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(54) Title: GAS LIFT VALVE MANDREL POCKET

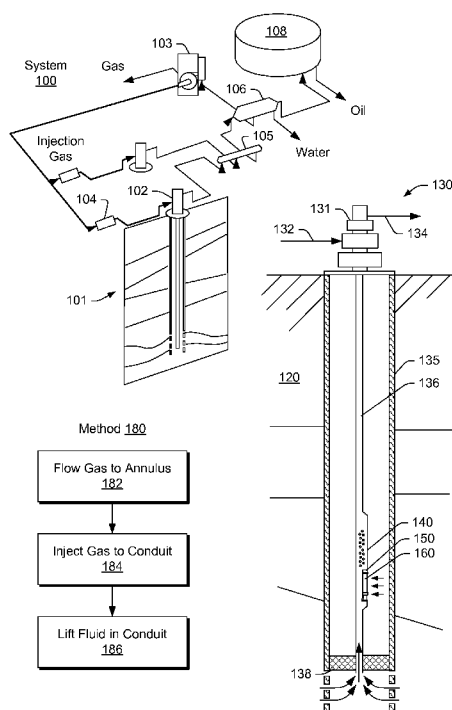


Fig. 1

(57) **Abstract:** A device can include an axial extension that includes an exterior mating surface defined in part by a mating radius that corresponds to a mandrel inner radius; a prop portion that is joined to the axial extension, that includes an interior surface that includes an interior opening of a fluid passage and that includes an exterior surface that includes an exterior opening of the fluid passage where the exterior surface extends radially outwardly from the exterior mating surface for receipt by a mandrel window; and a semi-tubular wall that is joined to the prop portion where the semi-tubular wall and the prop portion that includes the interior opening of the fluid passage define a bore having a bore axis.



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GAS LIFT VALVE MANDREL POCKET

RELATED APPLICATIONS

[0001] This application claims the benefit of and priority to U.S. Provisional Application Serial No. 61/831125, filed 4 June 2013, which is incorporated by reference herein.

BACKGROUND

[0002] A gas lift valve may be implemented in a gas lift system, for example, to control flow of lift gas into a production tubing conduit. As an example, a gas lift valve may be located in a gas lift mandrel, which may provide for communication with a lift gas supply, for example, in an annulus (e.g., between production tubing and casing). Operation of a gas lift valve may be determined, for example, by preset opening and closing pressures in the tubing or annulus.

SUMMARY

[0003] A device can include an axial extension that includes an exterior mating surface defined in part by a mating radius that corresponds to a mandrel inner radius; a prop portion that is joined to the axial extension, that includes an interior surface that includes an interior opening of a fluid passage and that includes an exterior surface that includes an exterior opening of the fluid passage where the exterior surface extends radially outwardly from the exterior mating surface for receipt by a mandrel window; and a semi-tubular wall that is joined to the prop portion where the semi-tubular wall and the prop portion that includes the interior opening of the fluid passage define a bore having a bore axis.

[0004] An assembly can include a mandrel that includes a mandrel inner radius and a mandrel window; and a device secured to the mandrel where the device includes an axial extension that includes an exterior mating surface defined in part by a mating radius that corresponds to the mandrel inner radius; a prop portion that is joined to the axial extension, that includes an interior surface that includes an interior opening of a fluid passage and that includes an exterior surface that includes an exterior opening of the fluid passage where the exterior surface extends radially outwardly from the exterior mating surface and is received by the mandrel window; and a semi-tubular wall that is joined to the prop portion where the semi-tubular wall

and the prop portion define a bore that is, via the interior opening of the prop portion, in fluid communication with the fluid passage.

[0005] A method can include welding a prop-in pocket device to a mandrel where a prop portion of the prop-in pocket device is received by a window of the mandrel; and latching a valve in a bore of the prop-in pocket device.

[0006] This summary is provided to introduce a selection of concepts that are further described below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Features and advantages of the described implementations can be more readily understood by reference to the following description taken in conjunction with the accompanying drawings.

[0008] Fig. 1 illustrates an example of a system and an example of a method;

[0009] Fig. 2 illustrates an example of a system;

[0010] Fig. 3 illustrates an example of a device;

[0011] Fig. 4 illustrates an example of an assembly;

[0012] Fig. 5 illustrates an example of an assembly;

[0013] Fig. 6 illustrates examples of assemblies;

[0014] Fig. 7 illustrates an example of an assembly;

[0015] Fig. 8 illustrates an example of an assembly;

[0016] Fig. 9 illustrates an example of an assembly;

[0017] Fig. 10 illustrates an example of an assembly; and

[0018] Fig. 11 illustrates an example of a method.

DETAILED DESCRIPTION

[0019] The following description includes the best mode presently contemplated for practicing the described implementations. This description is not to be taken in a limiting sense, but rather is made merely for the purpose of describing the general principles of the implementations. The scope of the described implementations should be ascertained with reference to the issued claims.

[0020] Gas lift is a process in which a gas may be injected from an annulus into tubing. An annulus, as applied to an oil well or other well for recovering a

subsurface resource may refer to a space, lumen, or void between any piping, tubing or casing and the piping, tubing, or casing immediately surrounding it, at a greater radius.

[0021] As an example, injected gas may aerate well fluid in production tubing in a manner that “lightens” the well fluid such that the fluid can flow more readily to a surface location. A gas lift valves may be configured to control flow of gas during an intermittent flow or a continuous flow gas lift operation. A gas lift valve may operate based at least in part on a differential pressure control, for example, with a variable orifice size that may constrain a maximum flow rate of gas.

[0022] As gas lift valve may include a so-called hydrostatic pressure chamber that, for example, may be charged with a desired pressure. As an example, an injection-pressure-operated gas lift valve or an unloading valve can be configured so that an upper valve in a production string opens before a lower valve in the production string opens. As an example, a gas lift valve may be considered a state machine. For example, a gas lift valve, as a state machine, may include an open state and a closed state where transitions can occur therebetween.

[0023] As an example, a gas lift valve may be configured, for example, in conjunction with a mandrel, for placement and/or retrieval of the gas lift valve using a kickover tool. For example, consider a side pocket mandrel that is shaped to allow for installation of one or more components at least partially in a side pocket or side pockets where a production flow path through the side pocket mandrel may provide for access to a wellbore and completion components located below the side pocket mandrel. As an example, a side pocket mandrel can include a main axis and a pocket axis where the pocket axis is offset a radial distance from the main axis. In such an example, the main axis may be aligned with production tubing, for example, above and/or below the side pocket mandrel.

[0024] As an example, a kickover tool may include an axial length from which a portion of the tool may be kicked-over (e.g., to a kicked-over position). In such an example, the tool may include a region that can carry a component such as a gas lift valve. An installation process may include inserting a length of the kickover tool into a side pocket mandrel (e.g., along a main axis) and kicking over a portion of the tool that carries a component toward the side pocket of the mandrel to thereby facilitate installation of the component in the side pocket. A removal process may operate in

a similar manner, however, where the portion of the tool is kicked-over to facilitate latching to a component in a side pocket of a side pocket mandrel.

[0025] Fig. 1 shows an example of a system 100, an example of a geologic environment 120 that includes equipment and an example of a method 180. The system 100 includes a subterranean formation 101 with a well 102. Injection gas is provided to the well 102 via a compressor 103 and a regulator 104. The injection gas can assist with lifting fluid that flows from the subterranean formation 101 to the well 102. The lifted fluid, including injected gas, may flow to a manifold 105, for example, where fluid from a number of wells may be combined. As shown in the example of Fig. 1, the manifold 105 is operatively coupled to a separator 106, which may separate components of the fluid. For example, the separator 106 may separate oil, water and gas components as substantially separate phases of a multiphase fluid. In such an example, oil may be directed to an oil storage facility 108 while gas may be directed to the compressor 103, for example, for re-injection, storage and/or transport to another location. As an example, water may be directed to a water discharge, a water storage facility, etc.

[0026] As shown in Fig. 1, the geologic environment 120 is fitted with well equipment 130, which includes a well-head 131 (e.g., a Christmas tree, etc.), an inlet conduit 132 for flow of compressed gas, an outlet conduit 134 for flow of produced fluid, a casing 135, a production conduit 136, and a packer 138 that forms a seal between the casing 135 and the production conduit 136. As shown, fluid may enter the casing 135 (e.g., via perforations) and then enter a lumen of the production conduit 136, for example, due to a pressure differential between the fluid in the subterranean geologic environment 120 and the lumen of the production conduit 136 at an opening of the production conduit 136. Where the inlet conduit 132 for flow of compressed gas is used to flow gas to the annular space between the casing 135 and the production conduit 136, a mandrel 140 operatively coupled to the production conduit 136 that includes a pocket 150 that seats a gas lift valve 160 that may regulate the introduction of the compressed gas into the lumen of the production conduit 136. In such an example, the compressed gas introduced may facilitate flow of fluid upwardly to the well-head 131 (e.g., opposite a direction of gravity) where the fluid may be directed away from the well-head 131 via the outlet conduit 134.

[0027] As shown in Fig. 1, the method 180 can include a flow block 182 for flowing gas to an annulus (e.g., or, more generally, a space exterior to a production

conduit fitted with a gas lift valve), an injection block 184 for injecting gas from the annulus into a production conduit via a gas lift valve or gas lift valves and a lift block 186 for lifting fluid in the production conduit due in part to buoyancy imparted by the injected gas.

[0028] As an example, a production process may optionally utilize one or more fluid pumps such as, for example, an electric submersible pump (e.g., consider a centrifugal pump, a rod pump, etc.). As an example, a production process may implement one or more so-called “artificial lift” technologies. An artificial lift technology may operate by adding energy to fluid, for example, to initiate, enhance, etc. production of fluid.

[0029] Fig. 2 shows an example of a system 200 that includes a casing 235, a production conduit 236 and a mandrel 240 that includes a pocket 250 that seats a gas lift valve 260. As shown, the mandrel 240 can include a main longitudinal axis (z_M) and a side pocket longitudinal axis (z_P) that is offset a radial distance from the main longitudinal axis (z_M). In the example of Fig. 2, the axes (z_M and z_P) are shown as being substantially parallel such that a bore of the pocket 250 is parallel to a lumen of the mandrel 240. Also shown in Fig. 2 are two examples of cross-sectional profiles for the mandrel 240, for example, along a line A-A. As shown, a mandrel may include a circular cross-sectional profile or another shaped profile such as, for example, an oval profile.

[0030] As an example, a completion may include multiple instances of the mandrel 240, for example, where each pocket of each instance may include a gas lift valve where, for example, one or more of the gas lift valves may differ in one or more characteristics from one or more other of the gas lift valves (e.g., pressure settings, etc.).

[0031] As shown in the example of Fig. 2, the mandrel 240 can include one or more openings that provide for fluid communication with fluid in an annulus (e.g., gas and/or other fluid), defined by an outer surface of the mandrel 240 and an inner surface of the casing 235, via a gas lift valve 260 disposed in the pocket 250. For example, the gas lift valve 260 may be disposed in the pocket 250 where a portion of the gas lift valve 260 is in fluid communication with an annulus (e.g., with casing fluid) and where a portion of the gas lift valve 260 is in fluid communication with a lumen (e.g., with tubing fluid). In such an example, fluid may flow from the annulus to the lumen to assist with lift of fluid in the lumen or fluid may flow from the lumen to

the annulus. The pocket 250 may include an opening that may be oriented downhole and one or more openings that may be oriented in a pocket wall, for example, directed radially to a lumen space. As an example, the pocket 250 may include a production conduit lumen side opening (e.g., an axial opening) for placement, retrieval, replacement, adjustment, etc. of a gas lift valve. For example, through use of a tool, the gas lift valve 260 may be accessed.

[0032] As an example, a side pocket mandrel may be configured with particular dimensions, for example, according to one or more dimensions of commercially available equipment. As an example, a side pocket mandrel may be defined in part by a tubing dimension (e.g., tubing size). For example, consider tubing sizes of about 2.375 in (e.g., about 60 mm), of about 2.875 in (e.g., about 73 mm) and of about 3.5 in (e.g., about 89 mm). As to types of valves that may be suitable for installation in a side pocket mandrel, consider dummy valves, shear orifice valves, circulating valves, chemical injection valves and waterflood flow regulator valves. As an example, a side pocket may include a bore configured for receipt of a device that includes an outer diameter of about 1 in (e.g., about 25 mm). As mentioned, a running tool, a pulling tool, a kickover tool, etc. may be used for purposes of installation, retrieval, adjustment, etc. of a device with respect to a side pocket. As an example, a tool may be positionable via a slickline technique.

[0033] As an example, a side pocket mandrel may include a circular and/or an oval cross-sectional profile (e.g., or other shaped profile). As an example, a side pocket mandrel may include an exhaust port (e.g., at a downhole end of a side pocket). Such a mandrel may extend into a casing annulus and connect to a packer (e.g., for a chamber-lift installation).

[0034] As an example, a mandrel may be fit with a gas lift valve that may be, for example, a valve according to one or more specifications such as a 1.5 in injection pressure-operated (IPO) valve, a 1.75 in injection pressure-operated (IPO) valve, an orifice valve, etc. As an example, a positive-sealing check valve may be used such as a valve qualified to meet API-19G1 and G2 industry standards and pressure barrier qualifications. For example, with a test pressure rating of about 10,000 psi (e.g., about 69,000 kPa), a valve may form a metal-to-metal barrier between production tubing and a casing annulus that may help to avoid undesired communication (e.g., or reverse flow) and to help mitigate risks associated with gas lift valve check systems.

[0035] Fig. 3 shows various views of an example of a device 350 that may be referred to as a prop-in pocket. As an example, a prop may be defined as a support that may be used to position another component. As an example, a prop-in pocket may be a device that defines a pocket where the device can be “propped into” a mandrel. In such an example, the mandrel may be considered to be a prop. As an example, a pocket may be considered a prop, for example, that positions a component therein (e.g., in a bore of the pocket). In such an example, a pocket may be defined by structure where the pocket includes a chamber or space, which may be defined in part by a bore. For example, a pocket may be defined by a machined or otherwise formed material that defines a bore that can receive a component such as a valve.

[0036] Fig. 3 shows a perspective view of the device 350, a longitudinal cross-sectional view and another cross-sectional along a line B-B. In the example of Fig. 3, the device 350 includes a length Δz and various radii, labeled r_1 to r_5 that may be defined with respect to one or more axes. Various features of a device may be defined, for example, with respect to one or more azimuthal angles (e.g., about an axis).

[0037] In the example of Fig. 3, the device 350 includes an end 352, an opposing end 354 and a prop portion 370 located between the ends 352 and 354. As shown in the example of Fig. 3, the prop portion 370 includes an exterior surface 371 that extends radially outwardly over a length of the device 350 (e.g., Δz_p), for example, between a shoulder 372 and a shoulder 374 where the shoulder 372 rises at an angle ϕ from an axial extension 356 that includes an arcuate mating surface (e.g., that can mate with an interior surface of a mandrel) and where the shoulder 374 rises at an angle ϕ from another axial extension 358 that includes an arcuate mating surface (e.g., that can mate with an interior surface of a mandrel). As shown in the example of Fig. 3, the shoulders 372 and 374 may have associated surfaces that may be crescent shaped (e.g., defined by a shape with a first radius and a shape with a second radius).

[0038] As an example, the axial extension 356 may function to mate with an interior surface of a mandrel and may also function as a discriminator. For example, the shape of the axial extension 356 (e.g., an interior shape) may allow for certain

tools to access the pocket while preventing certain other tools from accessing the pocket.

[0039] In the example of Fig. 3, the device 350 includes a semi-tubular portion 373 that joins at least the prop portion 370 to define at least a portion of one or more bores 377, 378 and 379. In such an example, the bores 377, 378 and 379 may include radii that are sized for receipt of a component such as a gas lift valve. As such, the bores 377, 378 and 379 may collectively define a pocket of the device 350 (e.g., a space shaped to receive a component). As mentioned, the axial extension 356 may function in part as a discriminator. For example, the shape of the axial extension 356 may allow for certain tools to access the pocket while preventing certain other tools from accessing the pocket. As mentioned, a tool may include one or more features that can couple to a component, for example, to transport the component, to adjust the component, etc.

[0040] As to the semi-tubular portion 373, it may azimuthally span at least a portion of a tube, which may include a circular cross-section and/or other shaped cross-section. As an example, a semi-tubular portion may span an arc angle of about 180 degrees or more. As an example, a prop portion may span an arc angle of about 60 degrees and a semi-tubular portion may span an arc angle of about 300 degrees. As an example, a device such as the device 350 of Fig. 3 may be a unitary device where various portions are integrally joined. For example, the device 350 may optionally be formed from a single piece of material or formed as a single piece of material (e.g., metal, alloy, etc.). As an example, the device 350 may be machined from a stock piece of material. As an example, the device 350 may be cast from fluid and/or particulate material and then machined, for example, to form bore wall surfaces, passages, etc.

[0041] As shown in Fig. 3, the prop portion 370 of the device 350 includes an exterior surface 371 and one or more passages 375 that extend radially inwardly to the bore 378. As shown, a passage may include an exterior opening and an interior opening. For example, consider the label 375 as identifying a particular passage that includes an exterior opening 375-EO and an interior opening 375-IO. As shown, the exterior opening 375-EO is on the exterior surface 371 and the interior opening 375-IO is on an interior surface that defines in part the bore 378. In such an example, the passage 375 is in fluid communication with the bore 378 at least in part via the interior opening 375-IO.

[0042] As an example, where a gas lift valve is seated in the device 350, as installed in a mandrel, the one or more passages 375 can provide for fluid communication between a casing annulus and a lumen of the mandrel, which may be contiguous with a lumen of production conduit. In the example of Fig. 3, the one or more passages 375 include two sets of passages where each set is set at an offset angle, which may be seen in the longitudinal cross-sectional view (e.g., two sets of four passages where each set is offset from a centerline of the prop portion 370). The number, openings, shape(s) and orientation(s) of one or more passages may be selected for one or more purposes, for example, to cooperate with a component positioned in the pocket, to exclude material greater than a particular size, etc.

[0043] As an example, a component may be disposed in the bores 377, 378 and 379 via an opening 376 to the bore 377. As mentioned, the axial extension 356 may function as a discriminator. For example, the shape of the axial extension 356 may allow for certain tools and/or components to access the pocket while preventing certain other tools and/or components from accessing the pocket. As shown, the opening 376 to the bore 377 may be adjacent a chamfer formed by a decreasing radius with respect to an axial direction moving inwardly from the opening 376.

[0044] As an example, a component may be latched in the bores 377, 378 and 379, for example, via a latch portion 355 of the device 350. As shown in the example of Fig. 3, the latch portion 355 extends radially inwardly from the axial extension 356 at a distance Δz_l as measured from the opening 376 of the bore 377. The latch portion 355 may be defined by an axial length and an azimuthal angle (e.g., an arc angle). As shown in Fig. 3, the latch portion 355 extends radially inwardly, for example, to an edge that may be defined by one or more radii (see, e.g., the radius r_5). In the cross-sectional view along the line B-B, a bore radius r_4 of the bore 377 is shown that is less than a latch radius r_5 of the latch portion 355. The latch portion 355 may function to latch a component in the pocket of the device 350. For example, the latch portion 355 can allow for passage of a component into the opening 376 and can allow for latching the component, for example, via a portion of the component that may include an extended radius that can be seated axially between the latch portion 355 and the opening 376.

[0045] As shown in Fig. 3, the axial extension 356 includes an arcuate mating surface that may be defined by a radius r_1 about an axis that is displaced from a common axis of the bores 377, 378 and 379. As an example, the arcuate mating surface may be symmetric or asymmetric and defined at least in part by one or more azimuthal angles (see, e.g., the arc angle Θ). As shown, the axial extension 356 can include an arcuate interior surface, for example, defined at least in part by a radius r_3 . As mentioned, the axial extension 356 may be a discriminator. In such an example, the arcuate interior surface may be shaped to discriminate with respect to tools and/or components.

[0046] As an example, a device, which may be a prop-in pocket, can include a first end, a second end, a prop portion that includes one or more openings, an axial extension that extends from the prop portion to the first end, and a semi-tubular wall that joins the prop portion to form at least a portion of a through bore where the one or more openings of the prop portion are in fluid communication with the through bore.

[0047] As an example, a device can include an axial extension that includes an exterior mating surface defined in part by a mating radius that corresponds to a mandrel inner radius; a prop portion that is joined to the axial extension, that includes an interior surface that includes an interior opening of a fluid passage and that includes an exterior surface that includes an exterior opening of the fluid passage where the exterior surface extends radially outwardly from the exterior mating surface for receipt by a mandrel window; and a semi-tubular wall that is joined to the prop portion where the semi-tubular wall and the prop portion that includes the interior opening of the fluid passage define a bore having a bore axis.

[0048] Fig. 4 shows the device 350 with respect to a mandrel 340 that is joined to production conduit 336-1 and 336-2 via transition portions 337-1 and 337-2. As shown in the example of Fig. 4, the mandrel 340 includes a window 347 that can receive the prop portion 370 of the device 350. As an example, the device 350 may be welded to the mandrel 340, for example, to form a seal about the prop portion 370 and a border of the window 347. As an example, a material may be molten via delivery of energy (e.g., beam welding, arc welding, etc.) to thereby form a weld pool that can solidify and act to structurally bind two components and, for example, to form a seal therebetween.

[0049] As an example, the device 350 may be positioned in the mandrel 340 and temporarily secured during a welding process that can permanently secure the device 350 to the mandrel 340. In such an example, permanent securement may be defined as being secured sufficiently for deployment in a downhole environment that may be at high temperature and high pressure (see, e.g., geologic environment 101 of Fig. 1).

[0050] Fig. 5 shows a perspective view of the device 350 and a cutaway view of the device 350 as positioned in a mandrel 340. As shown, the device 350 can include a common bore axis of the bores 377, 378 and 379 that is substantially parallel to and radially offset from a bore axis of the mandrel 340. In such a manner, the bores 377, 378 and 379 can define a "side" pocket, for example, for receipt of a valve (e.g., a gas lift valve). In such an example, the mandrel 340 together with the device 350 may be defined as a side pocket mandrel.

[0051] Fig. 6 shows an example of an assembly 700 and an example of an assembly 800. The assembly 700 includes a mandrel 740 with a single window 747 that receives a prop portion 770 of a device 750 where the device 750 defines a pocket. The assembly 800 includes a mandrel 840 with multiple windows 847-1 and 847-2 that receive respective prop portions 870-1 and 870-2 of a device 850 where the device 850 defines a pocket. Fig. 6 also shows lines C-C and D-D for which various cross-sectional views are shown in Fig. 7 and Fig. 8, respectively. In the various views, a central axis and a pocket axis are shown; noting that a main axis may be offset from a central axis where, for example, the main axis aligns with an axis or axes of one or more other conduits (e.g., as joined to an end or ends of a mandrel).

[0052] In Fig. 7, the device 750 is shown as including an axial extension 756 that may function to mate with an interior surface of a mandrel and may also function as a discriminator. For example, the shape of the axial extension 756 (e.g., an interior shape) may allow for certain tools to access a pocket while preventing certain other tools from accessing the pocket. The device 750 also includes a semi-tubular portion 773 that joins at least the prop portion 770 to define at least a portion of one or more bores (e.g., that form a pocket).

[0053] In Fig. 8, the device 850 is shown as including an axial extension 856 that may function to mate with an interior surface of a mandrel and may also function as a discriminator. For example, the shape of the axial extension 856 (e.g., an

interior shape) may allow for certain tools to access a pocket while preventing certain other tools from accessing the pocket. The device 850 also includes a semi-tubular portion 873 that joins at least the prop portion 870-2 to define at least a portion of one or more bores (e.g., that form a pocket).

[0054] Fig. 9 shows a cutaway view of a portion of an example of an assembly 900 that includes the mandrel 740 and the device 750 along with a valve 760. As shown, the valve 760 includes an end 762 that is positioned proximate to a discriminator 780 that may be joined to the device 750 and optionally integral to the device 750. As an example, the discriminator 780 may include two or more portions, which may be referred to as wings. For example, the discriminator 780 includes a wing 781-1 and a wing 781-2 that may be joined to (e.g., optionally joined integrally to) an axial extension 756 of the device 750. As shown, the valve 760 may include one or more features 764 that may be seated at least in part axially between a latch portion 755 and an opening 776 to a bore of the device 750. Such one or more features may be actuatable, for example, in a manner that pertains to latching, installation, removal, etc.

[0055] With reference to the wing 781-2, a surface may be defined by a portion of a cone. For example, the wing 781-2 may include an end 782 and an end 784 where a surface extends axially and radially inward from the end 782 to an edge 783. In such a manner, a tool may be guided to an axis (e.g., a cone axis that may align with a bore axis, etc.).

[0056] Fig. 9 also shows the device 750 as including a passage 775 that can allow fluid (e.g., gas, liquid, etc.) to pass from an exterior space exterior to the mandrel 740 to the valve 760. For example, the valve 760 may be a gas lift valve that can transmit gas to a lumen of the mandrel 740. As shown, the passage 775 may be defined in part by an axial dimension, which may be larger than a dimension orthogonal thereto (e.g., an arc span). For example, the passage 775 may be shaped substantially as a slot (e.g., optionally with radiused ends).

[0057] Fig. 10 shows a cutaway view of a portion of an example of an assembly 1000 that includes the mandrel 840 and the device 850. As shown, the assembly 1000 includes a discriminator 880 that may be joined to the device 850 and optionally integral to the device 850. As an example, the discriminator 880 may include two or more portions, which may be referred to as wings. For example, the

discriminator 880 includes a wing 881-1 and a wing 881-2 that may be joined to (e.g., optionally joined integrally to) an axial extension 856 of the device 850.

[0058] With reference to the wing 881-2, a surface may be defined by a portion of a cone. For example, the wing 881-2 may include an end 882 and an end 884 where a surface extends axially and radially inward from the end 882 to an edge 883. In such a manner, a tool may be guided to an axis (e.g., a cone axis).

[0059] In the example of Fig. 10, the device 850 is also shown as including a latch portion 855 and an opening 876 to a bore of the device 850. In such an example, the latch portion 855 and the opening 876 may be spaced axially by a dimension that provides for receipt of a latching portion of a valve (see, e.g., the one or more features 764 of the valve 760 of Fig. 9).

[0060] Fig. 10 also shows the device 850 as including a passage 875 that can allow fluid (e.g., gas, liquid, etc.) to pass from an exterior space exterior to the mandrel 840, for example, via a valve. For example, a valve may be a gas lift valve (see, e.g., the valve 760 of Fig. 9) that can transmit gas to a lumen of the mandrel 840.

[0061] As mentioned, the device 850 includes the prop portions 870-1 and 870-2. The prop portion 870-1 may be referred to as a dummy prop portion as it does not include passages that are in fluid communication with a bore that can seat a valve. As an example, the device 850 may be welded to the mandrel 840 or other twin window mandrel via welding that forms weld joints at perimeters of the windows 847-1 and 847-2. Such weld joints may secure and seal the device 850 with respect to the mandrel 840.

[0062] Fig. 11 shows an example of a method 1150 that includes a weld block 1152 for welding a prop-in pocket device to a mandrel where a prop portion of the prop-in pocket device is received by a window of the mandrel, a latch block 1154 for latching a valve in a bore of the prop-in pocket device, and a passage block 1156 for passing gas via one or more passages of the prop portion to the valve and then to a lumen of the mandrel.

[0063] As an example, an oval gas lift mandrel may be associated with a relatively low output pump. Various components of an oval mandrel may be manufactured by a forging process, which may be performed at relatively low cost. As an example, an oval mandrel may include a window or windows where a prop portion of a device that defines a pocket may be received to form a gas lift mandrel.

[0064] As an example, a prop-in pocket device for a gas lift mandrel may be machined or forged, then machined. A prop-in pocket approach may allow for a reduction in size of a pocket “window” that is cut in a body pipe member during a mandrel assembly process. As an example, a prop-in pocket approach may, due to a smaller window size, diminish risk of warping of a mandrel assembly during welding (e.g., compared to a larger, standard pocket window cut into a body pipe). As an example, a window may be formed via machining a body pipe, for example, compared to a plasma-based cutting process.

[0065] As an example, a device may include a tool discriminator, a latch, and a valve pocket bore that can at least partially house a gas lift valve. As an example, a device may be machined from bar stock or, for example, forged stock. A window/prop portion of an assembly may correspond to a gas injection region that can experience a pressure differential (e.g., thousands of psi or more). A prop-in pocket approach may provide sufficient pressure retaining section thickness, suitable pocket weld preparation features, and fit into a body pipe window during assembly to form a side pocket mandrel.

[0066] As an example, a milling operation may be performed on a top portion of a device, for example, along an arc profile to form a mating surface that can allow the device to sit flush with respect to an inside radius or radii of a body pipe (e.g., at one or more non-prop regions). Such a milling operation may form a portion of a circular profile or a portion of an oval profile, which may allow a prop-in pocket device to be employed in a round cross-section gas lift mandrel or an oval cross-section gas lift mandrel. When employed in a round cross-section low-tier gas lift mandrel, a fitting feature may allow for procurement of off-the-shelf pipes for use as the body pipe of the gas lift mandrel, which may reduce body pipe cost and lead time and, for example, reduce gas lift mandrel manufacturing cost and time. Flexibility as to design may allow a prop-in pocket approach to be implemented for manufacture of gas lift mandrels that meet specified inside diameter (ID) and outside diameter (OD) drifts.

[0067] As an example, for a pocket such as, for example, a 1.5 inch “M style” pocket, a device may include multiple prop regions (e.g., prop portions) that can be received by a corresponding number of windows (e.g., of a body pipe).

[0068] As an example, a method may include forming a discrete prop-in pocket device to secure a gas lift valve for a gas lift mandrel, the prop-in pocket

device being attachable to an inside of a body member of the gas lift mandrel; creating a valve pocket bore in the prop-in pocket device to house at least part of a gas lift valve in the gas lift mandrel; forming at least one prop in the prop-in pocket device to at least partially secure the prop-in pocket in the body member of the gas lift mandrel. As an example, a method may include forming a surface of the prop-in pocket device that can mate with an inside surface of an oval gas lift mandrel, a round gas lift mandrel, etc. As an example, a method may include forming a discriminator on a prop-in pocket device. As an example, a method may include forming a latch on the prop-in pocket device.

[0069] As an example, a device can include an axial extension that includes an exterior mating surface defined in part by a mating radius that corresponds to a mandrel inner radius; a prop portion that is joined to the axial extension, that includes an interior surface that includes an interior opening of a fluid passage and that includes an exterior surface that includes an exterior opening of the fluid passage where the exterior surface extends radially outwardly from the exterior mating surface for receipt by a mandrel window; a semi-tubular wall that is joined to the prop portion where the semi-tubular wall and the prop portion define a bore that is, via the interior opening of the prop portion, in fluid communication with the fluid passage. In such an example, the device may be a unitary device where the prop portion is integrally joined to the axial extension and where the semi-tubular wall is integrally joined to the prop portion.

[0070] As an example, a device may include a prop portion that includes a plurality of fluid passages that include respective interior openings and respective exterior openings.

[0071] As an example, a device may include a latch portion that extends radially inwardly from a surface of an axial extension. As an example, an axial extension may include an interior surface defined at least in part by a discriminator radius. As an example, a device may include a discriminator portion that is joined to an axial extension. As an example, a discriminator portion may include a surface defined at least in part by radii of a portion of a cone. As an example, a discriminator portion may include a surface that converges from an end with a larger radius to an end with a smaller radius. As an example, a discriminator portion may be defined at least in part by an arc angle.

[0072] As an example, a device can include opposing ends and axial extensions where each of the axial extensions extends axially from a prop portion to a respective one of the opposing ends. As an example, a device may include a dummy prop portion that includes an exterior surface that extends radially outwardly from an exterior mating surface for receipt by a mandrel window. Such a dummy prop portion may provide for additional joining area, for example, for formation of a weld joint to secure the device to a mandrel. Such additional joining area may provide for a pressure rating, for example, in conjunction with a valve seated in a device. For example, an additional joining area provided by a dummy prop portion received by a window may provide for additional structural integrity of a side pocket mandrel. As an example, a bore of a device may be a gas lift valve seating bore where the device may be joined to a mandrel (e.g., a body pipe, etc.) to form a side pocket mandrel for a gas lift valve.

[0073] As an example, an assembly can include a mandrel that includes a mandrel inner radius and a mandrel window; and a device secured to the mandrel where the device includes an axial extension that includes an exterior mating surface defined in part by a mating radius that corresponds to the mandrel inner radius; a prop portion that is joined to the axial extension, that includes an interior surface that includes an interior opening of a fluid passage and that includes an exterior surface that includes an exterior opening of the fluid passage where the exterior surface extends radially outwardly from the exterior mating surface and is received by the mandrel window; a semi-tubular wall that is joined to the prop portion where the semi-tubular wall and the prop portion define a bore that is, via the interior opening of the prop portion, in fluid communication with the fluid passage. In such an example, the device may be secured to the mandrel by a weld joint formed at a perimeter of the mandrel window. As an example, an assembly may include a valve disposed at least partially in a bore of a device (e.g., a prop-in pocket device) that is secured to a mandrel. In such an example, the valve may be a gas lift valve. As an example, a mandrel may include an oval cross-section. As an example, a mandrel may include a circular cross-section.

[0074] As an example, a method may include welding a prop-in pocket device to a mandrel where a prop portion of the prop-in pocket device is received by a window of the mandrel; and latching a valve in a bore of the prop-in pocket device.

Such a method may further include passing gas via one or more passages of the prop portion to the valve and then to a lumen of the mandrel.

Conclusion

[0075] Although only a few examples have been described in detail above, those skilled in the art will readily appreciate that many modifications are possible in the examples. Accordingly, all such modifications 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. Thus, although a nail and a screw may not be structural equivalents in that a nail employs a cylindrical surface to secure wooden parts together, whereas a screw employs a helical surface, in the environment of fastening wooden parts, a nail and a screw may be equivalent structures. It is the express intention of the applicant not to invoke 35 U.S.C. § 112, paragraph 6 for any limitations of any of the claims herein, except for those in which the claim expressly uses the words “means for” together with an associated function.

CLAIMS

What is claimed is:

A device (350, 750, 850) comprising:

an axial extension (356, 756, 856) that comprises an exterior mating surface defined in part by a mating radius that corresponds to a mandrel inner radius;

a prop portion (370, 770, 870-2) that is joined to the axial extension, that comprises an interior surface that comprises an interior opening of a fluid passage (375, 775, 875) and that comprises an exterior surface that comprises an exterior opening of the fluid passage wherein the exterior surface extends radially outwardly from the exterior mating surface for receipt by a mandrel window; and

a semi-tubular wall (373, 773, 873) that is joined to the prop portion wherein the semi-tubular wall and the prop portion define a bore that is, via the interior opening of the prop portion, in fluid communication with the fluid passage.

2. The device of claim 1 being a unitary device wherein the prop portion is integrally joined to the axial extension and wherein the semi-tubular wall is integrally joined to the prop portion.

3. The device of claim 1 wherein the prop portion comprises a plurality of fluid passages that comprise respective interior openings and respective exterior openings.

4. The device of claim 1 comprising a latch portion that extends radially inwardly from a surface of the axial extension.

5. The device of claim 1 wherein the axial extension comprises an interior surface defined at least in part by a discriminator radius.

6. The device of claim 1 comprising a discriminator portion that is joined to the axial extension.

7. The device of claim 6 wherein the discriminator portion comprises a surface defined at least in part by radii of a portion of a cone.
8. The device of claim 6 wherein the discriminator portion comprises a surface that converges from an end with a larger radius to an end with a smaller radius.
9. The device of claim 6 wherein the discriminator portion is defined at least in part by an arc angle.
10. The device of claim 1 comprising opposing ends and another axial extension wherein each of the axial extensions extends axially from the prop portion to a respective one of the opposing ends.
11. The device of claim 1 wherein the bore comprises a gas lift valve seating bore.
12. The device of claim 1 comprising a dummy prop portion that comprises an exterior surface that extends radially outwardly from the exterior mating surface for receipt by another mandrel window.
13. An assembly comprising:
 - a mandrel (340, 740, 840) that comprises a mandrel inner radius and a mandrel window; and
 - a device (350, 750, 850) secured to the mandrel wherein the device comprises
 - an axial extension (356, 756, 856) that comprises an exterior mating surface defined in part by a mating radius that corresponds to the mandrel inner radius;
 - a prop portion (370, 770, 870-2) that is joined to the axial extension, that comprises an interior surface that comprises an interior opening of a fluid passage (375, 775, 875) and that comprises an exterior surface that comprises an exterior opening of the fluid passage wherein the exterior surface extends radially outwardly from the exterior mating surface and is received by the mandrel window; and

a semi-tubular wall (373, 773, 873) that is joined to the prop portion wherein the semi-tubular wall and the prop portion define a bore that is, via the interior opening of the prop portion, in fluid communication with the fluid passage.

14. The assembly of claim 13 wherein the device is secured to the mandrel by a weld joint formed at a perimeter of the mandrel window.

15. The assembly of claim 13 further comprising a valve disposed at least partially in the bore.

16. The assembly of claim 15 wherein the valve comprises a gas lift valve.

17. The assembly of claim 13 wherein the mandrel comprises an oval cross-section.

18. The assembly of claim 13 wherein the mandrel comprises a circular cross-section.

19. A method (1150) comprising:
welding a prop-in pocket device to a mandrel wherein a prop portion of the prop-in pocket device is received by a window of the mandrel (1152); and
latching a valve in a bore of the prop-in pocket device (1154).

20. The method of claim 19 comprising passing gas via one or more passages of the prop portion to the valve and then to a lumen of the mandrel.

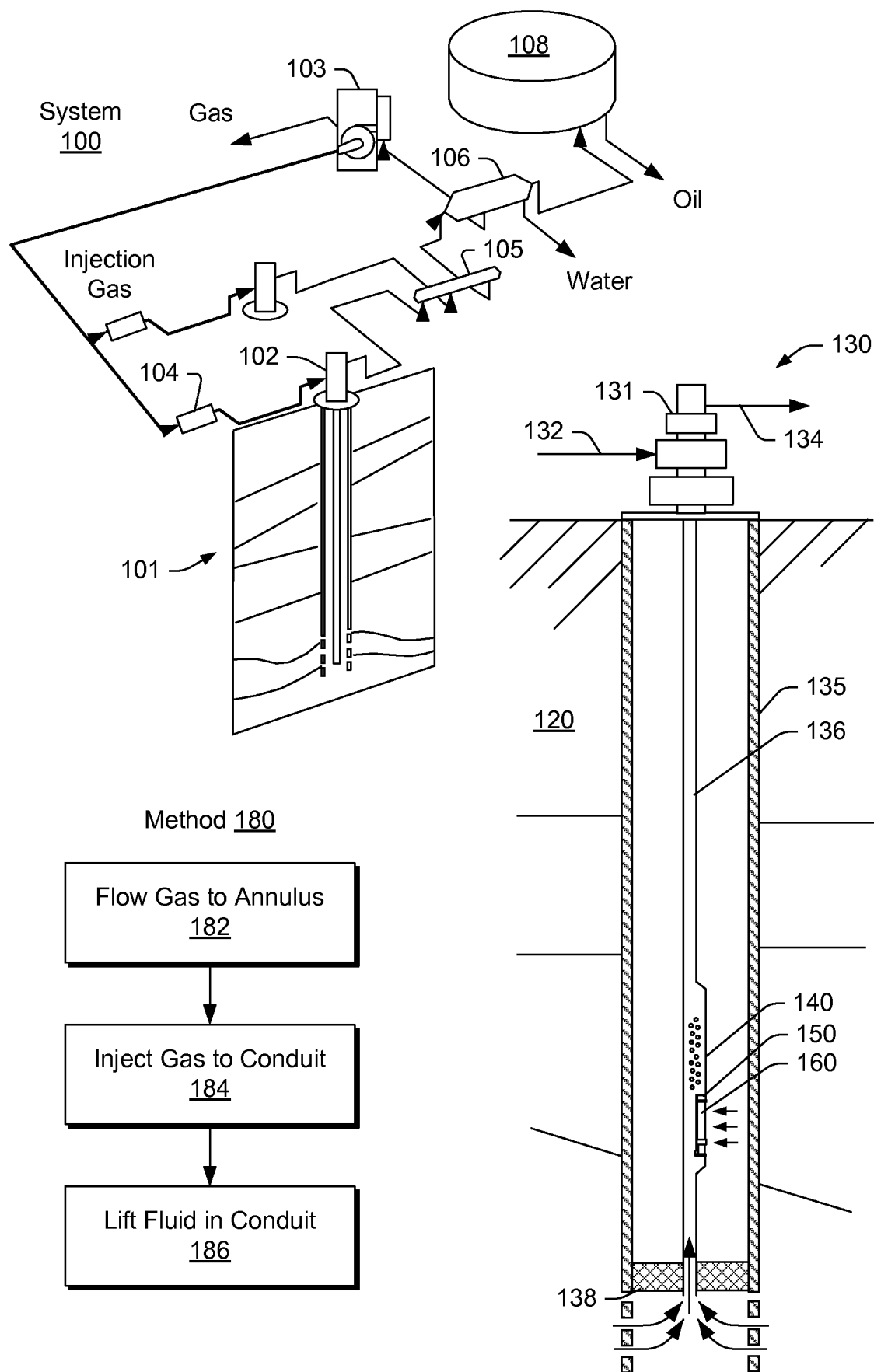


Fig. 1

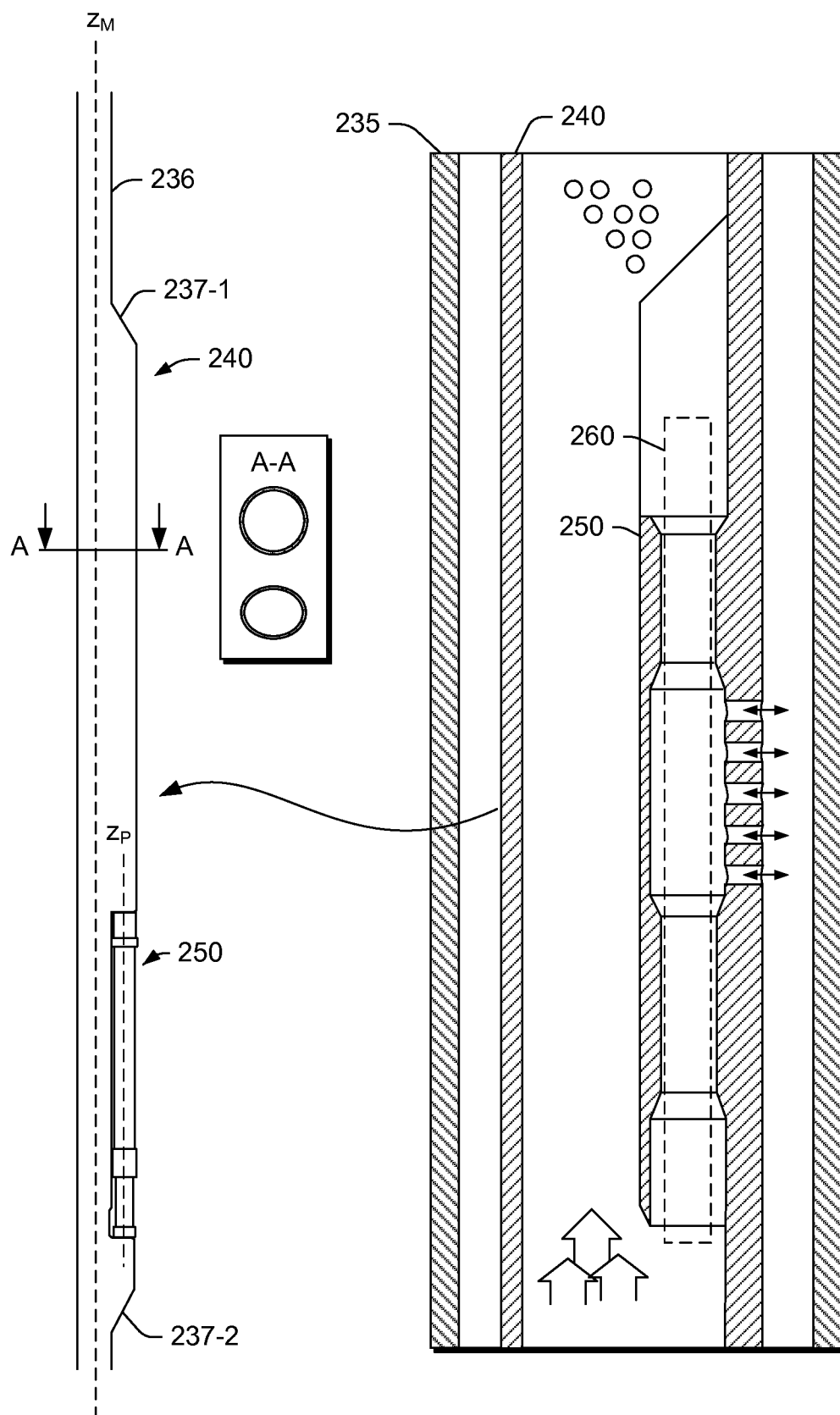
System 200

Fig. 2

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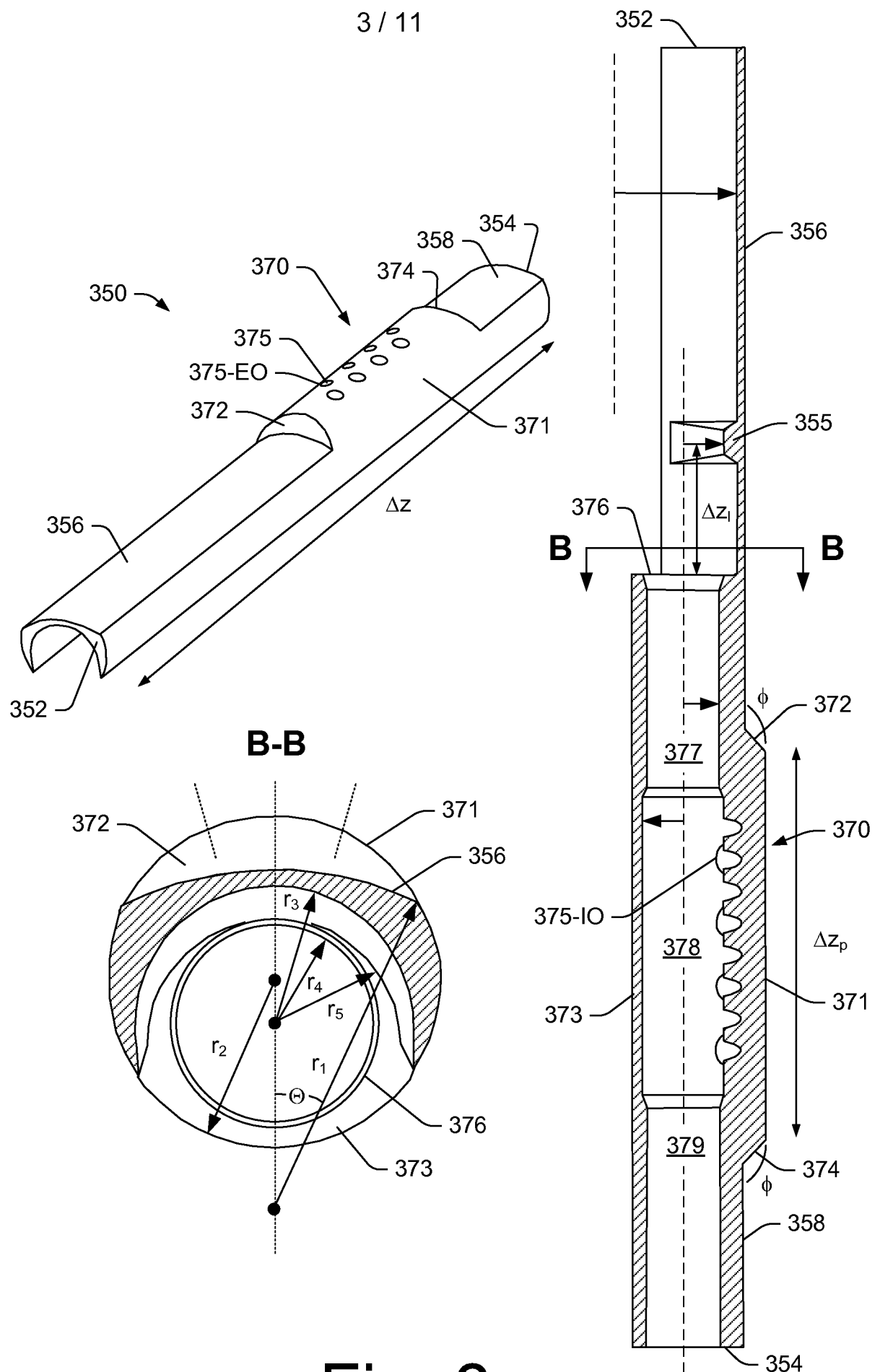
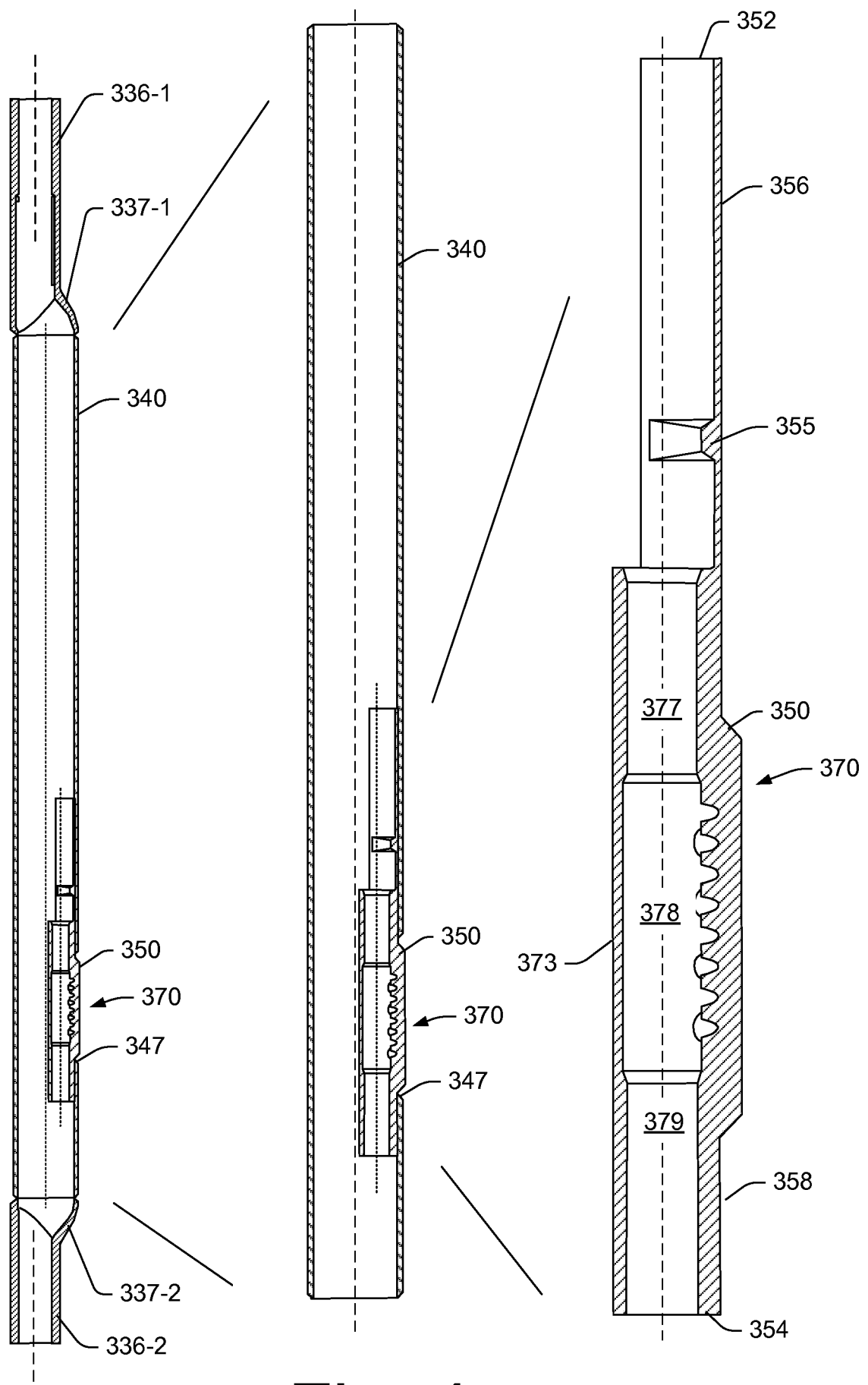


Fig. 3

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**Fig. 4**

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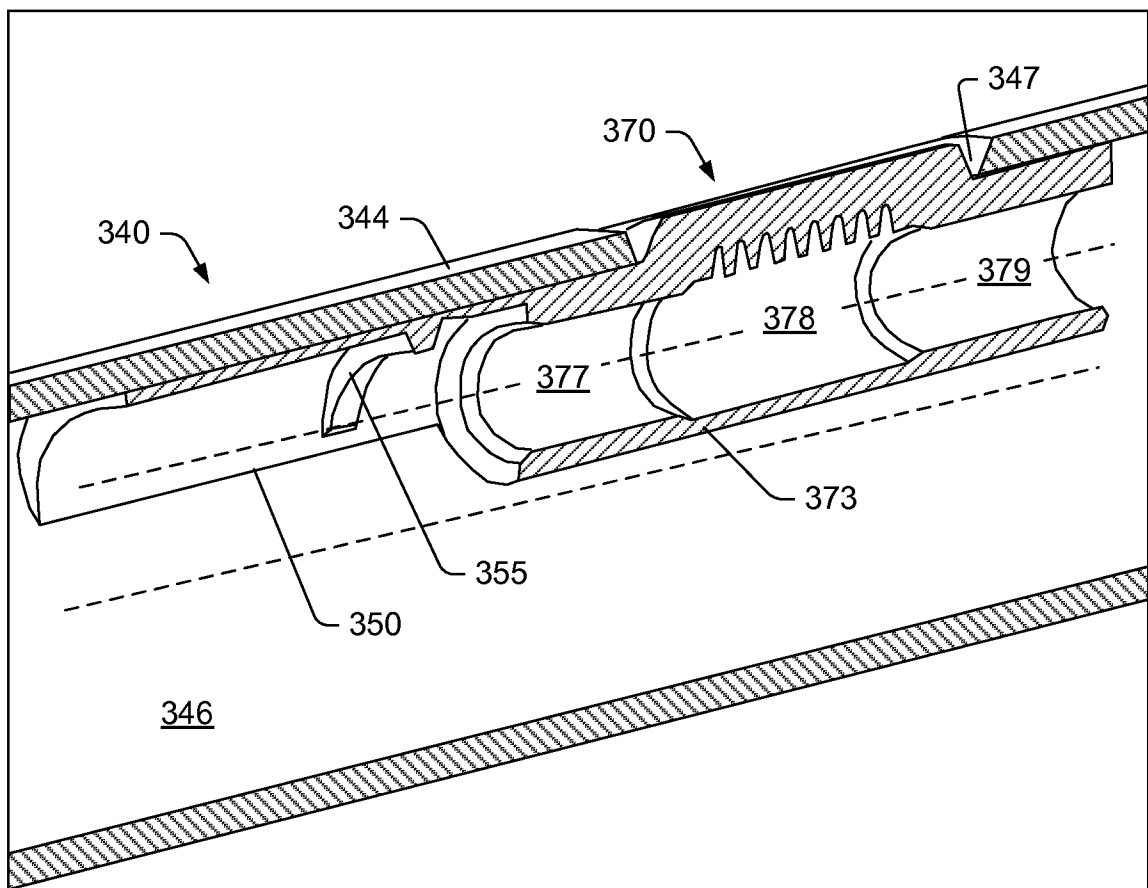
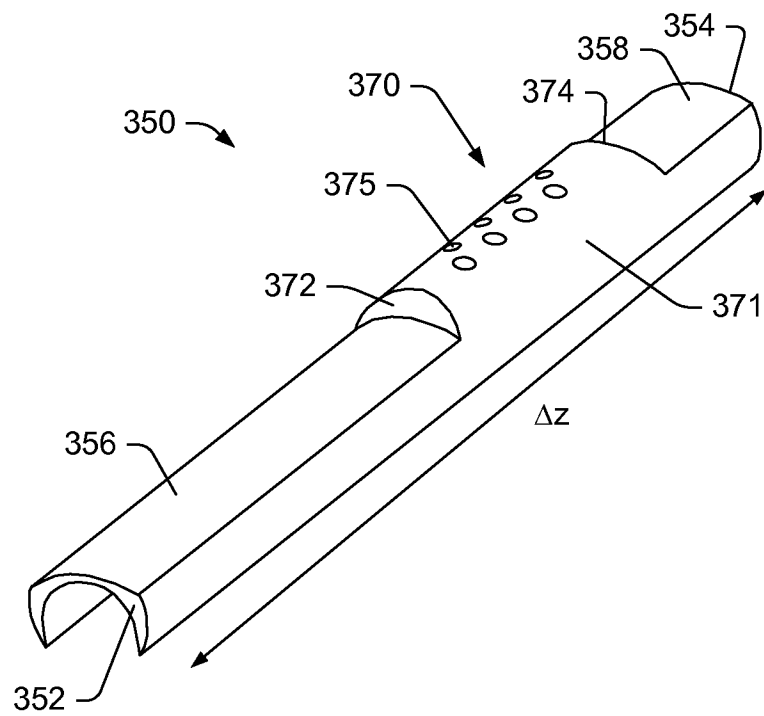


Fig. 5

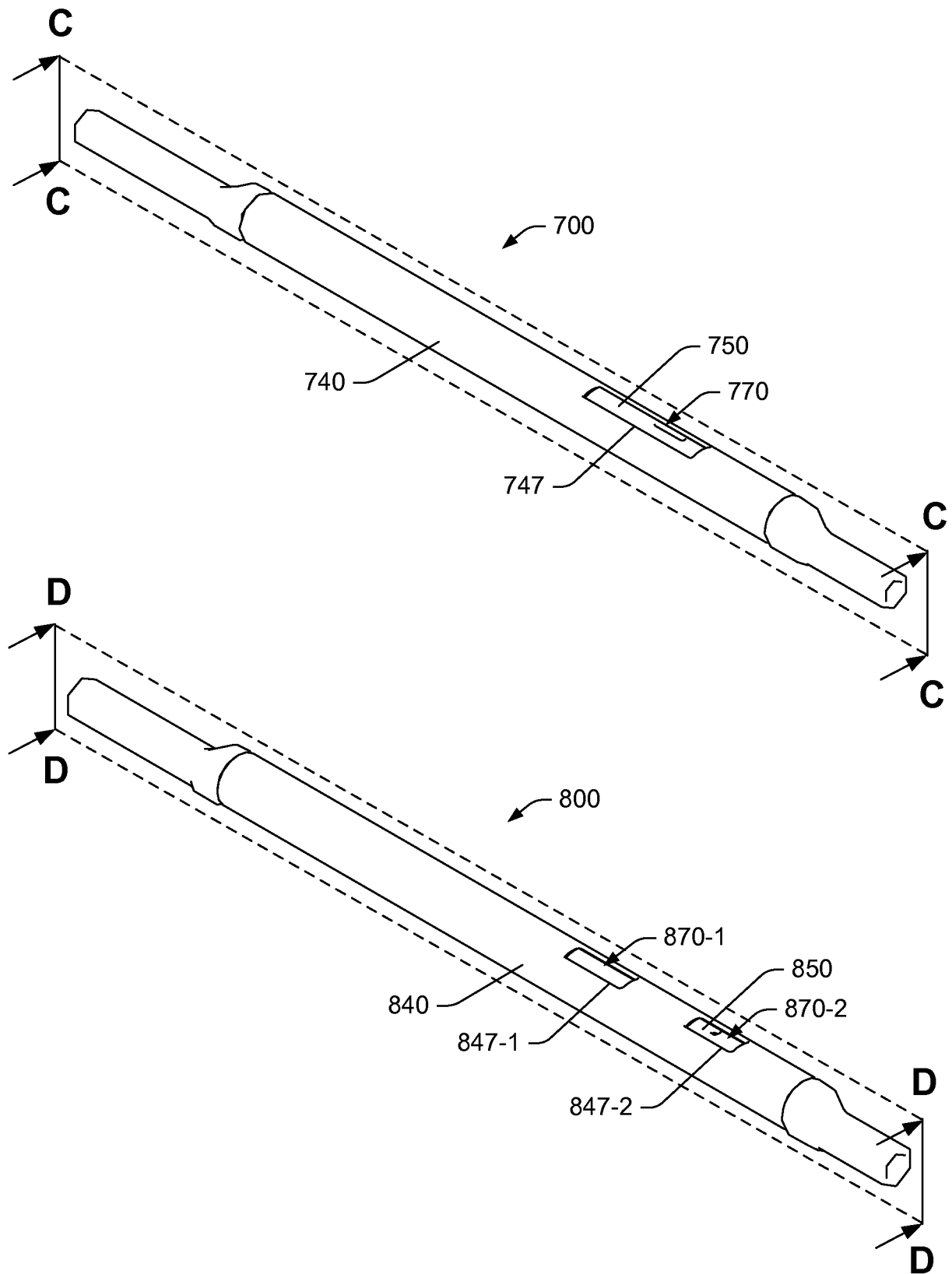


Fig. 6

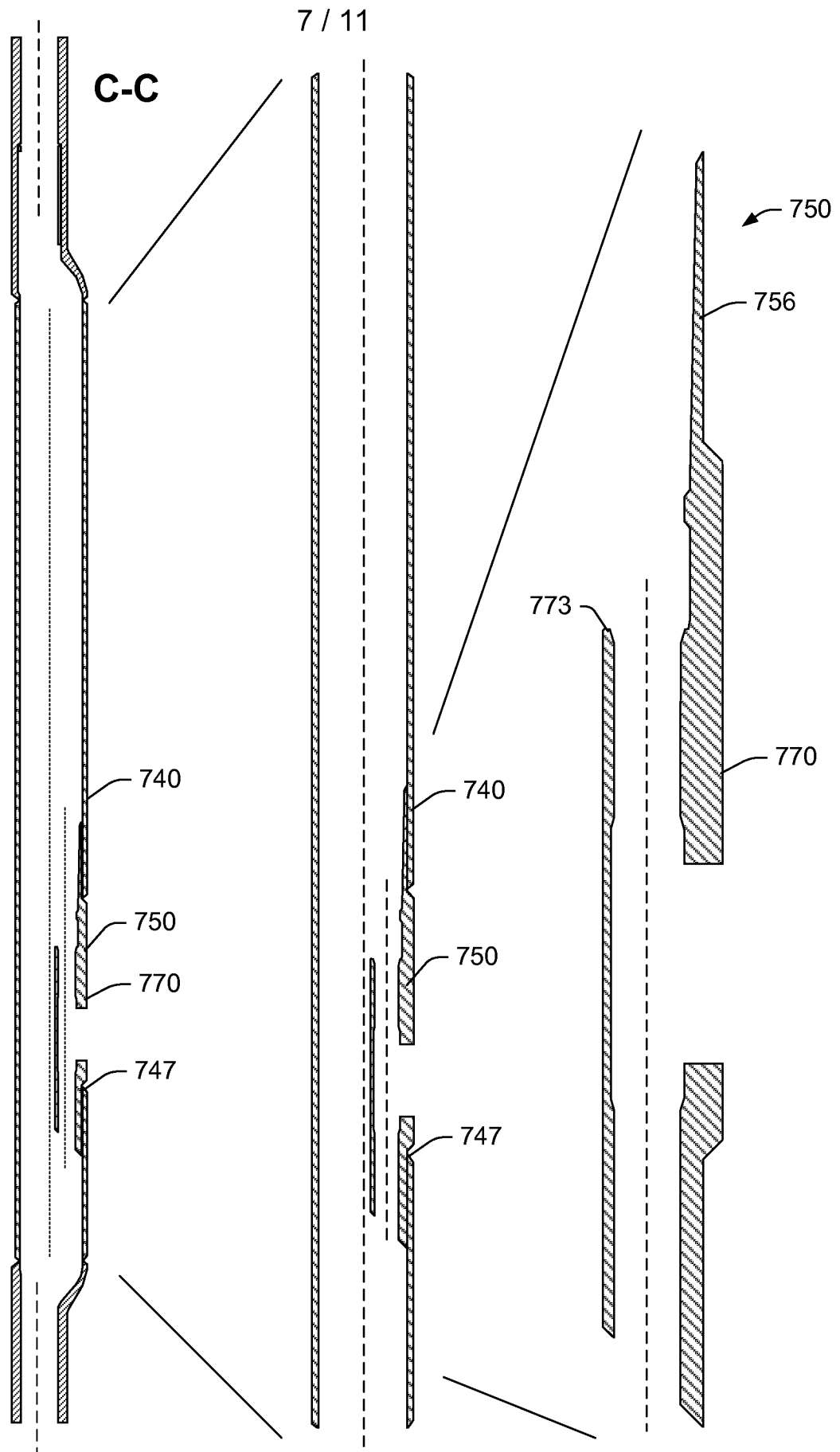


Fig. 7

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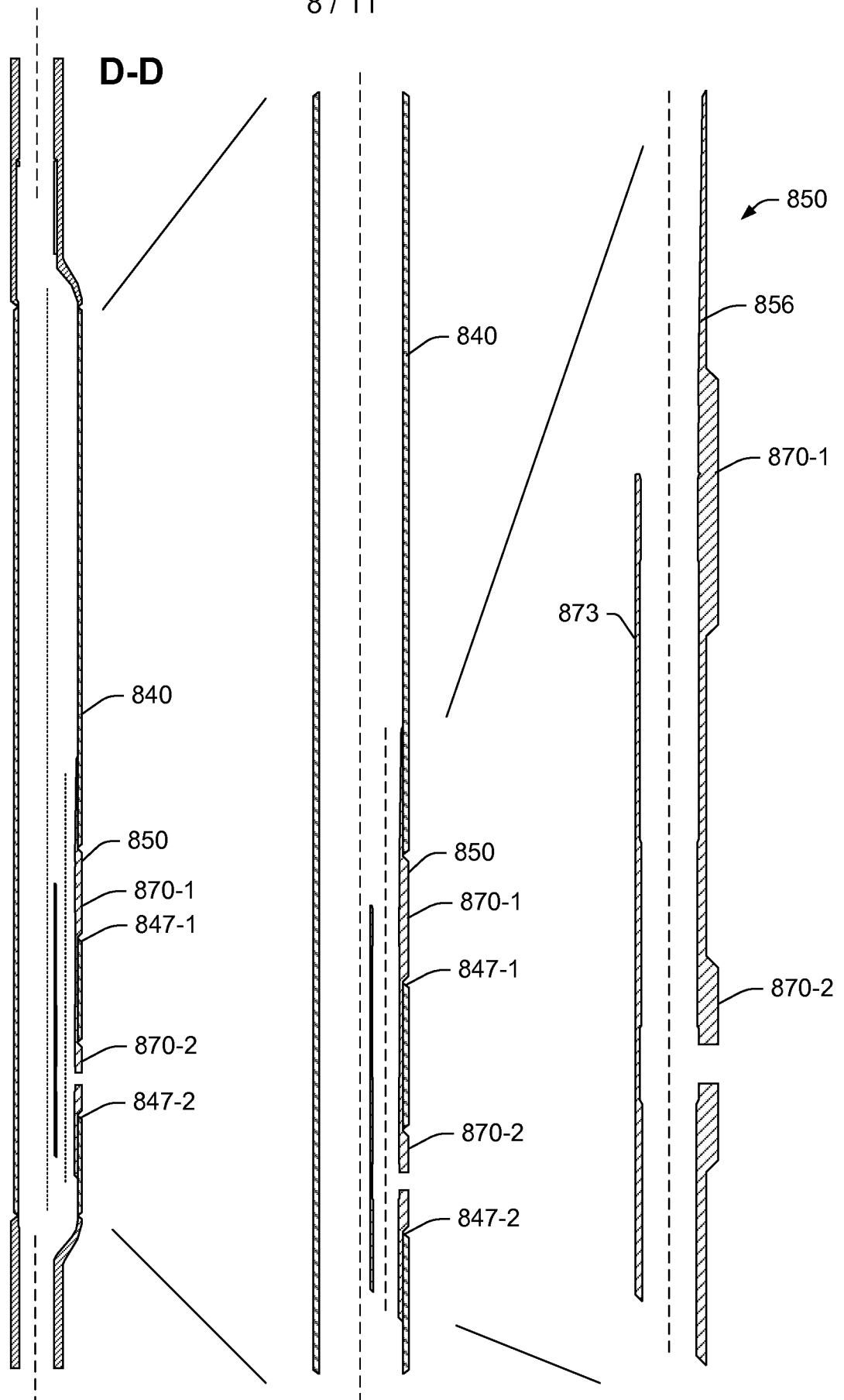


Fig. 8

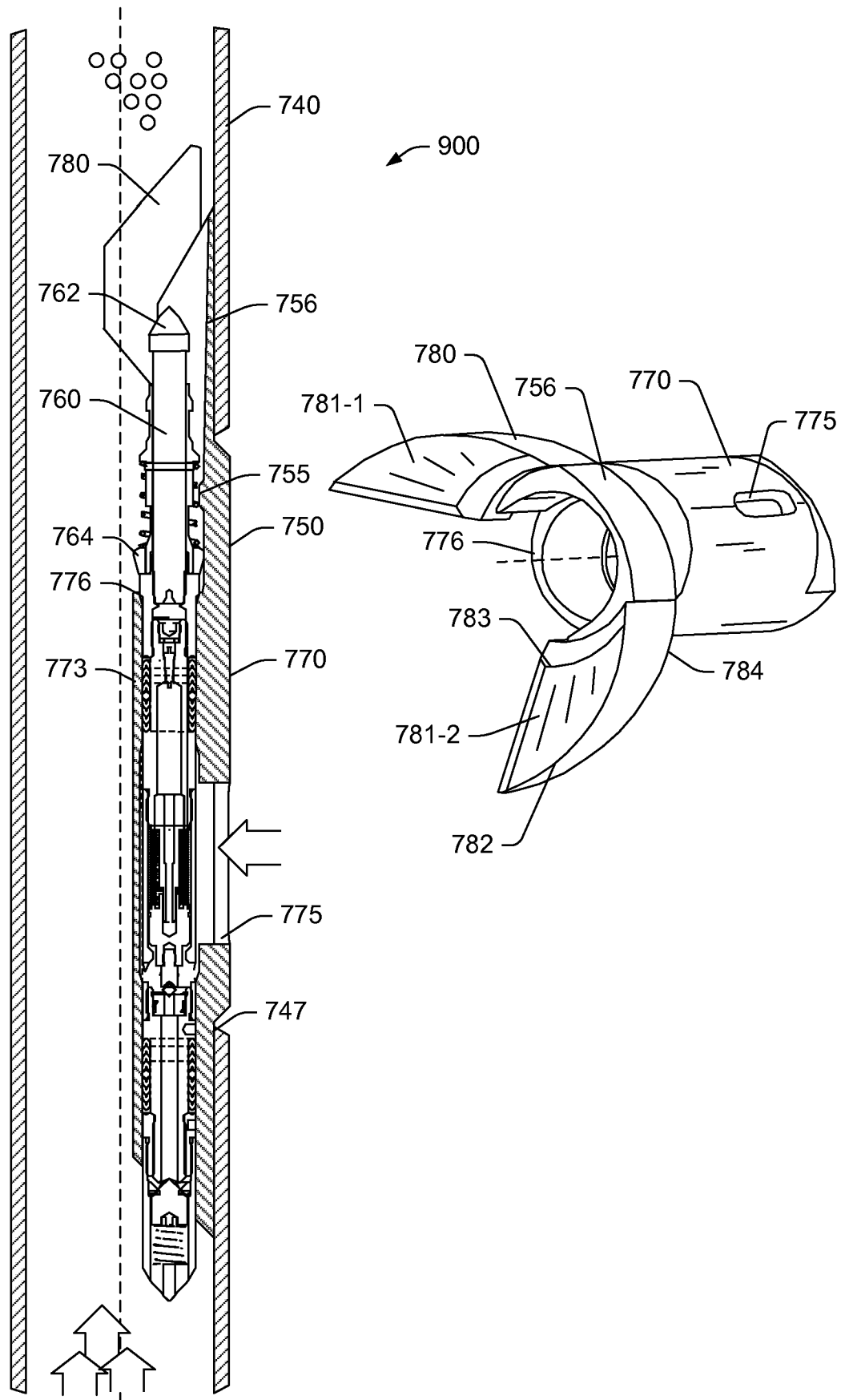


Fig. 9

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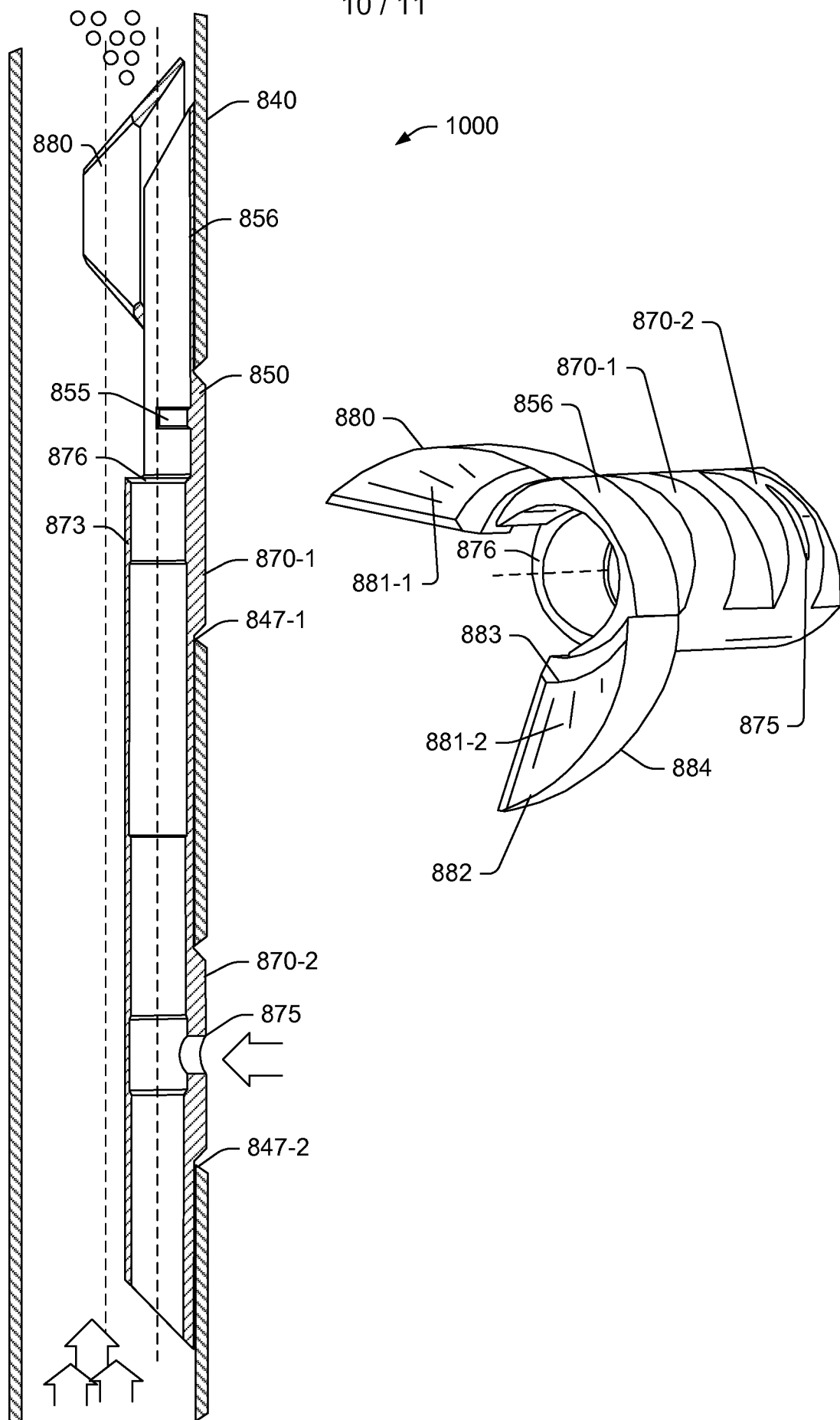


Fig. 10

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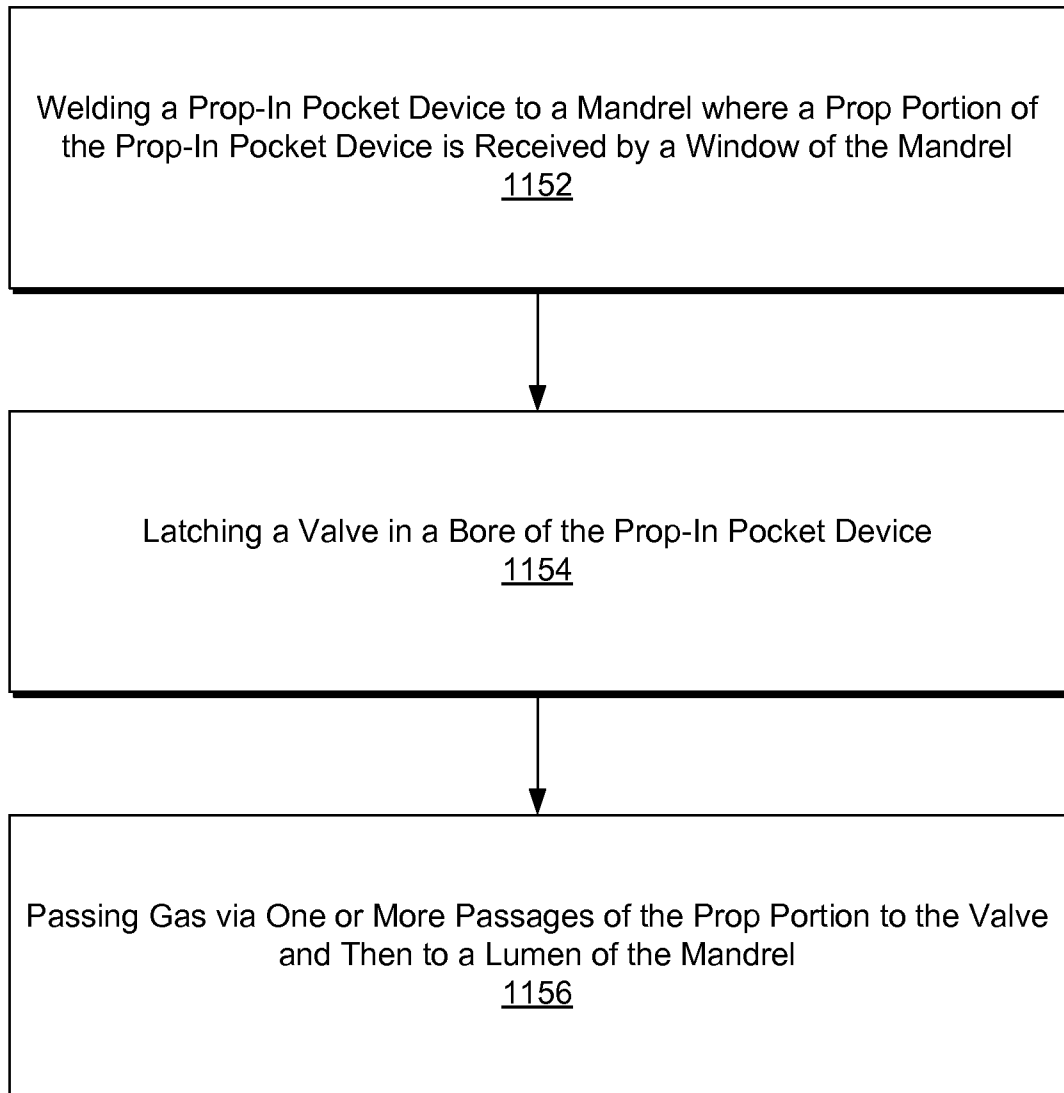
Method 1150

Fig. 11

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2014/040434**A. CLASSIFICATION OF SUBJECT MATTER****E21B 34/06(2006.01)i, E21B 43/12(2006.01)i, F04F 1/18(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 34/06; E21B 23/02; E21B 23/12; E21B 23/03; E21B 43/12; F04F 1/18

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: gas lift valve, axial extension, prop portion, fluid passage, semi-tubular wall, and mandrel window

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4498533 A (JOHNSTON, RUSSELL A.) 12 February 1985 See column 3, lines 4-39 and figures 1, 2, 5.	1-4, 10-20
Y		5-9
Y	US 4106563 A (GATLIN, ALVIN O. et al.) 15 August 1978 See column 3, lines 12-37 and figures 1B, 2.	5-9
A	US 4271902 A (MOORE, JR., HOWARD H.) 09 June 1981 See column 5, lines 48-59 and figure 1.	1-20
A	US 3874445 A (TERRAL, BEN D.) 01 April 1975 See column 3, line 66 - column 4, line 10 and figure 2B.	1-20
A	US 5181566 A (BARNECK, MICHAEL R.) 26 January 1993 See column 4, lines 21-54 and figures 1, 2. Note: For the claim 1, the claim was numbered by this authority because the claim followed by claim 2 was not numbered.	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

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"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

25 September 2014 (25.09.2014)

Date of mailing of the international search report

30 September 2014 (30.09.2014)

Name and mailing address of the ISA/KR

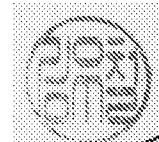
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2014/040434

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4498533 A	12/02/1985	None	
US 4106563 A	15/08/1978	None	
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US 3874445 A	01/04/1975	None	
US 5181566 A	26/01/1993	None	