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(54) **Mechanical device comprising a bearing and a lubrication system, implementing machine and method**

Mechanische Vorrichtung mit einem Lager und einem Schmiersystem, Inbetriebnahmevorrichtung und -verfahren

Dispositif mécanique comprenant un palier et un système de lubrification, machine de mise en oeuvre et procédé

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(73) Proprietors:
- **SKF Aerospace France**
  26240 Saint-Vallier (FR)
- **Aktiebolaget SKF**
  415 50 Göteborg (SE)

(72) Inventors:
- **Aury, Alexandre**
  07300 Tournon-sur-Rhône (FR)
- **Deloeil, Pascal**
  59171 Helesmes (FR)
- **Doki-Thonon, Thomas**
  26000 VALENCE (FR)

(74) Representative: **Lavoix**
62, rue de Bonnel
69448 Lyon Cedex 03 (FR)

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Description

[0001] The present invention relates to a mechanical device, comprising a bearing and a lubrication system. The invention also relates to a machine comprising at least one such mechanical device and a method for implementing such a mechanical device. The field of the invention is the lubrication of bearings, in particular rolling bearings, ball and socket joints or smooth bearings.

[0002] Traditionally, a rolling bearing comprises a fixed ring and a ring rotatable around a central axis, for example a fixed inner ring and a movable outer ring. An interface is defined between the rings, in this case a rolling path for example receiving balls or rollers. The rolling path receives a lubricant stream to allow satisfactory operation of the rolling bearing.

[0003] In a high acceleration application, for example a satellite rolling bearing equipping a planetary gear, the rolling bearing is subjected to a significant acceleration field, in other words a significant centrifugal force. In practice, this centrifugal force tends to push the lubricant toward a particular zone of the rolling bearing. Consequently, the rolling bearing is not regularly lubricated, which can cause premature failures in poorly lubricated zones. Additionally, the risk of drag loss increases in the excessively lubricated zone.

[0004] To resolve this lubricant distribution problem, it is known to implement an oil jet directed at the interface between the rings of the rolling bearing, in the zone outside which the lubricant is pushed by centrifugation. Such a solution is not suitable for all applications, in particular for bulk reasons. Furthermore, when the rolling bearing comprises several rows of rolling elements, the central rows are insufficiently lubricated compared to the lateral rows receiving the oil jet.

[0005] When the loads are low, it is known to use a hydrodynamic bearing or smooth bearing instead of a rolling bearing. Here again, such a solution is not suitable for all applications.

[0006] US-A-5 106 209 which describes the preamble of appended claim 1, discloses a mechanical device, comprising a bearing and a lubrication system which includes peripheral channels passing through the rotating ring of the bearing. The flow rate of lubricant in the peripheral channels is different in a first zone and in a second zone delimited along the central axis of the bearing.

[0007] The aim of the present invention is to propose an improved mechanical device, comprising a bearing and a lubrication system.

[0008] To that end, the invention relates to a mechanical device, comprising: a bearing including a fixed ring and a pivoting ring that are centered on a central axis and include an interface defined between them, for example a rolling path or a sliding surface; and a system for lubricating the interface, configured to bring a flow of lubricant from at least one supply channel to the interface through the fixed ring; in which an acceleration field tends to push the stream of lubricant from a first zone to a second zone of the bearing, each defining an angular sector around the central axis. The mechanical device is such that the lubrication system comprises a set of peripheral channels passing through the fixed ring and including, on the one hand, first channels that are positioned in the first zone and that define a first intake flow rate of lubricant to the interface and, on the other hand, second channels that are positioned in the second zone and that define a second intake flow rate up to the interface, the first intake flow rate being greater than the second intake flow rate, such that the interface between the rings of the bearing receives a greater quantity of lubricant in the first zone than in the second zone. The first zone and the second zone are diametrically opposite relative to the central axis, with a clockwise shift of the first zone, to counter the effects of the counterclockwise rotation of the outer ring and the mechanical loading of the bearing, as described in the appended claims.

[0009] Thus, the invention makes it possible to optimize the distribution of lubricant in the different zones of the bearing, thereby improving the operation and lifetime of the bearing. The lubrication is done through the fixed ring, below the interface between the rings of the bearing, i.e., below the rolling path when the bearing is a rolling bearing. Since the lubricant tends to migrate by centrifugation from the first zone to the second zone, the channels are distributed so as to bring more lubricant directly into the first zone of the bearing.

[0010] According to other advantageous features of the invention, considered alone or in combination:

- The first zone including the first channels and the second zone including the second channels each define an angular sector with an apical angle smaller than or equal to 180 degrees around the central axis, preferably an angular sector with an apical angle smaller than or equal to 90 degrees for the first zone and an angular sector with an apical angle smaller than or equal to 150 degrees for the second zone.
- The lubrication system comprises a number of first channels greater than the number of second channels.
- Each of the first channels has a section defining a first diameter, each of the second channels has a section defining a second diameter, and the first diameter is larger than the second diameter.
- Each of the first channels is separated by an angle comprised between 2 and 30 degrees around the central axis relative to an adjacent channel among the first channels, in the clockwise or counterclockwise direction.
- Each of the second channels is separated by an angle comprised between 45 and 75 degrees around the central axis relative to an adjacent channel among the second channels, in the clockwise or counterclockwise direction.
- Each of the first channels is inclined in the clockwise or counterclockwise direction by an angle comprised

between 0 and 30 degrees relative to a radial plane comprising the central axis and comprising the junction zone between a first channel and a distributing channel with an annular shape centered on the central axis.

- The lubrication system comprises at least one distributing channel that connects a set of first channels and/or second channels to each other and the overall lubricant flow rate flowing in the distributing channel(s) is greater in the first zone than the second zone.
- The lubrication system comprises several distributing channels positioned along the central axis, including at least one distributing channel that connects a set of first channels and/or second channels to each other and that extends both in the first zone and the second zone.
- The bearing comprises several rows of rolling elements positioned along the central axis and the lubrication system comprises, for each row of rolling elements, at least one distributing channel that connects a set of first channels and/or second channels to each other.
- For each row of rolling elements, the lubrication system comprises a number of first channels greater than the number of second channels.
- The supply channel is connected to the distributing channel(s) by junction channels situated in the first zone.
- The bearing is a rolling bearing, while the interface is a rolling path.
- The bearing is a ball joint or a smooth bearing and the interface is a sliding surface.
- The fixed ring is the inner ring of the bearing and the pivoting ring is the outer ring of the bearing.

[0011] The invention also relates to a machine comprising at least one such mechanical device. As an example, this machine may be a high-power planetary reduction gear.

[0012] The invention also relates to a method for implementing a mechanical device as described above. According to the invention, the method comprises at least the following successive steps:

a) forming orifices through the fixed ring of the bearing, these orifices being configured to receive the lubrication system and define the peripheral intake channels bringing a stream of lubricant to the interface between the rings of the bearing;

b) assembling the lubrication system and the bearing; and

c) supplying lubricant to the lubrication system, such that the interface between the rings of the bearing receives a larger quantity of lubricant in the first zone than the second zone.

[0013] The invention will be better understood upon reading the following description, provided solely as a non-limiting example and done in reference to the appended drawings, in which:

- figure 1 is a perspective view of a mechanical device according to the invention, comprising a bearing of the rolling bearing type and a lubrication system, partially shown for simplification purposes;
- figure 2 is a view along arrow II in figure 1;
- figure 3 is a cross-section along line III-III in figure 2; and
- figure 4 is another perspective view, from another angle and on another scale, showing a second embodiment of a mechanical device according to the invention, comprising several bearings positioned in parallel and a lubrication system partially shown for simplification purposes.

[0014] Figures 1 to 3 show a mechanical device 1 according to the invention.

[0015] The mechanical device 1 comprises a bearing 10 of the rolling bearing type and a lubrication system 20 suitable for receiving that rolling bearing 10. The device 1, the rolling bearing 10 and the lubrication system 20 are partially shown for simplification purposes, as described below. Figure 2 shows a vertical plane Pv and a horizontal plane Ph to facilitate spatial identification.

[0016] The rolling bearing 10 comprises a fixed inner ring 12, a pivoting outer ring 14 and an interface 16 situated between the rings 12 and 14. The ring 12 is fixed relative to a central axis X10 of the rolling bearing 10, while the ring 14 is rotatable around the central axis X10 of the rolling bearing 10. The interface 16 is formed by a rolling path provided to receive at least one row of rolling elements, for example balls or rollers 18. The inner ring 12 is not shown in figures 1 and 2, while the rollers 18 are not shown in figure 1, for simplification reasons. In figure 3, a tubular shaft 100 is mounted in the inner ring 12.

[0017] In the example of figures 1 to 3, the mechanical device 1 is provided to equip a planetary reduction gear. To that end, the outer ring 14 of the rolling bearing 10 includes teeth 140. In other words, the outer ring 14 forms a gear.

[0018] The lubrication system 20 comprises different types of fluid tunnels or channels 22, 24, 26, 28 and 30, embodied by a lubricant stream L in figures 1 to 3. The flow of the lubricant stream L is depicted by arrows, while the conduits delimiting those channels are not shown in figures 1 to 3, for simplification reasons. These conduits are preferably made from metal or plastic.

[0019] The lubrication system 20 is configured to bring the lubricant stream L from a supply channel 22 to the interface 16 formed by a rolling path, through the inner ring 12. The lubrication system 20 comprises the supply channel 22 connected to distributing channels 24 by junction channels 26 and 28, as well as peripheral channels 30 that extend from the distributing channels 24 through the inner ring 12. The supply channel 22 extends parallel to the central axis X10 of the rolling bearing 10. Each of the distributing channels 24 has an annular shape centered on the central axis X10. Radial junction channels 26 extend radially to the axis X10 between the channels 22 and 24. Axial junction channels 28 extend parallel to the axis X10 and the channel 22, between some of the channels 24. The peripheral channels 30 extend radially to the axis X10 from the distributing channels 24, moving away from the axes X10, up to the interface 16 between the rings 12 and 14.

[0020] In practice, an acceleration field G tends to push the lubricant stream L from a first zone Z1 to a second zone Z2 of the rolling bearing 10. In the example of figures 1 to 3, the acceleration field G is oriented upward, in connection with the particular application of the mechanical device 1. The zone Z1 may be described as the lower zone, while the zone Z2 may be described as the upper zone. The zones Z1 and Z2 each define an angular sector with an apical angle smaller than or equal to 180 degrees around the central axis X10.

[0021] In the context of the invention, the peripheral channels 30 include, on the one hand, first channels 31 that are positioned in the first zone Z1 and second channels 32 that are positioned in the second zone Z2. In the example of figures 1 to 3, the first zone Z1 including the first channels 31 defines an angular sector with an apical angle $\alpha 1$ smaller than or equal to 90 degrees around the axis X10, while the second zone Z2 including the second channels 32 defines an angular sector with an apical angle $\alpha 2$ smaller than or equal to 150 degrees around the axis X10. In other words, the first channels 31 are distributed in an angular sector with an apical angle $\alpha 1$ smaller than or equal to 90 degrees around the axis X10, while the second channels 32 are distributed in an angular sector with an apical angle $\alpha 2$ smaller than or equal to 150 degrees around the axis X10. Overall, the zones Z1 and Z2 are diametrically opposite relative to the central axis X10, with a clockwise shift of zone Z1 to counter the effects of the counterclockwise rotation of the outer ring 14 and the mechanical loading of the rolling bearing 10.

[0022] The first channels 31 jointly define a first intake flow rate Q31 for bringing lubricant L to the interface 16. The second channels 32 jointly define a second intake flow rate Q32 for bringing lubricant L to the interface 16. According to the invention, the first flow rate Q31 is greater than the second flow rate Q32. Thus, the interface 16 receives a greater quantity of lubricant L in the first zone Z1 relative to the second zone Z2, so as to counter the effects of the acceleration field.

[0023] Preferably, the lubrication system 20 comprises a number of first channels 31 greater than the number of second channels 32. Each of the first channels 31 has a section defining a first diameter d31. Each of the second channels 32 has a section defining a second diameter d32. Preferably, the first diameter d31 is larger than the second diameter d32. In the case where the first channels 31 have different diameters d31 from each other and the second channels 32 have different diameters d32 from each other, the smallest of the first diameters d31 is preferably larger than the largest of the second diameters d32.

[0024] In the example of figures 1 to 3, the lubrication system 20 comprises four distributing channels 24, the supply channel 22 and the junction channels 26 are positioned only in zone Z1, while the axial junction channels 28 are positioned only in zone Z2. More specifically, the system 20 includes two distributing channels 24 situated in zone Z1, one distributing channel 24 situated in zones Z1 and Z2, and one distributing channel situated in zone Z2. The channels 24 in the first zone Z1 have a section with width d241 radially to the central axis X10. The channel 24 in the first zone Z2 has a section with width d242 radially to the central axis X10. The width d241 is greater than the width d242. Preferably, the overall flow rate of lubricant L flowing in the channels 24 of zone Z1 is greater than the overall flow rate of lubricant L flowing in the channels 24 of zone Z2.

[0025] The configuration of the lubrication system 20 makes it possible to maximize pressure losses in zone Z2 relative to zone Z1, i.e., the lubricant L travels for a longer time to reach zone Z2, toward which the acceleration field G pushes it. Without this, the lubricant L would go directly towards zone Z2 without lubricating zone Z1 of the rolling bearing 10.

[0026] In figure 2, there are seven first channels 31 referenced 311, 312, 313, 314, 315, 316 and 317, and three second channels 32 referenced 321, 322 and 323 in the counterclockwise direction. Other channels 31 and 32 are situated on the same spokes designed around the axis X10 and are not visible in figure 2.

[0027] In practice, the first channels 31 are generally closer to each other than the second channels 32. Preferably in the context of the invention, each of the first channels 31 is separated by an angle comprised between 2 and 30 degrees around the axis X10 relative to an adjacent channel among the first channels 31, in the clockwise or counterclockwise direction, while each of the second channels 32 is separated by an angle comprised between 45 and 75 degrees around the axis X10 relative to an adjacent channel among the second channels 32, in the clockwise or counterclockwise direction. Furthermore, several channels 31 and/or several channels 32 can be situated in the same plane including the axis X10, as shown in figure 2.

[0028] In the example of figures 1 to 3, each of the first channels 31 extends radially to the axis X10. For example, figure 2 shows an angle β between the channel 316 and a plane tangent to the channel 24 is equal to 90 degrees. In an alternative that is not shown, each of the first channels 31 may be inclined in the clockwise or counterclockwise direction by an angle comprised between 0 and 30 degrees, inclusive, relative to a radial plane comprising the central axis X10 and comprising the junction zone between channels 31 and the channel 24. In that case, the angle β is comprised between 60 and 90 degrees, inclusive. This configuration makes it possible to direct the lubricant stream L leaving the first channels 31 preferably in the clockwise or counterclockwise direction.

[0029] In the example of figure 3, the channels 22 and 26 extend through the shaft 100, while the channels 24 and 30 extend through the inner ring 12 of the rolling bearing 10. Other arrangements can be considered without going beyond the scope of the invention.

[0030] The method for implementing the mechanical device 1 is outlined below.

[0031] According to the invention, the method comprises at least the following successive steps a), b) and c).

[0032] Step a) consists of forming orifices 120 through the fixed ring 12 of the rolling bearing 10. These orifices 120 are configured to receive the lubrication system 20 and limit the peripheral intake channels 30 for bringing the lubricant stream L to the interface 16 between the rings 12 and 14 of the rolling bearing 10. Step b) consists of assembling the lubrication system 20 and the rolling bearing 10. The conduits of the system 20 are positioned in the inner space defined by the inner ring 12; in particular, the conduits defining the channels 30 are inserted into the orifices 120. Step c) consists of supplying the lubrication system 20 with lubricant L, such that the interface 16 receives a higher quantity of lubricant L in the first zone Z1 than the second zone Z2.

[0033] The arrangement of the lubrication system 20 and orifices 120 can be adapted based on the anticipated application of the mechanical device 1, in order to counter the centrifugal effect and optimize the distribution of lubricant L at the interface 16. The behavior of the rolling bearing 10 during use and its lifetime are improved.

[0034] Figure 4 shows an alternative mechanical device 1, comprising a bearing with several rows, lubricated by a single lubrication system 20. The acceleration field G is oriented downward. The component elements of the device 1 of figure 4 are comparable to those of the first embodiment described above and, for simplification purposes, bear the same numerical references. Also for simplification purposes, the bearing is not shown in figure 4, while conduits of the system 20 defining the channels 22, 24, 26, 28 and 30 are shown.

[0035] In the device 1 of figure 4, the bearing comprises several rows positioned along the central axis X10. In the event the bearing is a rolling bearing, the rows are rows of rolling elements positioned between the inner and outer rings. The lubrication system 20 comprises, for each row, one or two distributing channels 24 that connect a set of first channels 31 and second channels 32 to each other. For each row, the number of first channels 31 is greater than the number of second channels 32.

[0036] Furthermore, the mechanical device 1 can be configured differently from figures 1 to 4 without going beyond the scope of the invention.

[0037] In one favored embodiment of the mechanical device 1, the lubrication system 20 comprises a set of peripheral channels 30 passing through the fixed inner ring 12 of the bearing 10 and including, on the one hand, first channels 31 that are positioned in a first zone Z1 and that define a first intake flow rate Q31 for bringing lubricant L to the interface 16 and, on the other hand, second channels 32 that are positioned in a second zone Z2 and that define a second intake flow rate Q32 bringing lubricant L to the interface 16, the first flow rate Q31 being higher than the second flow rate Q32, such that the interface 16 between the rings 12 and 14 of the bearing 10 receives a larger quantity of lubricant L in the first zone Z1 than the second zone Z2 of the bearing 10.

[0038] In an alternative that is not shown, the inner ring 12 is the rotating or pivoting ring, while the outer ring 14 is the fixed ring of the rolling bearing 10.

[0039] According to another alternative that is not shown, during use, the two rings 12, 14 of the rolling bearing 10 rotate or pivot.

[0040] According to another alternative that is not shown, the lubrication system 20 includes at least one distributing channel 24 that connects a set of first channels 31 and second channels 32 to each other. The system 20 can include different distributing channels 24, each connecting either channels 31 to each other, or channels 32 to each other, or both channels 31 and 32. The overall lubricant flow rate L flowing in the channel(s) 24 is greater in zone Z1 than zone Z2.

[0041] According to another alternative that is not shown, the bearing equipping the device 1 can be a ball and socket joint or a smooth bearing. In that case, the interface 16 is a sliding surface.

[0042] Furthermore, the technical features of the different embodiments and alternatives mentioned above can be combined in whole or in part. Thus, the mechanical device 1 can be adapted in terms of cost and performance.

Claims

1. A mechanical device (1), comprising:

- a bearing (10) including a fixed ring (12) and a pivoting ring (14) that are centered on a central axis (X10) and include an interface (16) defined between them, for example a rolling path or a sliding surface; and
- a system (20) for lubricating the interface (16), configured to bring a flow of lubricant (L) from at least one supply channel (22) to the interface (16) through the fixed ring (12);

in which an acceleration field (G) tends to push the stream of lubricant (L) from a first zone (Z1) to a second zone (Z2) of the bearing (10), each defining an angular sector around the central axis (X10);
the lubrication system (20) comprises a set of peripheral channels (30) passing through the fixed ring (12) and including, on the one hand, first channels

(31) that are positioned in the first zone (Z1) and that define a first intake flow rate (Q31) for bringing lubricant (L) to the interface (16) and, on the other hand, second channels (32) that are positioned in the second zone (Z2) and that define a second intake flow rate (Q32) bringing lubricant (L) to the interface (16), the first intake flow rate (Q31) being higher than the second intake flow rate (Q32), such that the interface (16) between the rings (12, 14) of the bearing (10) receives a larger quantity of lubricant (L) in the first zone (Z1) than in the second zone (Z2),
characterised in that overall the first zone (Z1) and the second zone (Z2) are diametrically opposite relative to the central axis (X10), with a clockwise shift of the first zone (Z1) to counter the effects of the counterclockwise rotation of the outer ring (14) and the mechanical loading of the bearing (10).

2. The mechanical device (1) according to claim 1, **characterized in that** the first zone (Z1) including the first channels (31) and the second zone (Z2) including the second channels (32) each define an angular sector with an apical angle ($\alpha1$; $\alpha2$) smaller than or equal to 180 degrees around the central axis (X10), preferably an angular sector with an apical angle ($\alpha1$) smaller than or equal to 90 degrees for the first zone (Z1) and an angular sector with an apical angle ($\alpha2$) smaller than or equal to 150 degrees for the second zone (Z2).

3. The mechanical device (1) according to one of the preceding claims, **characterized in that** the lubrication system (20) comprises a number of first channels (31) greater than the number of second channels (32).

4. The mechanical device (1) according to one of the preceding claims, **characterized in that** each of the first channels (31) has a section defining a first diameter (d31), **in that** each of the second channels (32) has a section defining a second diameter (D32), and **in that** the first diameter (d31) is larger than the second diameter (d32).

5. The mechanical device (1) according to one of the preceding claims, **characterized in that** each of the first channels (31) is separated by an angle comprised between 2 and 30 degrees around the central axis (X10) relative to an adjacent channel among the first channels (31), in the clockwise or counterclockwise direction.

6. The mechanical device (1) according to one of the preceding claims, **characterized in that** each of the second channels (32) is separated by an angle comprised between 45 and 75 degrees around the central axis (X10) relative to an adjacent channel among the second channels (32), in the clockwise or counterclockwise direction.

7. The mechanical device (1) according to one of the preceding claims, **characterized in that** each of the first channels (31) is inclined in the clockwise or counterclockwise direction by an angle comprised between 0 and 30 degrees relative to a radial plane comprising the central axis (X10) and comprising the junction zone between a first channel (31) and a distributing channel (24) with an annular shape centered on the central axis (X10).

8. The mechanical device (1) according to one of the preceding claims, **characterized in that** the lubrication system (20) comprises at least one distributing channel (24) that connects a set of first channels (31) and/or second channels (32) to each other and the overall lubricant flow rate (L) flowing in the distributing channel(s) (24) is greater in the first zone (Z1) than the second zone (Z2).

9. The mechanical device (1) according to one of the preceding claims, **characterized in that** the lubrication system (20) comprises several distributing channels (24) positioned along the central axis (X10), including at least one distributing channel (24) that connects a set of first channels (31) and/or second channels (32) to each other and that extends both in the first zone (Z1) and the second zone (Z2).

10. The mechanical device (1) according to one of the preceding claims, **characterized in that** the bearing (10) comprises several rows of rolling elements positioned along the central axis (X10) and **in that** the lubrication system (20) comprises, for each row of rolling elements, at least one distributing channel (24) that connects a set of first channels (31) and/or second channels (32) to each other.

11. The mechanical device (1) according to claim 10, **characterized in that** for each row of rolling elements, the lubrication system (20) comprises a number of first channels (31) greater than the number of second channels (32).

12. The mechanical device (1) according to one of claims 7 to 11, **characterized in that** the supply channel (22) is connected to the distributing channel(s) (24) by junction channels (26) situated in the first zone (Z1).

13. The mechanical device (1) according to one of claims 1 to 12, **characterized in that** the fixed ring (12) is the inner ring of the bearing (10) and **in that** the pivoting ring (14) is the outer ring of the bearing (10).

14. A machine, **characterized in that** it comprises at least one mechanical device (1) according to one of

claims 1 to 13.

15. A method for implementing a mechanical device (1) according to one of claims 1 to 13, **characterized in that** the method comprises at least the following successive steps:

a) forming orifices (120) through the fixed ring (12) of the bearing (10), these orifices (120) being configured to receive the lubrication system (20) and define the peripheral intake channels (30) bringing a stream of lubricant (L) to the interface (16) between the rings (12, 14) of the bearing (10);
b) assembling the lubrication system (20) and the bearing (10); and
c) supplying lubricant (L) to the lubrication system (20), such that the interface (16) between the rings (12, 14) of the bearing (10) receives a larger quantity of lubricant (L) in the first zone (Z1) than the second zone (Z2).

Patentansprüche

1. Mechanische Vorrichtung (1), umfassend:

- ein Lager (10), das einen feststehenden Ring (12) und einen Schwenkring (14) beinhaltet, die auf einer Mittelachse (X10) zentriert sind und eine zwischen ihnen definierte Schnittstelle (16), beispielsweise einen Rollweg oder eine Gleitfläche, beinhalten; und
- ein System (20) zum Schmieren der Schnittstelle (16), das dazu gestaltet ist, einen Strom von Schmiermittel (L) von zumindest einem Zufuhrkanal (22) durch den feststehenden Ring (12) zur Schnittstelle (16) zu bringen;

wobei ein Beschleunigungsfeld (G) dazu neigt, den Strom von Schmiermittel (L) von einem ersten Bereich (Z1) zu einem zweiten Bereich (Z2) des Lagers (10), die jeder einen Winkelbereich um die Mittelachse (X10) definieren, zu drängen;
wobei das Schmiersystem (20) eine Gruppe von peripheren Kanälen (30) umfasst, die durch den feststehenden Ring (12) verlaufen und einerseits erste Kanäle (31) beinhaltet, die im ersten Bereich (Z1) positioniert sind und die eine erste Einlassströmungsrate (Q31) zum Fördern von Schmiermittel (L) zur Schnittstelle (16) definieren, und andererseits zweite Kanäle (32), die im zweiten Bereich (Z2) positioniert sind und die eine zweite Einlassströmungsrate (Q32) zum Fördern von Schmiermittel (L) zur Schnittstelle (16) definieren, wobei die erste Einlassströmungsrate (Q31) höher als die zweite Einlassströmungsrate (Q32) ist, sodass die Schnittstelle (16) zwischen den Ringen (12, 14) des Lagers (10) im ersten Bereich (Z1) eine größere Menge von Schmiermittel (L) als im zweiten Bereich (Z2) aufnimmt, **dadurch gekennzeichnet, dass** insgesamt der erste Bereich (Z1) und der zweite Bereich (Z2) der Mittelachse (X10) diametral gegenüberliegen, mit einer Verschiebung des ersten Bereichs (Z1) im Uhrzeigersinn, um den Auswirkungen der Drehung des Außenrings (14) entgegen dem Uhrzeigersinn und der mechanischen Belastung des Lagers (10) entgegenzuwirken.

2. Mechanische Vorrichtung (1) nach Anspruch 1, **dadurch gekennzeichnet, dass** der erste Bereich (Z1), der die ersten Kanäle (31) beinhaltet, und der zweite Bereich (Z2), der die zweite Kanäle (32) beinhaltet, jeder einen Winkelbereich mit einem Scheitelwinkel ($\alpha 1$; $\alpha 2$) um die Mittelachse (X10), der kleiner als oder gleich 180 Grad ist, vorzugsweise einen Winkelbereich mit einem Scheitelwinkel ($\alpha 1$), der kleiner als oder gleich 90 Grad ist, für den ersten Bereich (Z1) und einen Winkelbereich mit einem Scheitelwinkel ($\alpha 2$), der kleiner als oder gleich 150 Grad ist, für den zweiten Bereich (Z2), definieren.

3. Mechanische Vorrichtung (1) nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** das Schmiersystem (20) eine Anzahl erster Kanäle (31) umfasst, die größer als die Anzahl zweiter Kanäle (32) ist.

4. Mechanische Vorrichtung (1) nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** jeder der ersten Kanäle (31) einen Abschnitt aufweist, der einen ersten Durchmesser (d31) definiert, dass jeder der zweiten Kanäle (32) einen Abschnitt aufweist, der einen zweiten Durchmesser (D32) definiert, und dass der erste Durchmesser (d31) größer als der zweite Durchmesser (d32) ist.

5. Mechanische Vorrichtung (1) nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** jeder der ersten Kanäle (31) um einen Winkel von 2 bis 30 Grad um die Mittelachse (X10) relativ zu einem benachbarten Kanal aus den ersten Kanälen (31) im Uhrzeigersinn oder entgegen dem Uhrzeigersinn getrennt ist.

6. Mechanische Vorrichtung (1) nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** jeder der zweiten Kanäle (32) um einen Winkel von 45 bis 75 Grad um die Mittelachse (X10) relativ zu einem benachbarten Kanal aus den zweiten Kanälen (32) im Uhrzeigersinn oder entgegen dem Uhrzeigersinn getrennt ist.

7. Mechanische Vorrichtung (1) nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** jeder der ersten Kanäle (31) im Uhrzeigersinn oder entgegen dem Uhrzeigersinn um einen Winkel von 0 bis 30 Grad relativ zu einer radialen Ebene, die die Mittelachse (X10) umfasst und den Verbindungsbereich zwischen einem ersten Kanal (31) und einem auf der Mittelachse (X10) zentrierten, ringförmigen Verteilkanal (24) umfasst, geneigt ist.

8. Mechanische Vorrichtung (1) nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** das Schmiersystem (20) zumindest einen Verteilkanal (24) umfasst, der eine Gruppe erster Kanäle (31) und/oder zweiter Kanäle (32) miteinander verbindet und die Schmiermittelgesamtströmungsrate (L), die in dem Verteilkanal (den Verteilkanälen) (24) fließt, im ersten Bereich (Z1) größer als im zweiten Bereich (Z2) ist.

9. Mechanische Vorrichtung (1) nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** das Schmiersystem (20) mehrere Verteilkanäle (24) umfasst, die entlang der Mittelachse (X10) positioniert sind und zumindest einen Verteilkanal (24) beinhalten, der eine Gruppe erster Kanäle (31) und/oder zweiter Kanäle (32) miteinander verbindet und der sich sowohl im ersten Bereich (Z1) als auch im zweiten Bereich (Z2) erstreckt.

10. Mechanische Vorrichtung (1) nach einem der vorangehenden Ansprüche, **dadurch gekennzeichnet, dass** das Lager (10) mehrere Reihen von Wälzelementen umfasst, die entlang der Mittelachse (X10) positioniert sind, und dadurch, dass das Schmiersystem (20) für jede Reihe von Wälzelementen zumindest einen Verteilkanal (24) umfasst, der eine Gruppe erster Kanäle (31) und/oder zweiter Kanäle (32) miteinander verbindet.

11. Mechanische Vorrichtung (1) nach Anspruch 10, **dadurch gekennzeichnet, dass** für jede Reihe von Wälzelementen das Schmiersystem (20) eine Anzahl von ersten Kanälen (31) umfasst, die größer als die Anzahl zweiter Kanäle (32) ist.

12. Mechanische Vorrichtung (1) nach einem der Ansprüche 7 bis 11, **dadurch gekennzeichnet, dass** der Zufuhrkanal (22) durch Verbindungskanäle (26), die sich im ersten Bereich (Z1) befinden, mit dem Verteilkanal (den Verteilkanälen) (24) verbunden ist.

13. Mechanische Vorrichtung (1) nach einem der Ansprüche 1 bis 12, **dadurch gekennzeichnet, dass** der feststehende Ring (12) der Innenring des Lagers (10) ist, und dadurch, dass der Schwenkring (14) der Außenring des Lagers (10) ist.

14. Maschine, **dadurch gekennzeichnet, dass** sie zumindest eine mechanische Vorrichtung (1) nach einem der Ansprüche 1 bis 13 umfasst.

15. Verfahren zum Implementieren einer mechanischen Vorrichtung (1) nach einem der Ansprüche 1 bis 13, **dadurch gekennzeichnet, dass** das Verfahren zumindest die folgenden aufeinanderfolgenden Schritte umfasst:

a) Ausbilden von Öffnungen (120) durch den feststehenden Ring (12) des Lagers (10), wobei diese Öffnungen (120) dazu gestaltet sind, das Schmiersystem (20) aufzunehmen und periphere Einlasskanäle (30) zu definieren, die einen Strom von Schmiermittel (L) zur Schnittstelle (16) zwischen den Ringen (12, 14) des Lagers (10) bringen;
b) Zusammenbauen des Schmiersystems (20) und des Lagers (10) und
c) Zuführen von Schmiermittel (L) zum Schmiersystem (20), sodass die Schnittstelle (16) zwischen den Ringen (12, 14) des Lagers (10) im ersten Bereich (Z1) eine größere Menge an Schmiermittel (L) als im zweiten Bereich (Z2) aufnimmt.

Revendications

1. Dispositif mécanique (1), comprenant :

- un palier (10) comportant une bague fixe (12) et une bague pivotante (14) qui sont centrées sur un axe central (X10) et comportent une interface (16) définie entre elles, par exemple un chemin de roulement ou une surface de glissement ; et
- un système (20) de lubrification de l'interface (16), configuré pour amener un flux de lubrifiant (L) depuis au moins un canal d'alimentation (22) jusqu'à l'interface (16) à travers la bague fixe (12) ;

dans lequel un champ d'accélération (G) tend à pousser le flux de lubrifiant (L) depuis une première zone (Z1) vers une deuxième zone (Z2) du palier (10), définissant chacune un secteur angulaire autour de l'axe central (X10) ;
le système de lubrification (20) comprend un ensemble de canaux périphériques (30) traversant la bague fixe (12) et comportant, d'une part, des premiers canaux (31) qui sont positionnés dans la première zone (Z1) et qui définissent un premier débit d'entrée (Q31) pour amener du lubrifiant (L) jusqu'à l'interface (16) et, d'autre part, des deuxièmes canaux (32) qui sont positionnés dans la deuxième zone (Z2) et qui définissent un deuxième débit d'entrée (Q32) amenant du lubrifiant (L) jusqu'à l'interface (16), le premier débit d'entrée (Q31) étant supérieur au deuxième débit d'entrée (Q32), de sorte que l'interface (16) entre les bagues (12, 14) du palier (10) reçoit une

quantité de lubrifiant (L) supérieure dans la première zone (Z1) par rapport à la deuxième zone (Z2), **caractérisé en ce que** globalement la première zone (Z1) et la deuxième zone (Z2) sont diamétralement opposées par rapport à l'axe central (X10), avec un décalage dans le sens horaire de la première zone (Z1) pour s'opposer aux effets de la rotation dans le sens antihoraire de la bague extérieure (14) et de la charge mécanique du palier (10).

2. Dispositif mécanique (1) selon la revendication 1, **caractérisé en ce que** la première zone (Z1) comportant les premiers canaux (31) et la deuxième zone (Z2) comportant les deuxièmes canaux (32) définissent chacune un secteur angulaire d'angle au sommet ($\alpha 1$; $\alpha 2$) inférieur ou égal à 180 degrés autour de l'axe central (X10), de préférence un secteur angulaire d'angle au sommet ($\alpha 1$) inférieur ou égal à 90 degrés pour la première zone (Z1) et un secteur angulaire d'angle au sommet ($\alpha 2$) inférieur ou égal à 150 degrés pour la deuxième zone (Z2) .

3. Dispositif mécanique (1) selon l'une des revendications précédentes, **caractérisé en ce que** le système de lubrification (20) comprend un nombre de premiers canaux (31) supérieur au nombre de deuxièmes canaux (32).

4. Dispositif mécanique (1) selon l'une des revendications précédentes, **caractérisé en ce que** chacun des premiers canaux (31) présente une section définissant un premier diamètre (d31), **en ce que** chacun des deuxièmes canaux (32) présente une section définissant un deuxième diamètre (D32) et **en ce que** le premier diamètre (d31) est supérieur au deuxième diamètre (d32).

5. Dispositif mécanique (1) selon l'une des revendications précédentes, **caractérisé en ce que** chacun des premiers canaux (31) est séparé d'un angle compris entre 2 et 30 degrés autour de l'axe central (X10) par rapport à un canal voisin parmi les premiers canaux (31), dans le sens horaire ou antihoraire.

6. Dispositif mécanique (1) selon l'une des revendications précédentes, **caractérisé en ce que** chacun des deuxièmes canaux (32) est séparé d'un angle compris entre 45 et 75 degrés autour de l'axe central (X10) par rapport à un canal voisin parmi les deuxièmes canaux (32), dans le sens horaire ou antihoraire.

7. Dispositif mécanique (1) selon l'une des revendications précédentes, **caractérisé en ce que** chacun des premiers canaux (31) est incliné dans le sens horaire ou antihoraire d'un angle compris entre 0 et 30 degrés par rapport à un plan radial comprenant l'axe central (X10) et comprenant la zone de jonction entre un premier canal (31) et un canal répartiteur (24) de forme annulaire centré sur l'axe central (X10).

8. Dispositif mécanique (1) selon l'une des revendications précédentes, **caractérisé en ce que** le système de lubrification (20) comprend au moins un canal répartiteur (24) qui relie un ensemble de premiers canaux (31) et/ou deuxièmes canaux (32) entre eux et **en ce que** le débit global de lubrifiant (L) circulant dans le ou les canaux répartiteurs (24) est supérieur dans la première zone (Z1) par rapport à la deuxième zone (Z2).

9. Dispositif mécanique (1) selon l'une des revendications précédentes, **caractérisé en ce que** le système de lubrification (20) comprend plusieurs canaux répartiteurs (24) positionnés le long de l'axe central (X10), dont au moins un canal répartiteur (24) qui relie un ensemble de premiers canaux (31) et/ou deuxièmes canaux (32) entre eux et qui s'étend à la fois dans la première zone (Z1) et dans la deuxième zone (Z2).

10. Dispositif mécanique (1) selon l'une des revendications précédentes, **caractérisé en ce que** le palier (10) comprend plusieurs rangées d'éléments roulants positionnées le long de l'axe central (X10) et **en ce que** le système de lubrification (20) comprend, pour chaque rangée d'éléments roulants, au moins un canal répartiteur (24) qui relie un ensemble de premiers canaux (31) et/ou deuxièmes canaux (32) entre eux.

11. Dispositif mécanique (1) selon la revendication 10, **caractérisé en ce que** le système de lubrification (20) comprend, pour chaque rangée d'éléments roulants, un nombre de premiers canaux (31) supérieur au nombre de deuxièmes canaux (32).

12. Dispositif mécanique (1) selon l'une des revendications 7 à 11, **caractérisé en ce que** le canal d'alimentation (22) est relié au ou aux canaux répartiteurs (24) par des canaux de jonction (26) situés dans la première zone (Z1).

13. Dispositif mécanique (1) selon l'une des revendications 1 à 12, **caractérisé en ce que** la bague fixe (12) est la bague intérieure du palier (10) et **en ce que** la bague pivotante (14) est la bague extérieure du palier (10).

14. Machine, **caractérisée en ce qu'**elle comprend au moins un dispositif mécanique (1) selon l'une des revendications 1 à 13.

15. Procédé de mise en oeuvre d'un dispositif mécanique (1) selon l'une des revendications 1 à 13, **caractérisé en ce que** le procédé comprend au moins les étapes successives suivantes :

a) former des orifices (120) à travers la bague fixe (12) du palier (10), ces orifices (120) étant configurés pour recevoir le système de lubrification (20) et délimiter les canaux d'entrée périphériques (30) amenant un flux de lubrifiant (L) jusqu'à l'interface (16) entre les bagues (12, 14) du palier (10) ;
b) assembler le système de lubrification (20) et le palier (10) ; et
c) alimenter le système de lubrification (20) en lubrifiant (L), de sorte que l'interface (16) entre les bagues (12, 14) du palier (10) reçoit une quantité de lubrifiant (L) supérieure dans la première zone (Z1) par rapport à la deuxième zone (Z2).

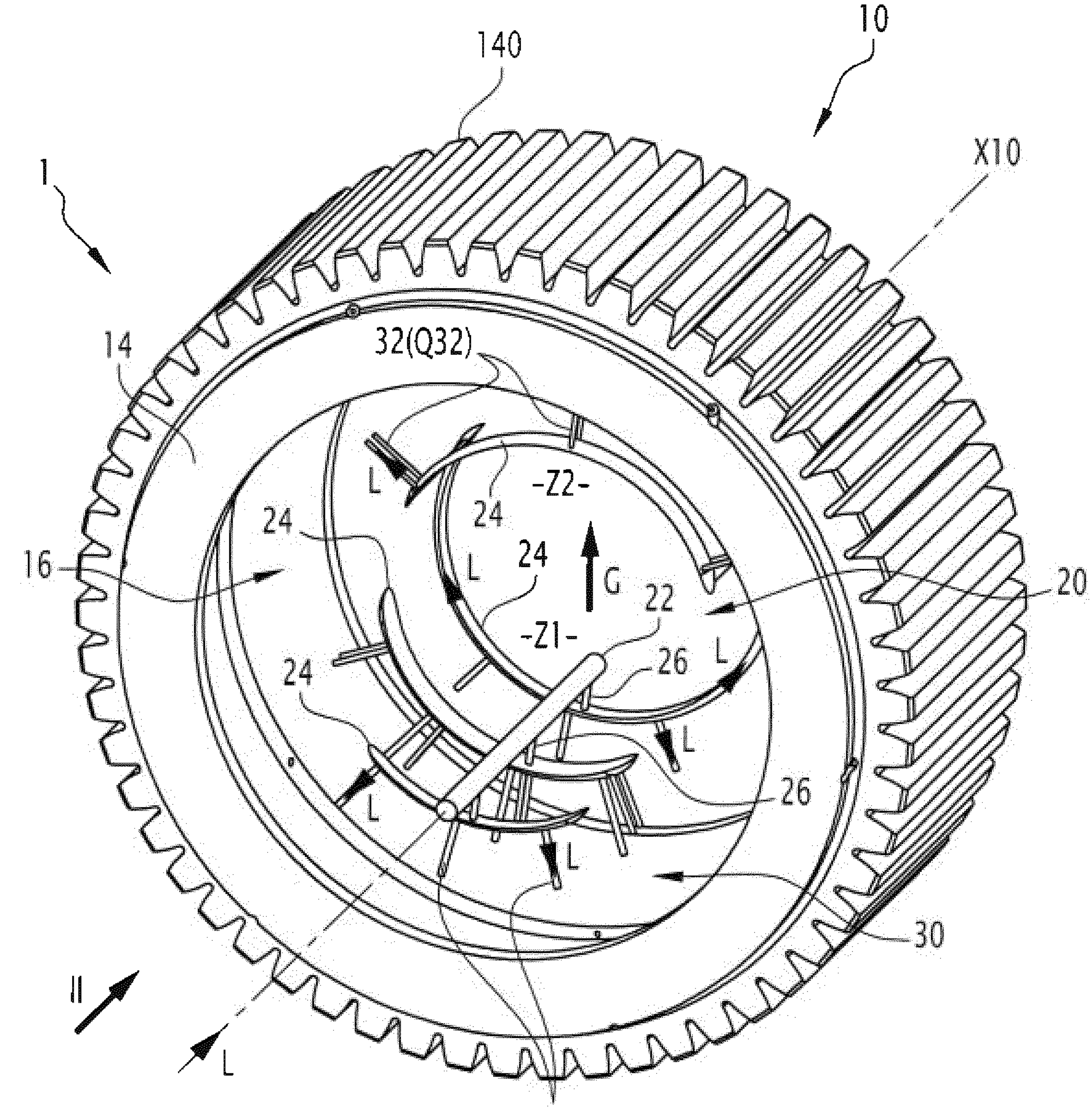
140
10
1
X10
14
32(Q32)
L
24
-Z2-
24
24
L
24
G
16
20
22
-Z1-
L
26
24
L
L
26
L
30
L
II
L
31(Q31)

FIG.1

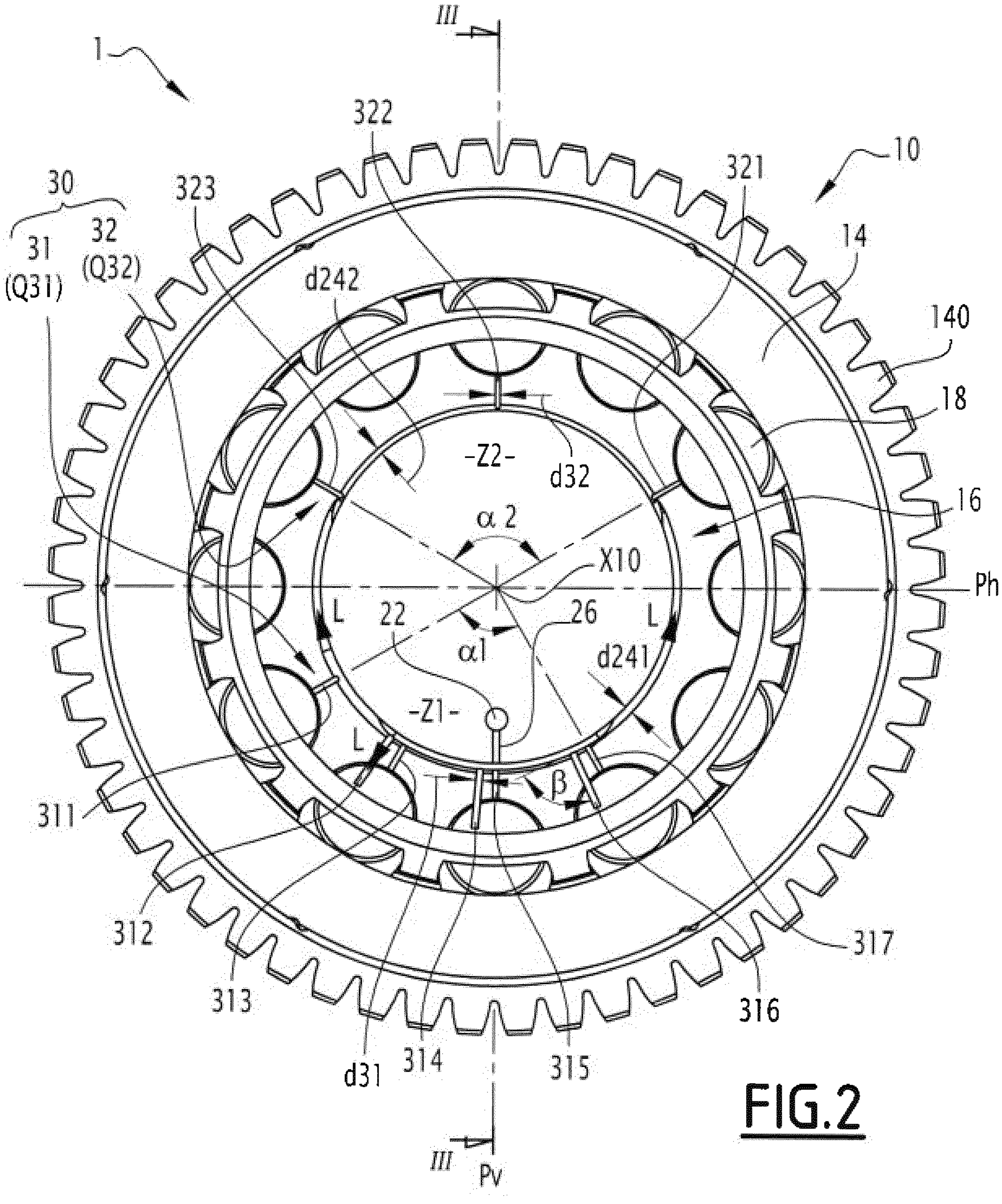
III
1
322
10
321
30
323
31
(Q31)
32
(Q32)
d242
14
140
18
-Z2-
d32
16
α 2
X10
Ph
L
22
26
L
α1
d241
-Z1-
L
β
311
312
313
d31
314
315
316
317
III
Pv

FIG.2

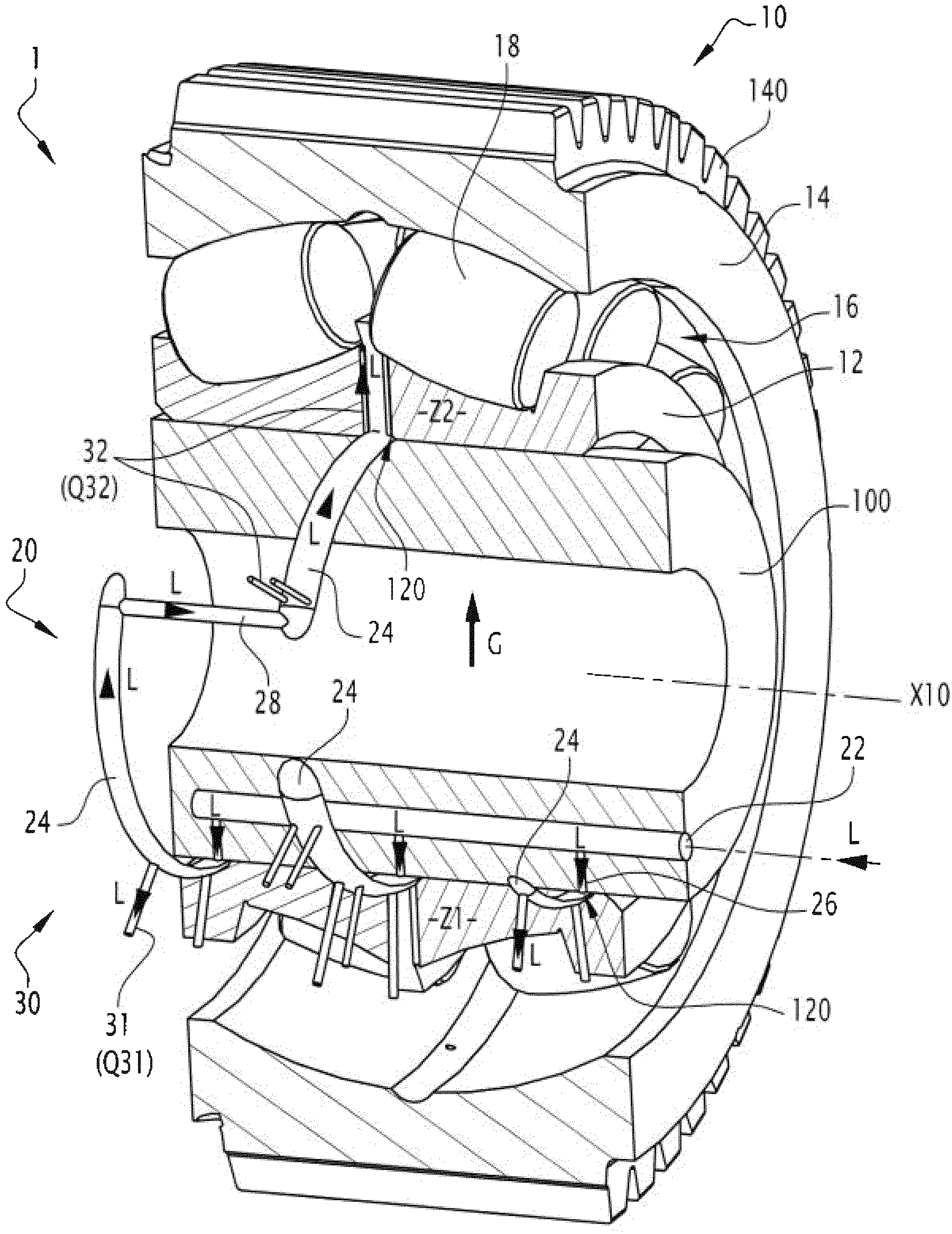
1
10
18
140
14
16
12
32
(Q32)
120
100
20
L
24
G
28
24
X10
24
22
24
L
26
30
Z1
Z2
120
31
(Q31)

FIG.3

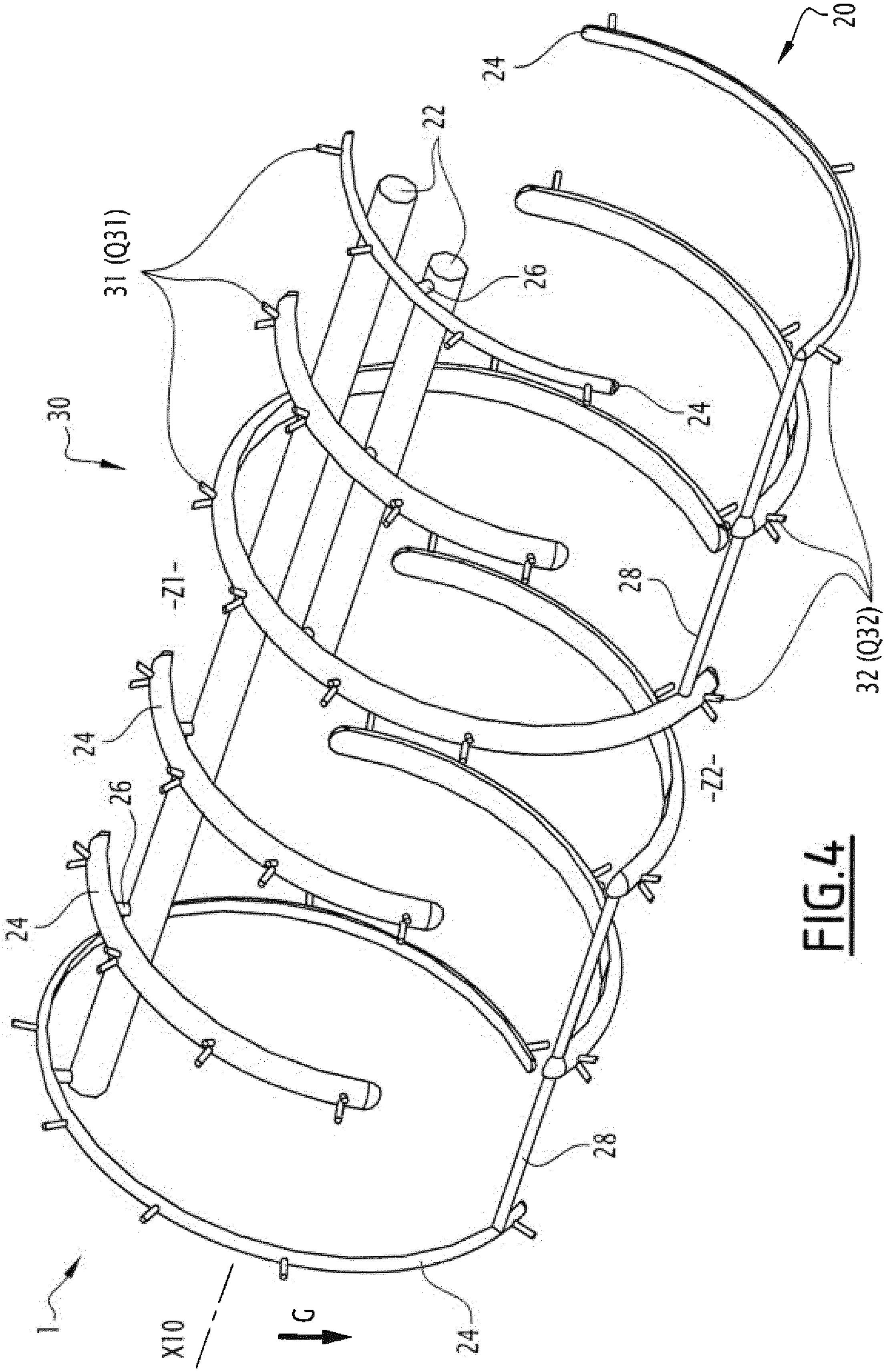

FIG.4

REFERENCES CITED IN THE DESCRIPTION

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