



- (51) International Patent Classification:
E21B 34/14 (2006.01) *E21B 23/04* (2006.01)
- (21) International Application Number:
PCT/US2023/033322
- (22) International Filing Date:
21 September 2023 (21.09.2023)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
63/376,454 21 September 2022 (21.09.2022) US
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(54) Title: ACTUATION ASSEMBLY FOR AN ISOLATION VALVE

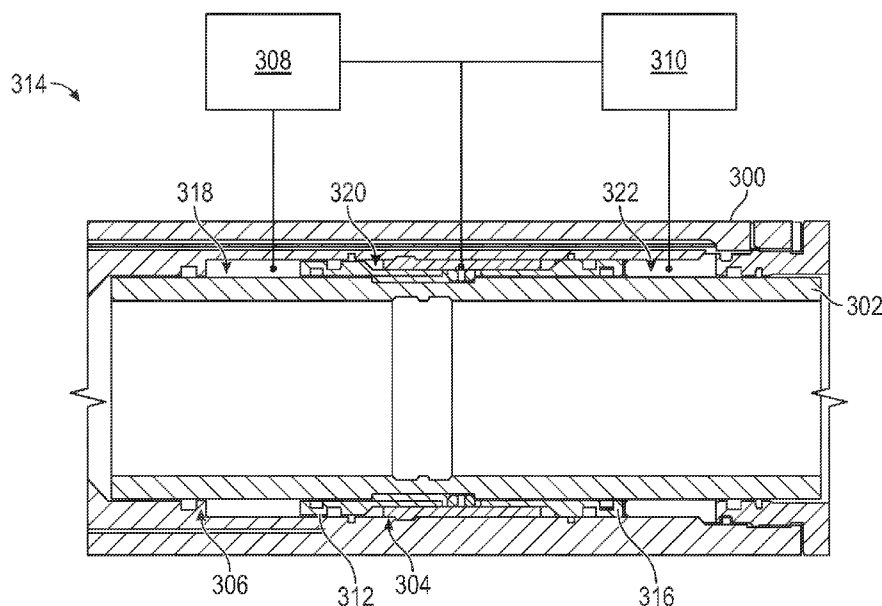


FIG. 3

(57) Abstract: An actuation assembly. The actuation assembly may include a housing, a mandrel disposed within the housing and shiftable within the housing to open and close an isolation valve, and a piston assembly disposed between the housing and the mandrel. The piston assembly may include a first hydraulic chamber fluidly couplable to a first trigger, a second hydraulic chamber fluidly couplable to the first trigger and a second trigger, a third hydraulic chamber fluidly couplable to the second trigger, a close collet piston positioned between the first hydraulic chamber and the second hydraulic chamber and close collet piston operable to shift the mandrel to close the isolation valve when the first trigger is activated, and an open collet piston positioned between the second hydraulic chamber and the third hydraulic chamber and open collet piston operable to shift the mandrel to open the isolation valve when the second trigger is activated.



(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

ACTUATION ASSEMBLY FOR AN ISOLATION VALVE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Any and all applications for which a foreign or domestic priority claim is identified in the Application Data Sheet as filed with the present application are hereby incorporated by reference under 37 CFR 1.57. The present application claims priority benefit of U.S. Provisional Application No. 63/376454 filed September 21, 2022, the entirety of which is incorporated by reference herein and should be considered part of this specification.

BACKGROUND

[0002] An isolation valve is a device that provides isolation to a reservoir. Specifically, a formation isolation valve is downhole completion equipment that is used to provide two-way isolation from the formation. This double isolation allows the performance of completion operations without placing a column of heavy fluid in the wellbore to prevent the production of reservoir fluids.

[0003] Although the main purpose of a formation isolation valve is formation isolation, the versatility of the formation isolation valve may be seen in a broad range of applications including prevention of fluid loss, packer setting, and lateral isolation. An isolation valve, such as a formation isolation valve, may include at least an actuation assembly to remotely change the state of the isolation valve.

SUMMARY

[0004] According to one or more embodiments of the present disclosure, an actuation assembly for use with an isolation valve, a first trigger, and a second trigger includes an actuation housing, a mandrel disposed within the actuation housing and shiftable within the housing to open and close the isolation valve, and a piston assembly disposed between the housing and the mandrel. The piston assembly includes a first

hydraulic chamber fluidly couplable to the first trigger, a second hydraulic chamber fluidly couplable to the first trigger and the second trigger, a third hydraulic chamber fluidly couplable to the second trigger, a close collet piston positioned between the first hydraulic chamber and the second hydraulic chamber and close collet piston operable to shift the mandrel to close the isolation valve when the first trigger is activated, and an open collet piston positioned between the second hydraulic chamber and the third hydraulic chamber and open collet piston operable to shift the mandrel to open the isolation valve when the second trigger is activated.

[0005] According to one or more embodiments of the present disclosure, a completion system includes a well string, an isolation valve operatively coupled to the well string, and an actuation assembly operatively coupled to the isolation valve. The actuation assembly includes a first trigger, a second trigger, an actuation housing, a mandrel disposed within the actuation housing and shiftable within the housing to open and close the isolation valve, and a piston assembly disposed between the housing and the mandrel. The piston assembly includes a first hydraulic chamber fluidly coupled to the first trigger, a second hydraulic chamber fluidly coupled to the first trigger and the second trigger, a third hydraulic chamber fluidly coupled to the second trigger, a close collet piston positioned between the first hydraulic chamber and the second hydraulic chamber and close collet piston operable to shift the mandrel and close the isolation valve when the first trigger is activated, and an open collet piston positioned between the second hydraulic chamber and the third hydraulic chamber and open collet piston operable to shift the mandrel and open the isolation valve when the second trigger is activated.

[0006] According to one or more embodiments of the present disclosure, a method for producing a well includes running a well string comprising an isolation valve and an actuation assembly into the well. The method also includes activating a first trigger of the actuation assembly to shift a mandrel of the actuation assembly via a close collet piston of the actuation assembly positioned between a first hydraulic chamber of the actuation assembly and a second hydraulic chamber of the actuation assembly to close the isolation valve. The method further includes activating a second trigger of the

actuation assembly to shift the mandrel via an open collet piston of the actuation assembly positioned between the second hydraulic chamber and a third hydraulic chamber of the actuation assembly to open the isolation valve.

[0007] However, many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Certain embodiments of the disclosure will hereafter be described with reference to the accompanying drawings, wherein like reference numerals denote like elements. It should be understood, however, that the accompanying figures illustrate the various implementations described herein and are not meant to limit the scope of various technologies described herein.

[0009] FIG. 1 shows a cross-sectional view of an example of a well string deployed in a wellbore and combined with an isolation valve, according to one or more embodiments of the present disclosure.

[0010] FIG. 2 shows a schematic view of a completion having an isolation valve deployed in a wellbore, according to one or more embodiments of the present disclosure.

[0011] FIG. 3 shows a diagram of an actuation assembly, according to one or more embodiments of the present disclosure.

DETAILED DESCRIPTION

[0012] In the following description, numerous details are set forth to provide an understanding of some embodiments of the present disclosure. However, it will be understood by those of ordinary skill in the art that the system and/or methodology may

be practiced without these details and that numerous variations or modifications from the described embodiments may be possible.

[0013] In the specification and appended claims, the terms “connect,” “connection,” “connected,” “in connection with,” and “connecting,” are used to mean “in direct connection with,” in connection with via one or more elements.” The terms “couple,” “coupled,” “coupled with,” “coupled together,” and “coupling” are used to mean “directly coupled together,” or “coupled together via one or more elements.” The term “set” is used to mean setting “one element” or “more than one element.” As used herein, the terms “up” and “down,” “upper” and “lower,” “upwardly” and “downwardly,” “upstream” and “downstream,” “uphole” and “downhole,” “above” and “below,” “top” and “bottom,” and other like terms indicating relative positions above or below a given point or element are used in this description to more clearly describe some embodiments of the disclosure. Commonly, these terms relate to a reference point at the surface from which drilling operations are initiated as being the top point and the total depth being the lowest point, wherein the well (e.g., wellbore, borehole) is vertical, horizontal, or slanted relative to the surface.

[0014] The present disclosure generally relates to systems and methods that facilitate actuation of an isolation valve or other downhole device. According to one or more embodiments of the present disclosure, an isolation valve includes an isolation valve member, e.g., a ball valve element, which may be actuated between positions. For example, the isolation valve member may be actuated between closed and open positions by a mechanical section having a shifting linkage.

[0015] In one or more embodiments of the present disclosure, actuation of the mechanical section, and thus actuation of the isolation valve member, is achieved by a redundant actuation assembly controlled according to a signal, which may be applied from the surface or from another suitable location. Indeed, one way to increase the reliability of remote opening of the isolation valve member is to introduce redundancy into the mechanism via the redundant actuation assembly according to one or more embodiments of the present disclosure. Advantageously, the redundant actuation

assembly according to one or more embodiments of the present disclosure provides two independent and equally reliable remote activation triggers, which may be installed simultaneously in a valve block of the redundant actuation assembly of the isolation valve. In one or more embodiments of the present disclosure, the first trigger may be a hydraulic trigger, and the second trigger may be an electronic trigger, for example. Other combinations are conceivable, and are within the scope of the present disclosure. For example, both triggers may be hydraulic triggers, or both triggers may be electronic triggers. Alternatively, the triggers may be any type of trigger. Additionally, although the redundant actuation assembly is described in relation to an isolation valve, the invention is not thereby limited. The redundant trigger may be used to actuate any type of downhole tool, for example, but not limited to, an ball valve, a sleeve valve, a flapper valve, or a packer.

[0016] Referring generally to FIG. 1, one example of a generic well system 100 is illustrated as employing an isolation valve system 102 comprising at least one isolation valve 104. Well system 100 may comprise a completion or other downhole equipment 106 that is deployed downhole in a wellbore 108. The isolation valve 104 may be one of a wide variety of components included as downhole equipment 106. Generally, the wellbore 108 is drilled down into or through a formation 110 that may contain desirable fluids, such as hydrocarbon-based fluids. The wellbore 108 extends down from a surface location 112 beneath a wellhead 114 or other surface equipment suitable for the given application.

[0017] Depending on the specific well application, e.g., such as a well perforation application, the completion/well equipment 106 is delivered downhole via a suitable well string 116, e.g., a well completion string. However, the well string 116 and the downhole equipment 106 often vary substantially. In many applications, one or more packers 118 is used to isolate the annulus between downhole equipment 106 and the surrounding wellbore wall, which may be in the form of a liner or casing 120. The isolation valve 104 may be selectively actuated to open or isolate formation 110 with respect to flow of fluid through the downhole equipment 106.

[0018] Referring now to FIG. 2, an example of a completion 206 is illustrated. The completion 206 may include a well string 216 deployed in a wellbore 208 or other type of borehole. The completion 206 also may include an actuatable device 200, which may be selectively actuated between operational positions in response to a controlled signal. For example, the controlled signal may be supplied from the surface and down through well string 216 to initiate actuation of device 200. Specifically, in one or more embodiments of the present disclosure, the controlled signal may be conveyed through a column of fluid inside the well string 216, for example. In one or more embodiments of the present disclosure, the nature of the controlled signal may be electric, electromagnetic, acoustic, optic, chemical, a series of pressure pulses, a pressure differential, and/or a temperature differential, for example.

[0019] Still referring to FIG. 2, the actuatable device 200 according to one or more embodiments of the present disclosure may be part of an isolation valve 202 disposed along the well string 216. For example, the actuatable device 200 may be in the form of a ball valve element 204 or other type of actuatable valve element. According to the illustrated embodiment, the isolation valve 202 may include a ball section 218, which includes the ball valve element 204 rotatably mounted in a corresponding ball section housing 220. In one or more embodiments of the present disclosure, the ball valve element 204 may rotate open or closed with special seals to secure effective isolation along an interior of the well string 216 and to prevent entry of unwanted debris.

[0020] Still referring to FIG. 2, the ball valve element 204 (or other actuatable device) may be shifted between operational positions via a mechanical section 210 coupled with the ball section 218. According to one or more embodiments of the present disclosure, the mechanical section 210 may include a mechanical linkage 212 connected to the ball valve element 204 or other actuatable device. According to one or more embodiments of the present disclosure, the mechanical linkage 212 may include a mechanical shifting profile and a position-lock collet, for example. The mechanical section 210 and mechanical linkage 212 are operatively coupled with the actuation assembly 214, which includes a remote opening mechanism that responds to a controlled signal to cause shifting of, for example, mechanical linkage 212 and ball

valve element 204. In one or more embodiments of the present disclosure, the actuation assembly 214 may be a redundant actuation assembly as further described below. By way of example, the actuation assembly 214 may be used to shift the ball valve element 204 from a closed position to an open position via the controlled signal applied from the surface or other suitable location, according to one or more embodiments of the present disclosure.

[0021] Referring now to FIG. 3, FIG. 3 is a diagram of an actuation assembly 314, according to one or more embodiments of the present disclosure. As described above, the actuation assembly 314 may be used to remotely actuate an isolation valve, such as the ball valve 204 described above. The actuation assembly includes an actuation housing 300, a mandrel 302 disposed within the actuation housing 300, a piston assembly 304 disposed in the annular space 306 between the actuation housing 300 and the mandrel 302, a first trigger 308, and a second trigger 310. The mandrel 302 is operatively coupled to isolation valve 202 and shiftable to actuate the isolation valve. In one or more embodiments, the mandrel 302 is coupled to the isolation valve via a mechanical linkage, such as the mechanical linkage 212 described above. Further, prior to and after actuation of the isolation valve via the actuation assembly 314, the mandrel 302 can shift within the actuation housing 300 to actuate the isolation valve 202 by pulling up on and pushing down a well string coupled to the mandrel 302.

[0022] The piston assembly 304 includes a close collet piston 312 and an open collet piston 316 that form three hydraulic chambers 318, 320, 322. Specifically, the actuation housing 300, the mandrel 302, and the close collet piston 312 form an upper hydraulic chamber 318, the actuation housing 300, the mandrel 302, the close collet piston 312, and the open collet piston 316 form a middle hydraulic chamber 320, and the actuation housing 300, the mandrel 302, and the open collet piston 316 form a lower hydraulic chamber 322. The upper hydraulic chamber 318 and the middle hydraulic chamber 320 are in fluid communication via the first trigger 308 and the middle hydraulic chamber 320 and the lower hydraulic chamber 322 are in fluid communication via the second trigger 310.

[0023] In operation, the upper, middle, and lower hydraulic chambers 320 are initially at a common pressure and both collet pistons 312, 316 are engaged with the mandrel 302. To close the isolation valve, the first trigger 308 is activated and decouples the upper hydraulic chamber 318 from the middle hydraulic chamber 320. Once the hydraulic chambers 318, 320 are decoupled, the first trigger 308 lowers the pressure within the upper hydraulic chamber 318. This causes a pressure differential between the two chambers, forcing the close collet piston 312 to shift the mandrel 302 and close the isolation valve. Once the mandrel 302 strokes sufficiently to close the isolation valve, the close collet piston 312 disengages from the mandrel 302.

[0024] To open the isolation valve, the second trigger 310 is activated and decouples the middle hydraulic chamber 320 from the lower hydraulic chamber 322. Once the hydraulic chambers 320, 322 are decoupled, the second trigger 310 lowers the pressure within the lower hydraulic chamber 322. This causes a pressure differential between the two chambers, forcing the open collet piston 316 to shift the mandrel 302 and open the isolation valve. Once the mandrel 302 strokes sufficiently to open the isolation valve, the open collet piston 316 disengages from the mandrel 302.

[0025] The individual triggers of the actuation assembly 314 may be electronic, mechanical, hydraulic, or any combination thereof. Additionally, each actuation assembly may actuate one, two, or more downhole tools and/or devices without departing from the scope of this invention.

[0026] Although a few embodiments of the disclosure have been described in detail above, those of ordinary skill in the art will readily appreciate that many modifications are possible without materially departing from the teachings of this disclosure. Accordingly, such modifications are intended to be included within the scope of this disclosure as defined in the claims.

CLAIMS

What is claimed is:

1. An actuation assembly for use with an isolation valve, the isolation valve comprising:
an actuation housing;
a mandrel disposed within the actuation housing and shiftable within the housing
to open and close the isolation valve; and
a piston assembly disposed between the housing and the mandrel, the piston
assembly comprising;
a first hydraulic chamber fluidly couplable to a first trigger;
a second hydraulic chamber fluidly couplable to the first trigger and a
second trigger;
a third hydraulic chamber fluidly couplable to the second trigger;
a close collet piston positioned between the first hydraulic chamber and
the second hydraulic chamber, the close collet piston operable to
shift the mandrel to close the isolation valve when the first trigger
is activated; and
an open collet piston positioned between the second hydraulic chamber
and the third hydraulic chamber, the open collet piston operable to
shift the mandrel to open the isolation valve when the second
trigger is activated.
2. The actuation assembly of claim 1, wherein the mandrel is coupled to the isolation
valve via a mechanical linkage and the mandrel is shiftable to actuate the isolation
valve.
3. The actuation assembly of claim 1, wherein the actuation housing, the mandrel, and
the close collet piston form the first hydraulic chamber;
the actuation housing, the mandrel, the close collet piston, and the open collet
piston form the second hydraulic chamber; and
the actuation housing, the mandrel, and the open collet piston form the third
hydraulic chamber.

4. The actuation assembly of claim 1, wherein the first hydraulic chamber and the second hydraulic chamber are in fluid communication via the first trigger; and wherein the second hydraulic chamber and the third hydraulic chamber are in fluid communication via the second trigger.
5. The actuation assembly of claim 1, wherein the first trigger and second trigger may be electronic, mechanical, hydraulic, or any combination thereof.
6. The actuation assembly of claim 1, wherein the actuation assembly shifts the isolation valve via the controlled signal applied from the surface or other suitable location.
7. The actuation assembly of claim 1, wherein prior to after actuation, the mandrel can shift within the actuation housing to actuate the isolation valve by pulling up on and pushing down a well string coupled to the mandrel.
8. The actuation assembly of claim 1, wherein the isolation valve is a ball valve element rotatably mounted in a ball section housing.
9. A completion system comprising:
 - a well string;
 - an isolation valve operatively coupled to the well string; and
 - an actuation assembly operatively coupled to the isolation valve, the actuation assembly comprising:
 - a first trigger;
 - a second trigger
 - an actuation housing;
 - a mandrel disposed within the actuation housing and shiftable within the housing to open and close the isolation valve; and
 - a piston assembly disposed between the housing and the mandrel, the piston assembly comprising:
 - a first hydraulic chamber fluidly coupled to the first trigger;
 - a second hydraulic chamber fluidly coupled to the first trigger and the second trigger;
 - a third hydraulic chamber fluidly coupled to the second trigger;

- a close collet piston positioned between the first hydraulic chamber and the second hydraulic chamber, the close collet piston operable to shift the mandrel and close the isolation valve when the first trigger is activated; and
- an open collet piston positioned between the second hydraulic chamber and the third hydraulic chamber, the open collet piston operable to shift the mandrel and open the isolation valve when the second trigger is activated.
10. The completion system of claim 9, wherein the mandrel is coupled to the isolation valve via a mechanical linkage and the mandrel is shiftable to actuate the isolation valve.
 11. The completion system of claim 9, wherein the actuation housing, the mandrel, and the close collet piston form the first hydraulic chamber;
the actuation housing, the mandrel, the close collet piston, and the open collet piston form the second hydraulic chamber; and
the actuation housing, the mandrel, and the open collet piston form the third hydraulic chamber.
 12. The completion system of claim 9, wherein the first hydraulic chamber and the second hydraulic chamber are in fluid communication via the first trigger; and wherein the second hydraulic chamber and the third hydraulic chamber are in fluid communication via the second trigger.
 13. The completion system of claim 9, wherein the first trigger and second trigger may be electronic, mechanical, hydraulic, or any combination thereof.
 14. The completion system of claim 9, wherein the actuation assembly shifts the isolation valve via the controlled signal applied from the surface or other suitable location.
 15. The completion system of claim 9, wherein prior to after actuation, the mandrel can shift within the actuation housing to actuate the isolation valve by pulling up on and pushing down a well string coupled to the mandrel.
 16. The completion system of claim 9, wherein the isolation valve is a ball valve element rotatably mounted in a ball section housing.
 17. A method of producing a well comprising:

- running a well string comprising an isolation valve and an actuation assembly into the well;
- activating a first trigger of the actuation assembly to shift a mandrel of the actuation assembly via a close collet piston of the actuation assembly positioned between a first hydraulic chamber of the actuation assembly and a second hydraulic chamber of the actuation assembly to close the isolation valve; and
- activating a second trigger of the actuation assembly to shift the mandrel via an open collet piston of the actuation assembly positioned between the second hydraulic chamber and a third hydraulic chamber of the actuation assembly to open the isolation valve.
18. The method of claim 17, wherein activating the first trigger of the actuation assembly comprising decoupling the first hydraulic chamber from the second hydraulic chamber;
- lowering the pressure within the first hydraulic chamber via the first trigger creating a differential pressure between the first hydraulic chamber and the second hydraulic chamber causing the close collet piston to shift the mandrel and close the isolation valve; and
- wherein the close collet piston disengages from the mandrel after the mandrel has shifted and the isolation valve is closed.
19. The method of claim 17, wherein activating the second trigger of the actuation assembly comprising decoupling the second hydraulic chamber from the third hydraulic chamber;
- lowering the pressure within the third hydraulic chamber via the second trigger creating a differential pressure between the second hydraulic chamber and the third hydraulic chamber causing the open collet piston to shift the mandrel and open the isolation valve; and
- wherein the open collet piston disengages from the mandrel after the mandrel has shifted and the isolation valve is opened.
20. The method of claim 17, wherein the first trigger and second trigger may be electronic, mechanical, hydraulic, or any combination thereof.

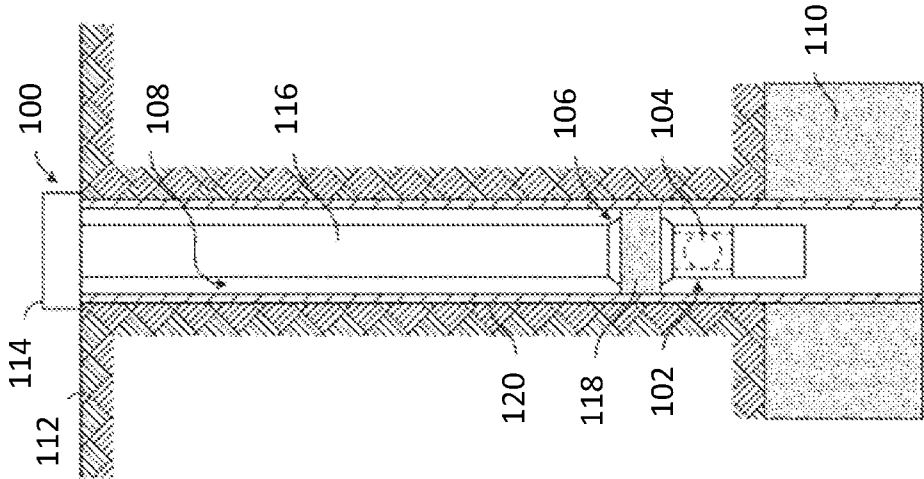


FIG. 1

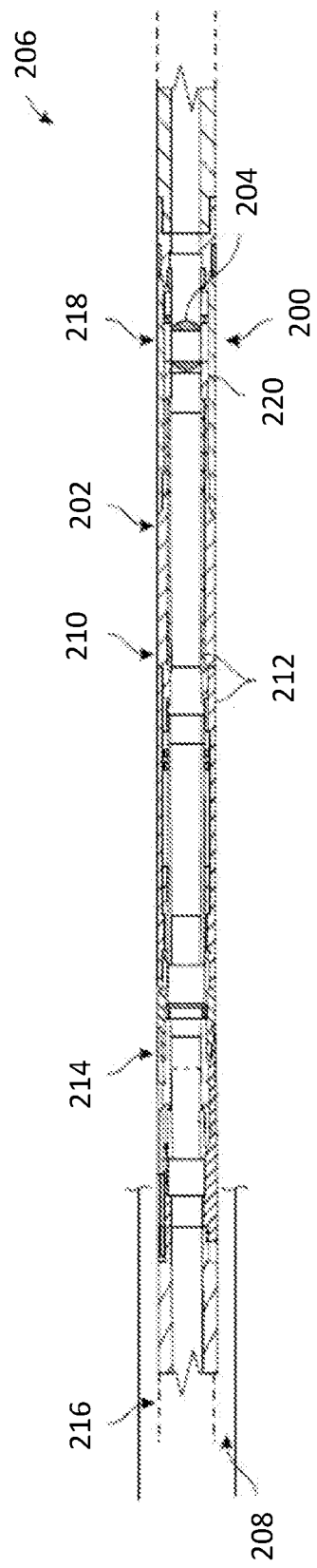
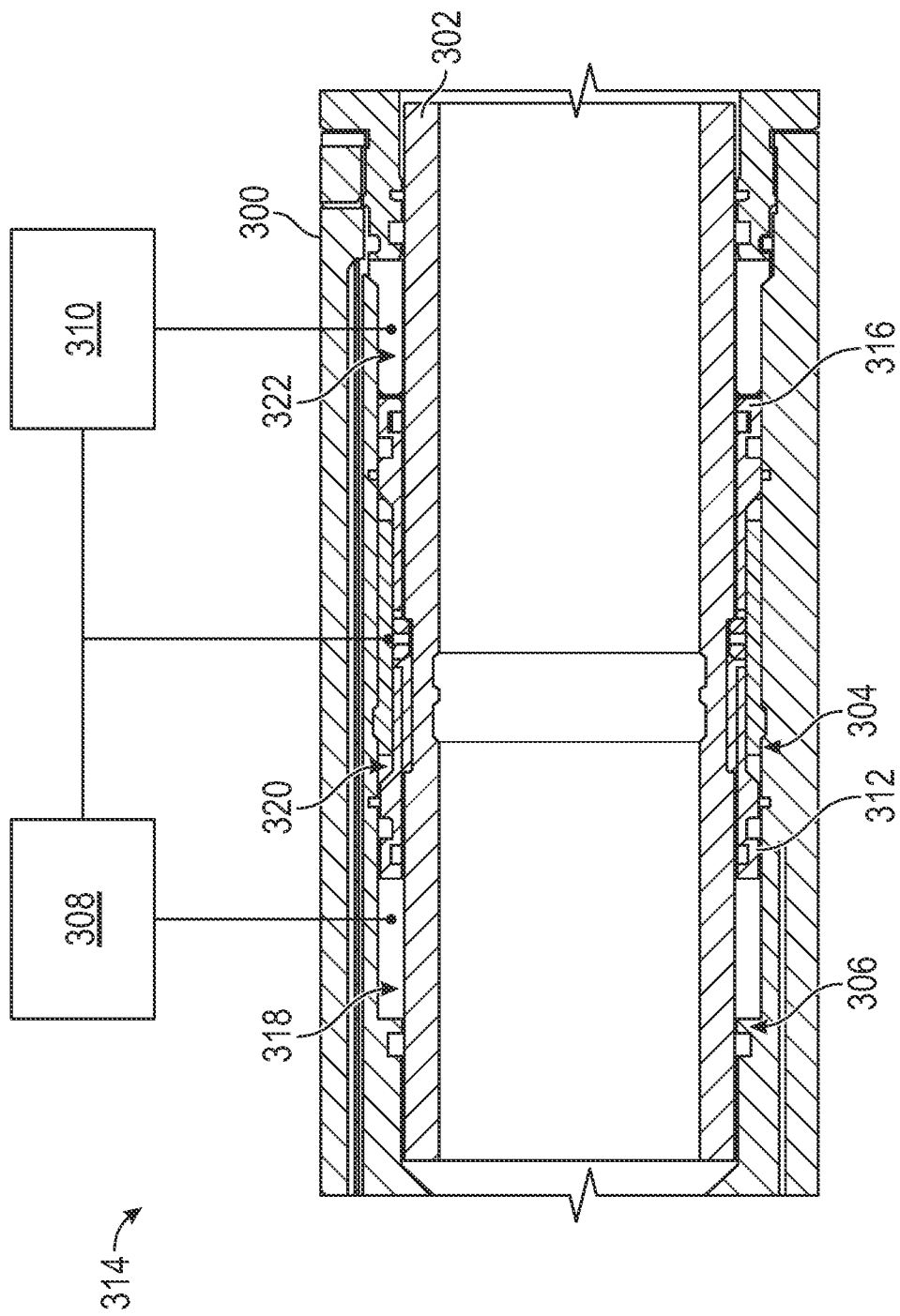


FIG. 2



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INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2023/033322

A. CLASSIFICATION OF SUBJECT MATTER E21B 34/14(2006.01)i; E21B 23/04(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 34/14(2006.01); E21B 23/00(2006.01); E21B 33/12(2006.01); E21B 34/00(2006.01); E21B 34/06(2006.01); E21B 34/08(2006.01); E21B 34/16(2006.01) 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: well, isolation valve, actuation assembly, mandrel, piston, hydraulic chamber, trigger		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2008-0066921 A1 (BANE et al.) 20 March 2008 (2008-03-20) paragraphs [0008]-[0011], [0016], claim 1 and figure 1	1-20
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A	EP 3012400 A1 (WEATHERFORD TECHNOLOGY HOLDINGS, L.L.C.) 27 April 2016 (2016-04-27) claims 1, 2 and figures 3A-3C	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 "D" document cited by the applicant in the international application "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 10 January 2024		Date of mailing of the international search report 11 January 2024
Name and mailing address of the ISA/KR Korean Intellectual Property Office 189 Cheongsa-ro, Seo-gu, Daejeon 35208, Republic of Korea Facsimile No. +82-42-481-8578		Authorized officer LEE Hun Gil Telephone No. +82-42-481-8525

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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