(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
23 December 2004 (23.12.2004)

PCT

(10) International Publication Number
WO 2004/111379 A2

(51) International Patent Classification[7]: E21B

(21) International Application Number: PCT/US2004/017146

(22) International Filing Date: 1 June 2004 (01.06.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/453,885 3 June 2003 (03.06.2003) US

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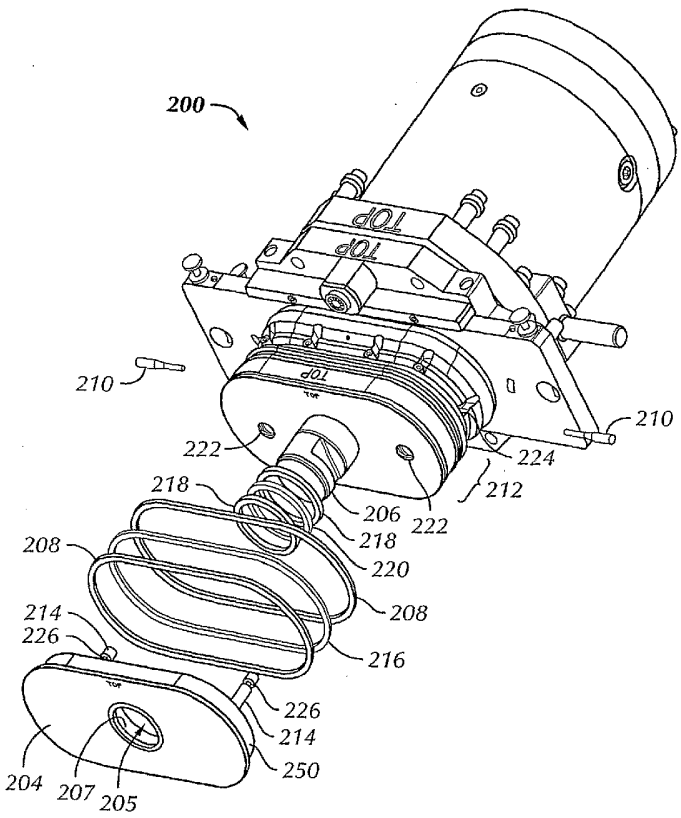
(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH,

[Continued on next page]

(54) Title: REMOVABLE SEAL CARRIER FOR BLOWOUT PREVENTER BONNET ASSEMBLY



(57) Abstract: A bonnet assembly for a blowout preventer uses a seal carrier that is removable so as to allow for efficient and easy seal replacement. The seal carrier has: a recess adapted to at least partially embed a seal for sealing the bonnet assembly to a body of the blowout preventer; and a first connecting rod coupled to and extending from an inner surface of the seal carrier, where the first connecting rod has a fastening structure proximal to a distal end of the first connecting rod, where the fastening structure is adapted to engage with a first fastening device, and where the seal carrier is removable from the bonnet assembly when the first fastening device is disengaged from the fastening structure.

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GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

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— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for all designations*

Published:

— *without international search report and to be republished upon receipt of that report*

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REMOVABLE SEAL CARRIER FOR BLOWOUT PREVENTER BONNET ASSEMBLY

Background of Invention

Field of the Invention

[0001] The present invention relates generally to blowout preventers used in the oil and gas industry. More particularly, the present invention relates to a removable seal carrier for a blowout preventer bonnet assembly.

Background Art

[0002] Well control is an important aspect of oil and gas exploration. When drilling a well in, for example, oil and gas exploration applications, devices must be put in place to prevent injury to personnel and equipment associated with drilling activities. One such well control device is known as a blowout preventer (BOP).

[0003] Blowout preventers are generally used to seal a wellbore. For example, drilling wells in oil or gas exploration involves penetrating a variety of subsurface geologic structures, or "layers." Generally, each layer is of a specific geologic composition such as, for example, shale, sandstone, limestone, etc. Each layer may contain trapped fluids or gas at different formation pressures, and the formation pressures increase with increasing depth. The pressure in the wellbore is generally adjusted to at least balance the formation pressure by, for example, increasing a density of drilling mud in the wellbore or increasing pump pressure at the surface of the well.

[0004] There are occasions during drilling operations when a wellbore may penetrate a layer having a formation pressure substantially higher than the pressure maintained in the wellbore. When this occurs, the well is said to have "taken a kick." The pressure increase associated with this "kick" is generally

produced by an influx of formation fluids (which may be a liquid, a gas, or a combination thereof) into the wellbore. The relatively high pressure "kick" tends to propagate from a point of entry in the wellbore uphole (from a high pressure region to a low pressure region). If the "kick" is allowed to reach the surface, drilling fluid, well tools, and other drilling structures may be blown out of the wellbore. These blowouts often result in catastrophic destruction of the drilling equipment (including, for example, the drilling rig) and in substantial injury or death to rig personnel.

[0005] Because of the risk of such blowouts, blowout preventers are typically installed at the surface or on the sea floor in deep water drilling water arrangements so that "kicks" may be adequately controlled and circulated out of the system. Blowout preventers may be activated to effectively seal in a wellbore until active measure can be taken to control a "kick." There are several types of blowout preventers, the most common of which are annular blowout preventers and ram-type blowout preventers.

[0006] Annular blowout preventers typically use annular elastomer "packers" that may be activated by, for example, inflation, to encapsulate drillpipe and well tools and completely seal the wellbore. The second type of common blowout preventer is the ram-type blowout preventer. Ram-type blowout preventers typically are formed by a body and at least two bonnet assemblies disposed on the body and opposite of each other with respect to a circumference or perimeter of the body.

[0007] Figure 1 shows an example of a ram-type blowout preventer **10**. The blowout preventer **10** is formed by a body **12** and oppositely disposed bonnet assemblies **14**. The blowout preventer **10** further includes a plurality of side openings **20** that are each adapted to be coupled to a bonnet assembly **14**.

[0008] Figure 1 shows a bonnet assembly **14** that may be secured to the body **12** using a radial lock mechanism to allow for maintenance access. A radial

lock mechanism for blowout preventers is disclosed in U.S. Patent No. 6,554,247, which is assigned to the assignee of the present invention and is incorporated herein by reference in its entirety. Figure 1 also shows bonnet assemblies **14** that are coupled to the blowout preventer body **12** by a slidable coupling. A slidable coupling is disclosed in U.S. Patent No. 6,510,897, which is assigned to the assignee of the present invention and is incorporated herein by reference in its entirety. Alternatively, in other typical blowout preventer designs, bonnet assemblies are generally secured to a body of the blowout preventer about the circumference of the body with, for example, bolts.

[0009] Inside of a bonnet assembly is a piston actuated ram. The rams may either be pipe rams, which, when activated, move to engage and surround drillpipe and well tools to seal the wellbore, or shear rams, which, when activated, move to engage and physically shear any drillpipe or well tools in the wellbore. The rams, whether pipe-type or shear-type, are typically located opposite of each other and typically seal against one another proximate a center of the wellbore in order to completely seal the wellbore.

[0010] As with any tool used in drilling oil and gas wells, blowout preventers must be regularly maintained. For example, a blowout preventer uses high pressure seals between bonnet assemblies and the body of the blowout preventer. Figure 2 shows a prior art bonnet assembly **100**. The bonnet assembly **100** includes a face **103** that is engaged with a corresponding face of a blowout preventer body (e.g., **12** in Figure 1) when the bonnet assembly **100** is installed on the blowout preventer. The bonnet face **103** includes a face seal **105** that seals the high pressure inside the blowout preventer body (e.g., **12** in Figure 1) and the bonnet assembly **100**.

[0011] The high pressure seals in many instances are elastomer seals. The elastomer seals must be regularly checked to ensure that the elastomer has not been cut, permanently deformed, or deteriorated by, for example, chemical reaction with the drilling fluid in the wellbore. Moreover, it is often desirable

to replace seals to ensure that the bonnet will be properly sealed in the event of a kick. Therefore, it is important that the blowout prevent bonnet include components that are easily removable so that seals may be easily accessed, checked, maintained, and replaced.

Summary of Invention

[0012] According to one aspect of one or more embodiments of the present invention, a seal carrier for a bonnet assembly of a blowout preventer comprises: a first recess adapted to at least partially embed a seal for sealing the bonnet assembly to a body of the blowout preventer; and a first connecting rod coupled to and extending from an inner surface of the seal carrier, where the first connecting rod has a fastening structure proximal to a distal end of the first connecting rod, where the fastening structure is adapted to engage with a first fastening device, and where the seal carrier is removable from the bonnet assembly when the first fastening device is disengaged from the fastening structure.

[0013] According to one aspect of one or more embodiments of the present invention, a seal carrier for a bonnet assembly of a blowout preventer comprises a first seal plate and a second seal plate. The first seal plate has: a first recess adapted to at least partially embed a seal for sealing the bonnet assembly to a body of the blowout preventer; and a first connecting rod coupled to and extending from an inner surface of the seal carrier, where the first connecting rod has a fastening structure proximal to a distal end of the first connecting rod, where the fastening structure is adapted to engage with a first fastening device, and where the first seal plate is removable from the bonnet assembly when the first fastening device is disengaged from the fastening structure. The second seal plate has: a second recess adapted to at least partially embed a second seal for sealing the bonnet assembly to the body of

the blowout preventer; and a seal plate coupling means for coupling the second seal plate to the first seal plate.

[0014] Other aspects and advantages of the invention will be apparent from the following description and the appended claims.

Brief Description of Drawings

[0015] Figure 1 shows a prior art blowout preventer.

[0016] Figure 2 shows a prior art blowout preventer bonnet assembly.

[0017] Figure 3 shows a blowout preventer bonnet assembly in accordance with an embodiment of the present invention.

[0018] Figure 4 shows an exploded view of the blowout preventer bonnet assembly shown in Figure 3.

[0019] Figure 5 shows a cut-away top view of a blowout preventer bonnet assembly in accordance with an embodiment of the present invention.

[0020] Figure 6 shows a cross-sectional blowup view of a portion of the cut-away top view shown in Figure 5.

[0021] Figure 7 shows a side cross-section view of a portion of a blowout preventer bonnet assembly in accordance with an embodiment of the present invention.

[0022] Figure 8 shows a side cross-section view of a portion of a blowout preventer bonnet assembly in accordance with an embodiment of the present invention.

Detailed Description

[0023] Embodiments of the present invention relate to a blowout preventer having a bonnet assembly with a removable seal carrier (also referred to as "removable seal plate"). Seals for sealing the bonnet assembly to a body of the

blowout preventer are mounted on the removable seal carrier, where the removable seal carrier is connected to a load block (or mating portion) of the bonnet assembly with a connector that is securable by a fastening device inserted into the load block (or mating portion) and through an aperture in the connector.

[0024] The use of a removable seal carrier as shown and discussed in the embodiments of the present invention below aids drilling personnel to maintain a blowout preventer by allowing them to replace, in addition to other blowout preventer components, consumable seals that seal a bonnet assembly to a body of the blowout preventer with minimal time, effort, and resources.

[0025] Figure 3 shows an exemplary seal carrier **204** for a blowout preventer bonnet assembly **200** in accordance with an embodiment of the present invention. The seal carrier is disposed on a proximal end of a ram block attachment portion **202** of the bonnet assembly **200.** About the perimeter of the removable seal carrier **204** are mounted seals **208** for effectively sealing the bonnet assembly **200** to a side opening (not shown) of a body (not shown) of the blowout preventer. Those skilled in the art will appreciate that the removable seal carrier **204** may be used to mount any number and type of seals **208**.

[0026] In an inner perimeter (not shown) of the removable seal carrier **204** are located seals (not shown) for sealing against a ram block actuator piston **206.** These seals will be described in more detail below with respect to Figure 4.

[0027] As will be described further below, the removable seal carrier **204** is secured to the remaining portion of the bonnet assembly **200** with fastening devices **210** that extend into a load block portion **212** of the ram block attachment portion **202** of the bonnet assembly **200**.

[0028] Figure 4 shows an exploded view of the removable seal carrier **204** shown in Figure 3. The removable seal carrier **204** includes a connecting

means **214** for connecting the removable seal carrier **204** to the load block portion **212** of the bonnet assembly **200**. The connecting means **214** extend from an inner surface of the seal carrier **204**. In one embodiment of the present invention, the connecting means **214** are connecting rods. Moreover, as shown in Figure 4, the connecting means **214** may protrude from and be permanently affixed to the removable seal carrier **204**. However, in one or more other embodiments of the present invention, the connecting means **214** may not be permanently affixed to the removable seal carrier **204**.

[0029] In some embodiments, such as the one shown in Figure 4, the fastening devices **210** are locking pins that are inserted into the load block **212** and engage with the connection means **214**. This engagement between the fastening devices **210** and the connecting means **214** is further described below with reference to Figures 6–8.

[0030] The removable seal carrier **204** is adapted so as to allow seals **208** to be positioned around a recess **250** of the removable seal carrier **204**. Moreover, in one or more embodiments of the present invention, a seal spacer **216** may be positioned in between seals **208**.

[0031] As shown in Figure 4, the seal carrier **204** also includes a center opening **205** to enable the ram block actuator piston **206** to move in and out of the bonnet assembly **200**. The center opening **205** includes an inner perimeter **207**, on which inner seals **218** and an optional seal spacer **220** are be positioned. The inner seals **218** seal the outer surface of a portion of the ram block actuator piston **206** against the high pressure of a kick.

[0032] As shown in Figure 4, the load block portion **212** of the bonnet assembly **200** may be provided with apertures **222** adapted to receive and at least partially house the connecting means **214**. Moreover, the load block portion **212** is provided with apertures **224** adapted to receive and at least partially house fastening devices **210**.

[0033] Although not shown in Figure 4 (but discussed below with reference to Figures 5–8), when the removable seal carrier **204** is fastened and secured to the bonnet assembly **200**, the fastening devices **210** extend into the load block portion **212** and engage with a locking (or "fastening") structure **226** provided in the connecting means **214**. In the embodiment shown, the locking structure **226** comprises a conferential groove near the distal end of the connecting means **226**. When the fastening devices **210** are in an unfastened positioned, or otherwise disengaged from the load block portion **212** of the bonnet assembly **200**, the connecting means **214** affixed to the removable seal carrier **204** may be slid out from the apertures **222**, thereby allowing for the removal of the removable seal carrier **204** from the bonnet assembly **200**.

[0034] A removable seal carrier **204** in accordance with one or more embodiments of the present invention can be easily removed from the bonnet **200** for maintenance and replacement. Removal of the fastening devices **210** will uncouple the connection means **214** from the bonnet **200**, and the seal carrier **204** can then be removed for maintenance.

[0035] Further, in one or more embodiments of the present invention, the removable seal carrier **204** may be implemented with a flat plate with machined recesses for mounting the seals **208**. In such embodiments, the connecting means **214** may be integral with the plate and extend from a flat surface of the flat plate. The flat plate mates against a flat surface of the load block portion **212** such that fastening devices **210** may extend into the load block portion **212** and through apertures **226** in connecting means **214** that are inserted into the load block portion **212**.

[0036] Figure 5 shows a top view of a cut-away of an exemplary removable seal carrier **204** in accordance with an embodiment of the present invention. Inner seals **218** are shown positioned in recessed surface **207** of the seal carrier **204** and axially held in place between a lip **211** of the seal carrier **204** and the bonnet **200**. The inner seals **218** seal the ram block actuator piston **206** against

the high pressure experienced during a kick.

[0037] Figure 6 shows a cross-sectional blowup view of a portion of the top view cut-away shown in Figure 5. The removable seal carrier **204** has a recess **250** for the positioning of seals **208** and a seal spacer **216**. The seals **208** and seal spacer **216** are axially retained in place between a lip **251** of the seal carrier **204** and a mating surface **230** on the load block **232** of the bonnet assembly (**200** in Figure 5).

[0038] The seal carrier **204** also includes a flat surface **228** that is mated against a mating surface **230** of a load block **232** (e.g., load block portion **212** shown in Figure 4). The connecting means comprises at least one connecting rod **234** that is used to secure an engagement between the mating surfaces **228**, **230**. As shown in Figure 6, a longitudinal axis of the connecting rod **234** is substantially perpendicular to a plane of flat surface **228** and flat surface **230**.

[0039] In some embodiments, the seal carrier **204** includes a female threaded connector **229** so that the connecting rod **234**, which may include a male threaded connector *id*, may be threadingly engaged with the seal carrier **204**. Other methods of coupling a connecting rod **234** to a seal carrier **204** (e.g., welding) may be used without departing from the scope of the invention. Those having ordinary skill in the art will be able to devise other methods for coupling a connecting rod to a seal carrier.

[0040] The connecting rod **234** is provided with an groove **240** adapted to engage with a fastening device. In Figure 6, the fastening device comprises at least one locking pin **238**. When the seal carrier **204** is connected to the bonnet (**200** in Figure 5), the portion of the connecting rod **234** provided with groove **240** is positioned inside the load block **232** of the bonnet (**200** in Figure 5) such that the locking pin **238** may extend into the load block **232** and engage with groove **240** of the connecting rod **234**.

[0041] As shown in Figure 6, the aperture **242** adapted to receive and at least

partially house the connecting rod **234** intersects an aperture **248** adapted to receive and at least partially house the locking pin **238**. More particularly, a longitudinal axis of aperture **242** is substantially perpendicular to a longitudinal axis of aperture **248**.

[0042] Moreover, as shown in Figure 6, in one or more embodiments of the present invention, the seal carrier **204** may be used with a bonnet (**200** in Figure 5) that includes a radial lock **246** and a radial lock displacement device **236**. This type of bonnet locking mechanism is described in U.S. Patent No. 6,554,247, which is assigned to the assignee of the present invention and has been incorporated by reference herein. In such embodiments, the locking pin **238** extends through a portion of the radial lock displacement device **236** into the load block **232** of the bonnet (**200** in Figure 5) and the aperture **242** and through the groove **240** in the connecting rod **234**.

[0043] Figure 7 shows a side cross-section view of a portion of an exemplary seal carrier **204** in accordance with an embodiment of the present invention. The seal carrier **204** is coupled to a load block **232** of a bonnet (**200** in Figure 5). A connecting rod **234** is coupled to the seal carrier **204** (e.g., threaded connection), and it extends into an aperture **242** in the load block **232**. Figure 7 shows one embodiment of an engagement between a connection rod **234** and a locking pin **238** that is positioned in the load block **234**.

[0044] As shown in Figure 7, the aperture **248** for the locking pin **238** partially intersects the aperture for the connecting rod **234**. Thus, when inserted, the upper half of the locking pin **238** engages with the load block **232** of the bonnet (**200** in Figure 5) and the lower half of the locking pin **238** engages with the circumferential groove **240** in the connecting rod **234**.

[0045] In some embodiments, it may be desirable for the locking pin **238** to be located substantially on the axial centerline **233** of the load block **232**, when the locking pin **238** in inserted into the load block **232**. In one embodiment, shown

in Figure 7, the aperture **248** for the locking pin **238** is positioned on the axial centerline **233** of the load block **232**. Thus, the aperture **242** for the connecting rod **234** must be located slightly above or below (below in Figure 7) the axial centerline **233** of the load block **232**. In this configuration, the locking pin **238** may be inserted at the axial centerline **233** of the load block **232** and engage with both the load block **232** and the connecting rod **234**.

[0046] When maintenance or inspection of a seal is required, the locking pins (e.g. **238** in Figure 7) associated with the seal carrier may be removed from the grooves (e.g., **240** in Figure 7) by pulling them out of the apertures (e.g., **248** in Figure 7) in the load block **232**. Once the connecting rods (e.g., **234** in Figure 7) are uncoupled from the locking pins, the seal carrier **204** may be removed from the bonnet.

[0047] Figure 8 shows another exemplary embodiment of a seal carrier **404** in accordance with the present invention. The seal carrier **404** includes two seal plates, a first seal plate **405** and a second seal plate **406**. The seal plates **405**, **406** are coupled together to form the seal carrier **404**.

[0048] The first seal plate **405** is coupled to the load block **432** of the bonnet (not shown) with a connection rod **434**. A first sealing element **411** is positioned in a recess **424** of the first seal plate **405**, and the first sealing element **411** is axially held in place by the load block **432** and a lip **425** of the first seal plate **405**.

[0049] A second seal plate **406** is coupled to the first seal plate **405** with a seal plate connecting means **423**. In the embodiment shown in Figure 8, the seal plate connection means **423** is a bolt that is coupled to the second seal plate **406** and threaded into the first seal plate **405**. In the embodiment shown in Figure 8, the seal plate connecting means **423** is coupled to the second seal plate **406** by a bolt recess **421** in the second seal plate **406**. A seal plate connecting means **423** may be oriented in a opposite direction, so that it is coupled to the

first seal plate **405** by a bolt recess and to the second seal plate **406** by a threaded connection. Also, other seal plate connecting means (e.g., clips) may be devised without departing from the scope of the invention.

[0050] A second sealing element **412** is positioned in a recess **426** of the second seal plate **406**, and the second sealing element **412** is axially held in place by the lip **425** of the first seal plate **405**, and a lip **427** on the second seal plate **406**.

[0051] In the embodiment shown in Figure 8, the connecting rod **434** includes an aperture **440** in which a locking pin **438** may be positioned. The connecting rod **434** is inserted into an aperture **442** in the load block **432** that is positioned substantially along the axial centerline **433** of the load block **432**. The locking pin **438** is inserted into the load block **432** and through the aperture **440** in the connecting rod **434**.

[0052] As shown in Figure 8, neither the connecting rod **434** nor the seal plate connecting means **423** penetrated all the way through a seal plate. This arrangement enables the use of connecting rods and seal plate connecting means, without the need for additional sealing mechanisms to seal the penetrations through the seal plates.

[0053] Although not shown in cross-sections of Figures 7 and 8, it will be understood that a seal plate in accordance with some embodiments will include a center opening (see, e.g., **205** in Figure 4) and the associated seals.

[0054] Those skilled in the art will understand that, in one or more other embodiments of the present invention, the seal plates may be used to mount any number and type of seals. Further, those skilled in the art will understand that additional seal plates may be coupled to the first and second seal plates **405**, **406** shown in Figure 8. The invention is not intended to be limited by the number of seal plates used in any particular embodiment.

[0055] Also, those skilled in the art will understand that the embodiment of the present invention shown in Figures 7 and 8 are shown without particular bonnet

assembly components for purposes of illustrative clarity. For example, it will be understood that a seal plate in accordance with some embodiments will include a center opening (see, e.g., **205** in Figure 4) and the associated seals so that a ram block actuator piston may move into and out of the bonnet.

[0056] Advantages of the present invention may include one or more of the following. In one or more embodiments of the present invention, because a BOP bonnet assembly seal carrier is secured to the bonnet assembly by fastening devices that can be easily removed, the seal carrier is removable from the bonnet assembly, thereby allowing for quick, easy, and efficient seal replacement and/or maintenance.

[0057] In or more embodiments, because a seal carrier of a BOP bonnet assembly is fastened in the bonnet assembly by easily removable a small number of fastening devices, the seal carrier may be removed without the need for removing multiple components between the seal carrier and a portion mated to the seal carrier.

[0058] In one or more embodiments, because a seal carrier of a BOP bonnet assembly is easily removable, seals for sealing the bonnet assembly to a body of the BOP are not limited to elastomer, or similar, seals. In one or more embodiments, because a seal carrier is easily removable from a bonnet assembly of a BOP, rams may be efficiently replaced and/or maintained.

[0059] In one or more embodiments, the invention includes one or more seal plates that do not have any penetrations though the seal plates. Advantageously, these seal plates will not require additional sealing that would accompany the leak paths created by a penetration.

[0060] While the invention has been described with respect to a limited number of embodiments, those skilled in the art, having benefit of this disclosure, will appreciate that other embodiments can be devised which do not depart from the scope of the invention as disclosed herein. Accordingly, the scope of the

invention should be limited only by the attached claims.

Claims

What is claimed is:

[1] A seal carrier for a bonnet assembly of a blowout preventer, comprising:

a first recess adapted to at least partially embed a seal for sealing the bonnet assembly to a body of the blowout preventer; and

a first connecting rod coupled to and extending from an inner surface of the seal carrier, the first connecting rod having a fastening structure proximal to a distal end of the first connecting rod, wherein the fastening structure is adapted to engage with a first fastening device,

wherein the seal carrier is removable from the bonnet assembly when the first fastening device is disengaged from the fastening structure.

[2] The seal carrier of claim 1, further comprising a second connecting rod coupled to and extending from the inner surface of the seal carrier, the second connecting rod having a fastening structure proximal to a distal end of the second connecting rod, wherein the fastening structure is adapted to engage with a second fastening device, and wherein the seal carrier is removable from the bonnet assembly when the second fastening device is disengaged from the fastening structure.

[3] The seal carrier of claim 1, wherein the fastening structure is a circumferential groove.

[4] The seal carrier of claim 1, wherein the fastening structure is an aperture.

[5] The seal carrier of claim 1, wherein the fastening device is a locking pin.

[6] A seal carrier for a bonnet assembly of a blowout preventer, comprising:

a first seal plate having:

a first recess adapted to at least partially embed a seal for sealing the bonnet assembly to a body of the blowout preventer,

a first connecting rod coupled to and extending from an inner surface of the seal carrier, the first connecting rod having a fastening structure proximal to a distal end of the first connecting rod, wherein the fastening structure is adapted to engage with a first fastening device, and

wherein the first seal plate is removable from the bonnet assembly when the first fastening device is disengaged from the fastening structure,

a second seal plate having:

a second recess adapted to at least partially embed a second seal for sealing the bonnet assembly to the body of the blowout preventer; and

a seal plate coupling means for coupling the second seal plate to the first seal plate.

[7] The seal carrier of claim 6, wherein the seal plate connecting means is a bolt.

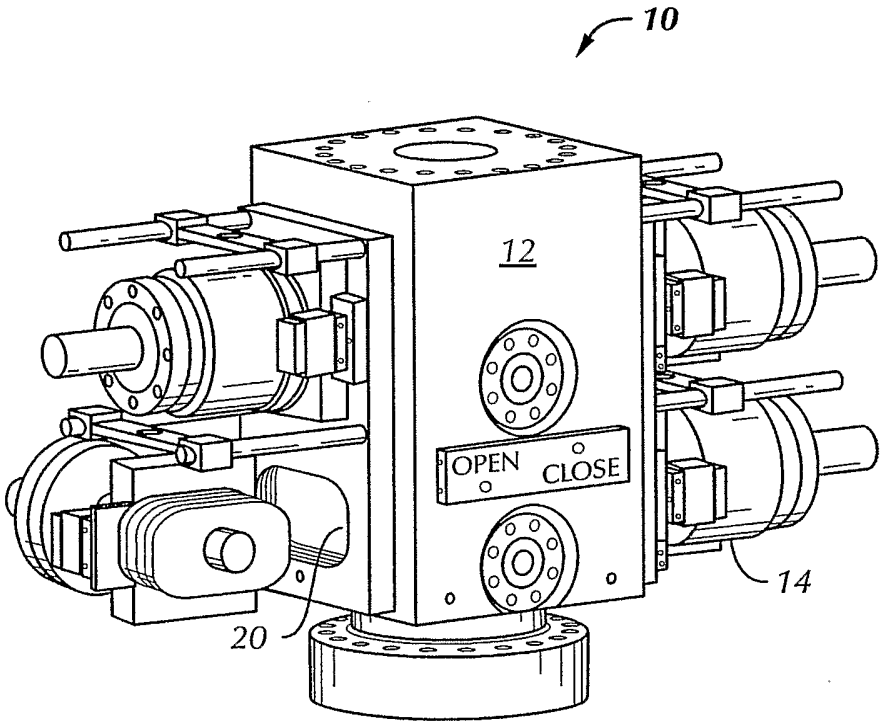

FIG. 1
(Prior Art)

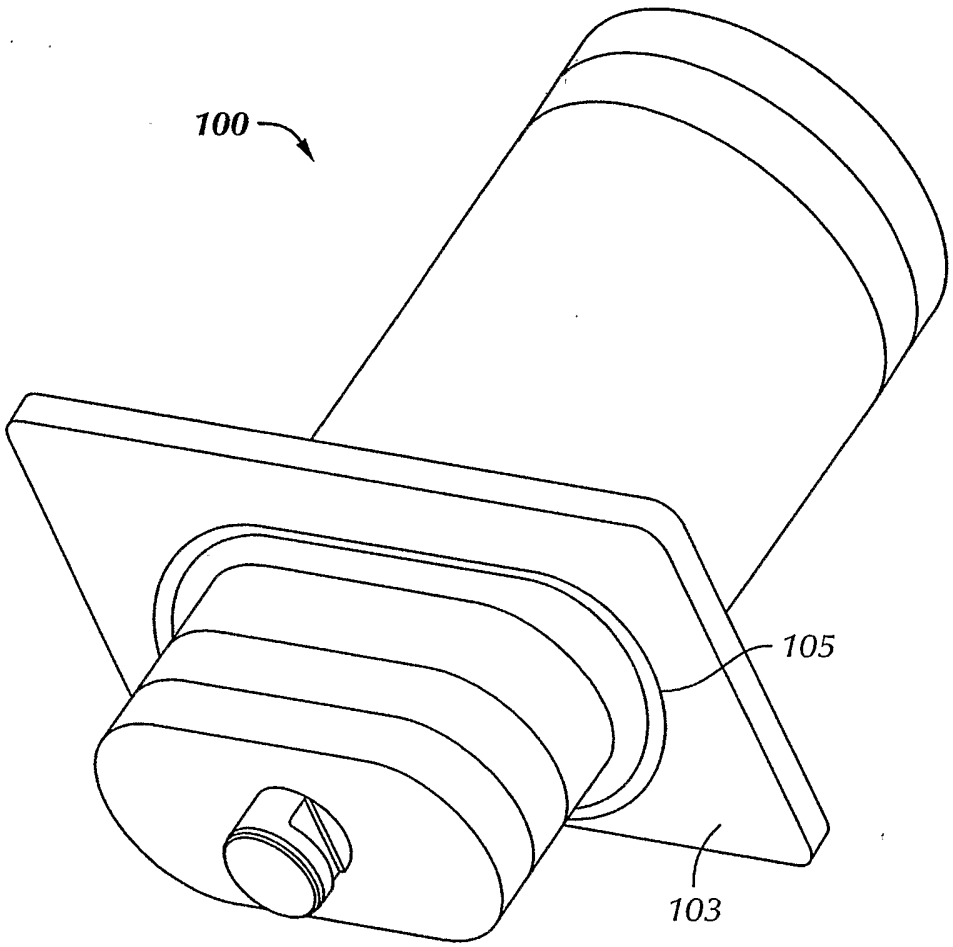

FIG. 2
(Prior Art)

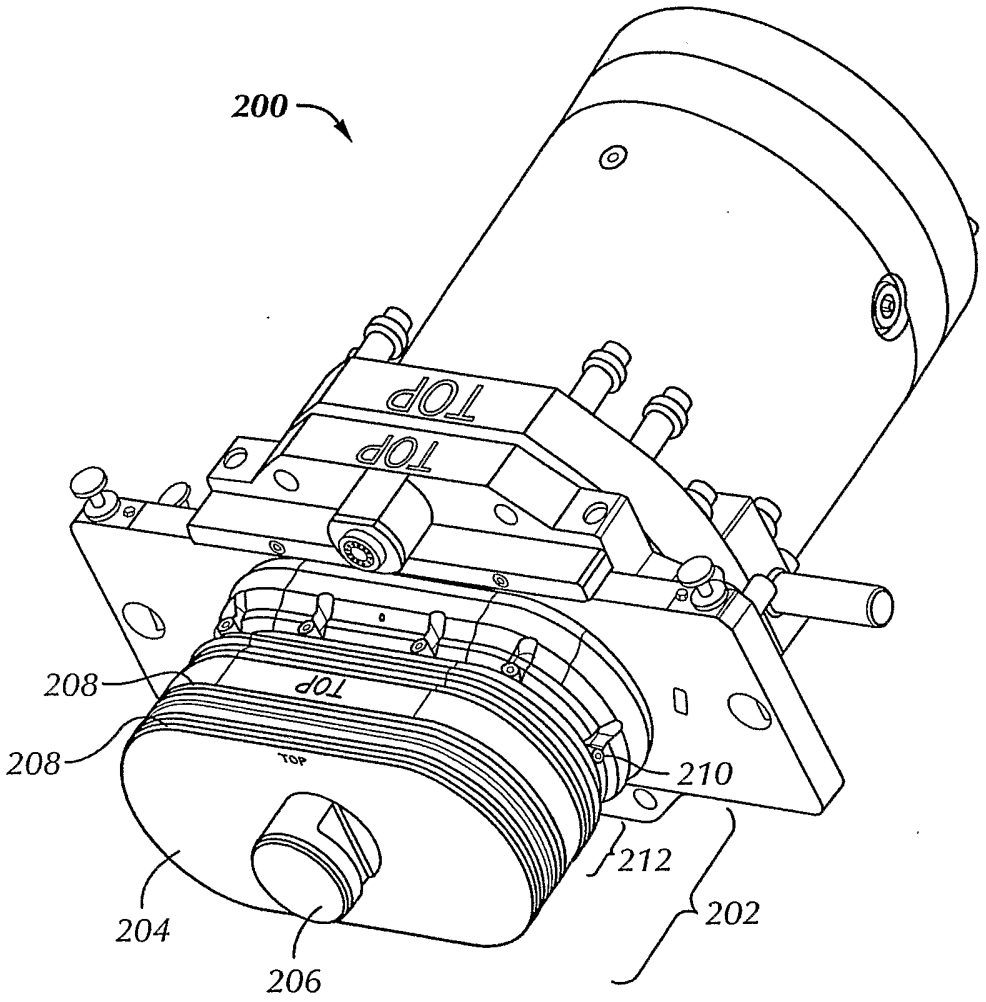

FIG. 3

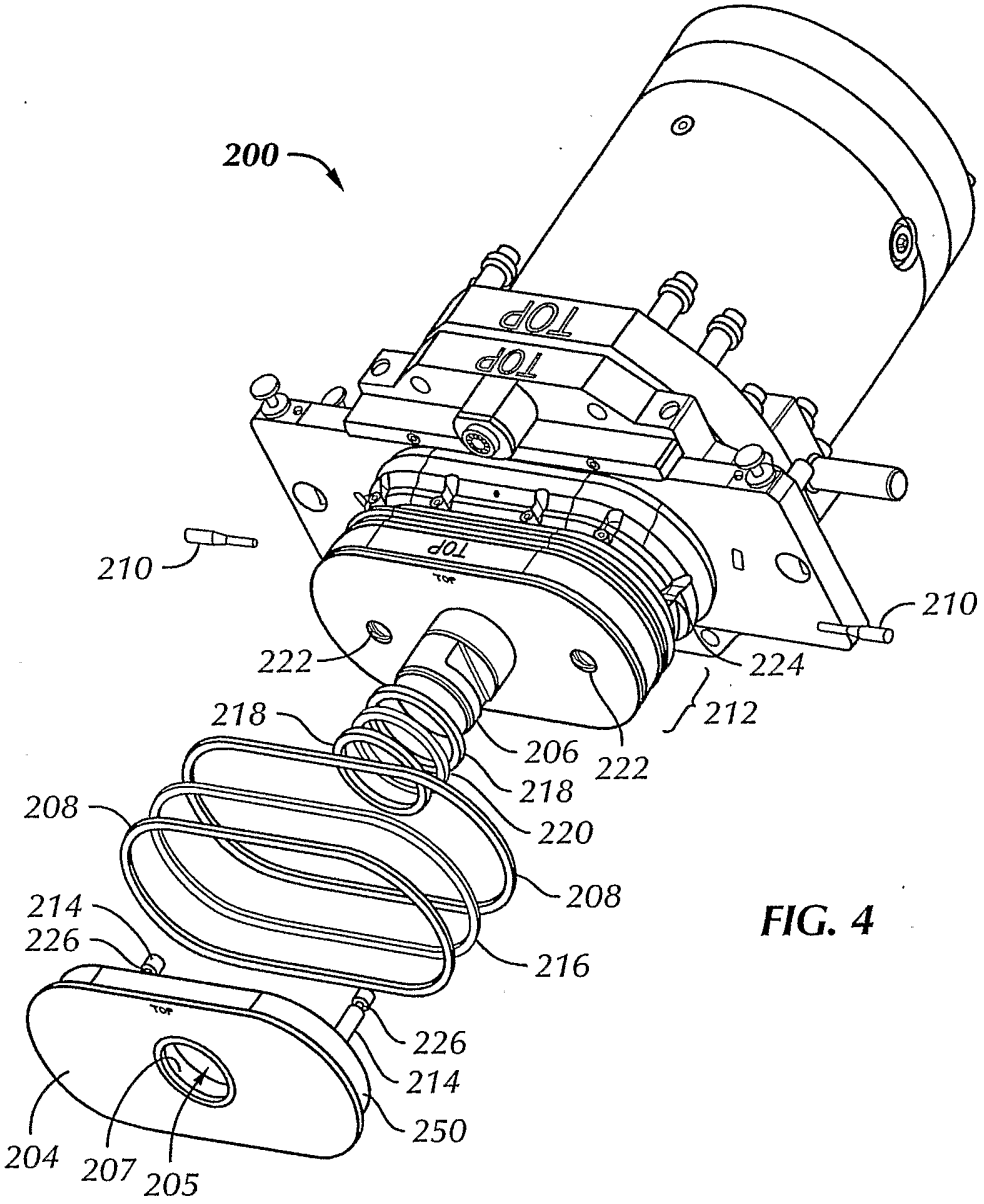
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FIG. 4

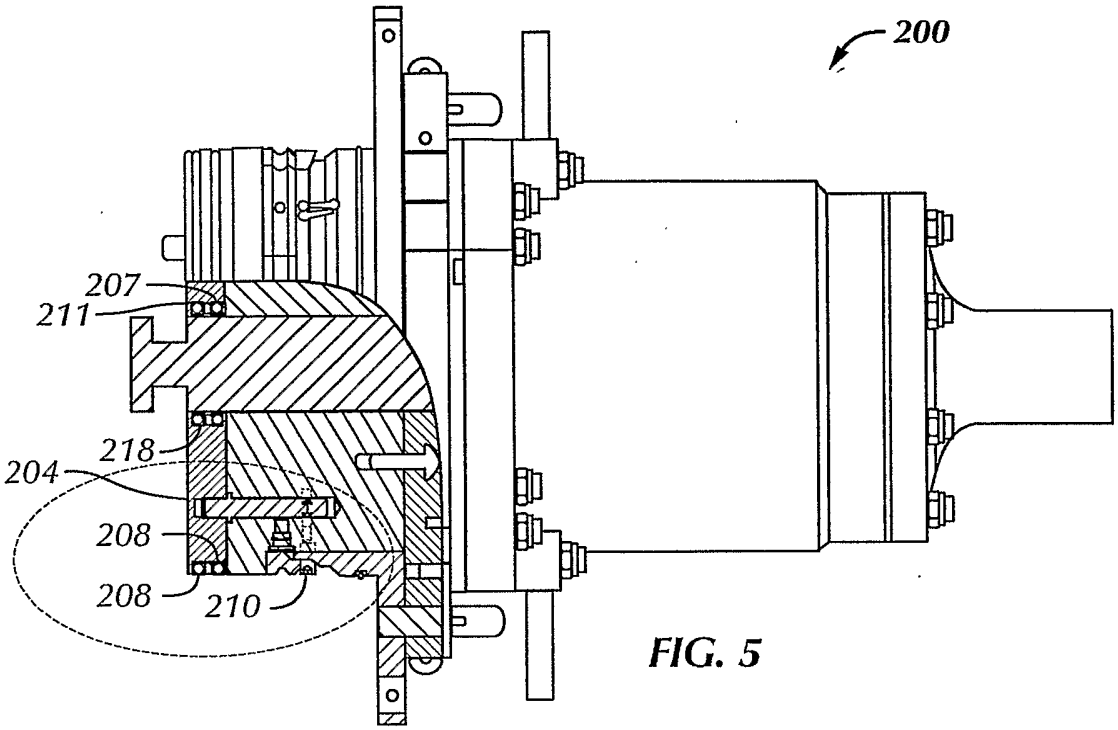
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FIG. 5

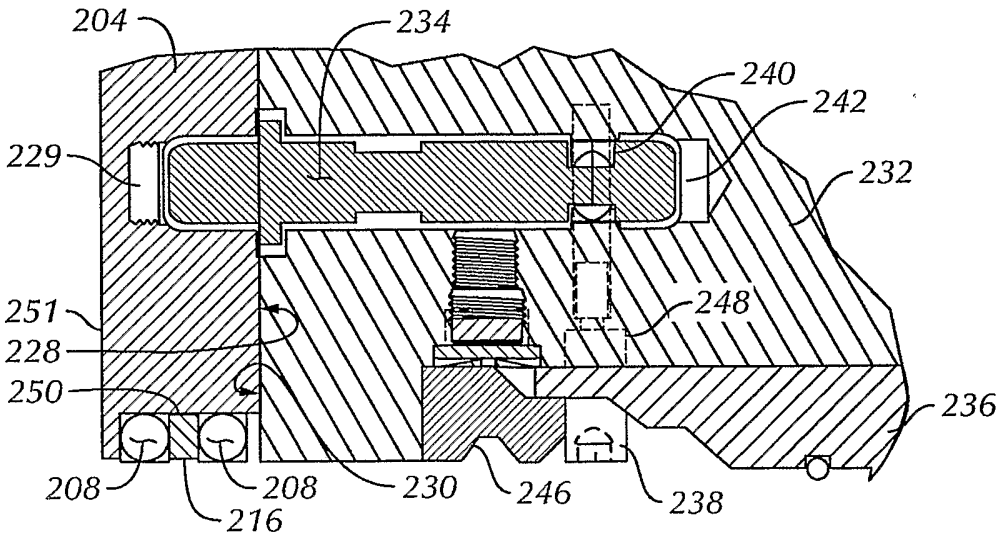
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FIG. 6

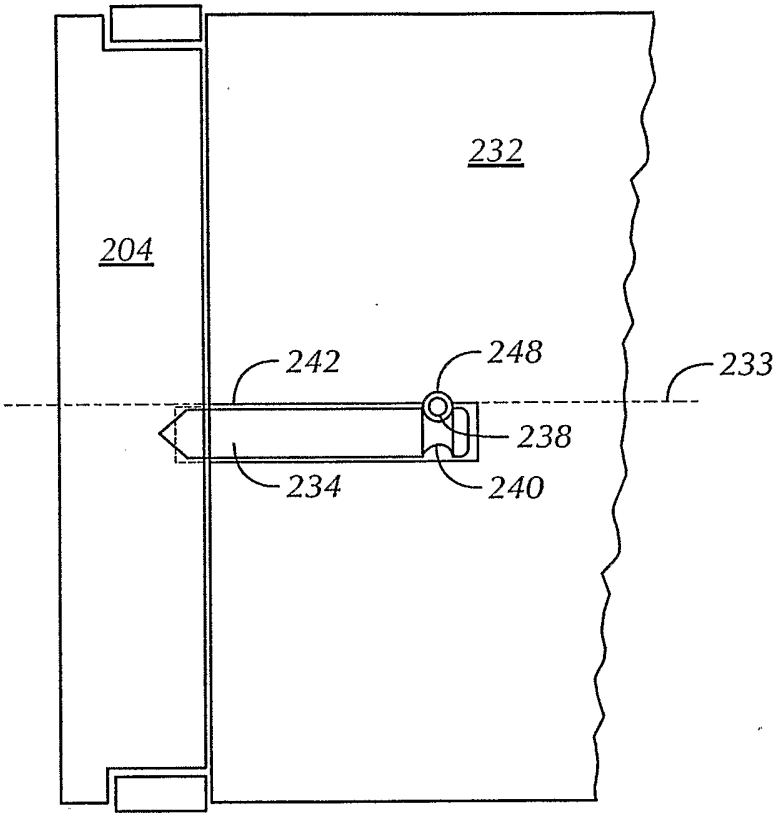

FIG. 7

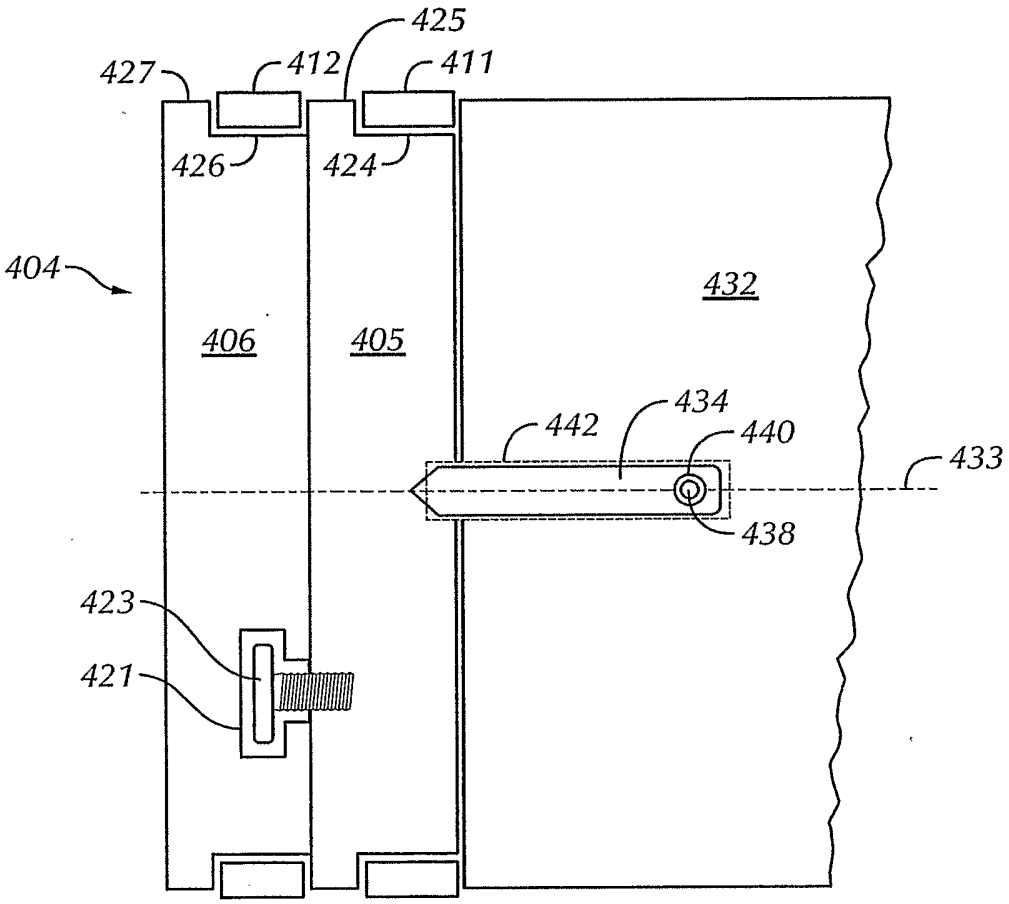
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FIG. 8