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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
31 October 2013 (31.10.2013)

WIPO | PCT

(10) International Publication Number
WO 2013/160672 A2

(51) International Patent Classification:
E21B 19/10 (2006.01)

(21) International Application Number:
PCT/GB2013/051032

(22) International Filing Date:
24 April 2013 (24.04.2013)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
1207167.6 24 April 2012 (24.04.2012) GB

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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, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, 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, 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, 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, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *of inventorship (Rule 4.17(iv))*

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

WO 2013/160672 A2

(54) Title: MOVEABLE JOINT

(57) Abstract: A moveable joint suitable for connection with a tubular member, comprising a socket member having an inner surface defining a cavity,and a rotation member having an outer surface corresponding to said cavity, said rotation member being journaled for rotation in said cavity. Said rotation member has an inner surface defining a cylindrical bore through said rotation member and centered on a longitudinal axis of said rotation member, the cylindrical bore being configured to receive a tubular member. Said moveable joint further comprises a releasable locking mechanism for releasably locking a tubular member in said cylindrical bore so that when said tubular member is locked in said cylindrical bore said tubular member and said rotation member are fixed with respect to one another and are rotatable relative to said socket member. Said locking mechanism comprises a cage connected to the rotation member and having a plurality of windows partially closing recesses in the inner surface of said rotation member, which recesses are elongate in a longitudinal direction parallel the longitudinal axis,house a roller and have a base inclined in said longitudinal direction so that at a lower end of each recess the roller protrudes through said window and at an upper end thereof the roller protrudes less or not at all.

Moveable Joint

[0001] This invention relates to a moveable joint, and more specifically to a moveable joint that is capable of releasably locking to a tubular member such as a wellbore casing member, a drill string tubing member, a pipe member, a collared tubing member, or a steel catenary riser (SCR).

BACKGROUND

[0002] For the reasons or rotatability and universality amongst others, the drilling of subterranean wells involves the use of many tubular shaped members. For example, each of a wellbore casing member, a drill string tubing member, a pipe member, a collared tubing member, and a steel catenary riser (SCR) are generally tubular in form. Such tubular members often rise from a subsea level and require mounting or otherwise fixing to a structure such as a rig. However, given that the motion of the sea causes movement of the tubular member, there is the risk of fatigue or damage to the tubular member and/or the structure that it is attached due to the movement of the tubular member. Joints including dampers (e.g. rubber dampers) reduce this problem to an extent but the elastomeric nature of dampers results in a biasing force that may be undesirable or that exerts a potentially damaging additional force on the tubular member.

[0003] It is an object of the present invention to provide an improved joint that mitigates at least some of the problems associated with the prior art.

BRIEF SUMMARY OF THE DISCLOSURE

[0004] The present invention is defined in the appended claims.

[0005] In accordance an aspect of the present invention there is provided a moveable joint suitable for connection with a tubular member, comprising:

a socket member having an inner surface defining a cavity; and

a rotation member having an outer surface corresponding to said cavity, said rotation member being journaled for rotation in said cavity;

wherein said rotation member has an inner surface defining a cylindrical bore through said rotation member and centred on a longitudinal axis of said rotation member, the cylindrical bore being configured to receive a tubular member, where said moveable joint further comprises a releasable locking mechanism for releasably

locking a tubular member in said cylindrical bore so that when said tubular member is locked in said cylindrical bore said tubular member and said rotation member are fixed with respect to one another and are rotatable relative to said socket member.

[0006] Preferably, said cavity corresponds to a spherical segment and said rotation member is a ball member that has an outer surface corresponding to a spherical segment that is complementary to said cavity. Said ball member preferably has three rotational degrees of freedom with respect to said socket member.

[0007] The moveable joint preferably further comprises one or more limiting members that are arranged to limit rotational movement of the rotation member relative to the socket member.

[0008] The locking mechanism comprises a cage connected to the rotation member and having a plurality of windows partially closing recesses in the inner surface of said rotation member, which recesses are elongate in a longitudinal direction parallel the longitudinal axis, house a roller and have a base inclined in said longitudinal direction so that at a lower end of each recess the roller protrudes through said window and at an upper end thereof the roller protrudes less or not at all. Said rotation member preferably comprises an outer sleeve having a frusto-conical bore centered on said longitudinal axis, a clamp member in the sleeve formed by clamp-segments, each having side faces, end faces, a frusto-conical exterior surface adapted to match said frusto-conical bore, and a cylindrical interior surface defining said cylindrical bore, wherein said cage comprises a cage-segment in respect of each clamp-segment. Further preferably, each of said clamp segments has a lift eye by which said clamp elements may be lifted with respect to said sleeves so that said clamp-segments slide up said frusto-conical bore separating from one another in a peripheral direction as they progress.

[0009] A key on one of said frusto-conical surfaces is preferably engageable in a groove in the other of said frusto-conical surfaces such that torque applied to said clamp-segments is transmitted to said sleeve. Said key is preferably slidable in said slot and said key and said slot are parallel the cone angle of said frusto-conical surfaces.

[0010] In one preferable arrangement, there are three clamp-segments.

[0011] In a further or alternative preferable arrangement, a bias mechanism urges said clamp-segments apart from each other in a peripheral direction, where said bias mechanism is preferably a spring disposed between said side faced of the clamp segments.

[0012] Between a clamp position and an open position of the moveable joint, the clamp-segments preferably move from a position in which the arcs of the cage-segments lie in a

common cylindrical surface and the frusto-conical surfaces are flush with each other, to a release position in which said side faces are spaced from one another and said frusto-conical surfaces have only line contact between them.

[0013] In one preferable embodiment, said frusto-conical surfaces are part-cylindrical surfaces that are inclined toward said longitudinal axis.

[0014] Said rollers are preferably balls and said recesses preferably have a semi-circular base of diameter substantially equal to the diameter of the balls.

[0015] In one preferable arrangement, one or both of the outer surface of the rotation member and the inner surface of the socket member comprise a low friction surface so as to permit rotation of the rotation member relative to the socket member. In a further or alternative arrangement, the moveable joint further comprises bearings between the rotation member and the socket member so as to permit rotation of the rotation member relative to the socket member.

[0016] In one preferable embodiment, said cylindrical bore passes through the rotation member such that the cylindrical bore has two open ends, the socket member being configured around said rotation member such that a tubular member may protrude from both of the open ends of the cylindrical bore. Said socket member preferably comprises two socket segments that are connectable to one another around said rotation member.

[0017] Alternatively, said cylindrical bore is a blind bore such that the cylindrical bore has only one open end, the socket member being configured around said rotation member such that a tubular member may protrude from the open end of the cylindrical bore.

[0018] The moveable joint preferably includes a tubular member, where preferably said tubular member is one of a wellbore casing member, a drill string tubing member, a pipe member, a collared tubing member, and a steel catenary riser (SCR).

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Embodiments of the invention are further described hereinafter with reference to the accompanying drawings, in which:

Figure 1 is a cut-away view of a moveable joint in accordance with an embodiment of the present invention;

Figure 2 is a cross-sectional view of a moveable joint in accordance with an embodiment of the present invention; and

Figure 3 is a detailed cross-sectional view of part of the moveable joint of Figure 3.

DETAILED DESCRIPTION

[0020] Figure 1 shows a cut-away view of a moveable joint 10 in accordance with an embodiment of the present invention. The joint 10 includes a socket member 12 and a rotation member 14 rotatable in the socket member 12. The socket member 12 has an inner surface 13 defining a cavity and the rotation member 14 has an outer surface 16a corresponding to the cavity formed by the inner surface 13 of the socket member 12. In the embodiment of Figure 1, the socket member 12 is formed of two socket segments 12a,12b that connect to one another around the rotation member 14.

[0021] The rotation member 14 has an inner surface 22 defining a substantially cylindrical bore in the rotation member 14 that is configured to receive a tubular member 100. The tubular member may be one of, but is not necessarily limited to being, a wellbore casing member, a drill string tubing member, a pipe member, a collared tubing member, and a steel catenary riser (SCR). Indeed, the present invention is suited for use with any suitable substantially tubular member.

[0022] The joint 10 further includes a releasable locking mechanism (which will be described in more detail below) for releasably locking the tubular member 100 in the cylindrical bore of the rotation member 14. When the tubular member 100 is locked to the rotation member 14 by the locking mechanism, the tubular member 100 and the rotation member 14 are substantially fixed with respect to one another and are moveable as a connected unit such that the rotation member 14 and tubular member 100 are rotatable in the cavity of the socket member 12.

[0023] In the specific embodiment shown in Figure 1, the rotation member 14 is a ball member that has an outer surface corresponding to a spherical segment that is complementary to cavity of the socket member 12. Indeed, the cavity of the socket member 12 also corresponds to a spherical segment in the embodiment of Figure 1. The ball member 14 has three rotational degrees of freedom with respect to the socket member 12. Indeed, the ball member 14 (and tubular member 100 when locked therein) is rotatable about each of x, y and z axes indicated in Figure 1. The joint 10 may include limiting members that are positioned and configured to limit rotational movement of the ball member 14 relative to the socket member 12. For example, the limiting members may be placed so as to prevent the tubular member 100 contacting the socket member 12 through rotation of the ball member 14.

[0024] The ball member 14 of Figure 1 comprises an outer sleeve 16 whose outer surface is the outer surface 16a of the ball member 14. The outer sleeve 16 has an inner surface 16b defining a frusto-conical bore which is centered on a longitudinal axis 200 of the ball member 14 (see Figure 2). Disposed within the frusto-conical bore is a clamp member 18 formed of three clamp-segments 18a,18b,18c. Each of the clamp segments 18a,18b,18c has side faces 19d, end faces 19b,19c and a frusto-conical exterior surface 19a adapted to match the frusto-conical bore of the outer sleeve 16. In preferable embodiments (not shown in the Figures), there is a key on one or more of the frusto-conical surfaces 19a,16b that is engageable in a groove in the other of the frusto-conical surfaces 19a,16b so that torque applied to the clamp segments 18a,18b,18c (e.g. by movement of the tubular member 100 fixed therein) is transmitted to the sleeve 16 so that the ball member 14 as a whole rotates relative to the socket member 12. In particularly preferable embodiments, the key is slidable in the slot and both of the key and the slot are orientated parallel to the cone angle of the frusto-conical surfaces 19a,16b.

[0025] The clamp segments 18a,18b,18c are removable from the sleeve 16 such that they may be assembled in the sleeve 16 around the tubular member 100. This arrangement allows a tubular member 100 with flanged or otherwise radially protruding parts to pass through the ball member 14 prior to the clamp member 18 (i.e. the clamp segments 18a,18b,18c forming the clamp member 18) being assembled in the frusto-conical bore of the sleeve 16 around the tubular member 100.

[0026] When assembled, the clamp segments 18a,18b,18b are disposed with their side faces 19 abutting the side faces 19 of the adjacent clamp segments 18a,18b,18c. The clamp segments 18a,18b,18c may include a bias mechanism that urges the clamp segments apart from each other in a peripheral direction so that when the clamp segments are move upward out of the frusto-conical bore, they are urged apart. The bias mechanism is preferably a spring disposed between the side faces 19 of the clamp segments 18a,18b,18c.

[0027] Inner surfaces of the clamp segments 18a,18b,18c include a plurality of recesses 24 that each house (partially, at least) a roller 26. Additionally, a cage 28 circumvents the cylindrical bore where an inner surface of the cage 28 is the inner surface 22 of the ball member 14 which defines the cylindrical bore. The cage 28 is formed of cage segments (not shown individually) where each cage segment is associated with one of the clamp segments 18a,18b,18c. The cage 28 has a plurality of windows 18a that partially close the recesses 24. Each of the recesses is elongate in a longitudinal direction parallel to the longitudinal axis and has a base inclined in the longitudinal direction so that at a lower end 24a of each recess 24 the roller 26 protrudes through the window 28a (as shown in

Figures 2 and 3), and at an upper end 24b of the recess 24 the roller 26 protrudes less or not at all (not shown). The cage segments are connected to the clamp segments 18a,18b,18c by a collar 20, which is also formed in segments 20a,20b,20c

[0028] As described above, the clamp segments 18a,18b,18c are moveable between a clamp position and an open position (i.e. assembled and non-assembled) where in the clamp position the arcs of the cage segments lie in a common cylindrical surface and the frusto-conical surfaces 19a,16b are flush with each other, and in the open position the side faces 19 are spaced from one another and said frusto-conical surfaces 19a,16b have only line contact between them. The clamp segments 18a,18b,18c may each have a lift eye by which they may be lifted with respect to the sleeve 16 so that the clamp segments 18a,18b,18c slide up the frusto-conical bore, separating from one another in a peripheral direction as they progress.

[0029] In one embodiment, the frusto-conical surfaces 19a,16b are part-cylindrical surfaces that are inclined toward the longitudinal axis 200.

[0030] In use, a tubular member 100 is positioned in the cylindrical bore and moved downwards (as indicated by direction A in Figure 3) relative to the ball member 14. The rollers 26 are caused to move downwards towards the lower ends 24a of the recesses so that they progressively protrude further (i.e. radially inwardly) through the windows 28a and bite into the tubular member 100 to "lock" the tubular member 100 relative to the ball member 14. In order to release the tubular member 100 from the ball member 14, the tubular member 100 must be moved upwards (as indicated by direction B in Figure 3) relative to the ball member 14 so that the rollers 26 are caused to move towards the upper ends 24b of the recesses 24 where they protrude less and permit further movement of the tubular member 100 relative to the ball member 14. Thus, the arrangement of rollers 26 in recesses 24 provides a releasable locking mechanism that releasably connects the tubular member 100 to the ball member 14. As discussed above, when the tubular member 100 is locked with respect to the ball member 14, the tubular member 100 and ball member 14 are together rotatable as a unit relative to the socket 12.

[0031] Each of the rollers 26 may be or comprise a substantially spherical member, such as a steel ball bearing. However, other materials and shapes are also within the scope of the present disclosure. For example, each of the rollers 26 may alternatively be a cylindrical or tapered pin configured to roll up and down the ramps defined by the recesses 24.

[0032] Additionally or alternatively, the cage 28 (or its individual cage segments) can be biased in a direction parallel the longitudinal axis 200 so as to bias the rollers 26. This arrangement can permit smaller windows 28a in the cage 28 that permit the rollers 26 to

protrude therefrom but not fall out. The biased cage 28 can be moved axially (i.e. up or down parallel the longitudinal axis 200) to bias the rollers 26 to the upper end 24b or lower end 24a of the recesses 24, moving between an engaging and disengaging position, respectively. The biased cage 28 may be mechanically sprung or hydraulically driven.

[0033] Although the above-described embodiment is a particularly preferable arrangement of the moveable joint 10 of the present invention, the present invention is not limited to that specific arrangement. Indeed, the rotation member 14 may have a shape that is not a spherical segment (e.g. to form a condyloid joint) where the cavity formed by the socket member 12 corresponds to the shape of the rotation member 14.

[0034] The outer surface 16a of the rotation member 14 and/or the inner surface 13 of the socket member 12 may be configured to be low friction such that movement of the rotation member 14 relative to the socket member 12 is permitted. Indeed, the friction of the surfaces 16a,13 may be configured so that a desired amount or rate of relative movement of the rotation member 14 relative to the socket member 12 is permitted. Additionally or alternatively, bearing members and/or lubricants may be disposed between the rotation member 14 and the socket member 12 so as to permit relative movement therebetween.

[0035] The cylindrical bore of the rotation member 16 may pass entirely through the rotation member 16 such that the cylindrical bore has two open ends (as shown in the Figures). Alternatively, the cylindrical bore may be a blind bore having just a single open end such that the cylindrical bore does not pass entirely through the rotation member 16. In either case, the socket member 12 should be configured around the rotation member 14 so that rotation of the rotation member 14 is permitted and the tubular member 100 is accommodated by the socket member 12.

[0036] The rotation member 14 has been described as being composed of various segmented components. The skilled person will appreciate that the precise number of segments described is not limiting and that the invention may comprise any suitable number of segments. In alternative embodiments, for example, the rotation member 14 may be formed of whole non-segmented components as opposed to the described segmented components. Indeed, the rotation member 14 may consist of a single component and a locking mechanism for locking the tubular member 100 to the rotation member 14.

[0037] In use the socket member 12 may be fixed to a rig or other structure so that the tubular member 100 locked to the rotation member 14 may move relative to the socket member 12 and the structure that it is attached to but remain axially fixed (i.e. along a direction parallel to the longitudinal axis 200) relative to the socket member 12 and the

structure that it is attached to. Amongst other advantages, the present invention provides an arrangement where the tubular member 100 and/or the structure to which the socket member 12 is attached to experience lower fatigue and stresses whilst maintaining a connection therebetween.

[0038] Throughout the description and claims of this specification, the words "comprise" and "contain" and variations of them mean "including but not limited to", and they are not intended to (and do not) exclude other moieties, additives, components, integers or steps. Throughout the description and claims of this specification, the singular encompasses the plural unless the context otherwise requires. In particular, where the indefinite article is used, the specification is to be understood as contemplating plurality as well as singularity, unless the context requires otherwise.

[0039] Features, integers, characteristics, compounds, chemical moieties or groups described in conjunction with a particular aspect, embodiment or example of the invention are to be understood to be applicable to any other aspect, embodiment or example described herein unless incompatible therewith. All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive. The invention is not restricted to the details of any foregoing embodiments. The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

[0040] The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

CLAIMS

1. A moveable joint suitable for connection with a tubular member, comprising:

a socket member having an inner surface defining a cavity; and

a rotation member having an outer surface corresponding to said cavity, said rotation member being journaled for rotation in said cavity;

wherein said rotation member has an inner surface defining a cylindrical bore through said rotation member and centred on a longitudinal axis of said rotation member, the cylindrical bore being configured to receive a tubular member, where said moveable joint further comprises a releasable locking mechanism for releasably locking a tubular member in said cylindrical bore so that when said tubular member is locked in said cylindrical bore said tubular member and said rotation member are fixed with respect to one another and are rotatable relative to said socket member; and

wherein said locking mechanism comprises a cage connected to the rotation member and having a plurality of windows partially closing recesses in the inner surface of said rotation member, which recesses are elongate in a longitudinal direction parallel the longitudinal axis, house a roller and have a base inclined in said longitudinal direction so that at a lower end of each recess the roller protrudes through said window and at an upper end thereof the roller protrudes less or not at all.

2. A moveable joint according to claim 1, wherein said cavity corresponds to a spherical segment and said rotation member is a ball member that has an outer surface corresponding to a spherical segment that is complementary to said cavity.

3. A moveable joint according to claim 2, wherein said ball member has three rotational degrees of freedom with respect to said socket member.

4. A moveable joint according to any preceding claim, further comprising one or more limiting members that are arranged to limit rotational movement of the rotation member relative to the socket member.

5. A moveable joint according to any preceding claim, wherein said rotation member comprises an outer sleeve having a frusto-conical bore centered on said

longitudinal axis, a clamp member in the sleeve formed by clamp-segments, each having side faces, end faces, a frusto-conical exterior surface adapted to match said frusto-conical bore, and a cylindrical interior surface defining said cylindrical bore, wherein said cage comprises a cage-segment in respect of each clamp-segment.

6. A moveable joint according to claim 5, wherein each of said clamp segments has a lift eye by which said clamp elements may be lifted with respect to said sleeves so that said clamp-segments slide up said frusto-conical bore separating from one another in a peripheral direction as they progress.

7. A moveable joint according to claim 5 or 6, wherein a key on one of said frusto-conical surfaces is engageable in a groove in the other of said frusto-conical surfaces such that torque applied to said clamp-segments is transmitted to said sleeve.

8. A moveable joint according to claim 7, wherein said key is slidable in said slot and said key and said slot are parallel the cone angle of said frusto-conical surfaces.

9. A moveable joint according to any of claims 5 to 8, wherein there are three clamp-segments.

10. A moveable joint according to any of claims 5 to 9, wherein a bias mechanism urges said clamp-segments apart from each other in a peripheral direction, where said bias mechanism is preferably a spring disposed between said side faced of the clamp segments.

11. A moveable joint according to any of claims 5 to 10, wherein between a clamp position and an open position of the moveable joint, the clamp-segments move from a position in which the arcs of the cage-segments lie in a common cylindrical surface and the frusto-conical surfaces are flush with each other, to a release position in which said side faces are spaced from one another and said frusto-conical surfaces have only line contact between them.

12. A moveable joint according to any of claims 5 to 10, wherein said frusto-conical surfaces are part-cylindrical surfaces that are inclined toward said longitudinal axis.

13. A moveable joint according to any preceding claim, wherein said rollers are balls and said recesses have a semi-circular base of diameter substantially equal to the diameter of the balls.

14. A moveable joint according to any preceding claim, wherein one or both of the outer surface of the rotation member and the inner surface of the socket member comprise a low friction surface so as to permit rotation of the rotation member relative to the socket member.

15. A moveable joint according to any of claims 1 to 13, further comprising bearings between the rotation member and the socket member so as to permit rotation of the rotation member relative to the socket member.

16. A moveable joint according to any preceding claim, wherein said cylindrical bore passes through the rotation member such that the cylindrical bore has two open ends, the socket member being configured around said rotation member such that a tubular member may protrude from both of the open ends of the cylindrical bore.

17. A moveable joint according to claim 16, wherein said socket member comprises two socket segments that are connectable to one another around said rotation member.

18. A moveable joint according to any of claims 1 to 15, wherein said cylindrical bore is a blind bore such that the cylindrical bore has only one open end, the socket member being configured around said rotation member such that a tubular member may protrude from the open end of the cylindrical bore.

19. A moveable joint according to any preceding claim, including a tubular member.

20. A moveable joint according to claim 19, wherein said tubular member is one of a wellbore casing member, a drill string tubing member, a pipe member, a collared tubing member, and a steel catenary riser (SCR).

21. A moveable joint for connection with a tubular member substantially as hereinbefore described with reference to the accompanying drawings.

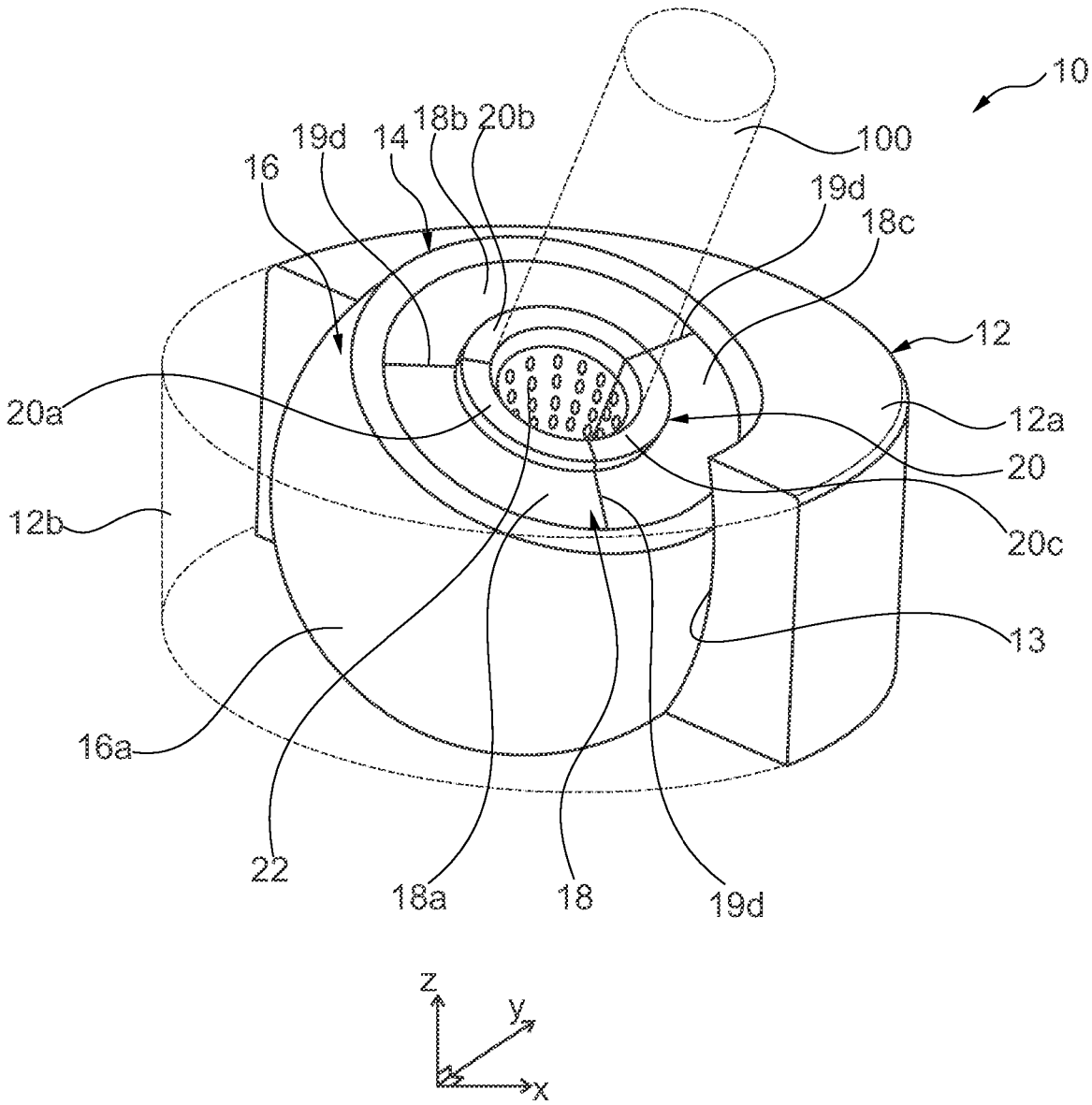
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Fig. 1

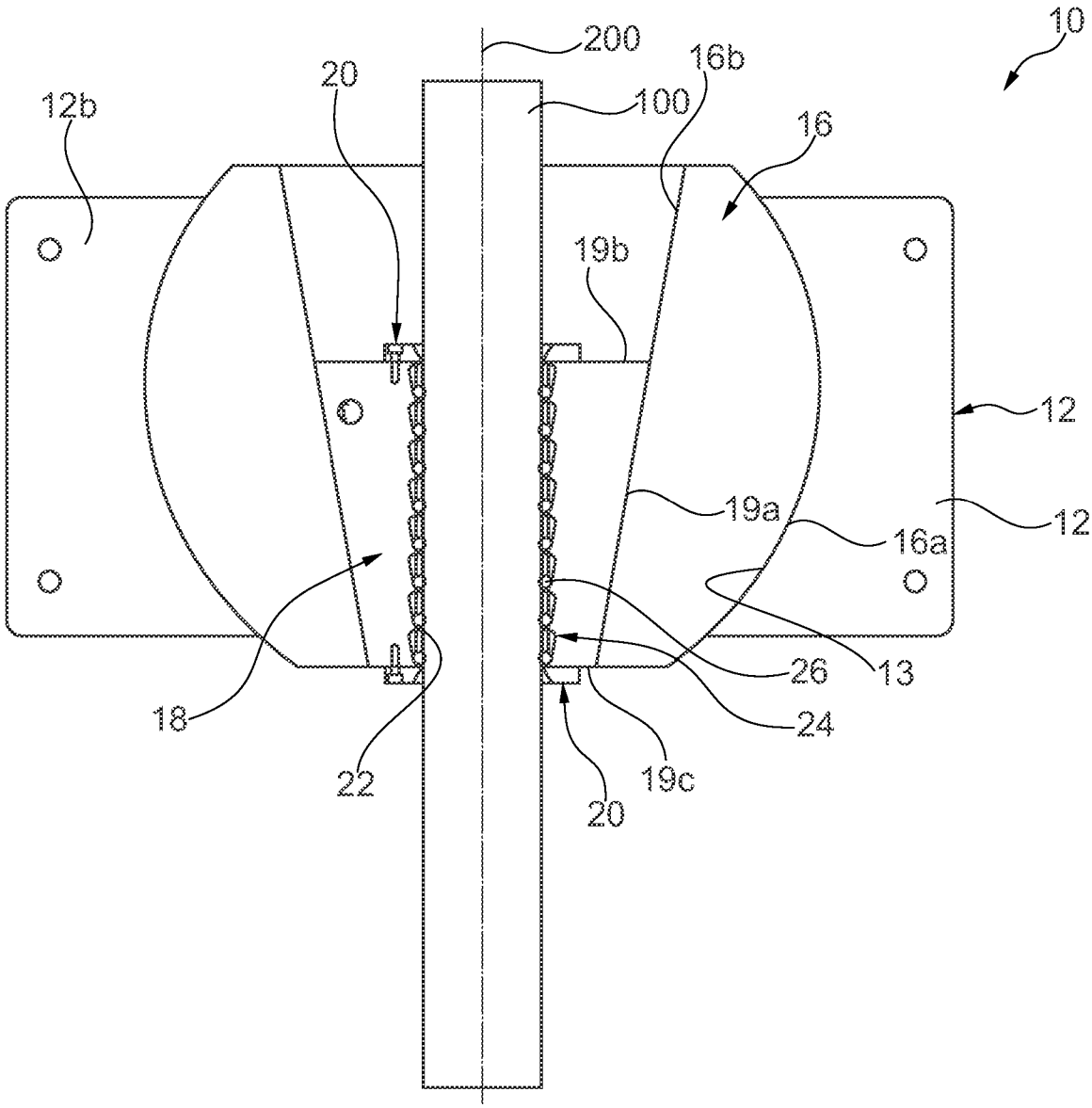

Fig. 2

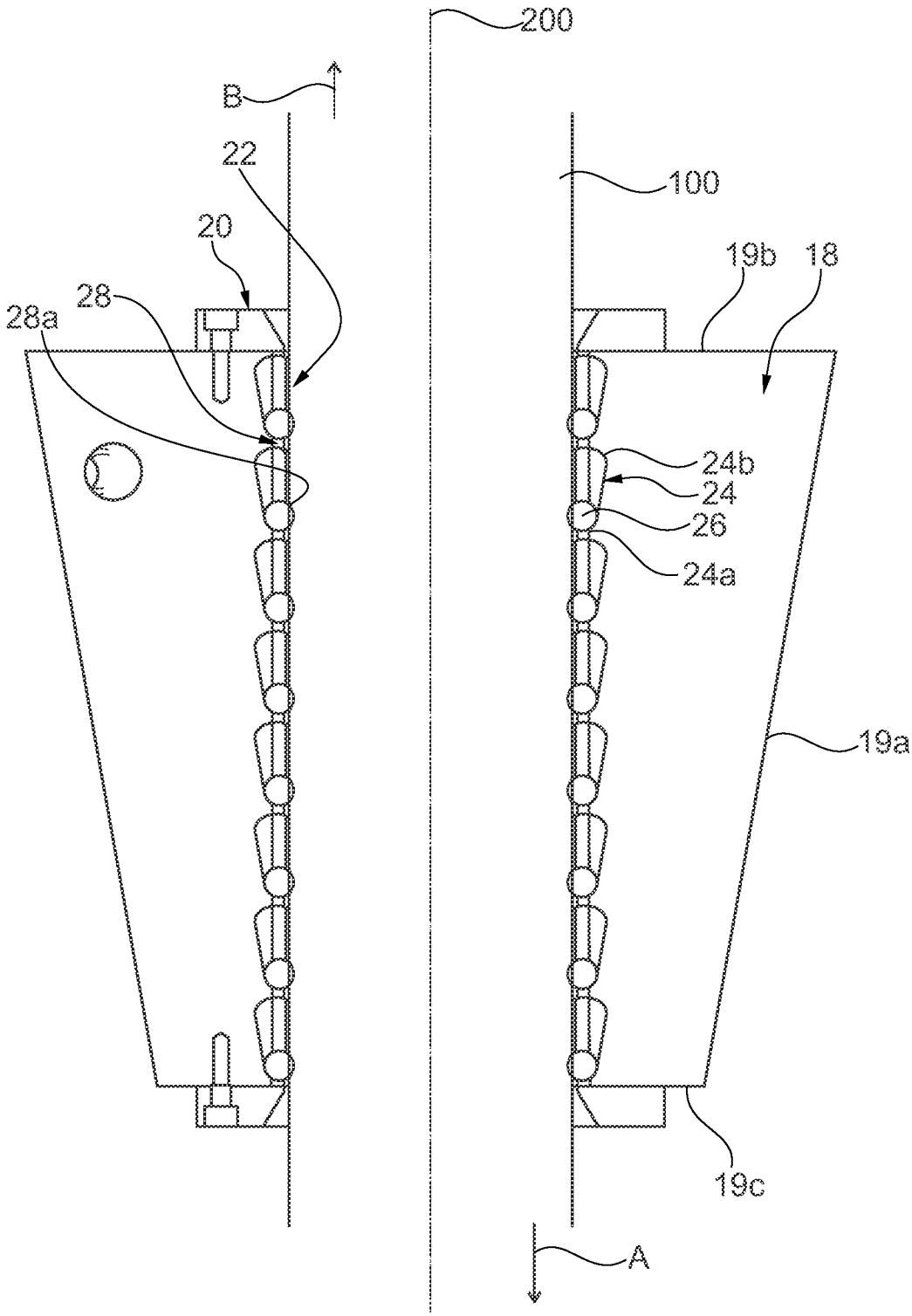

Fig. 3