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FLUID END FOR PUMP

Abstract

A fluid end of a pump includes a fluid end body defining a bore extending along a central axis of the fluid end and a first circumferential notch. The fluid end also includes a suction cap received within the bore of the fluid end body and a wear sleeve radially disposed between the fluid end body and the suction cap. The wear sleeve circumferentially surrounds the suction cap and is received within the first circumferential notch of the fluid end body. The wear sleeve is an L-shaped sleeve. An inner surface of the wear sleeve engages with the suction cap. An outer surface of the wear sleeve engages with the fluid end body. The wear sleeve includes a flange portion.

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Background/Summary

TECHNICAL FIELD

[0001] The present disclosure relates to a pump, and more particularly to, a fluid end of a pump.

BACKGROUND

[0002] A pump, such as a positive displacement pump, is used in hydraulic fracturing operations to pump high-pressure fracturing fluids into wells for recovery of oil and gas trapped in shale formations and the like. Typically, the pump has a power end which is coupled to a diesel engine and transmission that drives the pump. The pump also has a fluid end in which a mix of water, sand, and/or chemicals are pressurized by plungers.

[0003] Currently, the fluid end has limited service life due to fatigue crack failures. These failures are a result of operating pressures, mechanical stresses, erosion and corrosion due to contact of high pressure fluids, and the like. Specifically, a primary failure mode of the fluid end is a washed bore of the fluid end that receives a suction cap. The bore where a suction cover seal is disposed experiences excessive wear from wash boarding of seals and applied pressure. Damage to seals causes leakages within the fluid end. The fluid end needs to be weld repaired and re-machined to return the fluid end to service, which may increase operating costs associated with the pump. Further, the seals disposed in the fluid end may also have to be replaced, thereby incurring additional operating costs.

[0004] U.S. Pat. No. 9,739,130 describes a fluid end for high pressure reciprocating pump, in particular for hydraulic fracturing pumps, comprising: a body having a first bore for receiving a reciprocating plunger, a second bore for accommodating a suction valve, and a third bore for accommodating a discharge valve, the second bore and the third bore being perpendicular to the first bore; at least a tubular sleeve in said first bore; at least a tubular cartridge in the second bore and/or third bore; and a fluid tight seal between contacting surfaces of said sleeve and said cartridge.

SUMMARY OF THE DISCLOSURE

[0005] In an aspect of the present disclosure, a fluid end of a pump is provided. The fluid end includes a fluid end body defining a bore extending along a central axis of the fluid end and a first circumferential notch extending along the central axis and in communication with the bore. A first axial length of the bore is greater than a second axial length of the first circumferential notch. The fluid end also includes a suction cap received within the bore of the fluid end body. The fluid end includes a wear sleeve radially disposed between the fluid end body and the suction cap. The wear sleeve circumferentially surrounds the suction cap. The wear sleeve is received within the first circumferential notch of the fluid end body. The wear sleeve is an L-shaped sleeve that defines a first end, a second end opposite the first end along the central axis, an inner surface extending from the first end to the second end, and an outer surface disposed opposite the inner surface and extending from the first end to the second end. The inner surface of the wear sleeve engages with the suction cap. The outer surface of the wear sleeve engages with the fluid end body. The wear sleeve includes a flange portion.

[0006] In another aspect of the present disclosure, a fluid end of a pump is provided. The fluid end includes a fluid end body defining a bore extending along a central axis of the fluid end and a first circumferential notch extending along the central axis and in communication with the bore. A first axial length of the bore is greater than a second axial length of the first circumferential notch. The fluid end also includes a suction cap received within the bore of the fluid end body. The suction cap defines a circumferential groove at an outer surface thereof. The fluid end further includes a tubular sleeve radially disposed between the fluid end body and the suction cap. The tubular sleeve circumferentially surrounds the circumferential groove of the suction cap. The tubular sleeve is received within the first circumferential notch of the fluid end body. The fluid end includes a sealing element disposed within the circumferential groove of the suction cap and engaging with the tubular sleeve.

[0007] Other features and aspects of this disclosure will be apparent from the following description and the accompanying drawings.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a schematic sectional view of an exemplary pump;

[0009] FIG. **2** is a schematic sectional view illustrating a portion of a fluid end for the pump of FIG. **1**;

[0010] FIG. **3**A is a schematic perspective view of a wear sleeve of the fluid end of FIG. **2**;

[0011] FIG. **3**B is a schematic sectional view of the wear sleeve of FIG. **3**A;

[0012] FIG. **4** is a schematic sectional view illustrating a portion of a fluid end for the pump of FIG. **1**;

[0013] FIG. **5**A is a schematic perspective view of a tubular sleeve of the fluid end of FIG. **4**; and

[0014] FIG. **5**B is a schematic sectional view of the wear sleeve of FIG. **5**A.

DETAILED DESCRIPTION

[0015] Wherever possible, the same reference numbers will be used throughout the drawings to refer to the same or like parts.

[0016] Referring to FIG. **1**, a schematic sectional view of a fluid end **200** of a pump **100** is illustrated. The pump **100** may include any type of positive displacement pump. In an example, the pump **100** may include a reciprocating pump. Further, the pump **100** may be used in well stimulation arrangements as a hydraulic fracturing pump to pressurize high pressure fracturing (fracking) fluids into wells for recovery of oil and gas trapped in shale formations and the like. Alternatively, the pump **100** may be usable for other applications.

[0017] The pump **100** typically includes a power end (not shown), driven by a diesel engine and transmission, which is coupled to the fluid end **200** that is supplied with the fracking fluid containing water and other ingredients. The fluid end **200** receives the fracking fluid via an inlet **202**. Further, the fracking fluid is pressurized in the fluid end **200** and discharged through an outlet **204**.

[0018] The fluid end **200** includes a fluid end body **206**. In an example, the fluid end body **206** may be made of stainless steel. The fluid end body **206** defines a plunger bore **208**, a suction bore **210**, a center chamber **212** for pressurization of the fracking fluid, and a discharge bore **214**. The discharge bore **214** feeds into a discharge passage **216** through which high pressure fracking fluid leaves the fluid end body **206**. The fluid end **200** includes a suction check valve (not shown) and a suction valve spring retainer **244** disposed proximal to the inlet **202**. Further, the fluid end **200** may include a discharge check valve (not shown) proximal to the discharge passage **216**.

[0019] The fluid end **200** also includes a plunger (not shown) received in the plunger bore **208**. The plunger reciprocates to effect pressurization in the center chamber **212** to allow the fracking fluid therein, at low pressure from the suction bore **210**. Correspondingly, the discharge bore **214** receives the pressurized fracking fluid from the center chamber **212** and discharges the same into the discharge passage **216**.

[0020] Further, the fluid end body **206** also defines a bore **218** extending along a central axis X**1** of the fluid end **200**. As shown, an access opening **220** in communication with the bore **218** receives a removable, retaining nut **224** to provide selective access to the interior of the fluid end body **206**. The fluid end **200** also includes a suction cap **226** received within the bore **218** of the fluid end body **206**. The suction cap **226** is disposed to close off and isolate the center chamber **212** to prevent fluid flow-out through the bore **218** and the access opening **220**. The suction cap **226** has a stepped design herein. Further, the retaining nut **224** and the suction cap **226** may be removed to service components, such as, the suction check valve (not shown) and the plunger (not shown)

disposed in the fluid end **200**. The suction cap **226** defines a circumferential groove **228** at an outer surface **230** thereof.

[0021] Referring to FIG. **2**, the fluid end body **206** defines a first circumferential notch **232** extending along the central axis X**1** and in communication with the bore **218**. In some embodiments, the fluid end body **206** may define a second circumferential notch **234** in communication with the first circumferential notch **232** and the bore **218**. The second circumferential notch **234** may be used for disposition of a first sealing element **320** and a second sealing element **322**. However, the second circumferential notch **234** is optional as described in detail below. The bore **218** defines a first axial length L**1** and the first circumferential notch **232** defines a second axial length L**2**. The first axial length L**1** of the bore **218** is greater than the second axial length L**2** of the first circumferential notch **232**. In one embodiment, the first circumferential notch **232** defines a first notch portion **236** and a second notch portion **238**, thus the first circumferential notch **232** is an L-shaped notch.

[0022] The fluid end **200** also includes a wear sleeve **300** radially disposed between the fluid end body **206** and the suction cap **226**. The wear sleeve **300** circumferentially surrounds the suction cap **226**. The wear sleeve **300** is disposed such that the wear sleeve **300** circumferentially surrounds the circumferential groove **228** of the suction cap **226**. Further, the wear sleeve **300** is received within the first circumferential notch **232** of the fluid end body **206**. The wear sleeve **300** is made of a metallic material having a hardness value of at least 40 C on the Rockwell Scale of Hardness. The wear sleeve **300** may be made of a material that demonstrates anti-wear properties such as, toughness, hardness, and/or material consistency. In an example, the wear sleeve **300** may be made of steel. In some examples, the wear sleeve **300** may have a coating that demonstrates anti-wear properties such as, toughness, hardness, and/or material consistency. In certain implementations, the material composition, hardness value, anti-wear properties, and/or coating of the wear sleeve **300** can provide advantages that are needed to overcome one or more problems in the industry that are associated with fluid ends of hydraulic fracturing pumps. In an example, the wear sleeve **300** may be coupled with the pump **100** body via an interference fit that forms a metal to metal seal. Further, in an example, the wear sleeve **300** may be coupled with the suction cap **226** via a slip fit or a clearance fit.

[0023] Referring to FIGS. **2**, **3**A, and **3**B, the wear sleeve **300** is an L-shaped sleeve that defines a first end **302**. The wear sleeve **300** also defines a second end **304** opposite the first end **302** along the central axis X**1**. The wear sleeve **300** further defines an inner surface **306** extending from the first end **302** to the second end **304**. The wear sleeve **300** defines an outer surface **308** disposed opposite the inner surface **306**. The outer surface **308** extends from the first end **302** to the second end **304**. The inner surface **306** of the wear sleeve **300** engages with the suction cap **226**. Further, in some examples, the inner surface **306** of the wear sleeve **300**, at the second end **304**, is coplanar with an inner surface **242** of the bore **218** that is axially adjacent to the first circumferential notch **232**. Moreover, the outer surface **308** of the wear sleeve **300** engages with the fluid end body **206**.

[0024] The wear sleeve **300** includes a flange portion **312**. The flange portion **312** is disposed at the first end **302** and extends perpendicular to the central axis X**1**. The flange portion **312** is received within the first notch portion **236**.

[0025] The wear sleeve **300** also includes a tubular portion **310** extending from the second end **304** towards the first end **302**. The tubular portion **310** is integral with the flange portion **312**. The tubular portion **310** is received within the second notch portion **238**.

[0026] As shown in FIG. **3**B, in an example, an aspect ratio of a thickness T**1** of the tubular portion **310** to a thickness T**2** of the flange portion **312** lies in a range between ¼ and ½. Further, the flange portion **312** defines an axial length L**3** and the tubular portion **310** defines an axial length L**4**. The axial length L**4** of the tubular portion **310** is greater than the axial length L**3** of the flange portion **312**. In an example, a ratio of the axial length L**3** of the flange portion **312** to the axial length L**4** of the tubular portion **310** lies in a range between 0.1 and 0.2. In certain implementations, one or more

of the dimensional characteristics of the wear sleeve **300** listed above can provide advantages that are needed to achieve proper form, fit, and function of the part.
[0027] Further, the inner surface **306** of the wear sleeve **300** includes a first chamfered surface **316** proximal to the first end **302** of the wear sleeve **300**. The first chamfered surface **316** is disposed at an angle Al between 8 degrees and 30 degrees relative to the central axis X**1**. In an example, the angle A**1** of the first chamfered surface **316** relative to the central axis X**1** is equal to 15 degrees.
[0028] Further, the outer surface **308** of the wear sleeve **300** includes a second chamfered surface **318** proximal to the second end **304** of the wear sleeve **300**. Thus, the outer surface **308** includes a step profile created by the flange portion **312** and the tubular portion **310** of the wear sleeve **300**, and also includes the second chamfered surface **318**. The second chamfered surface **318** is disposed at an angle A**2** between 8 degrees and 30 degrees relative to the central axis X**1**. In an example, the angle A**2** of the second chamfered surface **318** relative to the central axis X**1** is equal to 15 degrees. In certain implementations, one or more of the angular characteristics of the wear sleeve **300** listed above can provide advantages that are needed to achieve proper form, fit, and function of the part.
[0029] Referring now to FIG. **2**, the fluid end **200** also includes the first sealing element **320** disposed within the second circumferential notch **234**. The first sealing element **320** engaging with the wear sleeve **300**. In an example, the first sealing element **320** is an O-ring herein. As described above, the second circumferential notch **234** is optional. For example, the second circumferential notch **234** may be omitted, and a metal to metal seal may be defined between the outer surface **308** of the wear sleeve **300** and an opposing inner surface of the bore **218** (e.g., within the first circumferential notch **232**).
[0030] Further, the fluid end **200** includes the second sealing element **322** disposed within the circumferential groove **228** defined at the outer surface **230** of the suction cap **226**. The second sealing element **322** may be interchangeably referred to as “sealing element” in this disclosure. The second sealing element **322** engages with the wear sleeve **300**. The first sealing element **320** and the second sealing element **322** are disposed on opposite sides of the wear sleeve **300**. In an example, the second sealing element **322** is a lip seal.
[0031] The fluid end **200** further includes a first back-up ring **324** disposed within the second circumferential notch **234**. The first back-up ring **324** and the first sealing element **320** are disposed adjacent to each other. Further, the first back-up ring **324** and the first sealing element **320** may be designed to withstand a pressure of up to 15 Kips per square inch (ksi) and may withstand operation at −40 to 175 degrees Fahrenheit. Moreover, the fluid end **200** includes a second back-up ring **326** disposed within the circumferential groove **228** of the suction cap **226**. The second back-up ring **326** and the second sealing element **322** are disposed adjacent to each other.
[0032] FIG. **4** illustrates another design for a fluid end **400** of the pump **100** of FIG. **1**. The fluid end **400** is substantially similar to the fluid end **200** described in relation to FIG. **2**. Identical components will be referred using the same numbers. The fluid end **400** includes a fluid end body **406**. The fluid end body **406** defines a bore **418** extending along a central axis X**1** of the fluid end **400**. The fluid end **400** also includes the suction cap **226** received within the bore **418** of the fluid end body **406**. The suction cap **226** defines the circumferential groove **228** at the outer surface **230** thereof.
[0033] The fluid end body **406** defines a first circumferential notch **432** extending along the central axis X**1** and in communication with the bore **418**. In some embodiments, the fluid end body **406** may define a second circumferential notch **434** in communication with the first circumferential notch **432** and the bore **418**. The second circumferential notch **434** may be used for disposition of the first sealing element **320** and the second sealing element **322**. However, the second circumferential notch **434** is optional as described in detail below. The bore **418** defines a first axial length L**1** and the first circumferential notch **432** defines a second axial length L**2**. The first axial length L**1** of the bore **418** is greater than the second axial length L**2** of the first circumferential notch **432**.

[0034] The fluid end **400** also includes a tubular sleeve **500** radially disposed between the fluid end body **406** and the suction cap **226**. The tubular sleeve **500** circumferentially surrounds the circumferential groove **228** of the suction cap **226**. Further, the tubular sleeve **500** is received within the first circumferential notch **432** of the fluid end body **406**. The tubular sleeve **500** is made of a metallic material having a hardness value of at least 40 C on the Rockwell Scale of Hardness. In an example, the tubular sleeve **500** may be made of steel. In some examples, the tubular sleeve **500** may have a coating that demonstrates anti-wear properties such as, toughness, hardness, and/or material consistency. The tubular sleeve **500** may be made of a material that demonstrates anti-wear properties such as, toughness, hardness, and/or material consistency. In certain implementations, the material composition, hardness value, anti-wear properties, and/or coating of the wear sleeve **500** can provide advantages that are needed to overcome one or more problems in the industry that are associated with fluid ends of hydraulic fracturing pumps. In an example, the tubular sleeve **500** may be coupled with the pump **100** body via an interference fit that forms a metal to metal seal. Further, in an example, the tubular sleeve **500** may be coupled with the suction cap **226** via a slip fit or a clearance fit.

[0035] Referring to FIGS. **4**, **5**A, and **5**B, the tubular sleeve **500** defines a first end **502**. The tubular sleeve **500** also defines a second end **504** opposite the first end **502** along the central axis X**1**. The tubular sleeve **500** further defines an inner surface **506** extending from the first end **502** to the second end **504**. The tubular sleeve **500** defines an outer surface **508** disposed opposite the inner surface **506**. The outer surface **508** extends from the first end **502** to the second end **504**. The inner surface **506** of the tubular sleeve **500** engages with the suction cap **226**. Further, the inner surface **506** of the tubular sleeve **500**, at the second end **504**, is coplanar with an inner surface **442** of the bore **418** that is axially adjacent to the first circumferential notch **432**. Moreover, the outer surface **508** of the tubular sleeve **500** engages with the fluid end body **406** to form a metal to metal seal.

[0036] As shown in FIG. **5**B, the inner surface **506** of the tubular sleeve **500** includes a first chamfered surface **516** proximal to the first end **502** of the tubular sleeve **500**. The first chamfered surface **516** is disposed at an angle between 8 degrees and 30 degrees relative to the central axis X**1**. In an example, the angle of the first chamfered surface **516** relative to the central axis X**1** is equal to 15 degrees.

[0037] Further, the outer surface **508** of the tubular sleeve **500** includes a second chamfered surface **518** proximal to the second end **504** of the tubular sleeve **500**. The second chamfered surface **518** is disposed at an angle between 8 degrees and 30 degrees relative to the central axis X**1**. In an example, the angle of the second chamfered surface **518** relative to the central axis X**1** is equal to 15 degrees. In certain implementations, one or more of the angular characteristics of the wear sleeve **500** listed above can provide advantages that are needed to achieve proper form, fit, and function of the part.

[0038] Referring again to FIG. **4**, the fluid end **400** also includes the first sealing element **320** disposed within the second circumferential notch **434**, the second sealing element **322** disposed within the circumferential groove **228** of the suction cap **226** and engaging with the tubular sleeve **500**, the first back-up ring **324** disposed within the second circumferential notch **434**, and the second back-up ring **326** disposed within the circumferential groove **228** of the suction cap **226**. Each of the first sealing element **320**, the second sealing element **322**, the first back-up ring **324**, and the second back-up ring **326** engage with the tubular sleeve **500**. Further, the first sealing element **320** and the sealing element **322** disposed within the circumferential groove **228** of the suction cap **226** are disposed on opposite sides of the tubular sleeve **500**. As described above, the second circumferential notch **434** is optional. For example, the second circumferential notch **434** may be omitted, and a metal to metal seal may be defined between the outer surface **508** of the tubular sleeve **500** and an opposing inner surface of the bore **418** (e.g., within the first circumferential notch **432**).

[0039] It is to be understood that individual features shown or described for one embodiment may

be combined with individual features shown or described for another embodiment. The above described implementation does not in any way limit the scope of the present disclosure. Therefore, it is to be understood although some features are shown or described to illustrate the use of the present disclosure in the context of functional segments, such features may be omitted from the scope of the present disclosure without departing from the spirit of the present disclosure as defined in the appended claims.

INDUSTRIAL APPLICABILITY

[0040] The present disclosure relates to the sleeve **300**, **500** associated with the corresponding fluid end **200**, **400** for the pump **100**. The sleeve **300**, **500** has a simple design herein and is retained within the fluid end body **206**, **406**, for example, by the interference fit. Further, the sleeve **300**, **500** includes the first chamfered surface **316**, **516** and the second chamfered surface **318**, **518** that may simplify an assembly process of the sleeve **300**, **500** within the fluid end **200**, **400**.

[0041] The sleeve **300**, **500** may prevent/reduce damage to various parts of the fluid end **200**, **400**, such as, the bore **218**, **418**, the second sealing element **322**, and the second back-up ring **326**. In some examples, the sleeve **300**, **500** may be embodied as a serviceable/replaceable part, that may be removed from the fluid end **200**, **400** in case of damage thereto. Thus, instead of replacing/servicing the entire fluid end **200**, **400**, only the sleeve **300**, **500** may have to be replaced. Further, the sleeve **300**, **500** may be made of a material or may have a coating that demonstrates anti-wear properties, such as, toughness, hardness, and/or material consistency. Thus, the sleeve **300**, **500** may be less susceptible to wear and tear.

[0042] As various parts of the fluid end **200**, **400** may be less susceptible to damage, incorporation of the sleeve **300**, **500** may reduce maintenance/servicing costs associated with the fluid end **200**, **400**. Further, the fluid end **200**, **400** also includes the first sealing element **320** and the first back-up ring **324** that may withstand pressures up to 15 ksi and withstands operation at −40 to 175 degrees Fahrenheit.

[0043] While aspects of the present disclosure have been particularly shown and described with reference to the embodiments above, it will be understood by those skilled in the art that various additional embodiments may be contemplated by the modification of the disclosed work machine, systems and methods without departing from the spirit and scope of the disclosure. Such embodiments should be understood to fall within the scope of the present disclosure as determined based upon the claims and any equivalents thereof.

Claims

1. A fluid end of a pump, comprising: a fluid end body defining a bore extending along a central axis of the fluid end and a first circumferential notch extending along the central axis and in communication with the bore, wherein a first axial length of the bore is greater than a second axial length of the first circumferential notch; a suction cap received within the bore of the fluid end body; and a wear sleeve radially disposed between the fluid end body and the suction cap, wherein: the wear sleeve circumferentially surrounds the suction cap, the wear sleeve is received within the first circumferential notch of the fluid end body, the wear sleeve is an L-shaped sleeve that defines a first end, a second end opposite the first end along the central axis, an inner surface extending from the first end to the second end, and an outer surface disposed opposite the inner surface and extending from the first end to the second end, the inner surface of the wear sleeve engages with the suction cap, the outer surface of the wear sleeve engages with the fluid end body, and the wear sleeve includes a flange portion.

2. The fluid end of claim 1, wherein the inner surface of the wear sleeve includes a first chamfered surface proximal to the first end of the wear sleeve, and wherein the first chamfered surface is disposed at an angle between 8 degrees and 30 degrees relative to the central axis.

3. The fluid end of claim 1, wherein the inner surface of the wear sleeve, at the second end, is

coplanar with an inner surface of the bore that is axially adjacent to the first circumferential notch.
4. The fluid end of claim 1, wherein the outer surface of the wear sleeve includes a second chamfered surface proximal to the second end of the wear sleeve, and wherein the second chamfered surface is disposed at an angle between 8 degrees and 30 degrees relative to the central axis.
5. The fluid end of claim 1, wherein the fluid end body further defines a second circumferential notch in communication with the first circumferential notch and the bore, and wherein the fluid end further includes a first sealing element disposed within the second circumferential notch and engaging with the wear sleeve.
6. The fluid end of claim 5 further comprising a first back-up ring disposed within the second circumferential notch.
7. The fluid end of claim 5 further comprising: a second sealing element disposed within a circumferential groove defined at an outer surface of the suction cap and engaging with the wear sleeve, wherein the first sealing element and the second sealing element are disposed on opposite sides of the wear sleeve; and a second back-up ring disposed within the circumferential groove of the suction cap.
8. The fluid end of claim 1, wherein the wear sleeve is made of a metallic material having a hardness value of at least 40 C on the Rockwell Scale of Hardness.
9. The fluid end of claim 1, wherein the wear sleeve includes a tubular portion extending from the second end towards the first end, and wherein an aspect ratio of a thickness of the tubular portion to a thickness of the flange portion lies in a range between ¼ and ½.
10. The fluid end of claim 9, wherein a ratio of an axial length of the flange portion to an axial length of the tubular portion lies in a range between 0.1 and 0.2.
11. The fluid end of claim 1, wherein the wear sleeve is coupled with the fluid end body via an interference fit that forms a metal to metal seal, and wherein the wear sleeve is coupled with the suction cap via a slip fit or a clearance fit.
12. A fluid end of a pump, comprising: a fluid end body defining a bore extending along a central axis of the fluid end and a first circumferential notch extending along the central axis and in communication with the bore, wherein a first axial length of the bore is greater than a second axial length of the first circumferential notch; a suction cap received within the bore of the fluid end body, the suction cap defining a circumferential groove at an outer surface thereof; a tubular sleeve radially disposed between the fluid end body and the suction cap, wherein the tubular sleeve circumferentially surrounds the circumferential groove of the suction cap, and wherein the tubular sleeve is received within the first circumferential notch of the fluid end body; and a sealing element disposed within the circumferential groove of the suction cap and engaging with the tubular sleeve.
13. The fluid end of claim 12, wherein the tubular sleeve defines a first end, a second end opposite the first end along the central axis, an inner surface extending from the first end to the second end, and an outer surface disposed opposite the inner surface and extending from the first end to the second end, wherein the inner surface of the tubular sleeve engages with the suction cap, and wherein the outer surface of the tubular sleeve engages with the fluid end body to form a metal to metal seal.
14. The fluid end of claim 13, wherein the inner surface of the tubular sleeve includes a first chamfered surface proximal to the first end of the tubular sleeve, and wherein the first chamfered surface is disposed at an angle between 8 degrees and 30 degrees relative to the central axis.
15. The fluid end of claim 13, wherein the inner surface of the tubular sleeve, at the second end, is coplanar with an inner surface of the bore that is axially adjacent to the first circumferential notch.
16. The fluid end of claim 13, wherein the outer surface of the tubular sleeve includes a second chamfered surface proximal to the second end of the tubular sleeve, and wherein the second chamfered surface is disposed at an angle between 8 degrees and 30 degrees relative to the central axis.

17. The fluid end of claim 12, wherein the fluid end body further defines a second circumferential notch in communication with the first circumferential notch and the bore, and wherein the fluid end further includes: a first sealing element disposed within the second circumferential notch and engaging with the tubular sleeve, wherein the first sealing element and the sealing element disposed within the circumferential groove of the suction cap are disposed on opposite sides of the tubular sleeve; and a first back-up ring disposed within the second circumferential notch.

18. The fluid end of claim 12 further comprising a second back-up ring disposed within the circumferential groove of the suction cap.

19. The fluid end of claim 12, wherein the tubular sleeve is made of a metallic material having a hardness value of at least 40 C on the Rockwell Scale of Hardness.

20. The fluid end of claim 12, wherein the tubular sleeve is coupled with the fluid end body via an interference fit that forms a metal to metal seal, and wherein the tubular sleeve is coupled with the suction cap via a slip fit or a clearance fit.