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(71) Applicant: **HALLIBURTON ENERGY SYSTEMS, INC.** [US/US]; 3000 N. Sam Houston Parkway E., Houston, Texas 77032-3219 (US).

(72) Inventors: **VEIT, Jan**; 3021 Dover Drive, Plano, Texas 75075 (US). **GOMMEL, Matthew Ryan**; 6412 Rolling HIll Road, The Colony, Texas 75056 (US).

(74) Agent: **HALBUR, Zachary A.**; Haynes and Boone, LLP, 2323 Victory Avenue, Suite 700, Dallas, Texas 75219 (US).

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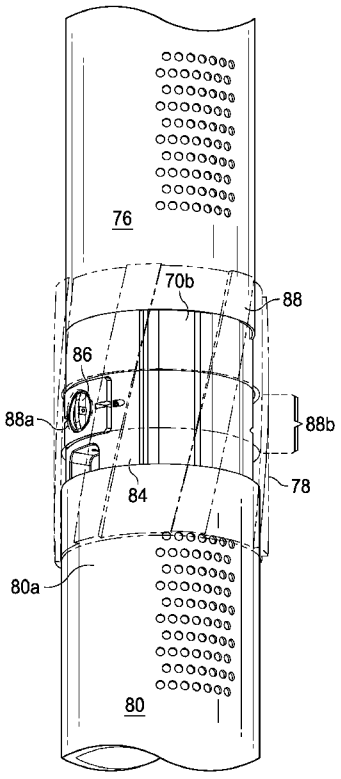

Fig. 4

(57) Abstract: An assembly adapted to be disposed within an oil or gas wellbore and including first and second completion joints, each including a base pipe, a shunt tube disposed along the base pipe, and a tubular outer shroud disposed about respective portions of the shunt tube and the base pipe; a jumper tube coupling the shunt tube of the first completion joint to the shunt tube of the second completion joint; and a tubular sliding shroud disposed about at least one of the first and second completion joints and adapted to slide longitudinally to a run-in position, in which the tubular sliding shroud is disposed about the jumper tube and respective portions of the first and second completion joints, thereby covering the jumper tube. A method and apparatus are also provided.

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SHUNT SYSTEM WITH SHROUD SECURED BY A LOCKING MEMBER

TECHNICAL FIELD

The present disclosure relates generally to well completion and production operations and, more specifically, to facilitating the making-up of a completion joint on an oil or gas platform by utilizing a shunt system with a shroud secured by a locking member.

BACKGROUND

In the process of completing an oil or gas well, a tubular is run down-hole and used to communicate fluids between the surface and the formation. During production, a well-screen assembly may be utilized to control and limit debris such as gravel, sand, or other particulates from entering the tubular and being communicated to the surface. The well-screen assembly is coupled to the tubular and includes several completion joints connected in series with one another. A gravel-packing operation may be utilized to form the filter around the well-screen assembly within the wellbore. During the gravel-packing operation, a slurry containing a particulate material is communicated from the surface to the wellbore. The particulate material is packed around the well-screen assembly to form a permeable mass, through which fluid is permitted to flow. Shunt tubes may be disposed longitudinally along the completion joints of the well-screen assembly to provide an alternate flow path for the slurry during the gravel-packing operation. The shunt tubes are in communication with the wellbore and operate to reduce sand-bridging during the gravel-packing operation, i.e., blockages formed in the wellbore by accumulated particulate material, which could inhibit the flow of the slurry around the well-screen assembly. The shunt tubes are susceptible to damage when the tubular and well-screen are run down-hole from the surface. However, a significant amount of time and tools are needed to install components capable of adequately protecting the shunt tubes before the completion joints are run down-hole. Therefore, what is needed is a system, assembly, method, or apparatus that addresses one or more of these issues, and/or other issues.

BRIEF DESCRIPTION OF THE DRAWINGS

Various embodiments of the present disclosure will be understood more fully from the detailed description given below and from the accompanying drawings. In the drawings, like reference numbers may indicate identical or functionally similar elements.

FIG. 1 is a schematic illustration of an offshore oil and gas platform operably coupled to a lower completion string disposed within a wellbore, the lower completion string including a well-screen assembly, according to an exemplary embodiment.

FIG. 2 is a perspective partial cut-away view of a completion joint from the well-screen assembly of FIG. 1, according to an exemplary embodiment.

FIGS. 3A-3D each illustrate a perspective partial-sectional view of the well-screen assembly of FIG. 1, including two completion joints substantially identical to the completion joint of FIG. 2 and connected in series with one another, according to an exemplary embodiment.

FIG. 4 is an enlarged perspective view of a portion of FIG. 3D including a locking mechanism, according to an exemplary embodiment.

FIG. 5 is a perspective view of a portion of the locking mechanism of FIG. 4, according to an exemplary embodiment.

FIG. 6 is an exploded view of the portion of the locking mechanism shown in FIG. 5, according to an exemplary embodiment.

FIGS. 7A-7D each illustrate a cross-sectional view of the portion of the locking mechanism shown in FIG. 5, each of the respective cross-sectional views being taken along line 7-7 of FIG. 5 and depicting different operational positions of the locking mechanism, according to an exemplary embodiment.

FIG. 8 is a perspective view of a portion of the locking mechanism of FIG. 4, according to another exemplary embodiment.

FIGS. 9A and **9B** each illustrate a cross-sectional view of the portion of the locking mechanism shown in FIG. 8, each of the respective cross-sectional views being taken along line 9-9 of Fig. 8 and depicting different operational positions of the locking mechanism, according to an exemplary embodiment.

DETAILED DESCRIPTION

Illustrative embodiments and related methods of the present disclosure are described below as they might be employed in a shunt system with a connection shroud secured by a centralizer. In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure. Further aspects and advantages of the various embodiments and related methods of the disclosure will become apparent from consideration of the following description and drawings.

The following disclosure may repeat reference numerals and/or letters in the various examples. This repetition is for the purpose of simplicity and clarity and does not in itself dictate a relationship between the various embodiments and/or configurations discussed. Further, spatially relative terms, such as "beneath," "below," "lower," "above," "upper," "up-hole," "down-hole," "upstream," "downstream," and the like, may be used herein for ease of description to describe one element or feature's relationship to another element(s) or feature(s) as illustrated in the figures. The spatially relative terms are intended to encompass different orientations of the apparatus in use or operation in addition to the orientation depicted in the figures. For example, if the apparatus in the figures is turned over, elements described as being "below" or "beneath" other elements or features would then be oriented "above" the other elements or features. Thus, the exemplary term "below" may encompass both an orientation of above and below. The apparatus may be otherwise oriented (rotated 90 degrees or at other orientations) and the spatially relative descriptors used herein may likewise be interpreted accordingly.

In an exemplary embodiment, as illustrated in **FIG. 1**, a lower completion string is installed in a well from an offshore oil or gas platform that is schematically illustrated and generally designated 10. A semi-submersible platform 12 is positioned over a submerged oil and gas formation 14 located below a sea floor 16. A subsea conduit 18 extends from a deck

20 of the platform 12 to a subsea wellhead installation 22, which includes blowout preventers 24. The platform 12 has a hoisting apparatus 26, a derrick 28, a travel block 30, a hook 32, and a swivel 34 for raising and lowering pipe strings, such as a substantially tubular, axially extending tubing string 36.

A wellbore 38 extends through the various earth strata including the formation 14 and has a casing string 40 cemented therein. A generally tubular lower completion string 50 is connected to, and/or is part of, the tubing string 36. The lower completion string 50 is disposed in a substantially horizontal portion of the wellbore 38 and includes one or more completion sections 52 such as, for example, completion sections 52a-c. Completion sections 52a-c correspond to different zones of the formation 14. An annulus 54 is defined between the lower completion string 50 and the casing string 40. Isolation packers 56, such as, for example, isolation packers 56a-d, each form a seal preventing annular flow within the annulus 54 and fluidically isolating each of the completion sections 52a-c. In an exemplary embodiment, one or more of the isolation packers 56a-d are hydraulic set packers. In several exemplary embodiments, one or more of the isolation packers 56a-d are other types of packers that are not hydraulic set packers, such as, for example, mechanical set packers, tension set packers, rotation set packers, inflatable packers, another type of packer capable of sealing the annulus 54, or any combination thereof. Each completion section 52a-c includes a respective well-screen assembly 58a-c and a respective packing valve 60a-c. Several intervals of the casing string 40 are perforated adjacent the well-screen assemblies 58a-c.

Generally, with continuing reference to FIG. 1, the operation of the lower completion string 50 includes communicating a slurry (not shown), made up of a carrier fluid and a particulate material, within a work string (not shown) from the surface to the completion sections 52a-c. The packing valves 60a-c correspond to the completion sections 52a-c, respectively, and direct the slurry into the annulus 54. The slurry flows through the perforations in the casing string 40 into the formation 14 and/or through the well-screen assembly 58 and back up the work string (not shown) to the surface. In an exemplary embodiment, a fracturing operation is performed wherein the carrier fluid transports the particulate material (in this case, proppant) into the formation 14, thereby propping open induced fractures in the formation 14. In another exemplary embodiment, a gravel-packing operation is performed wherein the particulate material (in this case, gravel) is packed around

the well-screen assembly 58 to form a gravel-pack filter, i.e., a permeable mass of gravel through which fluid is allowed to flow that prevents, or at least reduces, the flow of debris from the formation 14 into the well-screen assembly 58. During production, the well-screen assemblies 58a-c and the gravel-pack filters, in combination, control and limit debris such as gravel, sand, or other particulates from entering the lower completion string 50 and being communicated to the surface. The well-screen assembly 58 includes a shunt system (not visible in **FIG. 1**) disposed longitudinally therealong. The shunt system provides an alternate flow path for the slurry during the gravel-packing operation, thereby preventing sand-bridging, i.e., blockages formed in the annulus 54 by accumulated gravel and/or other accumulated particulates. Such blockages might otherwise inhibit the flow of the slurry along the well-screen assembly 58 during the gravel-packing operation.

Although **FIG. 1** depicts a horizontal wellbore, it should be understood by those skilled in the art that the exemplary embodiments of the present disclosure are equally well suited for use in wellbores having other orientations including vertical wellbores, slanted wellbores, multilateral wellbores or the like. Accordingly, it should be understood by those skilled in the art that the use of directional terms such as "above," "below," "upper," "lower," "upward," "downward," "up-hole," "down-hole" and the like are used in relation to the illustrative embodiments as they are depicted in the figures, the upward direction being toward the top of the corresponding figure and the downward direction being toward the bottom of the corresponding figure, the up-hole direction being toward the surface of the well, the down-hole direction being toward the toe of the well. Also, even though **FIG. 1** depicts an offshore operation, it should be understood by those skilled in the art that the exemplary embodiments of the present disclosure are equally well suited for use in onshore operations. Further, even though **FIG. 1** depicts a cased hole completion, it should be understood that the exemplary embodiments of the present disclosure are equally well suited for use in open hole completions.

As indicated above, each completion section 52a-c includes respective ones of the isolation packers 56a-c, the well-screen assemblies 58a-c, and the packing valves 60a-c. The completion sections 52a-c are substantially identical to one another. Therefore, in connection with **FIGS. 2**, **3A-3D**, **4**, **5**, **6**, **7A-7D**, **8**, **9A**, and **9B**, only one of the completion sections 52a-c will be described in detail below using the foregoing reference numerals, but the

suffixes a-c will be omitted to indicate that the description below applies to any one of the completion sections 52a-c.

Referring to **FIG. 2** with continuing reference to **FIG. 1**, the well-screen assembly 58 includes a plurality of completion joints 64 made up in series with one another, one of which is shown in **FIG. 2**. Each completion joint 64 is made-up as part of the well-screen assembly 58 before it is run downhole from the oil or gas platform 10 for completion operations. Each completion joint 64 includes a base pipe 66 and a screen 68 concentrically disposed thereabout. The base pipe 66 has a first end portion 66a and a second end portion 66b. A plurality of openings (not shown) are formed along intervals in the base pipe 66 beneath the screen 68, thereby allowing fluid to pass into the lower completion string 50. In an exemplary embodiment, the screen 68 is a filter formed of wire or synthetic mesh disposed along the outer surface of the base pipe 66. In several exemplary embodiments, the screen 68 is an elongated tubular member disposed on the base pipe 66 so as to define an annular flow passage (not shown) between the base pipe 66 and the screen 68. The annular flow passage (not shown) directs fluid flow towards the plurality of openings (not shown) in the base pipe 66 and into the lower completion string 50. Each completion joint 64 may also include one or more shunt tubes 70 longitudinally disposed along the outer surface of the base pipe 66 and the screen 68. Each shunt tube 70 includes a packing tube 70a spaced in a parallel relation from a transport tube 70b. The packing tube 70a branches off from the transport tube 70b and includes nozzles (not shown) which direct the flow of the slurry into the annulus 54. Jumper tubes 70c (not visible in **FIG. 2** but shown in **FIG. 3B**) are connected between corresponding transport tubes 70b of successive completion joints 64. The shunt tubes 70 are supported in place by support members 74. The support members 74 are disposed on the base pipe 66 and support the shunt tubes 70 in a generally parallel orientation with one another. A tubular outer shroud 76 is disposed about the completion joint 64 and mounted over the support members 74, thereby covering respective portions of the base pipe 66, the screen 68, and the shunt tubes 70. Each completion joint 64 also includes a locking mechanism 78, a tubular sliding shroud 80, and a shroud retaining member 82, all of which will be described in further detail below.

During the above described gravel-packing operation, in several exemplary embodiments, the packing tubes 70a, the transport tubes 70b, and the jumper tubes 70c

operate to prevent sand-bridging. When a sand-bridge begins to form in the annulus 54, the slurry is forced to enter the transport tubes 70b from the annulus 54. The slurry then flows along the well-screen assembly 58, through the transport tubes 70b and jumper tubes 70c from one completion joint 64 to the next until the slurry is past the sand-bridge, at which point the slurry flows from the transport tubes 70b into the packing tubes 70a and is directed back into the annulus 54 by the nozzles.

In an exemplary embodiment, the well-screen assembly 58 includes several completion joints 64 connected in series with one another, a pair of which are illustrated in **FIGS. 3A-3D**. In order to assemble the well-screen assembly 58, successive connections are made-up between adjacent ones of the completion joints 64 on the floor of the oil or gas platform 10. Each successive connection is made-up after the previously connected pair of completion joints 64 have been displaced toward the wellbore 38 and/or the casing string 40. The process of making-up the connection between adjacent ones of the completion joints 64 will be described in detail below. Specifically, in connection with **FIGS. 3A-3D** and **FIG. 4**, the process of connecting a first completion joint 64a to a second completion joint 64b will be described, the first and second completion joints 64a, 64b being substantially identical to the completion joint 64 described above. As shown in **FIGS. 3A** and **3B**, the first and second completion joints 64a, 64b are connected in series with one another. Specifically, the first end portion 66a of the base pipe 66 from the first completion joint 64a is threadably connected to the second end portion 66b of the base pipe 66 from the second completion joint 64b, as shown in **FIG. 3A**, thereby forming a pin and box connection and providing fluid communication between the base pipes 66 of the first and second completion joints 64a, 64b. Once the respective base pipes 66 of the first and second completion joints 64a, 64b have been connected, the jumper tubes 70c are installed, as shown in **FIG. 3B**. The jumper tubes 70c couple each transport tube 70b disposed along the first completion joint 64a to the corresponding transport tube 70b disposed along the second completion joint 64b, thereby providing fluid communication between the transport tubes 70b of the first and second completion joints 64a, 64b, respectively.

Once the first and second completion joints 64a, 64b have been connected as described above, the sliding shroud 80 may be displaced from its initial position, as shown in **FIGS. 3A** and **3B**, to a run-in position, as shown in **FIGS. 3C** and **3D**. In the run-in position,

the sliding shroud 80 is disposed about the jumper tubes 70c and respective portions of the first and second completion joints 64a, 64b, thereby covering and protecting the jumper tubes 70c when the first and second completion joints 64a, 64b are disposed within the wellbore 38. The sliding shroud 80 includes a first end portion 80a and a second end portion 80b. The shroud retaining member 82 is adapted to receive the second end portion 80b of the sliding shroud 80 as the sliding shroud 80 is displaced into the run-in position, as shown in **FIG. 3C**. The shroud retaining member 82 may be formed, for example, on the outer shroud 76 of the second completion joint 64b.

Once the sliding shroud 80 is in the run-in position, the locking mechanism 78 is operable to secure the first end portion 80a of the sliding shroud 80 to the first completion joint 64a, as shown in **FIG. 3D**. The locking mechanism 78 includes a support member 84, a retractable key 86, and a tubular locking member 88. When the sliding shroud is placed in the run-in position, the upper end 80a of the sliding shroud 80 is located proximate the support member 84. The tubular locking member 88 is adapted to be displaced longitudinally from its initial position, as shown in **FIGS. 3A-3C**, to a locking position, as shown in **FIG. 3D**, in which the tubular locking member 88 is disposed about the support member 84. Once the sliding shroud 80 is in the run-in position and the tubular locking member 88 is in the locking position, the retractable key 86 is operable to secure the tubular locking member 88 in the locking position, as will be discussed in further detail below. In an exemplary embodiment, the tubular locking member 88 is a centralizer. In an exemplary embodiment, the tubular locking member 88 is a sleeve that does not include centralizer vanes. In another exemplary embodiment, the tubular locking member 88 is integrally formed with the first end portion 80a of the sliding shroud 80.

As shown in **FIG. 3D**, in the locking position, the tubular locking member 88 is disposed about the support member 84 and the first end portion 80a of the sliding shroud 80. In an exemplary embodiment, the support member 84 supports the shunt tubes 70. The retractable key 86 is adapted to be moveable between a retracted position and a deployed position. In the retracted position, the retractable key 86 nests within the support member 84 such that the sliding shroud 80 and the tubular locking member 88 may slide freely past the support member 84 into the run-in position and the locking position, respectively. In the deployed position, the retractable key 86 protrudes from the support member 84. An access

port 88a is formed through the tubular locking member 88, allowing access to the retractable key 86 when the tubular locking member 88 is disposed about the support member 84. Once the tubular locking member 88 is in the locking position, the retractable key 86 may be manipulated through the access port 88a and moved to the deployed position in order to secure the tubular locking member 88 about the support member 84.

As shown in **FIG. 4** with continuing reference to **FIGS. 3A-3D**, the retractable key 86 remains in the retracted position until the tubular locking member 88 is moved to the locking position. Once the tubular locking member 88 is in the locking position, the retractable key 86 may be accessed through the access port 88a and placed in the deployed position. The retractable key 86 extends into a cavity 88b formed into the tubular locking member 88 and secures the tubular locking member 88 about the support member 84, thereby trapping the sliding shroud 80 in the run-in position between the shroud retaining member 82 and the locking mechanism 78. When the sliding shroud 80 is trapped in the run-in position, respective portions of the base pipes 66 and the shunt tubes 70 that are longitudinally disposed between the outer shrouds 76 of the first and second completion joints 64a, 64b are covered by the sliding shroud 80, the tubular locking member 88, and the shroud retaining member 82. During the installation and/or operation of the well-screen assembly 58, the tubular locking member 88, the shroud retaining member 82, and the sliding shroud 80 protect the connection between the first completion joint 64a and the second completion joint 64b, including at least the jumper tubes 70c, from any damaging impacts. In an exemplary embodiment, the tubular locking member 88 is omitted and the access port 88a and cavity 88b are formed as part of the sliding shroud 80 itself. In an exemplary embodiment, the above described locking mechanism 78, sliding shroud 80, and shroud retaining member 82 increase the reliability of the connection between successive completion joints 64, reduce the potential for failures in comparison with commonly used designs in shunt systems, and shorten the installation time of successive completion joints 64 on the oil or gas platform 10.

In an exemplary embodiment, as illustrated in **FIG. 5**, the retractable key 86 includes a body 90 and a latch 92. The body 90 of the retractable key 86 is complementarily disposed within a groove 84a formed into the support member 84. In an exemplary embodiment, the profiles of the groove 84a and the body 90 may form any one of a number of shapes such as, for example, circular shapes, triangular shapes, rectangular shapes,

polygonal shapes, other planar shapes, or any combination thereof. A recess 84b is formed into the support member 84 of the locking mechanism 78 proximate the groove 84a. A wall 94a is defined between the groove 84a and the recess 84b. The recess 84b extends from below the groove 84a toward the lower edge of the support member 84. The recess 84b is formed to allow a tool (not shown) to drill a pair of pin-holes 96a, 96b through the wall 94a during the manufacture of the locking mechanism 78. The pin-holes 96a, 96b are spaced in a parallel relation and extend from the recess 84b longitudinally through the wall 94a and into an opposing wall 94b of the groove 84a. In an exemplary embodiment, the recess 84b is omitted and the pin-holes 96a, 96b are formed by another mechanical process, drilling or otherwise.

In an exemplary embodiment, as illustrated in **FIG. 6** with continuing reference to **FIG. 5**, the components of the latch 92 are adapted to fit within a housing formed into the body 90. The housing is defined by a pair of flat-bottomed holes 98a, 98b, a guide-hole 100, and a pin-hole 102. The flat-bottomed hole 98a is formed into the front of the body 90 and the flat-bottomed hole 98b is formed into the back of the body 90. The profile of the flat-bottomed hole 98a forms a generally circular shape and the profile of the flat-bottomed hole 98b forms a generally square shape. In an exemplary embodiment, the profile of the flat-bottomed hole 98b may form a shape that is not a square, such as, for example, a circular shape or the shape of another polygon. Each flat-bottomed hole 98a, 98b has a depth, the depths being configured such that a portion of the body remains between the flat-bottomed holes 98a, 98b. The guide-hole 100 is formed centrally through the remaining portion of the body 90 between the flat-bottomed holes 98a, 98b. The pin-hole 102 extends through opposing side-walls of the flat-bottomed hole 98b and continues through the corresponding edges of the body 90, thereby forming a pair of openings. The pin-hole 102 is alternately aligned with the pin-hole 96a or the pin-hole 96b as the body 90 is received within the groove 84a.

In an exemplary embodiment, with continuing reference to **FIG. 6**, one or more flat-bottomed holes 104 are formed into the back of the body 90. Each flat-bottomed hole 104 accommodates a biasing member 106, which is compressed between the support member 84 and the bottom of the flat-bottomed hole 104, thereby spring-loading the retractable key 86. The biasing members 106 mechanically urge the retractable key 86 outward from the

groove 84a. In an exemplary embodiment, the biasing members 106 are springs. In several exemplary embodiments, the biasing members 106 are another type of biasing members that are not springs, such as, for example, hydraulic cylinders, gas-filled cylinders, magnets, other types of biasing members, or any combination thereof. One or more retaining channels 108 are formed into the front of the body 90 at the edges thereof. The one or more retaining channels 108 each accommodate a retaining pin 110. Each retaining pin 110 is fixed to the support member 84 and extends from a side-wall of the groove 84a into the corresponding retaining channel 108. As the biasing members 106 urge the retractable key 86 outward from the groove 84a, the retaining pins 110 bottom-out in the retaining channels 108, thereby at least partially retaining the body 90 of the retractable key 86 in the groove 84a.

In an exemplary embodiment, as shown in **FIGS. 7A-7D**, with continuing reference to **FIGS. 5** and **6**, the latch 92 includes a cam-shaft 112, a disc 114, a handle 116, a cam 118, and a pair of locking-pins 120. The guide-hole 100 supports the cam-shaft 112, which defines first and second end portions 112a, 112b extending within the flat-bottomed holes 98a and 98b, respectively. The disc 114 is disposed within the flat-bottomed hole 98a. The first end portion 112a of the cam-shaft 112 extends through the disc 114 and is coupled to the handle 116, thereby trapping the disc 114 in the flat-bottomed hole 98a. In an exemplary embodiment, the handle 116 and the disc 114 are integrally formed. The cam 118 is connected to the second end portion 112b of the cam-shaft 112 and is disposed within the flat-bottomed hole 98b. The locking-pins 120 each define a proximal end portion 120a and a distal end portion 120b. The distal end portions 120b of the locking-pins 120 are supported within the pair of openings formed by the pin-hole 102 through opposing side-walls of the flat-bottomed hole 98b. The proximal end portions 120a of the locking-pins 120 are each urged into contact with the cam 118 by a spring 122, each spring 122 being concentrically disposed about one of the locking-pins 120. Each spring 122 is compressed between the side-wall of the flat-bottomed hole 98b and the proximal end portion 120a of one of the locking-pins 120. The springs 122 urge the locking-pins 120 radially toward the cam 118, thereby engaging the proximal end portions 120a of the locking-pins 120 with the cam 118. The cam 118 defines a continuous outer profile having a relatively smaller diameter portion and a relatively larger diameter portion. When the proximal end portions 120a of the locking-pins 120 are urged into contact with the relatively smaller diameter portion of the cam 118, as

shown in **FIGS. 7B** and **7C**, the distal end portions 120b of the locking-pins 120 do not extend into either of the pin-holes 96a, 96b. Alternatively, when the proximal end portions 120a of the locking-pins 120 are urged into contact with the relatively larger diameter portion of the cam 118, as shown in **FIGS. 7A** and **7D**, the distal end portions 120b of the locking-pins 120 extend into either the pin-hole 96a or the pin-hole 96b. A smooth transition between the relatively smaller diameter portion and the relatively larger diameter portion of the cam 118 allows the proximal end portions 120a of the locking-pins 120 to track the profile of the cam 118 as the handle 116 is rotated. As a result, when the handle 116 is rotated, the distal end portions 120b are either driven into the pin-hole 96a or 96b, or retracted from the pin-hole 96a or 96b. In an exemplary embodiment, the cam 118 is omitted and another type of mechanical linkage is utilized to drive and retract the locking-pins 120 into, and out of, the pin-hole 96a or 96b.

FIGS. 7A and **7B** illustrate the retractable key 86 in the retracted position. In the retracted position, the body 90 is pressed into the groove 84a, thereby aligning the pin-hole 102 formed through the side-walls of the flat-bottomed hole 98b with the pin-hole 96a formed into the walls 94a, 94b of the groove 84a. In order to lock the retractable key in the retracted position, as shown in **FIG. 7A**, the handle 116 is rotated. The cam 118 rotates along with the handle 116 and the proximal end portions 120a of the locking-pins 120 track the profile of the cam 118, thereby driving the distal end portions 120b of the locking-pins 120 through the pin-hole 102 and into the pin-hole 96a.

FIGS. 7C and **7D** illustrate the retractable key 86 in the deployed position. In the deployed position, the body 90 is urged outward from the groove 84a by the biasing members 106 until the retaining pins 110 bottom-out in the retaining channels 108, thereby aligning the pin-hole 102 with the pin-hole 96b. In order to lock the retractable key in the deployed position, as shown in **FIG. 7D**, the handle 116 is rotated. The cam 118 rotates along with the handle 116 and the proximal end portions 120a of the locking-pins 120 track the cam 118, thereby driving the distal end portions 120b of the locking-pins 120 through the pin-hole 102 and into the pin-hole 96b.

In an exemplary embodiment, in order to make-up the connection between the first and second completion joints 64a, 64b on the floor of the oil or gas platform 10, the base pipes 66 of the first and second completion joints 64a, 64b are connected to one another. The

jumper tubes 70c are then coupled between corresponding ones of the transport tubes 70b disposed along the first and second completion joints 64a, 64b. Once the respective base pipes 66 and transport tubes 70b have been connected, the sliding shroud 80 is displaced until it reaches the run-in position. In the run-in position, the second end portion 80b of the sliding shroud 80 is received by the shroud retaining member 82 and the first end portion 80a of the sliding shroud 80 is located proximate the support member 84. The tubular locking member 88 is then displaced until it reaches the locking position. During the displacement of the sliding shroud 80 and the tubular locking member 88, the retractable key 86 remains locked in the retracted position. Once the tubular locking member 88 has been placed in the locking position, the handle 116 is rotated through the access port 88a. As the handle 116 is rotated, the springs 122 bias the locking-pins 120 toward the cam 118, causing the proximal end portions 120a of the locking-pins 120 to track the cam 118 from the relatively larger diameter portion to the relatively smaller diameter portion thereof. The distal end portions 120b of the pins 120 are retracted from the pin-hole 96a as the proximal end portions 120a track the cam 118, thereby unlocking the retractable key 86. Once the retractable key 86 is unlocked, the biasing members 106 mechanically urge the body 90 outward from the groove 84a into the deployed position. In the deployed position, a portion of the body 90 is disposed within the cavity 88b formed on the interior surface of the tubular locking member 88. The retractable key 86 is locked in the deployed position by rotating the handle 116 through the access port 88a. As the handle 116 is rotated, the proximal end portions 120a of the locking-pins 120 track the cam 118 from the relatively smaller diameter portion to the relatively larger diameter portion thereof, driving the distal end portions 120b of the locking-pins 120 into the pin-hole 96b. Once the retractable key 86 has been locked in the deployed position, it secures the tubular locking member 88 about the locking mechanism 78, thereby trapping the sliding shroud 80 between the tubular locking member 88 and the shroud retaining member 82. In this position, the sliding shroud 80, the shroud retaining member 82, and the tubular locking member 88 protect the connection between the first and second completion joints 64a, 64b from damaging impacts when they are disposed within the wellbore 38. In an exemplary embodiment, the first and second completion joints 64a, 64b do not require any small tools (wrenches, screwdrivers, etc.) in order to be made-up on the oil or gas platform 10.

In an exemplary embodiment, as illustrated in **FIG. 8** and **FIGS. 9A** and **9B**, the components of the latch 92, including the cam-shaft 112, the disc 114, the handle 116, the cam 118, and the pair of locking-pins 120 are omitted in favor of a screw mechanism 124. Additionally, the pin-hole 102 formed through opposing sidewalls of the flat-bottomed hole 98b is omitted. The screw mechanism 124 includes a shaft 126 having a proximal end portion 126a and a distal end portion 126b. The proximal end portion 126a is attached to a handle 128, which fits complementarily within the flat-bottomed hole 98a. The distal end portion 126b is threaded and extends within the flat-bottomed hole 98b. A threaded hole 130 is formed into the bottom of the groove 84a. The distal end portion 126b is threaded into the threaded hole 130. The body 90 of the retractable key 86 is displaced into the retracted position by manipulating the handle 128 to thread the distal end portion 126b of the shaft 126 into the threaded hole 130. Alternatively, the body 90 of the retractable key 86 is displaced into the deployed position by manipulating the handle 128 to thread the distal end portion 126b of the shaft 126 out of the threaded hole 130.

The present disclosure introduces an assembly adapted to be disposed within a wellbore, the assembly including first and second completion joints, each of which includes a base pipe; a shunt tube disposed along the base pipe; and a tubular outer shroud disposed about respective portions of the shunt tube and the base pipe; a jumper tube coupling the shunt tube of the first completion joint to the shunt tube of the second completion joint; and a tubular sliding shroud disposed about at least one of the first and second completion joints and adapted to slide longitudinally to a run-in position, in which the tubular sliding shroud is disposed about the jumper tube and respective portions of the first and second completion joints, thereby covering the jumper tube. In an exemplary embodiment, respective portions of the base pipes and shunt tubes that are longitudinally disposed between the tubular outer shrouds of the first and second completion joints are covered by the tubular sliding shroud when the tubular sliding shroud is placed in the run-in position. In an exemplary embodiment, a locking mechanism connected to the first completion joint and a retaining member connected to the second joint; wherein the locking mechanism and the retaining member, in combination, are adapted to secure the tubular sliding shroud in the run-in position; and wherein the locking mechanism is operable to secure a first end portion of the tubular sliding shroud and the retaining member is operable to secure a second end portion of

the tubular sliding shroud. In an exemplary embodiment, the locking mechanism includes a support member connected to the first joint; a groove formed into the support member; a key disposed at least partially within the groove; a tubular locking member adapted to be disposed about the first joint, and adapted to slide longitudinally relative to the support member into a locking position; and a cavity formed into the tubular locking member; wherein when the tubular locking member is in the locking position, the tubular locking member is disposed about the support member and the first end portion of the tubular sliding shroud. In an exemplary embodiment, the key is moveable between a retracted position and a deployed position; wherein the key nests within the groove when the key is in the retracted position, such that the tubular sliding shroud and the tubular locking member can slide freely past the support member into the run-in position and the locking position, respectively; wherein the key protrudes from the support member when the key is in the deployed position; and wherein the cavity is adapted to receive the key when the tubular locking member is in the locking position and the key is in the deployed position. In an exemplary embodiment, when the tubular locking member is in the locking position and the key is in the deployed position, the key secures the tubular locking member in the locking position and obstructs longitudinal displacement of the tubular sliding shroud in a first direction. In an exemplary embodiment, the retaining member secures the second end portion of the tubular sliding shroud to the second completion joint when the sliding shroud is in the run-in position, thereby obstructing longitudinal displacement of the tubular sliding shroud in a second direction that is opposite the first direction. In an exemplary embodiment, the tubular locking member is integrally formed with the first end portion of the tubular sliding shroud.

The present disclosure also introduces an apparatus adapted to be disposed within a wellbore, the apparatus including a support member; a groove formed into the support member; a key disposed at least partially within the groove; a tubular sliding member adapted to be displaced longitudinally relative to the support member into a locking position, in which the tubular sliding member is disposed about the support member; and a cavity formed into the tubular sliding member and adapted to receive the key when the tubular sliding member is in the locking position; wherein the key is disposed within both the groove and the cavity to secure the tubular sliding member in the locking position. In an exemplary embodiment, the key is moveable between a retracted position and a deployed position; wherein the key nests

within the groove when the key is in the retracted position, such that the tubular sliding member can slide freely past the support member into the locking position; wherein the key protrudes from the support member when the key is in the deployed position; and wherein the cavity is adapted to receive the key when the tubular sliding member is in the locking position and the key is placed in the deployed position. In an exemplary embodiment, a threaded hole is formed into the support member; wherein the key includes a housing; a shaft supported within the housing, the shaft including opposing first and second end portions, the first end portion being threaded; and a handle disposed within the housing and connected to the second end portion of the shaft, the handle operable to rotate the shaft; wherein the key is placed in the retracted position by threading the first end of the shaft into the threaded hole; and wherein the key is placed in the deployed position by threading the first end of the shaft out of the threaded hole. In an exemplary embodiment, the groove defines first and second surfaces of the support member; wherein first and second pin-holes are formed into the first and second surfaces of the support member, respectively; and wherein the key includes a body having a housing formed therein; and a latch disposed within the housing, the latch including a shaft supported by the housing, the shaft including opposing first and second end portions; a handle connected to the first end portion of the shaft, the handle operable to rotate the shaft when the tubular sliding member is in the locking position; and a mechanical linkage connected to the second end portion of the shaft, the mechanical linkage operable to deploy a pin into one of the first and second pin-holes when the handle is rotated. In an exemplary embodiment, a biasing member disposed between the support member and the key, the biasing member operable to urge the key out of the groove; wherein the key is secured in the retracted position when the pin is deployed into the first pin-hole; and wherein the key is secured in the deployed position when the pin is deployed into the second pin-hole.

The present disclosure also introduces a method for making-up a connection between first and second completion joints, the method including providing the first and second completion joints, each of the first and second completion joints including a base pipe; a shunt tube disposed along the base pipe; and a tubular outer shroud disposed about respective portions of the shunt tube and the base pipe; coupling the shunt tube of the first completion joint to the shunt tube of the second completion joint with a jumper tube; shifting a tubular sliding shroud from a first position to a second position; and locking the tubular

sliding shroud in the second position; wherein the tubular sliding shroud is disposed about at least one of the first and second completion joints in the first position; and wherein the tubular sliding shroud is disposed about the jumper tube and respective portions of the first and second completion joints in the second position. In an exemplary embodiment, locking the tubular sliding shroud in the second position includes securing a first end portion of the tubular sliding shroud with a locking mechanism; and securing a second end portion of the tubular sliding shroud with a retaining member. In an exemplary embodiment, the locking mechanism is connected to the first completion joint, and wherein securing the first end portion of the tubular sliding shroud with the locking mechanism includes shifting a tubular locking member from a third position to a fourth position; and locking the tubular locking member in the fourth position; wherein the tubular locking member is disposed about the tubular outer shroud of the first completion joint in the third position; and wherein the tubular locking member is disposed about a support member and the first end portion of the tubular sliding shroud in the fourth position, the support member being connected to the first joint. In an exemplary embodiment, the jumper tube and respective portions of the first and second completion joints, including respective portions of the base pipes and shunt tubes that are longitudinally disposed between the tubular outer shrouds of the first and second completion joints, are covered by at least one of the tubular sliding shroud and the tubular locking member when the tubular sliding shroud is in the second position and the tubular locking member is in the fourth position. In an exemplary embodiment, locking the tubular locking member in the fourth position includes deploying a key from a groove formed into the support member into a cavity formed into the tubular locking member by rotating a handle through an opening formed in the tubular locking member; wherein the key is disposed within both of the groove and the cavity when the key is deployed. In an exemplary embodiment, the tubular locking member is integrally formed with the first end portion of the tubular sliding shroud. In an exemplary embodiment, the retaining member is connected to the second completion joint; and wherein securing the second end portion of the tubular sliding shroud with the retaining member includes receiving the tubular sliding shroud within a portion of the retaining member as the tubular sliding shroud is displaced from the first position to the second position.

It is understood that variations may be made in the foregoing without departing from the scope of the disclosure.

In several exemplary embodiments, the elements and teachings of the various illustrative exemplary embodiments may be combined in whole or in part in some or all of the illustrative exemplary embodiments. In addition, one or more of the elements and teachings of the various illustrative exemplary embodiments may be omitted, at least in part, and/or combined, at least in part, with one or more of the other elements and teachings of the various illustrative embodiments.

Any spatial references such as, for example, "upper," "lower," "above," "below," "between," "bottom," "vertical," "horizontal," "angular," "upwards," "downwards," "side-to-side," "left-to-right," "left," "right," "right-to-left," "top-to-bottom," "bottom-to-top," "top," "bottom," "bottom-up," "top-down," etc., are for the purpose of illustration only and do not limit the specific orientation or location of the structure described above.

In several exemplary embodiments, while different steps, processes, and procedures are described as appearing as distinct acts, one or more of the steps, one or more of the processes, and/or one or more of the procedures may also be performed in different orders, simultaneously and/or sequentially. In several exemplary embodiments, the steps, processes and/or procedures may be merged into one or more steps, processes and/or procedures. In several exemplary embodiments, one or more of the operational steps in each embodiment may be omitted. Moreover, in some instances, some features of the present disclosure may be employed without a corresponding use of the other features. Moreover, one or more of the above-described embodiments and/or variations may be combined in whole or in part with any one or more of the other above-described embodiments and/or variations.

Although several exemplary embodiments have been disclosed in detail above, the embodiments disclosed are exemplary only and are not limiting, and those skilled in the art will readily appreciate that many other modifications, changes and/or substitutions are possible in the exemplary embodiments without materially departing from the novel teachings and advantages of the present disclosure. Accordingly, all such modifications, changes and/or substitutions are intended to be included within the scope of this disclosure as defined in the following claims. In the claims, means-plus-function clauses are intended to

cover the structures described herein as performing the recited function and not only structural equivalents, but also equivalent structures.

CLAIMS

What is claimed is:

1. An assembly adapted to be disposed within a wellbore, the assembly comprising:
first and second completion joints, each of which comprises:
a base pipe;
a shunt tube disposed along the base pipe; and
a tubular outer shroud disposed about respective portions of the shunt tube and the base pipe;
a jumper tube coupling the shunt tube of the first completion joint to the shunt tube of the second completion joint; and
a tubular sliding shroud disposed about at least one of the first and second completion joints and adapted to slide longitudinally to a run-in position, in which the tubular sliding shroud is disposed about the jumper tube and respective portions of the first and second completion joints, thereby covering the jumper tube.

2. The assembly of claim 1, wherein respective portions of the base pipes and shunt tubes that are longitudinally disposed between the tubular outer shrouds of the first and second completion joints are covered by the tubular sliding shroud when the tubular sliding shroud is placed in the run-in position.

3. The assembly of claim 1, further comprising a locking mechanism connected to the first completion joint and a retaining member connected to the second joint;
wherein the locking mechanism and the retaining member, in combination, are adapted to secure the tubular sliding shroud in the run-in position; and
wherein the locking mechanism is operable to secure a first end portion of the tubular sliding shroud and the retaining member is operable to secure a second end portion of the tubular sliding shroud.

4. The assembly of claim 3, wherein the locking mechanism comprises:
a support member connected to the first joint;
a groove formed into the support member;
a key disposed at least partially within the groove;
a tubular locking member adapted to be disposed about the first joint, and adapted to slide longitudinally relative to the support member into a locking position; and
a cavity formed into the tubular locking member;
wherein when the tubular locking member is in the locking position, the tubular locking member is disposed about the support member and the first end portion of the tubular sliding shroud.

5. The assembly of claim 4, wherein the key is moveable between a retracted position and a deployed position;
wherein the key nests within the groove when the key is in the retracted position, such that the tubular sliding shroud and the tubular locking member can slide freely past the support member into the run-in position and the locking position, respectively;
wherein the key protrudes from the support member when the key is in the deployed position; and
wherein the cavity is adapted to receive the key when the tubular locking member is in the locking position and the key is in the deployed position.

6. The assembly of claim 5, wherein when the tubular locking member is in the locking position and the key is in the deployed position, the key secures the tubular locking member in the locking position and obstructs longitudinal displacement of the tubular sliding shroud in a first direction.

7. The assembly of claim 6, wherein the retaining member secures the second end portion of the tubular sliding shroud to the second completion joint when the sliding shroud is in the run-in position, thereby obstructing longitudinal displacement of the tubular sliding shroud in a second direction that is opposite the first direction.

8. The assembly of claim 6, wherein the tubular locking member is integrally formed with the first end portion of the tubular sliding shroud.

9. An apparatus adapted to be disposed within a wellbore, the apparatus comprising:
a support member;
a groove formed into the support member;
a key disposed at least partially within the groove;
a tubular sliding member adapted to be displaced longitudinally relative to the support member into a locking position, in which the tubular sliding member is disposed about the support member; and
a cavity formed into the tubular sliding member and adapted to receive the key when the tubular sliding member is in the locking position;
wherein the key is disposed within both the groove and the cavity to secure the tubular sliding member in the locking position.

10. The apparatus of claim 9, wherein the key is moveable between a retracted position and a deployed position;
wherein the key nests within the groove when the key is in the retracted position, such that the tubular sliding member can slide freely past the support member into the locking position;
wherein the key protrudes from the support member when the key is in the deployed position; and
wherein the cavity is adapted to receive the key when the tubular sliding member is in the locking position and the key is placed in the deployed position.

11. The apparatus of claim 10, wherein a threaded hole is formed into the support member;
wherein the key comprises:
a housing;
a shaft supported within the housing, the shaft comprising opposing first and second end portions, the first end portion being threaded; and

a handle disposed within the housing and connected to the second end portion of the shaft, the handle operable to rotate the shaft;

wherein the key is placed in the retracted position by threading the first end of the shaft into the threaded hole; and

wherein the key is placed in the deployed position by threading the first end of the shaft out of the threaded hole.

12. The apparatus of claim 9, wherein the groove defines first and second surfaces of the support member;

wherein first and second pin-holes are formed into the first and second surfaces of the support member, respectively; and

wherein the key comprises:

a body having a housing formed therein; and

a latch disposed within the housing, the latch comprising:

a shaft supported by the housing, the shaft comprising opposing first and second end portions;

a handle connected to the first end portion of the shaft, the handle operable to rotate the shaft when the tubular sliding member is in the locking position; and

a mechanical linkage connected to the second end portion of the shaft, the mechanical linkage operable to deploy a pin into one of the first and second pin-holes when the handle is rotated.

13. The apparatus of claim 12, further comprising a biasing member disposed between the support member and the key, the biasing member operable to urge the key out of the groove;

wherein the key is secured in the retracted position when the pin is deployed into the first pin-hole; and

wherein the key is secured in the deployed position when the pin is deployed into the second pin-hole.

14. A method for making-up a connection between first and second completion joints, the method comprising:

providing the first and second completion joints, each of the first and second completion joints comprising:

a base pipe;

a shunt tube disposed along the base pipe; and

a tubular outer shroud disposed about respective portions of the shunt tube and the base pipe;

coupling the shunt tube of the first completion joint to the shunt tube of the second completion joint with a jumper tube;

shifting a tubular sliding shroud from a first position to a second position; and

locking the tubular sliding shroud in the second position;

wherein the tubular sliding shroud is disposed about at least one of the first and second completion joints in the first position; and

wherein the tubular sliding shroud is disposed about the jumper tube and respective portions of the first and second completion joints in the second position.

15. The method of claim 14, wherein locking the tubular sliding shroud in the second position comprises securing a first end portion of the tubular sliding shroud with a locking mechanism; and securing a second end portion of the tubular sliding shroud with a retaining member.

16. The method of claim 15, wherein the locking mechanism is connected to the first completion joint, and wherein securing the first end portion of the tubular sliding shroud with the locking mechanism comprises:

shifting a tubular locking member from a third position to a fourth position; and

locking the tubular locking member in the fourth position;

wherein the tubular locking member is disposed about the tubular outer shroud of the first completion joint in the third position; and

wherein the tubular locking member is disposed about a support member and the first end portion of the tubular sliding shroud in the fourth position, the support member being connected to the first joint.

17. The method of claim 16, wherein the jumper tube and respective portions of the first and second completion joints, including respective portions of the base pipes and shunt tubes that are longitudinally disposed between the tubular outer shrouds of the first and second completion joints, are covered by at least one of the tubular sliding shroud and the tubular locking member when the tubular sliding shroud is in the second position and the tubular locking member is in the fourth position.

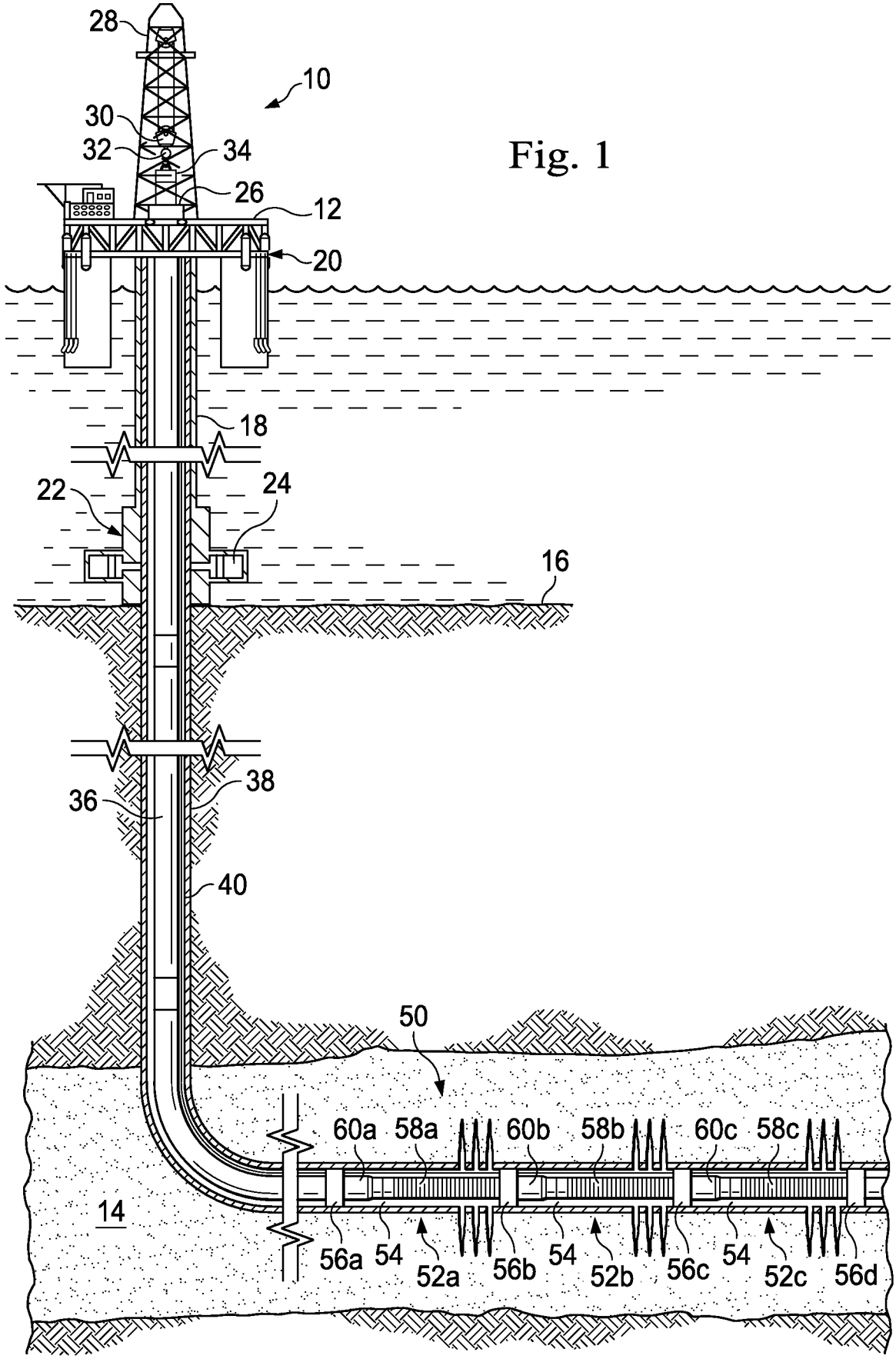
18. The method of claim 16, wherein locking the tubular locking member in the fourth position comprises deploying a key from a groove formed into the support member into a cavity formed into the tubular locking member by rotating a handle through an opening formed in the tubular locking member;

wherein the key is disposed within both of the groove and the cavity when the key is deployed.

19. The method of claim 18, wherein the tubular locking member is integrally formed with the first end portion of the tubular sliding shroud.

20. The method of claim 15, wherein the retaining member is connected to the second completion joint; and

wherein securing the second end portion of the tubular sliding shroud with the retaining member comprises receiving the tubular sliding shroud within a portion of the retaining member as the tubular sliding shroud is displaced from the first position to the second position.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56d

Fig. 1

Fig. 2

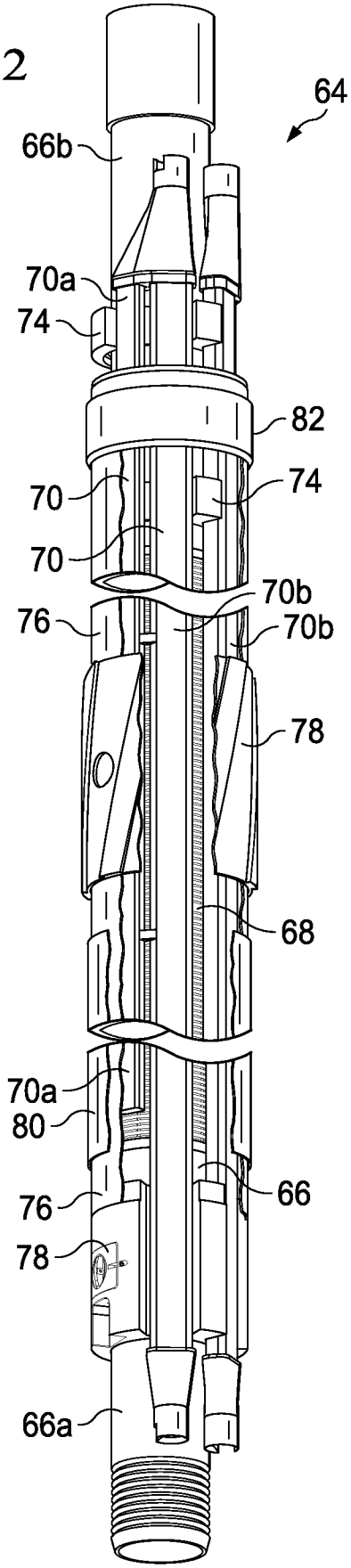


Fig. 3A

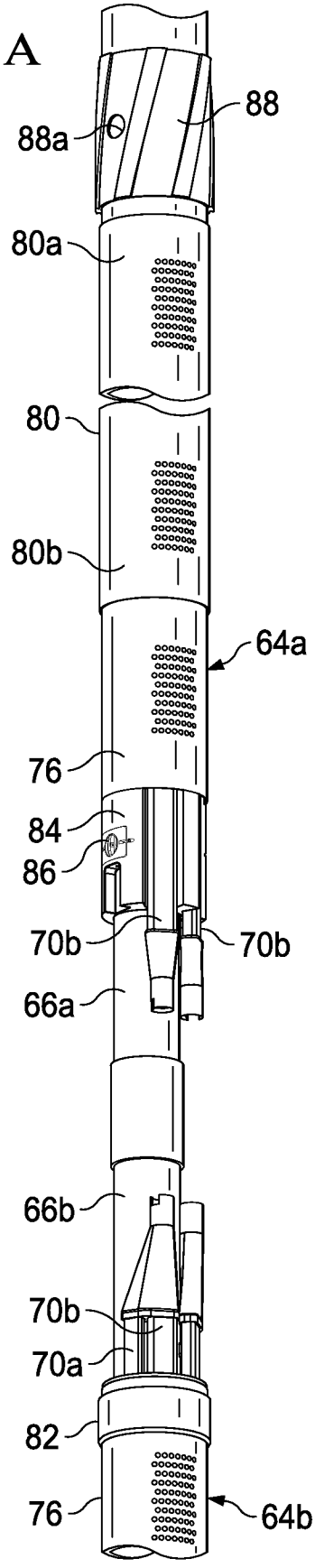
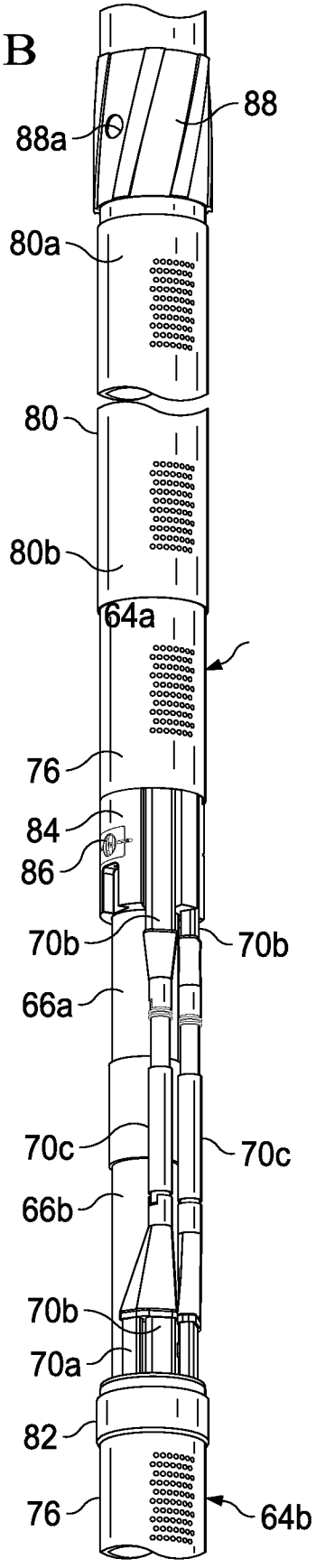


Fig. 3B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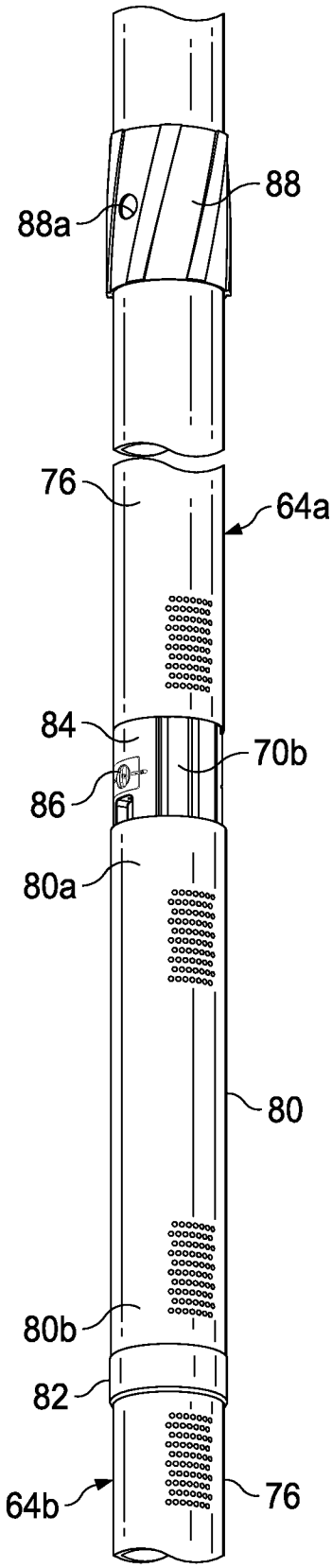

Fig. 3C

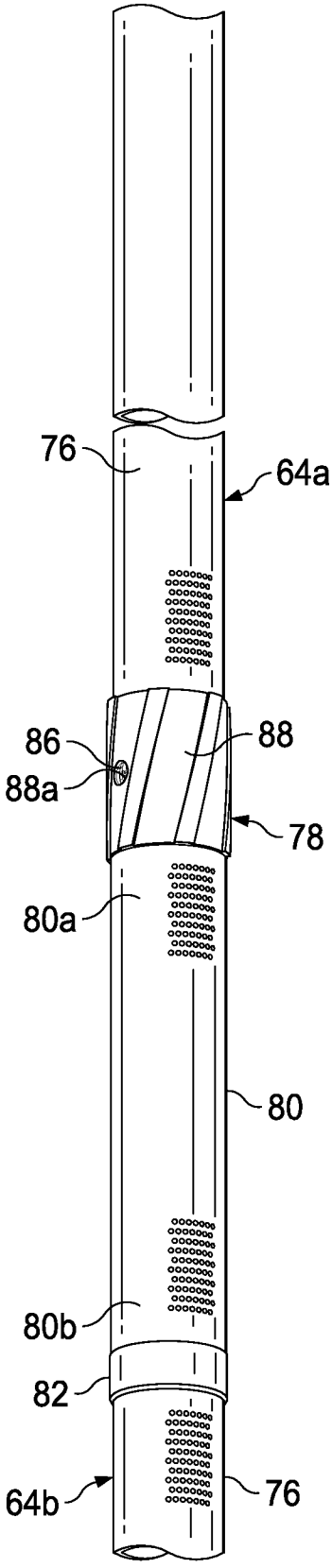

Fig. 3D

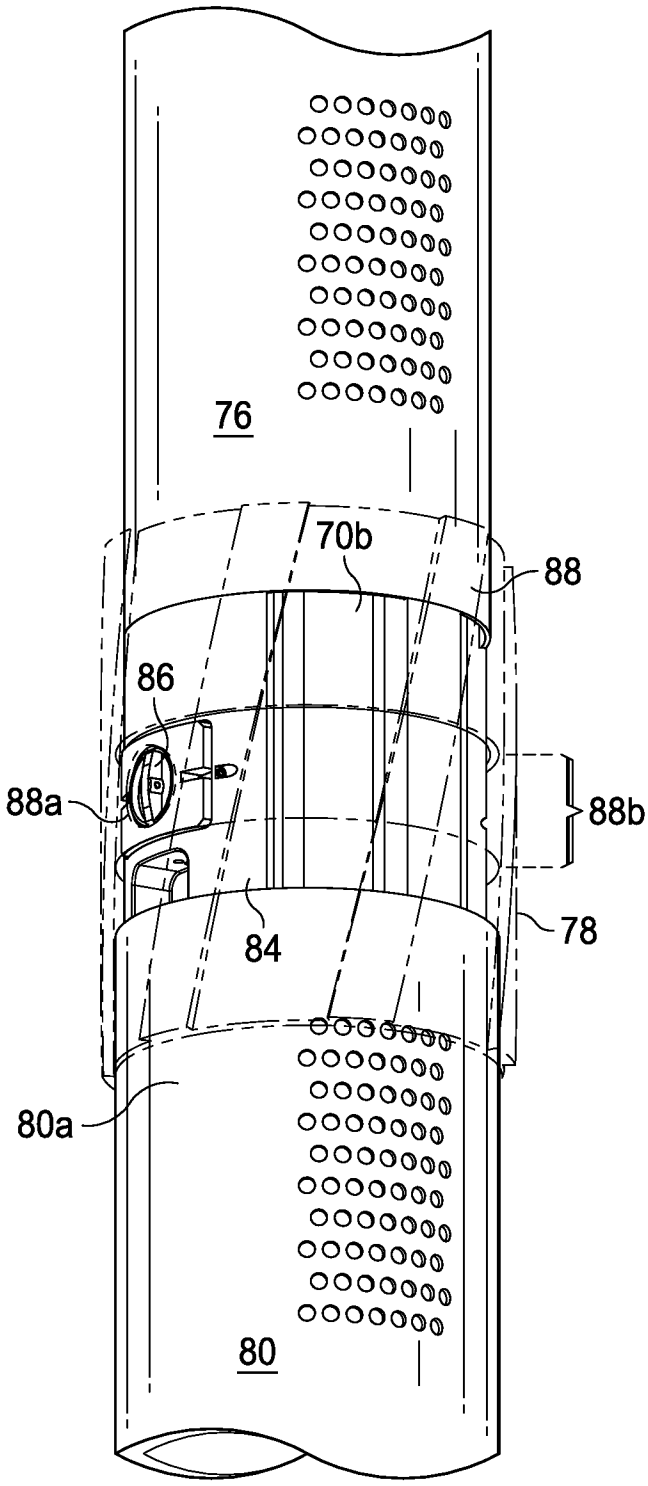

Fig. 4

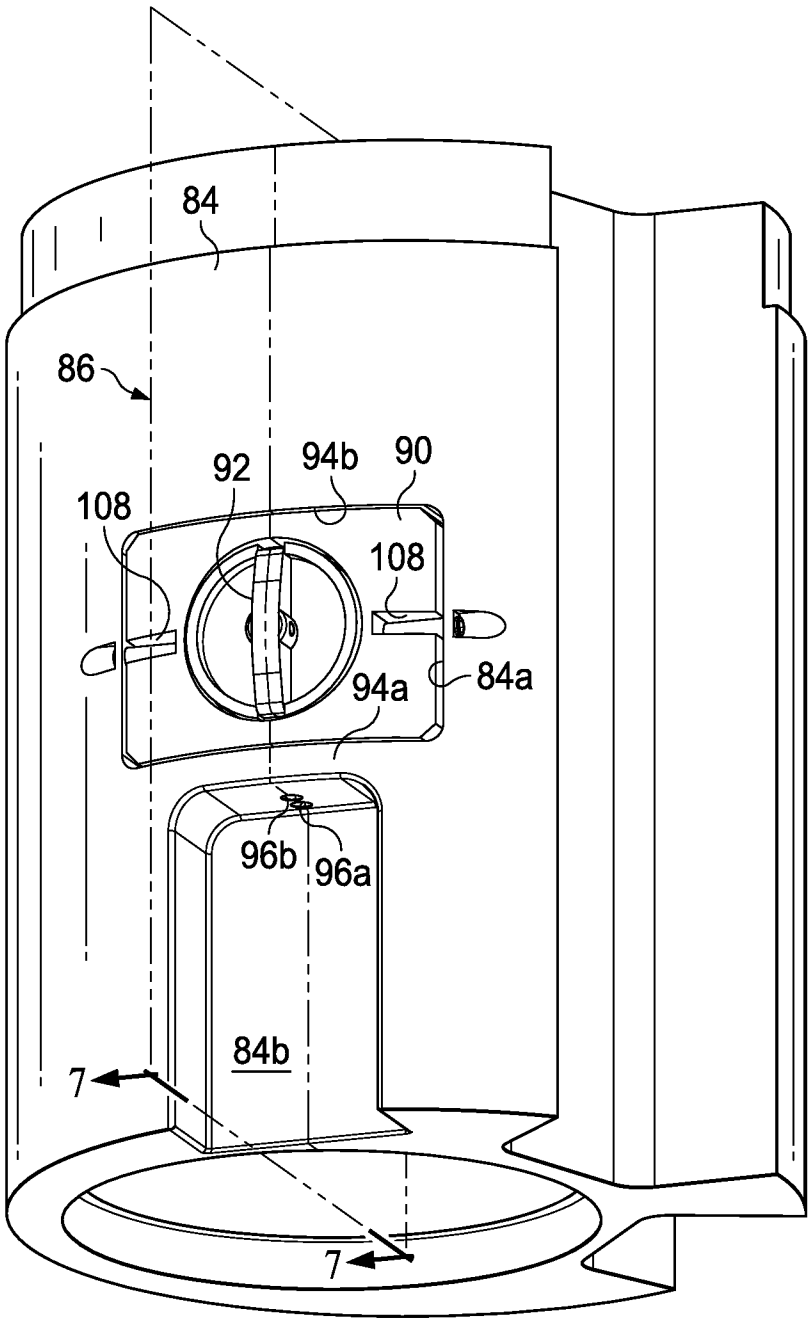

Fig. 5

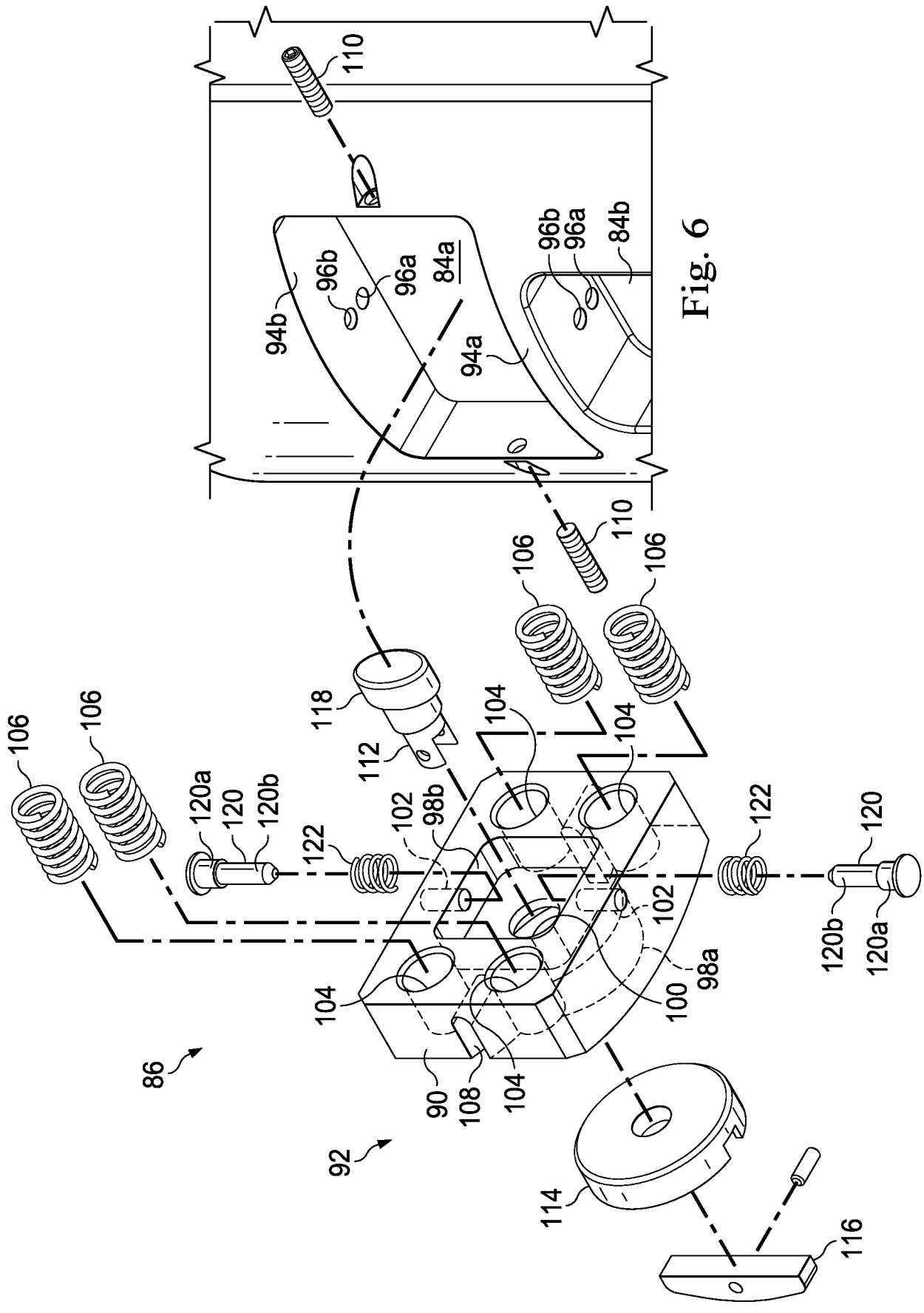
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Fig. 6

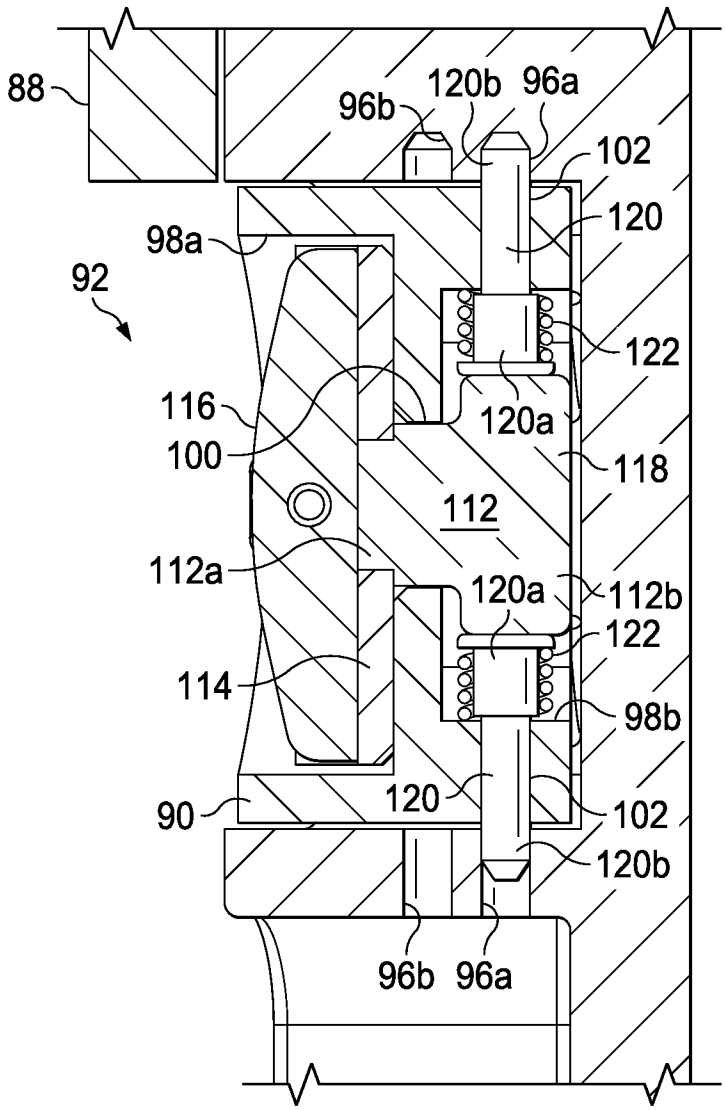
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Fig. 7A

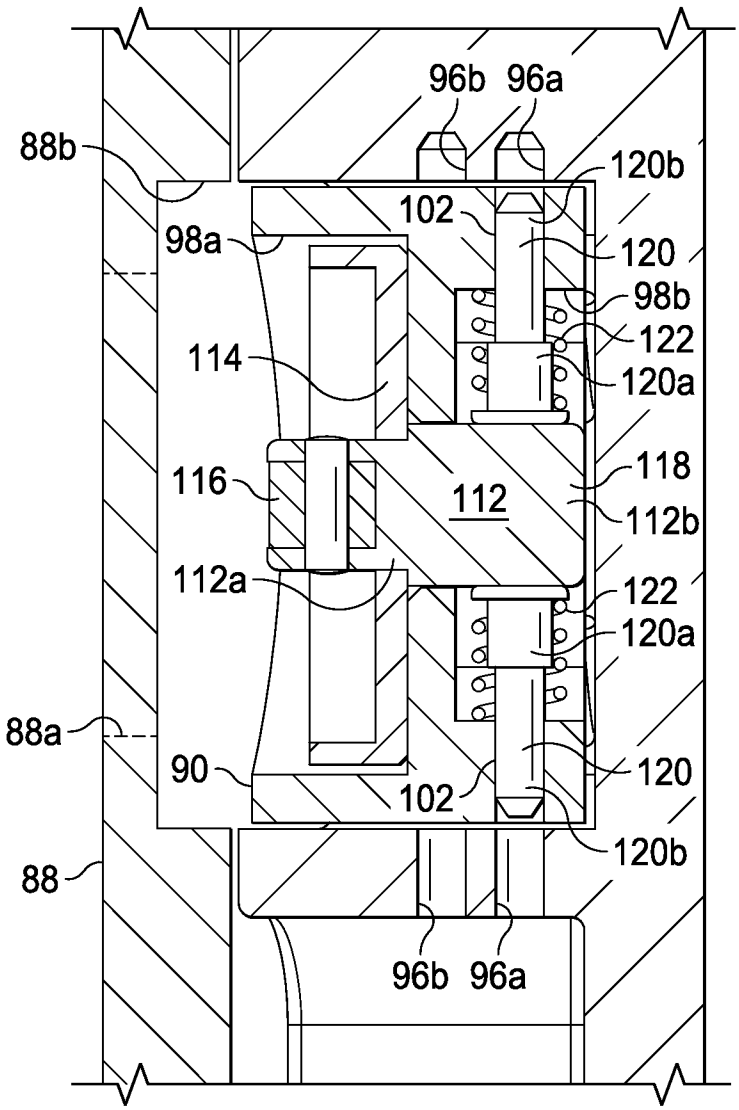
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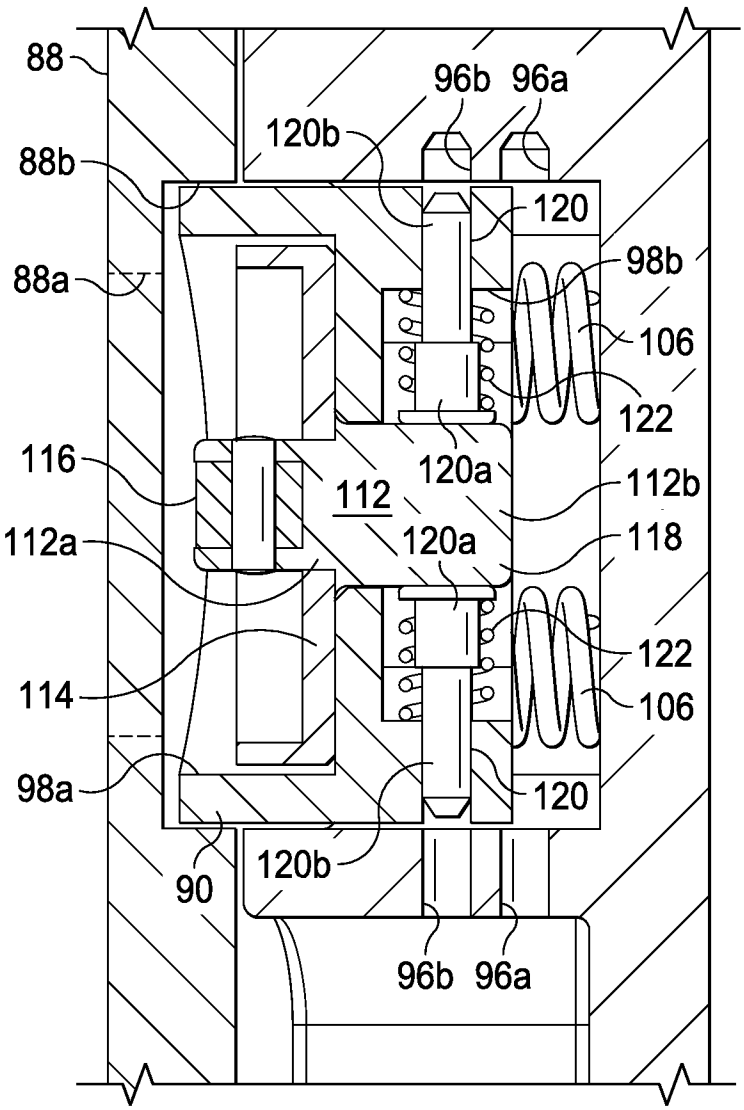
Fig. 7B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98a
120
120b
90
96b
96a

Fig. 7C

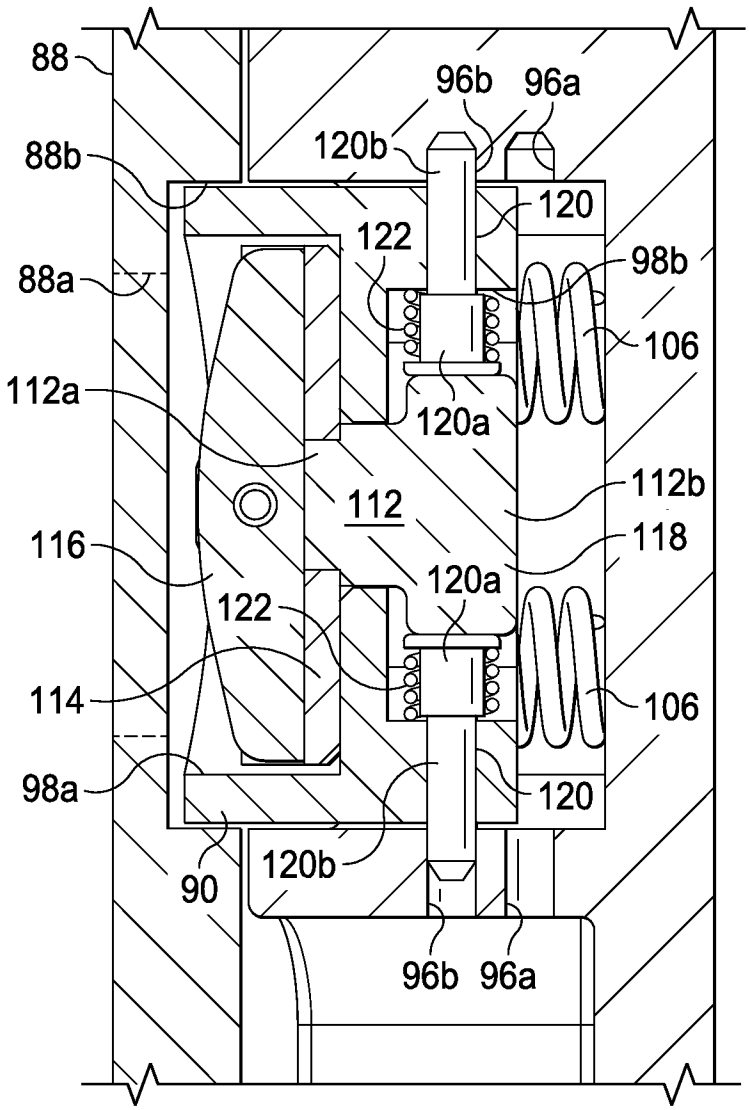
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Fig. 7D

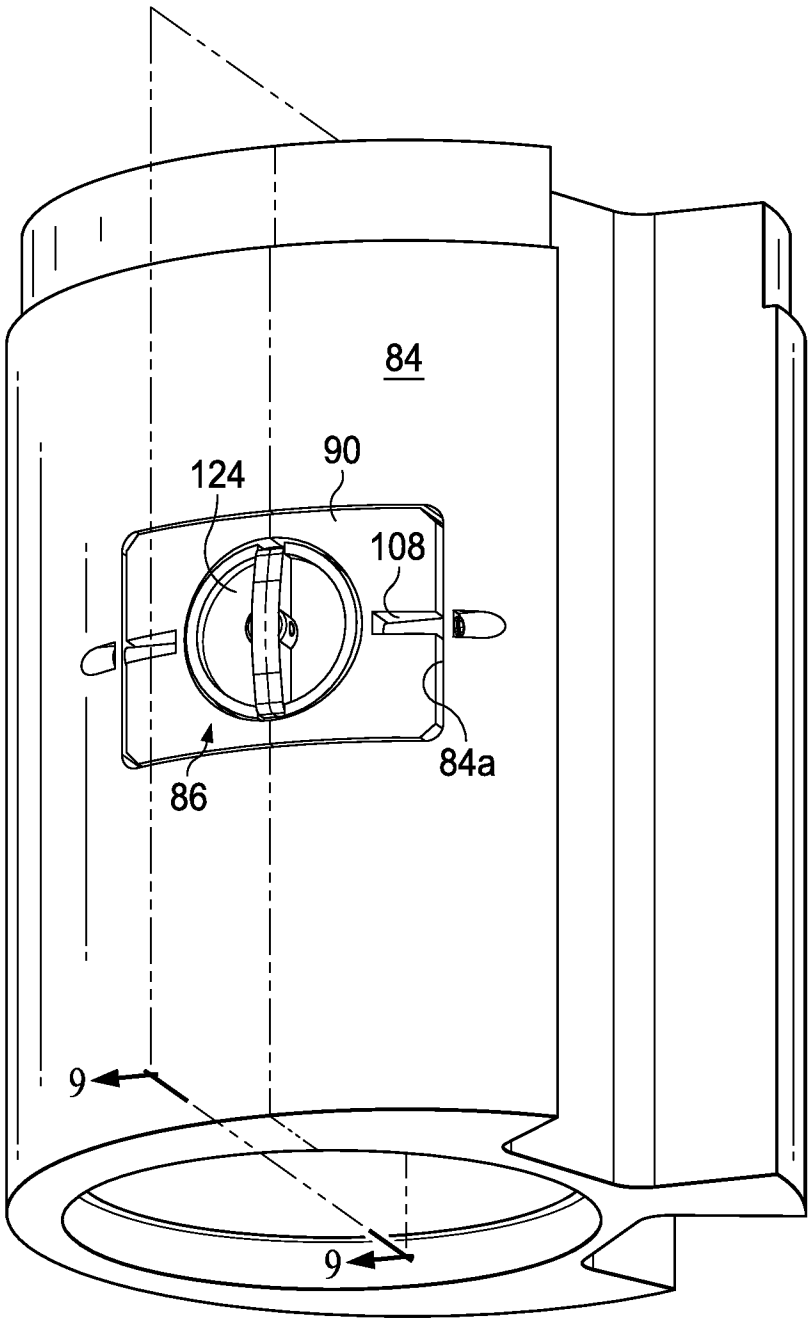

Fig. 8

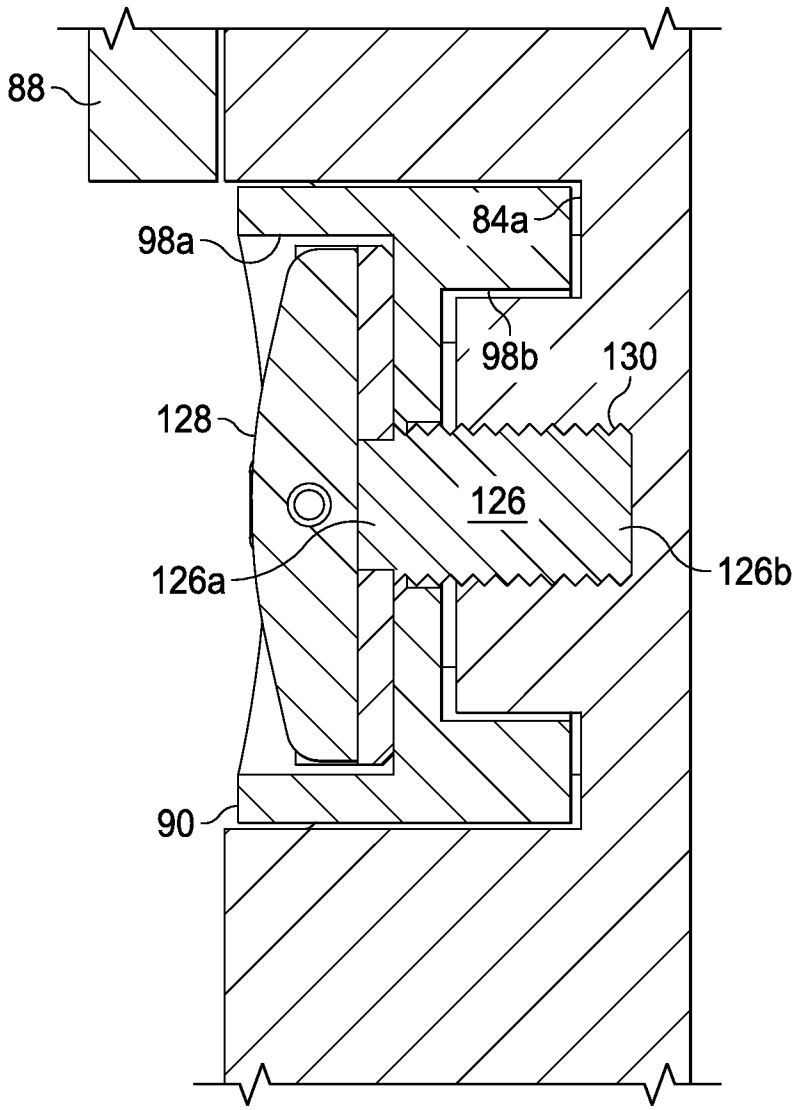

Fig. 9A

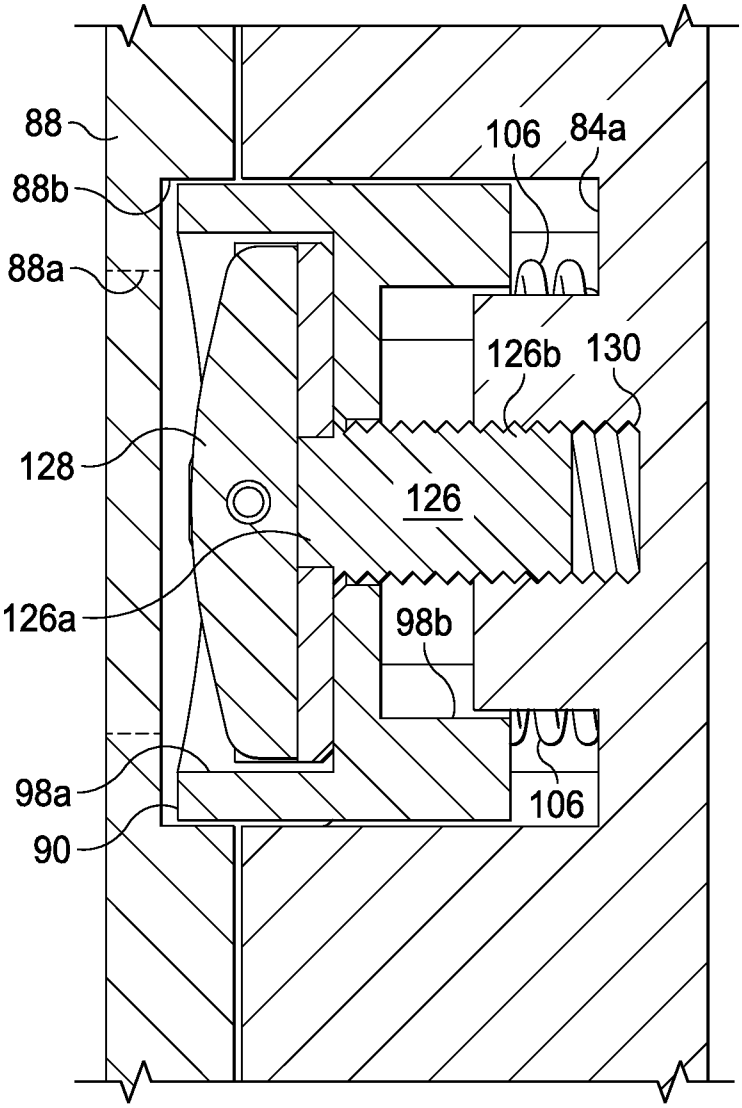

Fig. 9B

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2015/019243

A. CLASSIFICATION OF SUBJECT MATTER

E21B 17/02(2006.01)i, E21B 19/16(2006.01)i, E21B 17/20(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
E21B 17/02; E21B 43/04; F16L 25/00; E21B 19/16; E21B 23/00; E21B 43/08; E21B 17/20

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean utility models and applications for utility models
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKOMPASS(KIPO internal) & Keywords:movable sleeve, sliding shroud, shifting cover, shunt tube, jumper tube, transport tube, locking mechanism, securing and shafting key

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2014-0231097 A1 (HALLIBURTON ENERGY SERVICES, INC.) 21 August 2014 See paragraphs [0024]-[0063] and figures 1-10.	1-2,14
A		3-13,15-20
Y	US 2014-0262332 A1 (WEATHERFORD/LAMB, INC.) 18 September 2014 See paragraphs [0022]-[0070] and figures 1-7C.	1-2,14
A	US 2013-0327542 A1 (LEAST, BRANDAN THOMAS et al.) 12 December 2013 See abstract, paragraphs [0008]-[0072] and figures 1-8.	1-20
A	US 2010-0059232 A1 (LANGLAIS, MICHAEL D. et al.) 11 March 2010 See paragraphs [0016]-[0023] and figures 1-7B.	1-20
A	US 2013-0220635 A1 (GRECI, STEPHAN MICHAEL et al.) 29 August 2013 See paragraphs [0022]-[0072] and figures 1-7D.	1-20

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 October 2015 (29.10.2015)	**29 October 2015 (29.10.2015)**

Name and mailing address of the ISA/KR
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 35208, Republic of Korea
Facsimile No. +82-42-472-7140

Authorized officer
KIM, Jin Ho
Telephone No. +82-42-481-8699

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2015/019243

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		WO 2014-130021 A1	28/08/2014
US 2014-0262332 A1	18/09/2014	EP 2778340 A2	17/09/2014
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		CN 104583527 A	29/04/2015
		EP 2820229 A1	07/01/2015
		US 2014-000913 A1	02/01/2014
		US 8789611 B2	29/07/2014
		US 8794338 B2	05/08/2014
		WO 2013-130269 A1	06/09/2013