



(51) International Patent Classification:

E21B 43/01 (2006.01) *F16L 1/26* (2006.01)
E21B 43/013 (2006.01)

(21) International Application Number:

PCT/US2016/045692

(22) International Filing Date:

05 August 2016 (05.08.2016)

(25) Filing Language:

English

(26) Publication Language:

English

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(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, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR,

HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, 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, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, 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, 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))

(54) Title: CONNECTOR WITH INTEGRAL GASKET CHANGE OUT CAPABILITY

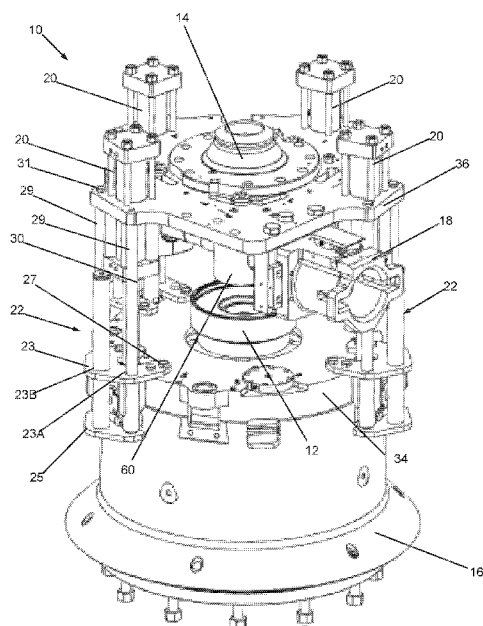


Figure 1A

(57) Abstract: One illustrative embodiment of a connector disclosed herein comprises an upper plate (33), a first hub (14), a second hub (12) and a guide funnel (16) coupled to the first hub (14). The connector also comprises a plurality of lifting mechanisms (20) coupled to the guide funnel (16) and a plurality of locking mechanisms (22) coupled to the guide funnel (16), wherein the locking mechanisms are adapted to secure the connector (10) in a first position wherein the first hub (14) and the second hub (12) are disengaged from one another, and in a second position wherein the first hub (14) and the second hub (12) are engaged with one another.



CONNECTOR WITH INTEGRAL GASKET CHANGE OUT CAPABILITY

FIELD OF INVENTION

The present invention generally relates to connectors that are used to couple a line to an item of equipment and, in one particular example, a connector that is used to couple a flowline or jumper to an item of equipment positioned in a subsea environment, wherein the connector is configured so as to permit gasket change out and inspection.

BACKGROUND OF THE INVENTION

After one or more subsea wells are drilled and completed in a particular field, various items of equipment are positioned on the sea floor to allow for the production of hydrocarbon fluids from the wells. Such equipment may include, for example, Christmas trees, one or more manifolds, multiple flowlines and jumpers, PLETs, etc. In general, a connector, typically a hydraulically powered connector, is used to couple a jumper or flowline between two items of equipment such that produced fluids may flow between the two items of equipment.

In some applications, these jumpers are relatively large tubular structures made of steel that are lowered to the sea floor from a surface vessel using one or more cranes and spreader bars. The jumpers may have one or more bends, e.g., ninety degree bends, to accommodate the desired routing of the jumper and/or elevation changes between the connectors on the two items of subsea equipment. The process of installing subsea jumpers is closely monitored by camera on ROV vehicles. During the installation process the jumper is slowly lowered toward to two items of equipment positioned on the sea floor with great care being taken to insure that the connections on the jumper are properly aligned with the connections on the two items of equipment. As the jumper nears contact with the subsea equipment, the jumper may contact and damage seals (typically metal seals) positioned on the subsea equipment. However, pressure test that are performed to test the integrity of the seal between the jumper and the equipment may not be performed until several weeks after the jumper was installed. If the pressure test reveals that the seal between the jumper and the equipment is leaking, the jumper has to be removed or at least lifted so that access can be had to the seal and the seal faces on the jumper and the equipment to determine what corrective actions need to be taken to correct the problem. Such actions may include removal and

replacement of the seal and/or correcting any damage to the sealing faces on the jumper and/or the equipment. However, the lifting the jumper to perform the above activities requires the presence of a surface vessel, all of which leads to increased cost and expenses as it relates to fixing the problem of the leaking seal

The present application is directed to a unique connector that comprises means to permit gasket change out and inspection that may eliminate or at least minimize some of the problems noted above.

BRIEF DESCRIPTION OF THE INVENTION

The following presents a simplified summary of the invention in order to provide a basic understanding of some aspects of the invention. This summary is not an exhaustive overview of the invention. It is not intended to identify key or critical elements of the invention or to delineate the scope of the invention. Its sole purpose is to present some concepts in a simplified form as a prelude to the more detailed description that is discussed later.

The present application is generally directed to a unique connector that comprises means to permit gasket change out and inspection. In one example, the connector comprises, among other things, an upper plate, a first hub that is operatively coupled to the upper plate wherein the first hub is adapted to be engaged with a second hub and a guide funnel that is coupled to the first hub. In this example, the connector further includes a plurality of lifting mechanisms that are coupled to the guide funnel, a plurality of locking mechanisms that are coupled to the guide funnel, wherein the locking mechanisms are adapted to secure the connector in a first position wherein the first hub and the second hub are disengaged from one another, and in a second position wherein the first hub and the second hub are engaged with one another.

In another example, the connector disclosed herein includes, among other things, an upper plate, a first hub that is operatively coupled to the upper plate wherein the first hub is adapted to be engaged with a second hub and a guide funnel that is coupled to the first hub. In this example, the connector further includes a first means for moving the first hub toward or away from engagement with the second hub, wherein the first means is operatively coupled to the to the guide funnel and a second means for locking the connector in in a first position,

wherein the first hub and the second hub are disengaged from one another, and in a second position wherein the first hub and the second hub are engaged with one another, wherein the second means is operatively coupled to the to the guide funnel.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described with the accompanying drawings, which represent a schematic but not limiting its scope:

Figure 1A is a perspective view of one illustrative embodiment of a connector disclosed herein;

Figure 1B is a cross-sectional view of one illustrative embodiment of a connector disclosed herein wherein a raising mechanism of the connector is retracted, an upper hub is engaged with a lower hub and a lockout mechanism is engaged so as to maintain the connector in this position wherein the upper and lower hubs are engaged;

Figure 1C is a cross-sectional view of one illustrative embodiment of a connector disclosed herein wherein the raising mechanism of the connector is extended, the upper hub is disengaged from the lower hub and the lockout mechanism is engaged so as to maintain the connector in this position where there is no engagement between the upper and lower hubs; and

Figure 1D is cross-sectional view of one illustrative embodiment of a lock mechanism disclosed herein that may be used to lock the connector in either of the positions shown in Figures 1B or 1C.

While the subject matter disclosed herein is susceptible to various modifications and alternative forms, specific embodiments thereof have been shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the description herein of specific embodiments is not intended to limit the invention to the particular forms disclosed, but on the contrary, the intention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

Various illustrative embodiments of the invention are described below. In the interest of clarity, not all features of an actual implementation are described in this specification. It will of course be appreciated that in the development of any such actual embodiment, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with connector-related and business-related constraints, which will vary from one implementation to another. Moreover, it will be appreciated that such a development effort might be complex and time-consuming, but would nevertheless be a routine undertaking for those of ordinary skill in the art having the benefit of this disclosure.

The present subject matter will now be described with reference to the attached figures. Various structures, connectors and devices are schematically depicted in the drawings for purposes of explanation only and so as to not obscure the present disclosure with details that are well known to those skilled in the art. Nevertheless, the attached drawings are included to describe and explain illustrative examples of the present disclosure. The words and phrases used herein should be understood and interpreted to have a meaning consistent with the understanding of those words and phrases by those skilled in the relevant art. No special definition of a term or phrase, *i.e.*, a definition that is different from the ordinary and customary meaning as understood by those skilled in the art, is intended to be implied by consistent usage of the term or phrase herein. To the extent that a term or phrase is intended to have a special meaning, *i.e.*, a meaning other than that understood by skilled artisans, such a special definition will be expressly set forth in the specification in a definitional manner that directly and unequivocally provides the special definition for the term or phrase.

One illustrative example of a novel connector 10 that comprises means for permitting gasket change out and inspection will now be described with reference to the attached drawings. The connector 10 disclosed herein may be used in variety of situations and applications wherein it is desired to establish a connection between two components. In one illustrative example, and not by way of limitation, the connector 10 disclosed herein may be used to couple a flowline or jumper to an item of equipment positioned in a subsea environment. The connector 10 disclosed herein may be of any size and it may be made of

any desired materials. Of course, the presently disclosed invention should not be considered to be limited to the illustrative embodiments depicted in the attached drawings.

As shown in Figures 1A-1C, the connector 10 will be used to couple a first hub 12 on a first component to a second hub 14 on a second component, wherein a gasket 13 (such as a metal gasket) is provided so as to effectuate a sealed connection between the first and second hubs 12, 14. The term “hub” as used herein and in the attached claim should be understood to be a generic term that refers to any type of component on a device or product whereby a sealed connection is to be established between two hubs. The hubs 12, 14 may be of any desired configuration, have any desired mating profile and they may use any type of sealing mechanism, such as the gasket 13, so as to establish a sealed connection between the two hubs. The hubs 12, 14 may be part of any type of structure, i.e., one of the hubs 12, 14 may be coupled to an item of equipment (e.g., a manifold, a Christmas tree, a PLEM, etc.) while the other hub may be coupled to, for example, a flowline, a jumper, a pipeline or another item of equipment. For example, the first hub 12 may be operatively coupled to a subsea manifold (not shown) at an end 12X and the second hub 14 may be operatively coupled to a subsea jumper (not shown) at an end 14X. So as not to obscure the presently disclosed subject matter, the items of structures to which the hubs 12, 14 may be coupled are not depicted in the attached drawings.

In the depicted example, the connector 10 comprises a guide funnel 16, a plurality of lifting mechanisms 20 (e.g., comprising dual-action or single-action hydraulic cylinders) and a plurality of lock mechanisms 22. In the depicted example, the lifting mechanisms 20 are dual-action hydraulic cylinders. The lock mechanisms 22 are adapted to lock the connector 10 in either its raised position (shown in Figures 1A and 1C) wherein the lifting mechanisms 20 are extended and the hubs 12, 14 are disengaged from one another or its lowered position (shown in Figures 1B and 1D) wherein the lifting mechanisms 20 are retracted and the hubs 12, 14 are engaged with one another. Figure 1D is an enlarged view of one illustrative embodiment of a lock mechanism 22 that may be employed with the connector 10 disclosed herein.

In the illustrative example disclosed herein, the connector 10 comprises a clamp 30 (see Figure 1B) that may be opened or closed by rotation of a clamp screw 32. Closing the clamp 30 establishes a pressure tight seal between the two hubs 12, 14. The clamp screw 32

may be actuated by an ROV (using an ROV interface 18) or an electronically driven actuator, such as an electric motor (not shown). The connector 10 comprises a plate 36 which is the top plate of the guide funnel 16, an upper plate 33 and a plurality of threaded fasteners 35 that are used to couple the upper plate 33 of the connector 10 to the upper hub 14. Each of the hydraulic cylinders 20 comprises a piston 20A. The hydraulic cylinders 20 extend through openings 33A in the upper plate 33. A plurality of support rods 20B for the hydraulic cylinder 20 also extend through openings 33B in the upper plate 33. An end of the piston 20A extends through an opening 36A in the plate 36 and is secured in place via a threaded nut 45. The lower plate 34 is secured to the lower hub 12 using a plurality of threaded fasteners, e.g., a threaded rod 40 and nut, wherein the threaded rod 40 is threaded into a threaded opening 39 defined in the lower hub 12.

In general, the locking mechanism 22 constitutes a means for locking the connector 10 in either its lowered position shown Figure 1B (wherein the two hubs 12, 14 are engaged) or in its raised position shown in Figure 1C (wherein the upper hub 14 is disengaged from the lower hub 12). With reference to Figure 1A-1D, in one illustrative embodiment, the locking mechanism 22 comprises a plurality of guide bars 29, an attachment plate 23, a lower plate 25 and a lock bar 22A. The attachment plate 23 is coupled to the upper plate 36 of the guide funnel 16 by a plurality of threaded fasteners 27. The guide bars 29 extend through openings 23A in the attachment plate 23. The upper end of the guide bars 29 extends to an opening in the upper plate 33 and is secured in place via a threaded fastener 31. The lower end of the guide bar 29 extends to an opening in the lower plate 25 and is secured in place via a threaded fastener (not shown). The lock bar 22A extends through an opening 23B in the attachment plate 23. The upper end of the lock bar 22A is not attached to any structure, while the lower end of the lock bar 22A extends to an opening in the plate 25 and is secured in place via a threaded bolt 43 (see Figure 1B). The lock bar 22A may be of and desired shape or configuration, e.g., a cylindrical rod, a plate-type member, etc. The locking mechanism 22 further comprises an upper recess or detent 22B, a lower recess or detent 22C and a hydraulically actuated, spring-biased dashpot 22D with a projection 22E. (See Figure 1D) The dashpot 22D is coupled to the underside of the attachment plate 23 using a plurality of threaded fasteners (not shown). The dashpot 22D comprises a schematically depicted spring 22F that is biased to force the projection 22E outward when there is no hydraulic power applied to the dashpot 22D.

In operation, the plate 34 may be secured to the lower hub 12 at any point in time. In one illustrative embodiment, the plate 34 may have a one-piece configuration. The connector 10 may be coupled to the upper hub 14 at any point in time, e.g., when the equipment or line that will be coupled to the hub 14, such as a jumper, is initially fabricated.

When the equipment or line comprising the upper hub 14 is initially lowered toward the equipment or line comprising the lower hub 12, the locking mechanism 22 of the connector 10 will be in the position shown in Figure 1B wherein the pistons 20A of the hydraulic cylinders 20 are fully retracted and the spring-biased projections 22E are engaged in the upper recesses 22B in the lock bars 22A thereby securing the connector 10 in position around the upper hub 14. During the initial landing of the connector 10 on the equipment positioned subsea containing the lower hub 12, the clamp screw 32 of the clamp 30 is open, i.e., the pressure tight seal between the two hubs 12, 14 has not yet been established. As it relates only to the locking mechanism 20, Figure 1B depicts the locking mechanism 20 in its lowered and locked position with the pistons 20A of the hydraulic cylinders 20 in the fully retracted position. At this point in time, pressurized hydraulic fluid is not supplied to the hydraulic cylinders 20. However, pressurized hydraulic fluid may be supplied to the dashpots 22D so that the spring biased projections 22E are further biased into engagement with the upper recess 22B in the lock bars 22A. With the locking mechanism 20 of the connector 10 locked in the position shown in Figure 1B and with the clamp 30 open, the equipment or line comprising the connector 10 is lowered toward the equipment or line comprising the lower hub 12. The lowering continues until the guide funnel 16 engages the lower plate 34, thereby insuring approximate alignment between the two hubs 12, 14. The first contact is made between a plurality of soft landing mechanisms 60 (see Figure 1A – only one shown) and the surface 34S (see Figure 1D) of the lower plate 34. The soft landing mechanisms 60 comprises at least one hydraulic cylinder and a means for controlled lowering of the hub 14 toward the hub 12 once contact is initially made. In the final stage of making the connection, the surface 14S of the upper hub 14 engages the surface 12S of the lower hub 12 thereby crushing the seal 13. Of course, it should be understood that the above referenced soft landing mechanisms 60 are not required to practice at least some aspects of the various inventions disclosed herein.

At some point after this landing, pressurized fluid is released from the soft landing mechanisms 60 and the clamp 30 is actuated so as to establish the final sealed connection

between the two hubs 12, 14. The pressurized hydraulic fluid described herein may be supplied to the hydraulic cylinders 20 and/or the dashpots 20D using a variety of techniques, e.g., an ROV, an umbilical from a surface vessel, a subsea supply of pressurized fluid, etc.

At some point in time, it may become necessary to break the connection between the hubs 12, 14 and raise the upper hub 14 relative to the lower hub 12, e.g., after a leak is detected in the sealed connection. The hydraulics are plumbed and connections to the dash pots 22D and the hydraulic cylinders 20 are configured such that the dash pots 22D and hydraulic cylinders 20 may be operated as follows. With reference to Figure 1B, in one embodiment, the first action taken is to release the clamp 30. Thereafter, pressurized fluid is supplied to the dashpots 22D at a sufficient pressure so as to generate a force 51 that overcomes the bias of the spring 22F and forces the projection 22E into the dashpot 22D and out of engagement with the upper recess 22B in the lock bar 22A. At this point, the connector 10 is now unlocked. At some point before, during or after the pressurized fluid is supplied to the dashpots 22D, pressurized fluid is supplied to the hydraulic cylinders 20 so as to urge the pistons 20A to extend in the direction indicated by the arrow 52 in Figure 1B, e.g., downward. If the above-referenced soft landing mechanisms 60 (see Figure 1A – only one shown) are present, the hydraulic cylinder that is part of the soft landing mechanisms 60 may also be used during the initial stages of lifting the upper hub 14. The pressure of the fluid supplied to the hydraulic cylinders 20 may initially be less than the pressure required to actually cause separation between the hubs 14, 12 so as to make sure that the hydraulic system is stable and functioning prior to actually raising the pressure to lift the hub 14 relative to the hub 12. The hydraulic pressure supplied to the cylinders 20 is sufficient so as to generate a net downward force on the upper plate 36 of the guide funnel 16 that is sufficient to raise and hold the connector 10 in its raised position shown in Figure 1C, wherein the upper hub 14 is separated from the lower hub 12. At this point, the pressure supplied to the dashpots 22D is released so as to allow all of the spring-biased projection 22E (previously disengaged with the lock bars 22A) to engage with the lower recess 22C in the lock bars 22A so as to maintain and lock the connector 10 in the raised and locked position shown in Figure 1C. In addition to relying on the spring 22F to bias the projection 22E into the lower recess 22C, hydraulic pressure may be supplied to the dashpots 22D to further bias the projection 22E into the lower recess 22C. Additionally, hydraulic pressure may be continuously supplied or locked to the hydraulic cylinders 20 at all times while the connector 10 is in the raised and locked position. With the hub 14 in the raised and locked position

shown in Figure 1C, the sealing interface may be accessed to perform various activities such as, for example, replace the gasket 13, rework the sealing surfaces on the upper and lower hubs, etc.

At some point after the gasket 13 has been replaced, the connector 10 is used to lower the hub 14 toward the hub 12. With reference to Figure 1C, if not already energized, fluid is supplied to the cylinders 20 at a sufficient pressure such that the cylinders 20 hold or support all of the weight of the equipment of jumper that is attached to the upper hub 14. At that point, pressurized fluid is supplied to the dashpots 22D at a sufficient pressure so as to generate a force 53 that overcomes the bias of the spring 22F and forces the projection 22E into the dashpot 22D out of engagement with the lower recess 22C in the lock bar 22A. The connector is now unlocked and the connector 10 may be used to lower the upper hub 14 toward the lower hub 12. With the connector 10 unlocked, pressurized fluid is supplied to the hydraulic cylinders 20 so as to urge the piston 20A to retract into the hydraulic cylinder, i.e., in the direction indicated by the arrow 54 in Figure 1C. The hydraulic pressure supplied to the cylinders 20 is controlled so as to provide slow controlled movement the equipment to which the upper hub 14 is attached. The soft landing mechanisms 60 (if present) engage the surface 34S (see Figure 1D) of the lower plate 34S and the soft landing mechanisms 60 may be used alone or in conjunction with the hydraulic cylinders 20 to complete the final stages of the lowering process. The lowering process continues until the hub 14 engages the hub 12 and the gasket 13 is initially crushed. At this point, the pressure supplied to the dashpots 22D is released so as to allow the spring-biased projection 22E (previously disengaged with the lock bar 22A) to engage with the upper recess 22B in the lock bar 22A so as to maintain and lock the connector 10 in the lowered and locked position shown in Figure 1B. In addition to relying on the spring 22F to bias the projection 22E into the upper recess 22B, hydraulic pressure may be supplied to the dashpots 22D to further bias the projection 22E into the recess 22B. With the hubs 12, 14 in the engaged position shown in Figure 1B, the clamp 30 may be actuated to establish the final sealed connection between the hubs 12, 14.

In general, as described above, the connector 10 comprises a first means for moving the first hub 14 toward or away from engagement with the second hub 12, wherein the first means is operatively coupled to the to the guide funnel 16. In the depicted example, the means for moving the first hub 14 toward or away from engagement with the second hub 12 comprises a plurality of hydraulic cylinders 20, wherein each of the hydraulic cylinders 20 is

operatively coupled to the upper plate 33 and a piston 20A of each of the hydraulic cylinders 20 is operatively coupled to the guide funnel 16. The connector also comprises a second means for locking the connector 10 in a raised and locked position, wherein a seal between the first hub 14 and the second hub 12 is not established, and a lowered and locked position wherein the first hub 14 and the second hub 12 are engaged, wherein the second means is also operatively coupled to the to the guide funnel 16. In the depicted example, the means for locking the connector 10 comprises a lock bar 22A, a first recess 22B and a second recess 22C defined in the lock bar 22A, wherein the first and second recesses are axially spaced apart from one another on the lock bar 22A, a hydraulically powered dashpot 22D wherein the dashpot 22D comprises a projection 22E and a spring 22F, wherein the projection 22E is adapted to engage one of the first and second recesses 22B, 22C and the spring 22F is adapted to bias the projection 22E into engagement with one of the first and second recesses 22B, 22C.

As will be appreciated by those skilled in the art after a complete reading of the present application the novel connector 10 disclosed herein may provide several improvements over the prior art methods of establishing a sealed connection between two hubs. For example, using the connector 10 disclosed herein, the final engagement between the two hubs 12, 14 may be a more controlled undertaking as opposed to simply lowering the two hubs into contact with one another using a crane or the like positioned on a vessel at a surface of a body of water. Such controlled mating of the hubs 12, 14 may result in less damage or potential damage to the sealing surfaces of the hubs 12, 14 and/or the gasket 13. Additionally, in the case where a leak is detected in a previously established connection between the hubs 12, 14, or where there is otherwise a need to access the seal 13 or the interior of the hubs 12, 14, the connector 10 may be raised (as described above) so as to expose the seal 13 and one or more of the hubs 12, 14 for inspection and possible repair or modification without the need of employing an expensive surface vessel with sufficient lift capabilities, i.e., crane capabilities, to raise the equipment or flow line that is coupled to the upper hub 14.

The particular embodiments disclosed above are illustrative only, as the invention may be modified and practiced in different but equivalent manners apparent to those skilled in the art having the benefit of the teachings herein. For example, the process steps set forth above may be performed in a different order. Furthermore, no limitations are intended to the

details of construction or design herein shown, other than as described in the claims below. It is therefore evident that the particular embodiments disclosed above may be altered or modified and all such variations are considered within the scope and spirit of the invention. Note that the use of terms, such as “first,” “second,” “third” or “fourth” to describe various processes or structures in this specification and in the attached claims is only used as a shorthand reference to such steps/structures and does not necessarily imply that such steps/structures are performed/formed in that ordered sequence. Of course, depending upon the exact claim language, an ordered sequence of such processes may or may not be required. Accordingly, the protection sought herein is as set forth in the claims below.

CLAIMS

1. A connector (10), comprising:
 - an upper plate (33)
 - a first hub (14) that is operatively coupled to the upper plate (33), the first hub (14) adapted to be engaged with a second hub (12);
 - a guide funnel (16) coupled to the first hub (14);
 - a plurality of lifting mechanisms (20) coupled to the guide funnel (16);
 - a plurality of locking mechanisms (22) coupled to the guide funnel (16), the locking mechanisms being adapted to secure the connector (10) in a first position, wherein the first hub (14) and the second hub (12) are disengaged from one another, and in a second position wherein the first hub (14) and the second hub (12) are engaged with one another.
2. The connector of claim 1, further comprising the second hub (12) and a plate (34) that is coupled to the second hub (12) by a plurality of threaded fasteners.
3. The connector of claim 1, wherein each of the plurality of lifting mechanisms comprises a hydraulic cylinder (20).
4. The connector of claim 3 wherein:
 - each of the hydraulic cylinders (20) is operatively coupled to the upper plate (33); and
 - a piston of each of the hydraulic cylinders is operatively coupled to the guide funnel (16).
5. The connector of claim 1, wherein each of the locking mechanisms comprise:
 - a lock bar (22A);
 - a first recess (22B) and a second recess (22C) defined in the lock bar (22A), wherein the first and second recesses are axially spaced apart from one another on the lock bar (22A); and
 - a hydraulically powered dashpot (22D) wherein the dashpot (22D) comprises a projection (22E) that is adapted to engage one of the first and second recesses (22B, 22C).

6. The connector of claim 5, wherein the lock bar (22A) comprises a cylindrically shaped rod.

7. The connector of claim 5, wherein the dashpot comprises a spring (22F) that is adapted to bias the projection (22E) into engagement with one of the first and second recesses (22B, 22C).

8. The connector of claim 5, wherein each of the plurality of lifting mechanisms (20) is coupled to the guide funnel (16) by attachment plate (23) that is threadingly attached to the guide funnel (16).

9. The connector of claim 8, wherein the lock bar (22A) extends through an opening (23B) in the attachment plate (23).

10. The connector of claim 1, wherein the plurality of lifting mechanisms (20) comprise four lifting mechanisms, and wherein the plurality of locking mechanisms (22) comprise four locking mechanisms.

11. The connector of claim 5, wherein the first recess (22B) is positioned vertically above the second recess (22C) and wherein the projection (22E) is positioned within the second recess (22C) when the connector is in the first position and in the first recess (22B) when the connector is in the second position.

12. A connector (10), comprising:
an upper plate (33)
a first hub (14) that is operatively coupled to the upper plate (33), the first hub (14) adapted to be engaged with a second hub (12);
a guide funnel (16) coupled to the first hub (14);
a hydraulic cylinder (20) coupled to the guide funnel (16);
a lock bar (22A) operatively coupled to the guide funnel (16);
a first recess (22B) and a second recess (22C) defined in the lock bar (22A), wherein the first and second recesses are axially spaced apart from one another on the

lock bar (22A) and the first recess (22B) is positioned vertically above the second recess (22C); and

a hydraulically powered dashpot (22D) wherein the dashpot (22D) comprises a projection (22E), wherein the projection (22E) is adapted to:

- engage the second recess (22C) to thereby secure the connector (10) in a first position, wherein the first hub (14) and the second hub (12) are disengaged from one another; and
- engage the first recess (22B) to thereby secure the connector (10) in a second position wherein the first hub (14) and the second hub (12) are engaged with one another.

13. The connector of claim 12, further comprising the second hub (12) and a plate (34) that is coupled to the second hub (12) by a plurality of threaded fasteners.

14. The connector of claim 12 wherein:

the hydraulic cylinder (20) is a dual action hydraulic cylinder that is operatively coupled to the upper plate (33); and

a piston (20A) of the hydraulic cylinder (20) is operatively coupled to the guide funnel (16).

15. The connector of claim 14, wherein the lock bar (22A) comprises a cylindrically shaped rod.

16. The connector of claim 12, wherein the dashpot comprises a spring (22F) that is adapted to bias the projection (22E) into engagement with one of the first and second recesses (22B, 22C).

17. A connector (10), comprising:

an upper plate (33)

a first hub (14) that is operatively coupled to the upper plate (33), the first hub (14) adapted to be engaged with a second hub (12);

a guide funnel (16) coupled to the first hub (14);

a first means for moving the first hub (14) toward or away from engagement with the second hub (12), wherein the first means is operatively coupled to the to the guide funnel (16);

a second means for locking the connector (10) in in a first position, wherein the first hub (14) and the second hub (12) are disengaged from one another, and in a second position wherein the first hub (14) and the second hub (12) are engaged with one another, wherein the second means is operatively coupled to the to the guide funnel (16).

18. The connector of claim 17, wherein the first means for moving the first hub (14) comprises a plurality of hydraulic cylinders (20).

19. The connector of claim 16 wherein:

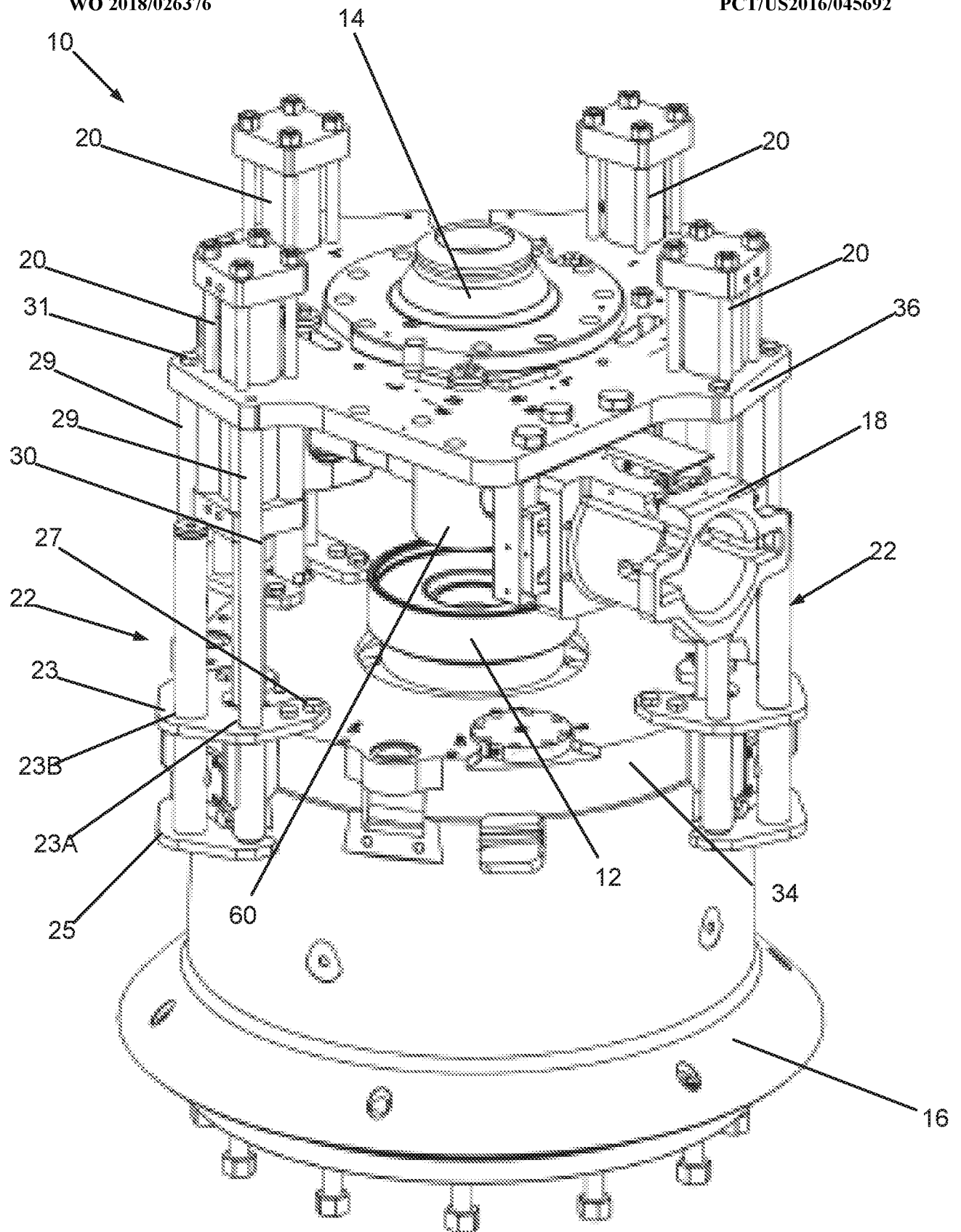
each of the hydraulic cylinders (20) is operatively coupled to the upper plate (33); and a piston of each of the hydraulic cylinders is operatively coupled to the guide funnel (16).

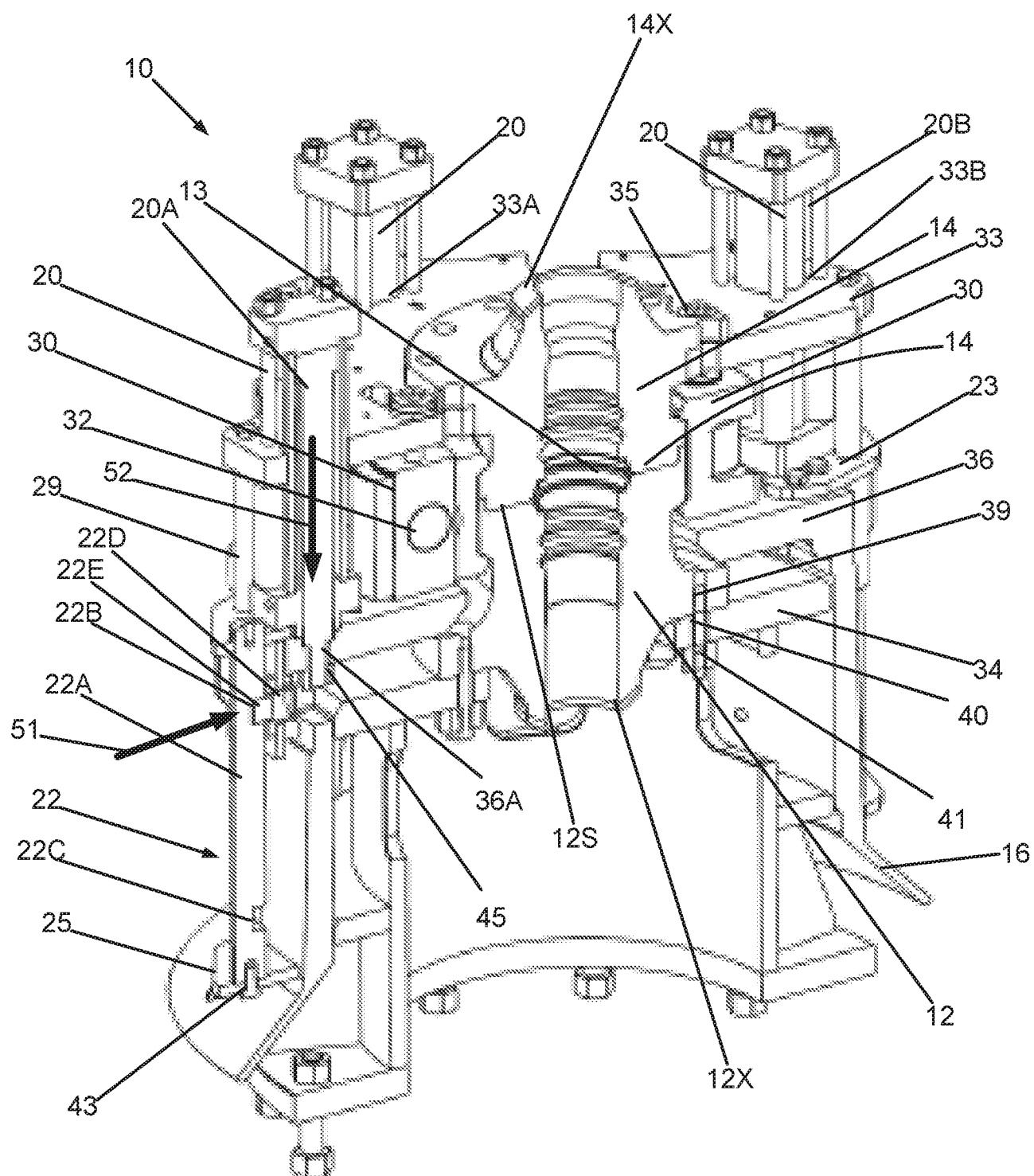
20. The connector of claim 16 wherein the second means for locking the connector (10) comprises:

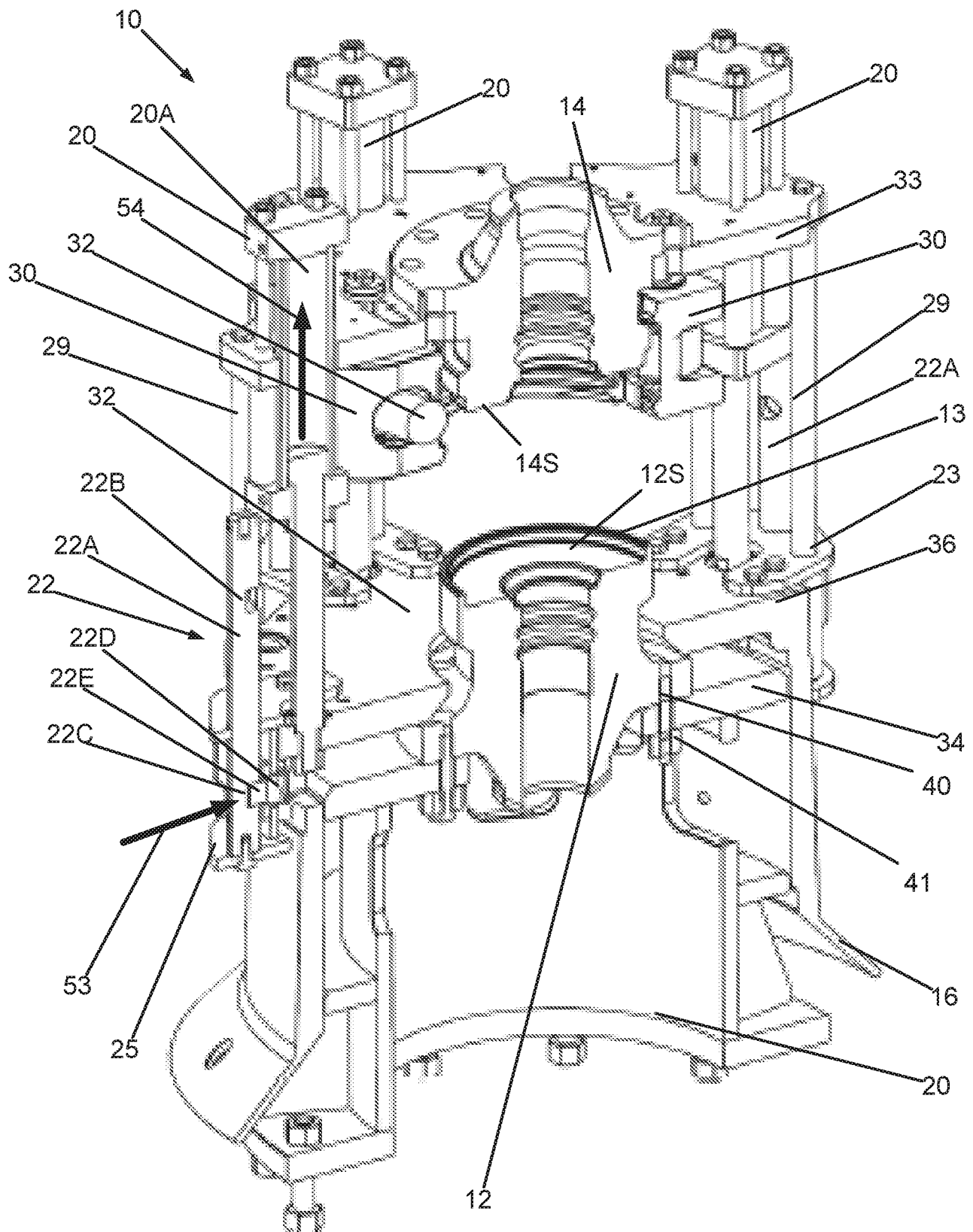
a lock bar (22A);

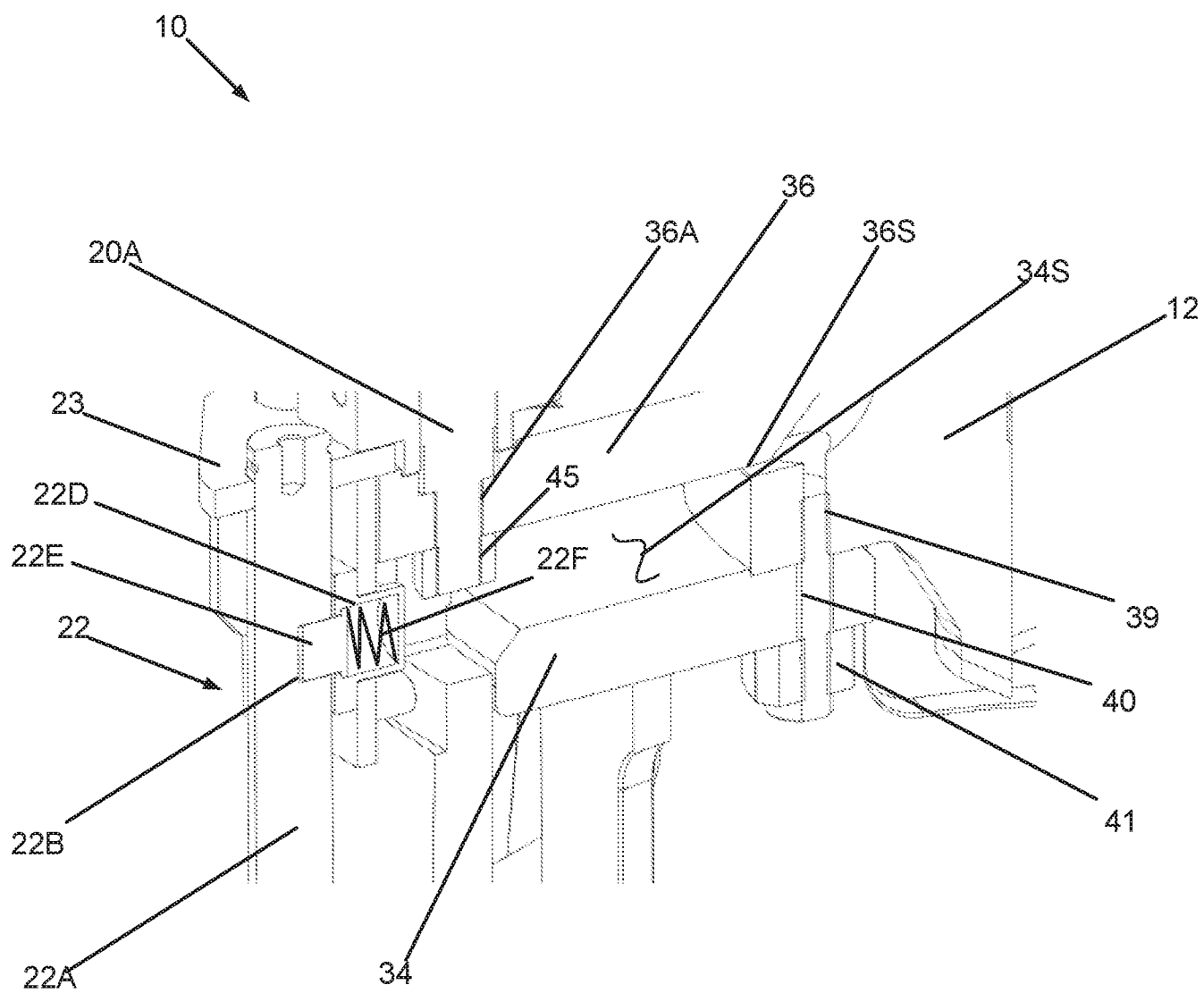
a first recess (22B) and a second recess (22C) defined in the lock bar (22A), wherein the first and second recesses are axially spaced apart from one another on the lock bar (22A);

a hydraulically powered dashpot (22D) wherein the dashpot (22D) comprises a projection (22E) and a spring (22F), wherein the projection (22E) is adapted to engage one of the first and second recesses (22B, 22C) and the spring (22F) is adapted to bias the projection (22E) into engagement with one of the first and second recesses (22B, 22C).

**Figure 1A**

**Figure 1B**

**Figure 1C**

**Figure 1D**

INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/045692

A. CLASSIFICATION OF SUBJECT MATTER

INV. E21B43/01 E21B43/013 F16L1/26
ADD.

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 F16L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	US 4 823 879 A (BRAMMER NORMAN [GB] ET AL) 25 April 1989 (1989-04-25) column 1, line 64 - column 2, line 11 column 4, line 42 - column 5, line 44; figures 1-3 -----	1-4,10, 17-19 12-16
X	GB 2 373 271 A (VETCO GRAY INC ABB [US]) 18 September 2002 (2002-09-18) paragraphs [0001], [0004], [0014] - [0016], [0021] - [0024]; figures 1, 6-8 -----	1-3,10, 17,18
A	GB 2 059 534 A (FMC CORP) 23 April 1981 (1981-04-23) page 1, line 4 - line 9 page 4, line 81 - line 122; figures 8-13 -----	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

"E" earlier application or patent but published on or after the international filing date

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"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

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Date of the actual completion of the international search

24 March 2017

Date of mailing of the international search report

05/04/2017

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2016/045692

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 4823879	A	25-04-1989	GB 2225044 A	23-05-1990
			US 4823879 A	25-04-1989

GB 2373271	A	18-09-2002	NONE	

GB 2059534	A	23-04-1981	NONE	
