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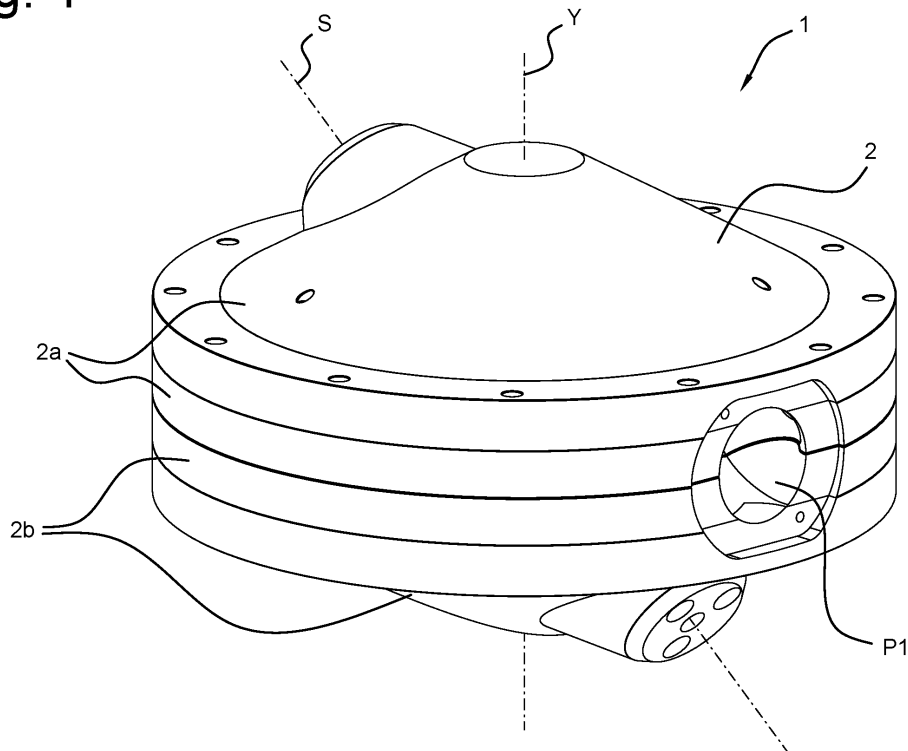
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(54) **ROTARY MACHINE**

(57) A rotary machine (1) for use in power generation and/or pumping applications, comprising a primary housing (2) enclosing a rotor (3) rotatably mounted in the primary housing (2) around a rotor axis (Y) having a fixed orientation with respect to the primary housing (2). The rotor (3) comprises a secondary housing (4) providing a compression chamber (5) in which a planar shaped joiner (6) is arranged that partitions the compression chamber

(5) into four subchambers for (de)compression. The joiner (6) comprises two opposing joiner ends (6a, 6b) rotatably mounted to the rotor (3) around a joiner axis (X) which extends through the two opposing joiner ends (6a, 6b). The joiner axis (X) is orthogonal to and rotatable around the rotor axis (Y) in unison with the rotor (3) and the joiner (6).

Fig. 1



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Description

Field of the invention

[0001] The present invention relates to a rotary machine, in particular a rotary machine for use in power generation and/or pumping applications.

Background

[0002] International application WO 2012/002816 A2 discloses a rotary machine for compression and decompression, comprising a disc-shaped rotor having a first rotation axis at right angles to the plane of the rotor and situated in a plane of orientation and a disc-shaped swing element having a second rotation axis. In the orientation plane, the second rotation axis makes an angle with the first rotation axis. A spherical housing surrounds the rotor and the swing element and in combination form four (de) compression chambers. A connecting body positions the rotor and the swing element in the housing. The rotary machine further comprises a power drive and a mechanical connection delivering power to or taking off power from the rotary machine.

[0003] Prior art rotary machines of the type described above are prone to leakage and pressure loss by the four (de)compression chambers due to complex engagement between the disc-shaped swing element and the spherical housing. Furthermore, adequate cooling of the rotary machine remains a challenge because of geometric and sealing complexities of the spherical housing.

[0004] In view of the above there is a need for a rotary machine that exhibits reduced complexity of engagement between the disc-shaped swing element and the spherical housing for (de)compression, and to minimize leakage and pressure loss. Furthermore, there is a need for a rotary machine exhibiting improved and reliable cooling.

Summary

[0005] It is an object of the present invention to provide an improved rotary machine for power generation and/or pumping applications, wherein the rotary machine is compact and exhibits improved efficiency, as well as reduces leakage and pressure loss. Furthermore, the rotary machine of the present invention allows for reduced component complexity and assembly.

[0006] According to the present invention, a rotary machine of the type described above is provided, comprising a primary housing enclosing a rotor mounted in the primary housing, wherein the rotor is rotatable around a rotor axis having a fixed orientation with respect to the primary housing, and wherein the rotor comprises a secondary housing providing a compression chamber. The rotary machine further comprises a planar shaped joiner arranged in the compression chamber and wherein the joiner partitions the compression chamber into four

subchambers for (de)compression.

[0007] The joiner comprises two opposing joiner ends that extend through the secondary housing, and wherein each joiner end of the two opposing joiner ends is rotatably mounted to the rotor, and wherein the joiner is rotatable around a joiner axis that extends through the two opposing joiner ends, and wherein the joiner axis is orthogonal to and rotatable around the rotor axis in unison with the rotor and the joiner.

[0008] The rotary machine further comprises a swinger bracket arrangement which is movably arranged in the primary housing and extends around the secondary housing spaced apart therefrom, and wherein the swinger bracket arrangement is in engagement with the two opposing joiner ends and is rotatable around the joiner axis in unison with the joiner.

[0009] A swinger guide arrangement is mounted to the primary housing and wherein the swinger bracket arrangement is in engagement with the swinger guide arrangement, wherein the swinger guide arrangement extends along a swing axis at a swing angle (α) between 0° and 90° with respect to the rotor axis, and wherein the swing axis has a fixed orientation with respect the primary housing.

[0010] According the present invention, when the rotary machine is in use, the compression chamber rotates in unison with the planar shaped joiner around the rotor axis and, at the same time, the swinger bracket arrangement engages the swinger guide arrangement for imposing oscillatory rotation of the joiner around the joiner axis. The swinger bracket arrangement rotates in oscillatory manner in unison with the joiner. Most notably, according to the invention there is a single degree of freedom of the joiner with respect to the compression chamber. That is, the joiner merely rotates in oscillatory manner in the compression chamber as the joiner and compression chamber simultaneously rotate around the rotor axis. By virtue of this single degree of freedom, engagement between the joiner and compression chamber is greatly simplified which in turn allows for reliable and leak free sealing between the joiner and the compression chamber.

[0011] As the joiner only oscillates around the joiner axis X inside the compression chamber when the rotary machine is in use, allows for different geometries of the compression chamber as well as the joiner whilst maintaining good sealing between the compression chamber and the joiner. For example, in an embodiment the compression chamber may be a spherical chamber, and wherein the joiner comprises a circular edge portion in congruent engagement with an inner surface of the spherical compression chamber. Alternatively, in an embodiment the compression chamber may be a cylindrical chamber extending along the joiner axis X, and wherein the joiner comprises a straight edge portion in congruent engagement with an inner surface of the cylindrical compression chamber.

Short description of drawings

[0012] The present invention will be discussed in more detail below, with reference to the attached drawings, in which

Figure 1 depicts a three-dimensional external view of a rotary machine and a primary housing thereof according to an embodiment of the present invention;

Figure 2 depicts a three-dimensional internal view of the rotary machine, showing a rotor, a secondary housing of the rotor and a swinger bracket arrangement according to an embodiment of the present invention;

Figure 3 depicts a three-dimensional view of a rotor, a planar shaped joiner arranged in a secondary housing of the rotor, and a swinger bracket arrangement according to an embodiment of the present invention;

Figure 4 depicts a three-dimensional view of a rotor, a planar shaped joiner, and a swinger bracket arrangement according to an embodiment of the present invention;

Figure 5 depicts a three-dimensional exploded view of a planer shaped joiner and a swinger bracket arrangement according to an embodiment of the present invention;

Figure 6 depicts a three-dimensional view of a rotor, a planar shaped joiner and a swinger bracket arrangement according to another embodiment of the present invention; and

Figure 7 depicts a three-dimensional view of a rotor provided with a shaft member according to another embodiment of the present invention.

Detailed description of embodiments

[0013] Figure 1 depicts a rotary machine 1 of the present invention and in particular an external view of the primary housing 2 of the rotary machine 1.

[0014] Figure 2 depicts a three-dimensional internal view of the rotary machine 1 of which a part of the primary housing 2 is removed, thereby showing an internally arranged rotor 3 comprising a secondary housing 4, and a swinger bracket arrangement 7 extending or spanning around the secondary housing 4.

[0015] Note that Figure 1 shows an embodiment wherein the primary housing 2 comprises two primary housing parts 2a, 2b stacked together to form an enclosure for the rotor 3 and swinger bracket arrangement 7. Figure 2 shows an embodiment wherein one of the two primary housing parts 2a, e.g. an upper part, is removed, thereby revealing the rotor 3 and swinger bracket arrangement 7.

[0016] Complete removal of the primary housing 2 results in Figure 3, depicting a three-dimensional view of the rotor 3, the planar shaped joiner 6 arranged in the

secondary housing 4, and the swinger bracket arrangement 7. Note that in Figure 3 a top part 4a of the secondary housing 4 has been removed along a circumferential line "C" as depicted in Figure 2 to allow the planar shaped joiner 6 to be visible inside the compression chamber 5.

[0017] As shown, the rotor 3 is rotatably mounted, e.g. journaled for rotation, in the primary housing 2 around a rotor axis Y, wherein the rotor axis Y has a fixed orientation with respect to the primary housing 2. That is, the only degree of freedom of the rotor 3 is the depicted rotational movement "ry" around the rotor axis Y when the rotary machine 1 is in use.

[0018] The rotor 3 comprises a secondary housing 4 which provides a compression chamber 5 as depicted in Figure 3. In this compression chamber 5 there is arranged a planar shaped joiner 6 that partitions the compression chamber 5 into four subchambers for (de)compression. Please note that the four subchambers are not explicitly shown.

[0019] As further depicted in Figure 1, 2 and 3, both the primary housing 2 and the rotor 3 are provided with one or more first and second fluid ports P1, P2, respectively, for fluid communication with the four subchambers. Details of the one or more first and second fluid ports P1, P2 will not be further discussed in the present disclosure as they are not particularly relevant for understanding for the present invention.

[0020] Further details of the planar shaped joiner 6 are shown in Figure 4, in which the secondary housing 4 is removed to provide a three-dimensional view of the rotor 3, the planar shaped joiner 6 and the swinger bracket arrangement 7.

[0021] From Figure 4 it follows that the joiner 6 comprises two opposing joiner ends 6a, 6b each of which extends through the secondary housing 4. Also, each joiner end of the two opposing joiner ends 6a, 6b is rotatably mounted, e.g. journaled for rotation, to the rotor 3. In particular, the joiner 6 is rotatable around a joiner axis X that extends through the two opposing joiner ends 6a, 6b, and wherein the joiner axis X is orthogonal to and rotatable around the rotor axis Y in unison with the rotor 3 and the joiner 6. That is, as the rotor 3 rotates around the rotor axis Y, so does the joiner 6 and the joiner axis X in unison, wherein the joiner axis X indicates a relative rotational degree of freedom of the joiner 6 with respect to the rotor 3. The rotational movement "rx" indicates rotation of the joiner 6 around the joiner axis X when the rotary machine 1 is in use.

[0022] The rotary machine 1 further comprises a swinger bracket arrangement 7 movably arranged in the primary housing 2 and extending or spanning around the secondary housing 4 spaced apart therefrom. From Figure 4 it can be deduced that the swinger bracket arrangement 7 is in engagement with the two opposing joiner ends 6a, 6b. In particular, the joiner 6 and the swinger bracket arrangement 7 are rotatable in unison around the joiner axis X.

[0023] As shown in Figure 2, 3 and 4, a swinger guide arrangement 8 is mounted to the primary housing 2 and the swinger bracket arrangement 7 is in engagement with the swinger guide arrangement 8. The swinger guide arrangement 8 extends along a swing axis S at a swing angle α between 0° and 90° with respect to the rotor axis Y. Like the rotor axis Y, the swing axis S has a fixed orientation with respect to the primary housing 2, so the swing axis S may be viewed as a fixed axis with respect to the primary housing 2.

[0024] To clarify kinematic operation of the rotary machine 1. The rotor 3 is rotatable around the fixed rotor axis Y. As the rotor 3 rotates around the rotor axis Y, the planar shaped joiner 6 and the swinger bracket arrangement 7 rotate around the joiner axis X relative hereto. Note that the joiner 6 and the swinger bracket arrangement 7 exhibit compound movement comprising rotation around the rotor axis Y in unison with the rotor 3 as well as rotation around the joiner axis X which also rotates in unison with the rotor 3. The swinger guide arrangement 8 imposes rotation of the swinger bracket arrangement 7 around the joiner axis X, such that the joiner 6 and the swinger bracket arrangement 7 rotate in oscillatory fashion around the joiner axis X when rotating around the rotor axis Y in unison with the rotor 3. The swinger guide arrangement 8 as depicted extends along the swing axis S and as such maintains its orientation with respect to the primary housing 2. The swing angle α determines an angle of oscillatory rotation of the joiner 6 and the swinger bracket arrangement 7 around the joiner axis X with respect to the rotor axis Y.

[0025] Therefore, according to the present invention the compression chamber 5 rotates in unison with the planar shaped joiner 6 around the rotor axis Y as indicated by the rotational movement "ry". At the same time, the swinger bracket arrangement 7 engages with the swinger guide arrangement 8 to impose oscillatory rotation of the joiner 6 around the joiner axis X as indicated by the oscillatory movement "rx". Therefore, there is a single degree of freedom of the joiner 6 relative to the compression chamber 5, thereby allowing for improved reliability of sealing engagement between the joiner 6 and the compression chamber 5.

[0026] Another advantageous characteristic of the rotary machine 1 of the present invention is that cooling is greatly improved as an intermediate chamber 5b is provided as depicted in e.g. Figure 3. In this depicted embodiment, the intermediate chamber 5b may be formed in part by the rotor 3 external to the secondary housing 4 and by the primary housing 2. That is, the primary housing 2 and the rotor 3 in combination may enclose or define an intermediate chamber 5b which is external to the secondary housing 4. The intermediate chamber 5b is configured to provide sufficient space to allow oscillatory movement of the swinger bracket arrangement 7 around the secondary housing 4. By providing a cooling medium in the intermediate chamber 5b results in direct cooling of the secondary housing 4 in which (de)compression oc-

curs when the rotary machine 1 is in use. Most notably, movement of the swinger bracket arrangement 7 around the secondary housing 4 may be utilized for moving the cooling medium through the intermediate chamber 5b to improve cooling of the secondary housing 4. Moreover, since the primary housing 2 does not act as a compressions chamber, the intermediate chamber 5b can be kept at or close to atmospheric pressures, thereby greatly reducing the need for pressure tight sealing requirements of the primary housing 2. This, in turn, simplifies the design of fluid ports, channels and the like through the primary housing 2 for cooling the secondary housing 4.

[0027] As depicted, in an embodiment the swinger bracket arrangement 7 comprises a circular outer circumference 9 provided with a guide slot 10, i.e. an outward facing guide slot 10, that extends along the circular outer circumference 9, and wherein the swinger guide arrangement 8 comprises a guide member 11 that moveably extends through the guide slot 10. In this embodiment the swinger bracket arrangement 7 is guided or forced to rotate/oscillate around the joiner axis X over the swing angle α by the guide member 11, wherein the guide member 11 extends along the fixed swing axis S. In turn, the joiner 6 is forced by the swinger bracket arrangement 7 to rotate/oscillate in unison around the joiner axis X for (de)compression of the four subchambers inside the compression chamber 5. Note that in Figure 2, 3 and 4 an embodiment is depicted wherein the swinger bracket arrangement 7 spans around the secondary housing 4 and is affixed the two opposing joiner ends 6a, 6b of the joiner 6.

[0028] In an exemplary embodiment, the guide member 11 comprises a roller member or slider member rotationally arranged around the swing axis S for rolling or sliding movement through the guide slot 10, respectively. In this embodiment the guide member 11 is able to rotate or slide through the guide slot 10 to impose oscillatory rotation of the swinger bracket arrangement 7 around the joiner axis X as the rotor 3 rotates around the rotor axis Y.

[0029] Figure 5 depicts a three-dimensional exploded view of the planer shaped joiner 6 and the swinger bracket arrangement 7 according to an embodiment. As shown, the swinger bracket arrangement 7 may comprise two opposing semi-circular brackets 7a, 7b each of which comprises a corresponding part of the circular outer circumference 9 provided with the guide slot 10. Providing two opposing semi-circular brackets 7a, 7b allows for a simplified and structured assembly of the rotary machine 1. That is, the joiner 6 and the secondary housing 4 can be assembled first, followed by placement of the two opposing semi-circular brackets 7a, 7b around the secondary housing 4 and mounting the opposing semi-circular brackets 7a, 7b to the corresponding joiner ends 6a, 6b.

[0030] In particular, Figure 5 shows an embodiment wherein each semi-circular bracket of the two opposing semi-circular brackets 7a, 7b comprises two bracket

ends 12a, 12b each of which is affixed to a corresponding joiner end of the two opposing joiner ends 6a, 6b. Affixing the two bracket ends 12a, 12b to corresponding joiner ends 6a, 6b provides for a rigid connection between the two semi-circular brackets 7a, 7b and the joiner 6, such that the two semi-circular brackets 7a, 7b and the joiner 6 are able to rotate in unison around the joiner axis X when the rotary machine 1 is in use. In an exemplary embodiment, each joiner end of the two opposing joiner ends 6a, 6b comprises one or more outward facing flat surface portions 13a, 13b in engagement with one or more inward facing flat surface portions 14a, 14b of a corresponding bracket end of the two bracket ends 12a, 12b. The one or more outward facing flat surface portions 13a, 13b and the one or more inward facing flat surface portions 14a, 14b prevent relative rotation between the two semi-circular brackets 7a, 7b and the joiner 6, and further allow forces to be transferred there between.

[0031] In a specific embodiment it is conceivable that each bracket end 12a, 12b is affixed to a corresponding joiner end 6a, 6b by means of one or more fastener (e.g. bolt).

[0032] Referring to the embodiments of Figure 3 and 4, the rotor 3 may comprise a stacked arrangement of a first rotor part 3a and a second rotor part 3b each of which comprises a corresponding housing part of the secondary housing 4. A first planar partition piece 15a and a second planar partition piece 15b is arranged between the first rotor part 3a and the second rotor part 3b on opposing sides of the joiner 6. Note that Figure 4 only shows the second rotor part 3b for exposing the first and second planar partition pieces 15a, 15b. This embodiment allows for efficient assembly of the rotary machine 1. For example, joiner 6 may be mounted on the second rotor part 3b first, followed by placement of the first and second planar partition pieces 15a, 15b on opposite sides of the joiner 6. Subsequently, the first rotor part 3a may be placed on the second rotor part 3a, thereby enclosing the first and second planar partition pieces 15a, 15b inside the rotor 3 and enclosing the joiner 6 inside the compression chamber 5. From Figure 4 it becomes clear that the first and second planar partition pieces 15a, 15b and the joiner 6 in combination partition the compression chamber 5 into four subchambers for (de)compression.

[0033] Referring to Figure 4 and 5, an embodiment is depicted wherein the joiner 6 comprises a joiner hub 16 extending along the joiner axis X and comprising the two opposing joiner ends 6a, 6b. A first planar joiner portion 16a and a second planar joiner portion 16b are provided and are arranged on opposing sides of the joiner hub 16. The joiner hub 16 is in sealed engagement with the first planar partition piece 15a and the second planar partition piece 15b. The joiner hub 16, the first planar joiner portion 16a and the second planar joiner portion 16b are in sealed engagement with the secondary housing 4, i.e. in sealed engagement with an inner surface of the compression chamber 5.

[0034] In Figures 4 and 5 there is depicted an exemp-

lary embodiment wherein the joiner hub 16 is cylindrically shaped along the joiner axis X. However, in an alternative embodiment the joiner hub 16 may be conically shaped along the joiner axis X. It will be clear that other suitable rotationally symmetric shapes around the joiner axis X would be possible for the joiner hub 16 as the joiner hub 16 merely oscillates relative to the first and second planar partition pieces 15a, 15b.

[0035] It was mentioned earlier that the first and second planar partition pieces 15a, 15b and the joiner 6 partition the compression chamber 5 into four subchambers for (de)compression. For particular applications it may be required that fluid or gas exchange is needed between two subchambers. For example, in Figure 4 there is depicted the first planar partition piece 15a and it will be understood that subchambers will exist above and below the first planar partition piece 15a. Please note that the subchambers are not explicitly shown but it will be readily understood that such subchambers exist above and below the first planar partition piece 15a when the secondary housing 4 fully encloses the joiner 6 inside the compression chamber 5.

[0036] The instantaneous position of the joiner 6 as shown in Figure 4 indicates that the subchamber below the first planar partition piece 15a will be smaller than the subchamber above the first planar partition piece 15a, because the first planar joiner portion 16a is at a much larger angle to the first planar partition piece 15a than the second planar joiner portion 16b, which is out of view in Figure 4. This instantaneous position of the joiner 6 may then indicate a scenario wherein the smaller lower subchamber holds a compressed gas that needs to be transferred to the larger upper subchamber above the first planar partition piece 15a.

[0037] To enable effective and efficient transfer of gas (or fluid) between the two aforementioned subchambers separated by the first planar partition piece 15a, there is provided an embodiment as shown in Figure 4 and 5 wherein the joiner hub 16 comprises one or more recesses 17 arranged along an outer circumference of the joiner hub 16 for fluid communication between two subchambers of the four subchambers partitioned or separated by the first planar partition piece 15a or the second planar partition piece 15b. The one or more recesses 17 arranged along an outer circumference of the joiner hub 16 allow for a temporary passage or conduit bypassing the first or second planar partition piece 15a, 15b such that a fluid or gas can be exchanged between two subchambers separated by the first or second planar partition piece 15a, 15b. Notably, the circumferential position of the one or more recesses 17 along the joiner hub 16 may determine the angular position of the joiner 6 with respect to the rotor axis Y at which the gas or fluid is able to bypass the first or second planar partition piece 15a, 15b.

[0038] In a specific embodiment as depicted in Figure 4 and 5, each recess of the one or more recesses 17 has a width "w" along the outer circumference of the joiner hub

16 larger than a thickness "t" of the first or second planar partition piece 15a, 15b. This embodiment allows for a sufficiently long passage for bypassing the first or second planar partition piece 15a, 15b for a given thickness t thereof. For example, from Figure 4 it follows that the one or more recesses 17 have a width w_{such} such that the one or more recesses 17 extend below and above the first planar partition piece 15a to allow fluid communication between the two subchambers separated by the first planar partition piece 15a.

[0039] Since the rotary machine 1 of the present invention can be utilized for power generation, such as operating as an internal combustion engine, or utilized as a pump/compressor, Figure 2 shows an embodiment wherein the rotor 3 comprises a circumferential gear or pulley 18, and wherein the primary housing 2 comprises two apertures 19a, 19b for connection of a belt or chain around the circumferential gear or pulley 18. The belt or chain can be further connected to an external electric generator or an external engine/power source. In case the primary housing 2 comprises the two stacked primary housing parts 2a, 2b as mentioned earlier, then an embodiment is conceivable wherein each of the two housing parts 2a, 2b comprises opposing slots that, when the two primary housing parts 2a, 2b are stacked together, form the two apertures 19a, 19b for allowing a belt or chain to extend through the primary housing 2. Note that having two primary housing parts 2a, 2b as shown in Figure 1 and 2 is advantageous as it facilitates placing a continuous belt or continuous chain around the circumferential gear or pulley 18 when one of the two primary housing parts 2a, 2b is not yet assembled.

[0040] In an alternative embodiment, which is not depicted, it is conceivable that an electrical generator/motor is integrated with the rotary machine 1. For example, instead of providing the rotor 3 with the circumferential gear or pulley 18 as mentioned above, it would be possible to provide the rotor 3 with circumferentially arranged magnets and/or electric generator/motor windings. The primary housing 2 would then be provided with internal circumferentially arranged opposing magnets and/or electric generator/motor windings. By integrating an electrical generator/motor in the rotary machine 1 provides for a compact design, which is advantageous for mobile applications.

[0041] It was mentioned earlier that the present invention provides a considerable advantage in that the joiner 6 only rotationally oscillates around the joiner axis X relative to the compression chamber 5 when the rotary machine 1 is in use. As a result, movement of the joiner 6 along an inner surface of the compression chamber 5 exhibits less complexity so that a number of different geometries of the compression chamber 5 as well as the joiner 6 are possible whilst attaining reliable and durable sealing engagement between the compression chamber 5 and the joiner 6.

[0042] A number of geometries are conceivable. For example, in an embodiment the compression chamber 5

may be a spherical chamber, and wherein the joiner 6 comprises a circular edge portion 6c, see e.g. the first and second planar joiner portions 16a, 16b, in congruent engagement with a spherical inner surface of the spherical compression chamber 5.

[0043] Alternatively, in an embodiment the compression chamber 5 may be a cylindrical chamber (not shown) extending along the joiner axis X, and wherein the joiner 6 comprises a straight edge portion 6c (not shown) in congruent engagement with a cylindrical inner surface of the cylindrical compression chamber 5.

[0044] Further shapes of the compression chamber 5 and the joiner are conceivable, such as an embodiment wherein the compression chamber 5 is a conical chamber extending along the joiner axis X, and wherein the joiner 6 comprises a conical edge portion 6c in congruent engagement with a conical inner surface of the conical compression chamber 5.

[0045] An embodiment was mentioned earlier wherein the swinger bracket arrangement 7 comprises a circular outer circumference 9 provided with a guide slot 10 that extends along the circular outer circumference 9, and wherein the swinger guide arrangement 8 comprises a guide member 11 that movably extends through the guide slot 10. In this embodiment the swinger bracket arrangement 7 is affixed to the two opposing joiner ends 6a, 6b to ensure that the joiner 6 and the swinger bracket arrangement 7 rotationally oscillate around the joiner axis X in unison. As the rotor 3 rotates around the rotor axis Y, the guide member 11 moves through the guide slot 10 whilst maintaining its orientation along the fixed swing axis S. In turn, both the swinger bracket arrangement 7 and the joiner 6 are forced to rotationally oscillate around the joiner axis X over the swing angle α as the rotor 3 rotates around the rotor axis Y.

[0046] From a kinematic point of view, to impose rotational oscillation of the joiner 6 around the joiner axis X it is not required that the swinger bracket arrangement 7 is affixed to the two opposing joiner ends 6a, 6b of the joiner 6, and wherein a guide member 11 moveably extends through an outward facing guide slot 10 as depicted in e.g. Figure 2 to 5.

[0047] Instead, an alternative kinematic configuration is depicted in Figure 6 allowing the rotor 3 to rotate around rotor axis Y and wherein the joiner 6 is forced to rotationally oscillate around the joiner axis X for (de)compression of the four subchambers inside the compression chamber 5.

[0048] In particular, Figure 6 depicts a three-dimensional view of a rotor 3, a planar shaped joiner 6 and a swinger bracket arrangement 7 according to another embodiment of the present invention. In this embodiment the swinger bracket arrangement 7 comprises two opposing semi-circular brackets 20a, 20b each of which is affixed to the swinger guide arrangement 8, wherein the swinger guide arrangement 8 is rotatable around the swing axis S, e.g. journalled for rotation in the primary housing 2, as indicated by the rotational movement "rs".

Each joiner end of the two opposing joiner ends 6a, 6b is movable along, or movably engages, a corresponding semi-circular bracket of the two opposing semi-circular brackets 20a, 20b. In this particular embodiment it can be seen that the swinger bracket arrangement 7 is affixed to the swinger guide arrangement 8 which in turn is rotatable around the fixed swing axis S indicated by the rotational movement "rs". The rotor 3 is able to rotate around the rotor axis Y by virtue of the two opposing joiner ends 6a, 6b being in movable engagement with a corresponding semi-circular brackets 20a, 20b. Therefore, when the rotor 3 rotates around the rotor axis Y, the two opposing semi-circular brackets 20a, 20b rotate around the swing axis S.

[0049] In a further embodiment as depicted in Figure 6, each semi-circular bracket of the two opposing semi-circular brackets 20a, 20b may comprise a circular inner circumference 21 provided with a guide slot 22, i.e. an inward facing guide slot 22, and wherein each joiner end of the two opposing joiner ends 6a, 6b movably extends through the guide slot 22. In this embodiment the two opposing joiner ends 6a, 6b are moveable through the guide slot 22. So when the rotor 3 rotates around the rotor axis Y, the two opposing semi-circular brackets 20a, 20b rotate around the swing axis S as the opposing joiner ends 6a, 6b move through the guide slot 22.

[0050] In an embodiment the two opposing joiners ends 6a, 6b may each comprise a roller or slider member that movably extends through the inward facing guide slot 22.

[0051] It was mentioned earlier in light of Figure 3, 4, 5 that in an embodiment the swinger bracket arrangement 7 may comprise two opposing semi-circular brackets 7a, 7b that extend or span around the secondary housing 4, and wherein both semi-circular brackets 7a, 7b are connected or affixed to the two opposing joiner ends 6a, 6b of the joiner 6. Each of these semi-circular brackets 7a, 7b comprises a corresponding part of the circular outer circumference 9 provided with the guide slot 10, wherein the guide member 11 of the swinger guide arrangement 8 movably extends through the guide slot 10 for inducing oscillatory rotation of the swinger bracket arrangement 7 and the joiner 6 around the joiner axis X when the rotor 3 rotates around the rotor axis Y. In an embodiment, the guide member 11 may comprise the roller member or slider member for movement through the guide slot 10 as mentioned earlier.

[0052] Figure 7 depicts an alternative embodiment wherein the swinger bracket arrangement 7 comprises a single semi-circular bracket 7a which comprises the circular outer circumference 9 provided with the guide slot 10. The swinger guide arrangement 8 remains the same in that the guide member 11 movably extends through the outward facing guide slot 10 of the single semi-circular bracket 7a. Note that this single semi-circular bracket 7a extends or spans around the secondary housing 4 spaced apart therefrom and is connected/affixed to the two opposing joiner ends 6a, 6b of the joiner 6.

So instead of having two opposing semi-circular brackets 7a, 7b spanning around the secondary housing 4, a semi-circular bracket 7b of the two opposing semi-circular brackets 7a, 7b is dispensed with.

[0053] Figure 7 further shows that the rotor 3 comprises a shaft member 23 that extends along the rotor axis Y and wherein the shaft member 23 is connected, e.g. directly connected, to the secondary housing 4 of the rotor 3. The shaft member 23 is arranged to extend through the primary housing 2 (not shown) for connection to a driven or driving member, such as an electrical generator or compressor/pump, respectively.

[0054] The embodiment of Figure 7 introduces an alternative arrangement on how to externally connect to the rotor 3 instead of using a circumferential gear or pulley 18 around the rotor 3 as explained in light of Figure 2. By utilizing a single semi-circular bracket 7a allows the shaft member 23 to be connected to the secondary housing 4 without interfering with another opposing semi-circular bracket 7b which would otherwise extend or span around a portion of the secondary housing 4 to which the shaft member 23 is connected. From Figure 7 it will be understood that the intermediate chamber 5b enclosed by the primary housing 2 and the rotor 3 provides sufficient space for the single semi-circular bracket 7a to rotate around the secondary housing 4 in oscillatory fashion. Therefore, having a shaft member 23 directly connected to the secondary housing 4, and wherein the shaft member 23 extends through the primary housing 2, facilitates mechanical interaction with the rotor 3 for exchanging power with an externally arranged third party electrical generator/motor or compressor/pump, for example.

[0055] From the above, the present invention can now be summarized by the following embodiments:

Embodiment 1. A rotary machine (1), comprising: a primary housing (2) enclosing a rotor (3) mounted in the primary housing (2), wherein the rotor (3) is rotatable around a rotor axis (Y) having a fixed orientation with respect to the primary housing (2), and wherein the rotor (3) comprises a secondary housing (4) providing a compression chamber (5);

a planar shaped joiner (6) arranged in the compression chamber (5) and wherein the joiner (6) partitions the compression chamber (5) into four subchambers for (de)compression; wherein the joiner (6) comprises two opposing joiner ends (6a, 6b) that extend through the secondary housing (4), wherein each joiner end of the two opposing joiner ends (6a, 6b) is rotatably mounted to the rotor (3), wherein the joiner (6) is rotatable around a joiner axis (X) that extends through the two opposing joiner ends (6a, 6b), and wherein the joiner axis (X) is orthogonal to and rotatable around the rotor axis (Y) in unison with the rotor (3) and the joiner (6); wherein the rotary machine (1) further com-

prises

a swinger bracket arrangement (7) movably arranged in the primary housing (2) and extending around the secondary housing (4) spaced apart therefrom, and wherein the swinger bracket arrangement (7) is in engagement with the two opposing joiner ends (6a, 6b) and is rotatable around the joiner axis (X) in unison with the joiner (6);

a swinger guide arrangement (8) mounted to the primary housing (2) and wherein the swinger bracket arrangement (7) is in engagement with the swinger guide arrangement (8),

wherein the swinger guide arrangement (8) extends along a swing axis (S) at a swing angle (α) between 0° and 90° with respect to the rotor axis (Y), and wherein the swing axis (S) has a fixed orientation with respect the primary housing (2).

Embodiment 2. The rotary machine according to embodiment 1, wherein the swinger bracket arrangement (7) comprises a circular outer circumference (9) provided with a guide slot (10) that extends along the circular outer circumference (9), and wherein the swinger guide arrangement (8) comprises a guide member (11) that movably extends through the guide slot (10).

Embodiment 3. The rotary machine according to embodiment 2, wherein the guide member (11) comprises a roller member or slider member rotationally arranged around the swing axis (S) for rolling or sliding movement through the guide slot (10), respectively.

Embodiment 4. The rotary machine according to embodiment 2 or 3, wherein the swinger bracket arrangement (7) comprises two opposing semi-circular brackets (7a, 7b) each of which comprises a corresponding part of the circular outer circumference (9) provided with the guide slot (10). Embodiment 5. The rotary machine according to embodiment 4, wherein each semi-circular bracket of the two opposing semi-circular brackets (7a, 7b) comprises two bracket ends (12a, 12b) each of which is affixed to a corresponding joiner end of the two opposing joiner ends (6a, 6b).

Embodiment 6. The rotary machine according to embodiment 5, wherein each joiner end of the two opposing joiner ends (6a, 6b) comprises one or more outward facing flat surface portions (13a, 13b) in engagement with one or more inward facing flat surface portions (14a, 14b) of a corresponding bracket end of the two bracket ends (12a, 12b).

Embodiment 7. The rotary machine according to embodiment 2 or 3, wherein the swinger bracket

arrangement (7) comprises a single semi-circular bracket (7a) comprising the circular outer circumference (9) provided with the guide slot (10), wherein the rotor (3) further comprises a shaft member (23) that extends along the rotor axis (Y) and wherein the shaft member (23) is connected to the secondary housing (4), and wherein the shaft member (23) extends through the primary housing (2) for connection to a driven or driving member.

Embodiment 8. The rotary machine according to any of embodiments 1-7, wherein the rotor (3) comprises a stacked arrangement of a first rotor part (3a) and a second rotor part (3b) each of which comprises a corresponding housing part of the secondary housing (4), and a first planar partition piece (15a) and a second planar partition piece (15b) arranged between the first rotor part (3a) and the second rotor part (3b) on opposing sides of the joiner (6).

Embodiment 9. The rotary machine according to embodiment 8, wherein the joiner (6) comprises a joiner hub (16) extending along the joiner axis (X) and comprising the two opposing joiner ends (6a, 6b), a first planar joiner portion (16a) and a second planar joiner portion (16b), wherein the first and second planar joiner portions (16a, 16b) are arranged on opposing sides of the joiner hub (16), and wherein the joiner hub (16) is in sealed engagement with the first planar partition piece (15a) and the second planar partition piece (15b), and wherein joiner hub (16), the first planar joiner portion (16a) and the second planar joiner portion (16b) are in sealed engagement with the secondary housing (4).

Embodiment 10. The rotary machine according to embodiment 9, wherein the joiner hub (16) comprises one or more recesses (17) arranged along the outer circumference of the joiner hub (16) for fluid communication between two subchambers of the four subchambers partitioned by the first planar partition piece (15a) or the second planar partition piece (15b).

Embodiment 11. The rotary machine according to embodiment 10, wherein each recess of the one or more recesses (17) has a width (w) along the outer circumference of the joiner hub (16) larger than a thickness (t) of the first or second planar partition piece (15a, 15b).

Embodiment 12. The rotary machine according to any of embodiments 1-11, wherein the rotor (3) comprises a circumferential gear or pulley (18) and wherein the primary housing (2) comprises two apertures (19a, 19b) for connection of a belt or chain around the circumferential gear or pulley (18).

Embodiment 13. The rotary machine according to any of embodiments 1-12, wherein the compression chamber (5) is a spherical chamber, and wherein the joiner (6) comprises a circular edge portion (6c) for congruent engagement with a spherical inner surface of the spherical compression chamber (5).

Embodiment 14. The rotary machine according to any of embodiments 1-12, wherein the compression chamber (5) is a cylindrical chamber extending along the joiner axis X, and wherein the joiner (6) comprises a straight edge portion (6c) in congruent engagement with a cylindrical inner surface of the cylindrical compression chamber (5).

Embodiment 15. The rotary machine according to embodiment 1, wherein the swinger bracket arrangement (7) comprises two opposing semi-circular brackets (20a, 20b) each of which is affixed to the swinger guide arrangement (8), wherein the swinger guide arrangement (8) is rotatable around the swing axis (S), and wherein each joiner end of the two opposing joiner ends (6a, 6b) is movable along a corresponding semi-circular bracket of the two opposing semi-circular brackets (20a, 20b).

[0056] The present invention has been described above with reference to a number of exemplary embodiments as shown in the drawings. Modifications and alternative implementations of some parts or elements are possible, and are included in the scope of protection as defined in the appended claims.

Claims

1. A rotary machine (1), comprising: a primary housing (2) enclosing a rotor (3) mounted in the primary housing (2), wherein the rotor (3) is rotatable around a rotor axis (Y) having a fixed orientation with respect to the primary housing (2), and wherein the rotor (3) comprises a secondary housing (4) providing a compression chamber (5);

a planar shaped joiner (6) arranged in the compression chamber (5) and wherein the joiner (6) partitions the compression chamber (5) into four subchambers for (de)compression;

wherein the joiner (6) comprises two opposing joiner ends (6a, 6b) that extend through the secondary housing (4), wherein each joiner end of the two opposing joiner ends (6a, 6b) is rotatably mounted to the rotor (3), wherein the joiner (6) is rotatable around a joiner axis (X) that extends through the two opposing joiner ends (6a, 6b), and wherein the joiner axis (X) is orthogonal to and rotatable around the rotor axis (Y) in unison with the rotor (3) and the joiner (6);

wherein the rotary machine (1) further comprises

a swinger bracket arrangement (7) movably arranged in the primary housing (2) and extending around the secondary housing (4) spaced apart therefrom, and wherein the swinger bracket arrangement (7) is in engagement with the two opposing joiner ends (6a, 6b) and is rotatable around the joiner axis (X) in unison with the joiner (6);

a swinger guide arrangement (8) mounted to the primary housing (2) and wherein the swinger bracket arrangement (7) is in engagement with the swinger guide arrangement (8),

wherein the swinger guide arrangement (8) extends along a swing axis (S) at a swing angle (α) between 0° and 90° with respect to the rotor axis (Y), and wherein the swing axis (S) has a fixed orientation with respect the primary housing (2).

2. The rotary machine according to claim 1, wherein the swinger bracket arrangement (7) comprises a circular outer circumference (9) provided with a guide slot (10) that extends along the circular outer circumference (9), and wherein the swinger guide arrangement (8) comprises a guide member (11) that movably extends through the guide slot (10).

3. The rotary machine according to claim 2, wherein the guide member (11) comprises a roller member or slider member rotationally arranged around the swing axis (S) for rolling or sliding movement through the guide slot (10), respectively.

4. The rotary machine according to claim 2 or 3, wherein the swinger bracket arrangement (7) comprises two opposing semi-circular brackets (7a, 7b) each of which comprises a corresponding part of the circular outer circumference (9) provided with the guide slot (10).

5. The rotary machine according to claim 4, wherein each semi-circular bracket of the two opposing semi-circular brackets (7a, 7b) comprises two bracket ends (12a, 12b) each of which is affixed to a corresponding joiner end of the two opposing joiner ends (6a, 6b).

6. The rotary machine according to claim 5, wherein each joiner end of the two opposing joiner ends (6a, 6b) comprises one or more outward facing flat surface portions (13a, 13b) in engagement with one or more inward facing flat surface portions (14a, 14b) of a corresponding bracket end of the two bracket ends (12a, 12b).

7. The rotary machine according to claim 2 or 3, wherein the swinger bracket arrangement (7) comprises a

- single semi-circular bracket (7a) comprising the circular outer circumference (9) provided with the guide slot (10),
 wherein the rotor (3) further comprises a shaft member (23) that extends along the rotor axis (Y) and wherein the shaft member (23) is connected to the secondary housing (4), and wherein the shaft member (23) extends through the primary housing (2) for connection to a driven or driving member.
8. The rotary machine according to any of claims 1-7, wherein the rotor (3) comprises a stacked arrangement of a first rotor part (3a) and a second rotor part (3b) each of which comprises a corresponding housing part of the secondary housing (4), and a first planar partition piece (15a) and a second planar partition piece (15b) arranged between the first rotor part (3a) and the second rotor part (3b) on opposing sides of the joiner (6).
9. The rotary machine according to claim 8, wherein the joiner (6) comprises a joiner hub (16) extending along the joiner axis (X) and comprising the two opposing joiner ends (6a, 6b), a first planar joiner portion (16a) and a second planar joiner portion (16b), wherein the first and second planar joiner portions (16a, 16b) are arranged on opposing sides of the joiner hub (16), and wherein the joiner hub (16) is in sealed engagement with the first planar partition piece (15a) and the second planar partition piece (15b), and wherein joiner hub (16), the first planar joiner portion (16a) and the second planar joiner portion (16b) are in sealed engagement with the secondary housing (4).
10. The rotary machine according to claim 9, wherein the joiner hub (16) comprises one or more recesses (17) arranged along the outer circumference of the joiner hub (16) for fluid communication between two sub-chambers of the four subchambers partitioned by the first planar partition piece (15a) or the second planar partition piece (15b).
11. The rotary machine according to claim 10, wherein each recess of the one or more recesses (17) has a width (w) along the outer circumference of the joiner hub (16) larger than a thickness (t) of the first or second planar partition piece (15a, 15b).
12. The rotary machine according to any of claims 1-11, wherein the rotor (3) comprises a circumferential gear or pulley (18) and wherein the primary housing (2) comprises two apertures (19a, 19b) for connection of a belt or chain around the circumferential gear or pulley (18).
13. The rotary machine according to any of claims 1-12, wherein the compression chamber (5) is a spherical chamber, and wherein the joiner (6) comprises a circular edge portion (6c) for congruent engagement with a spherical inner surface of the spherical compression chamber (5).
14. The rotary machine according to any of claims 1-12, wherein the compression chamber (5) is a cylindrical chamber extending along the joiner axis X, and wherein the joiner (6) comprises a straight edge portion (6c) in congruent engagement with a cylindrical inner surface of the cylindrical compression chamber (5).
15. The rotary machine according to claim 1, wherein the swinger bracket arrangement (7) comprises two opposing semi-circular brackets (20a, 20b) each of which is affixed to the swinger guide arrangement (8), wherein the swinger guide arrangement (8) is rotatable around the swing axis (S), and wherein each joiner end of the two opposing joiner ends (6a, 6b) is movable along a corresponding semi-circular bracket of the two opposing semi-circular brackets (20a, 20b).

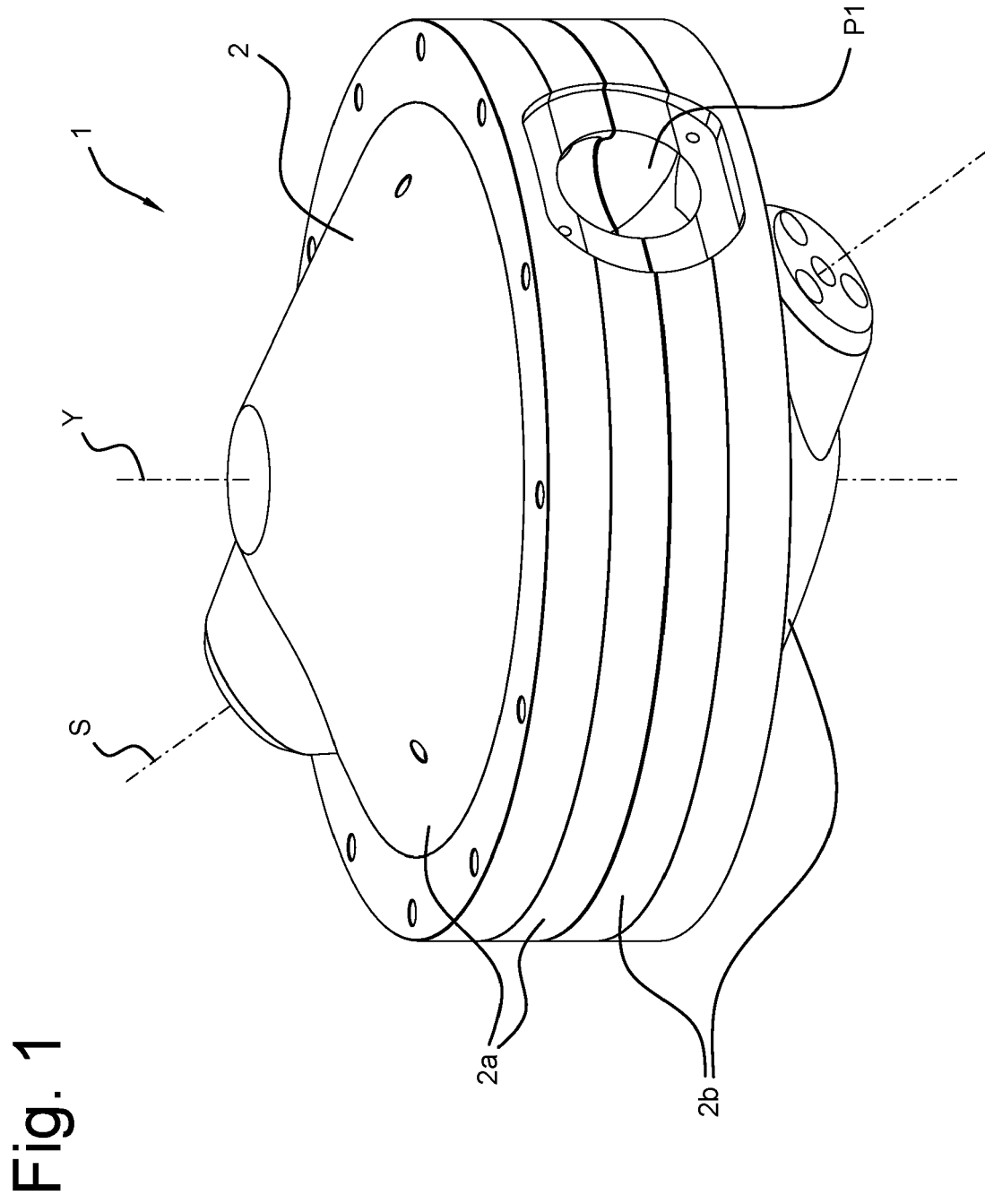


Fig. 2

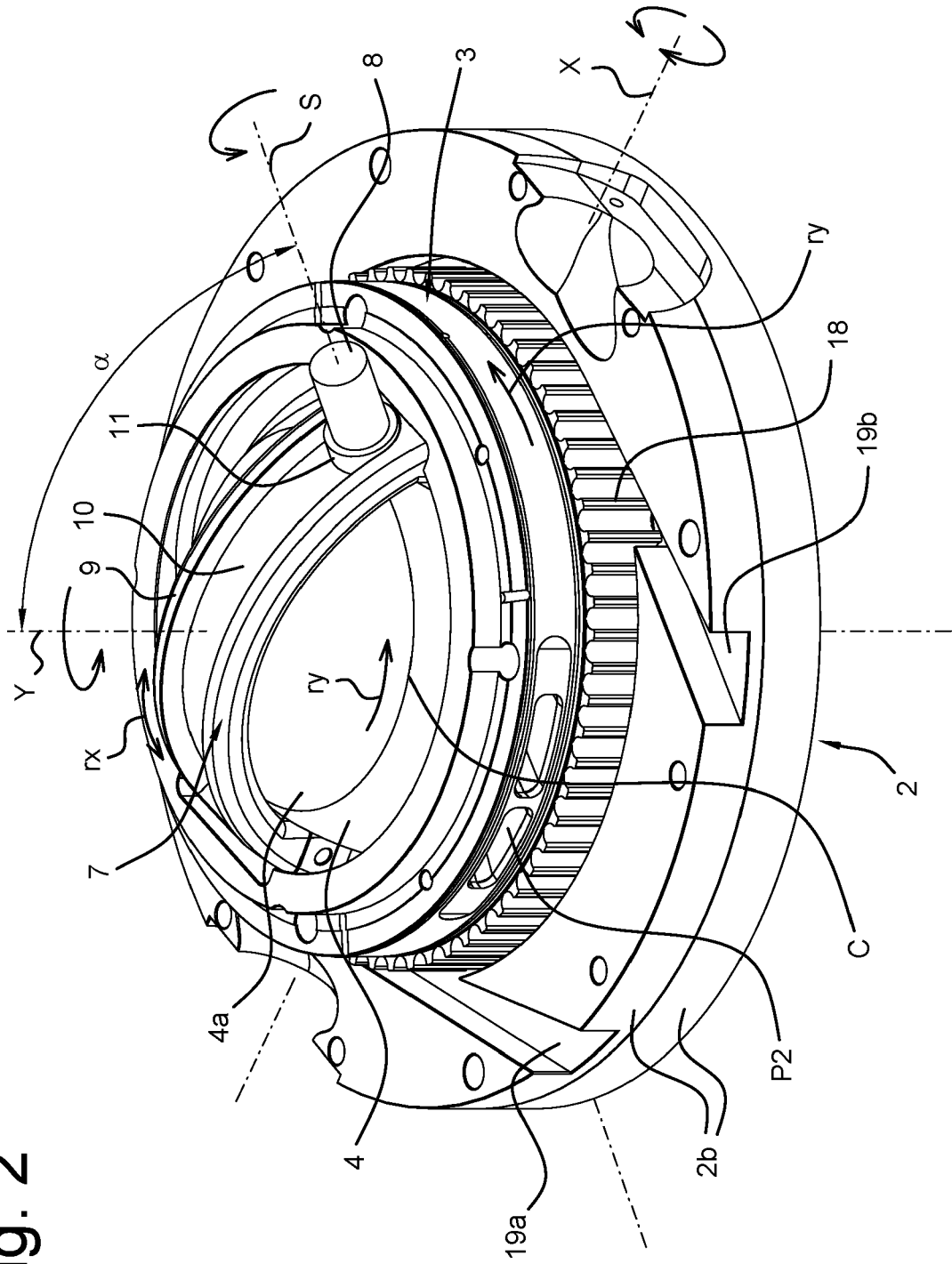


Fig. 3

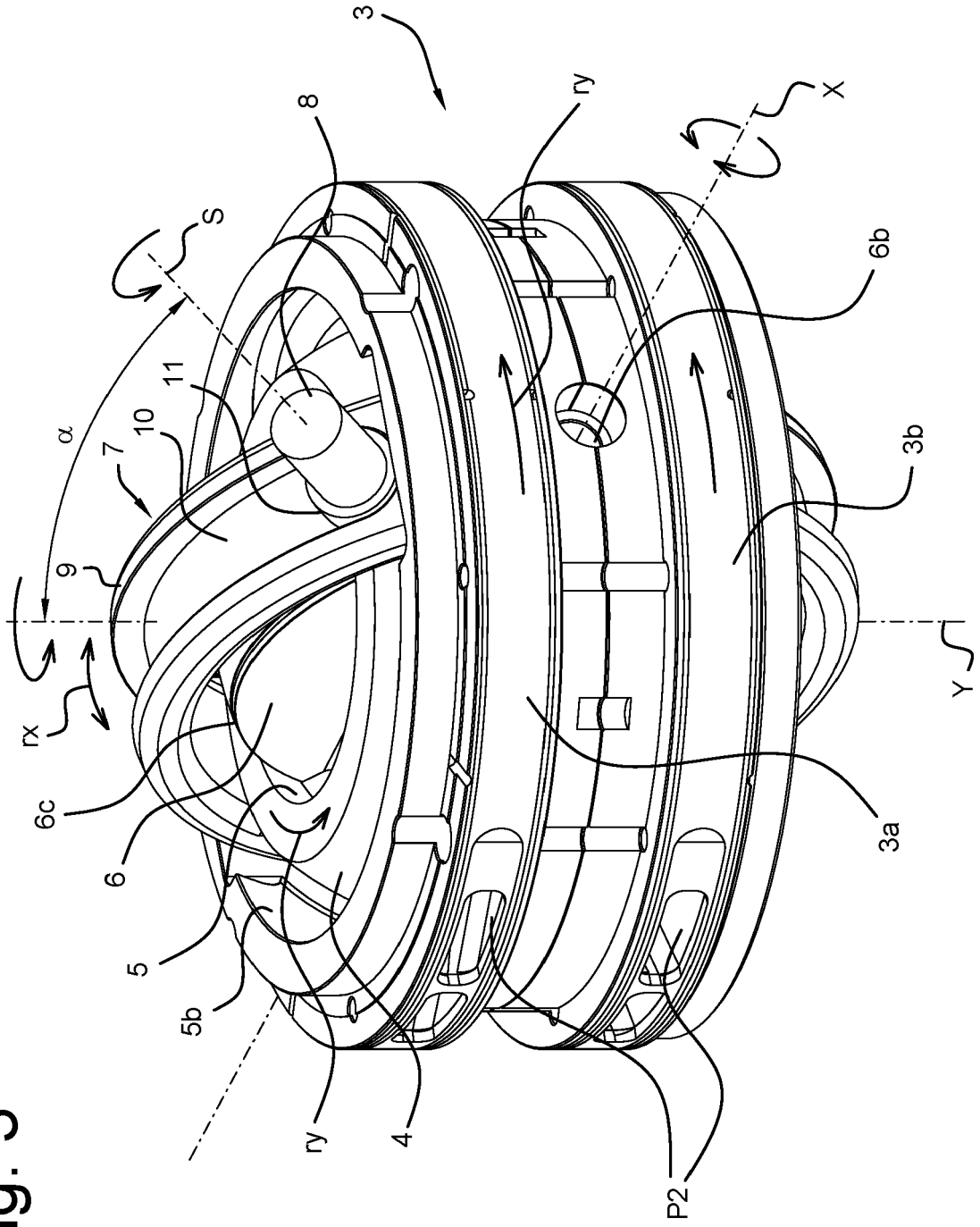


Fig. 4

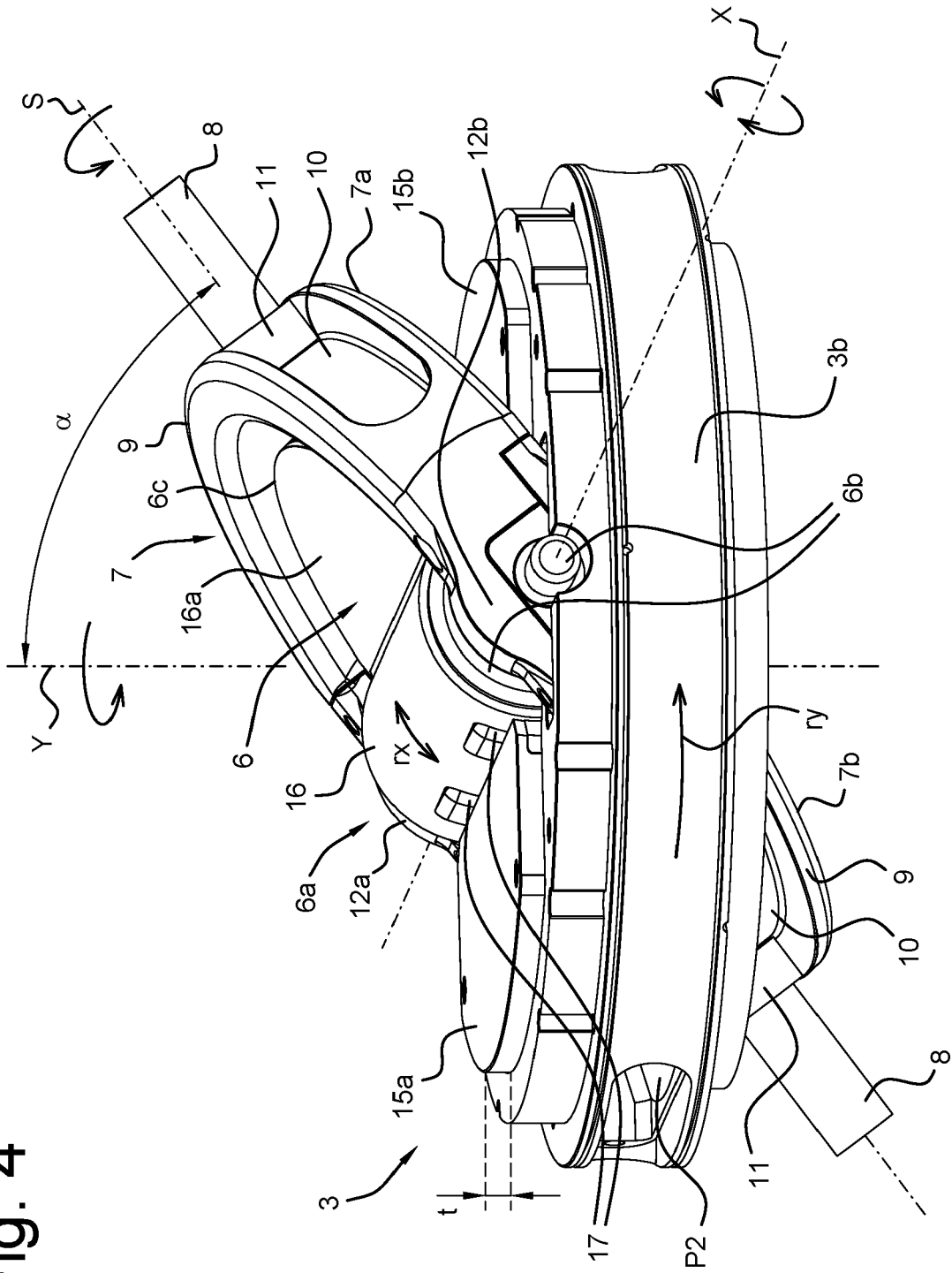


Fig. 5

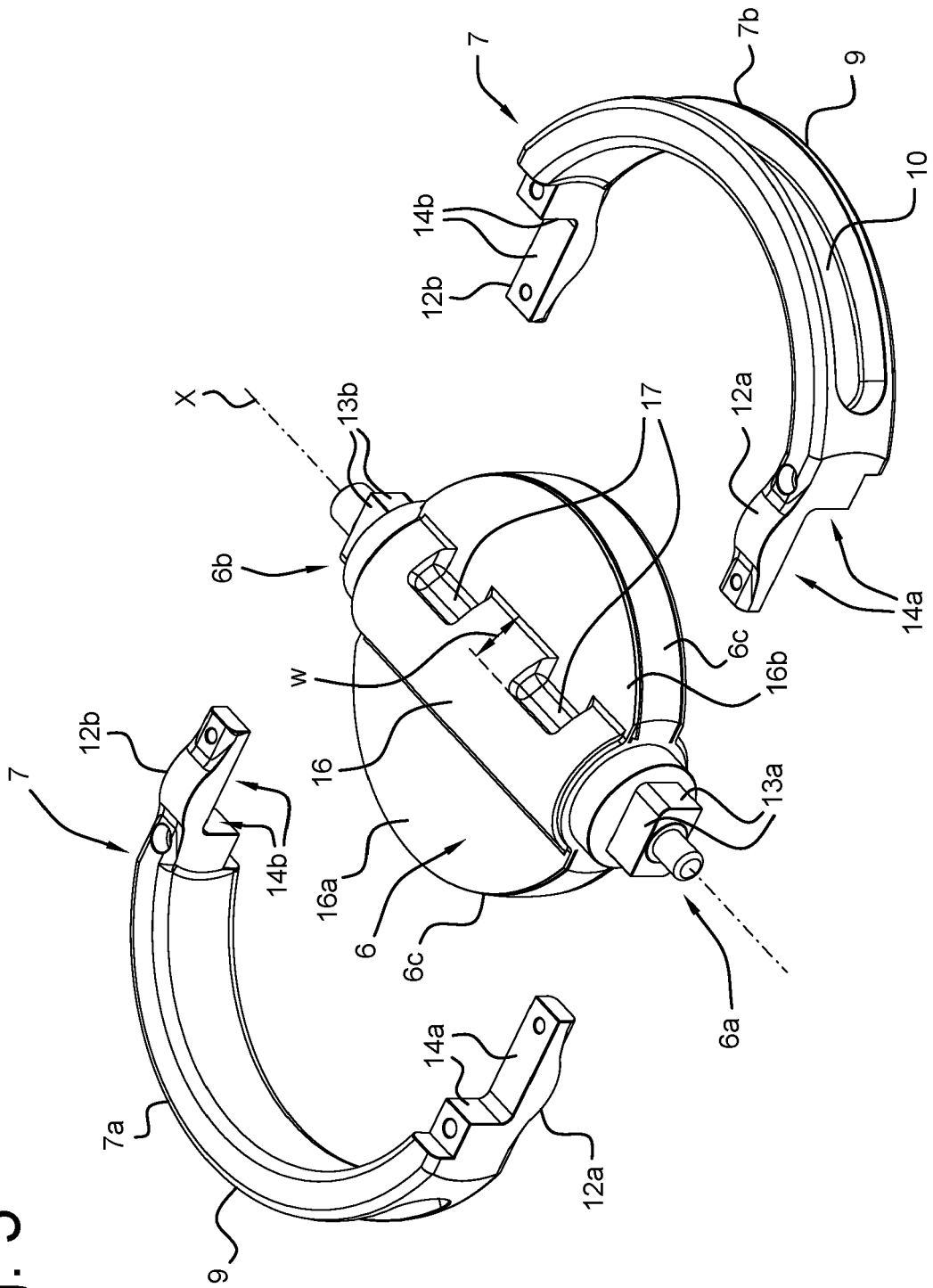
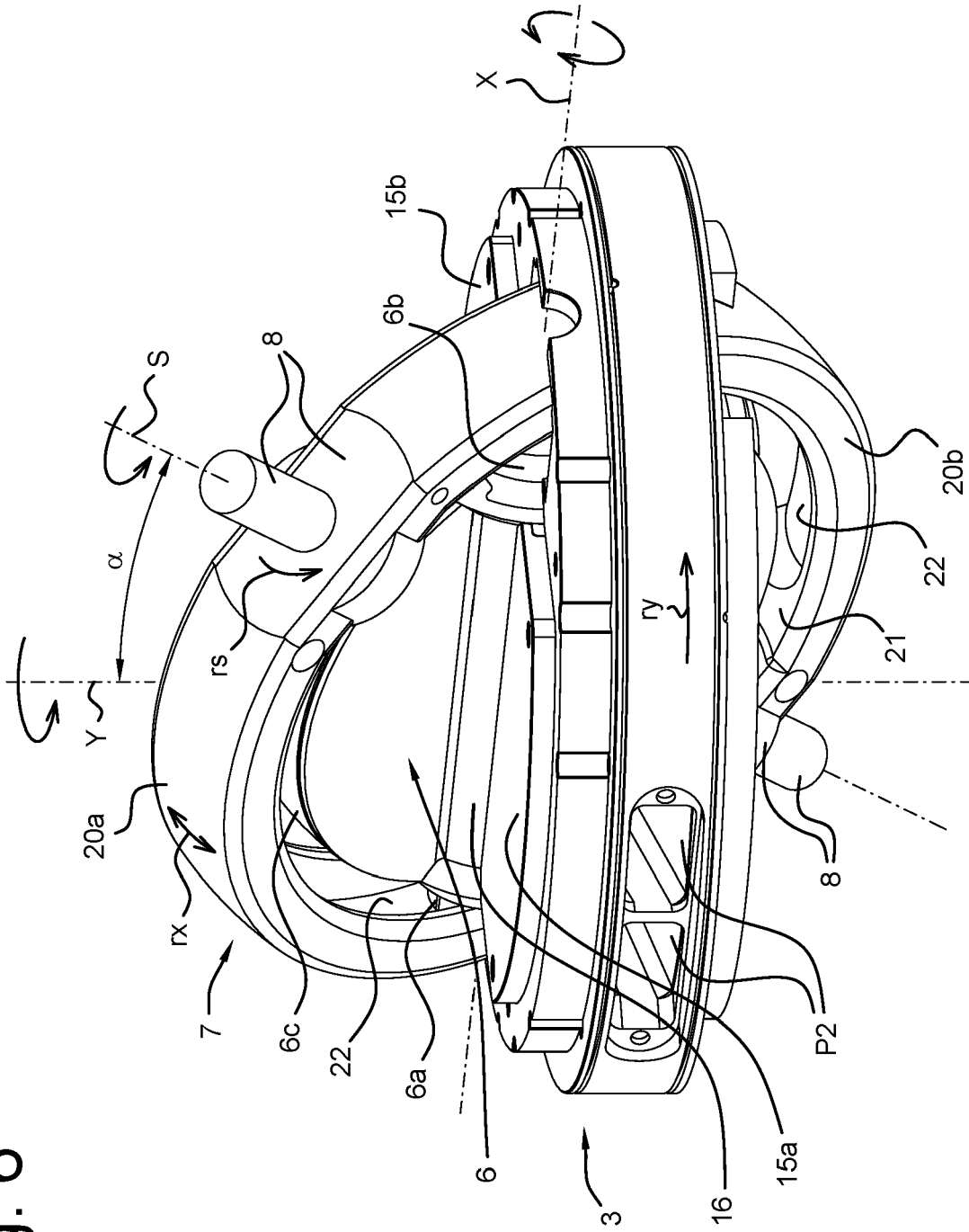


Fig. 6





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