



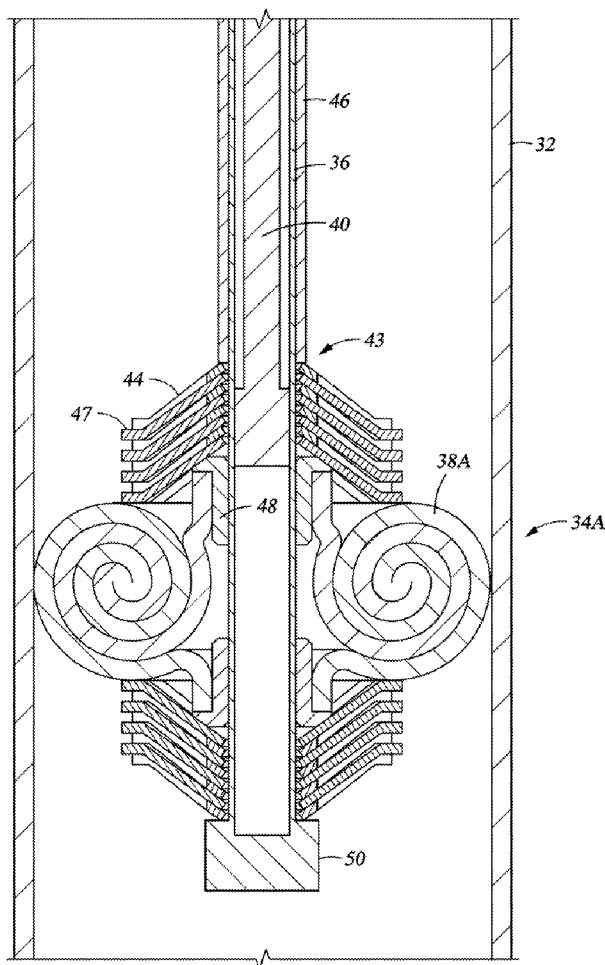
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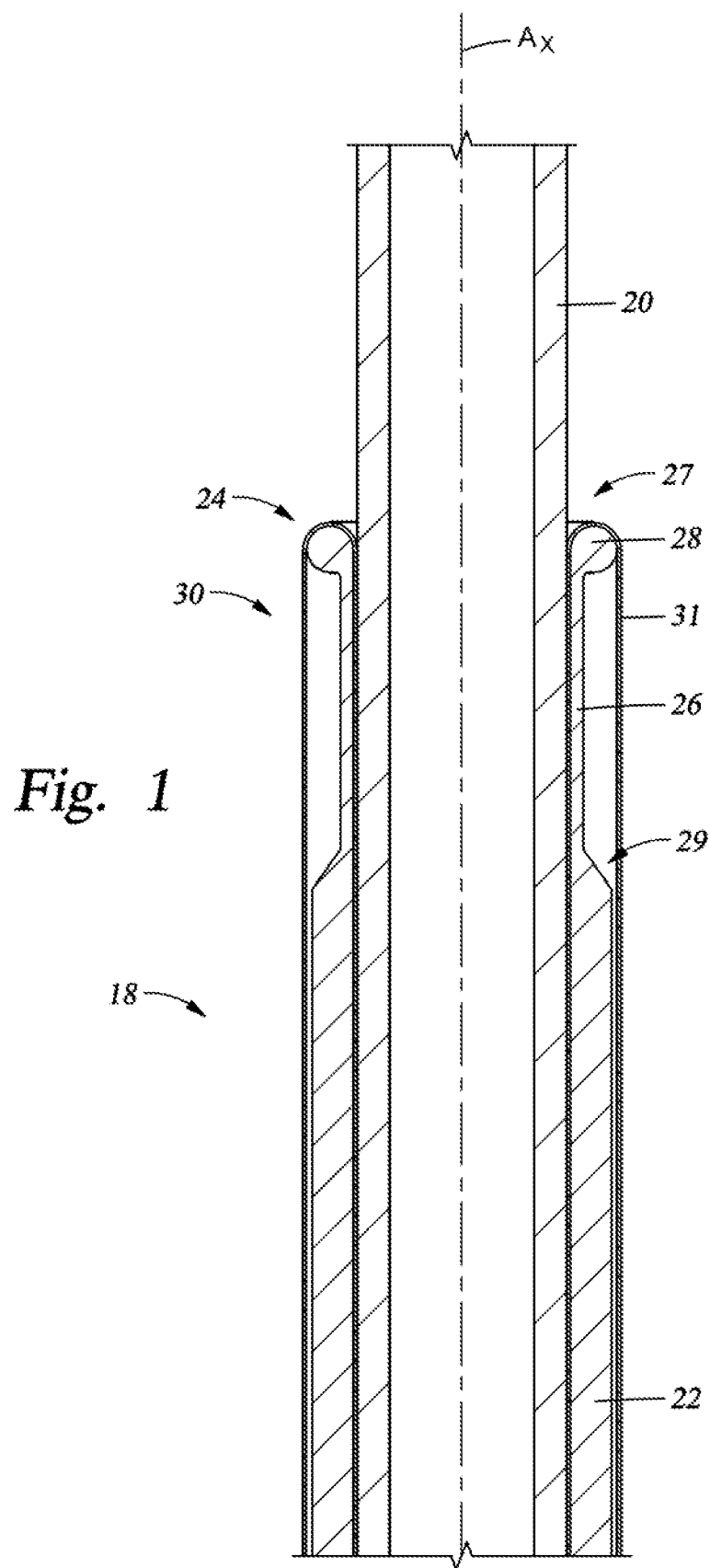
(19) **United States**(12) **Patent Application Publication**  
**Rinberg et al.**(10) **Pub. No.: US 2010/0288512 A1**(43) **Pub. Date: Nov. 18, 2010**(54) **ROLLING BRIDGE THROUGH TUBING**  
**BRIDGE PLUG****Related U.S. Application Data**

(60) Provisional application No. 61/160,458, filed on Mar. 16, 2009.

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**E21B 33/12** (2006.01)(52) **U.S. Cl.** ..... **166/387; 166/135**(57) **ABSTRACT**Correspondence Address:  
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A bridge plug assembly having a mandrel and an annular flexible member that is selectively fashioned into a volute that extends radially outward from the mandrel for isolating a portion of a tubular. In an example, a web member is provided that runs between the flexible member and the mandrel, and exits an end of the flexible member. Pulling the web member inverts an end of the flexible member rolling the sidewall of the flexible member into a volute. In another embodiment, upper and lower series of collars circumscribe the mandrel that when pushed towards one another axially squeeze the flexible member therebetween to outwardly bulge the flexible member into contact with a tubular. Continued force applied to the collars causes the flexible member to roll into a volute.

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**INCORPORATED**, Houston, TX (US)(21) Appl. No.: **12/724,981**(22) Filed: **Mar. 16, 2010**



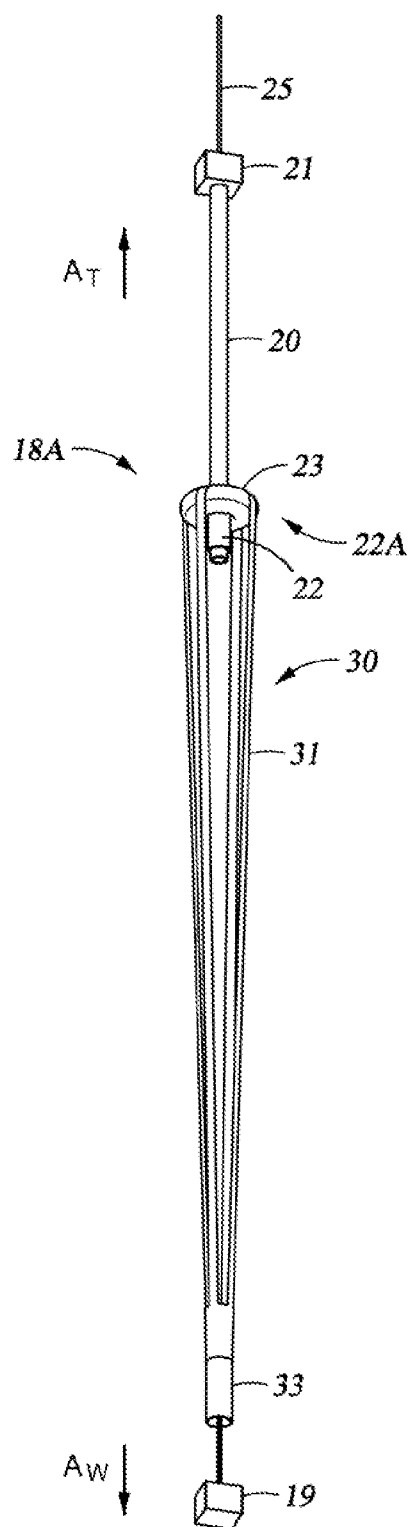


Fig. 2

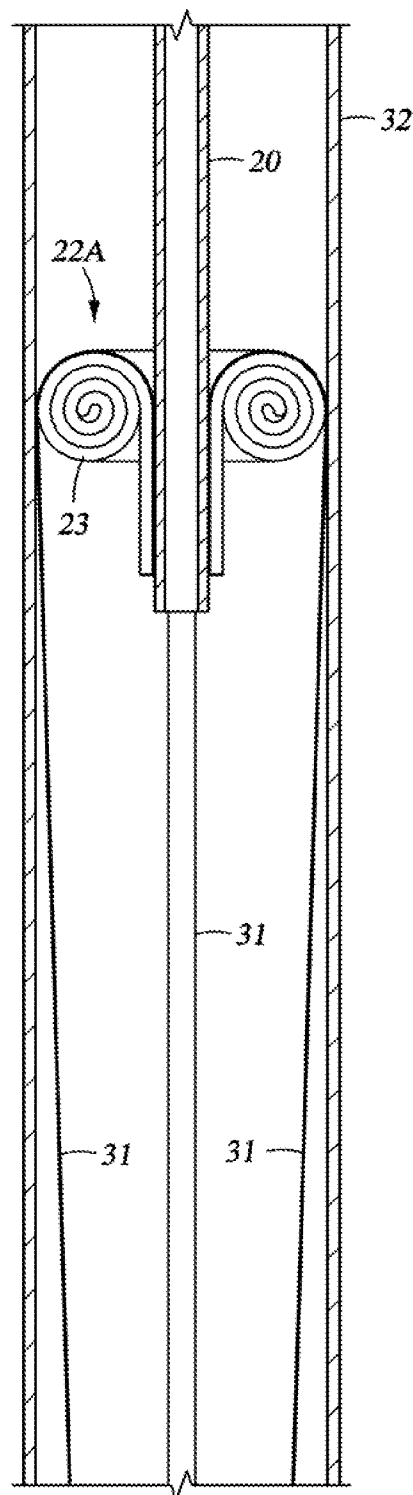


Fig. 3

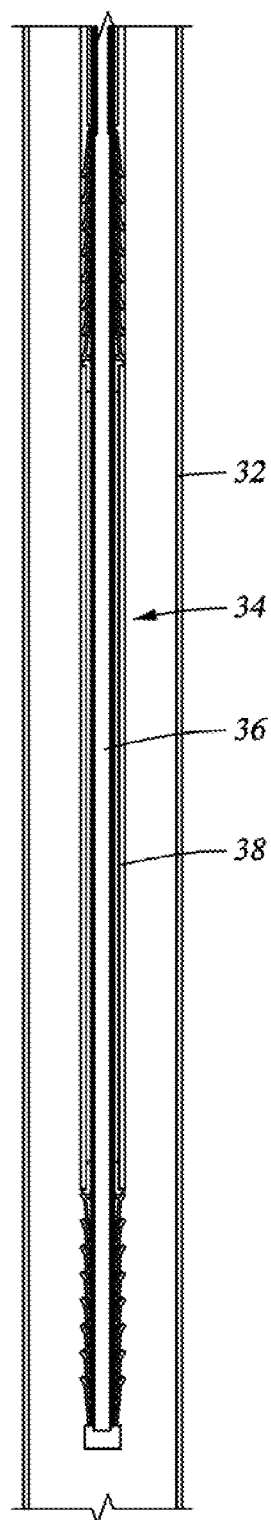


*Fig. 4*

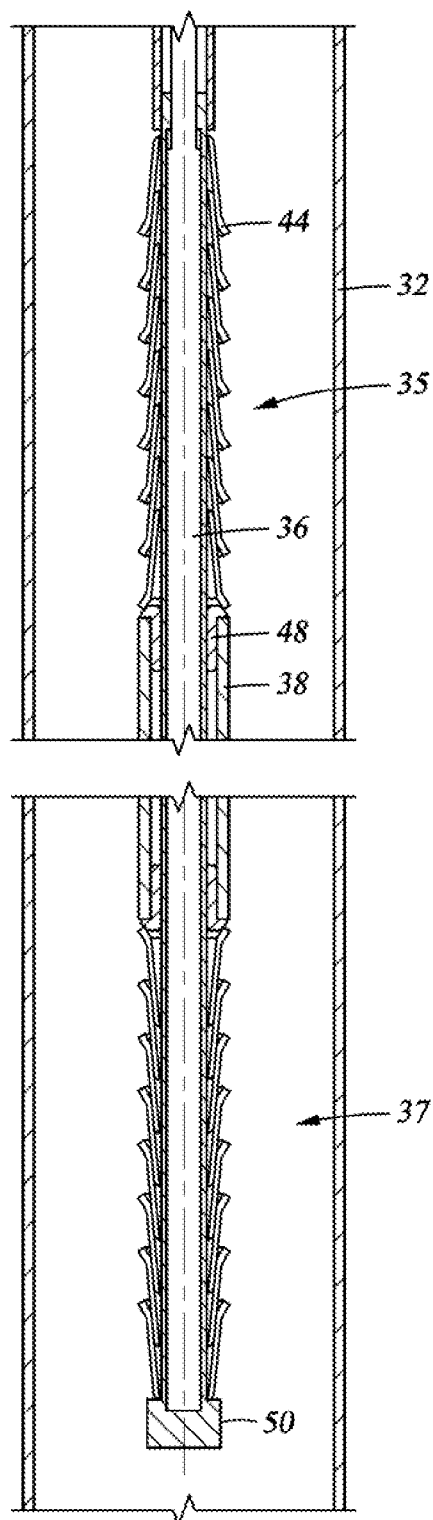


*Fig. 5*

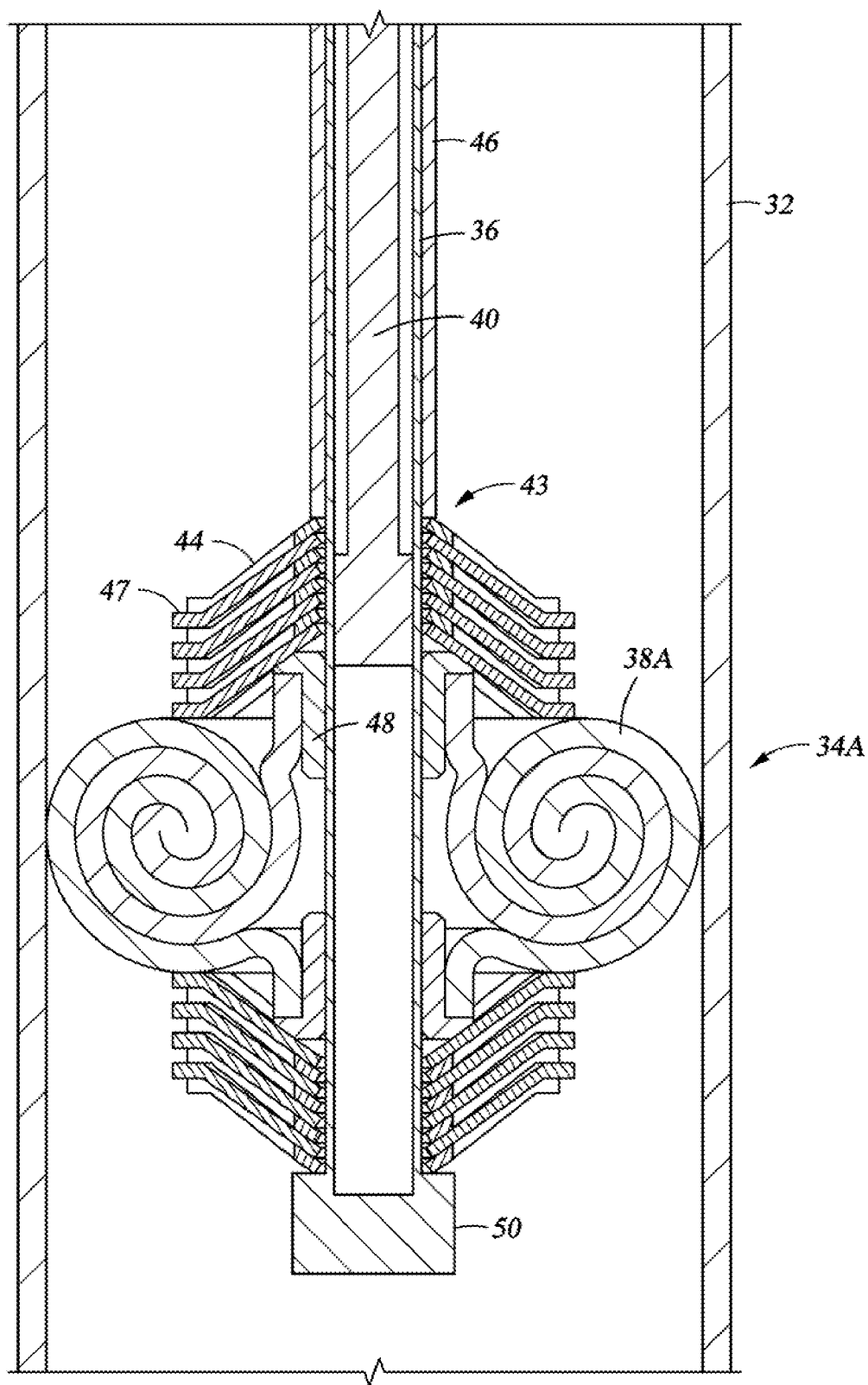


Fig. 6

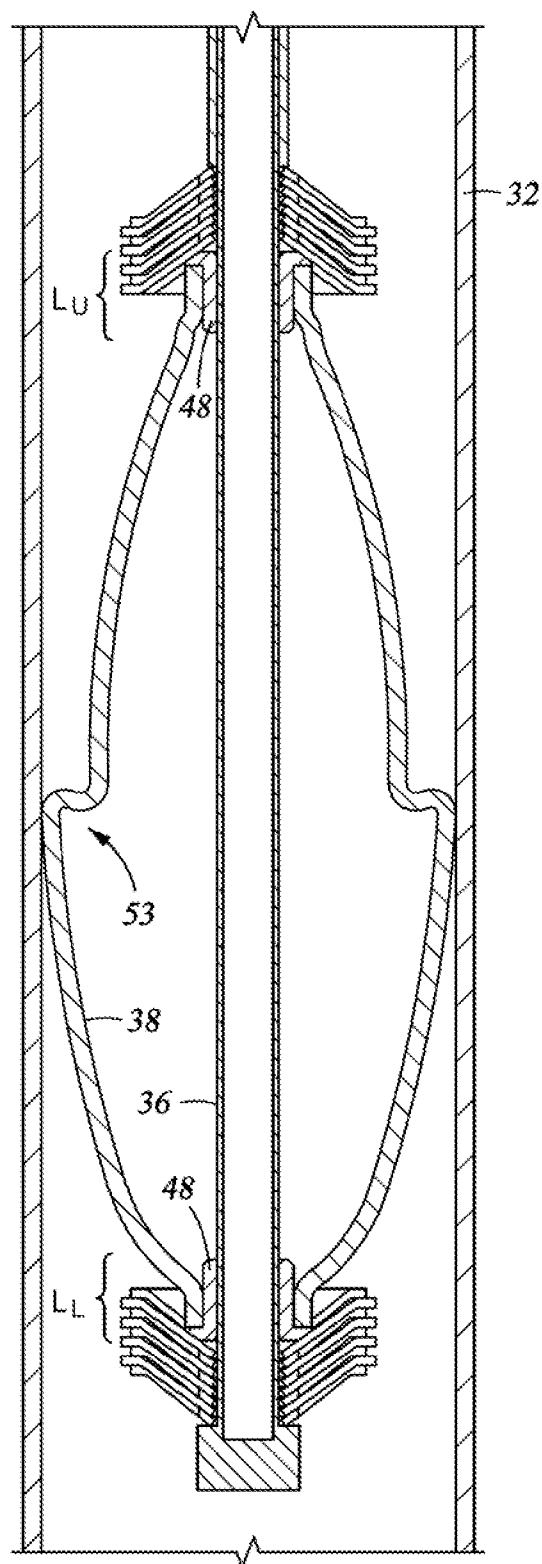


Fig. 6A

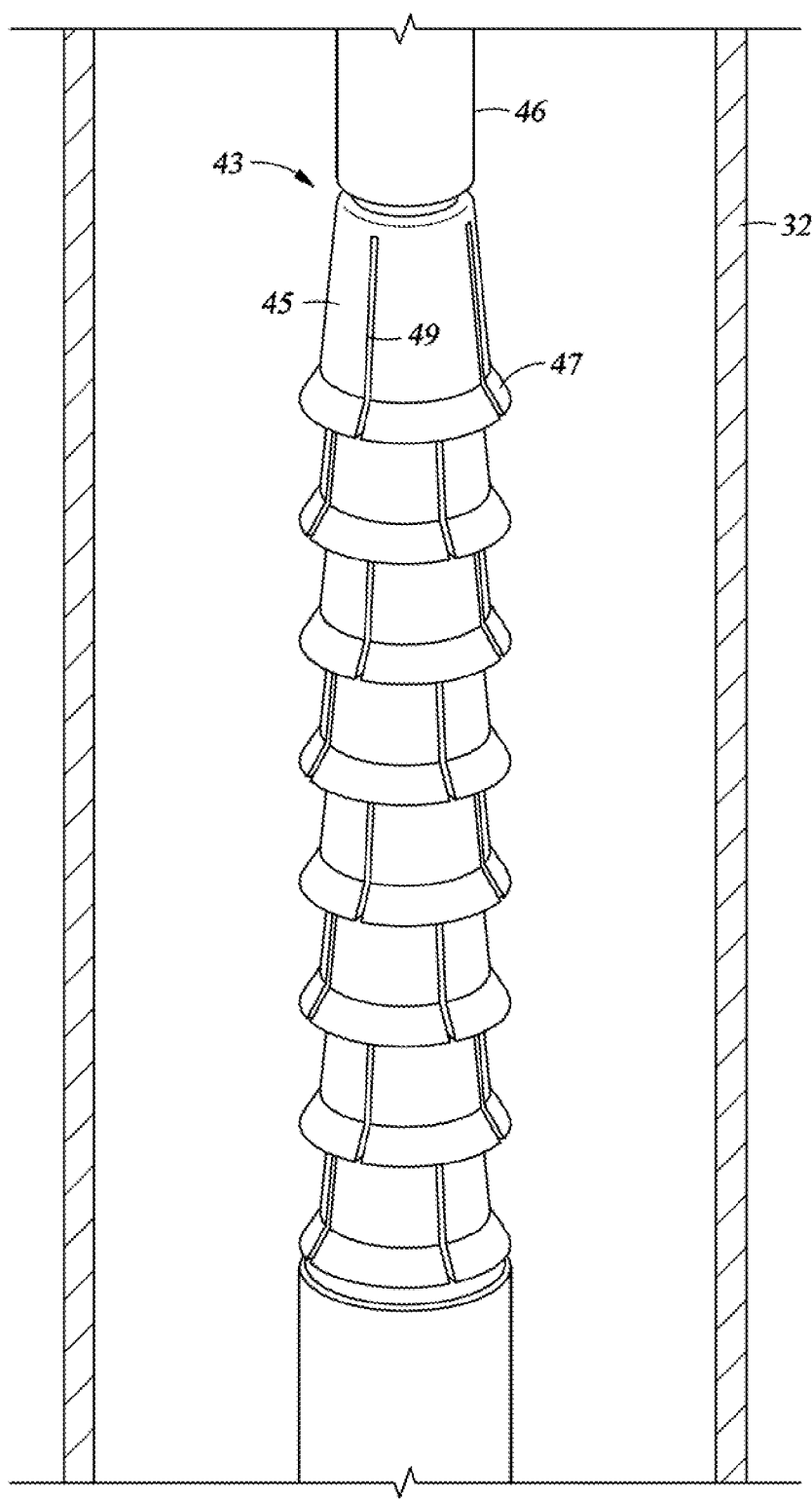


*Fig. 7*

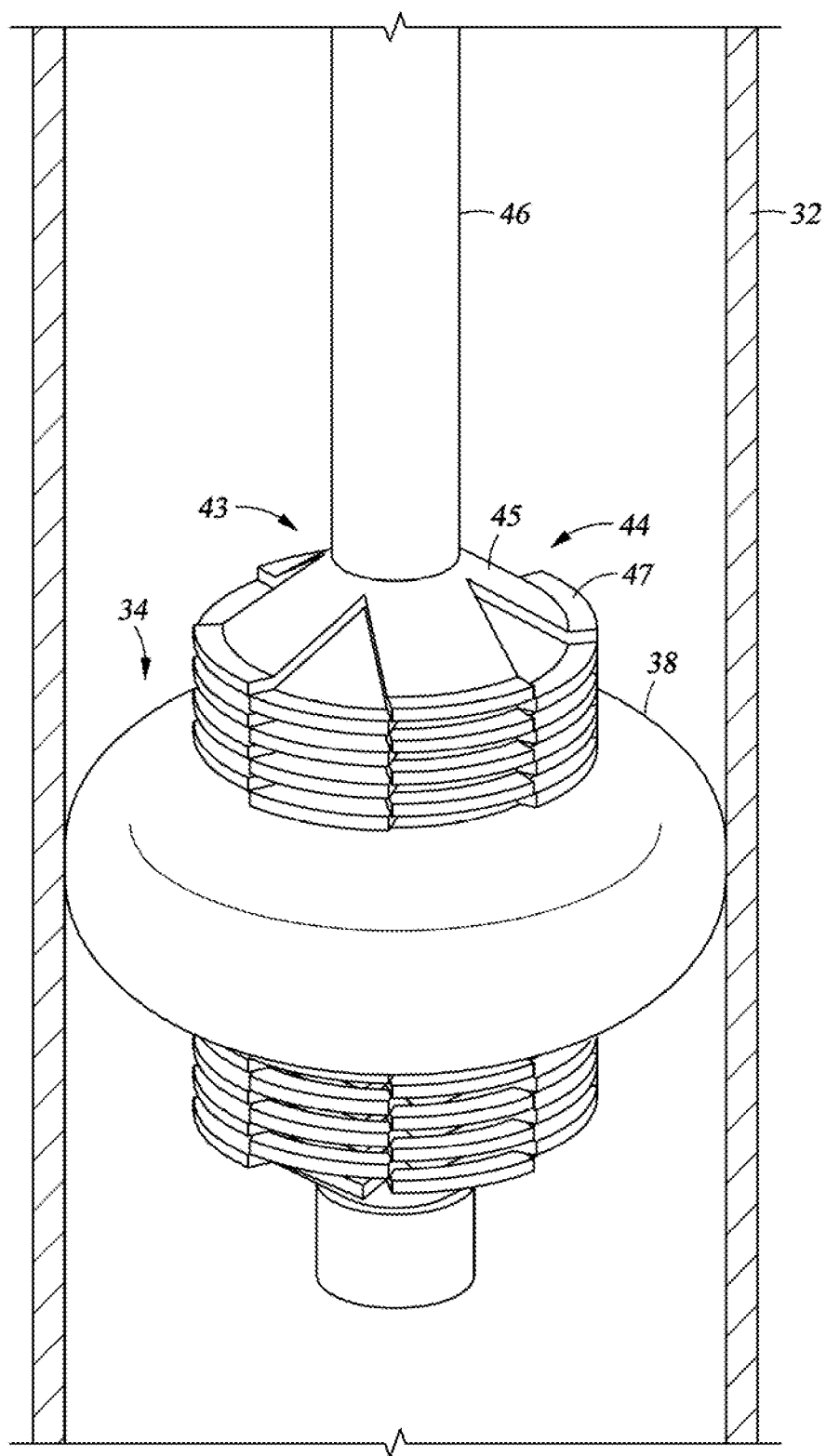


*Fig. 8*

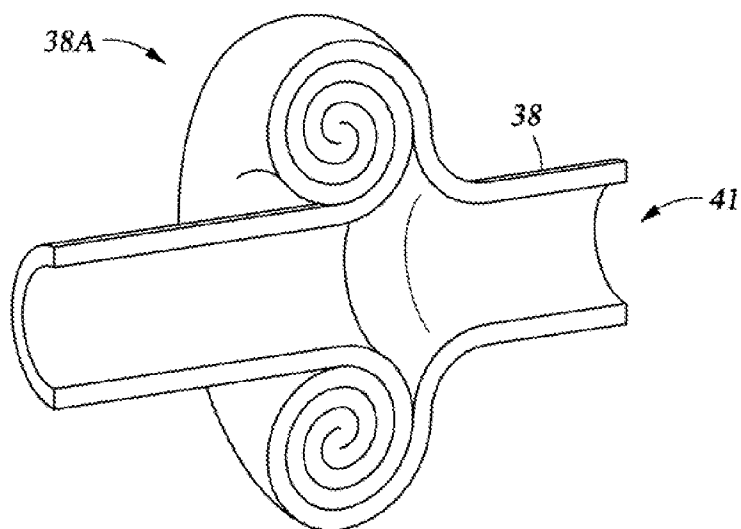


*Fig. 9*

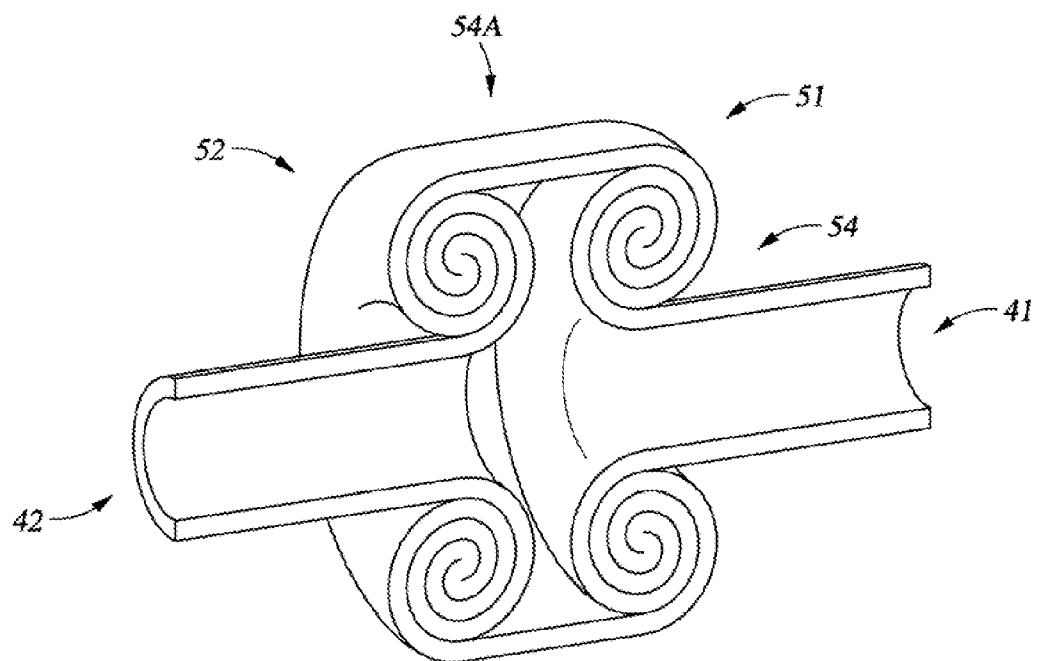


*Fig. 10*

## ROLLING BRIDGE THROUGH TUBING BRIDGE PLUG

### RELATED APPLICATIONS

**[0001]** This application claims priority to and the benefit of U.S. Provisional Application No. 61/160,458, filed on Mar. 16, 2009, the full disclosure of which is hereby incorporated by reference herein.

### BACKGROUND

**[0002]** 1. Field of Invention

**[0003]** The invention relates generally to the field of oil and gas production. More specifically, the present invention relates to a system and method for plugging tubing within a borehole.

**[0004]** 2. Description of Prior Art

**[0005]** Downhole plugs are used to block flow through a wellbore tubular or downhole bore for isolating a portion of the tubular. Downhole plugs, also referred to as bridge plugs, can include a mandrel having a portion circumscribed by an expandable element. The elements are typically formed from an elastomeric member or coaxially stacked members. Downhole plugs can be selectively set into place by expanding the membrane or collapsing the stacked members to block the annular space between the mandrel and tubular or bore. Plug or packer setting can occur by axially compressing the mandrel or by filling the elastomeric member with a pressurized fluid. The tubulars can be casing or production tubing. Example bridge plugs can be permanently set into a downhole tubular, or removable for later retrieval.

### SUMMARY OF INVENTION

**[0006]** Disclosed herein is a bridge plug assembly that can be set to block flow in a tubular, or to block flow in an annulus between two tubulars. In one example, the bridge plug assembly is made up of a mandrel circumscribed by an annular flexible member. The flexible member can have first and second ends and between the first and second ends is a portion where the sidewall of the flexible member has been rolled into an annular volute that projects radially outward into the annular space between the mandrel and the tubular. The bridge plug assembly can include an elongated continuous web member used for rolling the sidewall into a volute. In this example a portion of the web member is disposed between the flexible member and the mandrel. The web member exits the flexible member at the first end of the flexible member and projects into a space outside the flexible member and between the first and second ends of the flexible member. By pulling on the web member in a direction away from the first end the flexible member is turned inside out to form the volute. Optionally included with the embodiment of the bridge plug assembly is a ring like lip formed on the first end of the flexible member. An annular neck portion may be included adjacent the lip that is defined where the thickness of the flexible member is reduced. Additional elongated continuous web members may optionally be included and wherein free ends of the web members opposite the ends along the mandrel can be joined together to form a web harness. Example embodiments exist where the web harness connects to a downhole device. The web member can, in an example embodiment, be substantially planar with first and second planar surfaces, and wherein the first surface faces the mandrel in the portion of the web member that is between the

flexible member and the mandrel and wherein the first surface faces away from the mandrel in the outer portion of the web member. Additional example embodiments exist having a cable head attached to an end of the mandrel for attachment to a wireline.

**[0007]** In another example embodiment, included are first and second annular flange members inserted respectively into first and second ends of the flexible member. The flange members can be slidable along the mandrel. In one embodiment, further included is a collar around the mandrel that is made up of planar leaf members that project from a middle section of the collar. The leaf members can pivot from an orientation that is substantially parallel with an axis of the mandrel radially outward from the mandrel. When pivoted outward, the leaf members can form a support for the volute that resists forces directed axial to the mandrel. Example embodiments exist having a plurality of collars on opposing sides of the volute. An annular sleeve may be included that slides over the mandrel and selectively contacts the collars and provide a force for outwardly pivoting the leaf members to support the volute. Operation of the sleeve can also produce outward bulging of the sleeve. In an embodiment the flexible member is attached to one of the flange members along a greater axial length than the other flange member.

**[0008]** Also disclosed herein is a method of setting a bridge plug in a wellbore tubular. In an example the method includes inserting a bridge plug assembly into a downhole tubular where the bridge plug assembly includes a mandrel and a flexible member circumscribing a portion of the mandrel. In the example method the annular flexible member is converted into a volute having a rolled up portion that fills some of the annular space between the mandrel and the wellbore tubular. The volute can be created by inverting an end of the flexible member. In an example embodiment, the flexible member is inverted by pulling on a web member that loops from within to outside of the flexible member. Optionally, the volute can be formed by axially compressing the flexible member so the flexible member bulges outward to contacts the tubular to generate a fold in the sidewall of the flexible member. Annular flanges can be inserted into opposing first and second ends of the flexible member. In another alternative, the length of contact between one of the flanges and the flexible member can be greater than the length of contact between the other flange and the flexible member. In yet another example embodiment, the thickness of the flexible member can vary along the axis of the flexible member so that when the flexible member is compressed the volute is formed that comprises at least two rolls of the sidewall of the flexible member.

### BRIEF DESCRIPTION OF DRAWINGS

**[0009]** Some of the features and benefits of the present invention having been stated, others will become apparent as the description proceeds when taken in conjunction with the accompanying drawings, in which:

**[0010]** FIG. 1 is a sectional side view of an example of a bridge plug assembly as described herein in a non-deployed configuration.

**[0011]** FIG. 2 is a perspective view of an example of the bridge plug assembly of FIG. 1 in a deployed configuration.

**[0012]** FIG. 3 is a side sectional view of the bridge plug assembly of FIG. 2.

**[0013]** FIGS. 4-5 are side sectional views of an example embodiment of an alternative bridge plug assembly in a non-

deployed configuration and disposed in a tubular in accordance with the present disclosure.

[0014] FIG. 6 is a side sectional view of the alternative bridge plug assembly of FIGS. 4 and 5 deployed in a tubular.

[0015] FIG. 6A is a side schematic view of a formation step of the bridge plug assembly of FIG. 6.

[0016] FIG. 7 is a perspective view of the alternative bridge plug assembly of FIGS. 4 and 5 deployed in a tubular.

[0017] FIG. 8 is a perspective view of the alternative bridge plug assembly of FIG. 7 in a deployed configuration.

[0018] FIG. 9 is an example of a flexible membrane deployed as a single roll.

[0019] FIG. 10 depicts an example of a flexible membrane deployed as a double roll.

[0020] While the invention will be described in connection with the preferred embodiments, it will be understood that it is not intended to limit the invention to that embodiment. On the contrary, it is intended to cover all alternatives, modifications, and equivalents, as may be included within the spirit and scope of the invention as defined by the appended claims.

#### DETAILED DESCRIPTION OF INVENTION

[0021] The present invention will now be described more fully hereinafter with reference to the accompanying drawings in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the illustrated embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout. For the convenience in referring to the accompanying figures, directional terms are used for reference and illustration only. For example, the directional terms such as “upper”, “lower”, “above”, “below”, and the like are being used to illustrate a relational location.

[0022] It is to be understood that the invention is not limited to the exact details of construction, operation, exact materials, or embodiments shown and described, as modifications and equivalents will be apparent to one skilled in the art. In the drawings and specification, there have been disclosed illustrative embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for the purpose of limitation. Accordingly, the invention is therefore to be limited only by the scope of the appended claims.

[0023] FIG. 1 illustrates a sectional view of an example of a bridge plug assembly 18 shown made up of an elongate annular member 22 shown circumscribing a mandrel 20. The annular member 22 may be formed from flexible material such as an elastomer or other polymeric material. An opening 27 is on an upper end 24 of the annular member 22 in which the mandrel 20 is inserted. At the opening 27, the annular member 22 approximates a ring like structure to define a lip 28. The thickness of the flexible member 22 reduces adjacent to the lip 28 to form a neck portion 26 that extends along the annular member 22 a distance directed away from the open end 27. The neck portion 26 extends between the lip 28 and a transition 29 where the thickness of the annular member 22 is shown increasing. The thickness of the annular member 22 is shown linearly increasing along the transition 29, however embodiments exist having non-linear, including exponential, thickness changes.

[0024] A web harness 30 is provided having web members 31 shown wrapped around the upper end 24 of the annular member 22. The web members 31 extend generally lengthwise on the inner and outer surfaces of the annular member 22. The web members 31 of FIG. 1 are shown between the annular member 22 and the mandrel 20, wrapped transverse around the lip 28 between the inner and outer surface of the annular member 22, and projecting along at least a portion of the outer surface of the annular member 22 substantially parallel with the portion of the web member 31 set inside the annular member 22. The web members 31 of FIG. 1 are substantially elongate planar strips. Example materials used in the web materials include ductile metals, woven fibers, where the fibers can be made of natural materials such as cotton, aramid, polymers, and combinations thereof.

[0025] Referring now to FIG. 2, the bridge plug assembly 18A is shown in a deployed configuration where, starting at the opening 27 of the upper end 24, the annular member 22 is rolled over itself and reshaped into an annular volute 22A. As described in detail below, the annular volute 22A is formed by pulling the web members 31 on the outer surface of the annular member 22 in a direction away from the opening 27. The free ends of the web members 31 on the outer surface of the annular member 22 are joined together by a link 33. In the embodiment of FIG. 2, the link 33 is shown at an end of the web harness 30 distal from where the web members 31 loop over the lip 28 (FIG. 1). The ends of the web members 31 on the inner surface of the annular member 22 are joined to the mandrel 20. When in use in a borehole (not shown), the orientation of the bridge plug assembly 18 can be downward facing with the link 33 disposed farther downhole than the mandrel 20. Alternatively, the bridge plug assembly 18 can be upward facing so that the link 33 is disposed farther uphole than the mandrel 20. The link 33 can be secured to a downhole device 19 to provide a holding force represented by the direction of the arrow  $A_H$ . The downhole device 19 can be an anchor (not shown) that couples to a tubular, a perforating gun, a packer device, a plug device, acoustic and/or nuclear interrogation devices, as well as combinations thereof.

[0026] Illustrated in FIG. 2 is an example of how the bridge plug assembly 18 is changed into a deployed configuration that can block flow within a tubular. In this example a force is applied in the direction of arrow  $A_W$  while another force, illustrated by arrow  $A_T$ , is applied to the mandrel 20. The forces represented by arrows  $A_H$ ,  $A_T$  pull the web members 31 on the outer surface of the annular member 22 in a direction parallel to  $A_H$ . Since one of the ends of the web members 31 are joined to the mandrel 20, the portions of the web members 31 between the annular member 22 and mandrel 20 are “peeled” away from the mandrel 20. The peeling action puts the web members 31 in a curling motion that rolls the lip 28 along the axis  $A_X$  of the mandrel 20. The decreased thickness of the neck portion 26 promotes rolling of the ring 28. In an alternative, a wireline 25 may be attached to the mandrel 20 via a cablehead 21 for deploying the bridge plug assembly 18 within the borehole.

[0027] As shown in the cross sectional embodiment of FIG. 3, the volute 22A is made up of layers 23 of the annular member 22. Rolling the lip 28 as described above encapsulates the lip 28 within the annular member 22 thereby forming an annular laminate. Thus continued urging of the web member 31 in direction of arrow  $A_H$  perpetuates rotation of the lip 28 further adding layers 23 to the volute 22A and increasing the outer circumference of the volute 22A. Optionally, an

upward pull on the mandrel 20, represented by arrow  $A_T$ , such as from a wire line or slick line (not shown), can form the volute 22A. In an example of use, the bridge plug assembly 18 is deployed within a tubular 32, where the bridge plug assembly 18 can be upward or downward facing. The tubular 32 can be wellbore tubing, casing, or a production pipeline. An axial force, such as represented by  $A_T$ ,  $A_{WP}$ , or both, is applied to the bridge plug assembly 18 thereby peeling the web members 31 from the mandrel 20. As described above, the peeling action creates a volute 22A that increases in diameter with continued applied force. The applied force can be removed when the volute 22A has a desired diameter. In the example embodiment illustrated in FIG. 3, the volute 22A has an outer diameter that is about at least as great as the diameter of the annulus within the tubular 32 thereby providing a blocking bridge plug in the tubular 32. Alternatively, the outer diameter of the volute 22A may be less than the inner diameter of the annulus in the tubular 32, thereby regulating flow through the tubular 32. In this example, the amount of flow regulation can depend on the outer diameter of the volute 22A. In yet another alternative, the force or forces can be continue to be applied to the bridge plug assembly 18, 18A after the outer diameter of the volute 22A grows to match or exceed the inner diameter of the annulus in the tubular 32. Depending on the amount or duration of applied force, the volute 22A can become wedged in the annular space between the mandrel 20 and tubular 32 so that a substantial force is required to dislodge the volute 22A from within the tubular 32. In an example embodiment, the deployed bridge plug assembly 18A may be dislodged from within the tubular 32 by applying an axial force to the mandrel 20 in a direction opposite  $A_T$ .

[0028] Referring now to FIGS. 4 and 5, a side sectional view of an alternative embodiment of a bridge plug assembly 34 is illustrated. In this embodiment, the bridge plug 34 is depicted being disposed within a tubular 32, which can be production tubing as well as casing. The bridge plug assembly 34 of this embodiment includes an upper and lower series of collars 35, 37 coaxially disposed around an annular mandrel 36. It should be pointed out, however, that the position of the upper and lower series of collars 35, 37 is chosen for reference and may be reversed within a particular application. The series of collars 35, 37 each include individual annularly shaped collars 44, that as shown in the initial configuration, are made up of leaf members 45.

[0029] The embodiment of the bridge plug assembly 34 depicted in FIGS. 4 and 5 are shown in a non-blocking configuration to allow for insertion of the bridge plug assembly 34 within the tubular 32. In the non-blocking configuration, the leaf members 45 (FIG. 5) are generally planar and elongate shown disposed parallel with an axis  $A_{BP}$  of the assembly 34. Flared ends 47 are provided on the detached or free end of each of the leaf members 45. Each flared end 47 is oriented at an angle with respect to the remaining portion of each leaf member 45 so that when the leaf members 45 are disposed generally parallel with the mandrel 36 the flared ends 47 project away from the mandrel 36.

[0030] An annularly shaped flexible member 38 circumscribes the mandrel 36 in an axial space between the upper series of collars 35 and the lower series of collars 37. Flange members 48 are illustrated set within opposing ends of the flexible member 38. The flange members 48 each include a tubular portion shown inserted within the openings on each end of the flexible member 38. A shoulder projects radially outward from an end of the tubular portion. The flange mem-

bers 48 are disposed so that the shoulder is set against the ends of the flexible member 38. The side of each shoulder opposite from the elastic member 38 contacts with the collar 44 closest to the flexible member 38.

[0031] The assembly 38 further includes a cylindrically shaped bottom end 50 shown formed on an end of the mandrel 36 and having a diameter greater than the diameters of the collars 44. The bottom end 50 is provided on the end of the lower series of collars 37 opposite where the series of collars 37 contact one of the flange members 48. A sliding sleeve 46 is provided on the end of the assembly 38 opposite the bottom end 50. The sleeve 46 is annularly shaped and receives the upper end of the mandrel 36 within its annulus.

[0032] A side perspective view of the upper series of collars 35 and flexible member 38 is provided in FIG. 7. In this embodiment, slits 49 are shown extending along a portion of the length of the collars 44 thereby defining the lateral periphery of the leaf members 45. Additionally, an opening 43 is formed through the collar 44 for receiving the tubular 36 axially therethrough and to slide thereon. The collars 44 are shown arranged so that the slits 49 on adjacent collars 44 are at different circumferential locations around the mandrel 36.

[0033] A deployed configuration of the assembly 34 is provided in a perspective view in FIG. 8. As shown, the sleeve 46 has been urged over the tubular 36 and moved towards the bottom end 50 thereby coaxially sliding the collars 44 over one another to form a stacking configuration. Stacking the collars 44 outwardly pivots the leaf members 45 from the mandrel 36 forming a backstop that sets against the opposing ends of the flexible member 38. By stacking the collars 44 as shown in FIG. 8, the outer periphery of the collars 44 is increased, thereby supporting the flexible member 38 from buckling in this vicinity. Compressing the flexible member 38 bulges the midsection outward and into sealing contact with the inner surface of the tubular 32.

[0034] With reference now to FIG. 6, a side sectional view of the assembly 34 is shown in a deployed configuration where the flexible member 38 has been formed into a volute 38A. Manipulating the flexible member 38 into a volute 38A provides a more dense material between the mandrel 36 and outer tubular 32. The higher density volute 38A has an increased resistance to pressure differential than an inflated plug, and thus can operate in higher pressure environments. Optionally, the sleeve 46 may include a piston 40 attached on an upper end that slides within the tubular 36 as the sleeve 46 is urged against the collars 44.

[0035] In one example of use, the flexible member 38 is strategically mounted within the assembly 34 so that during deployment the flexible member 38 takes on the shape of the volute 38A. For example, with reference to FIG. 6, the portion of the flexible member 38 attached to the flange member 48 proximate the piston 40 is longer than the portion of the flexible member attached to the flange member 48 distal the piston. FIG. 6A is a schematic representation illustrating an example of axially compressing the flexible member 38 causing it to bulge radially outward. As shown, additional axial compression of the flexible member 38 generates a fold 53 in the sidewall of the flexible member 38. An upper attachment length  $L_U$  and lower attachment length  $L_L$  are shown respectively at ends of the flexible member 38 that schematically represent attachment lengths between the flexible member 38 and flange members 48. Although in the embodiments of FIG. 6 and FIG. 6A the upper attachment length  $L_U$  is greater than the lower attachment length  $L_L$ , embodiments exist having

the lower attachment length  $L_L$  being the longer of the two. Having unequal attachment lengths along opposing ends of the flexible member 38 locates the bulge between the mid-point of the flexible member 38 and the end having the shorter attachment length. Moving the flange member 48 distal from the bulge further compresses and outwardly bulges the flexible member 38 so that the tip of the bulge contacts the inner surface of the tubular 32. Friction between the wall of the tubular 32 and flexible member 38, coupled with the force directed to the flexible member 38 by the flange members 48, generates a torque in the sidewall of the flexible member 38 causing the initial fold 53. Further inward movement of the flange member 48 towards the opposing flange member 48 spirals the fold 53 within the wall of the flexible member 38 thereby forming the volute 38A of FIG. 6. Optionally, the flexible member 38 can have a varying thickness to induce formation of the fold 53.

[0036] In FIG. 9, a sectional view is depicted of the flexible member 38 having a portion manipulated into a volute 38A. In FIG. 10, an alternative flexible member 54 is shown in a sectional view having a volute 54A made up of first and second rolls 51, 52. In this example, the flexible member 54 has first and second openings 41, 42 at opposing ends and where the thickness of the flexible member 54 varies from adjacent the first opening 41 and the second opening 42. By strategically adjusting the thickness of the flexible member 54 in this fashion, initial folds (not shown) can be formed to produce the first and second rolls 51, 52 as shown.

[0037] The present invention described herein, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned, as well as others inherent therein. While a presently preferred embodiment of the invention has been given for purposes of disclosure, numerous changes exist in the details of procedures for accomplishing the desired results. These and other similar modifications will readily suggest themselves to those skilled in the art, and are intended to be encompassed within the spirit of the present invention disclosed herein and the scope of the appended claims. In an example embodiment, disclosed is a bridge plug assembly for use in a tubular comprising, a mandrel, an annular flexible member circumscribing a portion of the mandrel and having first and second ends, an elongated continuous web member having a portion disposed between the flexible member and the mandrel that exits the flexible member at the first end of the flexible member, and an outer portion disposed in a space past an outer diameter of the flexible member and between the first and second ends of the flexible member, so that when the bridge plug assembly is inserted within a tubular and the outer portion is pulled in a direction away from the first end, the flexible member is inverted at the first end to form a volute that projects radially outward into the annular space between the mandrel and the tubular.

What is claimed is:

1. A bridge plug assembly for use in a tubular comprising; a mandrel; and an annular flexible member circumscribing a portion of the mandrel, having first and second ends and that a portion that is fashioned into a volute that projects radially outward into the annular space between the mandrel and the tubular.
2. The bridge plug of claim 1, further comprising an elongated continuous web member having a portion disposed between the flexible member and the mandrel that exits the flexible member at the first end of the flexible member, and an

outer portion disposed in a space past an outer diameter of the flexible member and between the first and second ends of the flexible member, so that when the bridge plug assembly is inserted within a tubular and the outer portion is pulled in a direction away from the first end, the flexible member is inverted at the first end to form a volute

3. The bridge plug of claim 2, wherein a ring like lip is formed on the first end of the flexible member and adjacent the lip the thickness of the flexible member reduces to define an annular neck portion.

4. The bridge plug of claim 2, further comprising additional elongated continuous web members, wherein the web members each have ends coupled to the mandrel and free ends that are distal the ends attached to the mandrel that are joined together to form a web harness.

5. The bridge plug of claim 4, wherein the web harness is selectively attachable to a downhole device.

6. The bridge plug of claim 2, wherein the web member is substantially planar with first and second planar surfaces, and wherein the first surface faces the mandrel in the portion of the web member that is between the flexible member and the mandrel and wherein the first surface faces away from the mandrel in the outer portion of the web member.

7. The bridge plug of claim 1, further comprising a cable head attached to an end of the mandrel for attachment to a wireline.

8. The bridge plug of claim 1, further comprising a first annular flange member coaxially coupled within the first end of the flexible member that is slidable along the mandrel and a second annular flange member coaxially coupled within the second end of the flexible member.

9. The bridge plug of claim 8, further comprising a collar coaxially disposed around the mandrel and comprising planar leaf members projecting from a mid portion of the collar and that are selectively oriented substantially parallel with an axis of the mandrel and selectively pivotable radially outward from the mandrel.

10. The bridge plug of claim 9, wherein when the leaf members are pivoted radially outward a support is formed for the volute to resist directions axial to the mandrel.

11. The bridge plug of claim 9, further comprising a plurality of collars on a side of the volute to form an upper series of collars and another plurality of collars on a side of the volute opposite the upper series of collars to define a lower series of collars.

12. The bridge plug of claim 11, further comprising an annular sleeve that is slideable over the mandrel and having an end in selective contact with the upper series of collars, so that when the sleeve is pushed downward against the upper series of collars, the leaf members pivot radially outward and axially support the volute.

13. The bridge plug of claim 11, further comprising an annular sleeve that is slideable over the mandrel and having an end in selective contact with the upper series of collars, so that when the sleeve is pushed against the collars, one of the flange members is moved towards the other flange member to cause the flexible member to bulge radially outward from the mandrel and into contact with the tubular.

14. The bridge plug of claim 13, wherein the length of axial attachment between the first end of the flexible member and the first annular flange is greater than the length of axial attachment between the second end of the flexible member and the second annular flange, so that the flexible member

bulges radially outward at a position between the mid point of the flexible member and the second annular flange.

**15.** A method of setting a bridge plug in a wellbore tubular comprising:

inserting into the tubular a bridge plug assembly comprising a mandrel, and a flexible member circumscribing a portion of the mandrel;

fashioning a portion of the flexible member into a volute so that the volute extends into an annular space between the mandrel and the wellbore tubular.

**16.** The method of claim **15**, wherein fashioning a portion of the flexible member into a volute comprises inverting an end of the flexible member.

**17.** The method of claim **16**, wherein the flexible member has a first and a second end and the bridge plug assembly further comprises a web element that extends between the flexible member and the mandrel, exits from within the flexible member through the first end, and outside of the flexible member, the web element loops towards the second end of the flexible member, so that pulling the web element in a direction away from the first end and towards the second end inverts the flexible member.

**18.** The method of claim **15**, wherein fashioning a portion of the flexible member into a volute comprises axially compressing the flexible member and causing the flexible member to bulge outward and into contact with the tubular and form a fold in the sidewall of the flexible member.

**19.** The method of claim **18**, wherein a first annular flange is inserted into a first end of the flexible member and an upper connection is formed between the flexible member and the first annular flange and a second annular flange is inserted into a second end of the flexible member and a lower connection is formed between the flexible member and the second annular flange wherein the axial length of the upper connection is greater than the axial length of the lower connection.

**20.** The method of claim **18**, wherein planar collars that circumscribe the mandrel are provided on opposing sides of the flexible member that pivot radially outward when the flexible member is compressed and provide support for the volute.

**21.** The method of claim **18**, wherein the thickness of the flexible member varies so that when the flexible member is compressed the volute is formed that comprises at least two rolls of the sidewall of the flexible member.

\* \* \* \* \*