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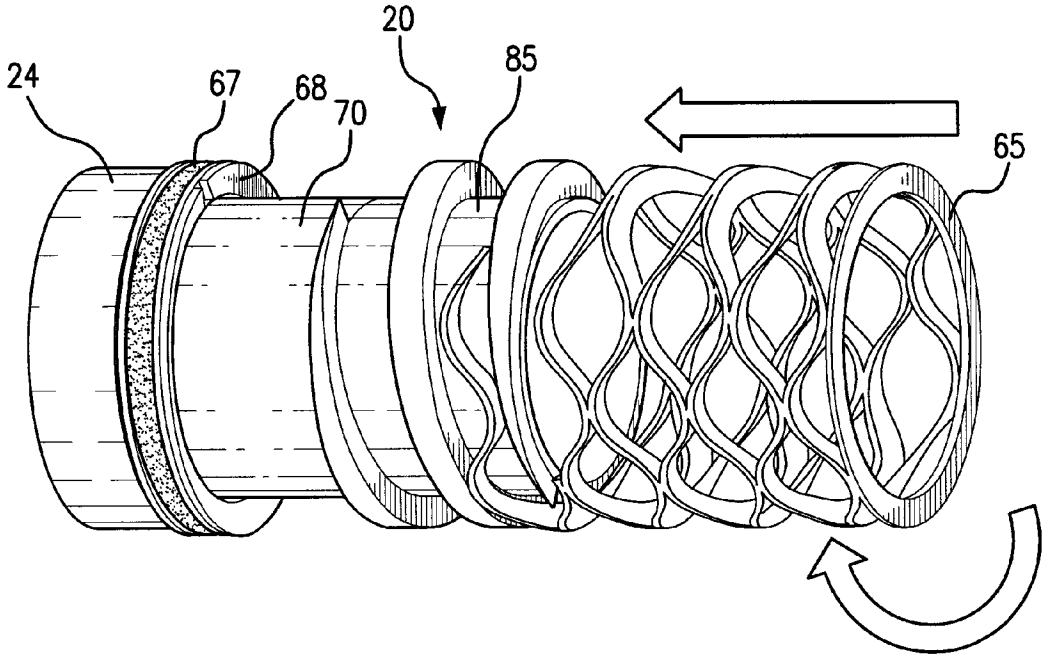
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(54) **Titre : JOINT DE SURETE COMPORTANT UNE BAGUE D'ETANCHEITE A COMPENSATION DE PRESSION ANTIBLOCAGE**
(54) **Title: SAFETY JOINT DESIGNED WITH ANTI-LOCK PRESSURE COMPENSATION SEAL**



(57) **Abrégé/Abstract:**
A safety joint designed to prevent hydrostatic locking is made up by assembling a pin end having a first seal, a threaded connection, and a movable second seal to a box end. The movable seal is disposed in a recess formed in the pin end and includes an O-ring and a spring. When the safety joint is assembled downhole, a volume of fluid may become trapped between the first seal and the second seal. The trapped fluid in turn pushes the O-ring towards the spring, thereby limiting pressure build-up by substantially maintaining the volume trapped between the first and second seals.

ABSTRACT

A safety joint designed to prevent hydrostatic locking is made up by assembling a pin end having a first seal, a threaded connection, and a movable second seal to a box end. The movable seal is disposed in a recess formed in the pin end and includes an O-ring and a spring. When the safety joint is assembled downhole, a volume of fluid may become trapped between the first seal and the second seal. The trapped fluid in turn pushes the O-ring towards the spring, thereby limiting pressure build-up by substantially maintaining the volume trapped between the first and second seals.

SAFETY JOINT DESIGNED WITH ANTI-LOCK PRESSURE COMPENSATION SEAL

TECHNICAL FIELD

The present disclosure relates in general to downhole safety joints for downhole use in a wellbore. In particular, the disclosure relates to a sealing mechanism for downhole safety joints.

BACKGROUND

Safety joints are commonly used with work strings including drilling, fishing, testing, wash-over, tubing or other strings. They allow the disengagement of the lower portion of the work string at a pre-determined location or position. These safety joints are important in situations in which, for example, a work string becomes stuck in a wellbore. Oftentimes, expensive equipment or tools are present at the lower end of the work string, and they must be retrievable. Safety joints are therefore placed below expensive equipment on the work string to ensure that the equipment can be retrieved once the safety joint is disconnected. Safety joints are designed to break out at a lower torque magnitude than all of the connections in the work string so that if the work string gets stuck, there is a known location and a known torque magnitude for disengagement of the safety joints.

Typical safety joints are tubular in shape, and are made up of two parts, namely an upper member (or "pin end") and a lower member (or "box end") that are connected by known means, such as, for example, coarse threads. When the safety joint is assembled, right-hand torque or rotation causes the pin to move axially into the box. When a work string becomes stuck in a wellbore, left-hand torque is applied to the work string to uncouple the pin from the box, allowing retrieval of the pin and the work string above it. The design of the safety joints allows them to be reconnected downhole by application of right-hand torque.

To avoid wash-out of the threads and the loss of fluid through the work string, two seals (for example, O-rings, or other suitable seal elements) are usually installed on

both sides of the threaded connection. When the safety joint is assembled on the surface, there is no wellbore fluid present and hence there is no problem during assembly of the safety joint. However, when wellbore fluid is present in the environment of the safety joint, particularly in the box, a volume of fluid gets trapped between the aforementioned two seals. This trapped fluid may pose a problem for reengaging the safety joint downhole. During reengagement, the volume between the two seals may be reduced and the wellbore fluid may be compressed, creating what is referred to as a hydraulic lock. This fluid compression, or hydraulic lock, results in an internal reaction force that reduces the tightening of the connection as torque is applied to the safety joint. This reduced tightening of the connection could cause an operator to assume that the safety joint is safely made up to its required make-up torque, when it is not made up at all. Furthermore, the break-out torque required to disengage the connection may be reduced as well, and consequently the safety joint may accidentally disconnect.

Currently, a number of options exist that aim to solve the problem of hydraulic lock between the two seals. For example, one or both of the seals could be removed to prevent trapping and compressing wellbore fluids altogether when reengaging the safety joint. However, this approach has drawbacks. Removing both seals means that there is no way of preventing washout of the threads if there is pressurized wellbore fluid circulating in the work string. Removing just one of the seals would not result in washout, but the life of the threads would be reduced due to corrosion pitting caused by the wellbore fluid.

There is therefore a need for a safety joint designed in a manner that ensures its safe and proper reengagement in downhole environment.

SUMMARY

Certain exemplary embodiments can provide a downhole safety joint for use in a wellbore, comprising: a tubular pin end including a first portion having a first outer diameter, a second portion having a second outer diameter that is smaller than the first outer diameter, and an external thread formed between the first and second portions; a tubular box end including an internal thread configured to engage the external thread of the tubular pin end; a first seal

located adjacent the first portion; a second seal located adjacent the second portion, wherein the second seal is a moveable seal including a spring and a sealing member, wherein the spring is compressed in response to the sealing member moving away from the first seal; and a recess formed on the tubular pin end and adjacent to the second portion for housing the second seal.

Certain exemplary embodiments can provide a method of assembling a safety joint comprising: providing a tubular pin end including a first portion having a first outer diameter, a second portion having a second outer diameter that is smaller than the first diameter, and an external thread formed between the first and second portions; providing a tubular box end including an internal thread configured to engage the external thread of the tubular end pin; providing a first seal located adjacent the first portion; providing a second seal located adjacent the second portion, wherein the second seal is a moveable seal including a spring and a sealing member; assembling the first seal, the second seal on to the tubular pin end; coupling the tubular pin end and the tubular box end by torquing the tubular pin end into the tubular box end; and moving the sealing member in a recess formed on the tubular pin end away from the first seal while compressing the spring.

Certain exemplary embodiments can provide a downhole safety joint for use in a wellbore, comprising: a tubular pin end including a threaded portion, a first seal disposed on a first side of the threaded portion, and a second seal disposed on a second side of the threaded portion opposite to the first side, wherein the second seal is a moveable seal including a spring and a sealing member, wherein the spring is compressed in response to the sealing member moving away from the first seal; a tubular box end configured to engage the threaded portion of the tubular pin end; and a recess formed on the tubular pin end on the second side of the threaded portion for housing the second seal.

In one or more aspects, the present disclosure teaches a downhole safety joint for use in a wellbore, wherein the downhole safety joint comprises a tubular pin end. The tubular end includes a first portion (alternatively referred to herein as a first pin end portion) having a first outer diameter, a second portion (alternatively referred to herein as

a second pin end portion) having a second outer diameter that is smaller than the first diameter, and an external thread formed between the first and second pin end portions.

The downhole safety joint further comprises a tubular box end including an internal thread configured to engage the external thread of the tubular pin end, a first seal located adjacent the first pin end portion, and a second seal located adjacent the second pin end portion. The second seal is a movable seal including a spring and a sealing member. The spring may be adjacent to the sealing member. The sealing member may comprise an extrusion ring and an O-ring.

The downhole safety joint may further comprise a snap ring disposed between the sealing member and the spring. The downhole safety joint may further comprise a recess formed adjacent to the second pin end portion for housing the second seal. The spring may surround the recess. The downhole safety joint may further comprise a helical groove formed in the second pin end portion. The second pin end portion may include a retainer sleeve enclosing the sealing member and the spring. The downhole safety joint may further be configured such that the sealing member moves in a recess formed on the tubular pin end and compresses the spring to maintain a constant volume between the first seal and the second seal when the safety joint is assembled.

In one or more aspects, the present disclosure teaches a method of assembling a safety joint, wherein the method involves providing a tubular pin end including a first pin end portion having a first outer diameter, a second pin end portion having a second outer diameter that is smaller than the first diameter, and an external thread formed between the first and second pin end portions. The method further involves providing a tubular box end including an internal thread configured to engage the external thread of the tubular end pin. The method further involves providing a first seal located adjacent the first pin end portion. The method further involves providing a second seal located adjacent the second pin end portion, wherein the second seal is a movable seal including a spring and a sealing member. The method further involves assembling the first seal and the second seal onto the tubular pin end, and coupling the tubular pin end and the tubular box end by torquing the tubular pin end into the tubular box end. The method may further involve moving the sealing member in a recess formed on the tubular pin end while compressing

the spring. The method may further involve compressing the spring to maintain a constant volume between the first seal and the second seal when the safety joint is assembled.

In one or more aspects, the present disclosure teaches a downhole safety joint for use in a wellbore, wherein the downhole safety joint comprises a tubular pin end including a threaded portion, a first seal disposed on a first side of the threaded portion, and a second seal disposed on a second side of the threaded portion opposite to the first side, wherein the second seal is a movable seal including a spring and a sealing member. The downhole safety joint further comprises a tubular box end configured to engage the threaded portion of the tubular pin end. The downhole safety joint may further comprise a recess formed adjacent to the second pin end portion for housing the second seal. The spring may surround the recess. The downhole safety joint may further comprise a helical groove formed in the second pin end portion. The second pin end portion may include a retainer sleeve enclosing the sealing member and the spring. The spring may be adjacent to the sealing member. The sealing member may comprise an extrusion ring and an O-ring. The downhole safety joint may further comprise a snap ring disposed between the sealing member and the spring.

BRIEF DESCRIPTION OF THE DRAWINGS

It being understood that the Figures presented herein should not be deemed to limit or define the subject matter claimed herein, the present disclosure may be understood by reference to the following description taken in conjunction with the accompanying drawings, which are not necessarily drawn to scale, and in which:

FIGURE 1 is a sectional view of a safety joint representative according to one embodiment.

FIGURE 1A is a sectional view of a portion of the safety joint illustrated in FIG. 1.

FIGURE 2 is a schematic illustrating a movable seal that can compensate for volume reduction by allowing the seal to travel in a groove.

FIGURE 3 is an isometric view of a portion of a safety joint illustrating assembly of a movable seal.

FIGURE 4A is an exploded isometric view of a portion of a safety joint having a movable seal according to one embodiment.

FIGURE 4B is a partially-sectional isometric view of the portion of the safety joint shown in FIG. 4A illustrating the movable seal after assembly.

DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

Illustrative embodiments in accordance with the present disclosure are described below. In the interest of clarity, not all features of an actual implementation are described in this specification. The following detailed description of exemplary embodiments, read in conjunction with the accompanying drawings, is merely illustrative and is not to be taken as limiting the scope of the present disclosure. Rather, the scope of the present disclosure is defined by the appended claims and equivalents thereof. It will of course be appreciated that in the development of an actual embodiment, numerous implementation-specific decisions might need to be made to achieve design-specific goals, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort, while possibly complex and time-consuming, would nevertheless be a routine undertaking for persons of ordinary skill in the art having the benefit of this disclosure. Further aspects and advantages of the various embodiments in accordance with the present disclosure will become apparent from consideration of the following description and the drawings.

A safety joint according to the present disclosure may solve the aforementioned hydraulic lock problem. The safety joint may be designed such that the reduction of volume trapped between two seals is minimized by providing a movable seal.

Referring to FIG. 1, an embodiment of a safety joint **100** in accordance with the present disclosure comprises a first tubular sub having a pin end **20** and second tubular sub having a box end **50** that are coupled to each other using threads, such as coarse Acme threads, or modified Acme threads. As such, pin end **20** comprises a threaded

portion **25** configured to engage a corresponding threaded portion **55** in box end **50**. The first second tubular subs comprise threaded connectors for coupling the safety joint to a work string (not shown). When assembled as shown in FIG. 1, pin end **20** extends into box end **50**. A shoulder **82** of box end **50** abuts a shoulder **80** of pin end **20**.

Pin end **20** has a first pin end portion **22** having a first diameter, and a second pin end portion **24** having a second diameter. The first diameter may be greater than the second diameter. Second pin end portion **24** is axially offset from first pin end portion **22** so that threaded portion **25** is located axially between the first and second pin end portions. The first and second pin end portions are configured to engage the inner diameter of box end **50** and transmit bending loads between pin end **20** and box end **50**.

To avoid wash-out of the threads and the loss of fluid through safety joint **100**, a first seal **30** and a second seal **60** are installed on second pin end **24**, one on each side of threaded portion **25**. As pin end **20** is made up onto box end **50**, axial relative movement therebetween causes engagement of first seal **30** with an inner surface of box end **50**, followed by engagement of second seal **60**, before the threaded connection is fully made up and shoulder **80** on pin end **20** mates with shoulder **82** on box end **50**. First seal **30** may be located in or adjacent first pin end portion **22**, and second seal **60** may be located in or adjacent second pin end portion **24**. Thus, the sealing diameter of first seal **30** may be larger than the sealing diameter of second seal **60**.

When safety joint **100** is assembled on the surface, there is usually no wellbore fluid in the safety joint. As a result, there is usually no issue assembling safety joint **100** since there is no fluid trapped between first seal **30** and second seal **60**. However, when wellbore fluid is present, such as when safety joint **100** is reconnected downhole, there is a volume of fluid that is effectively trapped between the two seals as shown in FIG. 2. In safety joint **100**, second seal **60** is a movable seal that allows the volume of trapped wellbore fluid to remain constant (i.e., preventing a large increase in the pressure of wellbore fluid being trapped between the seals) as safety joint **100** is connected. This movable seal may allow safety joint **100** to reliably reconnect downhole. It should be noted that while second seal **60** is shown to be the movable seal in FIG. 1, other

embodiments may differ as long as at least one of first seal **30** and second seal **60** is a movable seal.

FIG. 1B shows a portion of safety joint **100** in more detail. Second seal **60** may comprise a spring **65** and a sealing member **67** disposed in and surrounding a recess **70** located in or adjacent to second pin end portion **24**. Recess **70** is formed sufficiently wide to permit axial movement of sealing member **67**. Sealing member **67** may comprise, for example, an O-ring and an anti-extrusion ring. Spring **65** may compress and allow sealing member **67** to move axially back and forth in recess **70**. However, a person of skill in the art would recognize that spring **65** may still perform its intended function if separated from sealing member **67** but still adjacent to it. Spring **65** may be used to maintain a constant or near-constant volume of fluid trapped between first seal **30** and second seal **60**. For example, as shown in FIG. 1A, wellbore fluid may apply a pressure on sealing member **67** and push it away from a shoulder **75** of recess **70**. When the pressure in the fluid pressure is released, spring **65** may push sealing member **67** back against the shoulder **75**. As safety joint **100** is disassembled, spring **65** applies a reactionary force on the movable seal and may push it back to its original location.

As illustrated in FIG. 2, when safety joint **100** is assembled, right-hand torque or rotation causes pin end **20** to move axially into box end **50**. As pin end **20** is inserted into box end **50**, first seal **30** is engaged. With the continued axial movement, second seal **60** is also engaged, thereby trapping a volume of compressed fluid or gas inside. As pin end **20** further moves axially into box end **50** by a distance **d**, until engagement of shoulders **80** and **82**, the volume of fluid **V0** trapped between the two seal surfaces is displaced. The displaced volume **V1** is compensated for by a volume **V2** added by the movement of second seal **60**; i.e., by the compression of spring **65** and the retraction of sealing member **67** away from shoulder **75** of recess **70**. This volume compensation results in minimal pressure increase of the wellbore fluid trapped between first seal **30** and second seal **60**. Thus hydraulic lock may be prevented. At this final position illustrated in FIG. 2, sealing member **67** no longer moves, and is held in place with a balance of the spring force and the internal pressure. Conversely, as safety joint **100** is disassembled, the force applied

by spring **65** to sealing member **67** may extend sealing member **67** back to its original location against shoulder **75** in recess **70**.

An embodiment of safety joint **100**, and in particular of second pin end portion **24** and second seal **60**, is illustrated in FIG. 3. In the embodiment of FIG. 3, second seal **60** includes an optional snap ring **68** to distribute the load of spring **65** uniformly on sealing member **67**. Spring **65** is installed onto recess **70**, through a helical groove **85** formed in second pin end portion **24**. Helical groove **85** serves as a pathway allowing the installation of spring **65** into recess **70**. Such a design (i.e., helical groove **85** being formed in second pin end portion **24** of safety joint **100**) may permit pin end **20** to be made as a unitary body, while preserving some bending support between pin end **20** and box end **50** with two pin end portions.

Helical groove **85** may be specifically sized to allow spring **65** to pass through at least a portion of second pin end portion **24** without having to excessively enlarge spring **65**. Thus, helical groove **85** may help to minimize the risk of damaging spring **65** during installation.

As shown in FIGS. 4A and 4B, an alternative embodiment of safety joint **100** includes a second pin end portion **24** made of two pieces that allow sealing member **67** and spring **65** of second seal **60** to be disposed in, and to surround, recess **70**. A retainer sleeve **89** then encloses second seal **60** in recess **70**. As shown in FIGS. 4A and 4B, a distal end of pin end **20** is provided with a receiving portion **88** onto which retainer sleeve **89** may be press-fitted, threaded, welded or otherwise coupled to pin end **20**. Radial support between pin end **20** and box end **50** is provided through retainer sleeve **89**, which forms part of second pin end portion **24**.

In view of the foregoing and the appended Figures, those skilled in the art will recognize that some aspects of the present disclosure pertain to a safety joint that may be disconnected and properly reconnected under downhole environment without the formation of a hydraulic lock. Some aspects of the present disclosure pertain to the inclusion of a movable seal in the safety joint to ensure disconnection and correct reengagement of the safety joint in downhole environment by allowing the volume

trapped between two seals to be maintained rather than reduced as prior designs do, thereby preventing the formation of a hydraulic lock. In accordance with the present disclosure, the safety joint has a movable seal comprising a sealing member and a spring. In an embodiment, the sealing member includes an O-ring seal.

Some aspects of the present disclosure further pertain to a downhole safety joint for use in a wellbore comprising a tubular pin end including a first pin end portion having a first outer diameter, and a second pin end portion having a second outer diameter. The second diameter may be smaller than the first diameter. An external thread may be located between the first and second pin end portions. The downhole safety joint may further comprise a tubular box end having an internal thread configured to engage the external thread of the tubular pin end. The downhole safety joint may further comprise a first seal and a second seal located on each side of the external thread. At least one of the first and second seals is a movable seal having a spring adjacent to a sealing member.

In an embodiment, the spring is adjacent to the sealing member. In alternative embodiments, a snap ring may be added between the spring and the sealing member to help distribute the load on the sealing member. The downhole safety joint may be further configured such that the spring compresses to maintain a constant volume between the first seal and the second seal when the tubular pin end and tubular box end are assembled downhole, or in presence of wellbore fluid. The downhole safety joint may avoid hydraulic lock during connection.

In an embodiment in accordance with the present disclosure, the safety joint is configured such that when the tubular pin end and the tubular box end are engaged, the movable seal is displaced and held in place by the spring. In a further embodiment, the tubular pin end includes a recess that houses the second seal. The spring may surround at least part of the recess. In a further embodiment, the movable seal may comprise an extrusion ring or a snap ring.

Some aspects of the present disclosure also pertain to a method for assembling a safety joint involving providing a tubular pin end including a first pin end portion having a first diameter and a second pin end portion having a second diameter, such that the

second diameter is smaller than the first diameter, and wherein the second pin end portion comprises an external thread. The method further involves providing a tubular box end comprising an internal thread configured to engage the external thread of the tubular pin end. The method further involves providing a first seal located on a first side of the external thread, providing a second seal located on a second side of the external thread opposite to the first side of the external thread, and providing a spring adjacent the second seal. The method further involves assembling the first seal, the second seal, and the spring on the tubular pin end, and engaging the tubular pin end and the tubular box end by threading.

In an embodiment, the tubular pin end is formed as a unitary body, and the installation of the spring of the movable seal is performed by rotating the spring in a helical groove such that the spring passes into the groove into its final placement location. In another embodiment, the tubular pin end is formed as a two-piece system that allows the spring and the sealing member of the movable seal to be inserted first into a recess followed by the mating of a retainer sleeve to enclose the movable seal. In an embodiment of the method for assembling the safety joint, the pin and the box ends are configured such that when the pin and the box ends are engaged, the movable seal is displaced against the spring.

Some aspects of the present disclosure also pertain to a movable seal for use in safety joint wherein the movable seal comprises an O-ring seal and a spring. The movable seal is movable in a groove in the safety joint such that a volume trapped by the movable seal is kept constant when the safety joint is assembled in an environment where wellbore fluid or other fluid is present.

It will be understood by one of ordinary skill in the art that in general any subset or all of the various embodiments and inventive features described herein may be combined, notwithstanding the fact that the claims set forth only a limited number of such combinations. For example, while embodiments of a movable seal implemented on a pin end have been described, the movable seal may be implemented on a box end instead.

What is claimed is:

1. A downhole safety joint for use in a wellbore, comprising:

a tubular pin end including a first portion having a first outer diameter, a second portion having a second outer diameter that is smaller than the first outer diameter, and an external thread formed between the first and second portions;

a tubular box end including an internal thread configured to engage the external thread of the tubular pin end;

a first seal located adjacent the first portion;

a second seal located adjacent the second portion, wherein the second seal is a moveable seal including a spring and a sealing member, wherein the spring is compressed in response to the sealing member moving away from the first seal; and

a recess formed on the tubular pin end and adjacent to the second portion for housing the second seal.

2. The downhole safety joint of claim 1, wherein the spring is adjacent to the sealing member.

3. The downhole safety joint of claim 1, wherein the sealing member comprises an extrusion ring and an O-ring.

4. The downhole safety joint of claim 1, further comprising a snap-ring disposed between the sealing member and the spring.

5. The downhole safety joint of claim 1, wherein the spring surrounds the recess.

6. The downhole safety joint of claim 1, further comprising a helical groove formed in the second portion.

7. The downhole safety joint of claim 1, wherein the second portion includes a retainer sleeve enclosing the sealing member and the spring.

8. A method of assembling a safety joint comprising:

providing a tubular pin end including a first portion having a first outer diameter, a second portion having a second outer diameter that is smaller than the first diameter, and an external thread formed between the first and second portions;

providing a tubular box end including an internal thread configured to engage the external thread of the tubular end pin;

providing a first seal located adjacent the first portion;

providing a second seal located adjacent the second portion, wherein the second seal is a moveable seal including a spring and a sealing member;

assembling the first seal, the second seal on to the tubular pin end;

coupling the tubular pin end and the tubular box end by torquing the tubular pin end into the tubular box end; and

moving the sealing member in a recess formed on the tubular pin end away from the first seal while compressing the spring.

9. The method of claim 8, further comprising compressing the spring to maintain a constant volume between the first seal and the second seal when the safety joint is assembled.

10. A downhole safety joint for use in a wellbore, comprising:

a tubular pin end including a threaded portion, a first seal disposed on a first side of the threaded portion, and a second seal disposed on a second side of the threaded portion opposite to the first side, wherein the second seal is a moveable seal including a spring and a sealing member, wherein the spring is compressed in response to the sealing member moving away from the first seal;

a tubular box end configured to engage the threaded portion of the tubular pin end; and

a recess formed on the tubular pin end on the second side of the threaded portion for housing the second seal.

11. The downhole safety joint of claim 10, wherein the spring surrounds the recess.

12. The downhole safety joint of claim 10, further comprising a helical groove formed on the second side of the threaded portion.

13. The downhole safety joint of claim 10, wherein the second side of the threaded portion includes a retainer sleeve enclosing the sealing member and the spring.

14. The downhole safety joint of claim 10, wherein the spring is adjacent to the sealing member.

15. The downhole safety joint of claim 10, wherein the sealing member comprises an extrusion ring and an O-ring.

16. The downhole safety joint of claim 10, further comprising a snap-ring disposed between the sealing member and the spring.

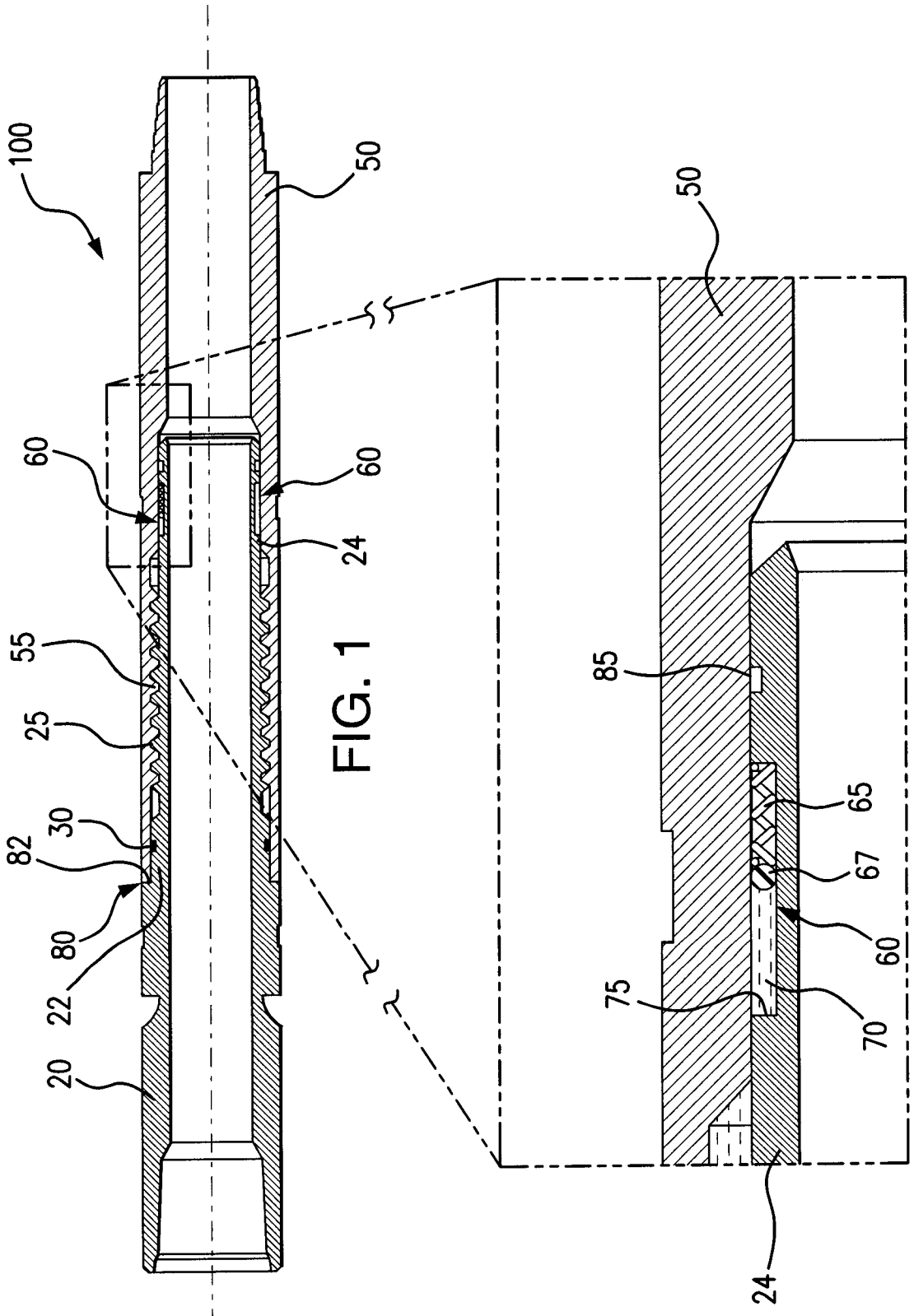


FIG. 1

FIG. 1A

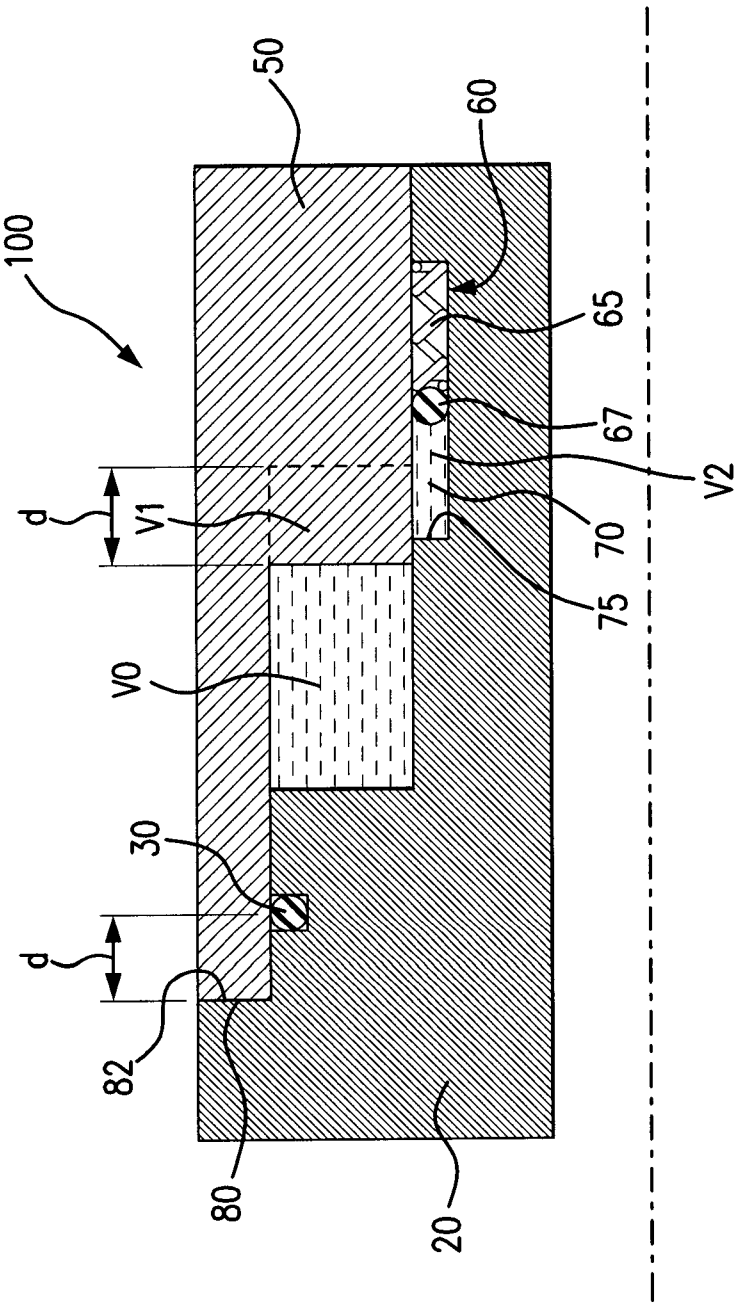


FIG. 2

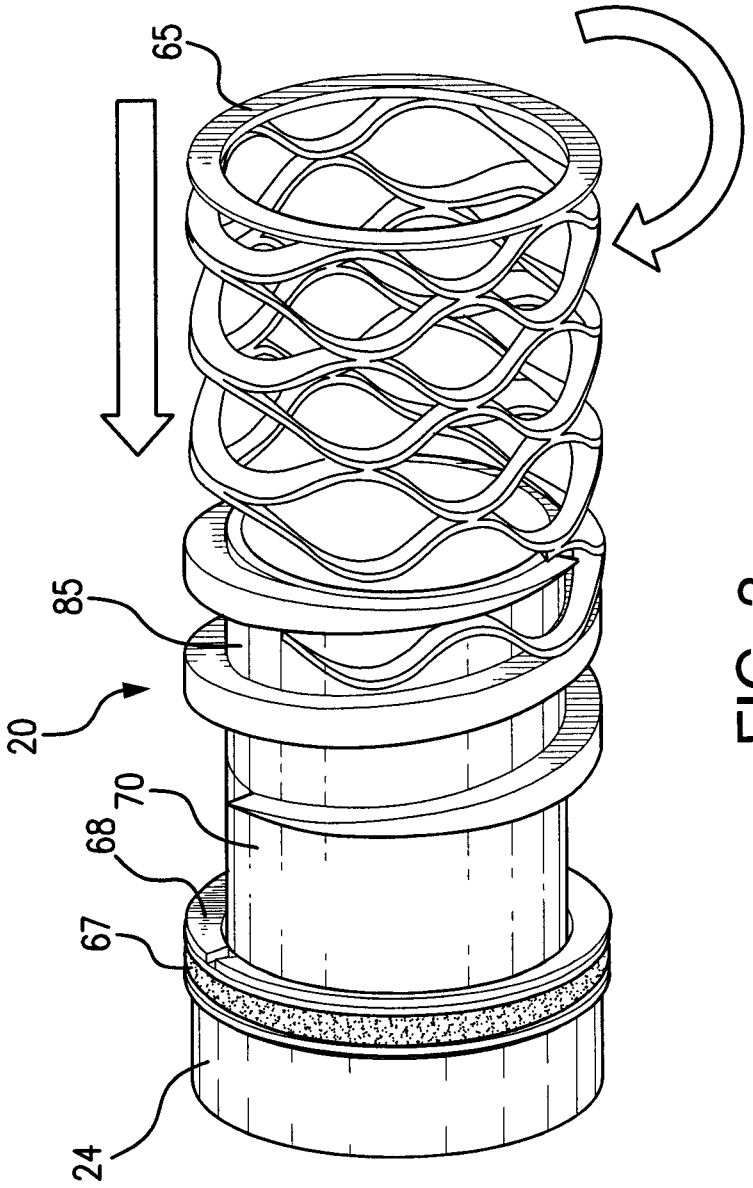


FIG. 3

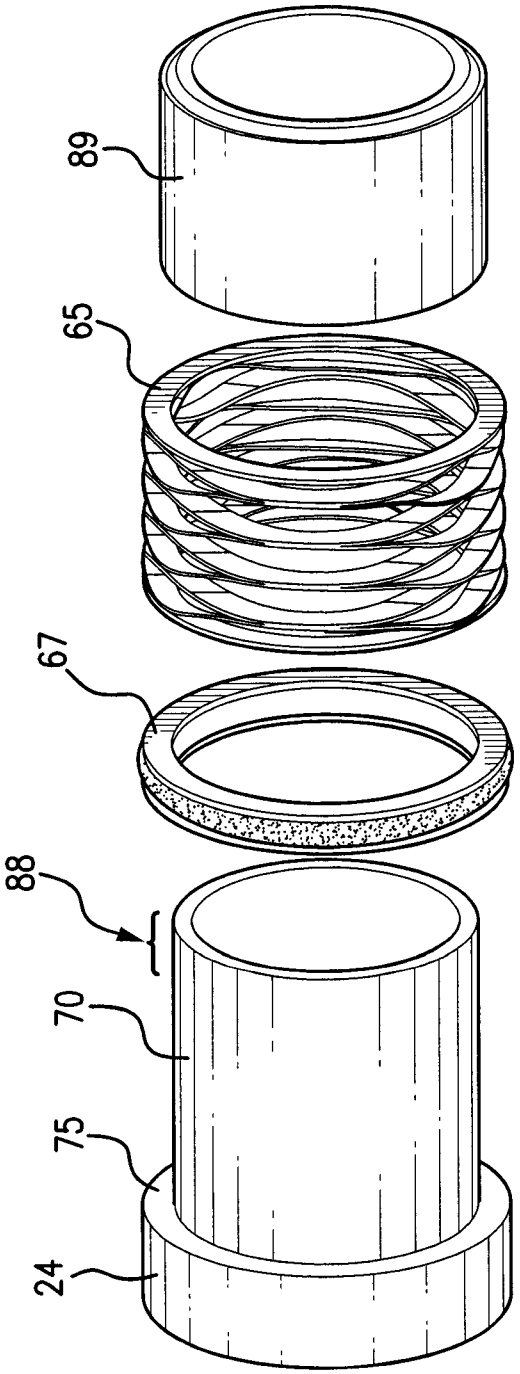


FIG. 4A

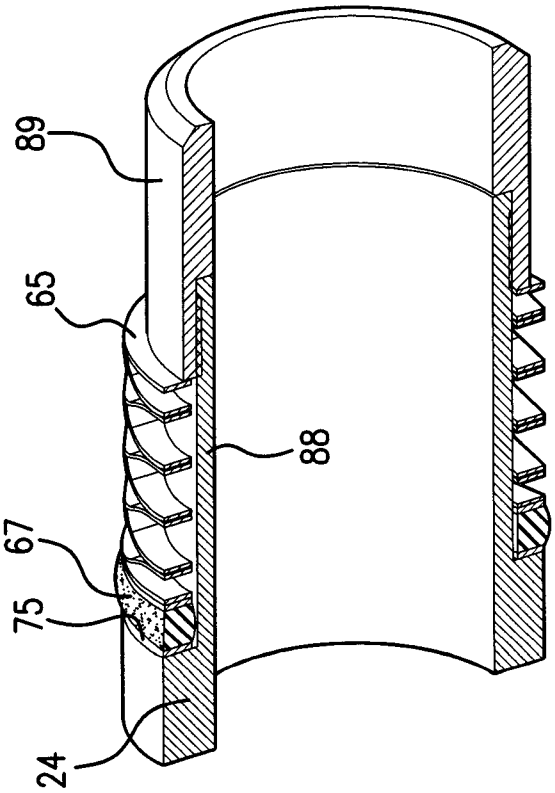
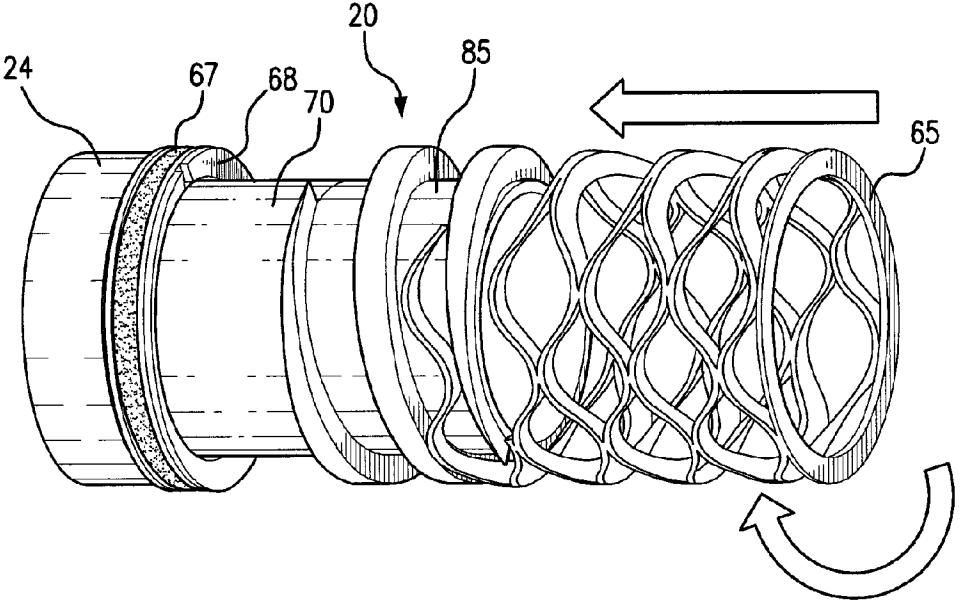


FIG. 4B


20
24
67
68
70
85
65