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ROTARY CONTROL DEVICE WITH SYSTEM FOR ACTUATING ACTIVE SEAL ELEMENT

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority to Indian Patent Application No. 202311018930, filed on March 21, 2023, the entirety of which is incorporated by reference herein.

BACKGROUND

[0001] In many oil and gas well applications, a wellbore is drilled by rotating a drill string which, in turn, rotates a drill bit so as to drill into a desired subterranean formation. To prevent unwanted release of pressure, a rotating control device may be employed as a well isolation tool. The rotating control device enables control over downhole pressures by sealing around the drill pipe during drilling of the wellbore. To achieve the seal, a passive sealing element is held against the drill pipe by a bearing assembly. However, maintaining the seal relies on the material properties and geometry of the passive sealing element. This type of structure can have a somewhat limited durability with respect to maintaining the seal.

SUMMARY

[0002] In general, a system and methodology provide a rotary control device for providing well isolation by sealing around a well pipe, e.g., a drill pipe. The rotary control device comprises a seal element and an actuation system. The actuation system is positioned to continually move the seal element against the drill pipe. As the sealing element degrades during a drilling operation, the actuation system is able to continually force the seal element against the drill pipe so as to maintain the desired seal.

[0003] 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

[0004] 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, and:

[0005] Figure 1 is an illustration of an example of a well system deployed at a wellsite and utilizing a rotary control device, according to an embodiment of the disclosure;

[0006] Figure 2 is a partial cross-sectional view of an example of the rotary control device illustrated in Figure 1, according to an embodiment of the disclosure; and

[0007] Figure 3 is a schematic view of an example of an actuation system which may be used in the rotary control device illustrated in Figure 2, according to an embodiment of the disclosure.

DETAILED DESCRIPTION

[0008] 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.

[0009] The disclosure herein generally involves a system and methodology in which a rotary control device is constructed so as to provide well isolation via improved sealing around a well pipe, e.g. a drill pipe. The rotary control device, sometimes referred to as a rotating control device, effectively serves as a well isolation tool which enables control of downhole pressure by sealing around the drill pipe or other type of rotatable well pipe. According to an embodiment, the rotary control device comprises a seal element, e.g. an elastomeric seal element, and an actuation system which is positioned to continually move the seal element against the drill pipe.

[0010] As the sealing element degrades during a drilling operation, the actuation system is able to continually force the seal element against the drill pipe so as to maintain the desired seal. In some embodiments, the seal element is allowed to rotate with the drill pipe via a sealed rotating bearing assembly. Additionally, the seal element may be utilized in combination with a guide system constructed to direct the seal element against the drill pipe in a lateral direction.

[0011] By way of example, the seal element also may be supported via a support system located between the actuation system and the seal element. During operation of the rotary control device, the actuation system continually drives the support system against the seal element which, in turn, causes the seal element to be continually biased toward the drill pipe. This bias causes the seal element to continually move against the drill pipe under force as the seal element degrades during operation of the rotary control device. The application of an external force to the seal element increases the durability of the seal and effectively continually replaces the wear region of the seal element with a new wear region.

[0012] This active sealing capability increases the reliability of the seal element and ensures the seal element is able to continue providing suitable sealing according to predetermined standards. An example of a predetermined standard requires the sealing element to work for at least 336 hours against 3000 psi of wellbore pressure. However,

many other standards may be applicable for a given location and the environment. The active sealing nature of the seal element helps ensure such standards can be met without losing well isolation.

[0013] Referring generally to Figure 1, an example of a well system 20 is illustrated as located at a wellsite 22. The wellsite 22 may include a well 24 formed by drilling a wellbore 26 down into a subterranean formation 28 to enable retrieval of desired well fluids, such as oil and/or gas. In the example illustrated, the well system 20 comprises well equipment 30 positioned above the wellbore.

[0014] Well equipment 30 may comprise various types of equipment depending on the parameters of a given drilling operation (or other well related operation). Additionally, the well equipment 30 may be selected to accommodate surface drilling operations, subsea drilling operations, or other types of well operations. By way of example, the well equipment 30 may comprise a rotary control device 32 mounted onto, for example, a blowout preventer 34. The blowout preventer 34 may be mounted on a corresponding wellhead 36 or other suitable well component. It should be noted the rotary control device 32 may be combined with various other types of equipment for use in many types of surface and subsea operations.

[0015] Referring generally to Figure 2, an example of the rotary control device 32 is illustrated partially in cross-section. In this example, the rotary control device 32 comprises a seal element 38 which extends circumferentially around a corresponding well pipe 40 and is constructed for engagement with the well pipe 40. In the illustrated embodiment, the well pipe 40 is a drill pipe. By way of example, the seal element 38 may be an elastomeric seal element formed from a suitable elastomer.

[0016] As illustrated, the rotary control device 32 also comprises a guide system 42 which directs the seal element 38 against the drill pipe 40. For example, the guide system 42 may be disposed around the drill pipe 40 and may include a guide block 44

having a curved surface 46. The curved surface 46 may be constructed and oriented to direct the seal element 38 against the drill pipe 40 in a lateral direction.

[0017] The guide block 44 may be mounted on bearings 48 which are disposed between the guide block 44 and a surrounding support structure 50. The bearings 48 enable rotational movement of the guide block 44 with respect to the stationary support structure 50. By way of example, the bearings 48 may comprise tapered roller bearings 52. However, other types of bearings 48 may be utilized. Additionally, the bearings 48 may be sealed bearings and may be contained by a retainer ring 54 or other suitable retention mechanism.

[0018] Furthermore, the rotary control device 32 may comprise an actuation system 56 which is operable to bias the seal element 38 against the well pipe/drill pipe 40. For example, the actuation system 56 may be constructed to continually move the seal element 38 against the pipe 40 as the seal element 38 degrades during operation of the rotary control device 32.

[0019] In some embodiments, a support system 58 may be positioned between the seal element 38 and the actuation system 56 to support the seal element 38. The support system 58 may comprise a composite support structure 60 coupled with the actuation system 56 via a loose connection 61, e.g. a metal-on-metal pivot connection.

[0020] According to some embodiments, the composite support structure 60 may comprise a plurality of support layers 62, including a damper layer 64. Other support layers 62 may comprise stiff support layers 66, e.g., metal support layers, and a connection layer 68 employed to form the loose connection 61. Additionally, a bearing layer 70 may be positioned between support layers 62, e.g. between stiff/metal support layers 66. It should be noted the support layers 62 may comprise continuous rings extending along the entire circumference around drill pipe 40. In other embodiments, some of the layers 62 may be intermittent rings or may comprise support sections disposed at various positions along the circumference. By way of example, the

connection layer 68 may comprise a ring, e.g. a planar, continuous metal ring engaged by the actuation system 56 at loose connection 61.

[0021] The bearing layer 70 may comprise a plurality of bearings 72. The bearings 72 enable rotational movement of the seal element 38 with respect to the stationary support structure 50 as the drill pipe 40 is rotated. By way of example, the bearings 72 may comprise tapered roller bearings. However, other types of bearings 72 may be utilized. Additionally, the bearings 72 may be sealed bearings which, in cooperation with sealed bearings 48, create a sealed rotating bearing assembly 76. The sealed rotating bearing assembly 76 allows rotation of both seal element 38 and guide system 42 with the drill pipe 40. In this example, the sealed rotating bearing assembly 76 enables such rotation relative to the stationary surrounding support structure 50.

[0022] Depending on the parameters of a given operation and/or environment, the actuation system 56 may comprise various components and structures. By way of example, the actuation system 56 comprises a screwjack system 78 having at least one screwjack 80 powered by a motor 82, e.g., an electric motor, as further illustrated in Figure 3. In the embodiment illustrated in Figure 3, the screwjack system 78 comprises a plurality of screwjacks 80, e.g. four screwjacks 80, arranged within stationary support structure 50 and around the illustrated drill pipe 40. The motors 82 may be controlled via a suitable motor controller 83.

[0023] By way of example, each screwjack 80 may comprise a screw 84 rotated within a screwjack mechanism 86 via a driving shaft 88 coupled with the corresponding motor 82. The rotating screw 84 is able to rotate against the connection layer 68 via loose connection 61. It should be noted the loose connection 61 may facilitate translation of support system 58 such that support system 58 can more effectively act as a piston against the seal element 38.

[0024] As the screw 84 is rotated relative to screwjack mechanism 86, the screw 84 moves in a linear direction against the support system 58 and thus against seal element

38. When the actuation system 56 is actuated via operation of motors 82 and screwjacks 80, the actuation system 56 continually drives the support system 58 against the seal element 38. Consequently, the seal element 38 remains biased against drill pipe 40 in a lateral direction controlled via guide block 44 of guide system 42. The curved surface 46 of guide block 44 ensures that the seal element 38 is circumferentially applying sealing pressure and maintaining sealing contact with drill pipe 40.

[0025] As the seal element 38 degrades during operation of rotary control device 32, e.g., during a drilling operation, this bias continually moves the seal element 38 tightly against the drill pipe 40 so as to maintain the desired seal and well isolation. As the drill pipe 40 rotates during the drilling operation, torque from the drill pipe is transferred to the seal element 38 which is allowed to rotate with the drill pipe 40. In fact, both the seal element 38 and the guide block 44 are allowed to rotate with the drill pipe 40 via bearings 48 and 72.

[0026] Depending on the specific well operation and well equipment, the rotary control device 32 may be used with many other types of well equipment. For example, the rotary control device 32 may be combined with various types of surface drilling equipment, subsea drilling equipment, or other types of equipment and operations utilizing rotating pipe. Additionally, the rotary control device 32 may be sized to accommodate drill pipe (or other types rotating pipe) of various diameters.

[0027] Furthermore, the rotary control device 32 may be constructed with various types of components and numbers of components. The components utilized may have different types of configurations to accommodate parameters and goals of, for example, a given drilling operation. For example, the support structure 50 may be constructed in various configurations suitable for supporting and containing at least portions of various components and systems, e.g. guide system 42, actuation system 56, and support system 58.

[0028] The bearings 48, 72 may comprise different types of bearings which are secured at desired positions via suitable retention devices. The seal element 38 may comprise various types of elastomers, composite materials, or other suitable sealing materials. The seal element 38 also may be constructed with materials having various degradation rates selected according to parameters of a specific operation.

[0029] Additionally, the guide system 42 may comprise various configurations of guide block 44 and/or other components to appropriately guide the seal element 38 against the well/drill pipe 40. The actuation system 56 may comprise various numbers of screwjacks 80 or other types of actuators able to impart the desired linear motion to the support system 58. The actuation system 56 may be powered by one or more electric motors, hydraulic motors, or other types of motive units. Additionally, the support system 58 may comprise various layers, materials, and configurations to facilitate actuation of the active sealing element 38.

[0030] 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. A system for use in isolating a well, comprising:
 - a rotary control device for providing well isolation by sealing around a drill pipe, the rotary control device comprising:
 - a seal element;
 - a guide system to direct the seal element against the drill pipe;
 - a support system to support the seal element; and
 - an actuation system engaging the support system, the actuation system being actuatable to continually drive the support system against the seal element to cause the seal element to continually move against the drill pipe as the seal element degrades during operation of the rotary control device.
2. The system as recited in claim 1, wherein the seal element comprises an elastomeric seal element.
3. The system as recited in claim 1, wherein the guide system is disposed around the drill pipe and includes a guide block having a curved surface to direct the seal element laterally against the drill pipe.
4. The system as recited in claim 3, wherein the guide block is mounted on bearings to enable rotation of the guide block.
5. The system as recited in claim 1, wherein the support system comprises a support ring coupled with the actuation system via a loose connection.
6. The system as recited in claim 5, wherein the support system further comprises a plurality of support layers and a damper layer.

7. The system as recited in claim 6, wherein the support system further comprises a bearing positioned to enable rotation of at least a portion of the support system about the drill pipe.
8. The system as recited in claim 1, wherein the actuation system comprises a screwjack powered by a motor.
9. The system as recited in claim 1, wherein the actuation system comprises a plurality of screwjacks powered by a plurality of motors.
10. The system as recited in claim 1, wherein the actuation system comprises four screwjacks powered by four motors.
11. A system, comprising:
 - a rotary control device for providing well isolation by sealing around a drill pipe, the rotary control device comprising:
 - a seal element; and
 - an actuation system positioned to continually move the seal element against the drill pipe as the seal element degrades during operation of the rotary control device, the actuation system having a plurality of screwjacks arranged to continually move the seal element.
12. The system as recited in claim 11, wherein the rotary control device further comprises a guide system to direct the seal element against the drill pipe.
13. The system as recited in claim 12, wherein the rotary control device further comprises a support system to support the seal element.
14. The system as recited in claim 13, wherein the seal element comprises an elastomeric seal element.

15. The system as recited in claim 14, wherein the guide system is disposed around the drill pipe and includes a guide block having a curved surface to direct the seal element laterally against the drill pipe.
16. The system as recited in claim 15, wherein the support system is coupled with the actuator system via a loose connection.
17. The system as recited in claim 16, wherein the support system further comprises a plurality of support layers, a damper layer, and a bearing positioned to enable rotation of at least a portion of the support system about the drill pipe.
18. A method, comprising:
 - providing well isolation via a rotary control device having a seal element mounted in a sealed rotary bearing assembly which enables rotation of the seal element with a well pipe;
 - using an actuation system to continually move the seal element against the well pipe as the seal element degrades during operation of the rotary control device; and
 - guiding the seal element to act against the well pipe in a lateral direction while the actuation system actuates in a non-lateral direction.
19. The method as recited in claim 18, wherein the step of using the actuation system comprises using a plurality of screwjacks driven by a plurality of motors.
20. The method as recited in claim 19, further comprising employing a support system positioned between the actuation system and the seal element.

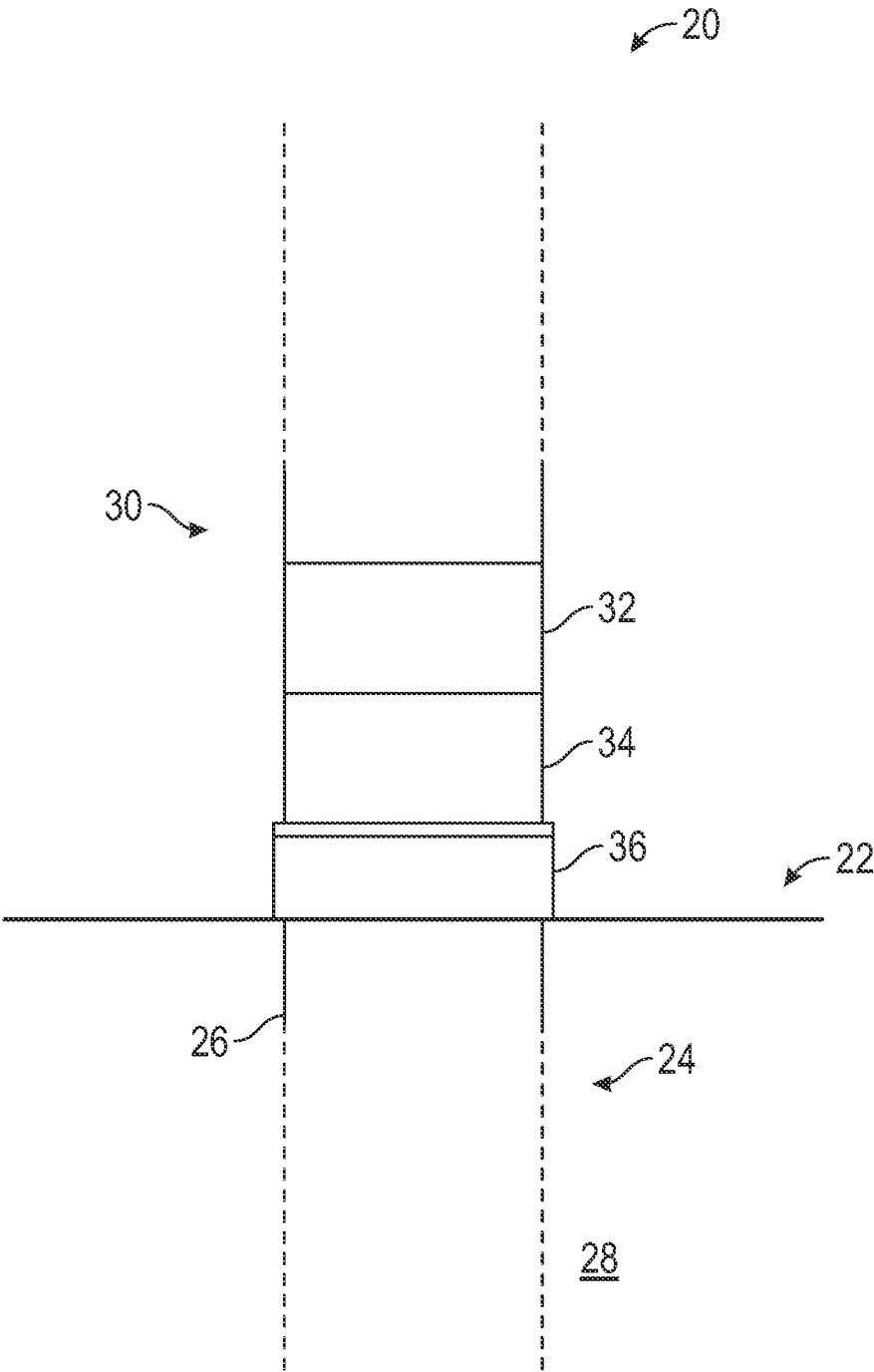


FIG. 1

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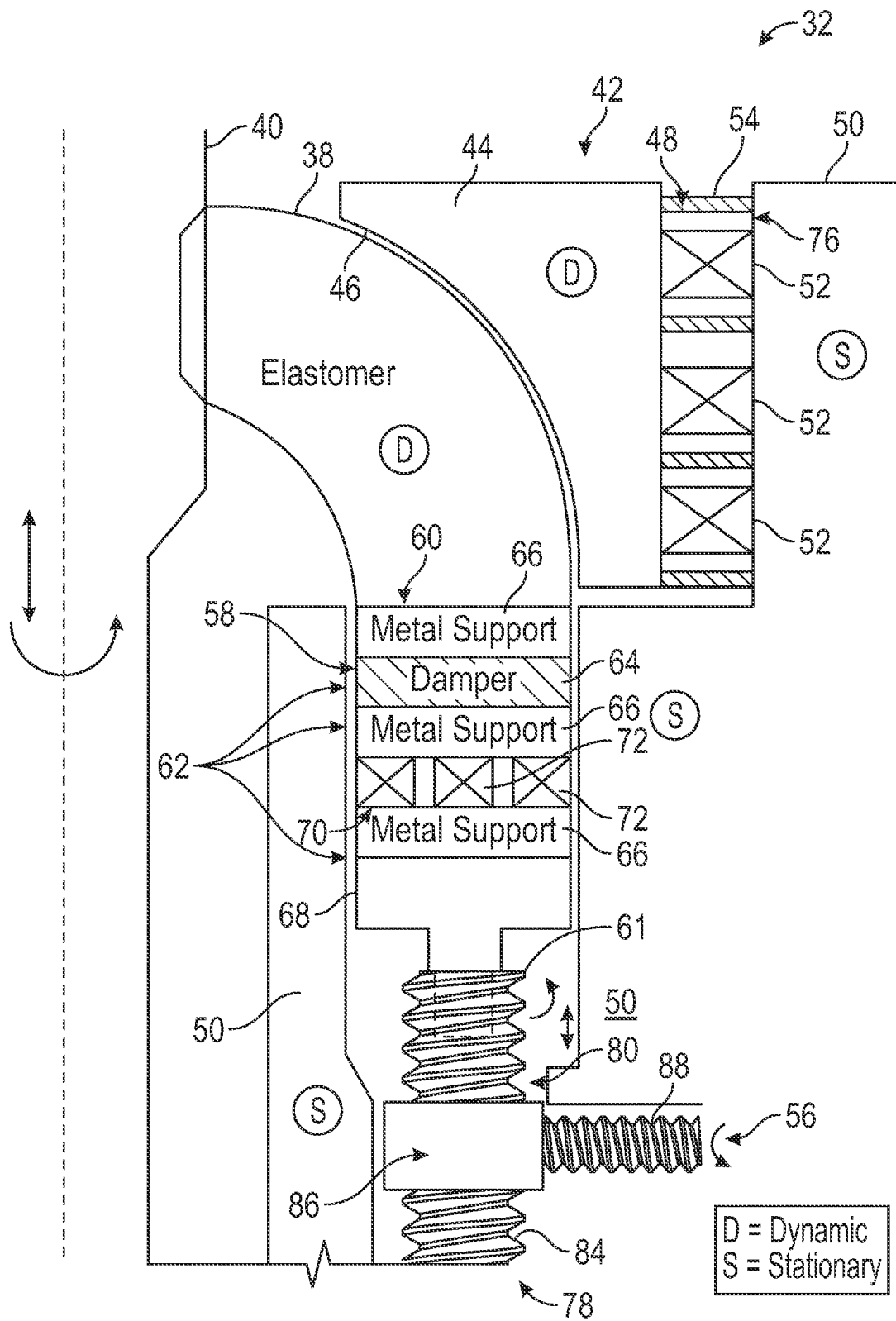


FIG. 2

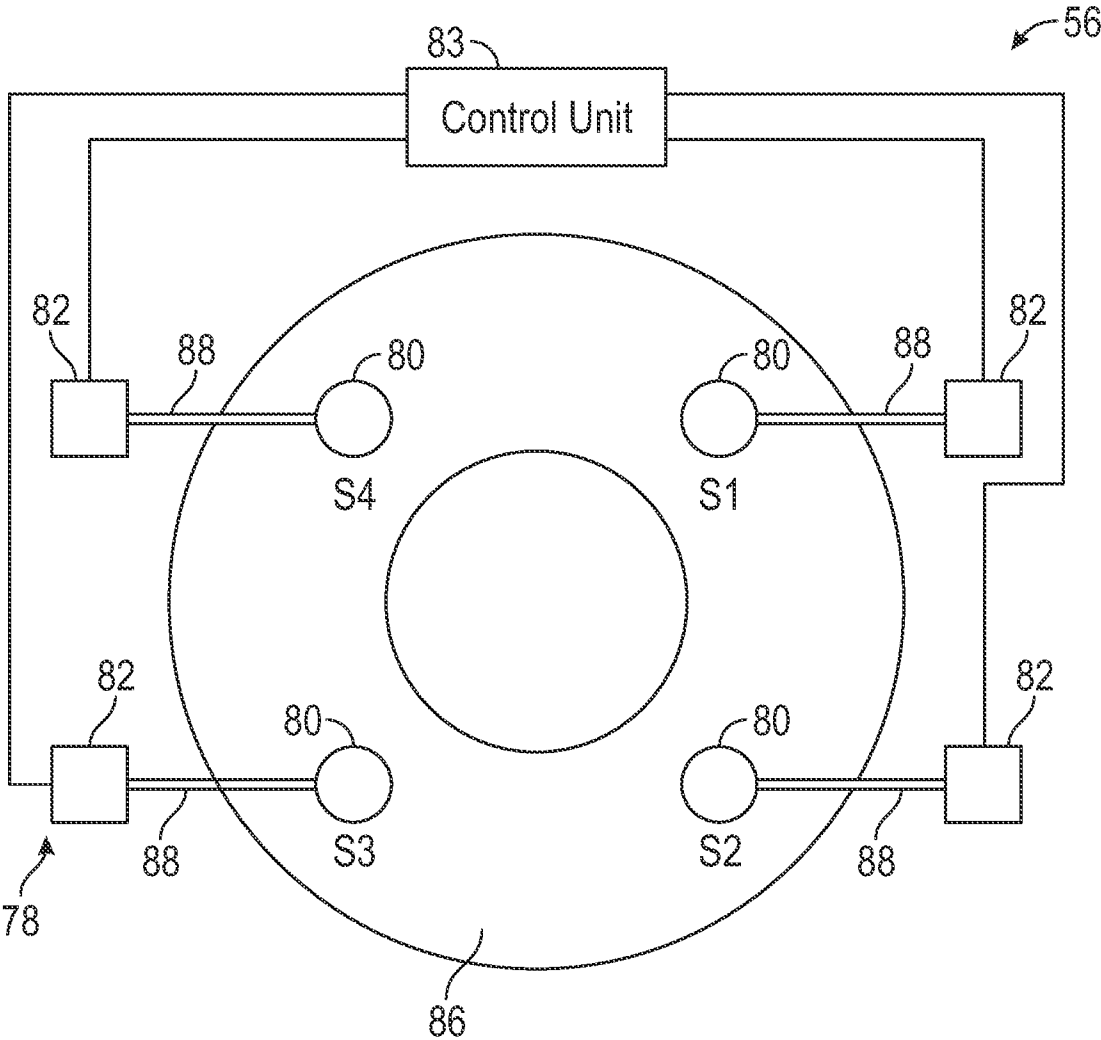


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2024/020377

A. CLASSIFICATION OF SUBJECT MATTER**E21B 33/129(2006.01)i; E21B 23/01(2006.01)i; E21B 33/12(2006.01)i; E21B 41/00(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 33/129(2006.01); E21B 17/00(2006.01); E21B 19/00(2006.01); E21B 21/06(2006.01); E21B 21/08(2006.01);
E21B 33/06(2006.01); E21B 33/08(2006.01); E21B 34/06(2006.01); E21B 47/08(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: rotary control device, seal, guide, support, actuation, screwjack, continuous, and force

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010-0012317 A1 (SHELTON, JAYE) 21 January 2010 (2010-01-21) paragraphs [0002], [0010], [0018]-[0030] and figures 2-3	1-4,18
Y		5-17,19,20
Y	US 2020-0115987 A1 (PATAGONIA PHARMACEUTICALS LLC) 16 April 2020 (2020-04-16) paragraph [0055] and figure 10	5-7,16,17
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Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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“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

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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/US2024/020377

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