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(54) **SLIP JOINT FOR DOWNHOLE TUBING**

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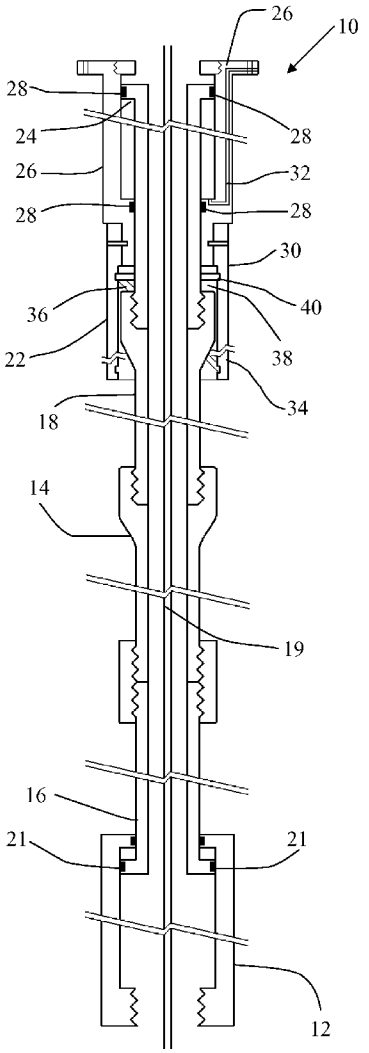
(57) **ABSTRACT**

A movable downhole tubing string for a downhole well. The well has a wellhead and a downhole pump. The movable downhole tubing string has a movable tubing string having a surface end adjacent to the wellhead and a pump end adjacent to the downhole pump. At least one of the surface end and the pump end is telescopically received within a stationary tubing section. The stationary tubing section is stationary relative to the wellhead. There is an actuator for telescopically moving the movable tubing string relative to the stationary tubing section.



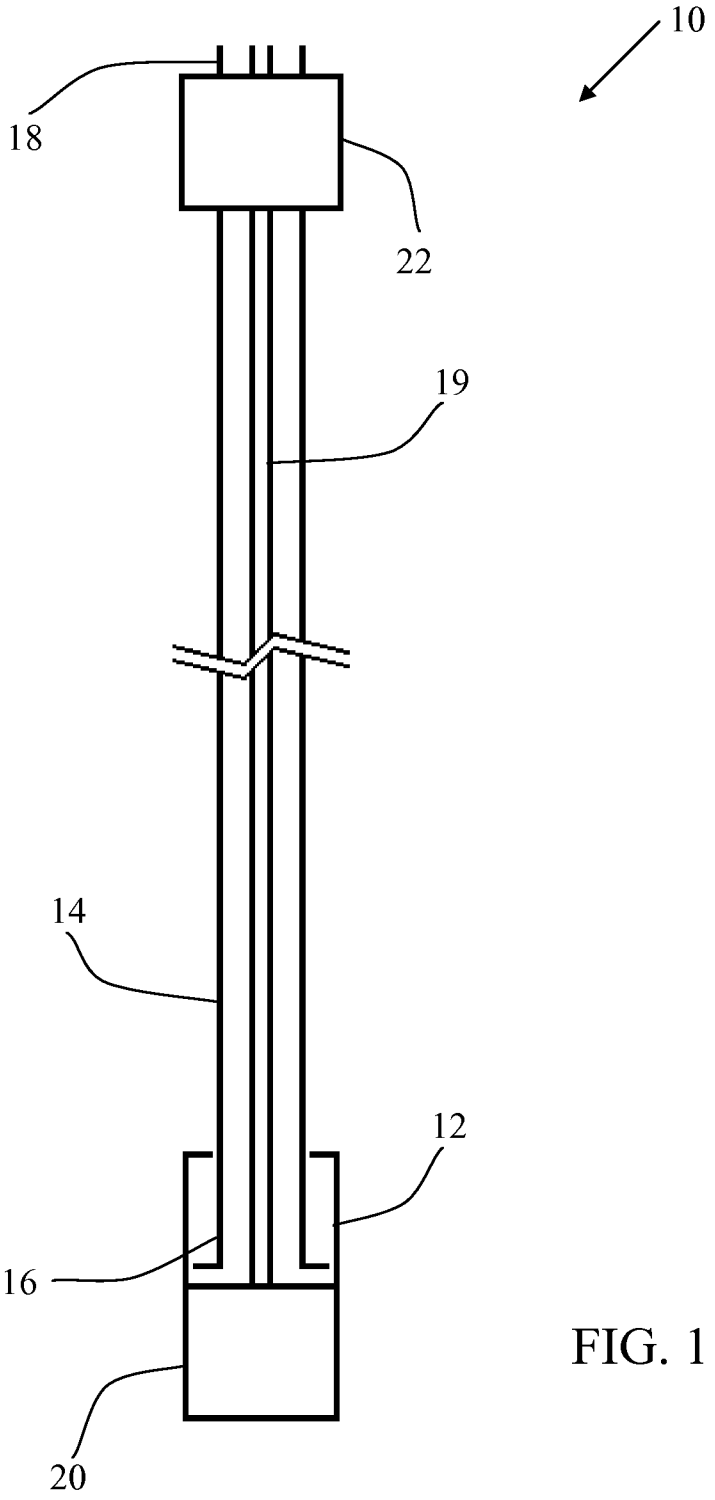


FIG. 1

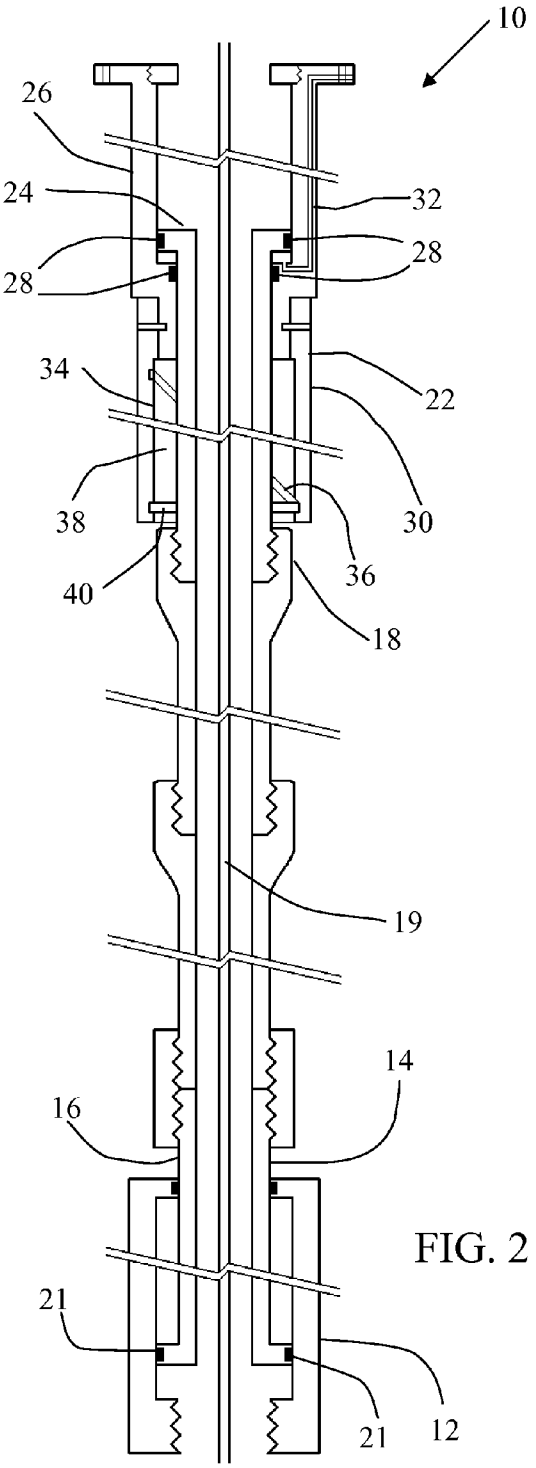

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FIG. 2

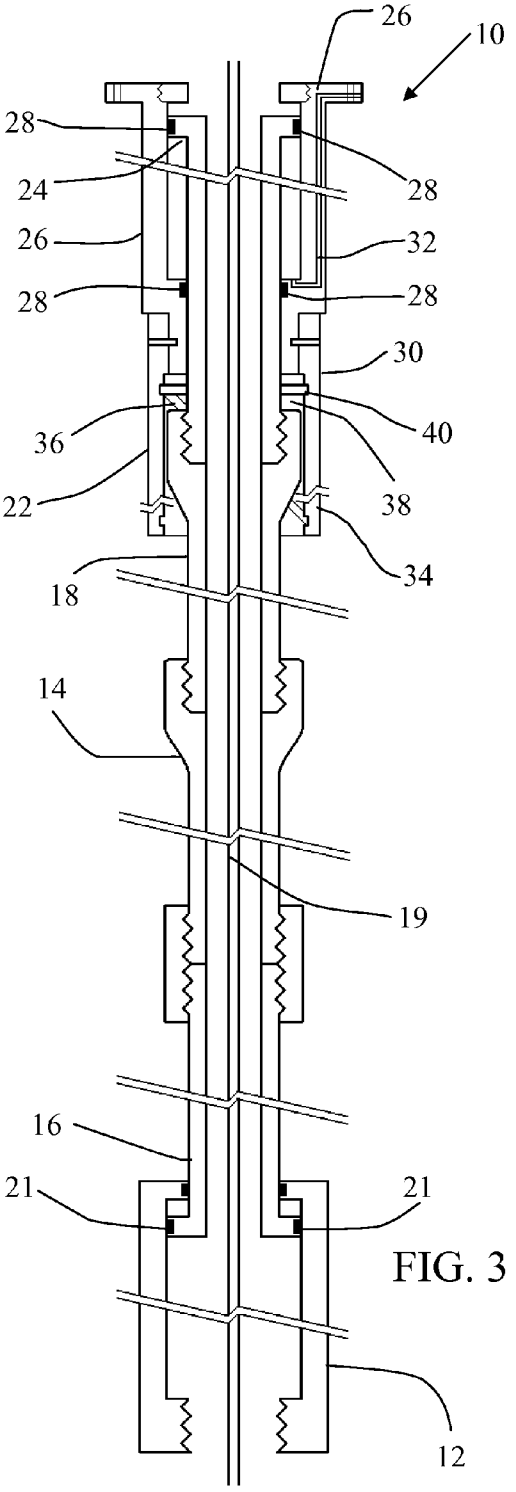
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FIG. 3

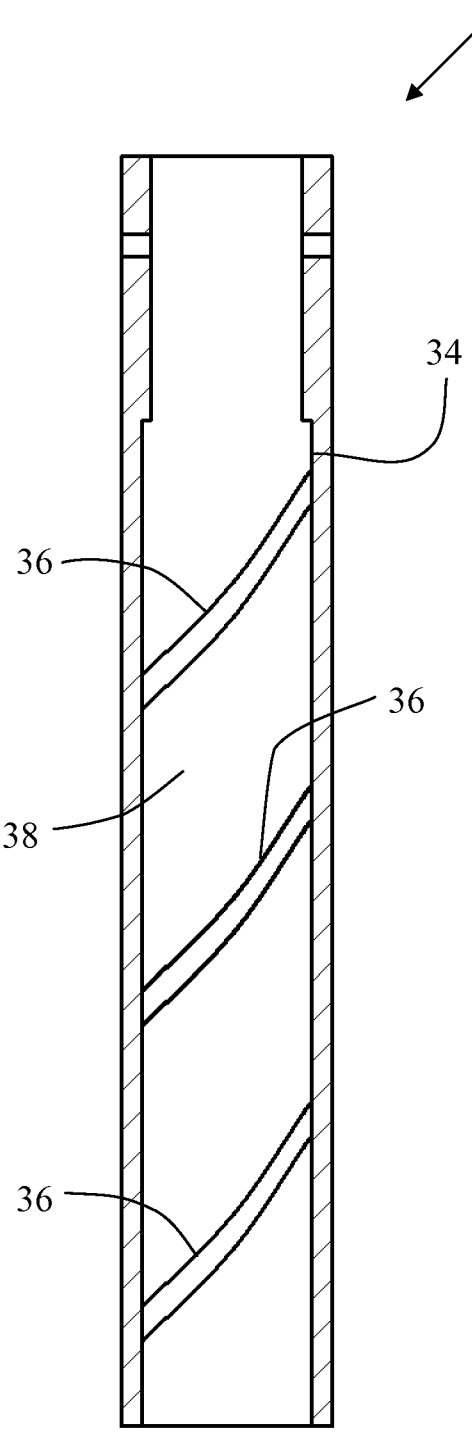

FIG. 4

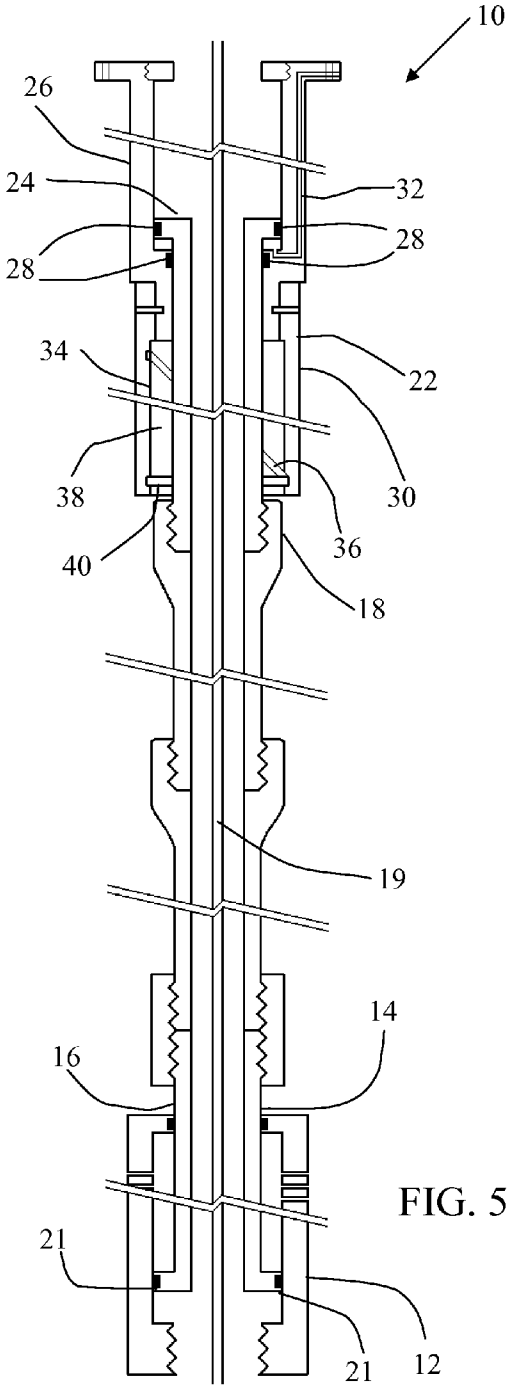
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FIG. 5

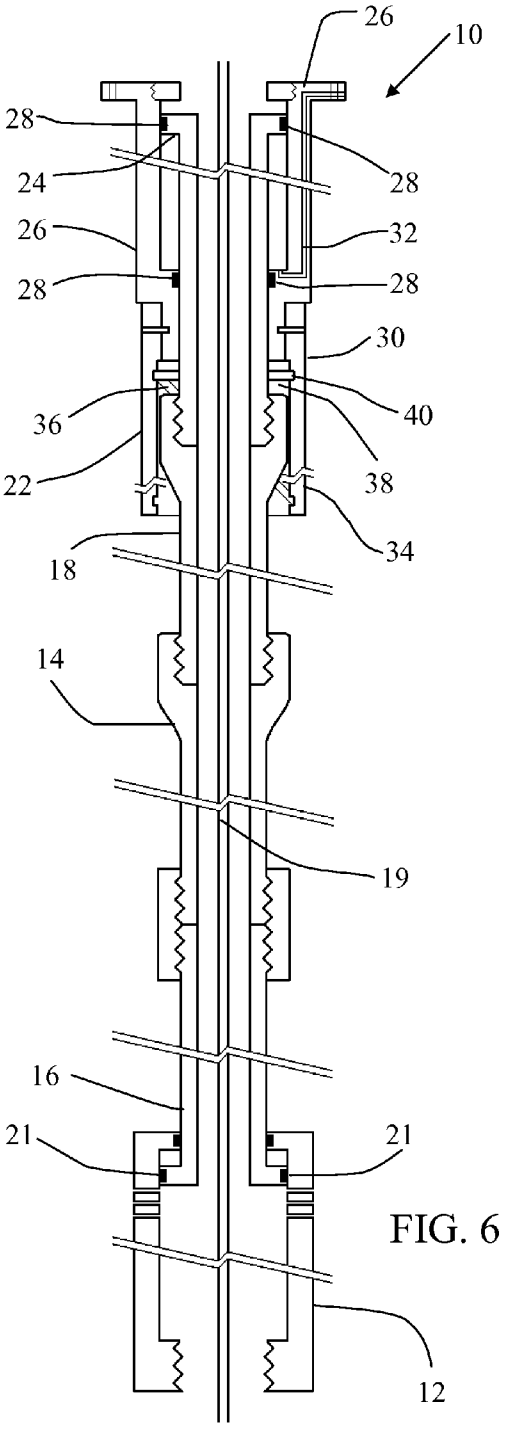
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FIG. 6

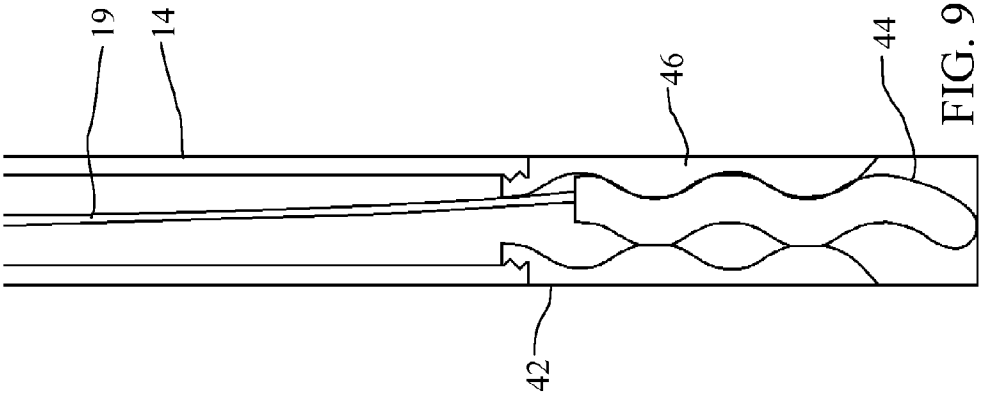

FIG. 9

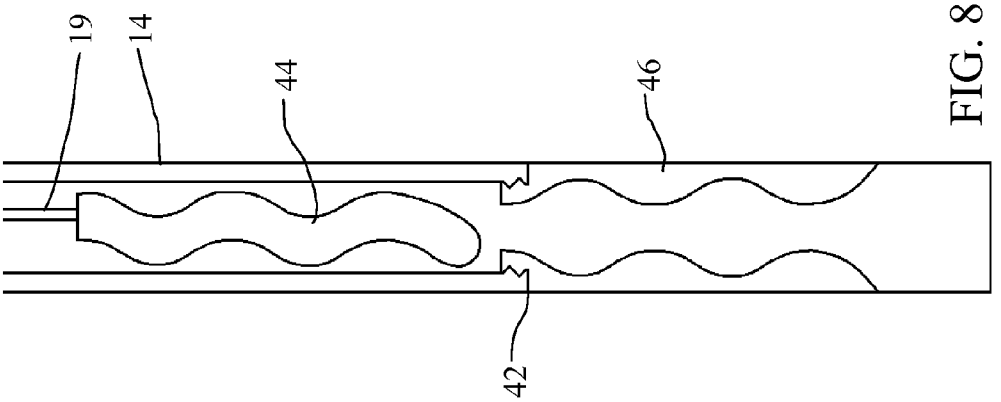

FIG. 8

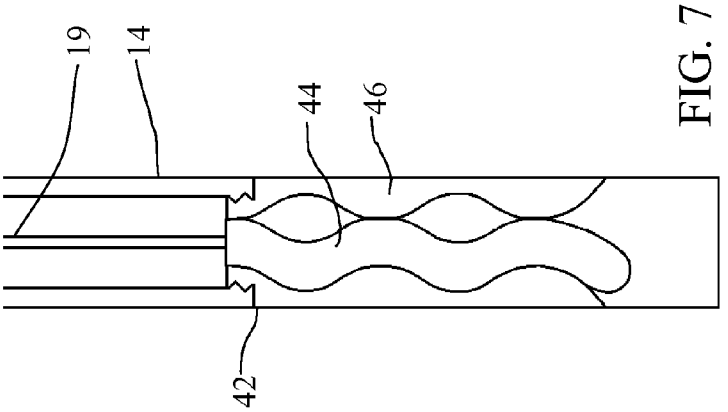

FIG. 7

SLIP JOINT FOR DOWNHOLE TUBING

FIELD

[0001] This disclosure relates to a slip joint for a downhole tubing string that allows the downhole tubing to be moved relative to a stationary tubing section.

BACKGROUND

[0002] As pumps are used downhole to produce wellbore fluids, the pump and its components, such as a sucker rod, move through repetitive, reciprocal, or rotary motions. This can cause wear in the tubing in which they are placed, and may result in a hole in the tubing. Tubing must be serviced regularly to repair or replace any sections of tubing that are damaged.

SUMMARY

[0003] According to an aspect, there is provided a movable downhole tubing string for a downhole well, the well having a wellhead and a downhole pump. The movable downhole tubing string comprises a movable tubing string having a surface end adjacent to the wellhead and a pump end adjacent to the downhole pump, at least one of the surface end and the pump end being telescopically received within a stationary tubing section. The stationary tubing section is stationary relative to the wellhead. There is an actuator for telescopically moving the movable tubing string relative to the stationary tubing section.

[0004] According to another aspect, the movable downhole tubing string may further comprise a rotator that rotates the movable tubing string as it moves relative to the stationary tubing section. The rotator may comprise a sleeve having a position that is fixed relative to the stationary tubing section, the sleeve having at least one groove that defines a spiral, each of the at least one groove being engaged by a pin that is carried by the movable tubing string, the pin travelling along the groove as the movable tubing string moves between the retracted position and the extended position.

[0005] According to another aspect, the actuator may comprise a hydraulic actuator or a mechanical actuator.

[0006] According to another aspect, the actuator may comprise a piston actuator formed by the movable tubing string and the stationary tubing section at at least one of the surface end and the pump end.

[0007] According to another aspect, the stationary tubing section may be at the surface end of the movable tubing string.

[0008] According to another aspect, the movable downhole tubing string may comprise a stationary tubing section at the surface end and at the downhole end of the movable tubing string. The stationary tubing section at the downhole end of the movable tubing string may comprise flow apertures, the flow apertures being selectively opened by movement of the movable tubing string.

[0009] According to another aspect, the downhole pump may be a progressive cavity pump comprising a rotor and a stator and the downhole end of the movable tubing string is attached to the rotor of the progressive cavity pump. The movable tubing string may move the stator up or down relative to the rotor.

[0010] According to an aspect, there is provided, in combination: a wellhead; a first stationary tubing section rigidly connected to the wellhead; a movable tubing string having a surface end and a pump end, the surface end being telescopically received within the first stationary tubing section; an actuator for telescopically moving the movable tubing string relative to the first stationary tubing section; a downhole pump adjacent to the pump end of the movable tubing string; and a pump drive string extending through the movable tubing string between the wellhead and the downhole pump.

[0011] According to another aspect, there may further comprise a rotator that rotates the movable tubing string as it is moves telescopically relative to the first stationary tubing section. The rotator may comprise a sleeve having a position that is fixed relative to the stationary tubing section, the sleeve having at least one groove that defines a spiral, each of the at least one groove being engaged by a pin that is carried by the movable tubing string, the pin travelling along the groove as the movable tubing string moves between the refracted position and the extended position.

[0012] According to another aspect, the actuator may comprises a piston actuator formed by the movable tubing string and the first stationary tubing section.

[0013] According to another aspect, there may further comprise a second stationary tubing section at the downhole end of the movable tubing string, the downhole pump being rigidly connected to the second stationary tubing section. The stationary tubing section at the downhole end of the movable tubing string may comprise flow apertures, the flow apertures being selectively opened by movement of the movable tubing string.

[0014] According to another aspect, the downhole pump may be a progressive cavity pump comprising a rotor and a stator and the downhole end of the movable tubing string is attached to the rotor of the progressive cavity pump. The movable tubing string may move the stator at least one of down relative to the rotor or up relative to the rotor.

[0015] According to another aspect, the actuator may comprise a hydraulic actuator and the tubing string may further comprise a piston mounted at an upper end of the movable tubing string.

[0016] According to an aspect, there is provided a method of operating a downhole pump, comprising the steps of: providing a tubing string having a stationary tubing section and a movable tubing string telescopically received within the stationary tubing section; attaching a downhole pump to the stationary tubing section of the tubing string and attaching a pump drive string to the downhole pump; inserting the tubing string into a producing wellbore; driving the pump using the pump drive string; and telescopically moving the movable tubing string of the tubing string relative to the stationary tubing section to distribute the wear on the movable tubing string incurred by the pump drive string along the movable tubing string.

[0017] According to another aspect, moving the movable tubing string may further comprise rotating the movable tubing string as it moves between the extended position and the refracted position.

BRIEF DESCRIPTION OF THE DRAWINGS

[0018] These and other features will become more apparent from the following description in which reference is made to the appended drawings, the drawings being for the purpose of illustration only and are not intended to be in any way limiting, wherein:

[0019] FIG. **1** is a side elevation schematic view of a slip joint for downhole tubing;

[0020] FIG. **2** is a side elevation view in section of a tubing string in a refracted position;

[0021] FIG. **3** is a side elevation view in section of a tubing string in an extended position;

[0022] FIG. **4** is a side elevation view in section of a rotator sleeve;

[0023] FIG. **5** is a side elevation view in section of an alternative tubing string in a retracted position;

[0024] FIG. **6** is a side elevation view in section of an alternative tubing string in an extended position;

[0025] FIG. **7** is a detailed side elevation view in section of an alternative tubing string attached to a downhole pump;

[0026] FIG. **8** is a detailed side elevation view in section of the alternative tubing string of FIG. **7** with the stator lowered; and

[0027] FIG. **9** is a detailed side elevation view in section of the alternative tubing string of FIG. **7** with the stator raised.

DETAILED DESCRIPTION

[0028] Referring to FIG. **1**, there is shown a movable downhole tubing string, generally indicated by reference numeral **10**, which includes a stationary tubing section **12** and a movable tubing string **14** that is telescopically received within stationary tubing section **12**. Stationary tubing section **12** may be positioned at a pump end **16** of movable tubing string **14**, at a surface end **18** of movable tubing string **14** or both. Movable tubing string **14** extends between surface end **18** and pump end **16**. The various sections of tubing that are described herein may be any length although 30 ft sections are commonly used in industry. It will be understood that the various components may not be the same length. However, it is preferred that the movement cover an entire length of a section of tubing, for reasons that will be apparent from the discussion below.

[0029] Stationary tubing section **12** is designed to be attached to a pump **20**. This attachment may be done in various ways, depending on the type of pump being used, as will be recognized by those skilled in the art. Stationary tubing section **12** may be anchored to the wellbore directly, or pump **20** may be anchored downhole to ensure stationary tubing section **12** remains stationary. A pump drive string **19**, such as a sucker rod string, extends from surface down through movable tubing string **14** and stationary tubing section **12** to engage and drive pump **20**. Pump **20** may be a rotary pump or a reciprocating pump. By way of example, FIG. **7** depicts rod string **19** connected to a progressive cavity pump **42**, which has a rotor **44** and a stator **46**.

[0030] Referring to FIG. **2**, movable tubing string **14** is preferably made up of sections of tubing string that are commonly used in the industry. The main differences between movable tubing string **14** and a traditional tubing string will be found at the pump end **16** and the surface end **18**, as will be described below.

[0031] Referring again to FIG. **1**, there is also an actuator **22** that telescopically moves movable tubing string **14** relative to stationary tubing section **12**. In the example described below, the movement of movable tubing string **14** will be from a refracted position to an extended position relative to stationary tubing section **12**. However, it will be understood that the movement could also be from an extended position to a refracted position, or from an intermediate position to either an extended or refracted position. Referring to FIG. **2**, seals **21** are provided between movable tubing string **14** and stationary tubing section **12**, however these are intended primarily to prevent debris and unwanted material from entering the mechanism while movable tubing string **14** is kept stationary. As will be understood, it is necessary for any fluid between these seals to escape, or for fluid to be drawn in, as the components move, and either seals **21** must be designed accordingly or another egress must be provided. In one example, the space between movable tubing string **14** and stationary tubing section **12** may be filled with hydraulic oil prior to installation. As movable tubing string **14** is moved upward relative to stationary tubing section **12**, the hydraulic oil is pushed out through seals **21**, which helps lubricate the movement.

[0032] Referring to FIG. **2**, actuator **22** may be a hydraulic actuator. In the depicted example, movable tubing string **14** includes a piston **24** that is received within a second stationary tubing section **26**, and sealed together by seals **28**. A hydraulic line **32** communicates hydraulic fluid below piston **24**, causing it to move upward and lift movable tubing string **14**. It will be understood that, if movable tubing string **14** is designed to move downward instead, the hydraulic force must be adjusted accordingly. If the weight of movable tubing string **14** is sufficient, it may be sufficient to remove hydraulic fluid from below piston **24** and allow it to descend based on gravity alone. Otherwise, it may be necessary to push downward on piston **24**.

[0033] In other examples, other types of actuators **22** may also be used. For example, actuator **22** may be mechanically driven, such as by gears or cables as will be recognized by those skilled in the art. Furthermore, it may be convenient to incorporate second stationary tubing section **26** into a wellhead.

[0034] Referring now to FIGS. **2** and **3**, tubing string **10** may be moved in order to distribute the wear and extend the life of tubing string **10**. In order to enhance this, tubing string may also have a rotator **30** that causes movable tubing string **14** to rotate as it is being raised. As depicted, rotator **30** is a section of tubing that rotates the movable tubing string as it is moves between the extended position and the retracted position.

[0035] The depicted rotator **30** is made up of a sleeve **34** that is attached to second stationary tubing section **26** and is stationary as movable portion **14** is received within sleeve **34**. The actual position of rotator sleeve **34** may be varied, provided that it is fixed relative to stationary tubing section **12**. Referring to FIG. **4**, sleeve **34** has grooves **36** along an inner surface **38** that define a spiral. In one example, two grooves that are offset by 180 degrees may be used, although there may be one or more than two grooves. Referring to FIGS. **2** and **3**, pins **40** mounted to movable tubing string **14** engage grooves **36**. As movable tubing string **14** is moved up or down, pins **40** travel along grooves **36** and apply a rotary force to movable tubing string **14**, causing it to rotate. It will be understood that other types of rotators may also be used.

[0036] Once installed, pump **20** is driven as is known in the art. Pump **20** is driven by either rotating or reciprocating drive string **19**. As this occurs, drive string **19** will create wear on the inside of tubing string **10**. In order to delay replacement or repair of tubing string **10**, actuator **22** may be actuated to cause movable tubing string **14** to move relative to stationary tubing section **12**. As movable tubing string **14** moves telescopically and rotationally, the wear due to either a rotating string **19**, which is generally localized at one position along tubing string **10**, and a reciprocating string **19**, which is generally localized at one radial position of tubing string **10**, is

distributed, thus increasing the useful life of tubing string **10**, or the time between servicing.

[0037] In other embodiments, movable tubing string **14** may be moved in order to flush the downhole pump. Referring to FIGS. **5** and **6**, stationary tubing section **12** may have perforations **48** or other types of flow openings that are accessible by moving movable tubing string **14**. As shown, when movable tubing string **14** is raised, perforations **48** are exposed, allowing fluid to be circulated down through movable tubing string **14** in order to flush above the pump.

[0038] Referring now to FIGS. **7** through **9**, an example is shown in which there is no stationary tubing section **12** at the pump end of movable tubing string **14**. Instead, movable tubing string **14** is attached to stator **46** while rod string **19** is attached to rotor **44**. As movable tubing string **14** moves, rod string **19** remains at a fixed length, allowing stator **46** to either be lowered below rotor **44** as shown in FIG. **8**, for example to allow pump **42** to be flushed, or lifted above rotor **44** as shown in FIG. **9**, for example to tap the bottom of stator **46** in order to alleviate gas lock in pump **42**.

[0039] In this document, the word "comprising" is used in its non-limiting sense to mean that items following the word are included, but items not specifically mentioned are not excluded. A reference to an element by the indefinite article "a" does not exclude the possibility that more than one of the element is present, unless the context clearly requires that there be one and only one of the elements.

[0040] The following claims are to be understood to include what is specifically illustrated and described above, what is conceptually equivalent, and what can be obviously substituted. The scope of the claims should not be limited by the preferred embodiments set forth in the examples, but should be given the broadest interpretation consistent with the description as a whole.

What is claimed is:

1. A movable downhole tubing string for a downhole well, the well having a wellhead and a downhole pump, the movable downhole tubing string comprising:

a movable tubing string having a surface end adjacent to the wellhead and a pump end adjacent to the downhole pump, at least one of the surface end and the pump end being telescopically received within a stationary tubing section, the stationary tubing section being stationary relative to the wellhead; and

an actuator for telescopically moving the movable tubing string relative to the stationary tubing section.

2. The movable downhole tubing string of claim **1**, further comprising a rotator that rotates the movable tubing string as it moves relative to the stationary tubing section.

3. The movable downhole tubing string of claim **2**, wherein the rotator comprises a sleeve having a position that is fixed relative to the stationary tubing section, the sleeve having at least one groove that defines a spiral, each of the at least one groove being engaged by a pin that is carried by the movable tubing string, the pin travelling along the groove as the movable tubing string moves between the retracted position and the extended position.

4. The movable downhole tubing string of claim **1**, wherein the actuator comprises a hydraulic actuator or a mechanical actuator.

5. The movable downhole tubing string of claim **1**, wherein the actuator comprises a piston actuator formed by the movable tubing string and the stationary tubing section at at least one of the surface end and the pump end.

6. The movable downhole tubing string of claim **1**, wherein the stationary tubing section is at the surface end of the movable tubing string.

7. The movable downhole tubing string of claim **1**, comprising a stationary tubing section at the surface end and at the downhole end of the movable tubing string.

8. The movable downhole tubing string of claim **7**, wherein the stationary tubing section at the downhole end of the movable tubing string comprises flow apertures, the flow apertures being selectively opened by movement of the movable tubing string.

9. The movable downhole tubing string of claim **1**, wherein the downhole pump is a progressive cavity pump comprising a rotor and a stator and the downhole end of the movable tubing string is attached to the rotor of the progressive cavity pump.

10. The movable downhole tubing string of claim **9**, wherein the movable tubing string moves the stator at least one of up and down relative to the rotor.

11. In combination:

a wellhead;

a first stationary tubing section rigidly connected to the wellhead;

a movable tubing string having a surface end and a pump end, the surface end being telescopically received within the first stationary tubing section;

an actuator for telescopically moving the movable tubing string relative to the first stationary tubing section;

a downhole pump adjacent to the pump end of the movable tubing string; and

a pump drive string extending through the movable tubing string between the wellhead and the downhole pump.

12. The combination of claim **11**, further comprising a rotator that rotates the movable tubing string as it is moves telescopically relative to the first stationary tubing section.

13. The combination of claim **12**, wherein the rotator comprises a sleeve having a position that is fixed relative to the stationary tubing section, the sleeve having at least one groove that defines a spiral, each of the at least one groove being engaged by a pin that is carried by the movable tubing string, the pin travelling along the groove as the movable tubing string moves between the refracted position and the extended position.

14. The combination of claim **11**, wherein the actuator comprises a piston actuator formed by the movable tubing string and the first stationary tubing section.

15. The combination of claim **11**, further comprising a second stationary tubing section at the downhole end of the movable tubing string, the downhole pump being rigidly connected to the second stationary tubing section.

16. The combination of claim **15**, wherein the stationary tubing section at the downhole end of the movable tubing string comprises flow apertures, the flow apertures being selectively opened by movement of the movable tubing string.

17. The combination of claim **11**, wherein the downhole pump is a progressive cavity pump comprising a rotor and a stator and the downhole end of the movable tubing string is attached to the rotor of the progressive cavity pump.

18. The combination of claim **17**, wherein the movable tubing string moves the stator at least one of down relative to the rotor or up relative to the rotor.

19. The combination of claim **11**, wherein the actuator comprises a hydraulic actuator and the tubing string further comprises a piston mounted at an upper end of the movable tubing string.

20. A method of operating a downhole pump, comprising the steps of:

providing a tubing string having a stationary tubing section and a movable tubing string telescopically received within the stationary tubing section;

attaching a downhole pump to the stationary tubing section of the tubing string and attaching a pump drive string to the downhole pump;

inserting the tubing string into a producing wellbore;

driving the pump using the pump drive string; and

telescopically moving the movable tubing string of the tubing string relative to the stationary tubing section to distribute the wear on the movable tubing string incurred by the pump drive string along the movable tubing string.

21. The method of claim **20**, wherein moving the movable tubing string further comprises rotating the movable tubing string as it moves between the extended position and the refracted position.

* * * * *