



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
03.08.2016 Bulletin 2016/31

(51) Int Cl.:
E21B 43/04^(2006.01) E21B 17/02^(2006.01)

(21) Application number: **16152241.2**

(22) Date of filing: **21.01.2016**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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(30) Priority: **22.01.2015 US 201514602557**

(54) **JUMPER CONNECTION FOR SHUNT TUBES ON WELLSCREEN ASSEMBLY**

(57) A method and apparatus for communicating ends (35) of adjoining shunt tubes (30A,30B) on connected wellscreen joints involves positioning a jumper tube (200) in a gap between opposed ends of adjoining shunt tubes on connected wellscreen joints. First and second sliding end connectors (210A,210B) of the jumper tube are engaged with the shunt tube ends by moving the

connectors into an extended position over the shunt tube ends and using slide lock components to lock the connectors with the shunt tube ends. If desired, the connectors of the jumper tube can be disengaged from the shunt tube ends by moving the connectors into a retracted position away from the shunt tube ends and by rotating the connectors, thereby unlocking the lock components.

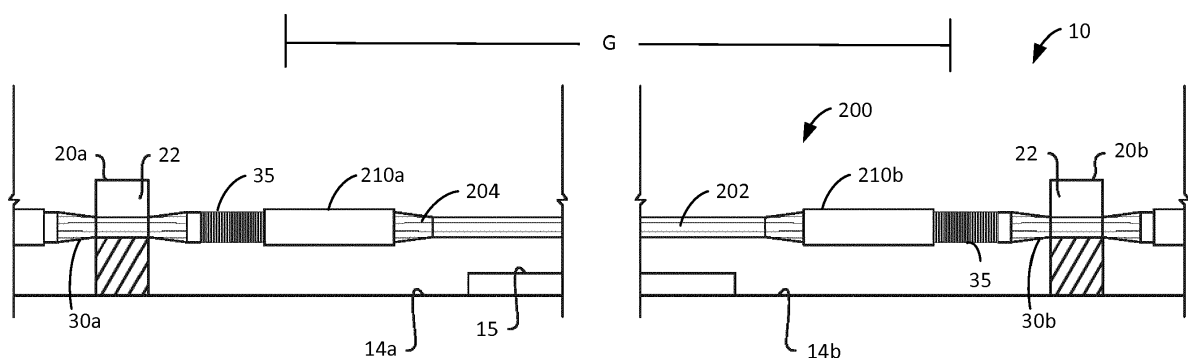


Fig. 4A

Description

BACKGROUND OF THE DISCLOSURE

[0001] Production of hydrocarbons from loose, unconsolidated, and/or fractured formations often produces large volumes of particulates along with the formation fluids. These particulates can cause a variety of problems. For this reason, operators use gravel packing as a common technique for controlling the production of such particulates.

[0002] To gravel pack a completion, a screen is lowered on a workstring into the wellbore and is placed adjacent the subterranean formation. Particulate material, collectively referred to as "gravel," and a carrier fluid, is pumped as slurry down the workstring. Eventually, the slurry exits through a "cross-over" into the wellbore annulus formed between the screen and the wellbore.

[0003] The carrier fluid in the slurry normally flows into the formation and/or through the screen. However, the screen is sized so that gravel is prevented from flowing through the screen. This results in the gravel being deposited or "screened out" in the annulus between the screen and the wellbore to form a gravel-pack around the screen. Moreover, the gravel is sized so that it forms a permeable mass that allows produced fluids to flow through the mass and into the screen but blocks the flow of particulates into the screen.

[0004] Due to poor distribution of the gravel, it is often difficult to completely pack the entire length of the wellbore annulus around the screen. This can result in an interval within the annulus that is not completely gravel packed. The poor distribution of gravel is often caused by the carrier liquid in the slurry being lost to more permeable portions of the formation. Due to the loss of the carrier liquid however, the gravel in the slurry forms "sand bridges" in the annulus before all of the gravel has been placed around the screen.

[0005] Such bridges block further flow of the slurry through the annulus, thereby preventing the placement of sufficient gravel below the bridge in top-to-bottom packing operations or above the bridge in bottom-to-top packing operations. Alternate flow conduits, called shunt tubes, can alleviate this bridging problem by providing a flow path for the slurry around such sand bridges. The shunt tubes are typically run along the length of the screen and are attached to the screen by welds.

[0006] Figures 1A-1B illustrate example schematic views of sand screens 18a-b provided with shunt tubes 30a-b in a wellscreen assembly 10. Figure 2A illustrates an example exploded view of the wellscreen assembly 10 components used in an open hole. Also, Figure 2B illustrates an example alternative exploded view of wellscreen assembly 10 components used in a cased hole.

[0007] As shown in the assembly 10, a first sand control device 12a is coupled to a second sand control device 12b, and each device 12a-b has basepipe joints 14 joined together to define a production bore 16. Screens 18a-b

having filter media surround the basepipe joints 14 and are supported by ribs 19. The assembly 10 is provided with shunt tubes 30a-b, which are typically steel tubes and have a substantially rectangular cross-section. The shunt tubes 30a-b are supported on the exterior of the screens 18a-b and provide an alternate flow path 32 to the main production bore 16.

[0008] To provide fluid communication between the adjacent sand control devices 12a-b, jumper tubes 40 are disposed between the shunt tubes 30a-b. In this way, the shunt tubes 30a-b and the jumper tubes 40 maintain the flow path 32 outside the length of the assembly 10, even if the borehole's annular space B is bridged, for example, by a loss of integrity in a part of the formation F. Additional examples of shunt tube arrangements can be found in U.S. Pat. Nos. 4,945,991 and 5,113,935. The shunt tubes may also be internal to the filter media, as described in U.S. Pat. Nos. 5,515,915 and 6,227,303.

[0009] As shown in Figures 1A-1B and 2A, the assembly for an open hole completion typically has main shrouds 28a-b that extend completely over the sand control devices 12a-b and provide a protective sleeve for the filter media and shunt tubes 30a-b. The shrouds 28a-b have apertures to allow for fluid flow. The main shrouds 28a-b terminate at the end rings 20a-b, which support the ends of the shrouds 28a-b and have passages for the ends of the shunt tubes 30a-b. For a cased hole completion, the assembly 10 as shown in Figure 2B may lack a shroud.

[0010] In either design, the shunt tubes 30a-b stop a certain length from the ends of the sand control devices 12a-b to allow handling room when the devices 12a-b are joined together at the rig. Once the devices 12a-b are joined however, their respective shunt tubes 30a-b are linearly aligned, forming a gap between them. Therefore, continuity of the shunt tubes' flow path 32 is typically established by installing the short, pre-sized jumper tubes 40 in the gap.

[0011] Each jumper tube 40 has a connector 50 at each end that contains a set of seals and is designed to slide onto the end of the jumper tube 40 in a telescoping engagement. When the jumper tube 40 is installed into the gap between the shunt tubes 30a-b, the connector 50 is driven partially off the end of the jumper tube 40 and onto the end of the shunt tube 30a-b until the connector 50 is in a sealing engagement with both shunt tubes 30a-b and the jumper tube 40.

[0012] The shunt tubes' flow path 32 is established once both connectors 50 are in place. Moreover, a series of set screws (not shown) have been used to engage both the jumper tube 40 and adjoining shunt tube 30a-b. The screws are driven against the tube surfaces, providing a friction lock to secure the connector 50 in place.

[0013] However, this connection is not very secure, and there is concern that debris or protruding surfaces of the wellbore can dislodge the connectors 50 from sealing engagement with the tubes 30a-b and 40 while running the wellscreen assembly 10 into the wellbore. There-

fore, a device called a split cover 22 as shown in Figure 1A is typically used to protect the connectors 50.

[0014] The split cover 22 is a piece of thin-gauge perforated tube, essentially the same diameter as the screen assembly 10, and the same length as the gap covered by the jumper tubes 40. The perforated cover 22 is split into halves with longitudinal cuts, and the halves are re-joined with hinges along one seam and locking nut and bolt arrangements along the other seam. The split cover 22 can be opened, wrapped around the gap area between the sand control devices 12a-b, and then closed and secured with the locking bolts.

[0015] Other ways of connecting shunt tubes on adjoining sand control devices are also known in the art. For example, U.S. Pat. No. 6,409,219 to Broome et al. describes a system wherein shunts on adjacent sand control devices are aligned when the correct torque is applied to join the devices. Alignment marks are included on the devices to indicate when the correct torque has been applied.

[0016] Further, U.S. Pat. No. 5,341,880 to Thorstensen et al. describes a sand screen structure assembled from a plurality of generally tubular filter sections that are axially snapped together in a manner facilitating the simultaneous interconnection of circumferentially spaced axially extending shunt tubes secured to and passing internally through each of the filter sections. In an alternate embodiment of the sand screen structure, the shunt tubes are secured within external side surface recesses of the filter section bodies.

[0017] U.S. Pat. No. 5,868,200 to Bryant et al. describes an alternate-path wellscreen that is made-up of joints. The screen has a sleeve positioned between the ends of adjacent joints. The sleeve acts as a manifold for fluidly-connecting the alternate-paths on one joint with the alternate-paths on an adjacent joint.

[0018] Another connector is disclosed in U.S. Pat. 7,497,267, which is incorporated herein by reference. Figures 3A-3B show examples of connections 100a-b disclosed therein. The connections 100a-b secure a jumper tube 40 to a shunt tube 30. In general, the connections 100a-b are designed to slide onto the end of the jumper tube 40 in a telescoping engagement. When the jumper tube 40 is installed into the gap between the shunt tubes 30, the connections 100a-b are driven partially off of the end of the jumper tube 40 and onto the end of the shunt tube 30 to form a sealing engagement between both tubes 30 and 40. Lugs and set screws are then used to secure the connectors 100a-b in place.

[0019] For example, Figure 3A shows a connection 100a having a connector 108 and a connector lock 102 disposed on a jumper tube 40. The jumper tube 40 has lugs 104 affixed to its sides. The connector 108 is pushed forward to engage a shunt tube 30 secured to the end ring 20. The connector lock 102 is then secured in place by screwing the screws 106 in the lock 102 to keep the lugs 104 in the side slots in the lock 102. The lugs 104 and screws 106 secure the lock 102 in the position to

hold the connector 108 in the engaged position.

[0020] In another example, Figure 3B shows a connection 100b having a connector 110 disposed on a jumper tube 40. A "C"-shaped receiver 112 is affixed to the shunt tube 30 and is positioned with the open side of the "C" toward the end of the tube 30. The connector 110 is moved to engage the shunt tube 30 so that the end of the connector 110 fits in the receiver 112. The connector 110 is attached to the jumper tube 40 with set screws 116, and other set screws 114 on the receiver 112 align with mating holes (not apparent in this view) in connector 110 to affix the tubes 30 and 40 together.

[0021] Currently, the STT (Shunt Tube Technology) jumper assembly needs to be set with set screws (e.g., eight set screws may need to be individually fixed) and typically requires more than one person to install. Moreover, different tools are needed in order to fix the set screws of the jumper assembly into position. As a result, more preparation time is needed to run screens down-hole, at times limiting screen installation and production to only five screens per hour.

[0022] Therefore, although the above-techniques for connecting shunt tubes on adjoining joints of a wellscreen assembly may be effective, operators seek more efficient and reliable ways to make these connections at the rig during deployment of the assembly.

[0023] The subject matter of the present disclosure is directed to overcoming, or at least reducing the effects of, one or more of the problems set forth above.

SUMMARY OF THE DISCLOSURE

[0024] A method and apparatus for communicating ends of adjoining shunt tubes on connected wellscreen joints is provided. The method involves positioning a jumper tube in a gap between the opposed ends of the adjoining shunt tubes on the connected wellscreen joints and connecting first and second ends of the jumper tube to the opposed ends of the adjoining shunt tubes. To connect the first and second ends, the method involves moving a first connector from a retracted position on the first end into an extended position at least partially over the opposed end of the shunt tube and engaging first thread between a first inner surface of the first connector and a first outer surface of the opposed end of the shunt tube.

[0025] It may be further possible to disengage the first thread by rotating and moving the first connector from the extended position into the retracted position away from the opposed end.

[0026] In a further embodiment, connecting the first and second ends can further involve moving a second connector from a retracted position on the second end into an extended position at least partially over the opposed end of the shunt tube and engaging second thread between a second inner surface of the second connector and a second outer surface of the opposed end of the shunt tube.

[0027] In one embodiment, a connection is used for communicating opposed ends of adjoining shunt tubes on connected wellscreen joints. The connection has a jumper tube having first and second ends. A first connector is disposed on the first end and is movable thereon at least from a retracted position to an extended position. The first connector in the extending position positions at least partially over the opposed end of the shunt tube. A first thread is disposed on a first inner surface of the first connector. The first thread on the first connector in the extended condition engages a first outer surface of the opposed end of the shunt tube.

[0028] The first connector can be movable from the extended position to the retracted position, and the first thread can be rotated with the moving first connector to disengage the first inner surface from the first outer surface of the opposed end.

[0029] In a further embodiment, the connection can have a second connector disposed on the second end and movable thereon at least from a retracted position to an extended position. The second connector in the extending position positions at least partially over the opposed end of the shunt tube. A second thread is disposed on a second inner surface of the second connector, and the second thread on the second connector in the extended condition engages a second outer surface of the opposed end of the shunt tube.

[0030] To move the first connector from the retracted position at least partially over the opposed end, the first connector can slide over the opposed end in one direction while locking ratchet threading of the first thread in an opposite direction. A first ratchet portion of the first thread can engage a second ratchet portion of the first thread on the first outer surface of the opposed end and can engage a third ratchet portion of the first thread on another outer surface of the first end of the jumper tube. Alternatively, a portion of the first inner surface of the first connector can engage a portion of the first outer surface of the first end with an interference fit.

[0031] In an additional embodiment, a wellscreen assembly has first and second screen joints connected together and having first and second adjoining shunt tubes. The first and second adjoining shunt tubes having opposed ends separated by a gap from one another. The assembly further includes the jumper tube with at least the first connector.

[0032] The foregoing summary is not intended to summarize each potential embodiment or every aspect of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033]

Fig. 1A illustrates a side view of a wellscreen assembly for an open hole, according to the prior art.

Fig. 1B illustrates an end view of the open hole wellscreen assembly of Fig. 1A.

Fig. 2A illustrates an exploded view of the components for the open hole wellscreen assembly of Fig. 1A.

Fig. 2B illustrates an exploded view of components for a cased hole wellscreen assembly.

Fig. 3A illustrates a side view of a prior art connector for shunt tubes of a wellscreen assembly.

Figs. 3B-3C illustrate side and perspective views of another prior art connector for shunt tubes of a wellscreen assembly.

Figs. 4A-4B illustrate examples of a jumper tube being installed on a wellscreen assembly according to the present disclosure.

Figs. 5A-5B illustrate side and partial cross-sectional views of a jumper tube according to the present disclosure.

Figs. 6A-6C illustrate partial cross-sectional views of the disclosed jumper tube connector in both retracted and engaged positions, according to the present disclosure.

Fig. 7 illustrates an end view of the disclosed jumper tube connector according to the present disclosure.

Fig. 8 illustrates a jumper tube having using one fixed end and one sliding connector according to the present disclosure.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0034] Examples of a wellscreen assembly according to the present disclosure include basepipe joints and screen sections attached to the outer surface of the basepipe joints. The assembly also features shunt tubes attached to the basepipe joints via top and bottom end rings. The shunt tubes can be attached to the screen sections via these rings and may be transport tubes or packing tubes for gravel packing operations or the like. Examples of the present disclosure provide connections for securing a jumper tube to adjoining shunt tubes of adjoining joints of the wellscreen assembly, which may be used in open or cased holes.

[0035] The examples provided in the present disclosure allow the jumper tube to be set by one person and without any additional tools. As a result, the requirement or need for using set screws, which currently need to be set manually, is alleviated. This leads to an ease in setting and installing the jumper tube (*i.e.*, one operator may only be needed), which can increase the rate at which wellscreens can be run in hole. Furthermore, the disclosed jumper tube connector can have a cylindrical shape, which leads to higher performance ratings and allows for longer completions.

[0036] The connections of the present disclosure can be used in open-hole or cased-hole wellscreen assemblies. However, cased-hole assemblies may typically use centralizers disposed between wellscreen joints and may not use end rings at the various joints. As will be appreciated, the joints of the wellscreen assemblies have timed threads so that the various shunt tubes can be aligned

with one another along the assembly as the joints are connected.

[0037] Turning now to the examples illustrated in Figures 4A and 4B, portion of a wellscreen assembly 10 is shown having first and second wellscreen joints 14a-b connected by a basepipe connection 15. Each joint 14a-b has adjoining shunt tubes 30a-b with opposed ends 35 that are separated from one another by a gap G. Although not shown, each joint 14a-b may have screens and other common components detailed previously.

[0038] As shown in Figure 4A, in order to communicate the ends 35 of the wellscreen assembly's shunt tubes 30a-b with one another, a jumper tube 200 is installed within the gap G between each of the shunt tube ends 35. Then, as shown in Figure 4B, at least one sliding end connector 210a-b on at least one end 205a-b of the jumper tube 200 affixes to at least one of the shunt tube ends 35.

[0039] Preferably, each end 205a-b of the jumper tube 200 has a sliding end connector 210a-b as shown. Each connector 210a-b is movably disposed on each end 205a-b of the jumper tube 200. However, an alternative arrangement may have a fixed end 205 on the jumper tube 200 that connects to one of the shunt tube ends 35 without a connector 210 and instead by fitting on the end 35 with an interference fit, locking on with a ratchet thread, or connecting in a conventional manner. Either way, the opposite end 205 of the jumper tube 200 can have the sliding end connector 210 for first aligning with the shunt tube end 35 and then sliding onto the end 35, as discussed in more detail below.

[0040] As shown in FIGS. 4A-4B, a center expanse 202 of the jumper tube 200 may be of a rectangular, square, or other structural shape. Referring also to the end view of the disclosed jumper tube 200 and connector 210 as shown in Fig. 7, the inside 206 of the center expanse 202 of the jumper tube 200 may have a rectangular or otherwise non-cylindrical shape. However, the sliding end connectors 210a-b that are movably disposed on the ends 205a-b of the jumper tube 200 may be cylindrical with a circular diameter or may have a different structural shape (e.g., oval, hexagonal, etc.).

[0041] In one example, although the sliding end connectors 210a-b may have a different shape and size than the center expanse 202 of the jumper tube 200, each end 205a-b of the jumper tube 200 where the sliding end connector 210a-b is located may be a cylindrical tube having about the same cross-sectional area as the center expanse 202 of the jumper tube 200. Also, because the shape and size of the sliding end connectors 210a-b may differ from the shape and size of the center expanse 202, the jumper tube 200 may have transitions 204 on each side of the center expanse 202 of the jumper tube 200 where the shape transitions from the rectangular cross-section of the expanse 202 to the cylindrical cross-section of the ends 205a-b.

[0042] The sliding end connectors 210a-b can be movably disposed on the jumper tube ends 205a-b using an

interference fit, using bearings, and/or using a sliding slot system that allows the connectors 210a-b to move both, axially along the major axis (i.e., length) of the jumper tube 200, and rotationally, allowing the connectors 210a-b to rotate about the circumference of the jumper tube's ends 205a-b.

[0043] The jumper tube ends 205a-b as shown act as an adapter between the center expanse 202 of the jumper tube 200 and the connectors 210a-b, and the ends 205a-b are structurally compatible to match the shape and size of the center expanse 202 of the tube 200.

[0044] Now that the components of the jumper tube 200 and wellscreen assembly 10 have been introduced, the engagement of the jumper tube 200 with the wellscreen assembly is now described.

[0045] As illustrated in Figure 4A, operators assemble the joints 14a-b together with the basepipe connection 15. Both joints 14a-b typically have end rings 20a-b already installed thereon, and the shunt tubes 30a-b may set in the slots 22 of the end rings 20a-b. When the joints 14a-b are connected, the timed threads align the adjoining shunt tubes 30a-b so that their ends 35 are spaced and aligned across from one another. An operator then positions the jumper tube 200 in the gap G with the jumper tube connectors 210a-b disengaged away from the shunt tube ends 35 in a retracted position on the ends 205a-b of the jumper tube 200.

[0046] As shown in Figure 4B, the operator then engages the jumper tube connectors 210a-b with the ends 35 of the shunt tubes 30a-b. Briefly, the connectors 210a-b engage with the shunt tube ends 35 when the connectors 210a-b are slid into an extended position over a portion of the shunt tube ends 35 and locking features (e.g., threading) of the connectors 210a-b lock with locking features (e.g., threading) on the shunt tube ends 35.

[0047] When slid to an engaged position (as shown in Figure 4B and described below), for example, the connectors 210a-b are moved in the direction of the shunt tube ends 35, until the connectors 210a-b slide over the ends 35 and have locked with the shunt tube ends 35 using the threading (not shown) within the inner surface of the jumper tube connectors 210a-b (not shown).

[0048] As shown in Figure 4A, the shunt tube ends 35 may also have threading as illustrated on the ends 35. Therefore, when the jumper tube connectors 210a-b engage the shunt tube ends 35 their respective threading locks the connectors 210a-b on the ends 35 of the shunt tubes 30a-b.

[0049] The threading disposed internally inside the connectors 210a-b and disposed externally on the shunt tube ends 35 may comprise different types of threads. In one example, the threads may allow the sliding end connector 210a-b to thread onto the shunt tube ends 35 in a conventional manner by rotating and twisting. Preferably, the threads comprise ratchet threading which the connectors 210a-b use during engagement by being capable of sliding over the shunt tube ends 35 in one direction, while being ratchet locked into position in the oppo-

site direction. In this way, rotating the end connectors 210a-b is not necessary to connect them to the shunt tube ends 35 because the sliding action is only needed to engage the ratchet threading.

[0050] If desired, the ratchet thread described above may also allow the connectors 210a-b to disengage with the shunt tube ends 35. In one example, the connectors 210a-b can retract from the shunt tube ends 35 by unthreading through rotating and twisting, thereby unlocking the ratchet threading from their locking engagement with each other.

[0051] In addition to the thread, additional locking features can be used to engage the connectors 210a-b with the ends 35. For example, the locking features can include slots defined in the opposing shunt tube ends 35. In this example, the locking features within the jumper tube connectors 210a-b can include tabs or catches for locking within the slots. Alternatively, the locking features disposed on the shunt tube ends 35 can be catches biased toward a locking position, and the locking features within the connectors 210a-b can be slots engaging the biased catches in the locking position. The above embodiments are not limited, as reverse and or other arrangements are also possible.

[0052] As illustrated in Figures 4A and 4B, the shunt tubes 30a-b run adjacent each wellscreen basepipe joint 14a-b of the assemblies, and the jumper tube 200 fits between end rings 20a-b. In one example, the ends of the shunt tubes 35 may fit at least partially in or beyond slots 22 in each of the end rings 20a-b. In another example however, the jumper tube 200 can engage directly to a portion of the end rings 20a-b, wherein the end rings 20a-b have openings and/or slots for the jumper tube 200. The end rings 20a-b may also have connector ends that have lock components disposed thereon for locking with the jumper tube connectors 210a-b when the connectors 210a-b have been extended.

[0053] Figures 5A-5B illustrate side and partial cross-sectional views of the jumper tube 200 being installed on opposing shunt tubes 30a-b. As shown at the disengaged connection (left side), the jumper tube connector 210a is in a retracted position, which allows the end 205a of the jumper tube 200 to be set up and aligned with the shunt tube end 35. As shown at the engaged connection (right side), the other jumper tube connector 210b is engaged with the shunt tube end 35. As described above, the jumper tube connector 210b can engage the shunt tube end 35 by moving into the extended position over the shunt tube end 35, and by engaging the locking features of the connector 210b with the locking features of the shunt tube end 35.

[0054] As best shown in Figures 6A-6B, the inside of the connectors 210a-b are shown having locking features in the form of thread 217 disposed in the interior. Also, the ends 35 of the shunt tube 30 have locking features in the form of thread 37 disposed around the exterior. As described above, the threads 37, 217 may be ratchet thread. By using ratchet thread, the shunt tube ends 35

allow the connectors 210a-b to progress over them with a sliding action and to then lock the connectors 210a-b to the ends 35. In general, the connectors 210a-b can extend over the ends 35 at any suitable length and achieve the desired locking.

[0055] After the connectors 210a-b have been engaged with the shunt tube ends 35, the connectors 210a-b may be disengaged from the end 35 depending on the type of locking feature (e.g., thread or ratchet thread) used. For example, by rotating the connectors 210a-b in either a clockwise or counterclockwise direction, the threads 217 of the connectors 210a-b may be able to unlock with the threads 37 of the shunt tube ends 35. In other words, by rotating the connector 210a-b, the connectors' threads 217 can effectively unthread from the tubes' threads 217 so that the connectors 210a-b becomes disconnected from the ends 35. Allowing the connectors 210a-b to disengage the ends 35 can allow the jumper tube 200 to be easily disconnected from the well screen assembly 10, if necessary.

[0056] Closer details of the ratchet thread configuration on the connectors 210a-b and the ends 35 are shown in Figure 6C. As shown in the partial cross sectional view in Figure 6C, one of the jumper tube connectors 210b is disposed in an extended position on the jumper tube end 205b and has engaged with the shunt tube end 35. In this illustration, the connector 210b and the end 35 each have ratchet thread 217 and 37, respectively.

[0057] As the connector 210b moves or slides over the end 35, the ratchet thread 217 on the inner surface of the connector 210b slides past the ratchet thread 37 disposed on the exterior surface of the shunt tube end 35. As illustrated, the ratchet thread 217 disposed inside the connector 210b then locks with the ratchet thread 37 on the end 35 by biasing the ratchet threading of these threads 217 and 37 in opposite directions. In this way, the ratchet threads 217 and 37 can slide past each other in one direction without locking, while being locked and or unable to slide back in the opposite direction. As a result, the connector 210b is locked into its extended condition, and the connector 210b is not able to slide in the opposite direction away from the end 35.

[0058] Additionally, the jumper tube end 205b may also have a ratchet thread 207 disposed thereon. In particular, the ratchet thread 207 may assist the connector 210b during engagement by being biased in an opposite direction relative to the connector's ratchet thread 217 in a manner similar to the shunt tube's thread 37. As described above, this will allow the connector 210b to slide along the end 205b in one direction without locking, while being locked and or unable to slide back in the opposite direction, thereby making the engagement more secure.

[0059] As shown in Figure 6C, the entire inner surface of the connector 210b may have the ratchet thread 217. Likewise, the expanse of ratchet thread 37 and 207 on the shunt tube end 35 and the jumper end 205b can encompass a comparable expanse. As an alternative, all or a portion of the inner surface of the connector 210b

may lack a threaded portion, and all or a portion of the jumper tube end 205b may also lack a threaded portion. Instead, a portion of the outer surface of the jumper tube end 205b may engage portion of the connector's inner surface with an interference fit.

[0060] As described previously, the connectors 210a-b in some arrangements may allow for disengagement from the end 35 by being retracted away from shunt tube ends 35. To do this, the connector 210a-b may be rotated, which may allow the connectors 210a-b to rotate off the ratchet threads 37 of the shunt tube ends 35 and may thereby allow the jumper tube 200 to be removed.

[0061] For example, one or more of the ratchet threads 37, 217, and 207 discussed above may be formed in a spiral pattern. Then, as the connector 210a-b is rotated, the connector 210a-b can be separated from the end 35 by unthreading the thread in an unscrewing fashion. However, considering that the connection is preferably a fixed connection, the ratchet thread 37, 217, and 207 comprising a spiraled thread may not be necessary. Instead, a non-spiral thread may be used for the ratchet thread 37, 217, and 207. In one example, such non-spiral thread may comprise a parallel thread orientation, or other thread pattern. In either of the examples above, the thread 37, 217, and 207 need not be completely disposed within the connectors 210a-b and/or on the ends 35 and 205a-b but can be selectively disposed anywhere within and/or thereupon.

[0062] As a result of the engagement described above, the ratchet threading effectively allows the connector 210a-b to move or slide over the ends 205a-b and 35 in one direction, but lock and prevent the connector 210a-b from sliding or moving in the opposite direction.

[0063] As noted above, both ends 205a-b of the jumper tube 200 preferably have sliding connectors 210a-b, but in other embodiments, only one sliding connector 210 may be used. As shown in Figure 8, for example, a jumper tube 200 is shown fitting between opposing shunt tubes 30a-b. One end 205b of the jumper tube 200 can have a fitting 208 or the like that directly couples with an end 35 of the shunt tube 30b. For example, the fitting 208 can use an interference fit, can lock with a ratchet thread, can thread with spiral thread, or can connect in a conventional manner (*i.e.*, pin, bolt, etc.). In this example, the end 35 has ratchet thread 37 against which the fitting 208 engages.

[0064] Either way, the opposite end 205a of the jumper tube 200 can have the sliding end connector 210a for first aligning with the shunt tube end 35 and then sliding onto the end 35, as discussed herein. Because room may be necessary to position the jumper tube 200 between the opposed ends 35, the jumper tube 200 may be shorter a distance D between the opposed ends 35, and portion of the connector 210a may be used to complete the connection between the end 35 and the jumper tube 200 when the connection is made.

[0065] The foregoing description of preferred and other embodiments is not intended to limit or restrict the scope

or applicability of the inventive concepts conceived of by the Applicants. It will be appreciated with the benefit of the present disclosure that features described above in accordance with any embodiment or aspect of the disclosed subject matter can be utilized, either alone or in combination, with any other described feature, in any other embodiment or aspect of the disclosed subject matter.

[0066] In exchange for disclosing the inventive concepts contained herein, the Applicants desire all patent rights afforded by the appended claims. Therefore, it is intended that the appended claims include all modifications and alterations to the full extent that they come within the scope of the following claims or the equivalents thereof.

Claims

1. A method of communicating opposed ends of adjoining shunt tubes on connected wellscreen joints, the method comprising:

positioning a jumper tube in a gap between the opposed ends of the adjoining shunt tubes; and connecting first and second ends of the jumper tube to the opposed ends by-moving a first connector from a retracted position on the first end to an

extended position at least partially over the opposed end of the shunt tube, and

engaging first thread between a first inner surface of the first connector and a first outer surface of the opposed end of the shunt tube.

2. The method of claim 1, further comprising disengaging the first thread by rotating and moving the first connector from the extended position into the retracted position away from the opposed end.
3. The method of claim 1 or 2, wherein connecting the first and second ends comprises moving a second connector from a retracted position on the second end into an extended position at least partially over the opposed end of the shunt tube and engaging second thread between a second inner surface of the second connector and a second outer surface of the opposed end of the shunt tube.
4. The method of claim 1, 2 or 3, wherein moving the first connector from the retracted position on the first end into the extended position at least partially over the opposed end of the shunt tube comprises sliding the first connector over the opposed end in one direction and locking ratchet threading of the first thread in an opposite direction.

5. The method of claim 1, 2, 3 or 4, wherein engaging the first thread between the first inner surface of the first connector and the first outer surface of the opposed end of the shunt tube comprises engaging a first ratchet portion of the first thread on the first inner surface of the first connector with a second ratchet portion of the first thread on the first outer surface of the opposed end.
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6. The method of claim 5, further comprising engaging the first ratchet portion of the first thread on the first inner surface of the first connector with a third ratchet portion of the first thread on another outer surface of the first end of the jumper tube.
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7. The method of claim 5 or 6, further comprising engaging a portion of the first inner surface of the first connector with a portion of the first outer surface of the first end with an interference fit.
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8. A connection for communicating opposed ends of adjoining shunt tubes on connected wellscreen joints, the connection comprising:
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 - a jumper tube having first and second ends;
a first connector disposed on the first end and movable thereon at least from a retracted position to an extended position, the first connector in the
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 - extending position positioning at least partially over the opposed end of the shunt tube; and
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 - a first thread disposed on a first inner surface of the first connector, the first thread on the first connector in the extended condition engaging a first outer surface of the opposed end of the shunt tube.
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9. The connection of claim 8, wherein the first connector is movable from the extended position to the retracted position; and wherein the first thread rotated with the moving first connector disengages the first inner surface from the first outer surface of the opposed end.
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10. The connection of claim 8 or 9, further comprising:
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 - a second connector disposed on the second end and movable thereon at least from a retracted position to an extended position, the second connector in
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 - the extending position positioning at least partially over the opposed end of the shunt tube; and
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- a second thread disposed on a second inner surface of the second connector, the second thread on the second connector in the extended condition engaging a second outer surface of the opposed end of the shunt tube.
11. The connection of claim 8, 9 or 10, wherein to move the first connector from the retracted position on the first end into the extended position at least partially over the opposed end of the shunt tube, the first connector slides over the opposed end in one direction while locking ratchet threading of the first thread in an opposite direction.
12. The connection of claim 8, 9, 10 or 11, wherein the first ratchet portion of the first thread on the first inner surface of the first connector engages a second ratchet portion of the first thread on the first outer surface of the opposed end.
13. The connection of claim 12, wherein the first ratchet portion of the first thread on the first inner surface of the first connector engages a third ratchet portion of the first thread on another outer surface of the first end of the jumper tube.
14. The connection of claim 12 or 13, wherein a portion of the first inner surface of the first connector engages a portion of the first outer surface of the first end with an interference fit.
15. A wellscreen assembly, comprising:
 - the connection of any one of claims 8 to 14; and
 first and second screen joints connected together and having first and second adjoining shunt tubes, the first and second adjoining shunt tubes having opposed ends separated by a gap from one another, the jumper tube being positioned in the gap between the opposed adjoining shunt tube ends.

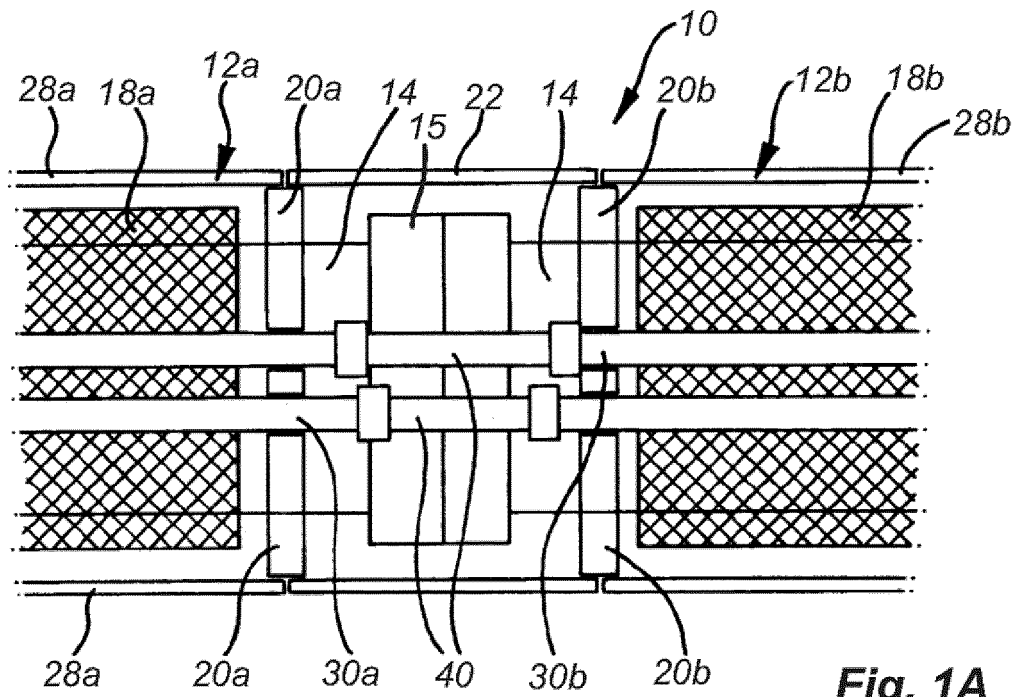


Fig. 1A
(Prior Art)

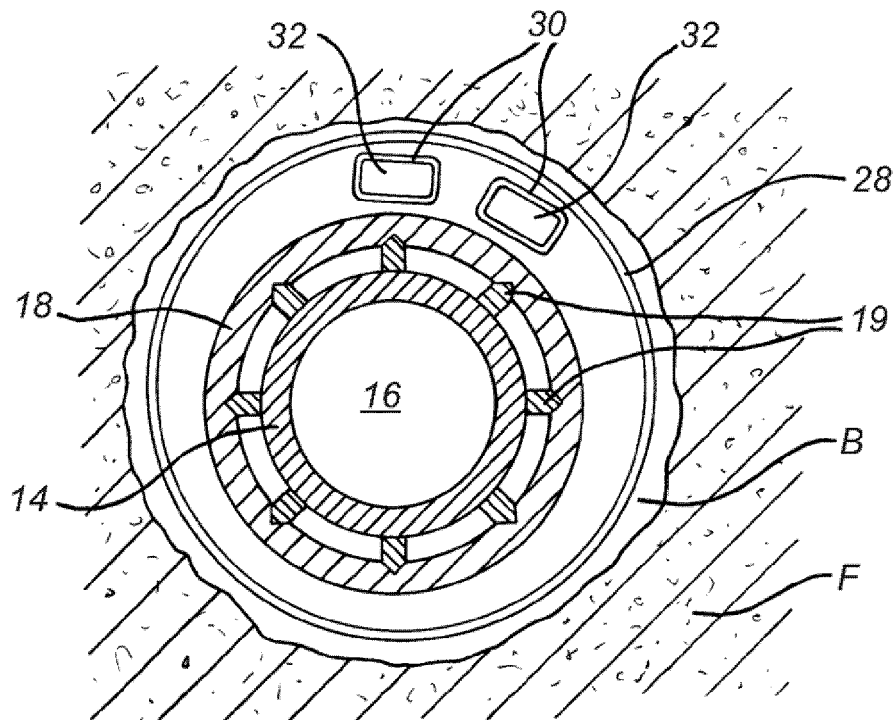
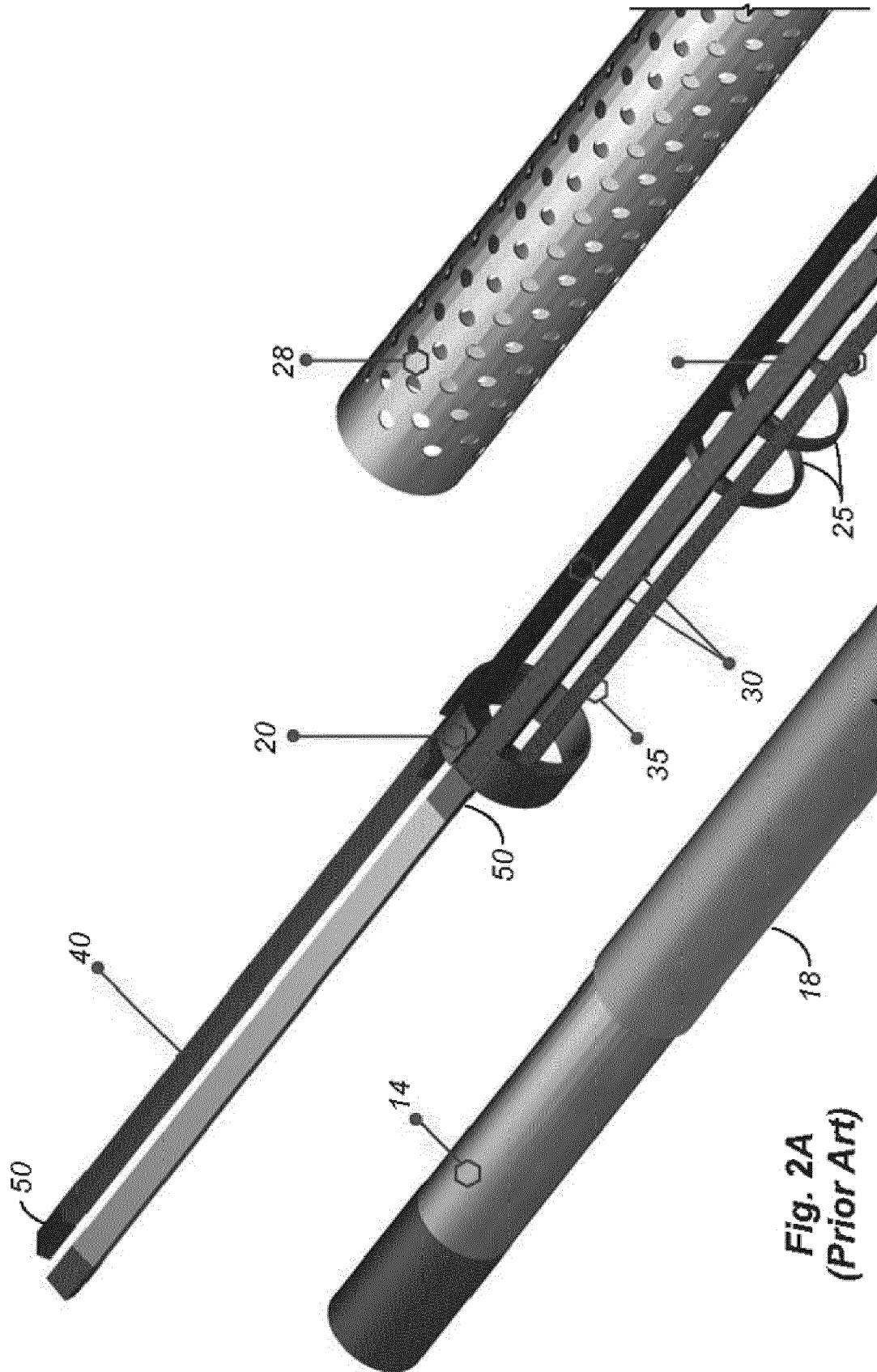
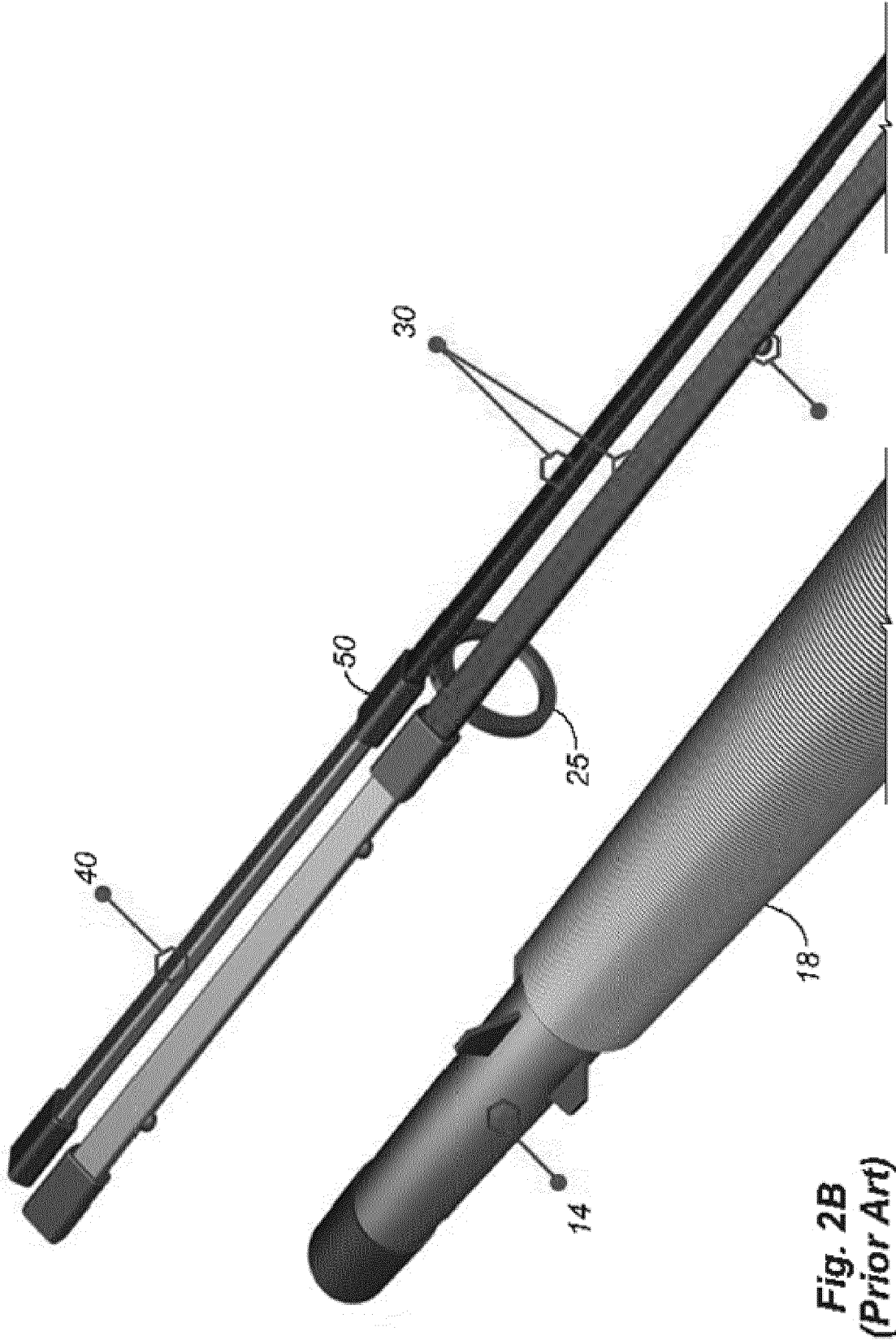
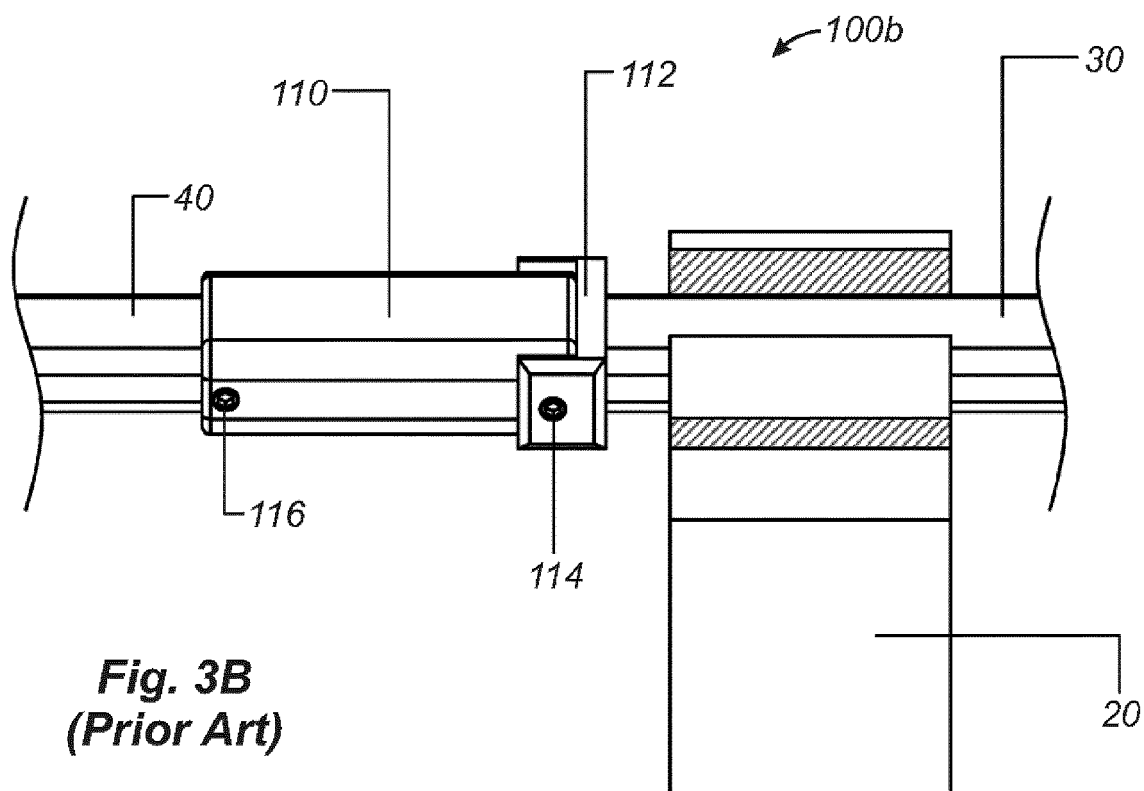
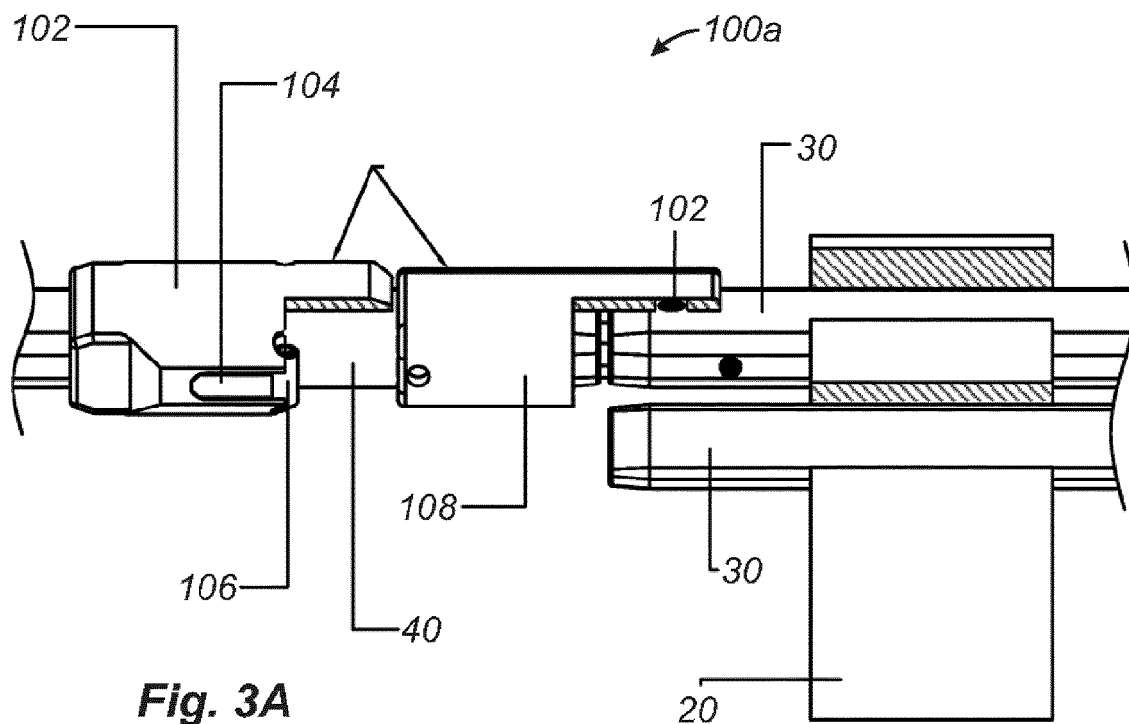
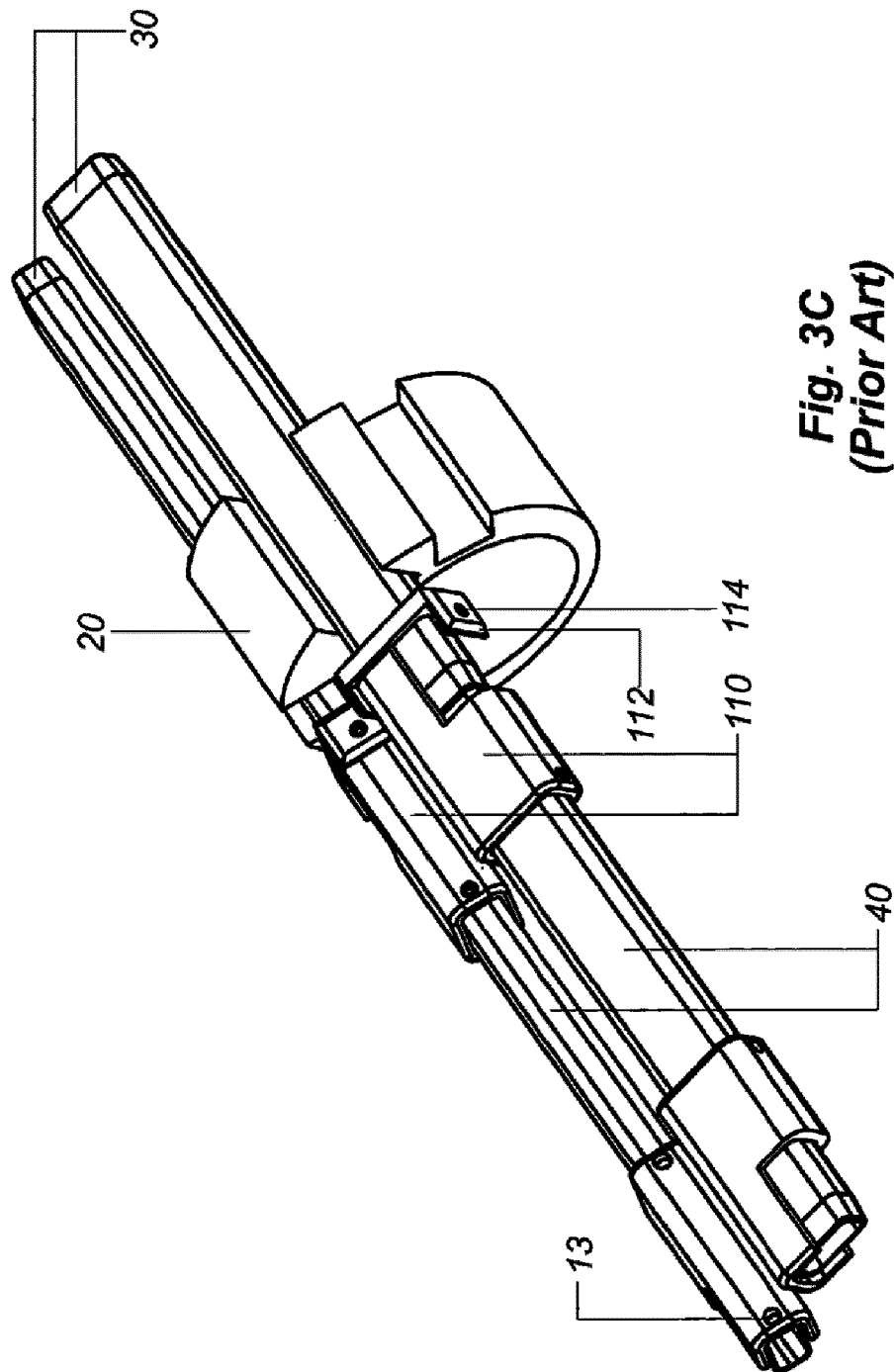


Fig. 1B
(Prior Art)









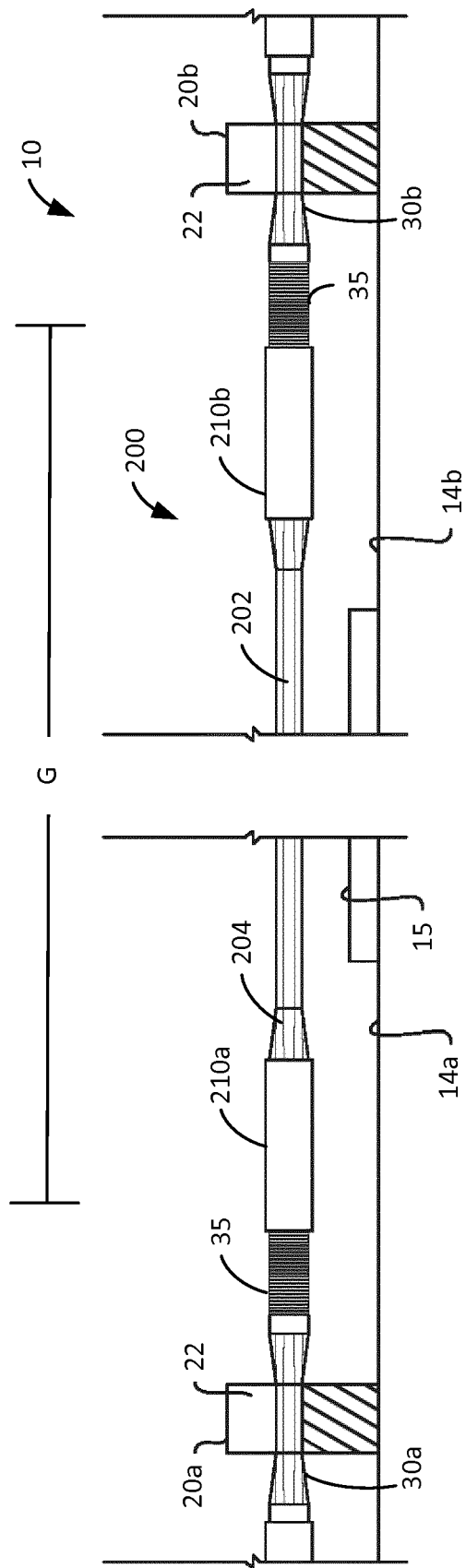


Fig. 4A

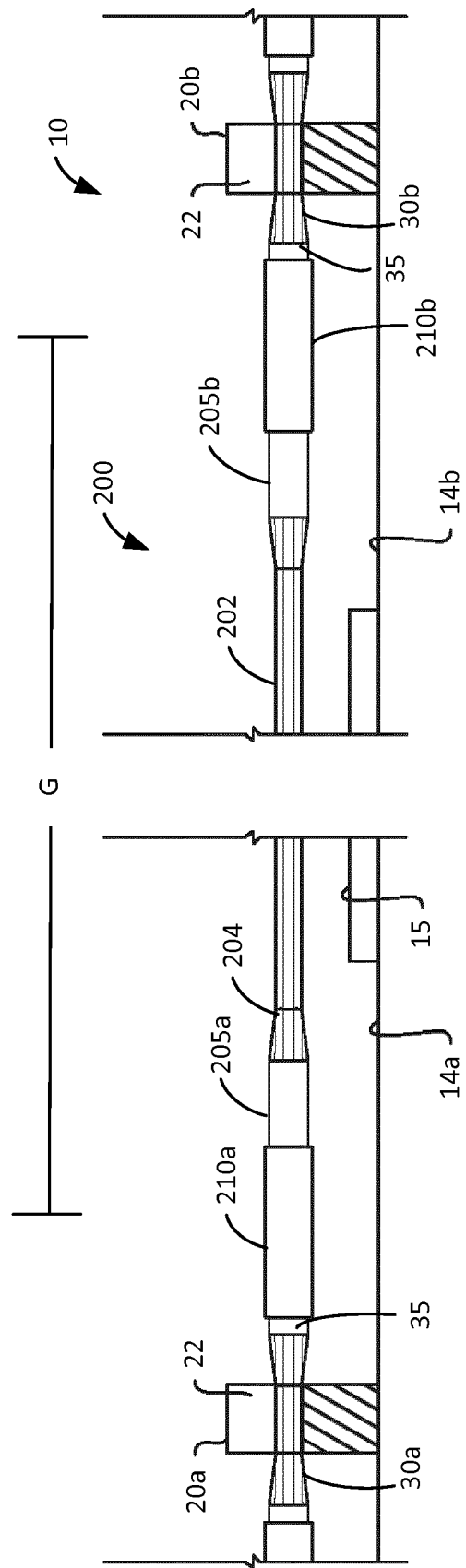


Fig. 4B

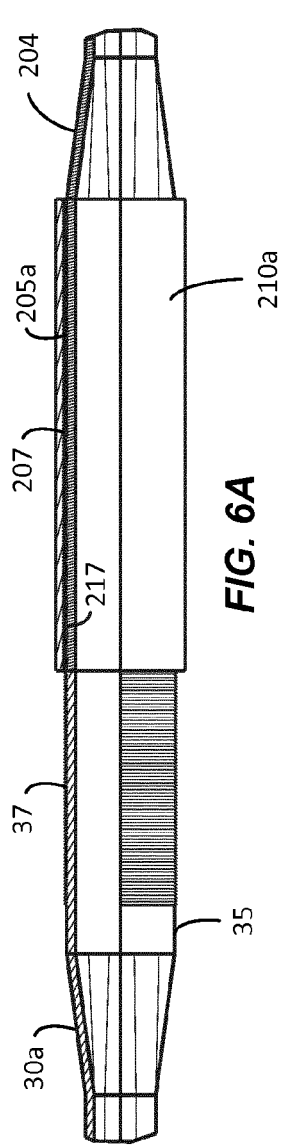


FIG. 6A

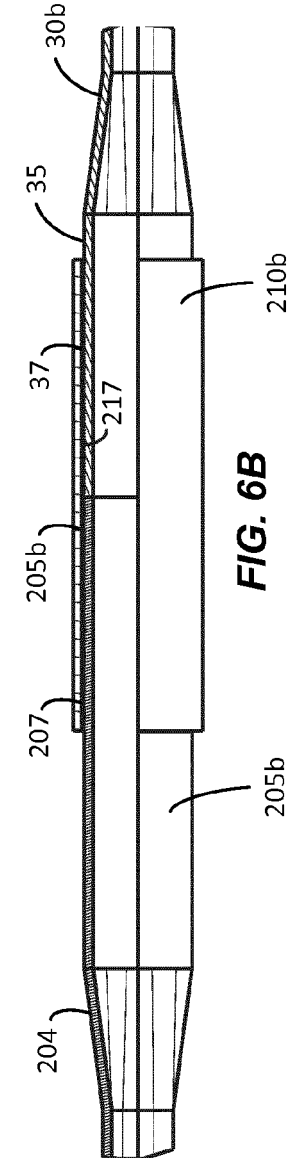


FIG. 6B

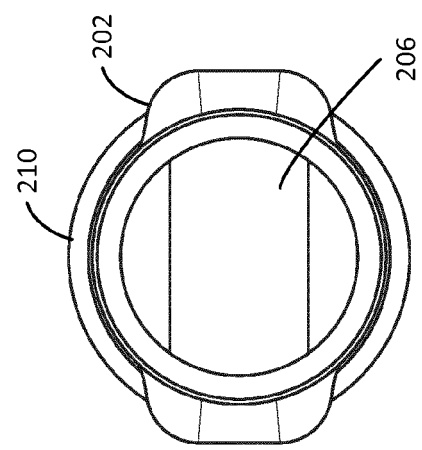


FIG. 7

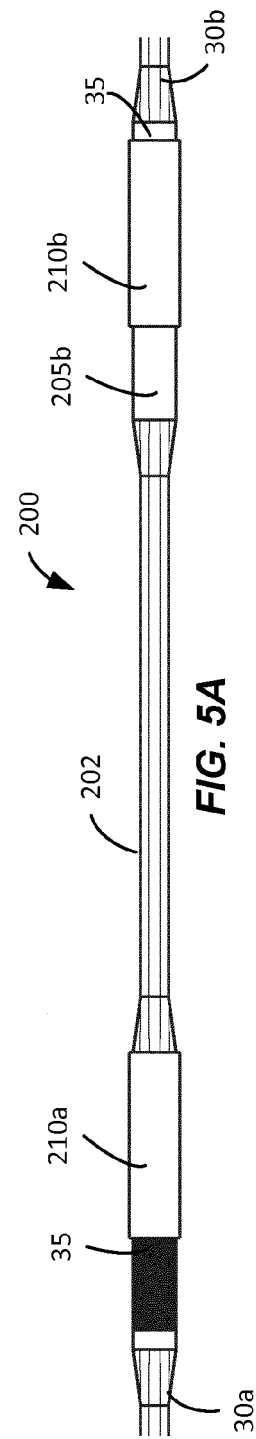


FIG. 5A

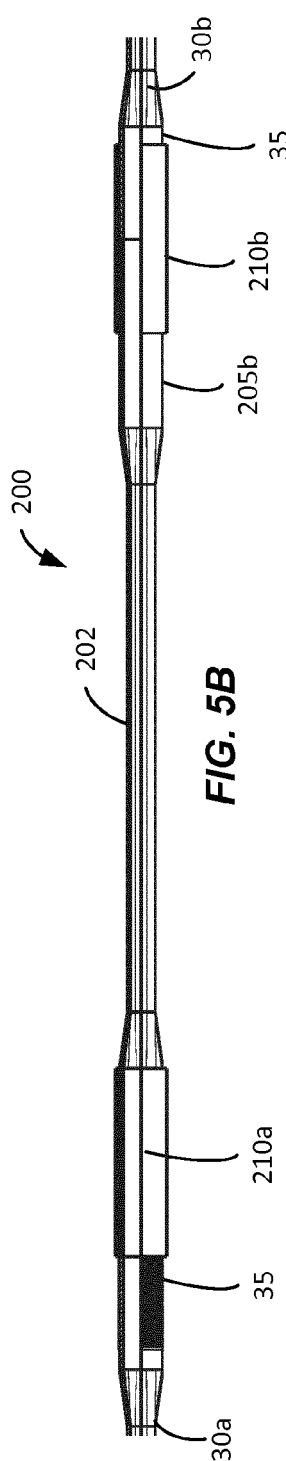


FIG. 5B

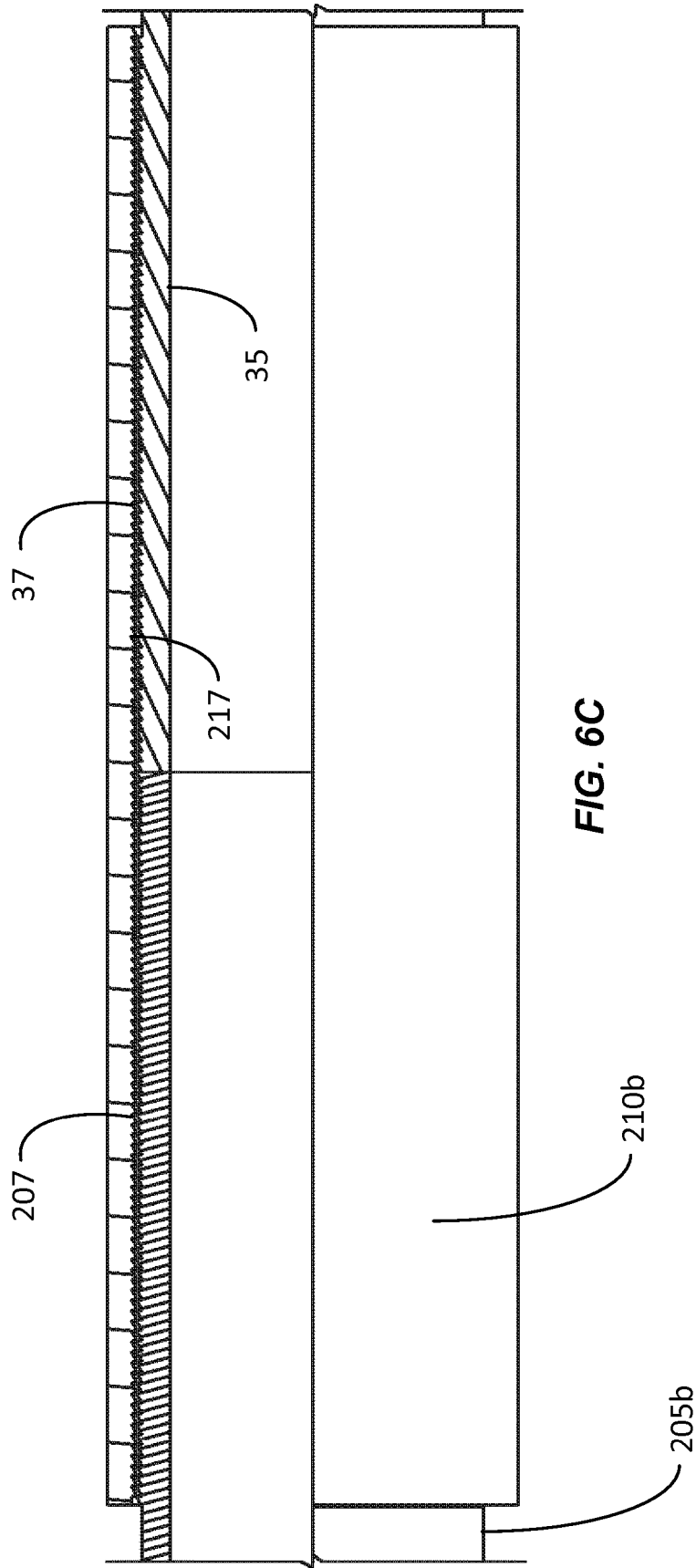


FIG. 6C

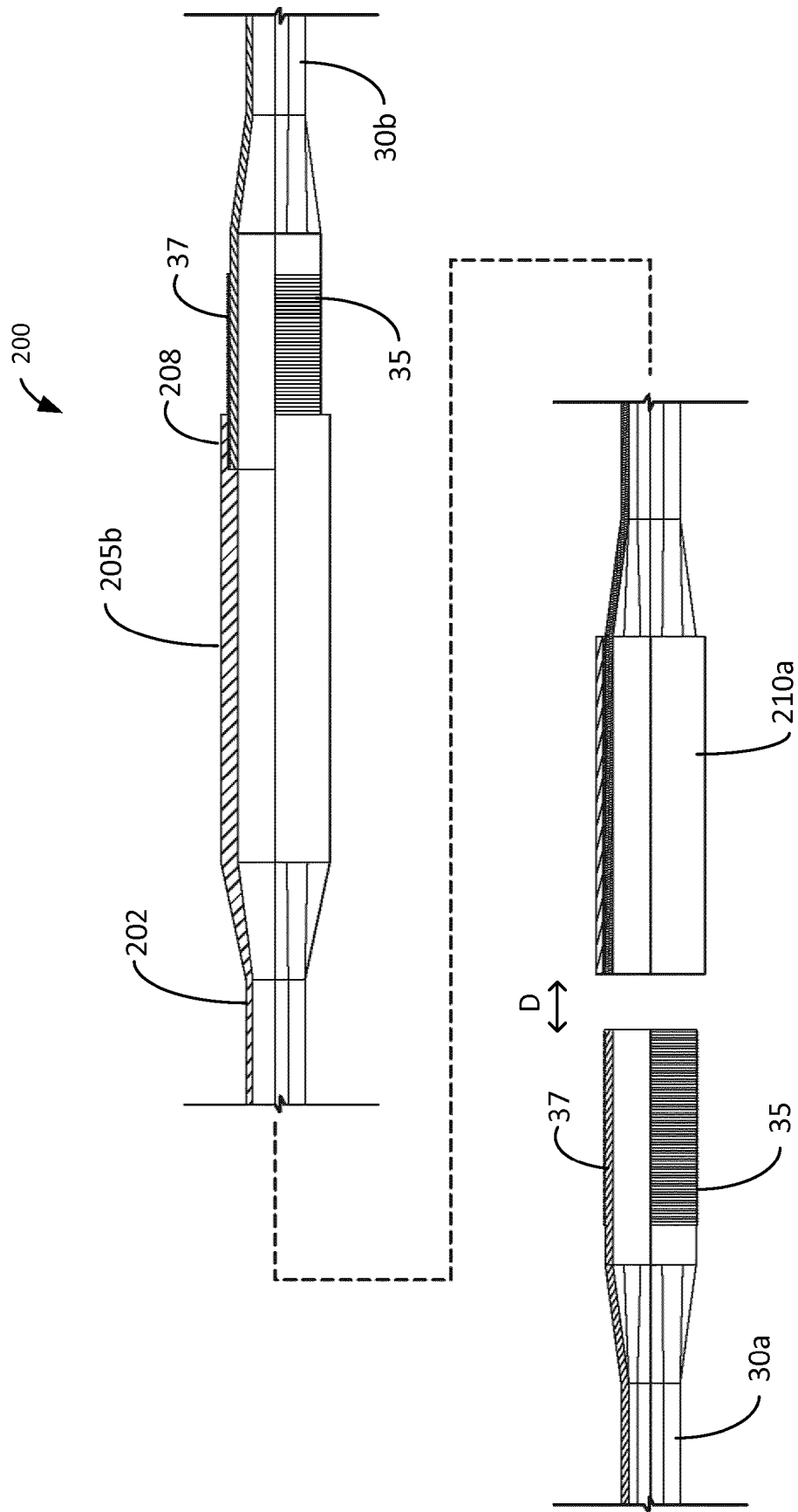


Fig. 8



EUROPEAN SEARCH REPORT

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