connec-

tion. Alternatively, the preload feature can be incorporated into the dog or other locking assembly that holds the components of the connection together. The connection is particularly useful in subsea chokes which have a removable insert which can be fixedly or removably mounted to the choke body which is located subsea.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a sectional elevational view of one form of the connection in assembled form.

Figure 2 is a sectional elevational view of another form of the connection, illustrating an embodiment with the dog mechanism removable with the actuator.

Figure 3 is a sectional elevational view of an alternative embodiment illustrating the preload feature in the dogs in the run-in position.

Figure 4 shows the view of Figure 3 with the dogs aligned with opposing grooves.

Figure 5 is the view of Figure 4 with the dogs cammed into the opposing grooves to complete the joint.

Figure 6 is a plan view of the dog-actuating mechanism of Figures 1 or 2 with the dogs retracted.

Figure 7 is the view of Figure 6 with the dogs extended for securing the connection.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to Figure 1, a choke body **10** which is usable in subsea applications is illustrated. The choke body **10** accepts an insert **12**. Inside of insert **12** is bore **14** which communicates through openings **16** to the inlet **18** of the choke body **10**. Bore **14** communicates to outlet **20** of the choke body **10**. An actuator **22** moves plug **24** between the two positions shown in the split view of Figure 1. In the upper position, the openings **16** are exposed, allowing the choke to operate to reduce pressure between inlet **18** and outlet **20**. In the lower position shown at the top of Figure 1, the plug **24** covers the opening **16** and there is no flow from inlet **18** to outlet **20** in the choke body **10**.

In the embodiment of Figure 1, the choke body **10** further comprises a dog-operating mechanism **26**, which is also shown in Figures 6 and 7. A series of dogs **28** extend through openings in a sleeve **30** and are retained by a tab **32** to keep them from being pushed all the way in through sleeve **30**. A cam **34** has teeth **36** which mesh with teeth **38** which are, in turn, rotatable by rotation of shaft **40**. Shaft **40** is configured so that it can be gripped by a remotely operated vehicle (ROV) for actuation subsea. Those skilled in the art will appreciate that rotation of shaft **40** rotates cam **34** from the position shown in Figure 6 to the position shown in Figure 7 and vice versa. By virtue of profiles **42**, the dogs **28** are pushed inwardly, as shown in Figure 7, or allowed to be pushed back to the position shown in Figure 6 for disconnection of the connection **C**.

The connection **C** as shown in Figure 1 has a male component **44** which is insertable into female component **46**. Male component **44** has a

tapered or sloping shoulder **48**. Dogs **28** have a sloping shoulder **50** matching the orientation of shoulder **48**. Figure 1 shows the male component **44** fully inserted into the female component **46**, with the dogs **28** extended so that sloping shoulders **48** and **50** are in contact. The female component **46** has an internal shoulder **52**. The male component **44** has a cantilevered component **54**, shown schematically in Figure 1. In actuality, the cantilevered component **54** bottoms on internal shoulder **52**. The cantilevered component extends obliquely with respect to the longitudinal axis **56** of the choke body **10**. In the preferred embodiment, the orientation of the cantilevered component **54** is within a range of substantially perpendicular to axis **56** to an offset of approximately 75° from axis **56**. The cantilevered component has the appearance of a U-shape in cross-section as shown in Figure 1. When the male component **44** is fully inserted into the female component **46** and the dogs **28** are extended, the cantilevered component **54** bottoms on shoulder **52**, thus bringing it closer to or even in contact with surface **58** under certain conditions. Those skilled in the art will appreciate that the cantilevered component **54**, when bottomed on shoulder **52**, gives preload to the connection **C**. Thus, uncertainties about the amount of extension radially toward axis **56** of dogs **28** becomes irrelevant since sufficient extension of dogs **28** radially inwardly towards axis **56** will cause the sloping shoulders **48** and **50** to contact sufficiently to force the cantilevered component **54** against the internal shoulder **52**, while at the same time locking the connection **C** together so as to prevent the male component **44** from being blown out of the female component **46**.

The configuration and location of the cantilevered component **54** can vary without departing from the spirit of the invention. The orientation of the cantilevered component **54** can also vary without departing from the spirit of the invention. The compliant portion of one of the male **44** or female **46** components can be anywhere on its length as long as it is energized by bringing the components together and holding them together with a locking assembly, such as dogs **28**. As long as at least one of the male and female components has a compliant segment that elastically deforms when the components are brought together, the benefits of the present invention are achieved. The compliant segment can be on both components of the connection **C**.

In the embodiment shown in Figure 1, the dog-operating mechanism **26** is a part of the choke body **10** and, thus, remains subsea, even if the actuator **22** is removed with insert **12** after the dogs **28** are retracted by an ROV or a diver.

An alternative preferred design allowing the dog-operating mechanism **26** to be removed from the choke body **10** is illustrated in Figure 2. The principle of operation is the same as in Figure 1, except that the compliant cantilevered component **54** is now part of the choke body **10**. In the embodiment of Figure 1, the choke body **10** had an internal shoulder **52**. In Figure 2, the internal shoulder on the choke body is eliminated, and the cantilevered component **54** represents the end of the choke body **10**. The difference is that the dog-operating mechanism **26** is now a portion of the female component **46** which is connected to the actuator **22**. In the Figure 1 embodiment, the male component **44** was connected to the actuator **22**. In essence, this

reversal of orientations between Figures 1 and 2 operates functionally the same, the difference being that when the actuator **22** is removed with the insert **12**, the dog-operating mechanism **26** comes away from the choke body **10** with the insert **12**. In either case of Figures 1 or 2, the flexing or compliance of the cantilevered or preload component **54** allows the preload to be built into the assembled connection **C** locked together by dogs **28**. As a clear juxtaposition to prior art designs which involved tapered cones pushing on collets where the amount of movement of the tapered cone plus reliance on residual frictional forces were required to hold the connection together, the connection **C** of the present invention is far simpler and cheaper to build and takes up less space. It is also not dependent on residual friction forces to hold the connection together. The connection stays together with preload as desired as long as sufficient radial inward movement of the dogs **28** occurs to prevent the male and female components **44** and **46**, respectively, from coming apart. Accordingly, there's no continuing wedging action required to maintain the preload on the connection. The preload occurs because of sufficient extension of the dogs **28** which, in turn, flexes or moves the preload or cantilevered component **54** sufficiently against an opposing member of the connection or internally within one component of the connection so as to retain a preload force when required. It should be noted that the preload is generally necessary when conditions of high flow and low pressure occur which could create chattering in the connection due to clearances inherent in dog-type closures. Additionally, in view of the fact that radial seals **60** are shown in the embodiments of Figures 1 and 2, there is less of a requirement of a longitudinal closing force on the connection to activate the seals. Thus,

it is the fit between the insert **12** and the passage in the choke body **10** which provides the necessary configuration to retain differential pressures across the seals **60**. The dogs **28** acting on shoulders **48** are for the purpose of holding the connection together and providing preload as opposed to loading up these particular types of seals. However, other types of seals (*i.e.*, face seals) can be used with this type of a connection without departing from the spirit of the invention.

The compliant component **54** need not be cantilevered; it can be a segment of the male **44** and/or female **46** components which can bend, fold, crumple or otherwise deform elastically under load created by actuating the closure, one type of which can be dogs **28**.

An alternative embodiment is illustrated in Figures 3–5. In the embodiment illustrated in these figures, the concept of a preload on the connection and the dogs which hold the connection together or allow it to be taken apart are combined. Referring to Figure 3, a choke insert **61** is attached to an actuator **62**. The running tool **88** has as a part thereof sleeve **94** and skirt **64**. Shoulder **65** on skirt **64** lands on choke body **64** as long as pin **68** is in a retracted position (not shown). Thus, pin **68** retains the running tool **88** to choke body **66** when it extends into groove **70**. The choke body **66** is partially shown in Figure 3. Pin **68** can be mechanically or hydraulically actuated. Choke body **66** has peripheral internal groove **72** and a series of alignment holes **74** which accept alignment pins **76**. Alignment pins **76** extend from actuator **62**. Actuator **62** has a series of peripheral openings **78**, in each of which is located a generally U–shaped dog **80**. Behind each of the dogs **80** is a sleeve **82**, which has a taper **84**. A split ring **86** holds the sleeve **82** to the

actuator body **62** during run-in. Run-in is accomplished using a running tool **88** which engages a groove **90** using a schematically illustrated pin **92**, which can be mechanically or hydraulically operated. The running tool **88** has an extension sleeve **94** such that pin **92** cannot be retracted out of groove **90** until it is in alignment with opening **96** of sleeve **94**, as shown in Figure 5. This prevents inadvertent release subsea of the actuator **62** and insert **61**. The actuator **62** enters choke body **66** with pins **76** guiding the advancement as they move into openings **74**. Eventually, the actuator **62** bottoms in choke body **66** as shown in Figure 4. At that point, sufficient setdown weight moves split ring **86** into groove **98** of sleeve **82**, thus allowing sleeve **82** to continue moving downwardly, thereby camming the dogs **80** radially outwardly into groove **72** due to the action of tapered surface **84**.

This final position is shown in Figure 5. Depending on the configuration of the dogs **80** and the groove **72**, the amount of movement of legs **100** and **102** determines how much preload is on the connection between the actuator **62** and the choke body **66**. It is within the scope of the invention to allow the legs **100** and **102** to touch during normal operations. Thus, for example, when high internal pressures are developed in the choke body **64**, the legs **100** and **102** will likely touch each other. However, when there is high flow and low pressure, the legs will be apart as a preload force is applied. Optionally, within the recess defined between legs **100** and **102**, small projections can be used on each or at least one of the legs **100** and **102** which will limit the amount of movement of the legs **100** and **102** toward each other during operation of the choke. These projections **104** are illustrated in Figure 5.

It should also be noted that when the sleeve **82** reaches its full downward movement as the split ring **86** is forced into groove **98**, the pin **92** comes into alignment with opening **96** in sleeve **94**. Thus, with the pin **92** no longer in groove **90**, the running tool **88** can be retrieved.

Those skilled in the art will appreciate that the drawings of Figures 3–5 illustrate one possible way of configuring the connection for application of a predetermined amount of preload. However, the actual construction of the actuator **62** insofar as how it operates the insert **60** is not a portion of the invention and is a design known in the art. The significant feature of the embodiment shown in Figures 3–5 is that preload is applied to a connection where the preload function and the locking function of the connection are combined in a single element.

Another feature of the invention illustrated in Figures 3–5 is the elimination of tapered cones acting on collets which left uncertainties as to the solidity of the connection in that reliance on residual friction forces was required. In the embodiment of Figures 3–5, sufficient sleeve movement to cam the dogs **80** outwardly into a groove **72** of predetermined configuration ensures the locking of the connection together with the desired preload. It should be noted that groove **72** has a cross–sectional shape in general conformance with the tapered surfaces **106** and **108** on legs **102** and **100**, respectively. While a U–shaped cross–section is shown for the dogs **80**, other configurations for the dogs can be used without departing from the spirit of the invention. The dog or dogs **80** can have some other shape as long as they also have a compliant component (*i.e.*, that bends, folds, crushes, or otherwise changes in dimension) that elastically deforms while at the same time serving to lock the con–

nection components together. While the orientation of the long axis of the dogs **110** is perpendicular to the axis **112**, different orientations of the dogs **80** can be used without departing from the spirit of the invention. As long as the dogs **80** can effect a straddle between the actuator **82** and the receptacle **66** so as to hold the connection together, while at the same time changing its configuration elastically so as to provide a preload, the physical embodiment of how those features are executed are all within the purview of the invention.

By integrating the compliant component **54** into a male **44** and/or female **46** portion of the joint, the installation and removal is simpler and faster as compared to using a separate element to achieve the preload which is independent of the constituent parts.

Those skilled in the art will appreciate that connections for services other than for subsea chokes with removable inserts are envisioned for the present invention and that the limits are well beyond chokes or even subsea equipment or even oilfield equipment in general.

The foregoing disclosure and description of the invention are illustrative and explanatory thereof, and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made without departing from the spirit of the invention.

What is claimed:

1. A connector, comprising:

a male component insertable into a female component;

a compliant portion on one of said male and female components which elastically moves to apply a preload when said male and female components are assembled to each other;

a lock mechanism extending at least in part into said male and female components to selectively hold them together with said compliant portion applying said preload.

2. The connector of claim 1, wherein:

said compliant portion is located near an end of one of said male and female components.

3. The connector of claim 2, wherein:

said compliant portion further comprises a cantilevered component.

4. The connector of claim 3, wherein:

said male and female components having a longitudinal axis, said cantilevered component extending in a direction transverse to said longitudinal axis of said male and female components.

5. The connector of claim 4, wherein:

said cantilevered component is oriented in a range of about 75–90° from said longitudinal axis.

6. The connector of claim 4, wherein:

said cantilevered component extends around the entire periphery of one of said male and female components.

7. The connector of claim 6, wherein:

said cantilevered component is on said male component.

8. The connector of claim 6, wherein:

said cantilevered component is on said female component.

9. The connector of claim 6, wherein:

said cantilevered component is on said male and said female components.

10. The connector of claim 4, wherein:

said locking mechanism comprises at least one dog extendable into a locking position in said male and female components to lock them together;

said extension of said dog into said locking position acts to put a force on said cantilevered component so that a preload force acts on said male and female components when held together.

11. The connector of claim 10, wherein:

said locking mechanism comprises a cam system actuable by shaft rotation.

12. The connector of claim 11, wherein:

said male component is a portion of a subsea choke body, said female component is connected to an actuator assembly which operates an insert in said choke body;

said locking mechanism is mounted to said female component so that it and said actuator can be removed from a subsea mounted choke body.

13. The connector of claim 11, wherein:

said female component is a portion of a subsea choke body, said male component is connected to an actuator assembly which operates an insert in said choke body;

said locking mechanism is mounted to said female component so that it remains with said choke body when said actuator assembly and said insert attached to it are removed from the choke body mounted subsea.

14. A connector, comprising:

a male component insertable into a female component;

a compliant locking member movable between a retracted position where said male and female components can be brought together or separated and a locking position where said locking member both holds said

male and female components together and applies a preload force to said connected components.

15. The connector of claim 14, wherein:

said compliant locking member comprises at least one dog selectively extendable from one of said male and female components into a groove in the other, said movement of said dog into said groove elastically deforms said dog to apply said preload force.

16. The connector of claim 15, wherein:

said dog has a generally U-shaped cross-section defined by a pair of extending legs, said legs brought closer together in said groove to apply said preload force.

17. The connector of claim 16, wherein:

said dog comprises a plurality of dogs mounted to said male component which further comprises an actuator connected to an insert for a subsea choke, said female component further comprises a receptacle mounted to a subsea choke body further comprising said groove to accept said dogs.

18. The connector of claim 17, wherein:

said actuator comprises a selectively locked camming sleeve which, when alignment between said dogs and said groove is attained, moves to cam said dogs into a locking relation with said groove.

19. The connector of claim 18, wherein:

said actuator is selectively retained by a running tool as said insert is inserted into said choke body;

said running tool is locked to said actuator and is releasable when said camming sleeve has shifted said dogs into said groove.

20. The connector of claim 19, wherein:

said subsea choke body further comprises a guide sleeve and a lateral opening;

said running tool retained to said actuator by a pin which cannot retract when said actuator is in said guide sleeve until said pin is brought into alignment with said opening as a result of shifting said camming sleeve.