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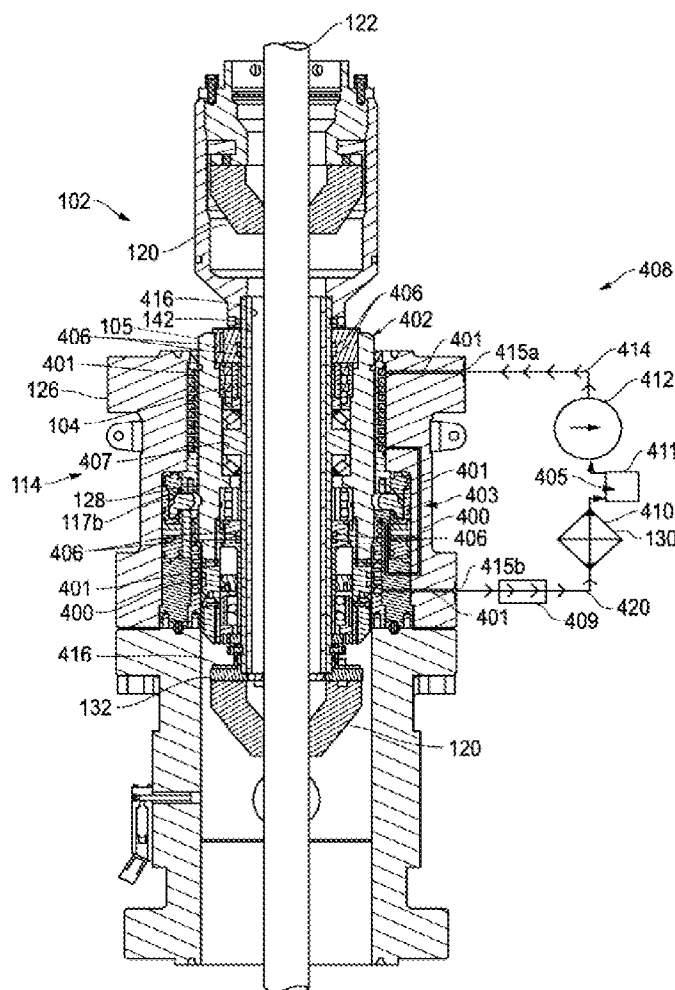
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(54)	Title	BEARING ASSEMBLY COOLING METHODS
(56)	References	
	Cited:	US 2006/0144622 A1, US 2013/0206386 A1
(57)	Abstract	

The disclosure relates to apparatus and methods for cooling a RCD at a wellbore including a bearing assembly configured for operating in the RCD. A fixed latch with a heat exchanger system and a volume of a cooling medium is configured for reducing heat proximate the bearing assembly, an inner member, and one or more seals between the bearing assembly and the inner member.



TITLE: Bearing Assembly Cooling Methods

BACKGROUND

[0001] Technical Field: The subject matter generally relates to systems and techniques in the field of oil and gas operations. Reduction of heat in rotating control devices (RCDs) improves the life of such RCDs.

[0002] When a well site is completed, pressure control equipment may be placed near the surface of the earth. The pressure control equipment may control the pressure in the wellbore while drilling, completing and producing the wellbore. The pressure control equipment may include blowout preventers (BOP), rotating control devices (RCDs), and the like. The RCD is a drill-through device with a rotating seal that contacts and seals against the drill string (drill pipe with tool joints, casing, drill collars, Kelly, etc.) for the purposes of controlling the pressure or fluid flow to the surface.

[0003] RCDs and other pressure control equipment are used in underbalanced drilling (UBD) and managed pressure drilling (MPD), which are relatively new and improved drilling techniques, and work particularly well in certain offshore drilling environments. Both technologies are enabled by drilling with a closed and pressurizable circulating fluid system as compared to a drilling system that is open-to-atmosphere at the surface. Managed pressure drilling is an adaptive drilling process used to more precisely control the annular pressure profile throughout the wellbore. MPD addresses the drill-ability of a prospect, typically by being able to adjust the equivalent mud weight with the intent of staying within a "drilling window" to a deeper depth and reducing drilling non-productive time in the process. The drilling window changes with depth and is typically described as the equivalent mud weight required to drill between the formation pressure and the pressure at which an underground blowout or loss of circulation would occur. The equivalent weight of the mud and cuttings in the annulus is controlled with fewer interruptions to drilling progress while being kept above the formation pressure at all times. An influx of

formation fluids is not invited to flow to the surface while drilling. Underbalanced drilling (UBD) is drilling with the hydrostatic head of the drilling fluid intentionally designed to be lower than the pressure of the formations being drilled, typically to improve the well's productivity upon completion by avoiding invasive mud and cuttings damage while drilling. An influx of formation fluids is therefore invited to flow to the surface while drilling. The hydrostatic head of the fluid may naturally be less than the formation pressure, or it can be induced.

[0004] The thrust generated by the wellbore fluid pressure, the radial forces on the bearing assembly within the RCD and other forces cause a substantial amount of heat to build in the conventional RCD. The heat causes the seals and bearings to wear and subsequently require repair. The conventional RCD typically requires an external cooling system that circulates fluid and utilizes various valves and hose through the seals and bearings in order to remove the heat. However, risers, used in many oilfield operations, particularly subsea operations, may pose significant obstacles to the use of external coolants, lubricants, lubricating systems and/or cooling systems.

[0005] Therefore, an improved system for cooling radial seals and the bearing section of an RCD is desired, particularly a system which is able to function in environments with or without an external control system. If the radial seals are not sufficiently cooled, the localized temperature at the sealing surface will rise until the temperature limitations of the seal material is reached and degradation of the radial seal begins. High pressure, velocity and temperature conditions at increasing lengths of time affect and reduce the length of usable life for a seal. In order to obtain sufficient life from radial seals, the rate of heat extraction should be fast enough to allow the temperature at the sealing surface to level off at a temperature lower than that of the seal material's upper limit.

[0006] US Pub. No. 2006/0144622 proposes a system and method for cooling a RCD while regulating the pressure on its upper radial seal. Gas, such as air, and liquid, such as oil, are alternatively proposed for use in a heat exchanger in the RCD. A hydraulic control system is proposed to provide fluid to energize a bladder of an active seal to seal around a drilling string and to lubricate the bearings in the RCD.

[0007] US20060144622A1, in accordance with its abstract, states "A system and method for reducing repairs to radial seals used in a rotating control head used while drilling is disclosed. Also, a system and method to detect leaks in the rotating control head and a latching system to latch the rotating control head to a housing is disclosed." US20130206386A1, in accordance with its abstract, states "A rotating control device is remotely hydraulically latched and unlatched with a docking station housing for use and removal, respectively. The system and method allows for interactive lubrication and cooling of the rotating control device, as needed, along with a supply of fluid for use with an active seal. A first sensor and a second sensor can be used to detect temperature, pressure and density of the supplied fluid at different locations and this data can be compared using a central processing unit (CPU). Also, a sensor can be used to detect the revolutions per minute of a rotating seal of the rotating control device and fluid can be provided to the rotating control device responsive to the detected revolutions per minute."

BRIEF SUMMARY

[0008] The disclosure relates to apparatus and methods for cooling a RCD at a wellbore including a bearing assembly configured for operating in the RCD. A fixed latch with a heat exchanger system and a volume of a cooling medium is configured for reducing heat proximate the bearing assembly, an inner member, and one or more seals between the bearing assembly and the inner member.

[0009] As used herein the term "RCD" or "RCDs" and the phrases "pressure control equipment", "pressure control apparatus" or "pressure control device(s)" shall refer to well related pressure control equipment/apparatus/device(s) including, but not limited to, rotating-control-device(s), active rotating control devices, blowout preventers (BOPs), and the like.

BRIEF DESCRIPTION OF THE FIGURES

[0010] The exemplary embodiments may be better understood, and numerous objects, features, and advantages made apparent to those skilled in the art by referencing the accompanying drawings. These drawings are used to illustrate only typical exemplary embodiments of this invention, and are not to be considered

limiting of its scope, for the invention may admit to other equally effective exemplary embodiments. The figures are not necessarily to scale and certain features and certain views of the figures may be shown exaggerated in scale or in schematic in the interest of clarity and conciseness.

[0011] Figure 1 depicts a schematic view of a well site having pressure control devices for sealing an item or piece of oilfield equipment.

Figure 2 depicts a cross sectional view of a pressure control device embodiment having a fixed latch with a heat exchanger therein and a heat exchanger system.

Figure 3 depicts a cross sectional view of half of a pressure control device embodiment having a carrier having a pressure reduction system and a heat exchanger profile.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENT(S)

[0012] The description that follows includes exemplary apparatus, methods, techniques, and instruction sequences that embody techniques of the inventive subject matter. However, it is understood that the described exemplary embodiments may be practiced without these specific details.

[0013] Figure 1 depicts a schematic view of a well site 100 having pressure control devices 102 for sealing a rotating drill string or other piece of oilfield equipment 122. The well site 100 may have a wellbore 106 formed in the earth and lined with a casing 108. At the Earth's surface or sea floor 110 (see, for example, US publication no, 2014/0027129 Figs. 1, 1A and 1B and accompanying description depicting exemplary schematic views of fixed offshore rig and land wellsites) the one or more pressure control devices 102 may control pressure in the wellbore 106. The pressure control devices 102 may include, but are not limited to, BOPs, RCDs, and the like. Risers 107 may be positioned above, with and/or below the pressure control devices 102. The risers 107 may present challenges to introducing lubricants, coolants, lubrication systems and/or cooling systems for the pressure control devices 102. As shown, the top pressure control device 102 is an RCD 114. A

staged seal 116 may be part of a bearing assembly 117a located in the RCD 114. The staged seal 116 may be a radial seal having a pressure reduction system 118. The pressure reduction system 118 may be a closed piston system configured to stage pressure across the staged seal 116. Further, the staged seal 116 may be configured to engage and seal an inner member 104 during oilfield operations. The inner member 104 may be any suitable, rotatable equipment to be sealed by the staged seal 116.

[0014] A pressure control device 102 is located directly below the RCD 114 (as shown) and may be a sealing device 119. The sealing device 119 may have stripper rubbers 120 for sealing against the rotating drill string or piece of oilfield equipment 122, and a bearing assembly 117b. The bearing assembly 117b includes a bearing 128. The pressure control device 102 may have a fixed latch (or RCD body) 126 configured to engage the bearing assembly 117b. The stripper rubbers 120 may engage the rotating drill string 122 as the drill string 122 is inserted into the wellbore 106. The fixed latch 126 may have a heat exchanger 130 (see Figure 2) built into the latch in order to cool the latch as will be discussed in more detail below. The RCD 114 with the staged seal 116 does not necessarily, although can be, used above or with the RCD 114 with the sealing device 119.

[0015] Figure 2 depicts a cross sectional view of the pressure control device 102 having the fixed latch 126 with a heat exchanger profile 400 therein. A bearing assembly 402 includes an outer member 105 and an inner member 104 rotatably mounted within the outer member 105. The fixed latch 126 may secure the bearing assembly 402 within the pressure control device 102. The fixed latch 126 may allow the inner member 104 to rotate relative to the fixed latch 126 as the drill string 122 is run through the pressure control device 102. As the inner member 104 rotates with or relative to the drill string 122, the motion creates friction between the inner member 104 and an inner surface 407 of the outer member 105. The friction may cause heating in both the bearing assembly 402 and the seals or shaft seals 406, which lie between the outer member 105 and the inner member 104. The increased heat decreases life span of the seals 406 and the bearing assembly 402. The bearing assembly 402 and the seals 406 may respectively be any suitable bearing assembly and seals used in the pressure control device 102 including those

described herein.

[0016] The heat exchanger profile 400 may cool the fixed latch 126, and bearing assembly 402 during operation thereby extending the life of the seals 406 and bearing assembly 402. This may further allow the bearing assembly 402 to operate or be operational with a self-contained lubricant (i.e. an integral bearing assembly 402 with lubricant without any external lubrication system or without any lubrication system running through a riser 107 to the surface). The heat exchanger profiles 400 may be fluid passages 401 through the interior surface area 403 of the fixed latch 126. The fluid passages 401 may be configured to maximize the interior surface area 403 that is cooled in the fixed latch 126. Any suitable heat exchanger shape or channel way for paths/fluid passages 401 may be used for the heat exchanger profile 400 so long as the fixed latch 126 is cooled. By way of example only, in the embodiment shown, there is one inlet 415a and one outlet 415b, to the path/fluid passages 401.

[0017] The heat exchanger profile 400 may be coupled to or integral with a heat exchanger system 408 and may cool through or from either side of the RCD 114. The heat exchanger system 408 may include, but is not limited to, a heat exchanger 410, a tank 411 for containing a volume of cooling medium or coolant 405, a pump 412, an optional separate condenser 409, and one or more conduits 414. The heat exchanger 410 may be any suitable device for cooling the fluid, a quantity or volume of cooling medium 405, circulating through the conduit 414 including, but not limited to, the exposed sea temperature on the conduit 414, a shell and tube exchanger, and the like. The pump 412 may be any suitable device for circulating the quantity of cooling medium 405 from the tank 411 through the conduit 414. The optional separate condenser 409 may be included to condense any gases or fluids after having circulated the fluid passages 401 and conduits 414. By way of example only, the optional separate condenser 409 may be located near the outlet 415b but could also be located near the inlet 415a or intermediate thereto. The pump 412 may be any suitable device for delivering the quantity of cooling medium 405 through the heat exchanger system 408 including, but not limited to, a centrifugal pump, a reciprocating pump, and the like. The quantity of cooling medium 405 may be any suitable medium for cooling the heat exchanger system 408 including, but not limited

to, water, sea water, refrigerant, refrigerant mixtures, liquids (including those that remain in a liquid state during the heat exchange process) or gasses, air, oil and/or the like.

[0018] The inner member 104 may further include an insulating coating 416 on the inner surface 142 of the inner member 104. The insulating coating 416 may be configured to reduce heat transfer from the inner surface 142 of the inner member 104 caused by heated wellbore fluids to the seals 406. This additional cooling may prevent the wear on the seals 406. By way of example only, in one embodiment, the insulating coating 416 may be made of ceramic, refractory, hard rubber, fiberglass, composite, elastomer, and/or thermal/electrical materials of suitable thickness for insulating a passage of inner member 104. In addition, the insulating coating 416 may extend to one or more surfaces on the stripper rubber mount 132 to which the stripper rubber(s) 120 are attached to.

[0019] Figure 3 depicts a cross sectional view of half of a pressure control device 102 embodiment having a carrier 500 (see US Provisional Appl. No. 61/986,544, filed on April 30, 2014) having the pressure reduction system 118 and in the heat exchanger profile 400. The carrier 500 as shown is configured to support a seal element 502 for engaging the drill string 122. The seal element 502 may be configured to seal drill string 122 as the drill pipe is run into or out of the wellbore 106 (as shown in Figure 1). The carrier 500 may be located below, above or within the bearing assembly 117 of an RCD 114. In one embodiment, the pressure reduction system 118 may operate in the same manner as described in US Provisional Appl. No. 61/986,544, in order to apply pressure to the outer radial surface 504 of the seal element 502. In another embodiment, the pressure reduction system 118 may be controlled by a hydraulic unit or controller in order to maintain the pressure on the outer radial surface 504 of the seal element 502.

[0020] The heat exchanger profile 400 may operate in the same manner as described in conjunction with Figure 2. To this end, the heat exchanger profile 400 may be a part of the heat exchanger system 408 and have the heat exchanger 410, the pump 412 and the conduit 414 (as shown in Figure 2). A carrier inlet 510 and a carrier outlet (not pictured) may continue or extend the heat exchanger profiles 400 from the fixed latch 126 into the carrier 500 (or from another heat exchanger profile

400 independent of the fixed latch 126), allowing the cooling medium 405 to circulate through the carrier 500. The heat exchanger profile 400 in the carrier 500 may reduce the heat in the carrier 500 and thereby reduce the temperature of the volume of fluid 303 applying pressure to the seal element 502. Further, the carrier 500 may have a layer of insulating coating 506 on the carrier's surfaces 508 (by way of example on the outer or exterior surface) to help reduce heat transfer caused by heated wellbore fluids. The decreased temperature applied to the seal element 502 may reduce wear and increase the life of the seal element 502.

[0021] In addition, the heat exchanger system 408, heat exchanger profile 400, and carrier 500 may be a closed hydraulic control system 420, thereby eliminating the need for an external cooling system to control the temperature of the pressure control device 102. A closed hydraulic system 420 may relieve demand on limited resources, and further, addresses difficulty in installing and maintaining an external cooling system in extreme environments. Risers 107, used in subsea operations, may also pose significant obstacles to the use of external cooling systems.

[0022] While the exemplary embodiments are described with reference to various implementations and exploitations, it will be understood that these exemplary embodiments are illustrative and that the scope of the inventive subject matter is not limited to them. Many variations, modifications, additions and improvements are possible. For example, although the exemplary embodiments have thus far been depicted and described with a closed hydraulic control system 420, the exemplary embodiments described within may also be utilized in conjunction with an open or external hydraulic control system. Further, the implementations and techniques used herein may be applied to any strippers, seals, or packer members at the well site, such as the BOP, and the like.

[0023] Plural instances may be provided for components, operations or structures described herein as a single instance. In general, structures and functionality presented as separate components in the exemplary configurations may be implemented as a combined structure or component. Similarly, structures and functionality presented as a single component may be implemented as separate components.

CLAIMS:

1. An apparatus for reducing heat in a pressure control device (102) in a wellbore, comprising:
 - a fixed latch (126) which secures a bearing assembly (402) within the pressure control device (102);
 - a heat exchanger system (408); and
 - a volume of cooling medium (405) housed within the fixed latch (126) and the heat exchanger system (408), wherein the volume of cooling medium (405) is configured for removing and absorbing heat from the pressure control device (102), characterized in that
 - an interior surface (403) of the fixed latch (126) defines one or more fluid passages (401) for cooling the fixed latch (126); and
 - the heat exchanger system (408) in fluid communication with the fluid passage (401).
2. The apparatus of claim 1, wherein the heat exchanger system (408) further comprises
 - a heat exchanger (410) in the heat exchanger system (408), wherein the heat exchanger (410) is configured for cooling the volume of cooling medium (405); and
 - one or more conduits (414) in the heat exchanger system (408), wherein the one or more conduits (414) is configured for circulating the volume of cooling medium (405) therethrough.
3. The apparatus of claim 2, further comprising
 - an inlet port (415a) connected to the fluid passage (401); and an outlet port (415b) connected to the fluid passage (401).

4. The apparatus of claim 2, further comprising
a condenser (409) in the heat exchanger system (408), wherein the
condenser (409) is configured to condense the volume of
cooling medium (405).
5. The apparatus of claim 4, wherein the heat exchanger system
(408) further comprises
a pump (412) configured to circulate the volume of cooling medium
(405) through the fluid passage (401) and the conduit (414).
6. The apparatus of claim 5 further comprising
a bearing assembly (117b, 402) housed within the fixed latch (126); and
an inner member (104) housed within the bearing assembly (117b, 402),
wherein the inner member (104) is configured to rotate relative to
the bearing assembly (117b, 402), and further wherein the inner
member (104) includes an insulating coating (416) on an inner
surface (142) of the inner member (104).
7. The apparatus of claim 6, wherein the insulating coating (416) is an
insulating ceramic coating.
8. The apparatus of claim 7, further comprising
a carrier (500) mounted to the pressure control device (102), wherein the
fluid passages (401) extend to a surface (508) of the carrier (500);
and further wherein the surface (508) of the carrier (500) has an
insulating coating.
9. The apparatus of claim 8, further comprising one or more seals (406)
situated between the inner member (104) and the bearing assembly (117b,

402).

10. The apparatus of claim 1, wherein the fluid passages (401) and the heat exchanger system (408) are a closed hydraulic system.
11. An apparatus for reducing heat in a pressure control device (102), comprising:
 - an inner member (104) housed within a bearing assembly (117b, 402), wherein the inner member (104) is configured to rotate with a drill string (122) running through the pressure control device (102) one or more seals (406) situated between the inner member (104) and the bearing assembly (117b, 402);
 - a fixed latch (126) configured to secure the bearing assembly (117b, 402) within the pressure control device (102), wherein the inner member (104) is configured to rotate relative to the bearing assembly (117b, 402) and the fixed latch (126), and characterized in that
 - the fixed latch (126) defines a first heat exchanger profile (400) located within the fixed latch (126) configured to allow a quantity of cooling medium (405) to circulate through the fixed latch (126) thereby cooling the bearing assembly (117b, 402), the inner member (104), and the seals (406) during operation.
12. The apparatus of claim 11, further comprising an insulating coating (416) on an inner surface (142) of the inner member (104).
13. The apparatus of claim 11, further comprising:
 - a seal element (502) for engaging the drill string (122);
 - a carrier (500) mounted to the bearing assembly (117b, 402), wherein the carrier (500) is configured to secure the seal element (502) within the pressure control device

(102); and

wherein the carrier (500) defines a second heat exchanger profile (400) located within the carrier (500), and wherein the second heat exchanger profile (400) is configured to allow a quantity of cooling medium (405) to circulate through the pressure control device (102) thereby cooling the seal element (502) during operation.

14. The apparatus of claim 13 wherein the carrier (500) has an exterior carrier surface (508); and further comprising a layer of insulating coating (506) on the exterior carrier surface (508).
15. A method for reducing heat proximate a pressure control device (102), comprising the steps of:
 - securing a bearing assembly (117b, 402) within the pressure control device (102) with a fixed latch (126);
 - rotating an inner member (104) housed within the bearing assembly (117b, 402); circulating a quantity of cooling medium (405) through a heat exchanger system (408); and
 - delivering the quantity of cooling medium (405) through a heat exchanger profile (400) of the fixed latch (126) connected to the heat exchanger system (408), characterized in that the heat exchanger profile (400) is defined on an interior surface of a fixed latch (126) for exchanging heat generated by the inner member (104) rotating within the bearing assembly (117b, 402).
16. The method according to claim 15, further comprising the steps of:
 - removing the quantity of cooling medium (405) from the heat exchanger profile (400); and
 - repeating the steps of circulating, delivering and removing.

17. The method according to claim 15, further comprising the step of insulating the inner member (104) with a ceramic coating (416) on an inner surface (142) of the inner member (104).
18. The method according to claim 15, wherein the heat exchanger profile (400) is further connected to a carrier (500) supporting a seal element (502), and further comprising the steps of
insulating the carrier (500) with a layer of ceramic coating (506) on a surface of the carrier (500);
reducing heat in the carrier (500); and
reducing heat of a volume of fluid (303) applying pressure to the seal element (502).
19. The method according to claim 15 further comprising the step of condensing the quantity of cooling medium (405).
20. The method according to claim 15 further comprising the step of reducing a temperature experienced by a seal (406) located between the inner member (104) and the outer member (105).

P a t e n t k r a v

1. Apparat for å redusere varme i en trykkrollanordning (102) i et brønnhull, omfattende:
 - en fast sperre (126) som fester en lagersammenstilling (402) inni trykkrollanordningen (102);
 - et varmevekslersystem (408); og
 - et volum av kjølemedium (405) anbrakt inni den faste sperren (126) og varmevekslersystemet (408), hvori volumet av kjølemedium (405) er konfigurert for å fjerne og absorbere varme fra trykkrollanordningen (102),
k a r a k t e r i s e r t v e d a t
en innvendig overflate (403) på den faste sperren (126) definerer én eller flere fluidpassasjer (401) for å kjøle den faste sperren (126); og
varmevekslersystemet (408) er i fluidkommunikasjon med fluidpassasjen (401).
2. Apparatet ifølge krav 1, hvori varmevekslersystemet (408) videre omfatter
 - en varmeveksler (410) i varmevekslersystemet (408), hvori varmeveksleren (410) er konfigurert for å kjøle volumet av kjølemedium (405); og
 - én eller flere ledninger (414) i varmevekslersystemet (408), hvori den ene eller flere ledningene (414) er konfigurert for å sirkulere volumet av kjølemedium (405) derigjennom.
3. Apparatet ifølge krav 2, videre omfattende
 - en innløpsport (415a) forbundet med fluidpassasjen (401); og
 - en utløpsport (415b) forbundet med fluidpassasjen (401).
4. Apparatet ifølge krav 2, videre omfattende
 - en kondensator (409) i varmevekslersystemet (408), hvori kondensatoren (409) er konfigurert til å kondensere volumet av kjølemedium (405).

5. Apparatet ifølge krav 4, hvori varmevekslersystemet (408) videre omfatter
en pumpe (412) konfigurert til å sirkulere volumet av kjølemedium (405)
gjennom fluidpassasjen (401) og ledningen (414).
6. Apparatet ifølge krav 5, videre omfattende
5 en lagersammenstilling (117b, 402) anbrakt inni den faste sperren (126);
og
et indre element (104) anbrakt inni lagersammenstillingen (117b, 402),
hvor det indre elementet (104) er konfigurert til å rotere relativt til
lagersammenstillingen (117b, 402), og videre hvori det indre elementet (104)
10 inkluderer et isolerende belegg (416) på en indre overflate (142) på det indre
elementet (104).
7. Apparatet ifølge krav 6, hvori det isolerende belegget (416) er et isolerende
keramisk belegg.
8. Apparatet ifølge krav 7, videre omfattende
15 en bærer (500) montert til trykkrollanordningen (102), hvori
fluidpassasjene (401) strekker seg til en overflate (508) av bæreren (500); og
videre hvori overflaten (508) på bæreren (500) har et isolerende belegg.
9. Apparatet ifølge krav 8, videre omfattende én eller flere tetninger (406)
beliggende mellom det indre elementet (104) og lagersammenstillingen (117b,
20 402).
10. Apparatet ifølge krav 1, hvori fluidpassasjene (401) og varmevekslersystemet
(408) er et lukket hydraulisk system.
11. Apparat for å redusere varme i en trykkrollanordning (102), omfattende:
et indre element (104) anbrakt inni en lagersammenstilling (117b, 402),
25 hvori det indre elementet (104) er konfigurert til å rotere med en borestreng
(122) som løper gjennom trykkrollanordningen (102) én eller flere tetninger
(406) beliggende mellom det indre elementet (104) og lagersammenstillingen
(117b, 402);

en festet sperre (126) konfigurert til å feste lagersammenstillingen (117b, 402) inni trykkrollanordningen (102), hvori det indre elementet (104) er konfigurert til å rotere relativt til lagersammenstillingen (117b, 402) og den faste sperren (126), og

5 k a r a k t e r i s e r t v e d a t

den faste sperren (126) definerer en første varmevekslerprofil (400) beliggende inni den faste sperren (126) konfigurert til å tillate en mengde av kjølemedium (405) å sirkulere gjennom den faste sperren (126) for derved å kjøle lagersammenstillingen (117b, 402), det indre elementet (104) og tetningene (406) under drift.

12. Apparatet ifølge krav 11, videre omfattende et isolerende belegg (416) på en indre overflate (142) av det indre elementet (104).

13. Apparatet ifølge krav 11, videre omfattende

et tetningselement (502) for inngrep med borestrengen (122);

15 en bærer (500) montert til lagersammenstillingen (117b, 402), hvori bæreren (500) er konfigurert til å feste tetningselementet (502) inni trykkrollanordningen (102); og

hvor bæreren (500) definerer en andre varmevekslerprofil (400) beliggende inni bæreren (500), og hvori den andre varmevekslerprofilen (400) er konfigurert til å tillate en mengde av kjølemedium (405) å sirkulere gjennom trykkrollanordningen (102) for derved å kjøle tetningselementet (502) under drift.

14. Apparatet ifølge krav 13, hvori bæreren (500) har en utvendig bæreroverflate (508); og videre omfattende et lag av isolerende belegg (506) på den utvendige bæreroverflaten (508).

15. Fremgangsmåte for å redusere varme nær en trykkrollanordning (102), omfattende trinnene:

å feste en lagersammenstilling (117b, 402) inni trykkrollanordningen (102) med en fast sperre (126);

å rotere et indre element (104) anbrakt inni lagersammenstillingen (117b, 402);

å sirkulere en mengde kjølemedium (405) gjennom varmevekslersystemet (408); og

5 å levere mengden kjølemedium (405) gjennom en varmevekslerprofil (400) av den faste sperren (126) forbundet til varmevekslersystemet (408),
k a r a k t e r i s e r t v e d at varmevekslerprofilen (400) er definert på en innvendig overflate av en fast sperre (126) for å utveksle varme generert av de indre elementet (104) som roterer inni lagersammenstillingen (117b, 402).

- 10 16. Fremgangsmåten ifølge krav 15, videre omfattende trinnene:
 å fjerne mengden av kjølemedium (405) fra varmevekslerprofilen (400); og
 å gjenta trinnene med å sirkulere, levere og fjerne.
- 15 17. Fremgangsmåten ifølge krav 15, videre omfattende trinnet å isolere det indre elementet (104) med et keramisk belegg (416) på en indre overflate (142) av det indre elementet (104).
18. Fremgangsmåten ifølge krav 15, hvori varmevekslerprofilen (400) videre er forbundet med en bærer (500) som støtter et tetningselement (502), og videre omfattende trinnene:
 å isolere bæreren (500) med et lag av keramisk belegg (506) på en
20 overflate av bæreren (500);
 å redusere varme i bæreren (500); og
 å redusere varme i et volum av fluid (303) som påfører trykk til tetningselementet (502).
- 25 19. Fremgangsmåten ifølge krav 15, videre omfattende trinnet å kondensere mengden av kjølemedium (405).
20. Fremgangsmåten ifølge krav 15, videre omfattende trinnet
 å redusere en temperatur opplevd av en tetning (406) plassert mellom det indre elementet (104) og det ytre elementet (105).

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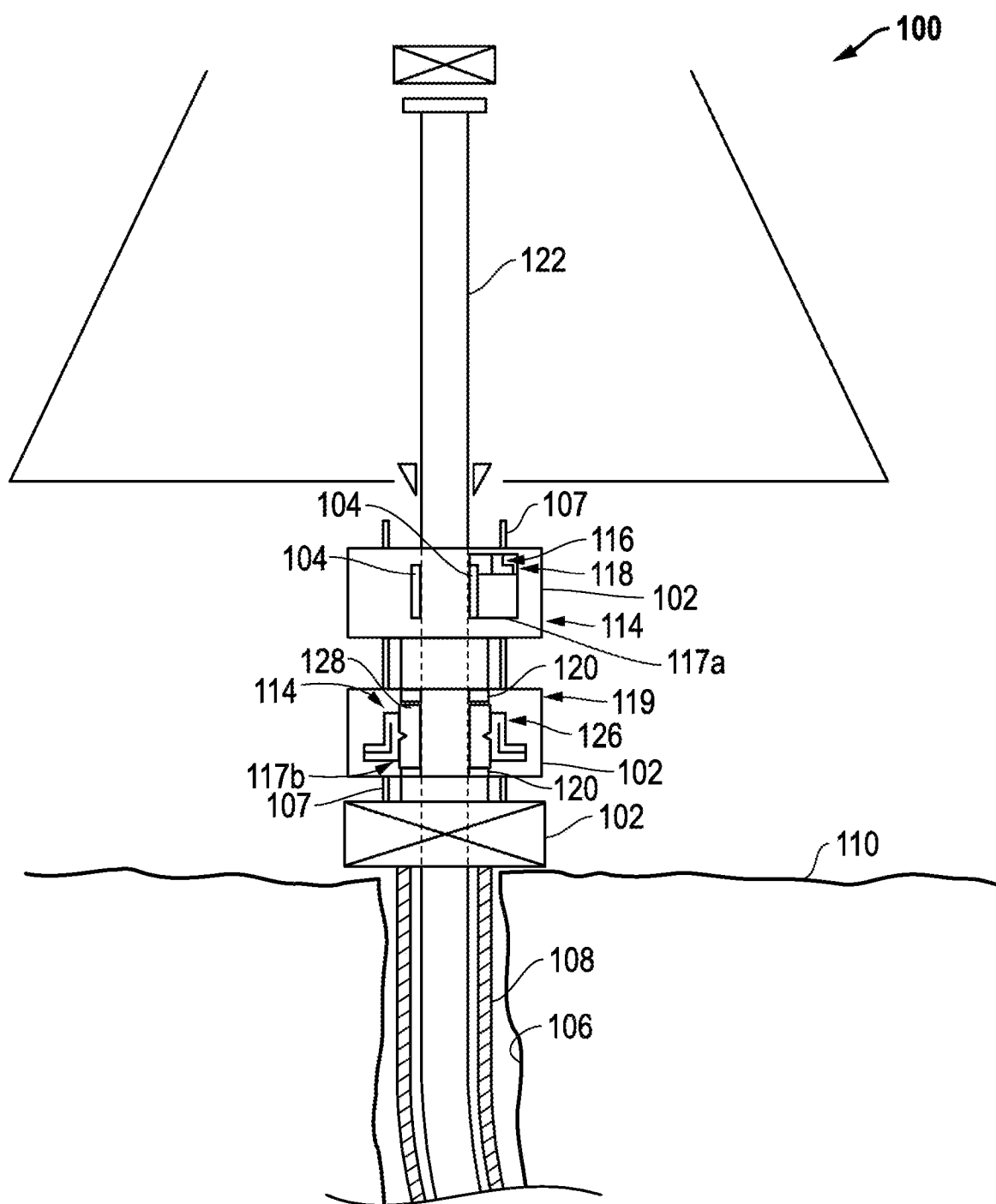


FIG. 1

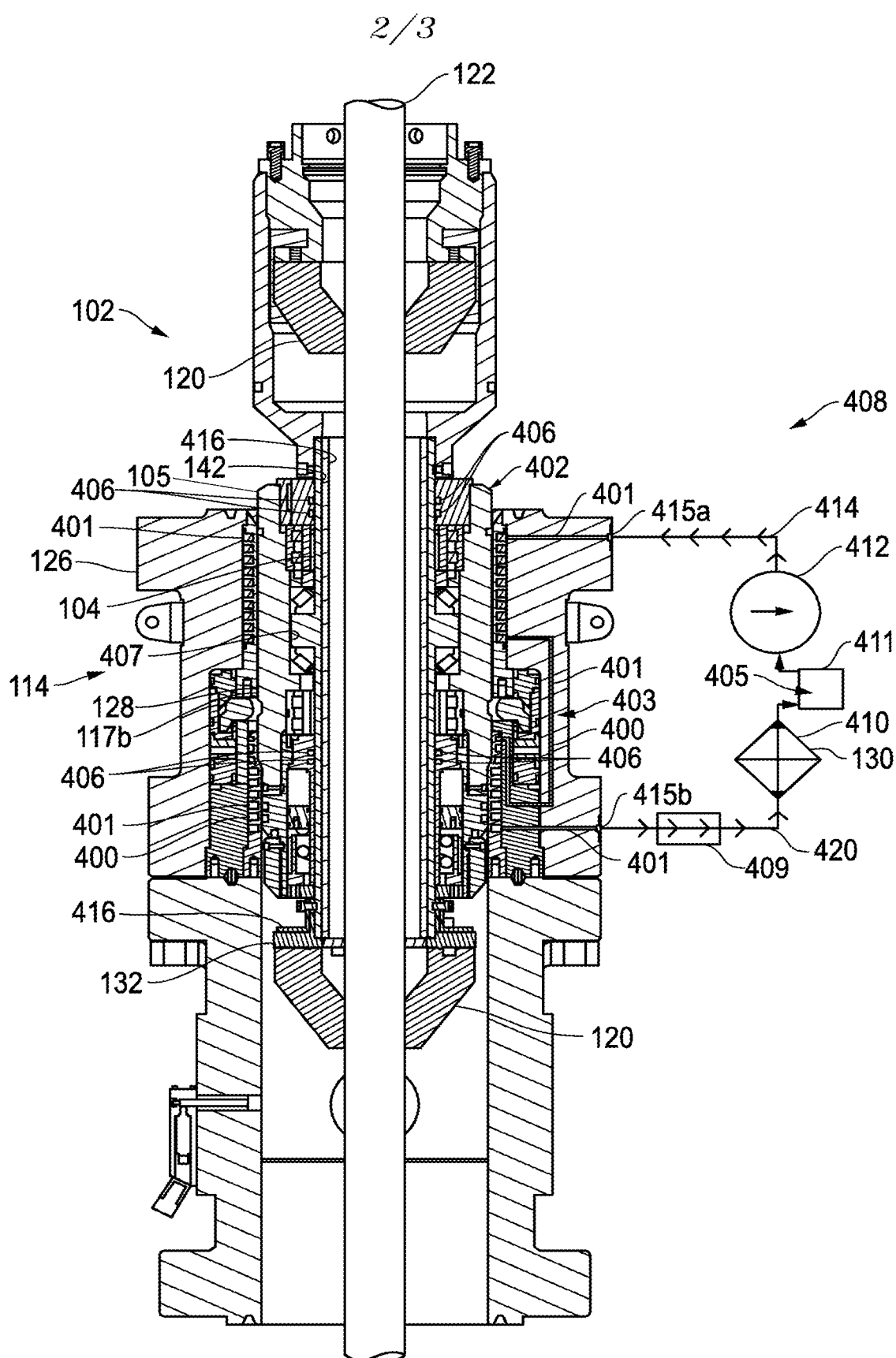


FIG. 2

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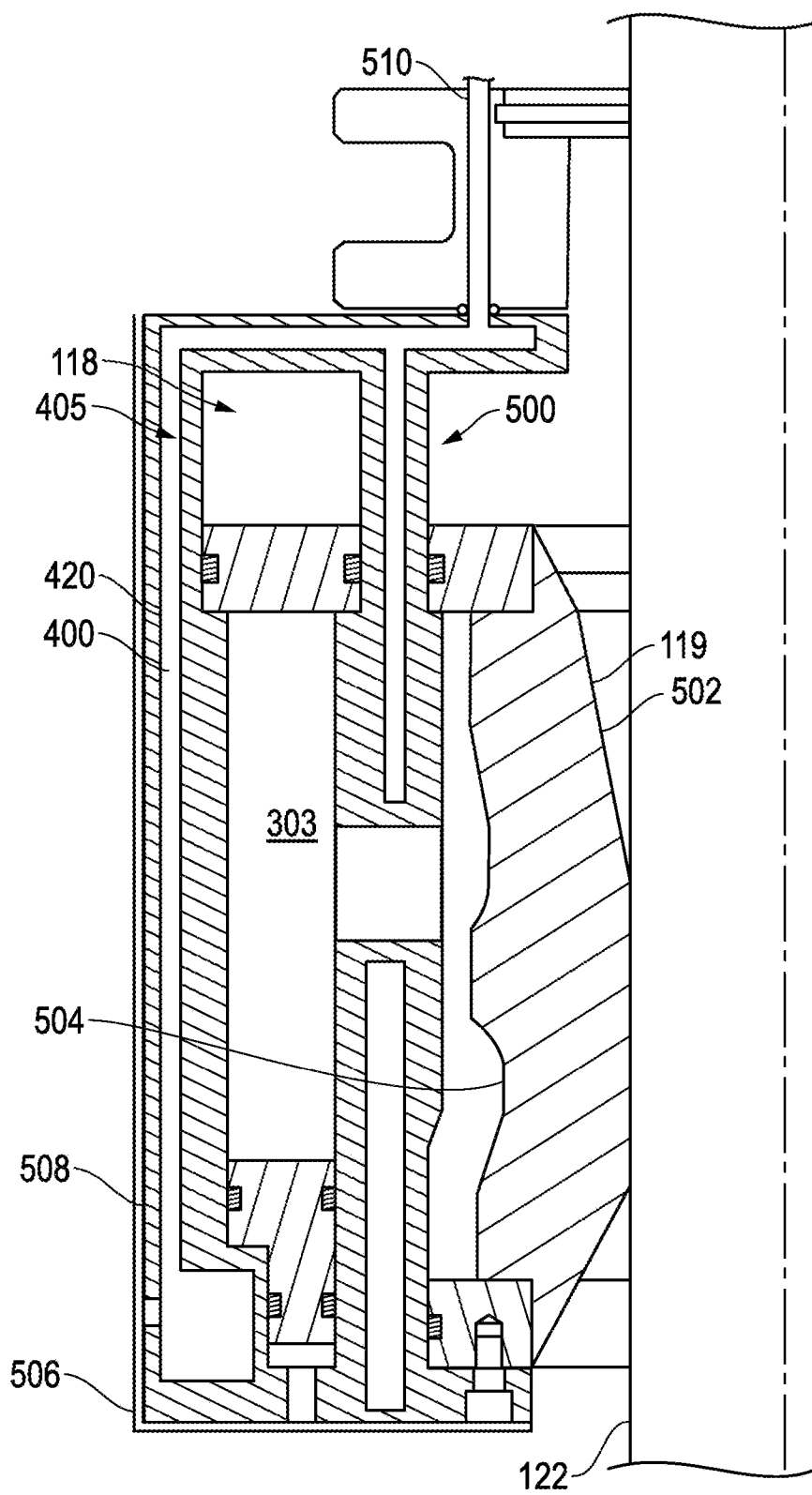


FIG. 3