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(54) **ELECTRICAL ACTUATION OF A VALVE IN A WELLHEAD ASSEMBLY**

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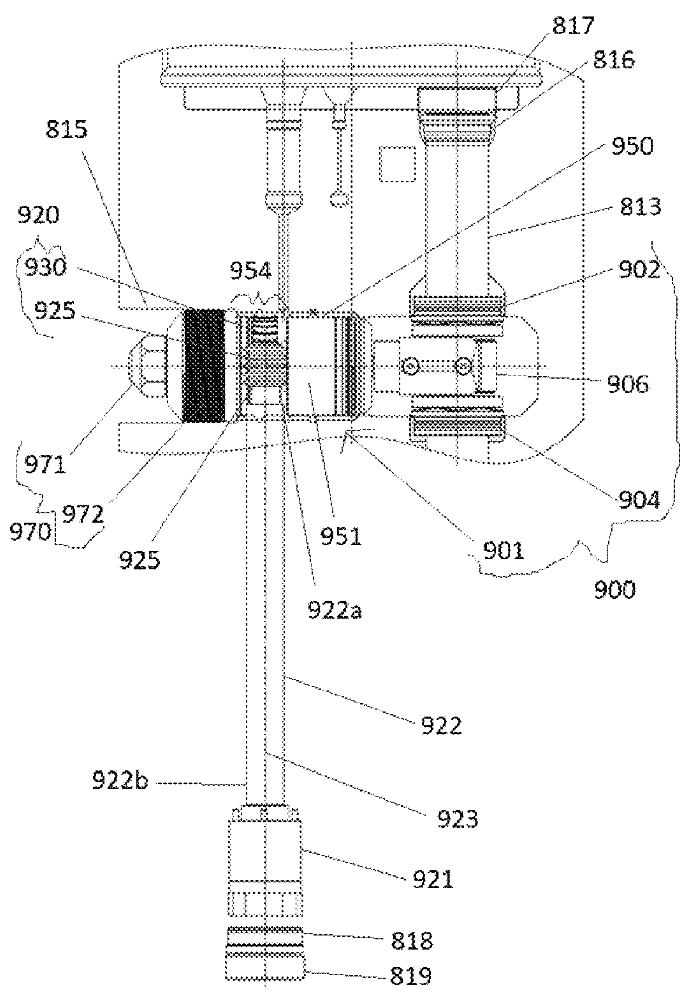
CPC ***E21B 34/04*** (2013.01); ***E21B 33/035*** (2013.01); ***E21B 33/04*** (2013.01)

(57) **ABSTRACT**

A system includes a tubing hanger configured to be positioned in a wellhead assembly, the tubing hanger configured to support a tubing string, the tubing hanger including: a bore extending at least partially through the tubing hanger; and a valve disposed along the bore of the tubing hanger, wherein the valve is configured to control the flow of a fluid medium through the bore, and wherein the valve includes: an electrical actuator, wherein the electrical actuator is disposed at least partially within the tubing hanger, and wherein the electrical actuator is configured to selectively open or close the valve in response to one or more electrical signals.



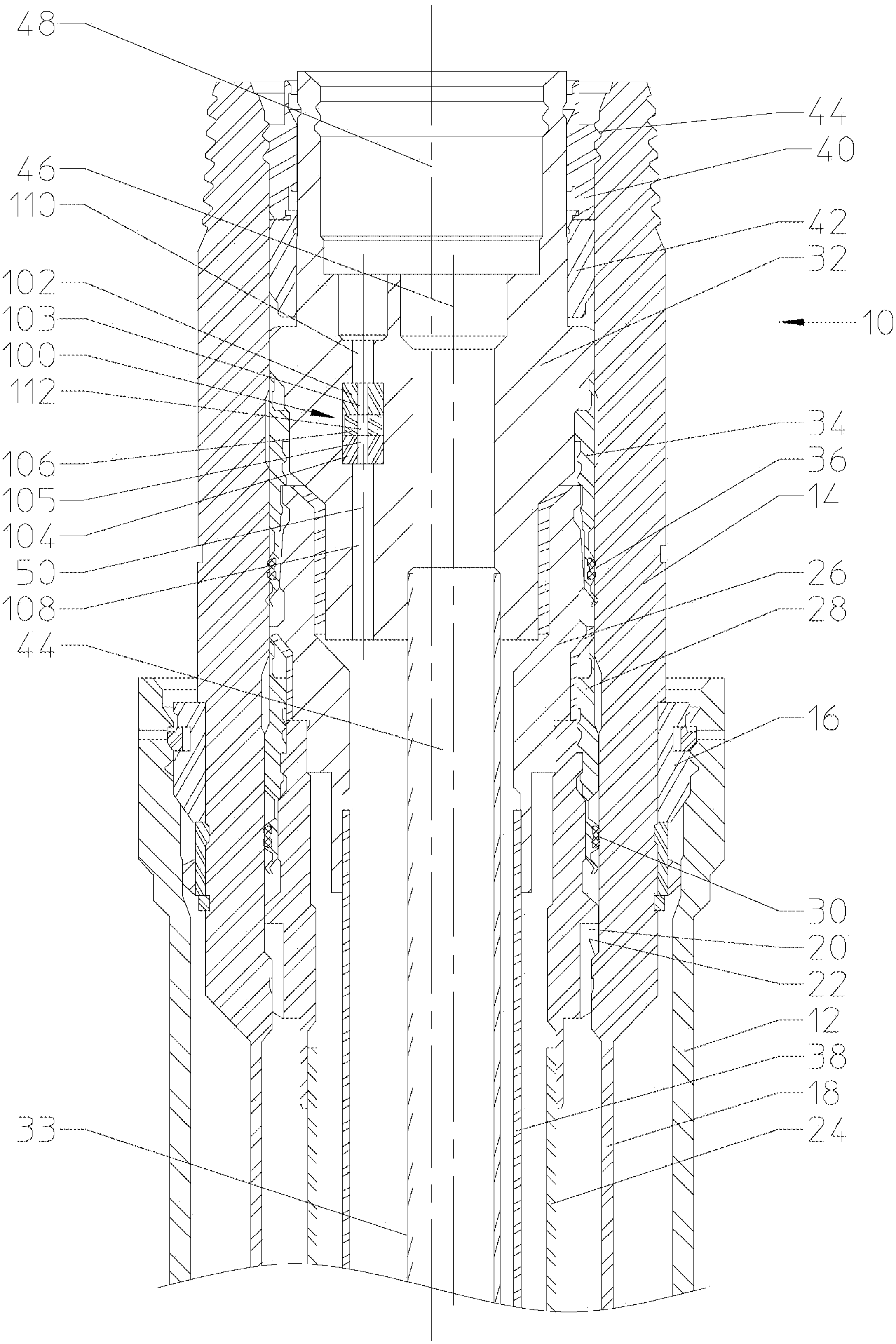

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FIGURE 1

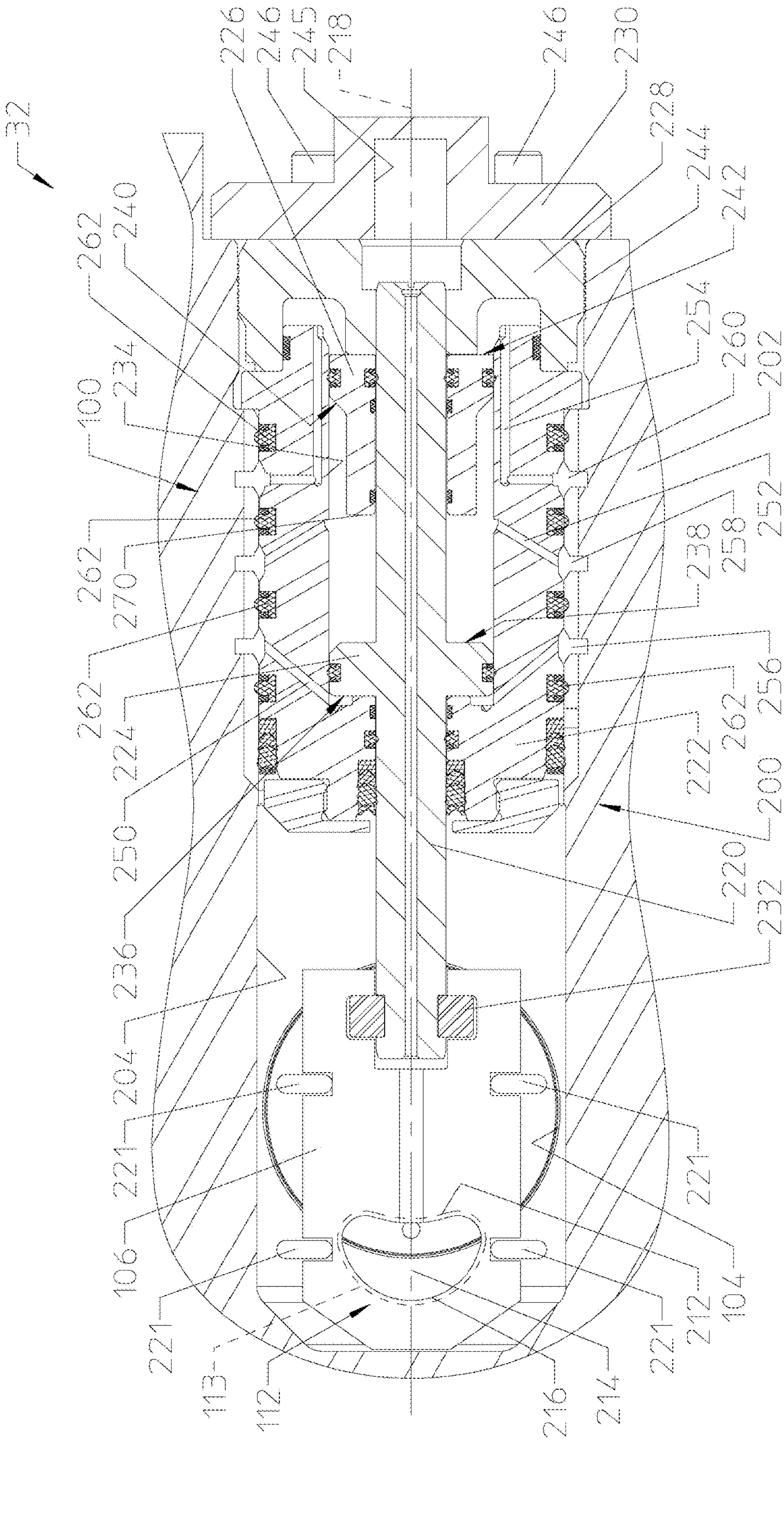
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FIGURE 2

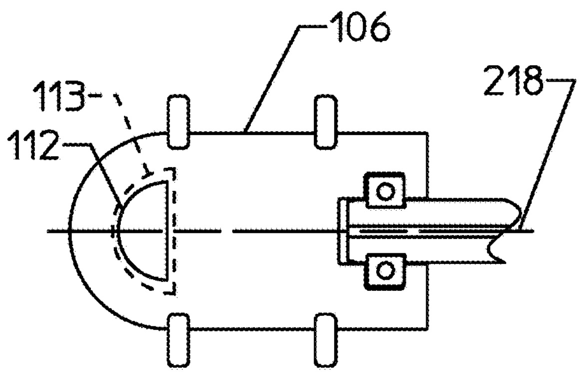

FIGURE 3A

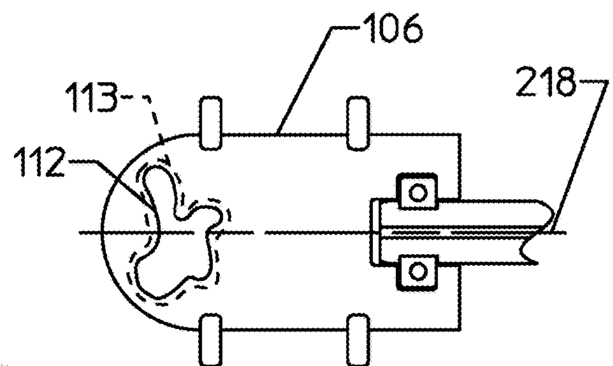

FIGURE 3B

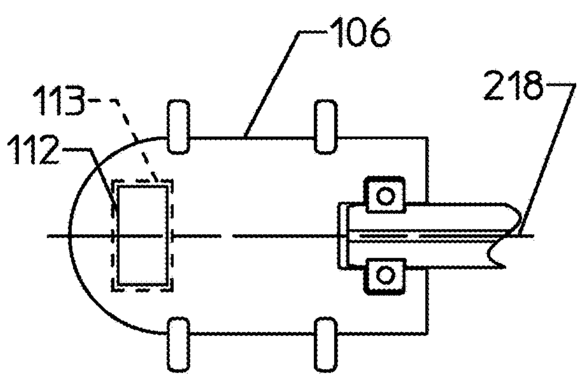

FIGURE 3C

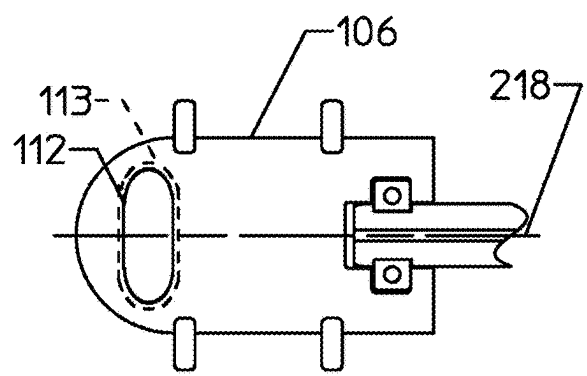

FIGURE 3D

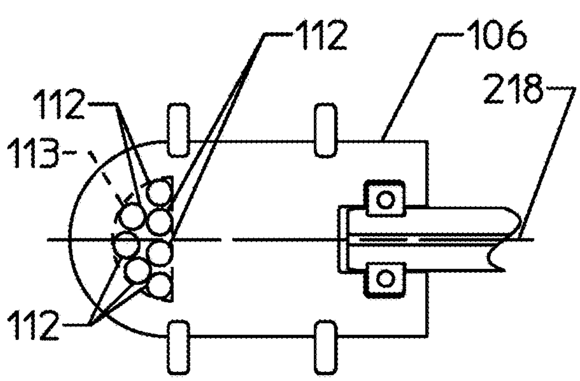

FIGURE 3E

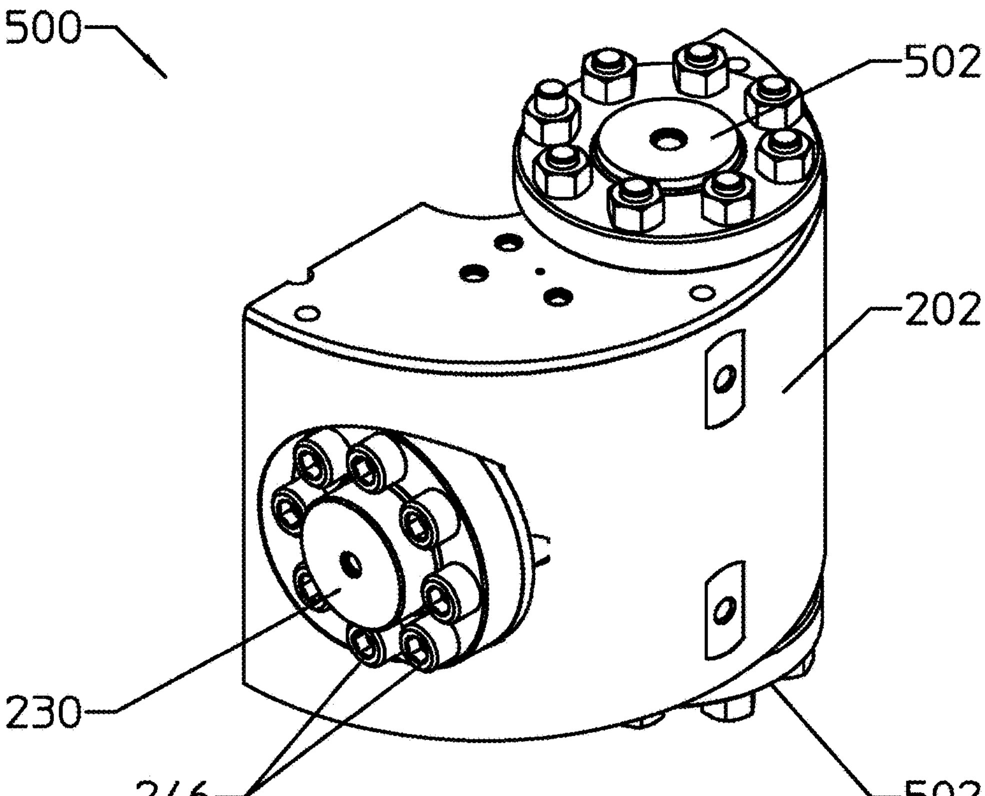

FIGURE 4

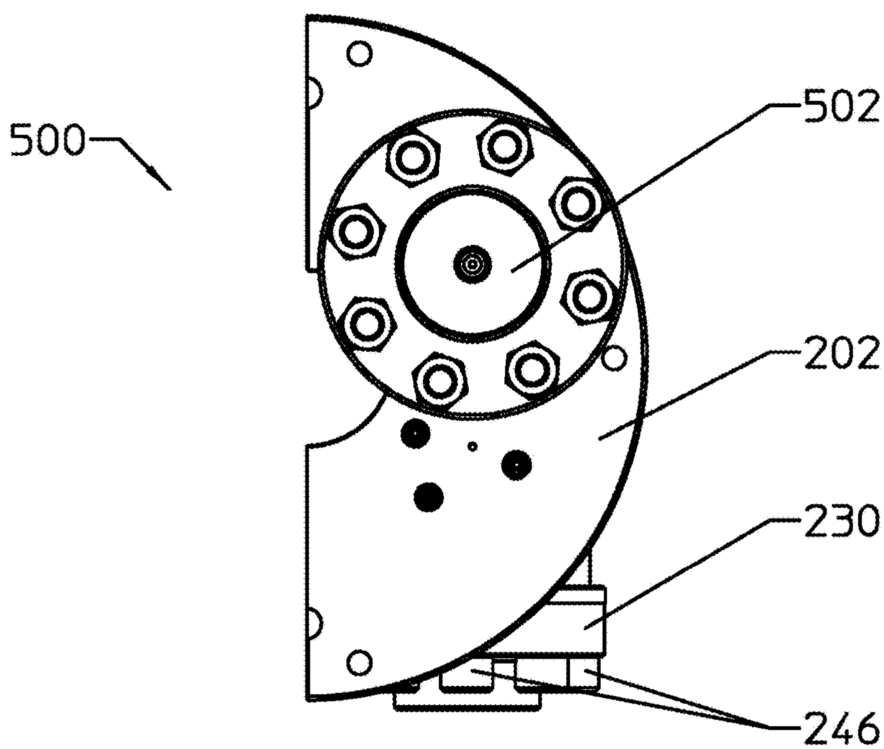

FIGURE 5

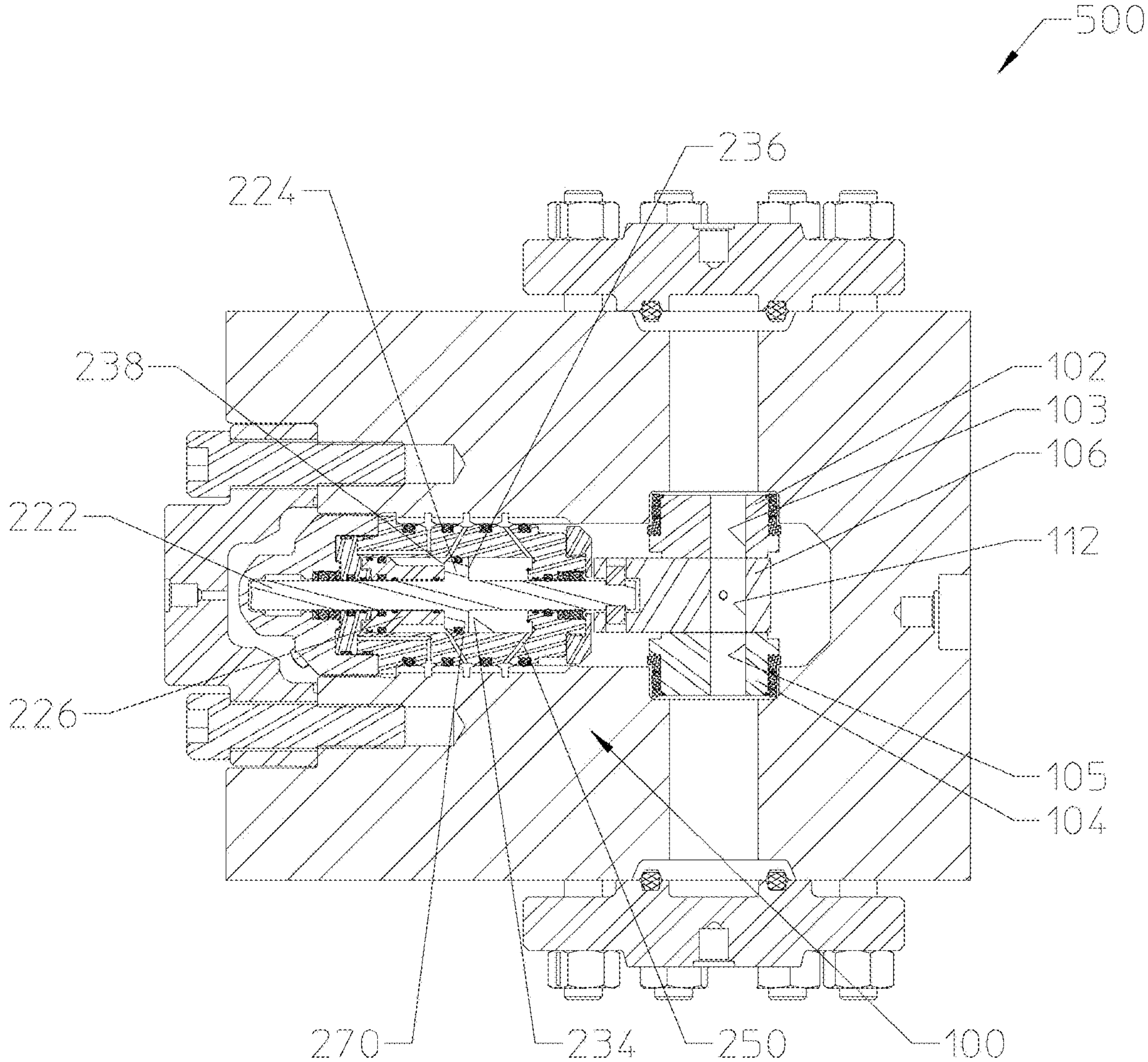

FIGURE 6

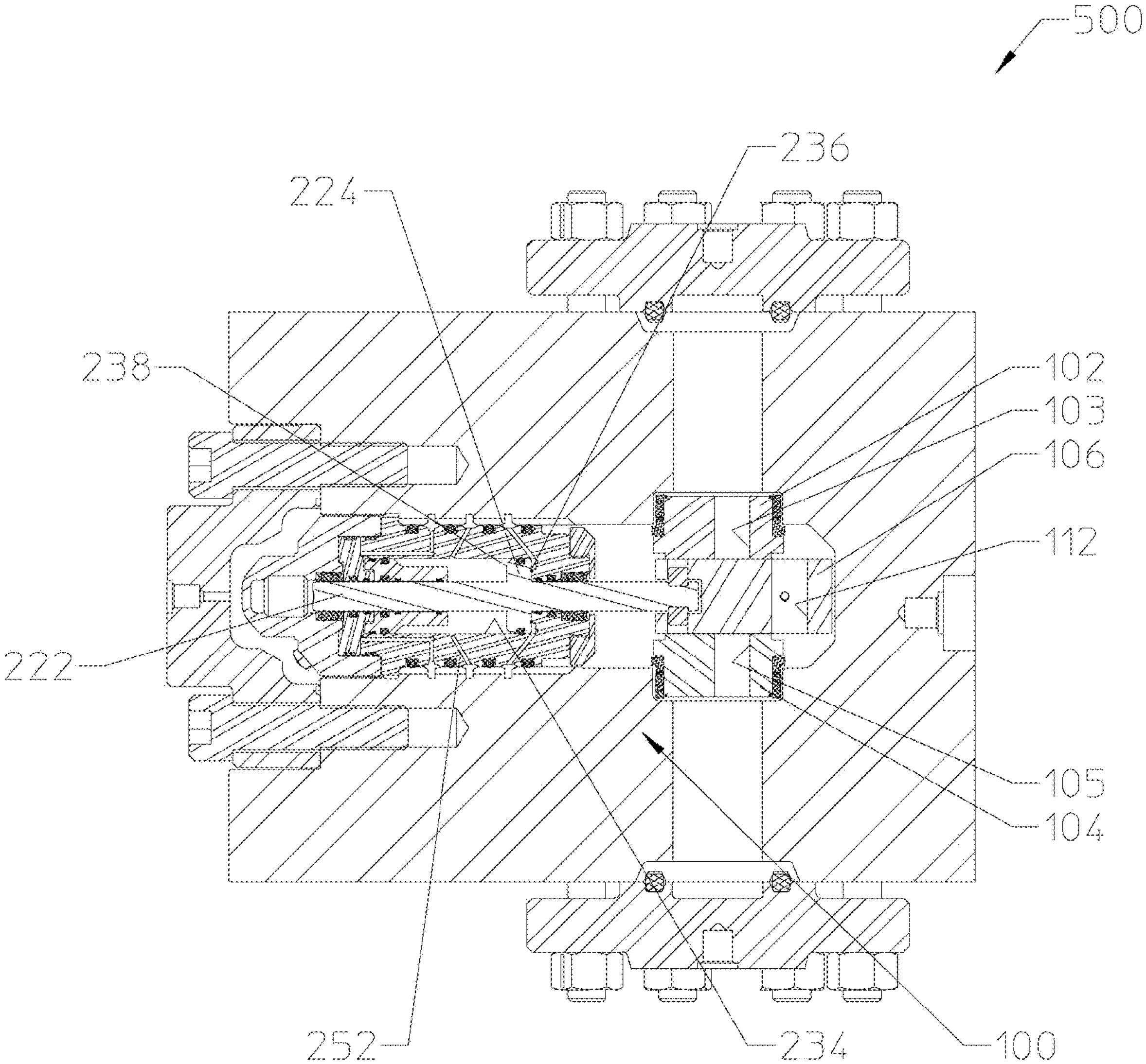

FIGURE 7

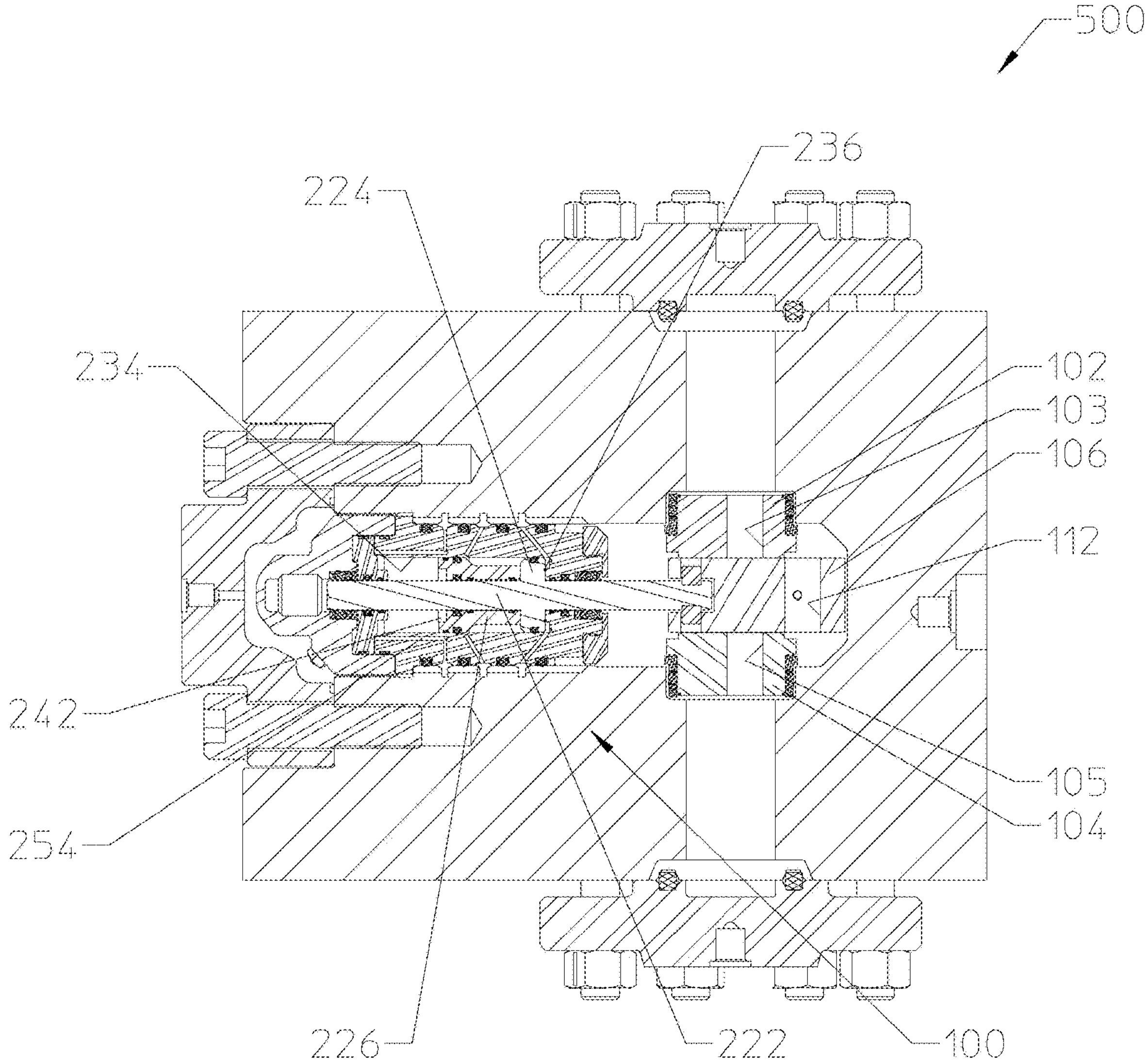

FIGURE 8

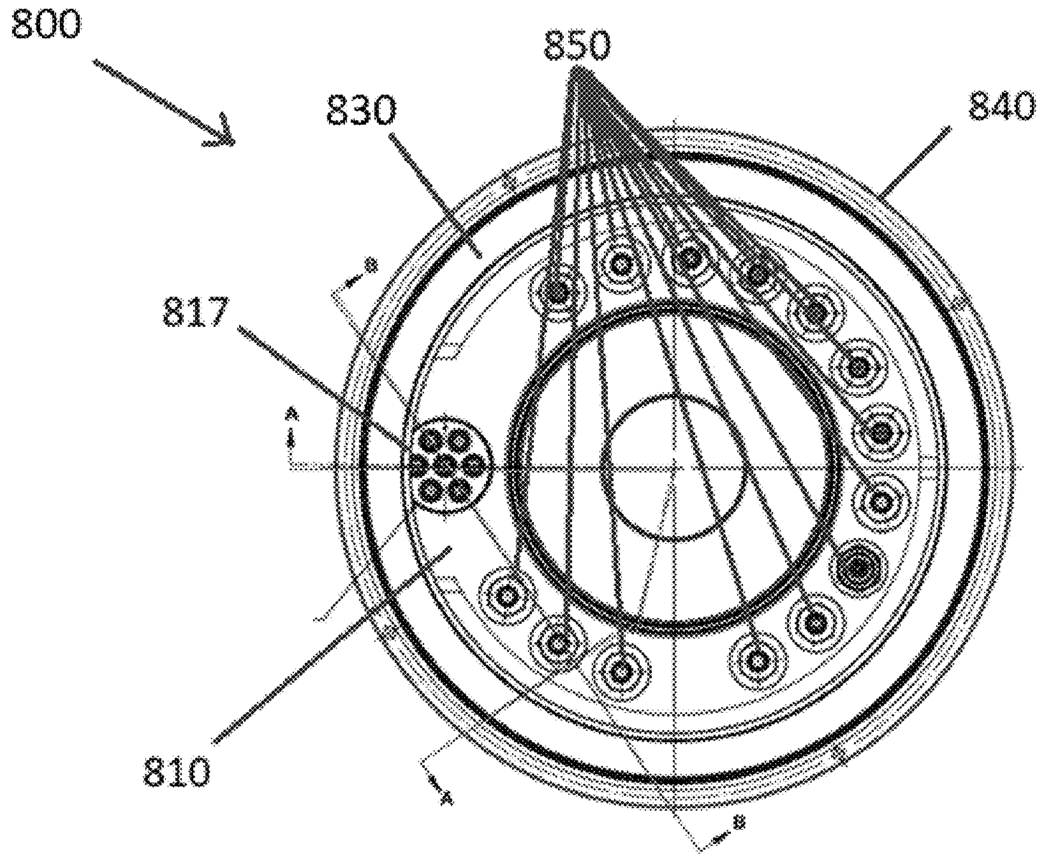

FIG. 9A

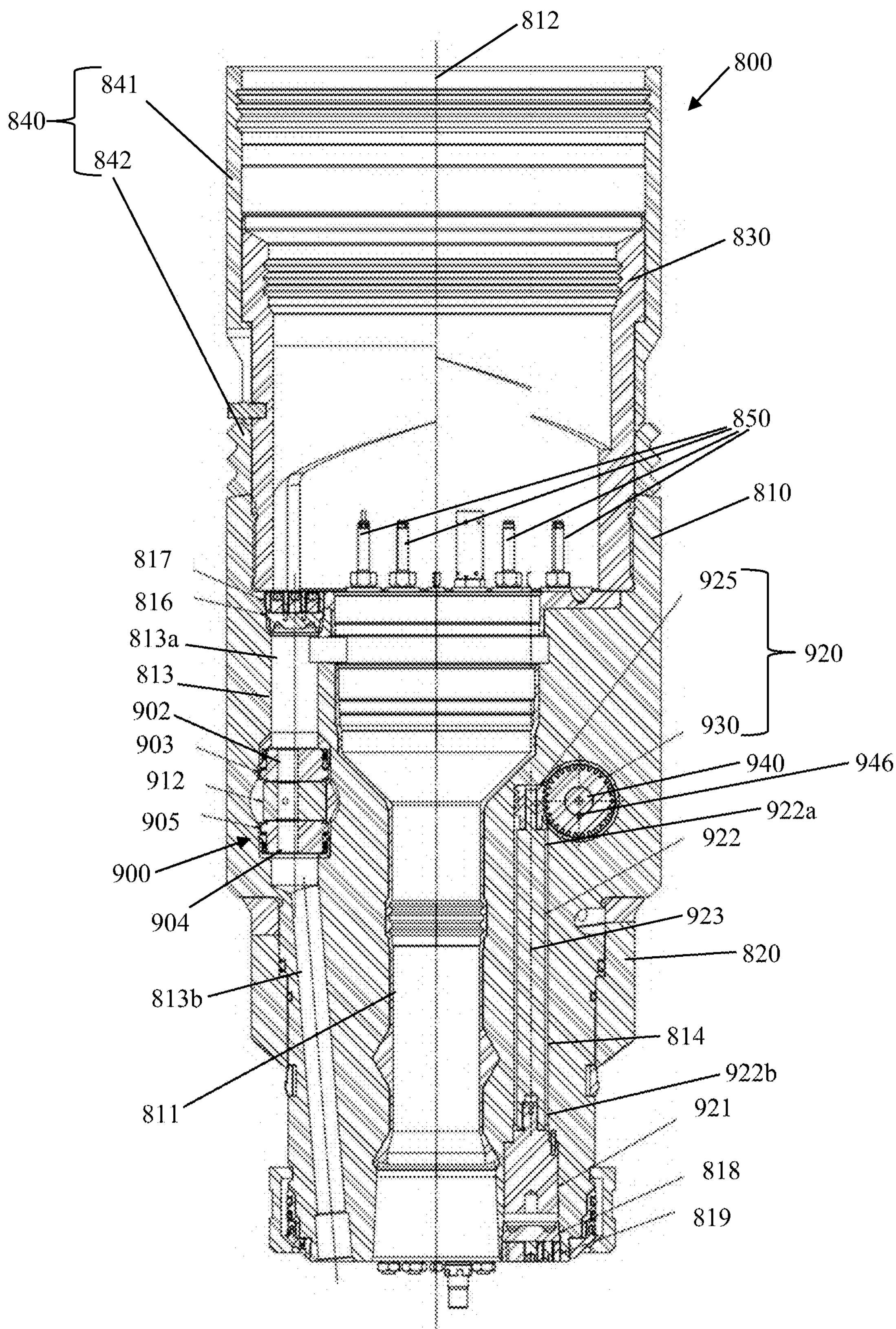
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FIG. 9B

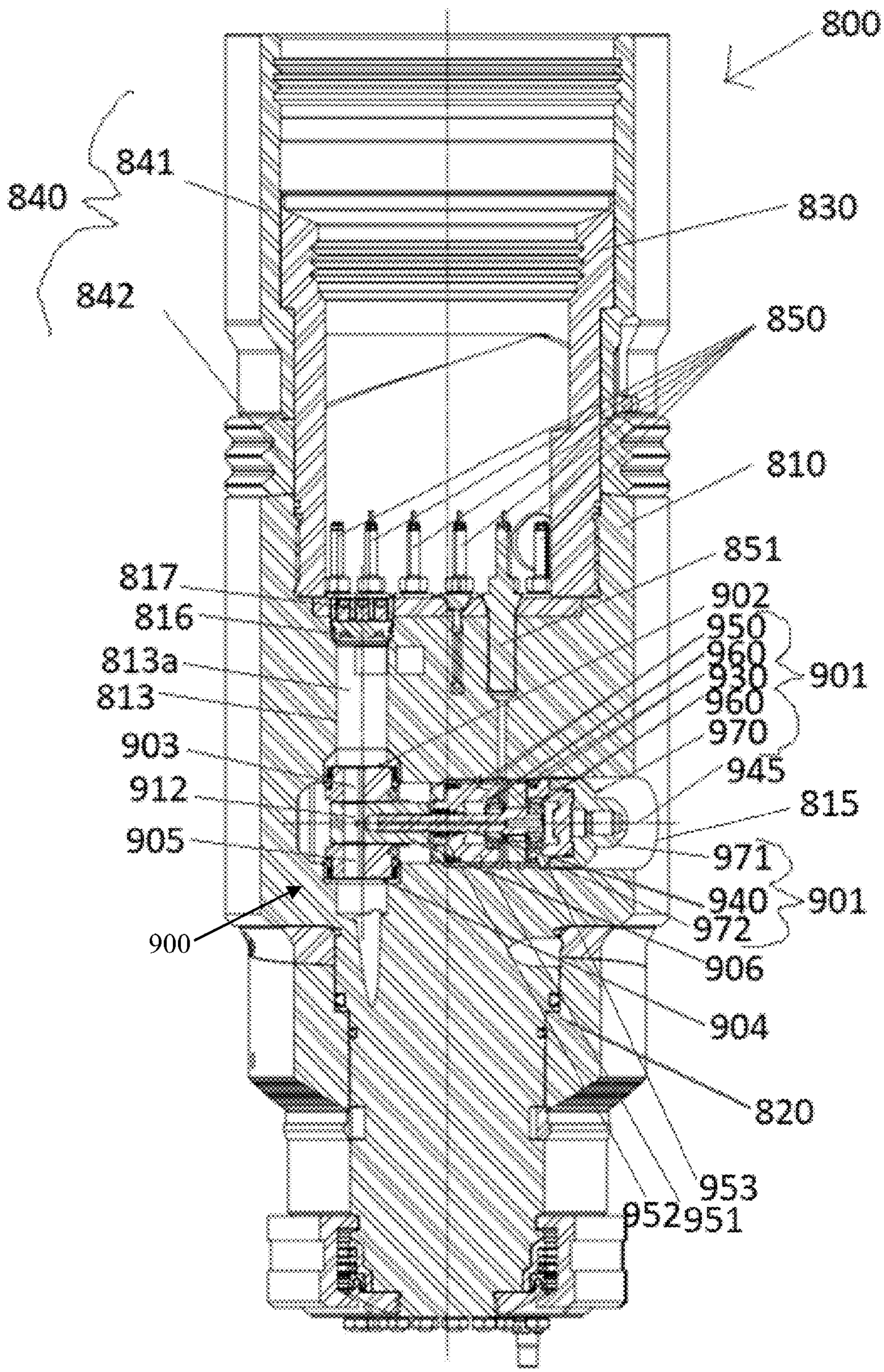
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FIG. 9C

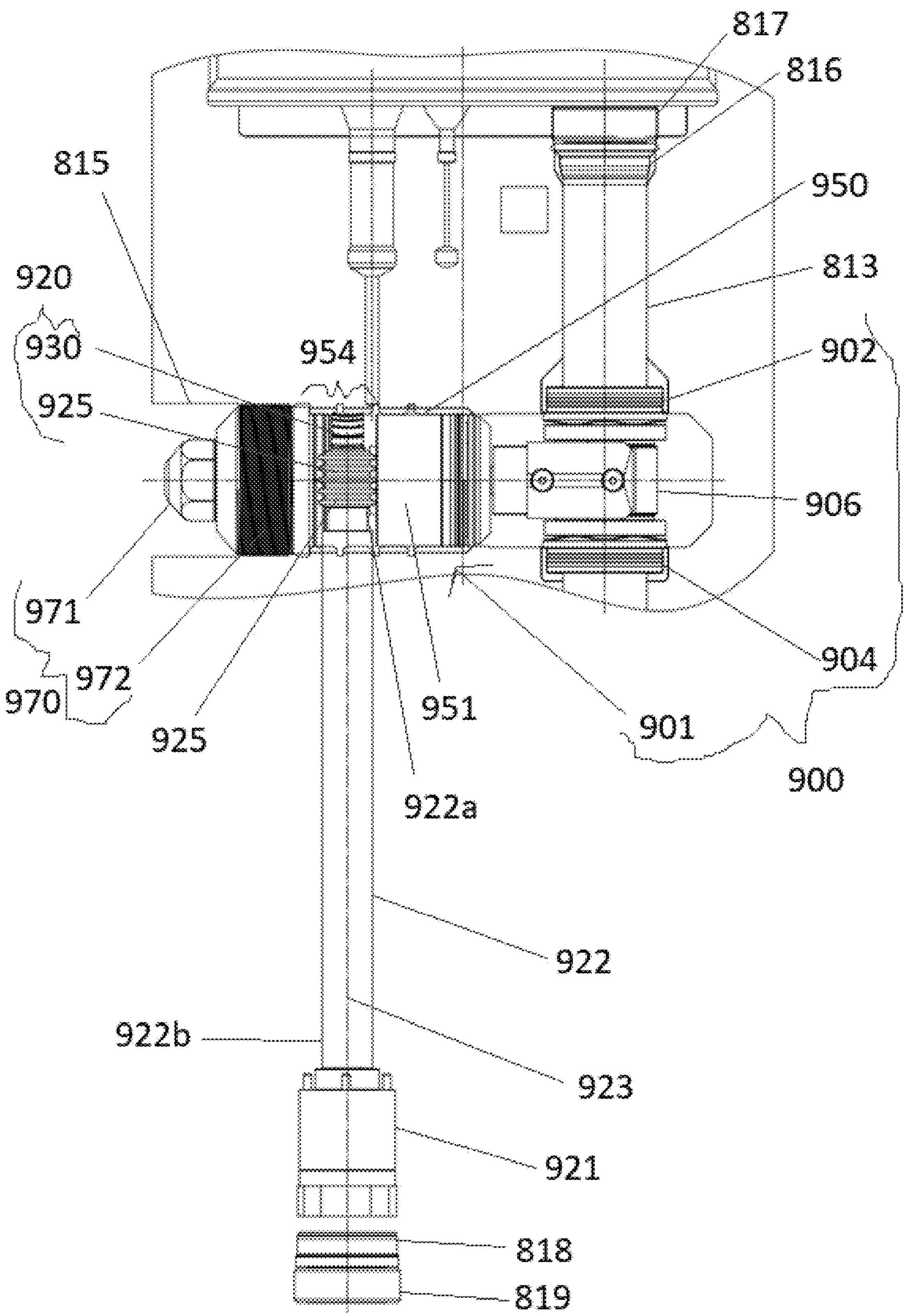
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FIG. 9D

ELECTRICAL ACTUATION OF A VALVE IN A WELLHEAD ASSEMBLY

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application is a continuation of U.S. application Ser. No. 18/103,639, filed Jan. 31, 2023, now U.S. Pat. No. 12,291,939, issued May 6, 2025, which is a U.S. continuation-in-part of U.S. Non-Provisional application Ser. No. 17/083,041, filed on Oct. 28, 2020, now U.S. Pat. No. 12,181,065, issued Dec. 31, 2024, which claims the benefit of U.S. Provisional Application Ser. No. 62/927,287 filed on Oct. 29, 2019, all of which are incorporated herein by reference in their entirety for all purposes.

TECHNICAL FIELD

[0002] The present disclosure relates generally to valves and, more particularly, to systems and methods for electrical actuation of a valve in a wellhead assembly.

BACKGROUND

[0003] A conventional tubing hanger in a wellhead assembly has a vertical production bore and at least one generally vertical annulus bore which is in communication with the tubing annulus between the production tubing and the production casing. The lower end of the annulus bore thus exits the bottom of the tubing hanger, and in a conventional tree or a single-bore tree the upper end of the annulus bore typically exits the top of the tubing hanger for communication with the tree. In a horizontal tree, the well annulus is typically in communication with a lateral bore in the tree housing, which in turn may be connected by a crossover line to a crossover valve, thereby allowing annulus fluids to flow laterally out of the tubing hanger and through the tree body.

[0004] Gate valves have sometimes been used to selectively open and close the annulus bore in tubing hangers. Gate valves are generally more reliable for closing off an annulus bore than other types of valves, such as ball valves for example. However, gate valves require a large amount of space for installation and operation, since the tubing hanger must accommodate an actuator system that strokes the gate valve linearly between its open and closed positions. Because room in the tubing hanger must also be provided for various penetrations, such as control lines, the overall length of the valve and its actuator have limited the use of gate valves for the purpose of opening/closing the annulus bore due to space constraints. It is now recognized that a need exists for a more compact gate valve assembly for use in such equipment. In addition, a need exists for the efficient actuation of such valves, and other valves located in a wellhead assembly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] For a more complete understanding of the present disclosure and its features and advantages, reference is now made to the following description, taken in conjunction with the accompanying drawings, in which:

[0006] FIG. **1** is a schematic cross-sectional view of a wellhead assembly with a tubing hanger that utilizes a reduced stroke gate valve, in accordance with an embodiment of the present disclosure;

[0007] FIG. **2** is a top cutaway view of a reduced stroke gate valve, in accordance with an embodiment of the present disclosure;

[0008] FIGS. **3**A-**3**E illustrate various embodiments of a gate that may be used in a reduced stroke gate valve, in accordance with an embodiment of the present disclosure;

[0009] FIG. **4** is a perspective cutaway view of a test fixture equipped with the reduced stroke gate valve of FIG. **2**, in accordance with an embodiment of the present disclosure;

[0010] FIG. **5** is a top cutaway view of the test fixture of FIG. **4**, in accordance with an embodiment of the present disclosure;

[0011] FIG. **6** is a side cross-sectional view of the test fixture of FIGS. **4** and **5** with the reduced stroke gate valve in an open position, in accordance with an embodiment of the present disclosure;

[0012] FIG. **7** is a side cross-sectional view of the test fixture of FIGS. **4** and **5** with the reduced stroke gate valve in a first closed position, in accordance with an embodiment of the present disclosure; and

[0013] FIG. **8** is a side cross-sectional view of the test fixture of FIGS. **4** and **5** with the reduced stroke gate valve in a second closed position, in accordance with an embodiment of the present disclosure.

[0014] FIG. **9**A is a top view of a wellhead assembly that utilizes a valve, in accordance with an embodiment of the present disclosure.

[0015] FIG. **9**B is a cutaway view taken along lines A-A of the wellhead assembly of FIG. **9**A, in accordance with an embodiment of the present disclosure.

[0016] FIG. **9**C is a cutaway view taken along lines B-B of the wellhead assembly of FIG. **9**A, in accordance with an embodiment of the present disclosure.

[0017] FIG. **9**D is a side view of the valve of FIGS. **9**A-**9**C with the wellhead assembly cutaway, in accordance with an embodiment of the present disclosure.

DETAILED DESCRIPTION

[0018] Illustrative embodiments of the present disclosure are described in detail herein. In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation specific decisions must be made to achieve developers' specific goals, such as compliance with system related and business related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of the present disclosure. Furthermore, in no way should the following examples be read to limit, or define, the scope of the disclosure.

[0019] Certain embodiments of the present disclosure may be directed to a reduced stroke gate valve. The reduced stroke gate valve may be used in a variety of contexts wherever a compact gate valve is desired. For example, the disclosed reduced stroke gate valve may be used in surface or subsea tubing hangers, Christmas trees, and/or other flow control devices used in oil and gas wells. The disclosed reduced stroke gate valve is not limited to use in the context of oil and gas wells, but may be similarly applied to fluid flow control devices in other environments that would benefit from the reliability of a gate valve with a relatively compact packaging of the valve actuation component(s).

[0020] The disclosed reduced stroke gate valve is a gate valve that provides a predetermined or desired flow area for a given bore size through the gate valve while reducing a total length through which the gate valve strokes between an open position and a closed position.

[0021] In traditional gate valve design, the size of the bore along which the gate valve is operated dictates how far the gate must travel in order to move from fully opened to fully closed. The required stroke to move the gate from fully opened to fully closed is multiplied by a certain amount to determine the necessary length of the gate valve actuation system. For example, in certain actuation systems, the actuation system may need to be as much as four times the stroke length used to move the gate from fully opened to fully closed. The gate valve may need to be fit in amongst a plurality of additional bores, connectors, stabs, and control lines in a relatively compact equipment component. As such, it is now recognized that a need exists to reduce the stroke of the gate/seat interface from fully open to fully closed in a gate valve. The disclosed gate valve provides this reduced stroke length, thereby significantly reducing a total length of the actuation system that operates the gate valve. This may help to simplify the layout and operation of equipment components that include the reduced stroke gate valve, as a more compact packaging of the gate valve is possible.

[0022] The disclosed reduced stroke gate valve includes one or more openings spanning an area of the gate having a smaller dimension in a direction parallel to a gate actuation direction than in a direction perpendicular to the gate actuation direction. The one or more openings in the gate may provide a flow area equivalent to a predetermined flow area for a single round hole that would otherwise be used for the gate valve application, but with a shape or distribution of openings that provides a considerably reduced stroke length to move the gate valve from the open position to the closed position. In some embodiments, the reduced stroke gate valve may include a single non-circular and/or non-round opening in the gate. The single non-circular and/or non-round opening may be a crescent shaped opening in the gate that reduces the stroke of the valve. However, other non-circular and/or non-round shapes may be utilized as well. In other embodiments, the reduced stroke gate valve may include a plurality of smaller round openings that are arranged in a distribution that reduces the stroke of the valve over that of a single round opening.

[0023] The disclosed reduced stroke gate valve provides several advantages over existing gate valves, particularly those used to provide flow through bores in tubing hangers, trees, and similar equipment components. For example, the reduced stroke gate valve greatly reduces the length dimension of the overall valve package with its actuator (e.g., hydraulic, manual, or electric actuator), thereby allowing the gate valve to be packaged in smaller spaces. The disclosed gate valve requires less stroke to move the valve from fully open to fully closed while providing the same flow area as a gate valve with a single conventionally circular or round hole. The shorter overall length of the valve/actuator resulting from the reduced stroke allows for more space efficient packaging of the valve than is currently available using traditional gate valves.

[0024] Certain embodiments of the present disclosure may be directed to an electrically actuated valve (which may or may not include a reduced stroke gate valve) located in a tubing hanger or any other desired subsea component. An electrical actuator is configured to selectively open or close the valve in response to one or more electrical signals. In some embodiments, the electrical actuator may include an electric motor, a motor shaft, a spindle, and a gear assembly used to selectively open or close the valve in response to electrical signals.

[0025] Turning now to the drawings, FIG. **1** depicts an embodiment of a wellhead assembly **10** supporting a tubing hanger therein having a reduced stroke gate valve **100** according to the present disclosure. The assembly **10** as shown includes an outer conductor **12** supporting a wellhead housing **14** by a conventional connector **16**. The wellhead housing **14** supports an outer casing **18**. A lower casing hanger **20** is shown landed on a support surface **22** of the wellhead housing **14**, with an outer casing **24** extending downward from the casing hanger **20**. An upper casing hanger **26** is shown landed on the lower casing hanger **20**. A pusher sleeve **28** is pressed downward by a setting tool (not shown) so that a seal **30** is in reliable sealing engagement with the wellhead housing **14**. A tubing hanger **32** is shown landed on the upper casing hanger **26**. The tubing hanger **32** may be landed on an upper casing hanger **26** after the pusher sleeve **34** has previously forced the seal **36** into sealing engagement with the wellhead housing **14**. The upper casing hanger **26** supports the inner casing **38**, which is commonly referred to as a production casing, and the tubing hanger **32** supports a tubing string **33** positioned within the production casing **38**. A locking sub **42** is threadably connected to the tubing hanger **32** and a lockdown member **40** cooperates with internal grooves **44** on the wellhead housing **14** to reliably secure the tubing hanger **32** within the wellhead housing **14**.

[0026] The tubing hanger **32** generally includes a production bore **44**, which may have a central axis **46** spaced from a central axis **48** of the wellhead housing **14** (i.e., the production bore **44** may be eccentric). In other embodiments, though, the production bore **44** may be concentric with its central axis **46** aligned with the central axis **48** of the wellhead housing **14**. The tubing hanger **32** also includes an annulus bore **50** that is fluidly isolated from the production bore **44** by the tubing string **33**. The annulus bore **50** is thus in fluid communication with the annulus between the production casing **38** and the tubing **33**, while the production bore **44** is in fluid communication with the tubing string **33**. In some embodiments, the axis **46** of the production bore is aligned with the axis of the upper end of the tubing string **33**. The annulus bore **50** at an upper end of the tubing hanger **32** may be in fluid communication with an annulus bore through a subsea tree, flowline connector, or other component connected to an upper end of the tubing hanger **32**, as will be understood by one of ordinary skill in the art. Similarly, the production bore **44** extending through the tubing hanger **32** at its upper end may be in fluid communication with a production bore formed through a subsea tree, flowline connector, or other component connected to an upper end of the tubing hanger **32**.

[0027] As illustrated, the tubing hanger **32** may be equipped with a reduced stroke gate valve **100** in accordance with an embodiment of the present disclosure. For example, the tubing hanger **32** may include the reduced stroke gate valve (hereinafter "gate valve") **100** located along the annulus bore **50**. The gate valve **100** may be used to selectively close off the annulus bore **50** as needed during various operations of the tubing hanger **32**/wellhead assembly **10**. In general, the gate valve **100** may be maintained in a fully open position, as illustrated in FIG. **1**, so that the annulus bore **50** provides fluid communication between the annulus (located between the tubing string **33** and the production casing **38**) and an annulus bore in a subsea tree or other component located above the tubing hanger **32**. The gate valve **100** may be closed as needed, e.g., when performing remedial operations on the wellhead assembly **10** or its associated components, workover operations, retrieving the tubing hanger **32** from the wellhead assembly **10**, removing the subsea tree without having to set a wireline plug, etc.

[0028] As illustrated, the gate valve **100** may include an upper seat **102**, a lower seat **104**, and a movable gate **106** located between the upper and lower seats **102** and **104**. The upper and lower seats **102** and **104** each include a flowpath (**103** and **105**, respectively) formed therethrough for routing fluid from a portion **108** of the annulus bore **50** on one side of the gate valve **100** to a portion **110** of the annulus bore **50** on an opposite side of the gate valve **100**. The gate **106** includes one or more openings **112** formed therethrough. The opening(s) **112** may have the same cross-sectional area (in a plane perpendicular to the longitudinal axis of the annulus bore **50**) as the flowpaths **103**, **105** through the upper and lower seats **102**, **104**. When the gate valve **100** is in the fully open position as shown in FIG. **1**, the opening(s) **112** in the gate **106** are aligned with the flowpaths **103**, **105** through the upper and lower seats **102**, **104**. The gate valve **100** may be selectively moved to a closed position in which the gate **106** is shifted in a horizontal direction relative to the seats **102**, **104** such that the opening(s) **112** in the gate **106** are not aligned with and do not overlap with the flowpaths **103**, **105** through the seats **102**, **104**. Thus, when the gate valve **100** is shifted to the fully closed position, the gate **106** prevents fluid from flowing from the portion **108** of the annulus bore **50** below the gate valve **100** to the portion **110** of the annulus bore **50** above the gate valve **100**.

[0029] The gate valve **100** also includes an actuation assembly (not shown in FIG. **1**) that selectively moves the gate **106** of the gate valve **100** between the open and closed positions. As discussed in detail below, the one or more openings **112** within the gate **106** of the gate valve **100** span a total area **113** that has a smaller dimension in a direction parallel to a gate actuation direction than in a direction perpendicular to the gate actuation direction. This specific area **113** of the opening(s) **112** facilitates a reduced stroke length for moving the gate valve **100** between the open and closed positions. In embodiments where the gate **106** includes only a single opening **112**, the opening **112** has a non-circular and/or non-round shape. In embodiments of the gate valve **100** with multiple openings **112**, the openings **112** may be circular (or any other desired shape) but arranged in a distribution that conforms to the shape of the area **113**.

[0030] Although the disclosed gate valve **100** is described as being used within a tubing hanger **32** (in FIGS. **1** and **2**) and a general test fixture (in FIGS. **4-8**), it should be noted that the gate valve **100** may be similarly used in other equipment components (e.g., trees, surface tubing hangers, flowline connectors, etc.) where compact packaging of a gate valve is desired.

[0031] FIG. **2** illustrates an embodiment of the gate valve **100** including the gate **106** and a gate valve actuation assembly **200**. The gate valve **100** is shown in the fully closed position, such that the one or more openings **112** in the gate **106** do not overlap whatsoever with one or more corresponding openings in the seat (e.g., lower seat **104**). As with FIG. **1**, the embodiment shown in FIG. **2** has the gate valve **100** disposed within a tubing hanger **32**. The tubing hanger **32** includes a body **202** with a single horizontally oriented bore **204** formed therethrough to accommodate the gate valve **100**. A length of the bore **204** may be selected to accommodate an overall length of the gate valve **100** including both the gate **106** and the associated gate valve actuation assembly **200**. The total length of the gate valve actuation assembly **200**, and therefore the bore **204** may be reduced via the non-circular/non-round shape of the area **113** covered by the one or more openings **112** through the gate **106**.

[0032] The disclosed gate valve **100** includes one or more openings **112** covering a non-circular area **113** formed in the gate **106** to provide an equivalent total flow area (i.e., cross-sectional area in a direction of fluid flow) from the one or more openings **112** as would otherwise be required of a single circular opening in a conventional gate valve used for the same application. The one or more openings **112** arranged in the non-circular or non-round area **113** allows for a reduced stroke length through which the actuation assembly **200** moves the gate valve **100** between the fully open and fully closed positions.

[0033] FIG. **2** illustrates an embodiment of the gate valve **100** having a single opening **112** in the gate **106**. The opening **112** in the gate **106** is illustrated in a plane of the page in FIG. **2**. The opening **112** conforms to a non-circular or non-round area **113** defined by the outer edges of the opening **112**. As such, the opening **112** may have a non-circular or non-round shape. The term "non-circular" means that the cross-sectional shape is not equivalent to a circle with all points along the perimeter of the shape being the same distance from a centroid (or geometric center in the plane) of the shape. The term "non-round" means that the cross-sectional shape includes at least one side or portion that does not have a convex shape relative to a centroid (or geometric center in the plane) of the shape. For example, while an elliptical shape would qualify as "non-circular," it does not qualify as "non-round."

[0034] In some embodiments, at least one side or portion of the cross-sectional shape may have a concave shape relative to centroid (or geometric center in the plane) of the shape. This is the case with the illustrated shape of the opening **112** in FIG. **2**. One side **212** of the shape is concave with respect to a centroid **214** of the shape, while an opposite side **216** of the shape is convex with respect to the centroid **214** of the shape. The concave side **212** is closest to the actuation assembly **200** in a longitudinal direction of the gate valve **100** along axis **218**, while the convex side **216** is farthest from the actuation assembly **200** in the longitudinal direction of axis **218**. As such, the illustrated shape of the opening **112** may generally be defined as a "crescent shape" curving in a direction away from the actuation assembly **200**. In other embodiments, the concave side **212** and convex side **216** may be reversed in terms of proximity to the actuation assembly **200** so that the "crescent shape" curves in a direction toward the actuation assembly **200**.

[0035] Other non-circular and/or non-round shapes may be used as well for a single opening **112** formed in the gate. For example, in some embodiments, at least one side or portion of the cross-sectional shape may have a straight edge perpendicular to the longitudinal axis **218**, instead of a concave shape. For example, the cross-sectional shape of the opening **112** may be equivalent to a semi-circle, or similar semi-rounded shape. Such a shape of the single opening **112** is illustrated in FIG. **3**A. In other embodiments, the cross-sectional shape of a single opening **112** in the gate **106** may be an irregular shape that is not symmetric across the longitudinal axis **218**, as illustrated in FIG. **3**B. The cross-sectional shape of a single opening **112** in the gate **106** may be a rectangular shape (as shown in FIG. **3**C) or an elliptical shape (as shown in FIG. **3**D).

[0036] In other embodiments, the gate valve **100** may include multiple openings **112** that span a non-circular or non-round area **113** defined by the outer edges of the group of openings **112**. FIG. **3**E illustrates an embodiment of the gate **106** having multiple openings **112** formed therein. As shown, the multiple openings **112** may be circular or round in shape, although other shapes may be possible as well. The non-circular or non-round area **113** covered by the group of openings **112** has a shorter dimension in the longitudinal direction of axis **218** than in a direction perpendicular to the axis **218**. The cross-sectional area of each of the multiple openings **112** added together equals the required cross-sectional area for the gate valve application. As such, the multiple openings **112** in the gate valve **100** provide a reduced stroke length for the same cross-sectional area as is available using a gate valve with a single circular or round opening.

[0037] In any of the above embodiments of FIGS. **2** and **3**A-**3**E, a length of the area **113** spanned by the one or more openings **112** in a direction parallel to the longitudinal axis **218** is shorter than a length of the area **113** spanned by the one or more openings **112** in a direction perpendicular to the longitudinal axis **218** (and in the plane of the page). This reduces the overall length (in the direction of the longitudinal axis **218**) through which the actuation assembly **200** strokes the gate **106** between a fully open position and fully closed position. The stroke length of the disclosed gate valve **106** may be only slightly longer than a total length of the area **113** spanned by the opening(s) **112** in the direction parallel to the longitudinal axis **218**.

[0038] Even with the non-circular or non-round shape of the area covered by the opening(s) **112**, the opening(s) **112** maintain a cross-sectional area that is equivalent to a desired or predetermined cross-sectional area for a gate valve being used to seal a particular piece of equipment (e.g., an annulus bore of the tubing hanger **32**). For example, regulations for tubing hangers **32** generally dictate that a valve used to open/close the annulus bore maintains a nominal cross-sectional flow area corresponding to, for example, a 1 inch diameter circle or a 2 inch diameter circle. The shape, size, and/or distribution of the opening(s) **112** may be chosen such that to the opening(s) have a total cross-sectional area in the plane of the page equivalent to that of the predetermined or regulatory flow area needed for the gate valve application. Thus, the disclosed gate valve **100** provides a required amount of fluid flow through the valve while it is fully open, and is able to be closed with a shorter stroke length along the longitudinal axis **218** of the gate valve **100**.

[0039] The disclosed gate valve **100** includes an actuation assembly **200**. In the illustrated embodiment, the actuation assembly may include a hydraulically operated actuation assembly. However, other types of actuations assemblies may be used in other embodiments of the gate valve **100**, including for example, manual or electric actuators. For example, an electrical actuator that may be used with a reduced stroke gate valve **100** is illustrated and described at length below with reference to FIGS. **9**A-**9**D.

[0040] In the system of FIG. **2**, the actuation assembly **200** may include, among other things, a stem **220**, a piston housing **222**, a primary piston **224**, a secondary piston **226**, a primary cap **228**, and a secondary cap **230**. The stem **220** is connected to the gate **106** at one end (e.g., via a connector **232**) and extends through a chamber **234** defined by the piston housing **222**.

[0041] The stem **220** is configured to move longitudinally (in the direction of axis **218**) with respect to the piston housing **222** and the tubing hanger body **202** to transition the gate **106** between the fully open position and fully closed position. One or more guides **221** may be disposed along and coupled to edges of the gate **106** so as to keep the gate **106** aligned within the bore **204** of the tubing hanger body **202**. The guides **221** may have a specific shape to ensure that the gate **106** is maintained in a desired orientation (i.e., parallel to the plane of the page) with respect to the valve seats. The guides **221** may also centralize the gate **106** within the bore **204** while keeping the gate **106** from rotating about the longitudinal axis **218**.

[0042] The primary piston **224** is either attached to or integral with the stem **220**, so that these two components move together. One or more seals on a radially external surface of the primary piston **224** fluidically isolate the chamber **234** on a first side **236** of the piston **224** from the chamber **234** on a second side **238** of the piston **224** while allowing the piston **224** to slide axially within the bore of the piston housing **222**.

[0043] The secondary piston **226** is separate from and able to move with respect to the stem **220**. One or more seals on a radially external surface of the secondary piston **226** fluidically isolate the chamber **234** on a first side **240** of the piston **226** from the chamber **234** on a second side **242** of the piston **226** while allowing the piston **226** to slide axially along the bore of the piston housing **222**. The secondary piston **226** may also include a bore formed therethrough, wherein the stem **220** passes through this bore, and one or more seals located between the bore of the piston **226** and the stem **220**.

[0044] The piston housing **222** may be secured within the bore **204** of the tubing hanger housing **202** via primary cap **228**. The primary cap **228** may include a bore formed therethrough, wherein the stem **220** passes at least partially through this bore, and one or more seals located between the bore of the primary cap **228** and the stem **220**. The primary cap **228** is coupled to an end of the piston housing **222** extending away from the gate **106**. The primary cap **228** may be secured to the tubing hanger housing **202** via a threaded connector **244** that engages threads formed along an end of the bore **204** proximate an external surface of the housing **202**.

[0045] The secondary cap **230** may be secured over the primary cap **228** and other actuation assembly components to keep the actuation assembly **200** within the bore **204** of the housing **202**. The secondary cap **230** may provide some additional length to accommodate the full stroke of the stem **222**. Specifically, the secondary cap **230** may include a bore or space **245** formed at least partially therethrough to receive an end of the stem **222** during opening of the gate valve **100**.

The secondary cap **230** may be secured to one or both of the primary cap **228** and the housing **202** via a series of bolts **246**.

[0046] The piston housing **222** may include a series of hydraulic fluid ports formed therethrough to direct hydraulic fluid for actuating the pistons **224/226**, stem **222**, and gate **106** between open and closed valve positions. The piston housing **222** may include a first one or more ports **250** extending from a radially external surface of the piston housing **222** to the chamber **234** on the first side **236** of the primary piston **224**. The piston housing **222** may include a second one or more ports **252** extending from a radially external surface of the piston housing **222** to the chamber **234** on the second side **238** of the primary piston **224**/first side **240** of the secondary piston **226**. The piston housing **222** may include a third one or more ports **254** extending from a radially external surface of the piston housing **222** to the chamber **234** on the second side **242** of the secondary piston **226**.

[0047] As illustrated, the tubing hanger body **202** may include three hydraulic galleries **256**, **258**, and **260** formed circumferentially around the bore **204** and in hydraulic communication with the ports **250**, **252**, and **254**, respectively. The presence of the hydraulic galleries **256**, **258**, and **260** allows hydraulic fluid to be communicated through the ports **250**, **252**, and **254** in the piston housing **222** regardless of an orientation of the piston housing **222** relative to the bore **204** of the tubing hanger body **202**. One or more hydraulic fluid lines formed through the tubing hanger body **202** may provide hydraulic fluid to and/or from each of the galleries **256**, **258**, and **260** for operating the actuation assembly **200**. Seals **262** positioned at an interface between the piston housing **222** and the bore **204** of the tubing hanger body **202** fluidly isolate each of the galleries **256**, **258**, and **260** from each other.

[0048] Having described the general layout of the actuation assembly **200** used to open and close the disclosed gate valve **100**, a more detailed description of the actuation operations will now be provided. For ease of understanding, reference will be made to FIGS. **6-8**, which show the gate valve **100** disposed within a test fixture **500**. The test fixture **500** represents any desired equipment component (e.g., tubing hanger, tree, flowline connector, etc.) having a flow bore therethrough that may be selectively closed using a gate valve in accordance with the disclosed embodiments.

[0049] Perspective and top views of a section of the overall test fixture **500** are shown in FIGS. **4** and **5**. These figures show the test fixture **500** having a body **200**, vertically oriented caps **502** located on opposing ends of an annulus bore through the test fixture, and the secondary cap **230** and its associated bolts **246** extending from a lateral edge of the body **200**. As can be clearly seen in FIGS. **4** and **5**, the cap **230** extends only slightly outside of the body **200** of the test fixture **500** and does not significantly increase the dimensions of the overall test fixture **500**. This is due to the relatively compact size of the actuation assembly of the disclosed gate valve having a reduced stroke length. In addition, the compact size of the actuation assembly of the gate valve frees up additional space for other fluid, electrical, and communication lines to be routed through other portions of the body **202** of the test fixture **500**.

[0050] Turning to FIGS. **6-8**, gate valve actuation operations will now be described. To open the gate valve **100**, hydraulic fluid may be communicated through the first port(s) **250** to the chamber **234** on the first side **236** of the primary piston **224**. As illustrated in FIG. **6**, this hydraulic fluid communication increases the pressure on the first side **236** of the primary piston **224**, thereby urging the piston **224** in a direction toward the capped end of the assembly. The piston **224** moves the stem **222** and connected gate **106** in this direction as well, until the opening(s) **112** in the gate **106** are brought into alignment with the flowpaths **103** and **105** through the valve seats **102** and **104**, respectively. At this point, the second end **238** of the primary piston **224** abuts a shoulder **270** of the secondary piston **226**, which stops the longitudinal motion of the stem **222** upon the gate valve **100** reaching the fully open position of FIG. **6**.

[0051] To close the gate valve **100**, hydraulic fluid may be communicated through the second port(s) **252** to the chamber **234** on the second side **238** of the primary piston **224**. As illustrated in FIG. **7**, this hydraulic fluid communication increases the pressure on the second side **238** of the primary piston **224**, thereby urging the piston **224** back in a direction away from the capped end of the actuation assembly. The piston **224** moves the stem **222** and connected gate **106** in this direction as well, until the opening(s) **112** in the gate **106** are no longer overlapping with the flowpaths **103** and **105** through the valve seats **102** and **104**, respectively. At this point, the first end **236** of the primary piston **224** abuts an end of the chamber **234**, which stops the longitudinal motion of the stem **222** upon the gate valve **100** reaching the fully closed position of FIG. **7**.

[0052] In the event that the gate valve **100** does not respond properly to fluid communicated through the second port(s) **252**, as described above with reference to FIG. **7**, the third port(s) **254** may be used to close the gate valve **100**. This may be needed, for example, in the event that one or more seals of the actuation assembly fail. To close the gate valve **100** in this situation, hydraulic fluid may be communicated through the third port(s) **254** to the chamber **234** on the second side **242** of the secondary piston **226**. As illustrated in FIG. **8**, this hydraulic fluid communication increases the pressure on the second side **242** of the secondary piston **226**, thereby urging the piston **226** in the longitudinal direction away from the capped end of the actuation assembly. The piston **226** moves both the piston **224** and the connected stem **222** and gate **106** in this direction as well, until the opening(s) **112** in the gate **106** are no longer overlapping with the flowpaths **103** and **105** through the valve seats **102** and **104**, respectively. At this point, the first end **236** of the primary piston **224** abuts an end of the chamber **234**, which stops the longitudinal motion of the piston **226** and the stem **222** upon the gate valve **100** reaching the fully closed position of FIG. **8**. As such, the secondary piston **226** serves as a back-up for the primary piston **224** in closing the gate valve **100**.

[0053] While the above described actuation operations of the gate valve **100** are taking place, hydraulic fluid must be vented from certain sections of the chamber **234** as the pistons **224/226** move. The hydraulic fluid may be vented via the same fill ports used to supply hydraulic fluid, or through separate vent ports (not shown).

[0054] Due to the various actuation operations that may be performed using the actuation assembly **200** of FIGS. **2** and **6-8**, the required stroke length to move the gate **106** from fully open to fully closed may be multiplied four times to provide the overall length of the actuation assembly **200**. This is because each piston **224/226** must be able to move the full length of the gate valve stroke in each direction to provide the desired flexibility of operation in the actuation assembly **200**. Thus, reducing the stroke length via the non-circular or non-round shape of the area **113** spanned by the gate valve opening(s) **112** provides a large reduction in the overall length of the actuation assembly **200** and greater ease of incorporating the actuation assembly **200** into compact equipment installations.

[0055] It should be noted that other arrangements of the hydraulic fluid port(s), chamber(s), piston(s), etc. may be used to actuate the disclosed gate **106** between open and closed positions. For example, in some embodiments, the secondary piston **226** and third port(s) **254** may not be present. In some embodiments, the actuation system may move the gate **106** in opposite directions to open/close the valve **100** (e.g., closing the valve by pulling the gate **106** toward the capped end and opening the valve by extending the gate **106** away from the capped end). These various embodiments of the actuation assembly **200** may similarly benefit from the reduced overall stroke length of the gate **106** provided via the non-circular and/or non-round area spanned by the opening(s) **112**.

[0056] As noted previously, the gate valve **100** may be utilized with other types of actuation assemblies **200**, including manual or electric actuation assemblies (for example, as described below). The reduced stroke of the gate still applies in these instances and will help reduce the overall length of the gate valve assembly **100** for more compact packaging of the valve.

[0057] Referring now to FIGS. **9A-9D**, an embodiment of a wellhead assembly **800** that utilizes a valve **900** is illustrated according to the present disclosure. The wellhead assembly **800** as shown may be a subsea wellhead assembly and may include a tubing hanger **810**, a tubing hanger space-out mechanism **820**, a tubing hanger alignment device **830**, and a locking mechanism **840**. The tubing hanger **810** (or may be integral with the tubing hanger **810**) is shown landed on the tubing hanger space-out mechanism **820**, and in one or more embodiments, the tubing hanger space-out mechanism **820** may be landed on a casing hanger (not shown). The casing hanger supports a production casing (not shown), and the tubing hanger **810** supports a tubing string (not shown) positioned within the production casing. The tubing hanger alignment device **830** is coupled to the tubing hanger **810**. In one or more embodiments, the tubing hanger alignment device **830** may be threadably connected to the tubing hanger **810** such that when a tree (not shown) is landed on the tubing hanger **810**, one or more lengths of coiled hydraulic tubing and/or electrical conduits (not shown) align with and couple to one or more hydraulic and/or electrical connectors **850** of the tubing hanger **810**. Further, the tubing hanger alignment device **830** may be disposed within and through the locking mechanism **840**. The locking mechanism **840** may engage a locking profile of a wellhead housing (not shown) in order to lock the casing hanger, the tubing hanger **810**, the tubing hanger space-out mechanism **820**, the tubing hanger alignment device **830**, and the locking mechanism **840** in place within the wellhead housing and rigidize the system.

[0058] Additionally, the locking mechanism **840**, according to one or more embodiments of the present disclosure, may include a locking mandrel **841** and locking dogs **842**. The locking dogs **842** may be supported around the locking mandrel **841**. The locking mechanism **840** may be run into the wellhead housing until the locking mechanism **840** abuts an upward facing contact surface of the tubing hanger **810**.

[0059] The tubing hanger **810** generally includes a primary bore **811**. As depicted, the primary bore **811** may be a production bore which may be configured to support a tubing string that extends into the wellbore. Further, the primary bore **811** may be concentric with a bore of the wellhead housing and may have a central axis **812** aligned with a central axis of the wellhead housing. In other embodiments, though, the primary bore **811** may have a central axis **812** spaced from a central axis of the wellhead housing (i.e., the primary bore **811** may be eccentric). The tubing hanger **810** may also include a secondary bore **813** that extends at least partially through the tubing hanger **810** for communicating a fluid medium through the secondary bore **813**. As depicted, the secondary bore **813** may be an annulus bore which may be configured for communicating a fluid medium through an annulus outside of the production bore. In one or more embodiments, the secondary bore **813** may be formed within the tubing hanger **810** between a radially external wall of the tubing hanger **810** and the primary bore **811**, and the secondary bore **813** may be fluidly isolated from the primary bore **811** by the tubing string (not expressly shown). The secondary bore **813** may include an upper portion **813*a*** and a lower portion **813*b***, where the upper portion **813*a*** is parallel to the central axis **812** of the primary bore **811** while the lower portion **813*b*** is angled relative to the central axis **812** of the primary bore **811**. In other embodiments, the upper portion **813*a*** may be angled relative to the central axis **812** of the primary bore **811** while and the lower portion **813*b*** may be parallel to the central axis **812** of the primary bore **811**. Still further, in other embodiments, the upper portion **813*a*** and the lower portion **813*b*** may be aligned and may be either parallel to or angled relative to the central axis **812** of the primary bore **811**. The secondary bore **813** is thus in fluid communication with the annulus between the production casing and the tubing string, while the primary bore **811** is in fluid communication with the tubing string. The secondary bore **813** at an upper end of the tubing hanger **810** may be in fluid communication with an annulus bore through a subsea tree, flowline connector, or other component connected to an upper end of the tubing hanger **810**, as will be understood by one of ordinary skill in the art. Similarly, the primary bore **811** extending through the tubing hanger **810** at its upper end may be in fluid communication with a primary bore formed through a subsea tree, flowline connector, or other component connected to an upper end of the tubing hanger **810**. Further, in one or more embodiments, when the secondary bore **813** is not in use, a first plug body **816** may be disposed within the upper portion **813*a*** of the secondary bore **813**, and a first jack plate **817** may be threaded into the upper portion **813*a*** of the secondary bore **813** such that the first plug body **816** is maintained within the upper portion **813*a*** of the secondary bore **813**.

[0060] As illustrated, the tubing hanger **810** may be equipped with a valve **900** in accordance with an embodiment of the present disclosure. The tubing hanger **810** may include a first valve groove **814** and a second valve groove **815**, and the valve **900** may be disposed within the first valve groove **814** and the second valve groove **815** and may extend into the secondary bore **813**. While the valve **900** is depicted as extending into the secondary bore **813**, in other embodiments, the valve **900** may instead extend into the primary bore **811** or any other bore extending at least partially through the tubing hanger **810** and through which flow of a fluid medium is to be controlled by selective opening or closing of the valve **900**. In one or more embodiments, the first valve groove **814** may be formed within the tubing hanger **810** between a radially external wall of the tubing hanger **810** and the primary bore **811**. Further, the first valve groove **814** may be formed at least partially through tubing hanger **810** from a longitudinally external face of the tubing hanger **810**. Furthermore, the second valve groove **815** may be formed at least partially through the tubing hanger **810** from the radially external wall of the tubing hanger **810** to the secondary bore **813**. Additionally, the second valve groove **815** may at least partially intersect the first valve groove **814**. In one or more embodiments, as illustrated, the valve **900** is an annulus valve located along the secondary bore **813** of the tubing hanger **810**. However, it should be noted that similar embodiments of an electrical actuation assembly described below may be used with valves **900** that are not annulus valves. For example, the valve **900** in some embodiments may include a crossover valve configured to selectively connect a production flow bore (e.g., primary bore **811**) through the tubing hanger **810** with an annulus bore (e.g., secondary bore **813**) through the tubing hanger **810**. In addition, similar embodiments of an electrical actuation assembly described below may be used with valves **900** located in other types of equipment within a wellhead assembly such as, for example, a wellhead sensor/injection module, tubing spool, or flowline connection body, among others.

[0061] The valve **900** may be used to selectively close off and open the secondary bore **813** to fluid flow as needed during various operations of the tubing hanger **810**/wellhead assembly. In one or more embodiments, the valve **900** may be a gate valve or a reduced stroke gate valve; however, in other embodiments, the valve **900** may be any other type of valve, such as a ball valve, butterfly valve, gate valve, shuttle valve, sleeve valve, flapper valve, rotary valve, and so forth. Further, while the valve **900** is depicted as an annulus valve, in other embodiments, the valve may be a production flow valve, an injection valve, a control valve, or a choke valve. In general, the valve **900** may be maintained in a fully open position, as illustrated in FIGS. **9**B and **9**C, so that the secondary bore **813** provides fluid communication between the annulus (located between the tubing string and the production casing as described above) and an annulus bore in a subsea tree or other component located above the tubing hanger **810**. The valve **900** may be closed as needed, e.g., when performing remedial operations on the wellhead assembly or its associated components, workover operations, retrieving the tubing hanger **810** from the wellhead assembly, removing the subsea tree without having to set a wireline plug, etc.

[0062] As illustrated, the valve **900** may include an upper seat **902**, a lower seat **904**, and a movable gate **906** located between the upper and lower seats **902** and **904**. The upper and lower seats **902** and **904** each include a flowpath (**903** and **905**, respectively) formed therethrough for routing fluid between the upper portion **813***a* and the lower portion **813***b* of the secondary bore **813**. The gate **906** includes one or more openings **912** formed therethrough. The opening(s) **912** may have the same cross-sectional area (in a plane perpendicular to the longitudinal axis of the secondary bore **813**) as the flowpaths **903**, **905** through the upper and lower seats **902**, **904**. When the valve **900** is in the fully open position as shown in FIGS. **9**B and **9**C, the opening(s) **912** in the gate **906** are aligned with the flowpaths **903**, **905** through the upper and lower seats **902**, **904**. The valve **900** may be selectively moved to a closed position in which the gate **906** is shifted in a horizontal direction relative to the seats **902**, **904** such that the opening(s) **912** in the gate **906** are not aligned with and do not overlap with the flowpaths **903**, **905** through the seats **902**, **904**. Thus, when the valve **900** is shifted to the fully closed position, the gate **906** prevents fluid from flowing between the upper portion **813***a* of the secondary bore **813** above the valve **900** and the lower portion **813***b* of the secondary bore **813** below the valve **900**.

[0063] The valve **900** also includes an actuation assembly **901** that selectively moves the gate **906** of the valve **900** between the open and closed positions. Similar to the gate valve **100** as described above, the one or more openings **912** within the gate **906** of the valve **900** span a total area that has a smaller dimension in a direction parallel to a gate actuation direction than in a direction perpendicular to the gate actuation direction. This specific area of the opening(s) **912** facilitates a reduced stroke length for moving the valve **900** between the open and closed positions. In embodiments where the gate **906** includes only a single opening **912**, the opening **912** has a non-circular and/or non-round shape. In embodiments of the valve **900** with multiple openings **912**, the openings **912** may be circular (or any other desired shape) but arranged in a distribution that conforms to the shape of the specific area.

[0064] In one or more embodiments, the actuation assembly **901** of the valve **900** is an electrical actuator. The electrical actuator may be coupled to the gate **906** of the valve **900** and may be configured to selectively move the gate **906** so as to open or close the valve **900** in response to one or more electrical signals received from a surface of the wellbore. As depicted, the actuation assembly **901** may include at least a gear assembly **920**, an electric motor **921**, and a spindle **940**. The gear assembly **920** may include a worm **925** and a worm gear **930**. The electric motor **921** and the worm **925** may be disposed within the first valve groove **814** of the tubing hanger **810**, and the worm gear **930** and the spindle **940** may be disposed within the second valve groove **815** of the tubing hanger **810**. Further, an axis of the first valve groove **814** may be substantially parallel to the longitudinal axis of the secondary bore **813**, while an axis of the second valve groove **815** may be substantially perpendicular to the longitudinal axis of the secondary bore **813**. Furthermore, while the actuation assembly **901** is depicted as being disposed fully within the tubing hanger **810**, in one or more embodiments, portions of the actuation assembly **901** may at least partially extend from one or both of a longitudinally external face of the tubing hanger **810** or a radially external wall of the tubing hanger **810**.

[0065] The worm **925** may be coupled to and driven by the electric motor **921** and may be configured to translate rotation created by the electric motor **921** into rotation of the worm gear **930**. The worm **925** is coupled to the electric motor **921** by way of a motor shaft **922**. In one or more embodiments, the worm **925** is rotationally coupled to a first end **922***a* of the motor shaft **922**, and the second end **922***b* of the motor shaft **922** is rotationally coupled to the motor **921**. The first end **922***a* and the second end **922***b* of the motor shaft **922** may be rotationally coupled to the worm **925** and the electric motor **921**, respectively, by way of key and groove systems, where one of the key or the groove may be formed on the motor shaft **922** and the other of the key or the groove may be formed on the electric motor **921** and the worm **925**, where the key is configured to be disposed within the groove. Thus, when the motor **922** is actuated, the motor shaft **922** rotates about an axis **923**, which causes the worm **925** to rotate about the axis **923**. While a key and groove system may be used in one or more embodiments, in other embodiments, the motor shaft **922** may be coupled to the electric motor **921** and the worm **925** by other types of connections. Further, in one or more embodiments, the electric motor **921**, the motor shaft **922**, and the worm **925** may be rotationally coupled together and inserted into the second valve groove **815** of the tubing hanger **810**. Furthermore, in one or more embodiments, once the electric motor **921**, the motor shaft **922**, and the worm **925** are disposed within the second valve groove **815**, a second plug body **818** may be disposed within the second valve groove **815** and a second jack plate **819** may be threaded into the second valve groove **815** such that the electric motor **921**, the motor shaft **922**, and the worm **925** of the valve **900** are maintained within the second valve groove **815**. In still further embodiments, the worm **925** may not be needed, as the motor shaft **922** may directly contact the valve **900** in embodiments where the valve **900** includes, for example, a rotary valve, sleeve valve, or shuttle valve.

[0066] Further, the worm **925** may engage the worm gear **930** such that rotation of the worm **925** rotates the worm gear **930**. Specifically, the worm **925** may include an external geared face, and the worm gear **930** may include an external geared face. The external geared face of the worm **925** and the external geared face of the worm gear **930** may be configured to engage such that rotation about the axis **923** of the motor shaft **922** is translated to rotation about an axis **945** of the spindle **940**. As depicted, the axis **923** of the motor shaft **922** is perpendicular to the axis **945** of the spindle **940**; however, in one or more embodiments, the angle between the axis **923** of the motor shaft **922** and the axis **945** of the spindle **940** may be any angle between 0 and 180 degrees.

[0067] Furthermore, the spindle **940** may include a first end that is disposed through and rotationally coupled to the worm gear **930** such that rotation of the worm gear **930** rotates the spindle **940**. In one or more embodiments, the spindle **940** may be rotationally coupled to the worm gear **930** by way of a key and groove system, where a key (e.g., **946**) may be disposed within complementary grooves formed in both the worm gear **930** and the spindle **940**. Additionally, the spindle **940** may include a second end that is threaded and configured to be threadedly coupled to the gate **906** such that when the spindle **940** rotates in a first direction, the threaded engagement between the spindle **940** and the gate **906** causes the gate **906** to shift from a first position to a second position, and such that when the spindle **940** rotates in a second direction, the threaded engagement between the spindle **940** and the gate **906** causes the gate **906** to shift from the second position to the first position. More specifically, rotation of the spindle **940** in a first direction causes the spindle **940** to at least partially unthread from the gate **906** such that the gate **906** is shifted linearly away from the spindle **940**. Further, rotation of the spindle **940** in the second direction causes the spindle **940** to thread further into the gate **906** such that the gate **906** is shifted linearly towards the spindle **940**. Thus, in one or more embodiments, rotation of the spindle **940** in a first direction shifts the gate **906** towards the second position in which the gate **906** is in a closed position (not expressly shown), and rotation of the spindle **940** in a second direction shifts the gate **906** towards the first position in which the gate **906** is in an open position (as depicted in FIGS. **9**B and **9**C). In the open position, the one or more openings **912** overlap, at least partially, with the one or more corresponding openings in both of the seats (e.g., upper seat **902** and lower seat **904**), and a fluid medium is able to flow through the valve **900**. Further, in the closed position, the one or more openings **912** in the gate **906** do not overlap with one or more corresponding openings in one or more of the seats (e.g., upper seat **902** and/or lower seat **904**), and a fluid medium is prevented from flowing through the valve **900**.

[0068] Furthermore, in one or more embodiments, the openings **912** of the valve **900** may be designed as described above with regard to FIGS. **2** and **3**A-**3**E. The opening(s) **912** may maintain a cross-sectional area that is equivalent to a desired or predetermined cross-sectional area for a valve being used to seal a particular piece of equipment (e.g., an annulus bore of the tubing hanger **810**). For example, regulations for tubing hangers **810** generally dictate that a valve used to open/close the annulus bore maintains a nominal cross-sectional flow area corresponding to, for example, a 1 inch diameter circle or a 2 inch diameter circle. The shape, size, and/or distribution of the opening(s) **912** may be chosen such that to the opening(s) have a total cross-sectional area equivalent to that of the predetermined or regulatory flow area needed for the valve application. Thus, the disclosed valve **900** provides a required amount of fluid flow through the valve while it is in the open position and is able to be closed.

[0069] Additionally, in one or more embodiments, the actuation assembly **901** of the valve **900** may include a bonnet **950**, one or more thrust bearings **960**, and an end cap **970**. The bonnet **950** may include a body **951** having a first opening **952**, a second opening **953**, and a gap **954**. The spindle **940** may be disposed within and through the bonnet **950**. Specifically, the spindle **940** may be inserted into the bonnet **950** through the first opening **952**, and the spindle **940** may be further inserted until the second end of the spindle **940** is disposed through the second opening **953** of the bonnet **950** and extends from the bonnet **950**. Further, the worm gear **930** may be disposed within the gap **954** formed in a side of the bonnet **950**, and the spindle **940** may be disposed through the worm gear **930** such that the first end of the spindle **940** may be rotationally coupled to the worm gear **930**. Furthermore, one or more thrust bearings **960** may be disposed within the body **951** of the bonnet **950**, and the spindle **940** may be disposed through the one or more thrust bearings **960** such that one or more thrust bearings **960** may be disposed about the spindle **940** on one or both sides of the worm gear **930**. Additionally, in one or more embodiments, the valve **900** including at least the gate **906**, the worm gear **930**, the spindle **940**, the bonnet **950**, and the one or more thrust bearings **960** may be disposed within the second valve groove **815** of the tubing hanger **810**. Then the end cap **970** may be disposed within the second valve groove **815** until it abuts the bonnet **950** and may be threadedly coupled to the second valve groove **815** until the valve **900** is rigidized within the second valve groove **815**. Further, in one or more embodiments, the end cap **970** may include a first end which is a hex cap **971** and a second end **972** which is threaded.

[0070] Further, as discussed above, in one or more embodiments, the valve **900** may be electrically actuated.

Electrical power and electrical signals may be delivered to the electric motor **921** of the valve **900** in order to actuate the valve **900**. The electrical power and electrical signals may be delivered to the electric motor **921** by way of an electrical connector **851** of the one or more hydraulic and/or electrical connectors **850**. Further, electrical power and electrical signals may be delivered to the electrical connector **851** from a surface of the wellbore by way of an electrical conduit (not shown) of the one or more lengths of coiled hydraulic tubing and/or electrical conduits. While the valve **900** is depicted as being electrically actuated, in other embodiments, the valve **900** may be actuated by other means such as hydraulic actuation or manual actuation.

[0071] Furthermore, although the disclosed valve **900** is described as being used within a tubing hanger **810** (in FIGS. **9A-9D**), it should be noted that the valve **900** may be similarly used in other equipment components (e.g., wellhead housings, trees, surface tubing hangers, flowline connectors, etc.) where compact packaging of a valve is desired. In one or more embodiments, the valve **900** including the electrical actuation assembly **901**, the upper seat **902**, the lower seat **904**, and the movable gate **906** may be incorporated into any subsea component having one or more bores extending at least partially therethrough and through which flow of a fluid medium is to be controlled by selective opening or closing of the valve **900**. The subsea component may be one of a subsea wellhead, a tubing hanger, or a tubing spool. The subsea component may include a body having a radially external wall and at least one bore extending at least partially through the body for communicating a fluid medium through the subsea equipment component. Further, the valve **900** may be inserted into the subsea component adjacent to the bore and may be configured to open or close the bore to fluid flow in response to one or more electrical signals. Furthermore, in one or more embodiments, the one or more bores of the subsea component may include a primary bore (e.g., **811**) and a secondary bore (e.g., **813**), and the valve **900** may be disposed along either the primary bore or the secondary bore in order to control the flow of a fluid medium therethrough.

[0072] Although the present disclosure and its advantages have been described in detail, it should be understood that various changes, substitutions and alterations can be made herein without departing from the spirit and scope of the disclosure as defined by the following claims.

What is claimed is:

1. A system, comprising:

a tubing hanger configured to be positioned in a wellhead assembly, the tubing hanger configured to support a tubing string, the tubing hanger comprising a bore extending at least partially through the tubing hanger; and

a valve disposed along the bore of the tubing hanger, wherein the valve is configured to control the flow of a fluid medium through the bore, and wherein the valve comprises:

an electrical actuator, wherein the electrical actuator is disposed at least partially within the tubing hanger, wherein the electrical actuator is configured to selectively open or close the valve in response to one or more electrical signals, and wherein the electrical actuator comprises:

a spindle, wherein rotation of the spindle is configured to shift the valve between a first position and a second position, wherein in the first position, the valve is open, and wherein in the second position, the valve is closed;

a gear assembly, wherein the gear assembly is coupled to a motor shaft and the spindle, wherein the gear assembly is configured to transfer rotation of the motor shaft to rotation of the spindle, wherein the gear assembly comprises a worm gear, wherein the worm gear is rotationally coupled to the spindle, and wherein a worm that is rotationally coupled to the motor shaft is configured to engage the worm gear such that rotation of the worm about an axis of the motor shaft causes rotation of the worm gear about an axis of the spindle.

2. The system of claim **1**, wherein the electrical actuator further comprises an electric motor.

3. The system of claim **2**, wherein the electrical actuator further comprises the motor shaft, wherein the motor shaft is rotationally coupled to the electric motor, and wherein the electric motor is configured to rotate the motor shaft.

4. The system of claim **3**, wherein:

the valve further comprises a gate; and

the gate is coupled to the spindle such that rotation of the spindle in a first direction shifts the gate towards the second position and such that rotation of the spindle in a second direction shifts the gate towards the first position.

5. The system of claim **4**, wherein:

the valve further comprises an upper seat and a lower seat;

the upper seat is disposed within the bore;

the upper seat comprises a first flowpath;

the lower seat is disposed within the bore;

the lower seat comprises a second flowpath;

the gate is disposed between the upper seat and the lower seat within the bore;

the gate comprises one or more openings;

when the valve is in the first position, the one or more openings of the gate at least partially align with the first flowpath and the second flowpath; and

when the valve is in the second position, the one or more openings of the gate do not align with the first flowpath and the second flowpath.

6. The system of claim **4**, wherein:

the spindle is threadedly coupled to the gate;

rotation of the spindle in the first direction at least partially unthreads the gate from the spindle such that the gate shifts linearly away from the spindle; and

rotation of the spindle in the second direction at least partially threads the gate further onto the spindle such that the gate shifts linearly towards the spindle.

7. The system of claim **4**, wherein:

the tubing hanger further comprises:

a first valve groove; and

a second valve groove,

wherein the electric motor, the motor shaft, and the worm are disposed within the first valve groove, and

wherein the spindle and the worm gear are disposed within the second valve groove.

8. The system of claim **7**, wherein an axis of the first valve groove is orientated substantially parallel to an axis of the bore, and wherein an axis of the second valve groove is orientated substantially perpendicular to the axis of the bore.

9. The system of claim 7, wherein:
the electrical actuator further comprises:
a bonnet, wherein the spindle is disposed through the bonnet, and wherein the bonnet is disposed within the second valve groove;
one or more thrust bearings, wherein the one or more thrust bearings are disposed about the spindle on one or more sides of the worm gear; and
an end cap, wherein the end cap is configured to abut the bonnet, and wherein the end cap is threadedly coupled to the second valve groove.

10. The system of claim 1, wherein:
the tubing hanger further comprises a primary bore formed therethrough, wherein the primary bore is configured to support the tubing string; and
the bore is a secondary bore disposed between the primary bore and a radially external wall of the tubing hanger.

11. The system of claim 1, wherein the valve is an annulus valve, a production flow valve, an injection valve, a control valve, or a choke valve.

12. A system, comprising:
a subsea component comprising:
a body with a radially external wall; and
a bore extending at least partially through the body; and
a valve disposed along the bore, wherein the valve is configured to control the flow of a fluid medium through the bore, and wherein the valve comprises:
an electrical actuator, wherein the electrical actuator is disposed at least partially within the body of the subsea component, wherein the electrical actuator is configured to selectively open or close the valve in response to one or more electrical signals, and wherein the electrical actuator comprises:
a spindle, wherein rotation of the spindle is configured to shift the valve between a first position and a second position, wherein in the first position, the valve is open, and wherein in the second position, the valve is closed;
a gear assembly, wherein the gear assembly is coupled to a motor shaft and the spindle, wherein the gear assembly is configured to transfer rotation of the motor shaft to rotation of the spindle, wherein the gear assembly comprises a worm gear, wherein the worm gear is rotationally coupled to the spindle, and wherein a worm that is rotationally coupled to the motor shaft is configured to engage the worm gear such that rotation of the worm about an axis of the motor shaft causes rotation of the worm gear about an axis of the spindle.

13. The system of claim 12, wherein the electrical actuator further comprises:
an electric motor; and
the motor shaft, wherein the motor shaft is rotationally coupled to the electric motor, and wherein the electric motor is configured to rotate the motor shaft.

14. The system of claim 13, wherein:
the valve further comprises:
a gate;
an upper seat; and
a lower seat;
the upper seat is disposed within the bore;
the upper seat comprises a first flowpath;
the lower seat is disposed within the bore;
the lower seat comprises a second flowpath;
the gate is disposed between the upper seat and the lower seat within the bore;
the gate comprises one or more openings;
when the valve is in a first position, the one or more openings of the gate at least partially align with the first flowpath and the second flowpath;
when the valve is in a second position, the one or more openings of the gate do not align with the first flowpath and the second flowpath; and
the gate is coupled to the spindle such that rotation of the spindle in a first direction shifts the gate towards the second position and such that rotation of the spindle in a second direction shifts the gate towards the first position.

15. The system of claim 14, wherein:
the spindle is threadedly coupled to the gate;
rotation of the spindle in the first direction at least partially unthreads the gate from the spindle such that the gate shifts linearly away from the spindle; and
rotation of the spindle in the second direction at least partially threads the gate further onto the spindle such that the gate shifts linearly towards the spindle.

16. The system of claim 13, wherein the electrical actuator further comprises:
a bonnet, wherein the spindle is disposed through the bonnet;
one or more thrust bearings, wherein the one or more thrust bearings are disposed about the spindle on one or more sides of the worm gear; and
an end cap, wherein the end cap is configured to abut the bonnet, and wherein the end cap is threadedly coupled to subsea component.

17. The system of claim 12, wherein the subsea component is a tubing hanger, a subsea wellhead, or a tubing spool.

18. The system of claim 12, wherein the subsea component further comprises a primary bore, and wherein the bore is a secondary bore disposed between the primary bore and the radially external wall of the subsea component.

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