US 20110042102A1

(19) **United States**

(12) **Patent Application Publication**

Buytaert

(10) **Pub. No.: US 2011/0042102 A1**

(43) **Pub. Date: Feb. 24, 2011**

(54) **METHOD OF AND KIT FOR INSTALLING A CENTRALIZER ON A PIPE SEGMENT**

(75) Inventor: **Jean Buytaert**, Mineral Wells, TX (US)

Correspondence Address:
Streets & Steele-Frank's International.
13100 Wortham Center Drive, Suite 245
Houston, TX 77065 (US)

(73) Assignee: **Frank's International, Inc.**, Houston, TX (US)

(21) Appl. No.: **12/543,349**

(22) Filed: **Aug. 18, 2009**

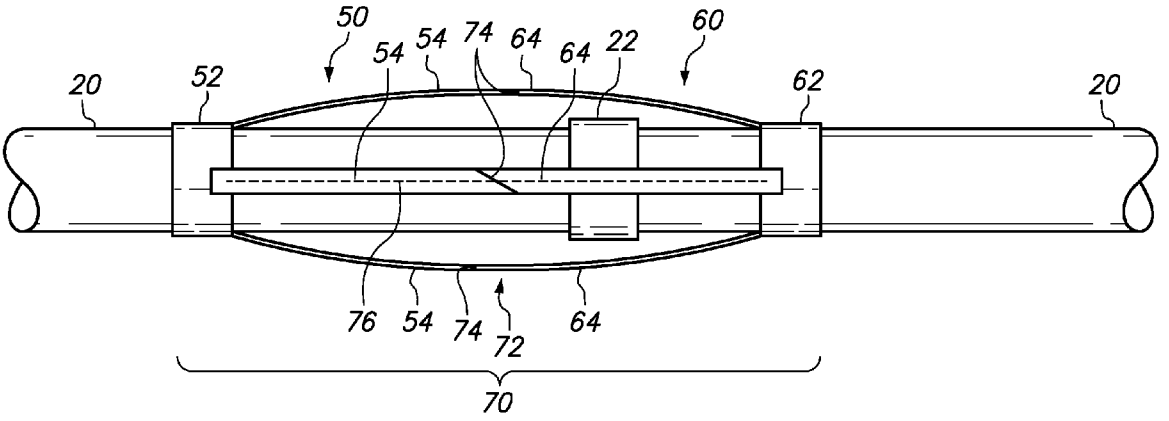
Publication Classification

(51) **Int. Cl.**
E21B 17/10 (2006.01)
E21B 19/24 (2006.01)

(52) **U.S. Cl.** **166/380**; 166/241.6

(57) **ABSTRACT**

First and second centralizer portions, comprising a first end collar coupled to a plurality of first bow spring segments and a second end collar coupled to a plurality of second bow spring segments, respectively, may be received onto the pipe segment on opposite sides of an installed stop collar. The plurality of first bow spring segments are coupled to the plurality of second bow spring segments, such as by welding, to form a bow spring centralizer with a plurality of bow springs extending between the first and second end collars, the bow spring centralizer movable along the pipe segment within a limited range defined by the separation of the first and second end collars. In one embodiment, the first centralizer portion and the second centralizer portion may be formed by cutting through the bow springs of a bow spring centralizer.



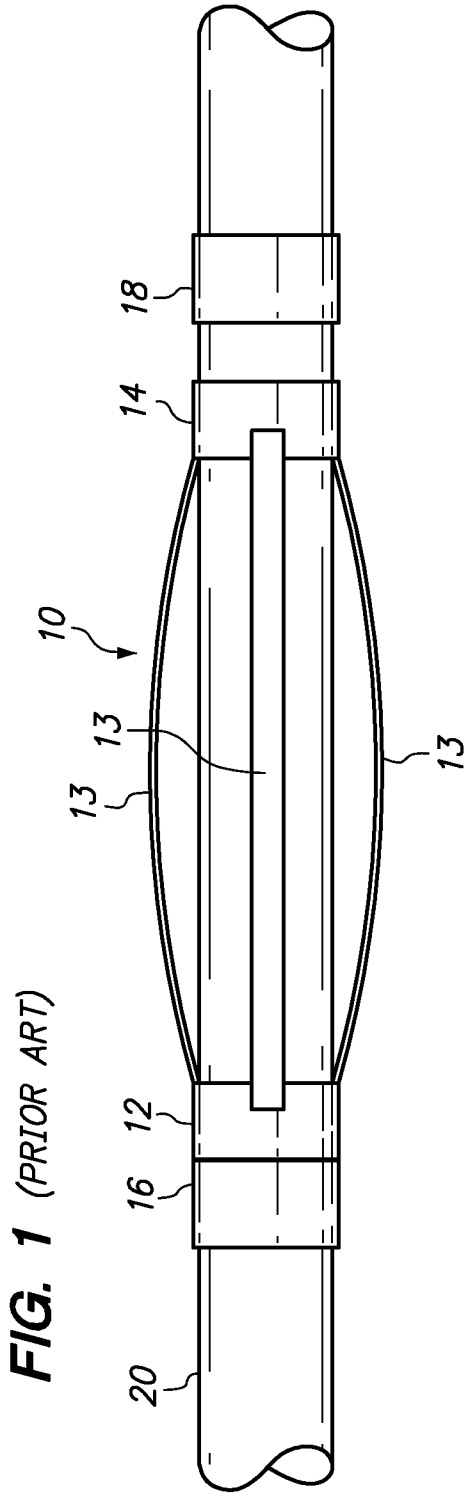


FIG. 1 (PRIOR ART)

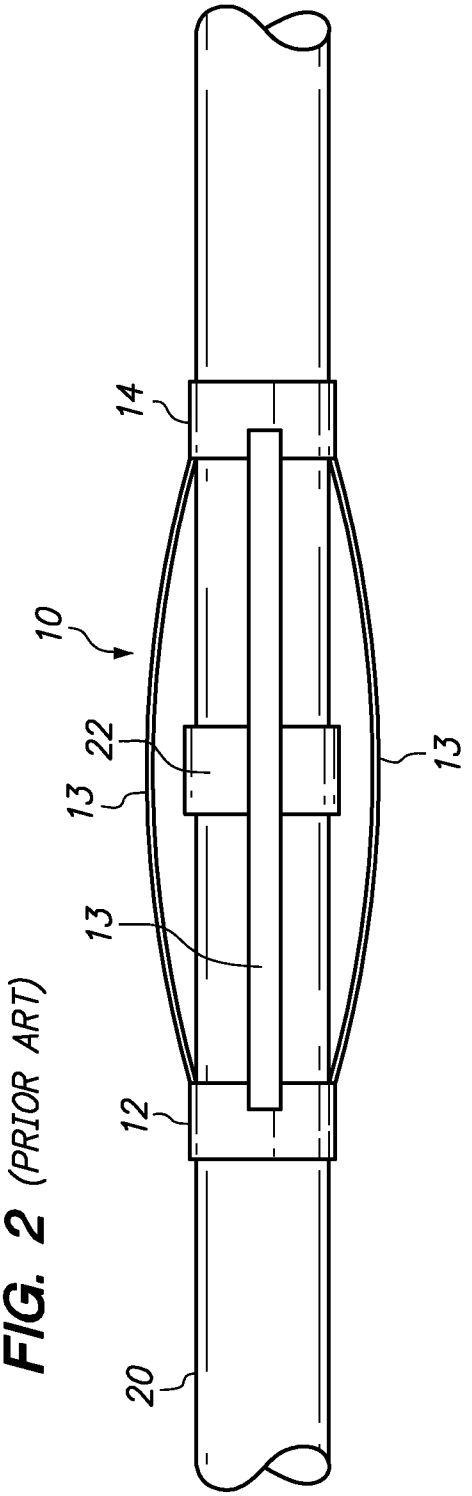


FIG. 2 (PRIOR ART)

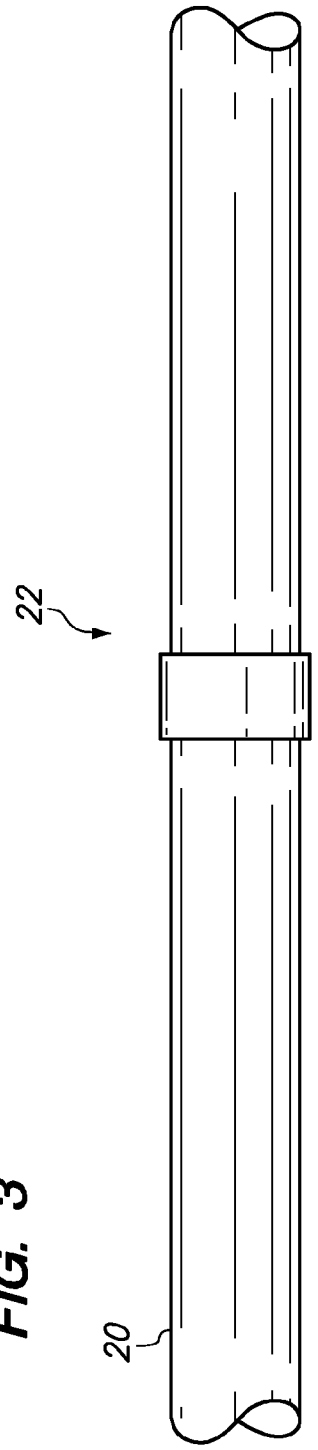


FIG. 3

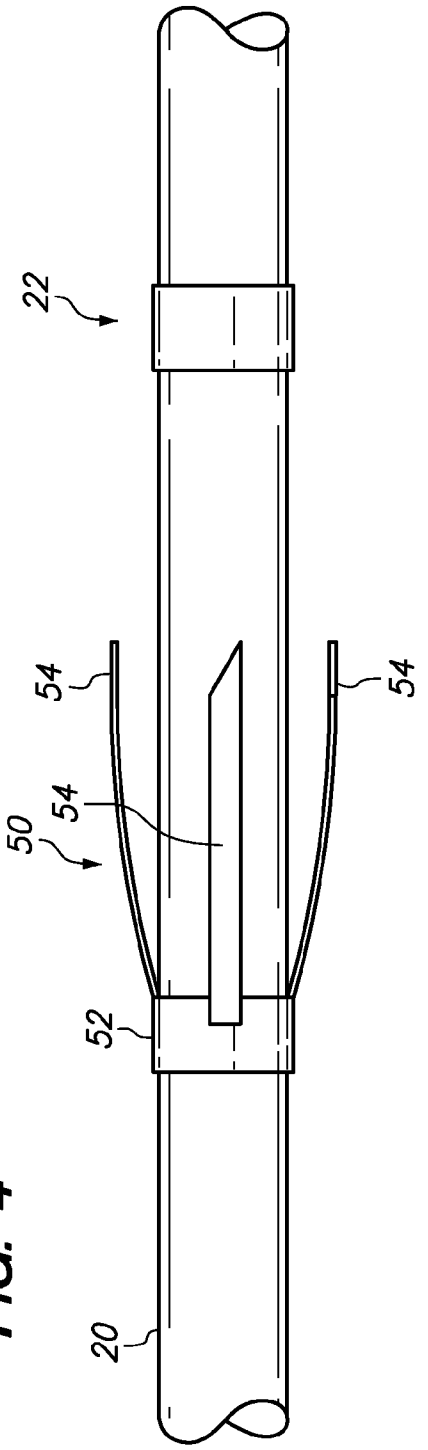


FIG. 4

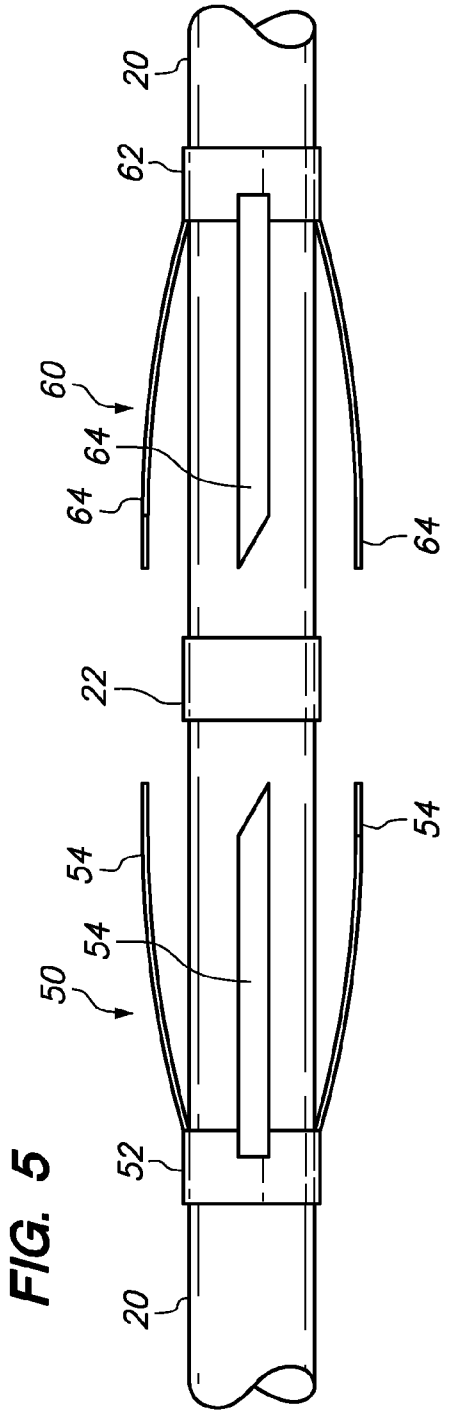

20
62
60
64
64
64
22
54
54
54
50
52
20

FIG. 5

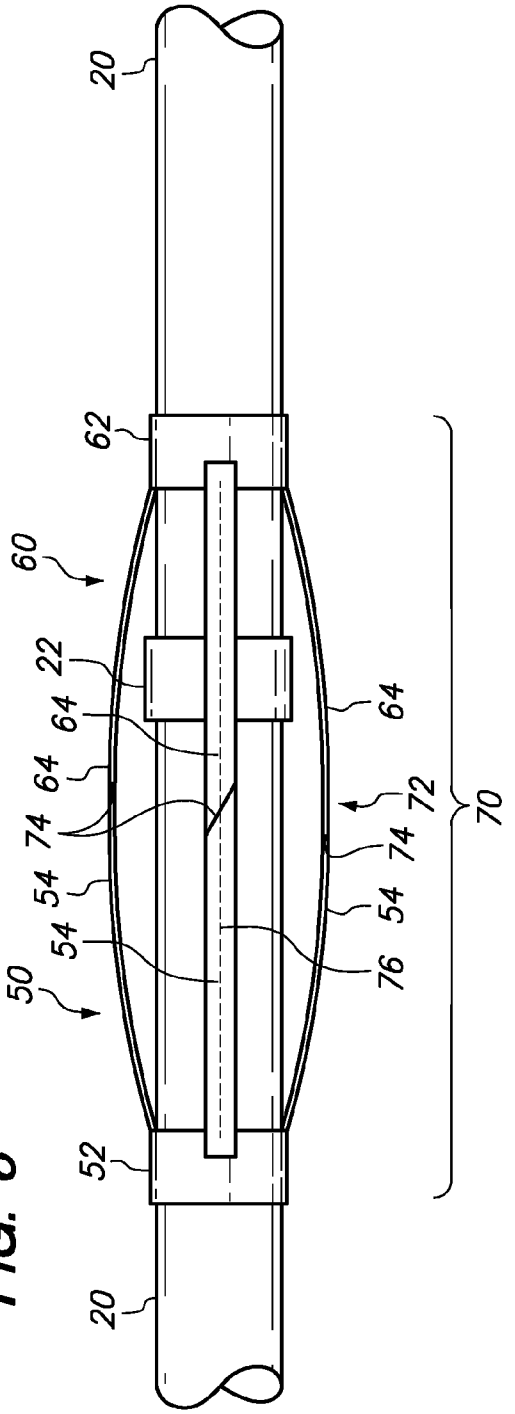

20
62
60
22
64
64
64
74
72
74
70
54
54
54
50
76
52
20

FIG. 6

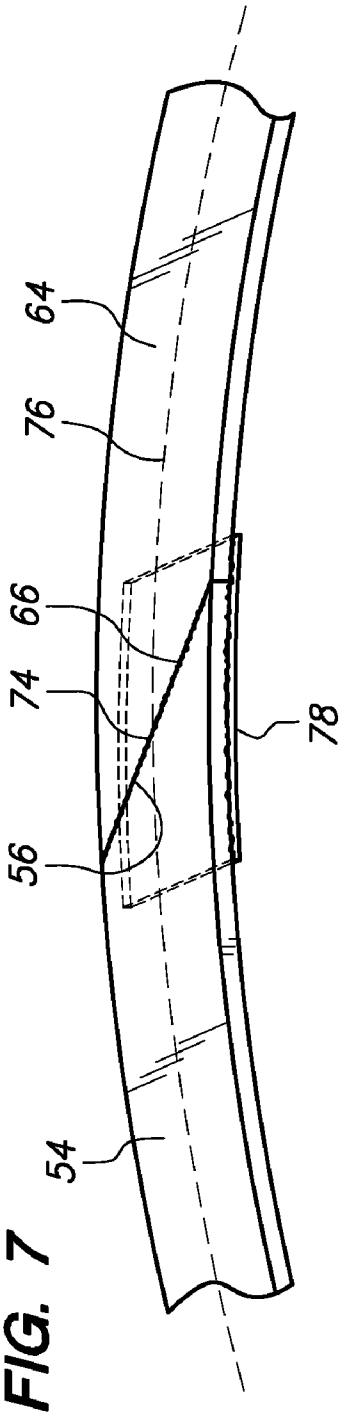


FIG. 7

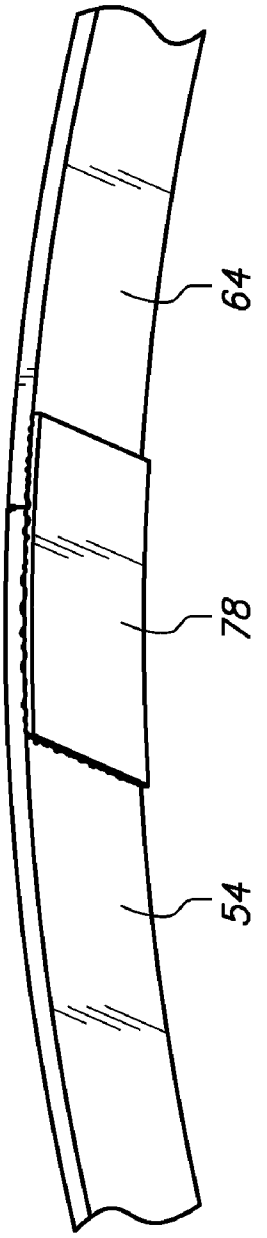


FIG. 8

METHOD OF AND KIT FOR INSTALLING A CENTRALIZER ON A PIPE SEGMENT

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] This application relates to centralizers to position a pipe string within a borehole. Specifically, this invention relates to a method of and a kit for installing a centralizer on a pipe segment to be made-up into a pipe string, for example, a pipe string of the kind used in oil and gas wells.

[0003] 2. Brief Description of the Related Art

[0004] Centralizers may be secured at spaced intervals along a pipe string to provide radial stand-off of the pipe string from the wall of a borehole. The term "pipe string," as used herein, may refer to a casing string, a drill string, or any other tubular string made up of a plurality of connected pipe segments. A "centralizer," as that term is used herein, comprises two spaced-apart end collars aligned one with the other to define a bore there through to be received onto the end of a pipe segment, and a plurality of angularly-spaced ribs that project radially outwardly from the end collars to provide stand-off between the pipe string and the wall of the borehole. In one aspect, the ribs of a centralizer are bow springs that provide variable stand-off between the pipe string and the wall of the borehole. Bow spring centralizers provide an additional advantage in that the bow springs may collapse to pass through restrictions such as, for example, a previously installed pipe string, a wellhead or a borehole irregularity.

[0005] A centralizer may position a pipe string within a drilled borehole to provide an annulus radially intermediate the pipe string and the wall of the borehole. In one aspect, positioning the pipe string within the borehole may provide a generally uniform and continuous distribution of cement slurry within the annulus during a step of cementing the pipe string within a targeted interval of the drilled borehole. In another aspect, a centralizer may provide stand-off between the pipe string and the wall of the borehole to prevent unwanted sticking of the pipe string to the wall of the borehole at a portion of the wall at which fluid loss from the borehole into a porous geologic formation may occur. In another aspect, a centralizer may provide stand-off between the pipe string and the wall of a drilled borehole to prevent the wall of the borehole from engaging a device installed on the pipe string generally adjacent to the centralizer. In another aspect, a centralizer may position a slotted or perforated liner within a producing interval of the drilled borehole to optimize feed-in of produced oil and/or gas. It should be understood that centralizers may be used to position a pipe string within a drilled borehole for other purposes and objectives.

[0006] Generally, it is desirable to prevent movement, or to limit the range of movement, of a centralizer along a pipe string on which it is installed. In one aspect, one or more stop collars may be coupled to the exterior of a pipe segment adjacent the centralizer to limit or prevent axial movement of a centralizer. For example, FIG. **1** illustrates a prior art method of limiting the movement of a centralizer **10** along a pipe segment by disposing two end collars **12**, **14** of a bow spring centralizer **10** intermediate two stop collars **16**, **18** (or intermediate a stop collar and a non-flush pipe connection coupling adjacent pipe segments). This "straddled" configuration permits the bow spring centralizer **10** to move along the pipe segment **20** within a limited range as permitted by the separation of stop collars **16**, **18** (or, e.g., between a stop collar and a non-flush pipe connection). Alternatively, FIG. **2** illustrates a single stop collar **22** disposed on a pipe segment **20** intermediate two end collars **12**, **14** of bow spring centralizer **10**. This alternate configuration facilitates a limited range of movement of the bow spring centralizer **10** along the pipe segment until an end collar **12**, **14** engages the stop collar **22**. Using conventional methods, the configuration illustrated in FIG. **2** may be achieved by, for example, receiving a first end collar **12** of the bow spring centralizer **10** over an end (not shown in FIG. **2**) of the pipe segment **20**, followed by the stop collar **22** and then the second end collar **14** of the bow spring centralizer **10**. The stop collar **22** and the bow spring centralizer **10** may then be together moved along the pipe segment to a targeted position and the stop collar **22** may then be secured, for example, by tightening a plurality of set screws in the stop collar **22**, to the pipe segment to limit the range of movement of the bow spring centralizer **10** on the pipe segment **20**.

[0007] As a pipe string is installed within a targeted interval of a borehole, a bow spring centralizer installed on a pipe segment that is made-up within the pipe string may encounter a restriction that engages the ribs and obstructs or opposes movement of the centralizer past the restriction. The bow spring centralizer may then slide along the advancing pipe segment until an end collar engages a stop collar. If the bow spring centralizer is installed between two stop collars (as illustrated in FIG. **1**), the trailing stop collar will engage and push against the trailing end collar of the bow spring centralizer. As the pipe string continues to advance, the bow springs will collapse and pass the restriction. The mode of interaction between the restriction and the bow springs, for example, the pushing of the bow spring centralizer through the restriction by the trailing stop collar, causes a large amount of friction due to an inefficient mode of collapse of the bow spring.

[0008] By comparison, if a stop collar **22** is disposed intermediate the end collars of a bow spring centralizer, as illustrated in FIG. **2**, then a restriction causes the bow spring centralizer to slide along the pipe string until the leading end collar of the bow spring centralizer engages the stop collar. As the pipe segment continues to advance, the centralizer is pulled through the restriction as opposed to being pushed through the restriction. All other conditions and dimensions being equal, this mode of interaction between the bow springs and the restriction causes less resistance, e.g., frictional resistance, to movement of the pipe string as compared to the configuration illustrated in FIG. **1** because the bow spring centralizer is pulled through the restriction to provide a more efficient, progressive mode of collapse of the bow springs. Where the bow spring centralizer is, as a unit, pushed through the restriction from the rear (rather than being pulled through the restriction from the front, i.e., from immediately within the leading end collar), the initial contact between the bow spring and the restriction causes the leading end collar to move toward the trailing end collar of the bow spring centralizer. This in initially results in the bow springs bending or bowing further rather than collapsing, and thus this pushing the bow spring centralizer through a restriction creates more resistance to passage.

[0009] It may be difficult or impractical to position a stop collar intermediate two end collars of a centralizer using conventional methods. Necessarily, the outer diameter of a stop collar is larger than the inner diameter of the end collars of a centralizer to be positioned using the stop collar to prevent the end collars from moving beyond the stop collar. As a result, a stop collar is typically installed intermediate two end collars of a bow spring centralizer by receiving a first end

collar of the centralizer onto the end of a pipe segment, disposing a stop collar (e.g., inserting between two adjacent bow springs) within the bow springs and intermediate the end collars of the bow spring centralizer, rotating the stop collar so that the bore of the stop collar is brought into alignment with the first end collar of the bow spring centralizer that is already received onto the pipe segment and also into alignment with the end of the pipe segment, and receiving the bore of the stop collar onto the end of the pipe segment. After the stop collar is received onto the pipe segment adjacent the first end collar, the centralizer is moved to receive the second end collar onto the end of the pipe segment. The centralizer and the stop collar are then moved together along the length of the pipe segment to the targeted installation location and the stop collar is then secured to the pipe segment to limit the range of movement of the centralizer along the pipe string.

[0010] The shortcoming of this method of installation arises from the difficulty in securing the stop collar to the pipe segment after it is positioned intermediate the end collars of the centralizer. In the position shown in FIG. **2**, access to the stop collar may be substantially impaired by the bow springs. For example, a stop collar having one or more set screws may normally be tightened to "bite" into the surface of the pipe segment to secure the stop collar in place and thereby limit the range of movement of the bow spring centralizer. It may be difficult to adequately tighten the set screws if access to the stop collar is obstructed by bow springs, as shown in FIG. **2**. If the pipe segment is made of a hardened material, such as high-carbon steel or an extremely hard alloy, a large number of set screws may be required to secure the stop collar, and it may not be possible to access and tighten all of the set screws due to the bow springs.

[0011] Other types of stop collars are securable to a pipe segment using an adhesive, such as an epoxy adhesive, but these types of stop collars may require even more access for installation than a set screw-type stop collar. As a result, centralizers are more often installed intermediate a pair of stop collars (as illustrated in FIG. **1**) instead of the stop collar being installed intermediate the end collars of the centralizer. As a result, increased running force from the less efficient centralizer installation may be tolerated because the stop collars are easier to install in the straddling configuration, e.g., as in FIG. **1**, as opposed to being intermediate the end collars of the bow spring centralizer as in FIG. **2**.

[0012] What is needed is an improved method of installing a bow spring centralizer on a pipe segment so that the stop collar is intermediate the end collars of a bow spring centralizer. What is needed is a method of installing low-clearance bow spring centralizers on a pipe string to reduce the running force required to run the pipe string into a borehole. What is needed is a kit that can be used to install a bow spring centralizer on a pipe segment so that the stop collar is intermediate the end collars of a bow spring centralizer and/or to reduce the running force required to run the pipe string into a borehole.

SUMMARY

[0013] Embodiments of the disclosed invention satisfy one or more of the above-stated needs. Embodiments of the invention provide a method of installing a bow spring centralizer on a pipe string so that a stop collar is secured to the pipe string intermediate the end collars of a bow spring centralizer. One embodiment of the method comprises the steps of assembling a bow spring centralizer with first and second end collars on opposite sides of a stop collar installed on a pipe string wherein the range of movement of the centralizer along the pipe string is limited by the stop collar. Another embodiment of the method comprises the steps of assembling a bow spring centralizer with the first and second end collars on opposite sides of a non-flush pipe coupling, wherein the range of movement of the bow spring centralizer along the pipe string is limited by the pipe coupling. Another embodiment of the method comprises the steps of assembling a bow spring centralizer with the first and second end collars on opposite sides of a radially upset portion of a pipe segment, wherein a range of movement of the bow spring centralizer along the pipe segment is limited by the radially upset portion of the pipe segment.

[0014] In another embodiment of the method, assembling the low-clearance bow spring centralizer with first and second end collars on opposing sides of the stop collar comprises the steps of (i) slidably receiving a first centralizer portion onto a pipe segment on a first side of an installed stop collar, wherein the first centralizer portion comprises a first end collar, having an inner diameter smaller than an outer diameter of the stop collar, and a first plurality of bow spring segments coupled to the first end collar, (ii) slidably receiving a second centralizer portion onto a pipe segment on a second, opposite side of the stop collar, wherein the second centralizer portion comprises a second end collar, having an inner diameter smaller than an outer diameter of the stop collar, and a second plurality of bow spring segments coupled to the second end collar, and then (iii) coupling the first plurality of bow spring segments to the second plurality of bow spring segments to form a bow spring centralizer having a plurality of bow springs extending between the first and second end collars. Optionally, the first plurality of bow spring segments is coupled to the second plurality of bow spring segments at a midpoint between the first and second end collars. Optionally, the first and second plurality of bow spring segments may be coupled together to form bow springs by welding.

[0015] Optionally, a first bow spring segment and a second bow spring segment are positioned to abut (or to be in close proximity across a small gap) and then coupled one to the other to form a bow spring by welding along a weld path at the abutment (or gap) at an angle between about 20 and about 70 degrees to the longitudinal centerline of the bow spring. Optionally, a backing plate may first be welded to an interior side of the abutting interface (or gap) between the first bow spring segment and the second bow spring segment to stabilize the first and second bow spring segments for welding and to facilitate proper positioning of the first and second bow spring segments for being coupled together to form bow springs.

[0016] In one embodiment, the first centralizer portion and the second centralizer portion may be formed by cutting each of a plurality of bow springs of a bow spring centralizer intermediate the first and second end collars. For example, in one embodiment of the method, cutting each of the plurality of bow springs of a low-clearance bow spring centralizer at a non-perpendicular angle relative to a longitudinal centerline of the bow spring to form a first centralizer portion and a second centralizer portion provides the first and second centralizer portions that may be positioned, in accordance with embodiments of the method, and then coupled to form a low-clearance bow spring centralizer movable within a range defined by an installed stop collar intermediate the first end collar of the first centralizer segment and the second end

collar of the second centralizer segment. Optionally, the non-perpendicular angle is between 20 and 70 degrees relative to the longitudinal centerline of the bow spring.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] FIG. **1** is a elevation view of a centralizer disposed on a pipe segment intermediate a first stop collar and a second stop collar using a prior art method.

[0018] FIG. **2** is a elevation view of a centralizer disposed on a pipe segment and secured in position using a stop collar intermediate the end collars of the centralizer.

[0019] FIG. **3** is an elevation view of a stop collar secured to a pipe segment.

[0020] FIG. **4** is an elevation view of the pipe segment in FIG. **3** with a first centralizer portion slidably received onto the pipe segment and positioned adjacent to and on one side of the stop collar.

[0021] FIG. **5** is an elevation view of the pipe segment in FIG. **4** with a second centralizer portion slidably received onto the pipe segment adjacent to and on the opposite side of the stop collar from the first centralizer portion, and positioned with first ends of the plurality of bow spring segments of the first centralizer portion in alignment with second ends of the plurality of bow spring segments of the second centralizer portion.

[0022] FIG. **6** is an elevation view of the pipe segment in FIG. **5** with the first centralizer portion and the second centralizer portion adducted one to the other about the stop collar, and with first ends of the plurality of bow spring segments of the first centralizer portion welded to the second ends of the plurality of bow spring segments of the second centralizer portion to form a low-clearance bow spring centralizer with the stop collar intermediate the first end collar and the second end collar.

[0023] FIG. **7** is a top perspective view of a first end of a bow spring segment and a second end of a bow spring segment welded together and coupled to a backing plate.

[0024] FIG. **8** is a bottom perspective view of the bow spring in FIG. **7**

DETAILED DESCRIPTION OF EMBODIMENTS

[0025] One embodiment of the invention provides a method of installing a low-clearance bow spring centralizer on a pipe segment comprising assembling a bow spring centralizer with first and second end collars on opposite sides of an installed stop collar wherein the stop collar limits the range of movement of the bow spring centralizer along the pipe segment. For purposes of this description, a "low-clearance" centralizer is one that has sleeve-shaped end collars and bow springs that flexibly collapse to lie generally along the exterior wall of a pipe segment received through the centralizer so that a pipe string that includes the pipe segment may pass through restrictions larger than the diameter of the end collars, and so that the bow springs may flexibly redeploy to position the pipe segment within a portion of the borehole beyond the restriction.

[0026] FIG. **3** is an elevation view of a stop collar **30** that has been received on and secured to a pipe segment **20**.

[0027] FIG. **4** is an elevation view of the pipe segment **20** in FIG. **3** with a first centralizer portion **50** received onto the pipe segment **20** on a first side of the stop collar **30**. The first centralizer portion **50** comprises a first end collar **52**, having an inner diameter smaller than an outer diameter of the stop collar **30**, and a first plurality of bow spring segments **54** coupled to the first end collar **52**.

[0028] FIG. **5** is an elevation view of the pipe segment **20** in FIG. **4** with the first centralizer portion **50** and a second centralizer portion **60** received on the pipe segment **20** on opposite sides of the stop collar **30**. Like the first centralizer portion **50**, the second centralizer portion **60** comprises a second end collar **62**, also having an inner diameter smaller than an outer diameter of the stop collar **30**, and a second plurality of bow spring segments **64** coupled to the second end collar **62**. The first and second centralizer portions **50**, **60** are illustrated in FIG. **5** as having the first plurality of bow spring segments **54** in general alignment with the second plurality of bow spring segments **64**.

[0029] FIG. **6** is an elevation view of the pipe segment **20** in FIG. **5** with the first centralizer portion **50** and the second centralizer portion **60** adducted one toward the other about the stop collar **22**, and with the first plurality of bow spring segments **54** coupled to the second plurality of bow spring segments **64** to form a low-clearance bow spring centralizer **70**. A plurality of bow springs are formed by coupling the first plurality of bow spring segments **54** to the second plurality of bow spring segments **64**, and the bow springs formed thereby extend between the first end collar **52** and the second end collar **62**. The specific embodiment of the method illustrated in FIG. **6** shows that the first plurality of bow spring segments **54** may be coupled, e.g., welded, to the second plurality of bow spring segments **64** at about a midpoint **72** between the first and second end collars **52**, **62**.

[0030] In a further option, the first and second plurality of bow spring segments may be coupled, such as by welding, along a generally linear path **74** disposed at a non-perpendicular angle, e.g., between about 20 and about 70 degrees relative to a longitudinal centerline **76** of the bow spring formed by coupling the aligned first and second bow spring segments **54**, **64**. It should be understood that the weld path may be non-linear. By positioning the path **74** substantially separated from the end collars **52**, **62**, heat from welding the first and second bow spring segments **54**, **64** to form a bow spring will not damage or otherwise affect pipe segment **20**. As heat conducts from the weld interface at path **74** through the slender first and second bow spring segments **54**, **64** and toward end collars **52**, **62**, respectively, the heat rapidly dissipates, e.g., due to the favorable flat cross-section and elongate shape of the first and second bow spring segments **54**, **64**, which perform like heat dissipation fins. As a result, heat introduced into the first and second bow spring segments **54**, **64** at the weld interface **74** favorably dissipates so that any interior and/or exterior pipe coatings, pipe linings and the pipe **20** material itself all maintain their chemical, structural and/or metallurgical integrity and remain uncompromised by heat damage or heat affected zones.

[0031] Although the first and second plurality of bow spring segments **54**, **64** are illustrated in FIG. **5** as being substantially equal in length, it should be understood that the first and second bow spring segments **54**, **64** may be of unequal lengths, and the weld interface at path **74** may, in other embodiments, not be at the midpoint **72**. Instead, the path **74** may be closer to one end collar than the other. Generally, it may be desired to avoid welding along a path that is too close to an end collar, and the first centralizer portion **50** and the second centralizer portion **60** should, if possible, comprise bow spring segments of sufficient length to favorably dissipate a substantial portion of the heat introduced into

the bow spring segments by welding at the weld interface along path **74**. It should be understood that in the depicted embodiment, the weld path **74** (e.g., the ends of first and second plurality of bow spring segments **54**, **64** to be joined) is spaced apart from the exterior of the pipe segment **20** to prevent unwanted heat affected zones or damage to any interior or exterior pipe coatings.

[0032] Optionally, the first centralizer portion **50** and the second centralizer portion **60** may be formed by cutting through a plurality of bow springs of an assembled centralizer intermediate the first and second end collars **52**, **62**. The first bow spring segments **54** and the second bow spring segments **64** may be heat treated prior to assembly of the first centralizer portion **50** and the second centralizer portion **60** so that the plurality of bow springs formed by joining the bow spring segments may be installed on a pipe segment and run into a borehole without the need for further heat treating. Although the first and second centralizer portions may be separately manufactured using, for example, dies prepared specifically for the purpose of making first and second bow spring segments, the same result may be achieved by cutting through the bow springs of an existing bow spring and/or the bow springs of a pre-assembled bow spring centralizer.

[0033] FIGS. **7** and **8** are top and bottom perspective views, respectively, of a first bow spring segment **54** welded to a second bow spring segment **64** along a weld interface at weld path **74** formed at the ends **56**, **66** thereof. Although the ends **56**, **66** may be secured at any angle or along any interface, the illustrated segments are welded generally along a weld path **74** at a non-perpendicular angle relative to a longitudinal centerline **76** of the aligned bow spring segments (**54**, **64**).

[0034] In one embodiment, the non-perpendicular angle is between about 20 and about 70 degrees relative to the longitudinal centerline of the bow spring. A weld angle within this range may better distribute stresses from flexible working of the bow spring along a longer weld seam instead of concentrating the stress along a shorter, more perpendicular weld seam in a "hinge-effect" bending moment. In accordance with a further option, a backing plate **78** may be welded to an interior side and/or exterior side of the abutting first and second bow spring segments **54**, **64**, wherein the backing plate **78** covers at least a portion of the weld path **74**. Application of the backing plate to the interior side of the abutting first and second bow spring segments **54**, **64** may provide access to weld the exterior side. A backing plate **78** may be secured to abutting first and second bow spring segments **54**, **64** prior to welding of the path **74** by tack welding to secure the first and second bow spring segments **54**, **64** in the abutting configuration for welding.

[0035] Although embodiments of the invention are described and shown primarily in relation to a bow spring centralizer, it should be recognized that the methods of the invention are equally applicable to a centralizer having rigid ribs instead of bow springs as the ribs.

[0036] The terms "comprising," "including," and "having," as used in the claims and specification herein, shall be considered as indicating an open group that may include other elements not specified. The terms "a," "an," and the singular forms of words shall be taken to include the plural form of the same words, such that the terms mean that one or more of something is provided. The term "one" or "single" may be used to indicate that one and only one of something is intended. Similarly, other specific integer values, such as "two," may be used when a specific number of things is intended. The terms "preferably," "preferred," "prefer," "optionally," "may," and similar terms are used to indicate that an item, condition or step being referred to is an optional (not required) feature of the invention.

[0037] It should be understood that the term "stop collar," as used herein, refers to a collar to limit the range of movement of a centralizer movably received on a tubular segment, and that the use of the modifier "stop" within the term "stop collar" should not be considered as limiting the use of the device to secure only stationary or fixed devices. It should be further understood that the inventive method may be used with epoxy-secured, set screw-secured, heat shrunk and any other type of stop collar.

[0038] While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the invention should be limited only by the attached claims.

We claim:

1. A method of installing a centralizer on a pipe segment, comprising the steps of:

installing a stop collar on a pipe segment;

receiving an end collar of a first centralizer portion onto the pipe segment on a first side of the stop collar and receiving an end collar of a second centralizer portion onto the pipe segment on a second side of the stop collar opposite the first side;

assembling a centralizer by coupling the first centralizer portion to the second centralizer portion;

wherein the range of axial movement of the centralizer along the pipe segment is limited by the stop collar.

2. The method of claim **1**, wherein the step of assembly comprises the step of:

coupling a first plurality of bow spring segments of the first centralizer portion to a second plurality of bow spring segments of the second centralizer portion to form a bow spring centralizer having a plurality of bow springs extending between the end collars of the first and second centralizer portions.

3. The method of claim **2**, wherein the coupling step comprises connecting the first plurality of bow spring segments to the second plurality of bow spring segments using a plurality of welds along a plurality of weld paths intermediate the end collars of the first and second centralizer portions.

4. The method of claim **2**, further comprising:

cutting through a plurality of bow springs of a bow spring centralizer intermediate a first end collar and a second end collar to form the first centralizer portion and the second centralizer portion.

5. The method of claim **4**, wherein the cuts are linear.

6. The method of claim **5**, wherein the cuts through the bow springs are made at a non-perpendicular angle.

7. The method of claim **2**, wherein coupling the first plurality of bow spring segments to the second plurality of bow spring segments comprises welding the first plurality of bow spring segments to the second plurality of bow spring segments.

8. The method of claim **7**, wherein the welding occurs along generally linear weld paths forming a non-perpendicular angle relative to the longitudinal centerlines of the bow springs formed thereby.

9. The method of claim **7**, further comprising:

welding a backing plate to an interior face of at least one of the plurality of bow springs, wherein the backing plate covers at least a portion of the weld path between the first bow spring segment and second bow spring segment.

10. A kit for assembling a bow spring centralizer about a stop collar on a pipe segment comprising:

a first centralizer portion having a first end collar and a first plurality of bow spring segments coupled at a first end to the first end collar;

a second centralizer portion having a second end collar and a second plurality of bow spring segments coupled at a first end to the second end collar;

wherein at least one of the first plurality of bow spring segments has a second end with a shape complimentary to a second end of at least one of the second plurality of bow spring segments to facilitate forming a bow spring by welding the second end of the at least one of the first plurality of bow spring segments to the second end of the at least one of the second plurality of bow spring segments.

11. The kit of claim **11** wherein the kit further comprises a backing plate.

12. The kit of claim **10** further comprising a stop collar having a bore to be received on a pipe segment.

13. The kit of claim **10** wherein the first end collar and the second end collar have bores sized to receive a pipe segment.

14. The kit of claim **13** further comprising a stop collar having a bore sized to receive the pipe segment.

15. The kit of claim **13** wherein the second end of the at least one of the first plurality of bow spring segments forms an angle of 20 to 70 degrees, inclusive, to a longitudinal centerline of the bow spring segment.

16. The kit of claim **13** wherein the second end of the at least one of the plurality of bow spring segments is chamfered.

17. The kit of claim **15** wherein the second end of the at least one of the first plurality of bow spring segments is chamfered.

* * * * *