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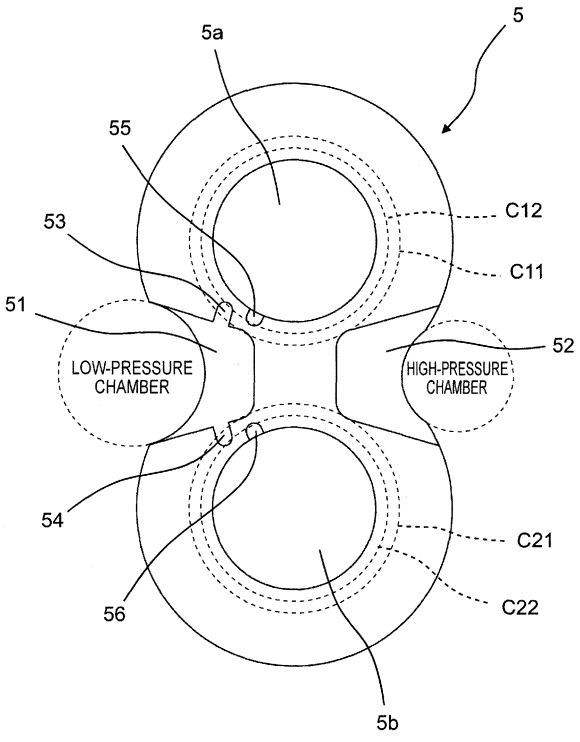
(54) **GEAR FLUID DEVICE**

(57) Groove portions (53, 55) are provided in a sliding contact surface of a first side plate (5) as to be positioned radially inside a root diameter of a drive gear (1) and radially outside a through hole (5a) into which a first rotary shaft (11) of the drive gear (1) is inserted, so that the through hole (5a) and a clearance groove (51) are not communicated with each other. Moreover, grooves (54, 56) are provided radially inside a root diameter of a driven gear (2) on the first side plate and radially outside a through hole (5b) into which a second rotary shaft (12) of the driven gear (2) is inserted, so that the through hole (5b) and the clearance groove (51) are not communicated with each other. As a consequence, a gear fluid device is provided which is capable of effectively preventing wear of sliding contact surfaces while keeping the lubricated state of the bearing part with simple construction.

Fig.2



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Description

TECHNICAL FIELD

[0001] The present invention relates to a gear fluid device.

BACKGROUND ART

[0002] As a conventional gear fluid device, there has been provided a gear pump which includes a drive gear and a driven gear to be engaged with each other and in which sliding contact surfaces of side plates are brought into sliding contact with a side face of the drive gear and a side face of the driven gear (see, e.g., JP H8-121352 A (PTL1), JP H6-317261 A (PTL2)).

[0003] For this gear pump, a gap between a gear side face and a housing facing the gear side face is preferably set narrow so as to reduce internal leaks of the pump. With a view to achieving this purpose, presently, pressure balance type side plates or bearing cases are adopted so that the gaps are narrowed aggressively.

[0004] For the gear pump, whereas less operating fluid leaks at gear side faces are desirable, part of leaked operating fluid flows into the bearing part of the gear, helping for lubrication and cooling of the bearing part.

[0005] Figs. 6 and 7 show plan views of a conventional first gear pump, as viewed from the sliding contact surface side of a side plate 405. Fig. 8 shows a sectional view of main part of the gear pump. In Figs. 6 to 8, reference signs 405a, 405b denote through holes, 410 denotes a body, 430 denotes a cover, 430a denotes a return passage, 440 denotes a gasket, and 451, 452 denote clearance grooves, and like component members are designated by like reference signs. In addition, the cross section of the side plate 405 in Fig. 8 is taken along the line A-A of Fig. 7.

[0006] Fig. 9 shows a plan view of a conventional second gear pump as viewed from the sliding contact surface side of a side plate 505. Fig. 10 shows a sectional view of main part of the gear pump. In Figs. 9 and 10, reference signs 505a, 505b denote through holes, 510 denotes a body, 530 denotes a cover, 530a denotes a return passage, 540 denotes a gasket, and 551, 552 denote clearance grooves, and like component members are designated by like reference signs. In addition, the cross section of the side plate 505 in Fig. 10 is taken along the line B-B of Fig. 9.

[0007] As described above, in order that operating fluid leaked from the high pressure side is made to flow into the bearing part as much as possible, the sliding contact surface is desirably formed into such a shape, as shown in Fig. 6, that the low pressure side clearance groove 451 does not communicate with the through holes 405a, 405b, through which rotary shafts pass, respectively, in the side plate 405. As shown in Fig. 8, part of the operating fluid leaked at the gear side faces is fed to a bearing part 413A (indicated by solid-line arrow) while the rest of the operating fluid flows toward the low pressure side via a gap between the side plate 405 and an end face of the cover 430 (indicated by dotted-line arrow).

[0008] However, with the shape of the sliding contact surface (hatched area) shown in Fig. 6, when some foreign matters in operating fluid have intruded into gaps between a side face of a drive gear 401 as well as a side face of a driven gear 402 and the sliding contact surface of the side plate 405 in regions S1, S2 (hatched areas shown in Fig. 7) between root diameters of the drive gear 401 (shown in Fig. 7) as well as the driven gear 402 (shown in Fig. 7) and diameters of the through holes 405a, 405b through which rotary shafts pass, respectively, it is difficult for the foreign matters to escape from the gaps, as shown in Fig. 7, so that the regions S1, S2 out of the sliding contact surfaces between the drive gear 401 or the driven gear 402 and the side plate 405 are more likely to wear. Therefore, the conventional first gear pump has a drawback that internal leaks at the gear side faces increase, more likely causing deterioration of the pump performance.

[0009] For prevention of this pump performance deterioration, it is appropriate, as in the conventional second gear pump shown in Fig. 9, that a low pressure side clearance groove 551 and the through holes 505a, 505b are communicated with each other by communicating portions 551a, 551b. This is because the communicating portions 551a, 551b of the clearance groove 551 make it easier for the foreign matters in the operating fluid to escape from the gaps between the gear side faces and the side plate 505 so that wear of the sliding contact surface can be prevented.

[0010] However, in the conventional second gear pump, as shown in Fig. 10, some of operating fluid leaked at the gear side faces return to the low pressure side via the communicating portions 551a, 551b (shown in Fig. 9) without passing through a bearing part 513A (indicated by solid-line arrow). As a result, the quantity of operating fluid (indicated by dotted-line arrow) flowing into the bearing part 513A decreases, resulting in worsened lubrication and cooling of the bearing part 513A and more likely causing damage to the bearing, as a drawback.

[0011] As already described, giving priority to the lubrication and cooling of the bearing part leads to adopting such side plate shapes as shown in Figs. 6 to 8. In such cases, however, the sliding contact surfaces between the drive gear, the driven gear and the side plate are more likely to wear.

[0012] In contrast to this, in cases where side plate shapes of such forms as shown in Figs. 9 and 10 are adopted to prevent wear of the sliding contact surfaces between the drive gear, the driven gear and the side plate, damage to the

bearing part is more likely to occur.

[0013] As described above, with the conventional first and second gear pumps, it has been impossible to achieve both lubrication of the bearing part and wear prevention of the sliding contact surfaces at the same time.

CITATION LIST

[0014] Patent Literature

PTL1: JP H8-121352 A
PTL2: JP H6-317261 A

SUMMARY OF INVENTION

Technical Problem

[0015] An object of the invention is, therefore, to provide a gear fluid device capable of effectively preventing wear of sliding contact surfaces while keeping a lubricated state of the bearing part with simple construction.

Solution to Problem

[0016] In order to achieve the above object, according to the present invention, a gear fluid device of the present invention comprises:

a drive gear and a driven gear to be engaged with each other;
sliding contact members having sliding contact surfaces to be brought into sliding contact with a side face of the drive gear and a side face of the driven gear, rotary shaft holes into which rotary shafts of the drive gear and the driven gear are inserted respectively, and clearance grooves which allow confinement regions formed at engagement portions of the drive gear and the driven gear to be communicated with a low pressure side and a high pressure side, respectively; and
at least one groove portion or recessed portion which is provided in the sliding contact surfaces of the sliding contact members so as to be positioned radially inside root diameters of the drive gear and the driven gear and moreover radially outside the rotary shaft holes in such a way that the rotary shaft holes and the clearance grooves are not communicated with each other.

[0017] With this structure, by the arrangement that the groove portion or the recessed portion is provided in the sliding contact surfaces of the sliding contact members (side plate, bearing case, housing, etc.) so as to be positioned radially inside the root diameter of the drive gear and moreover radially outside the rotary shaft hole, into which the rotary shaft of the drive gear is inserted, in such a way that the rotary shaft hole and the clearance groove are not communicated with each other, since the low pressure side and the rotary shaft hole are not communicated with each other, operating fluid leaked at the side face of the drive gear never returns to the low pressure side by passing through the groove portion or the recessed portion. Thus, operating fluid supplied to the bearing part for the drive-gear rotary shaft is prevented from leaking at the side face of the drive gear, with the result that the operating fluid, not decreasing in quantity, can be supplied to the bearing part in enough quantity for lubrication of the bearing part. Further, foreign matters that have intruded into the gaps between the side face of the drive gear and the sliding contact surfaces of the sliding contact members in the region between the root diameter of the drive gear and the inner diameter of the rotary shaft hole for the drive gear drop off into the groove portion or the recessed portion, so that wear of the sliding contact surfaces of the sliding contact members can also be prevented.

[0018] Similarly, by the arrangement that the groove portion or the recessed portion is provided in the sliding contact surfaces of the sliding contact members so as to be positioned radially inside the root diameter of the driven gear and moreover radially outside the rotary shaft hole, into which the rotary shaft of the driven gear is inserted, in such a way that the rotary shaft hole and the clearance groove are not communicated with each other, since the low pressure side and the rotary shaft hole are not communicated with each other, operating fluid leaked at the side face of the driven gear never returns to the low pressure side by passing through the groove portion or the recessed portion. Thus, operating fluid supplied to the bearing part for the driven-gear rotary shaft is prevented from leaking at the side face of the driven gear, with the result that the operating fluid, not decreasing in quantity, can be supplied to the bearing part in enough quantity for lubrication of the bearing part. Further, foreign matters that have intruded into the gaps between the side face of the driven gear and the sliding contact surfaces of the sliding contact members in the region between the root diameter of the driven gear and the inner diameter of the rotary shaft hole for the driven gear drop off into the groove

portion or the recessed portion, so that wear of the sliding contact surfaces of the sliding contact members can also be prevented.

[0019] Therefore, according to the invention, it is implementable to effectively prevent wear of the sliding contact surfaces while keeping the lubricated state of the bearing part with simple construction.

[0020] In one embodiment, the sliding contact members are side plates or bearing cases which are placed so as to sandwich both side faces of the drive gear and both side faces of the driven gear, or a housing in which the drive gear and the driven gear are housed.

[0021] In one embodiment, the groove portion or the recessed portion of the sliding contact members is provided on the low pressure side of the gear fluid device.

[0022] According to this embodiment, since the groove portion or recessed portion of the sliding contact members (side plate, bearing case, or housing, etc.) is provided on the low pressure side of the gear fluid device, sealing areas for operating fluid on the high pressure side to be sealed by the side faces of the drive gear as well as the driven gear and the sliding contact members do not need to be reduced. That is, since internal leaks at the side faces of the drive gear and the driven gear are never increased, the pump performance can be prevented from adverse effects.

[0023] In one embodiment, the groove portion or the recessed portion of the sliding contact members is provided so as to connect to the clearance grooves.

[0024] According to this embodiment, by the arrangement that the groove portion (or recessed portion) of the sliding contact members (side plate, bearing case, or housing, etc.) is provided so as to connect to the clearance groove, foreign matters which have intruded into the gaps between the side faces of the drive gear as well as the driven gear and the sliding contact surfaces of the sliding contact members and which have dropped off into the groove portion (or recessed portion) flow out into the clearance groove along with the operating fluid. Therefore, the removal of foreign matters can be achieved effectively.

[0025] In one embodiment, at least one of the groove portions or the recessed portions of the sliding contact members is provided so as to connect to the clearance groove, and another at least one of the groove portions or the recessed portions of the sliding contact members is provided so as to connect to the rotary shaft hole.

[0026] According to this embodiment, by the arrangement that at least one of the groove portions (or recessed portions) of the sliding contact members (side plate, bearing case, or housing, etc.) is provided so as to connect to the clearance groove while another at least one of the groove portions (or recessed portions) of the sliding contact members is provided so as to connect to the rotary shaft hole, foreign matters which have intruded into the gaps between the side faces of the drive gear as well as the driven gear and the sliding contact surfaces of the sliding contact members drop off into the groove portion (or recessed portion) and flow out into both the clearance groove and the rotary shaft hole along with the operating fluid. Therefore, the removal of foreign matters can be achieved more effectively.

[0027] In one embodiment, a radially-inner end portion of at least one of the groove portions or the recessed portions connecting to the clearance groove of the sliding contact members is positioned radially inside a radially-outer end portion of the at least one of the groove portions or the recessed portions connecting to the rotary shaft hole of the sliding contact members.

[0028] According to this embodiment, by the arrangement that a radially-inner end portion of at least one of the groove portions (or recessed portions) connecting to the clearance groove of the sliding contact members (side plate, bearing case, or housing, etc.) is positioned radially inside a radially-outer end portion of at least one of the groove portions (or recessed portions) connecting to the rotary shaft hole of the sliding contact members, a foreign-matter removal region by the groove portion (or recessed portion) connecting to the clearance groove and a foreign-matter removal region by the groove portion (or recessed portion) connecting to the rotary shaft hole overlap with each other. Therefore, it is made possible to securely remove foreign matters on the side face part of the drive gear and the side face part of the driven gear both facing the region of the sliding contact members ranging radially inside the root diameters of the drive gear as well as the driven gear and radially outside the rotary shaft hole.

Advantageous Effects of Invention

[0029] As apparent from the above description, according to the present invention, there can be realized a gear fluid device capable of effectively preventing wear of sliding contact surfaces while keeping the lubricated state of the bearing part with simple construction.

BRIEF DESCRIPTION OF DRAWINGS

[0030]

Fig. 1 is a sectional view of a gear pump as an example of a gear fluid device which is a first embodiment of the present invention;

Fig. 2 is a plan view of the gear pump as viewed from a sliding contact surface side of a first side plate;
Fig. 3 is a plan view of a gear pump as an example of a gear fluid device which is a second embodiment of the invention, as viewed from a sliding contact surface side of its first side plate;
Fig. 4 is a sectional view of a gear pump as an example of a gear fluid device which is a third embodiment of the invention;
Fig. 5 is a sectional view of a gear pump as an example of a gear fluid device which is a fourth embodiment of the invention;
Fig. 6 is a plan view of a conventional first gear pump as viewed from a sliding contact surface side of its side plate;
Fig. 7 is a plan view as viewed from a sliding contact surface side of the side plate;
Fig. 8 is a sectional view of main part of the gear pump;
Fig. 9 is a plan view of a conventional second gear pump as viewed from a sliding contact surface side of its side plate; and
Fig. 10 is a sectional view of main part of the gear pump.

DESCRIPTION OF EMBODIMENTS

[0031] Hereinbelow, the gear fluid device of the present invention will be described in detail by embodiments thereof illustrated in the accompanying drawings.

(First Embodiment)

[0032] Fig. 1 is a sectional view of a gear pump as an example of a gear fluid device which is a first embodiment of the present invention.

[0033] The gear pump of this first embodiment, as shown in Fig. 1, includes a body 10 which has two cylindrical spaces having axes parallel to each other and partly overlapping with each other, a drive gear 1 which is a spur gear placed within the body 10, and a driven gear 2 which is placed in the body 10 and which is a spur gear to be mutually engaged with the drive gear 1. The body 10 is provided with an inlet port (not shown) and a discharge port (not shown). In addition, the body 10 is made by using cast iron, aluminum alloy or the like. Also, the drive gear 1 and the driven gear 2 are made by using carburizing hardened steel or the like.

[0034] Also, in the body 10, a first side plate 5 and a second side plate 6 as an example of sliding contact members are placed so as to sandwich both side faces of the drive gear 1 and both side faces of the driven gear 2. A high-pressure part area on a non-sliding contact surface side of the first side plate 5 and the second side plate 6 is slightly larger than a high-pressure part area on their sliding contact surface side, by which the sliding contact surfaces are to be pressed against the side faces of the drive gear 1 and the driven gear 2 so as to provide as narrow gaps as possible. A gap between the non-sliding contact surface of the first side plate 5 and a mount member 20 on the left side in the figure, as well as a gap between the non-sliding contact surface of the second side plate 6 and a cover 30 on the right side in the figure, define high pressure and low pressure parts with the gasket 40. Also, a left end of the body 10 in the figure is covered by the mount member 20 while a right side of the body 10 in the figure is covered by the cover 30. The body 10, the mount member 20 and the cover 30 constitute a housing. In this housing, the drive gear 1 and the driven gear 2 having teeth (not shown) to be engaged with each other are contained.

[0035] One end (right side in Fig. 1) of a first rotary shaft 11 for driving the drive gear 1 is rotatably supported by the cover 30 via a bearing 13A while the other end (left side in Fig. 1) of the first rotary shaft 11 is rotatably supported by mount member 20 via a bearing 13B. The other-end side coupling part 11a of the first rotary shaft 11 is protruded from the mount member 20, and a drive shaft of an unshown motor is coupled to the coupling part 11a. Also, one end (right side in Fig. 1) of a second rotary shaft 12 for the driven gear 2 is rotatably supported by the cover 30 via a bearing 14A while the other end (left side in Fig. 1) of the second rotary shaft 12 is rotatably supported by the mount member 20 via a bearing 14B. In Fig. 1, reference sign 15 denotes an oil seal.

[0036] Fig. 2 is a plan view of the gear pump as viewed from the sliding contact surface side of the first side plate 5. It is noted that the second side plate 6 is similar in structure to the first side plate 5.

[0037] As shown in Fig. 2, the first side plate 5 formed into an 8-like shape has a through hole 5a as an example of a rotary shaft hole into which the first rotary shaft 11 (shown in Fig. 1) is inserted, a through hole 5b as an example of a rotary shaft hole into which the second rotary shaft 12 (shown in Fig. 1) is inserted, a clearance groove 51 extending toward the low-pressure chamber side from a proximity of an engagement portion of the drive gear 1 and the driven gear 2, and a clearance groove 52 extending toward the high-pressure chamber side from a proximity of the engagement portion of the drive gear 1 and the driven gear 2.

[0038] With regard to the clearance groove 51, when a confinement region (central portion of the first side plate 5) of operating fluid formed by the first, second side plates 5, 6 and individual teeth of the drive gear 1 and the driven gear 2 in proximity of the engagement portion of the drive gear 1 and the driven gear 2 is expanded so as to come to low

pressure, the operating fluid is supplied from the low pressure side of the gear pump to the confinement region to prevent the confinement region from going to negative pressure. With regard to the clearance groove 52, on the other hand, when the confinement region is contracted along with rotations of the drive gear 1 and the driven gear 2, high-pressure operating fluid within the confinement region is let to escape toward the high pressure side of the gear pump to prevent occurrence of high pressure within the confinement region.

[0039] Then, a groove portion 53 is formed which communicates with the clearance groove 51 of the first side plate 5 and which extends radially inward of a root diameter (indicated by C11) of the drive gear 1 but which does not reach the through hole 5a. This groove portion 53 extends radially inward of an intermediate diameter (indicated by C12). Also, a groove portion 55 is formed which communicates with the through hole 5a of the first side plate 5 and which extends radially outward of the intermediate diameter (indicated by C12). This groove portion 55 does not communicate with the clearance groove 51. It is noted that the intermediate diameter (indicated by C12) is a diameter equal to 1/2 of a sum of the root diameter of the drive gear 1 and the inner diameter of the through hole 5a.

[0040] That is, a radially-inner end portion of the groove portion 53 connecting to the clearance groove 51 of the first side plate 5 is positioned radially inside a radially-outer end portion of the groove portion 55 connecting to the through hole 5a of the first side plate 5.

[0041] Meanwhile, a groove portion 54 is formed which communicates with the clearance groove 51 of the first side plate 5 and which extends radially inward of a root diameter (indicated by C21) of the driven gear 2 but which does not reach the through hole 5b. This groove portion 54 extends radially inward of an intermediate diameter (indicated by C22). Also, a groove portion 56 is formed which communicates with the through hole 5b of the first side plate 5 and which extends radially outward of the intermediate diameter (indicated by C22). This groove portion 56 does not communicate with the clearance groove 51. It is noted that the intermediate diameter (indicated by C22) is a diameter equal to 1/2 of a sum of the root diameter of the driven gear 2 and the inner diameter of the through hole 5b.

[0042] That is, a radially-inner end portion of the groove portion 54 connecting to the clearance groove 51 of the first side plate 5 is positioned radially inside a radially-outer end portion of the groove portion 56 connecting to the through hole 5b of the first side plate 5.

[0043] The groove portion 53 is formed so as to extend from the low-pressure side clearance groove 51 of the first side plate 5 toward the through hole 5a for the first rotary shaft 11, being terminated on the way leading to the through hole 5a. On the other hand, the groove portion 55 is formed also from the through hole 5a toward the low-pressure side clearance groove 51, being terminated on the way leading to the clearance groove 51.

[0044] Similarly, the groove portion 54 is formed so as to extend from the low-pressure side clearance groove 51 of the first side plate 5 toward the through hole 5b for the second rotary shaft 12, being terminated on the way leading to the through hole 5b. On the other hand, the groove portion 56 is formed also from the through hole 5b toward the low-pressure side clearance groove 52, being terminated on the way leading to the clearance groove 52.

[0045] As a result of this, the groove portions 53, 55 are present in an annular region which is radially inside the root diameters (indicated by C11) and which is radially outside the inner diameter of the through hole 5a, and moreover the groove portions 54, 56 are present in an annular region which is radially inside the root diameters (indicated by C21) and which is radially outside the inner diameter of the through hole 5b. That is, the radially-inner end portions of the groove portions 53, 54 connecting to the clearance groove 51 of the first, second side plates 5, 6 are positioned radially inside the radially-outer end portions of the groove portions 55, 56 connecting to the through holes 5a, 5b of the first, second side plates 5, 6. Thus, even foreign matters pinched at any positions in the individual annular regions are let to drop off into either the groove portions 53, 54 or the groove portions 55, 56.

[0046] According to the gear pump structured as described above, the groove portions 53, 55 are provided radially inside the root diameters of the drive gear 1 of the first, second side plates 5, 6 (sliding contact members) and radially outside the through hole 5a into which the first rotary shaft 11 of the drive gear 1 is inserted, in such a way that the through hole 5a and the clearance groove 51 are not communicated with each other. Moreover, the groove portions 54, 56 are provided radially inside the root diameters of the driven gear 2 of the first, second side plates 5, 6 (sliding contact members) and radially outside the through hole 5b into which the second rotary shaft 12 of the driven gear 2 is inserted, in such a way that the through hole 5b and the clearance groove 51 are not communicated with each other. As a result, since the low pressure side of the gear pump and the through holes 5a, 5b are not communicated with each other, operating fluid leaked at the side faces of the drive gear 1 and the driven gear 2 never returns to the low pressure side of the gear pump by passing through the groove portions 53, 54, 55, 56. Thus, operating fluid supplied to the bearings 13A, 13B, 14A, 14B for the first, second rotary shafts 11, 12 is prevented from leaking at the side faces of the drive gear 1 and the driven gear 2, with the result that the operating fluid, not decreasing in quantity, can be supplied to the bearings 13A, 13B, 14A, 14B in enough quantity for lubrication.

[0047] Further, since foreign matters that have intruded into the gaps between the side faces of the drive gear 1 as well as the driven gear 2 and the side faces as sliding contact surfaces of the first, second side plates 5, 6 in the annular region radially inside the root diameter (indicated by C11) of the drive gear 1 and radially outside the inner diameter of the through hole 5a as well as in the annular region radially inside the root diameter (indicated by C21) of the driven

gear 2 and radially outside the inner diameter of the through hole 5b drop off into the groove portions 53, 54, 55, 56, it follows that wear of the sliding contact surfaces between the drive gear 1 as well as the driven gear 2 and the first, second side plates 5, 6 in the above-described annular regions can also be prevented.

[0048] Therefore, according to the gear pump of the first embodiment, it is implementable to effectively prevent wear of the sliding contact surfaces while keeping the lubricated state of the bearing part with simple construction.

[0049] Also, since the groove portions 53, 54, 55, 56 of the first, second side plates 5, 6 are provided on the low pressure side of the gear pump, sealing areas for operating fluid on the high pressure side to be sealed by the side faces of the drive gear 1 and the driven gear 2 as well as the first, second side plates 5, 6 do not need to be reduced. That is, since internal leaks at the side faces of the drive gear 1 and the driven gear 2 are never increased, the pump performance can be prevented from adverse effects.

[0050] Also, by the arrangement that the groove portions 53, 54 of the first, second side plates 5, 6 are provided so as to connect to the clearance groove 51, foreign matters which have intruded into the gaps between the side faces of the drive gear 1 as well as the driven gear 2 and the side faces as sliding contact surfaces of the first, second side plates 5, 6 and which have dropped off into the groove portions 53, 54 flow out into the clearance groove 51 along with the operating fluid. Therefore, the removal of foreign matters can be achieved more effectively.

[0051] Furthermore, by the arrangement that the groove portions 53, 54 of the first, second side plates 5, 6 are provided so as to connecting to the clearance groove 51 while the groove portions 55, 56 of the first, second side plates 5, 6 are provided so as to connect to the through holes 5a, 5b, foreign matters which have intruded into the gaps between the side faces of the drive gear 1 as well as the driven gear 2 and the side faces as sliding contact surfaces of the first, second side plates 5, 6 and which have dropped off into the groove portions 53, 54, 55, 56 flow out into both the clearance grooves 51, 52 and the through holes 5a, 5b along with the operating fluid. Therefore, the removal of foreign matters can be achieved more effectively.

[0052] Further, by the arrangement that radially-inner end portions of the groove portions 53, 54 connecting to the clearance groove 51 of the first, second side plates 5, 6 are positioned radially inside the radially-outer end portions of the groove portions 55, 56 connecting to the through holes 5a, 5b of the first, second side plates 5, 6, a foreign-matter removal region by the groove portion 53 connecting to the clearance groove 51 and a foreign-matter removal region by the groove portion 55 connecting to the through hole 5a overlap with each other, and moreover a foreign-matter removal region by the groove portion 54 connecting to the clearance groove 51 and a foreign-matter removal region by the groove portion 56 connecting to the through hole 5b overlap with each other. Hence, it is made possible to securely remove foreign matters on the side face part of the drive gear 1 and the side face part of the driven gear 2 both facing the annular region ranging radially inside the root diameters of the drive gear 1 and the driven gear 2 of the first, second side plates 5, 6 and radially outside the through holes 5a, 5b.

[0053] In the above first embodiment, the groove portions 53, 54, 55, 56 communicating with only either the rotary shaft-dedicated through holes 5a, 5b or the clearance grooves 51, 52 are provided in the first, second side plates 5, 6 as sliding contact members. However, the number of the groove portions is not particularly limited.

[0054] Furthermore, without being limited to groove portions, recessed portions may be provided in annular regions which are radially inside the root diameters of the first, second side plates 5, 6 as sliding contact members and which are radially outside the inner diameters of the through holes 5a, 5b as rotary shaft holes. These recessed portions may be communicated with either the rotary shaft holes or the clearance grooves and moreover may be communicated with neither the rotary shaft holes nor the clearance grooves. In this case, foreign matters which have intruded into the gaps between the side faces of the drive gear as well as the driven gear and the sliding contact surfaces of the sliding contact members drop off into the recessed portions of the sliding contact members.

[0055] Furthermore, in the above first embodiment, by the arrangement that radially-inner end portions of the groove portions 53, 54 connecting to the clearance groove 51 of the first, second side plates 5, 6 are positioned radially inside the radially-outer end portions of the groove portions 55, 56 connecting to the through holes 5a, 5b of the first, second side plates 5, 6, the foreign-matter removal region by the groove portion 53 connecting to the clearance groove 51 and the foreign-matter removal region by the groove portion 55 connecting to the through hole 5a overlap with each other, and moreover the foreign-matter removal region by the groove portion 54 connecting to the clearance groove 51 and the foreign-matter removal region by the groove portion 56 connecting to the through hole 5b overlap with each other. However, the invention may be so modified that a foreign-matter removal region by a groove portion (or recessed portion) connecting to a clearance groove and a foreign-matter removal region by a groove portion (or recessed portion) connecting to a through hole do not overlap with each other and are close to each other.

(Second Embodiment)

[0056] Fig. 3 is a plan view of a gear pump as an example of a gear fluid device which is a second embodiment of the invention, as viewed from a sliding contact surface side of its first side plate 105. The gear pump of this second embodiment is similar in structure to the gear pump of the first embodiment except groove portions of side plates and therefore Fig.

1 is referenced also in this case. The second side plate is also similar in structure to the first side plate 105.

[0057] As shown in Fig. 3, the first side plate 105 formed into an 8-like shape has a through hole 105a as an example of a rotary shaft hole into which the first rotary shaft 11 (shown in Fig. 1) is inserted, a through hole 105b as an example of a rotary shaft hole into which the second rotary shaft 12 (shown in Fig. 1) is inserted, a clearance groove 151 extending toward the low-pressure chamber side from a proximity of an engagement position of the drive gear 1 (shown in Fig. 1) and the driven gear 2 (shown in Fig. 1), and a clearance groove 152 extending toward the high-pressure chamber side from a proximity of the engagement position of the drive gear 1 and the driven gear 2.

[0058] Then, a groove portion 153 is formed which communicates with the clearance groove 151 on the low pressure side of the first side plate 105 and which extends from the clearance groove 151 toward the rotary shaft-dedicated through hole 105a up to a proximity of the through hole 105a.

[0059] Meanwhile, a groove portion 154 is formed which communicates with the clearance groove 151 on the low pressure side of the first side plate 105 and which extends from the clearance groove 151 toward the rotary shaft-dedicated through hole 105b up to a proximity of the through hole 105b.

[0060] As a result of this, the groove portion 153 is present generally over a region which is radially inside the root diameter (C111) and which is radially outside the inner diameter of the through hole 105a, and moreover the groove portion 154 is present generally over a region which is radially inside the root diameter (C121) and which is radially outside the inner diameter of the through hole 105b. Thus, foreign matters pinched at any positions over the generally whole range extending radially inward from the root diameter to the through holes 105a, 105b drop off into the groove portions 153, 154.

[0061] The gear pump of the above-described second embodiment, as in the gear pump of the first embodiment, is capable of effectively preventing wear of sliding contact surfaces while keeping the lubricated state of the bearing part with simple construction.

[0062] With the gear pump of the above structure, foreign matters having intruded to around the through holes 105a, 105b do not drop, so that wear of the relevant spots cannot be prevented. However, wear of the annular regions where the groove portions 153, 154 are present can be prevented. Therefore, this embodiment can obtain sufficient effects, though inferior to the first embodiment. The gear pump of this second embodiment can be embodied by taking into account the labor for forming the groove portions and the effects of preventing deterioration of pump performance.

[0063] Further, according to the second embodiment, since the groove portions 153, 154 are not communicated with the through holes 105a, 105b, foreign matters never intrude into the bearings 13A, 13B, 14A, 14B (shown in Fig. 1), so that damage to the bearings due to foreign matters can be prevented.

[0064] In this second embodiment, the groove portions 153, 154 communicating with only either the through holes 105a, 105b (rotary shaft holes) or the clearance grooves 151, 152 are provided in the first side plate 105 and the second side plate as sliding contact members. However, the number of groove portions is not limited.

[0065] Also, without being limited to groove portions, recessed portions may be provided in annular regions which are radially inside the root diameters of the sliding contact members and which are radially outside the inner diameters of the through holes 105a, 105b. These recessed portions may be communicated with either the rotary shaft holes or the clearance grooves, or may be communicated with neither the rotary shaft holes nor the clearance grooves. In this case, foreign matters which have intruded into the gaps between the side faces of the drive gear as well as the driven gear and the sliding contact surfaces of the sliding contact members drop off into the recessed portions of the sliding contact members.

[0066] In cases other than the first and second embodiments, similar effects can be obtained even when the groove portions or the recessed portions are formed on the high pressure side of the first, second side plates (sliding contact members).

(Third Embodiment)

[0067] Fig. 4 is a sectional view of a gear pump as an example of a gear fluid device which is a third embodiment of the invention.

[0068] The gear pump of this third embodiment, as shown in Fig. 4, includes a body 210 which has two cylindrical spaces having axes parallel to each other and partly overlapping with each other, two bearing cases 220, 220 as an example of sliding contact members placed in the body 210 with a specified spacing to each other, a drive gear 201 which is a spur gear placed between the bearing cases 220, 220, and a driven gear 202 which is a spur gear placed between the bearing cases 220, 220 and to be mutually engaged with the drive gear 201. The body 210 is provided with an inlet port (not shown) and a discharge port (not shown).

[0069] A high-pressure part area on non-sliding contact surfaces of the bearing cases 220, 220 is slightly larger than a high-pressure part area on their sliding contact surface side. The sliding contact surfaces are to be pressed against the side faces of the drive gear 201 and the driven gear 202 so as to provide as narrow gaps as possible. A gap between the bearing case 220 and a mount member 230 on the left side in the figure, as well as a gap between the bearing case

220 and a cover 240 on the right side in the figure, define high pressure and low pressure parts with a gasket 250. Also, a left end of the body 210 in the figure is covered by the mount member 230 while a right side of the body 210 in the figure is covered by the cover 240. The body 210, the mount member 230 and the cover 240 constitute a housing. In this housing, the drive gear 201 and the driven gear 202 to be engaged with each other are contained.

[0070] One end (right side in Fig. 4) of a first rotary shaft 211 for driving the drive gear 201 is rotatably supported by a bearing case 220 via a bearing 213A while the other end (left side in Fig. 4) of the first rotary shaft 211 is rotatably supported by another bearing case 220 via a bearing 213B. The other-end side coupling part 211a of the first rotary shaft 211 is protruded from the mount member 230, and a drive shaft of an unshown motor is coupled to the coupling part 211a. Also, one end (right side in Fig. 4) of a second rotary shaft 212 for the driven gear 202 is rotatably supported by the bearing case 220 via a bearing 214A while the other end (left side in Fig. 4) of the second rotary shaft 212 is rotatably supported by the bearing case 220 via a bearing 214B. In Fig. 4, reference sign 215 denotes an oil seal.

[0071] In the gear pump of this third embodiment, the sliding contact surface side of the bearing cases 220, 220 (sliding contact members) to be brought into sliding contact with the side faces of the drive gear 201 and the driven gear 202 is similar in structure to that of the first, second side plates of the first embodiment or the second embodiment.

[0072] The gear pump of the third embodiment has the same effects as the gear pump of the first embodiment.

[0073] The side plates or the bearing cases have been mentioned in the first to third embodiments. However, the present invention is applicable also to sliding contact surfaces of mount members or covers facing gear side faces in even pumps of the fixed gap method using neither the side plates nor the bearing cases.

[0074] A fourth embodiment in which the invention is applied to the sliding contact surfaces of the mounting and the cover will be described below.

(Fourth Embodiment)

[0075] Fig. 5 is a sectional view of a gear pump as an example of a gear fluid device which is a fourth embodiment of the invention. The gear pump of this fourth embodiment is similar in structure to the gear pump of the first embodiment except that neither the side plates nor the bearing cases are included and that the mount member and the cover are different therefrom.

[0076] The gear pump of the fourth embodiment, as shown in Fig. 5, includes a body 310 which has two cylindrical spaces having axes parallel to each other and partly overlapping with each other, a drive gear 301 which is a spur gear placed within the body 310, and a driven gear 302 which is placed in the body 310 and which is a spur gear to be mutually engaged with the drive gear 301. The body 310 is provided with an inlet port (not shown) and a discharge port (not shown).

[0077] Also, a left end of the body 310 in the figure is covered by a mount member 320 while a right side of the body 310 in the figure is covered by a cover 330. The body 310, the mount member 320 and the cover 330 constitute a housing. In this housing, the drive gear 301 and the driven gear 302 having teeth (not shown) to be engaged with each other are contained.

[0078] By the mount member 320 and the cover 330 as an example of sliding contact members placed so as to sandwich both side faces of the drive gear 301 and both side faces of the driven gear 302, sealing is performed between the side faces of the drive gear 301 as well as the driven gear 302 and the sliding contact surface of the mount member 320 as well as between the side surfaces of the drive gear 301 and the driven gear 302 and the sliding contact surface of the cover 330, by which a low-pressure chamber communicating with the inlet port and a high-pressure chamber communicating with the discharge port are formed.

[0079] One end (right side in Fig. 5) of a first rotary shaft 311 for driving the drive gear 301 is rotatably supported by the cover 330 via a bearing 313A while the other end (left side in Fig. 5) of the first rotary shaft 311 is rotatably supported by the mount member 320 via a bearing 313B. The other-end side coupling part 311a of the first rotary shaft 311 is protruded from the mount member 320, and a drive shaft of an unshown motor is coupled to the coupling part 311a. Also, one end (right side in Fig. 5) of a second rotary shaft 312 for the driven gear 302 is rotatably supported by the cover 330 via a bearing 314A while the other end (left side in Fig. 5) of the second rotary shaft 312 is rotatably supported by the mount member 320 via a bearing 314B. In Fig. 5, reference sign 315 denotes an oil seal.

[0080] In the gear pump of this fourth embodiment, the sliding contact surface side of the mount member 320 and the cover 330 to be brought into sliding contact with the side faces of the drive gear 301 and the driven gear 302 is similar in structure to that of the first, second side plates of the first embodiment or the second embodiment.

[0081] The gear pump of the fourth embodiment has the same effects as the gear pump of the first embodiment.

[0082] Hereinabove, the first to fourth embodiments have been described on gear pumps as an example of the gear fluid device. However, the present invention is applicable also to gear motors because gear motors are similar in structure to gear pumps except that their actions are reverse to each other.

[0083] Also, the first to fourth embodiments have been described on gear fluid devices including, as the sliding contact members, the first, second side plates 5, 6, 105 and the bearing cases 220, 220, as well as the mount member 320 and the cover 330. However, without being limited to these ones, the sliding contact members need only to be members

having sliding contact surfaces to be brought into sliding contact with the side face of the drive gear and the side face of the driven gear.

[0084] Also, the first to fourth embodiments have been described on gear pumps in which the drive gears 1, 201, 301 and the driven gears 2, 202, 302 are spur gears. However, the invention may also be applied to gear fluid devices in which the drive gear and the driven gear are helical gears.

[0085] Also, the first to fourth embodiments have been described on gear pumps which are provided with the groove portions 53, 54, 153, 154 communicating with the clearance grooves 51, 151 on the low pressure side of the first, second side plates 5, 6, 105 as well as the groove portions 55, 56 communicating with the through hole 5a. However, the groove portions (or recessed portions) to be provided in the side plates may be non-communicated with the clearance grooves or may be provided not on the low pressure side of the gear pumps but on the high pressure side of the gear pump. In this case also, by the arrangement that the groove portions or recessed portions are provided radially inside the root diameters of the drive gear and the driven gear and moreover radially outside the rotary shaft holes in such a way that the rotary shaft holes and the clearance grooves are not communicated with each other, it is achievable to effectively prevent wear of sliding contact surfaces while keeping the lubricated state of the bearing part.

[0086] Although specific embodiments of the present invention have been described hereinabove, yet the invention is not limited to the above first to fourth embodiments and may be carried out as they are changed and modified in various ways within the scope of the invention.

REFERENCE SIGNS LIST

[0087]

1	drive gear
2	driven gear
5	first side plate
5a, 5b	through hole
6	second side plate
10	body
11	first rotary shaft
11a	coupling part
12	second rotary shaft
13A, 13B, 14A, 14B	bearing
15	oil seal
20	mount member
30	cover
40	gasket
51, 52	clearance groove
53, 54, 55, 56	groove portion
105	first side plate
105a, 105b	through hole
151, 152	clearance groove
153, 154	groove portion
201	drive gear
202	driven gear
210	body
211	first rotary shaft
211a	coupling part
212	second rotary shaft
213A, 213B, 214A, 214B	bearing
215	oil seal
220, 220	bearing case
230	mount member
240	cover
250	gasket
301	drive gear
302	driven gear
310	body
311	first rotary shaft

311a	coupling part
312	second rotary shaft
313A, 313B, 314A, 314B	bearing
315	oil seal
320	mount member
330	cover

Claims

1. A gear fluid device comprising:

a drive gear (1) and a driven gear (2) to be engaged with each other;
sliding contact members (5, 6, 105, 106, 220, 220, 320, 330) having sliding contact surfaces to be brought into sliding contact with a side face of the drive gear (1) and a side face of the driven gear (2), rotary shaft holes (5a, 5b) into which rotary shafts (11, 12) of the drive gear (1) and the driven gear (2) are inserted respectively, and clearance grooves (51, 52, 151, 152) which allow confinement regions formed at engagement portions of the drive gear (1) and the driven gear (2) to be communicated with a low pressure side and a high pressure side, respectively; and
at least one groove portion (53, 54, 55, 56, 153, 154) or recessed portion which is provided in the sliding contact surfaces of the sliding contact members (5, 6, 105, 106, 220, 220, 320, 330) so as to be positioned radially inside root diameters of the drive gear (1) and the driven gear (2) and moreover radially outside the rotary shaft holes (5a, 5b) in such a way that the rotary shaft holes (5a, 5b) and the clearance grooves (51, 52, 151, 152) are not communicated with each other.

2. The gear fluid device as claimed in claim 1, wherein
the sliding contact members (5, 6, 105, 106, 220, 220, 320, 330) are side plates (5, 6, 105, 106) or bearing cases (220, 220) which are placed so as to sandwich both side faces of the drive gear (1) and both side faces of the driven gear (2), or a housing (320, 330) in which the drive gear (1) and the driven gear (2) are housed.

3. The gear fluid device as claimed in claim 1 or 2, wherein
the groove portion (53, 54, 55, 56, 153, 154) or the recessed portion of the sliding contact members (5, 6, 105, 106, 220, 220, 320, 330) is provided on the low pressure side of the gear fluid device.

4. The gear fluid device as claimed in any one of claims 1 to 3, wherein
the groove portion (53, 54, 153, 154) or the recessed portion of the sliding contact members (5, 6, 105, 106, 220, 220, 320, 330) is provided so as to connect to the clearance grooves (51, 52, 151, 152).

5. The gear fluid device as claimed in any one of claims 1 to 4, wherein
at least one of the groove portions (53, 54) or the recessed portions of the sliding contact members (5, 6) is provided so as to connecting to the clearance groove (51), and
another at least one of the groove portions (55, 56) or the recessed portions of the sliding contact members (5, 6) is provided so as to connecting to the rotary shaft hole (5a, 5b).

6. The gear fluid device as claimed in claim 5, wherein
a radially-inner end portion of at least one of the groove portions (53, 54) or the recessed portions connecting to the clearance groove (51) of the sliding contact members (5, 6) is positioned radially inside a radially-outer end portion of the at least one of the groove portions (55, 56) or the recessed portions connecting to the rotary shaft hole (5a, 5b) of the sliding contact members (5, 6).

Fig.1

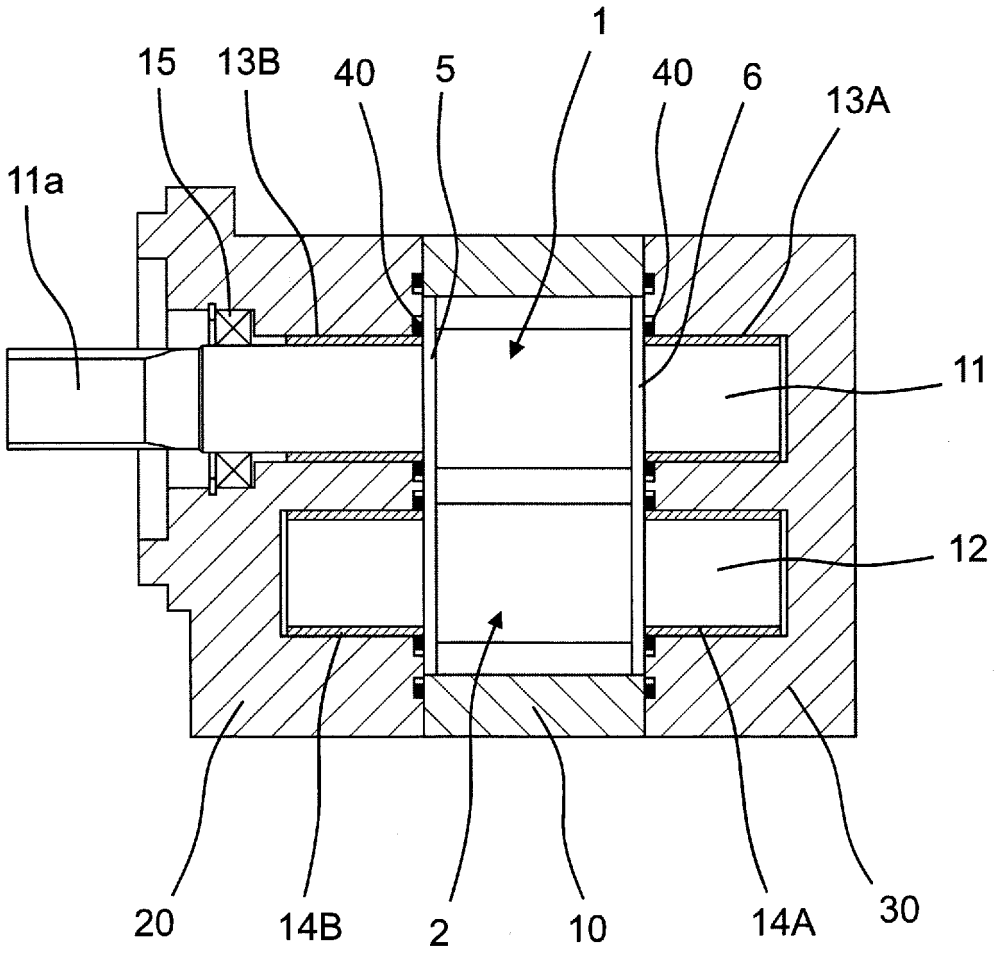


Fig.2

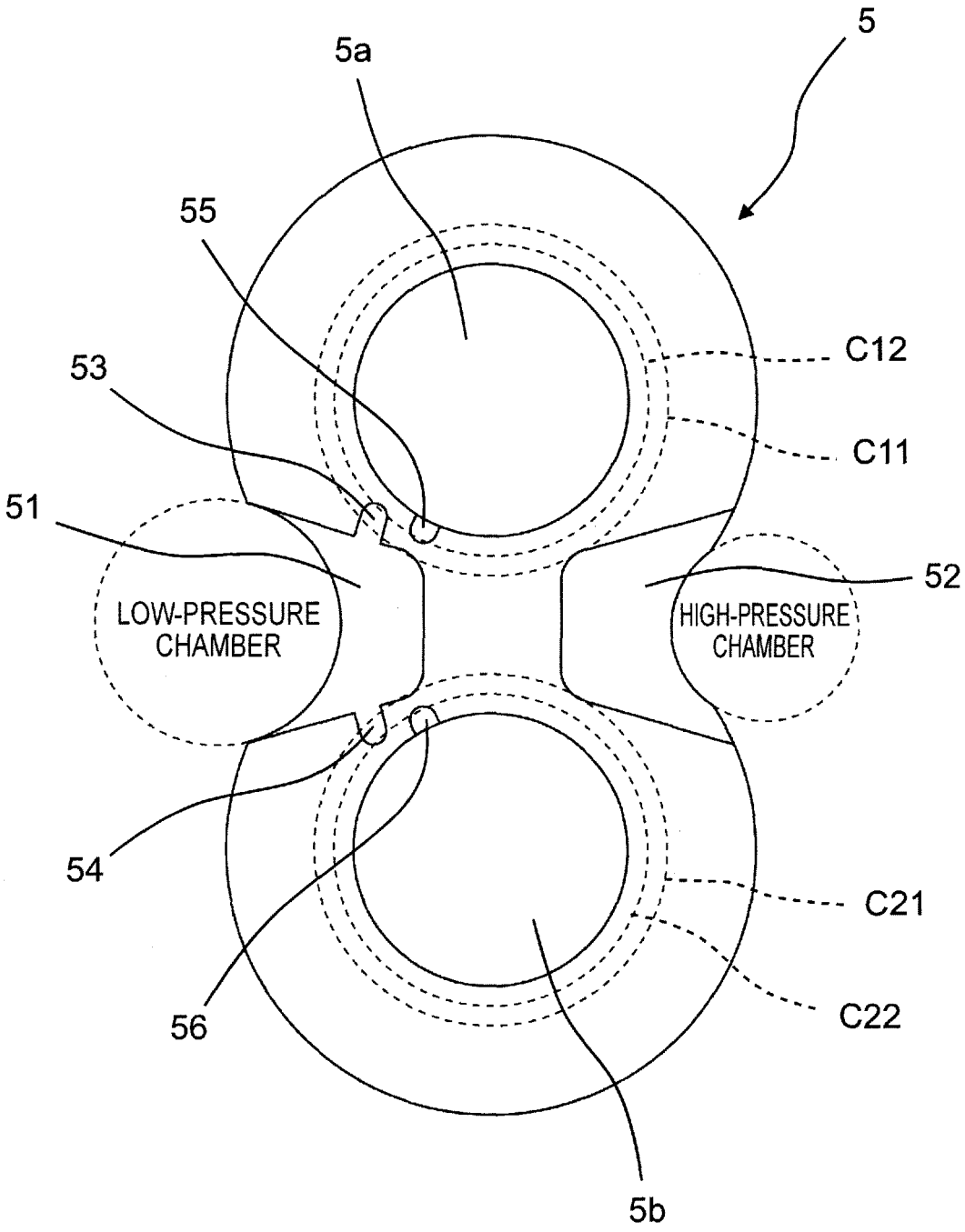
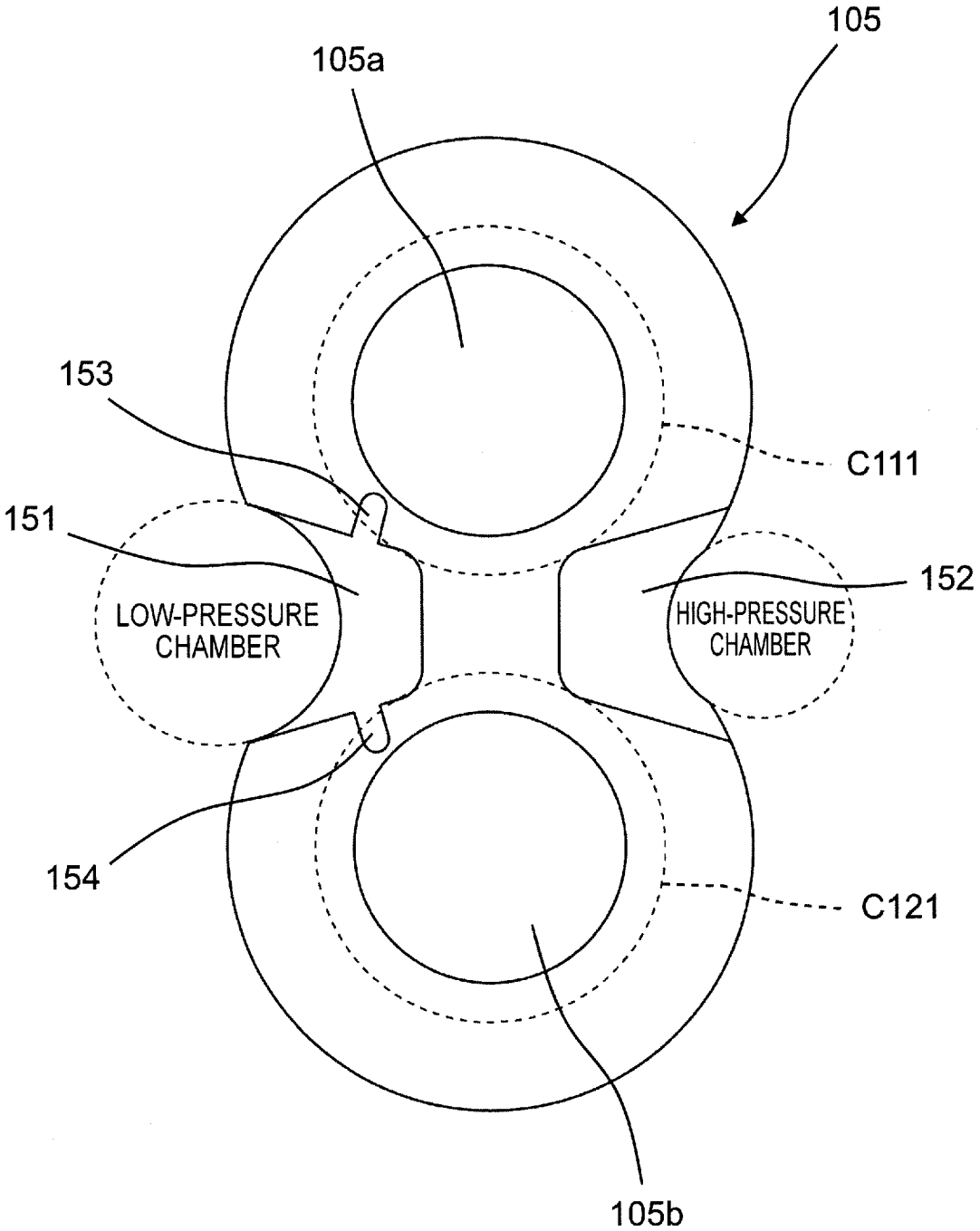

5
5a
55
C12
53
C11
51
52
LOW-PRESSURE CHAMBER
HIGH-PRESSURE CHAMBER
54
C21
C22
56
5b

Fig.3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C111
151
152
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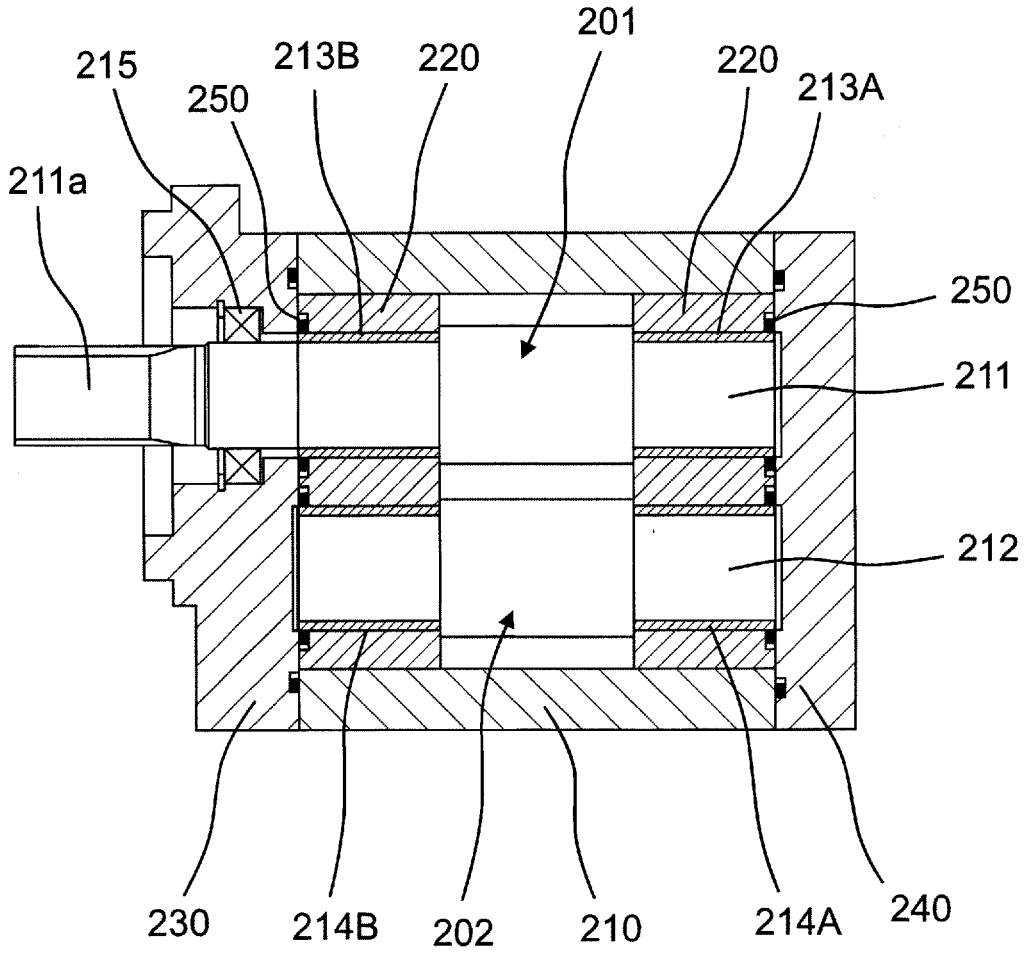
HIGH-PRESSURE CHAMBER
154
C121
105b

Fig.4


201
215
213B
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213A
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211a
250
211
212
230
214B
202
210
214A
240

Fig.5

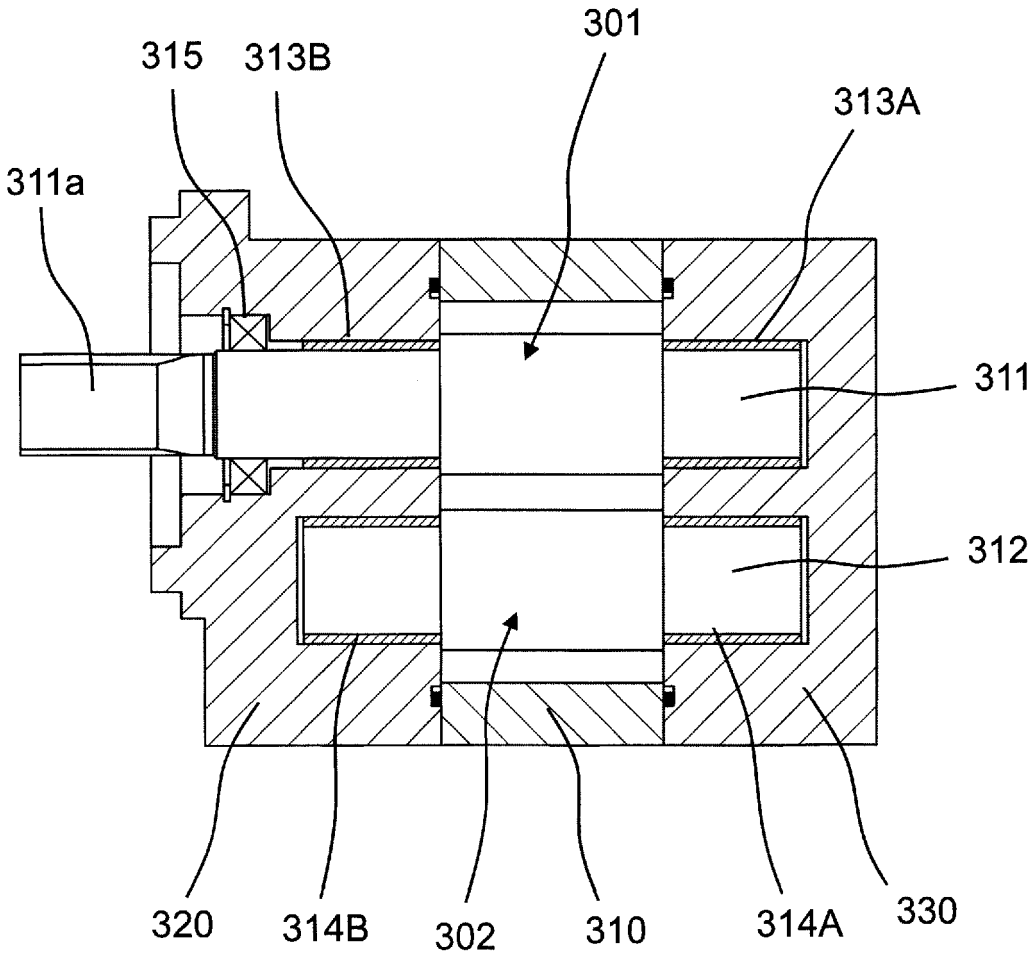
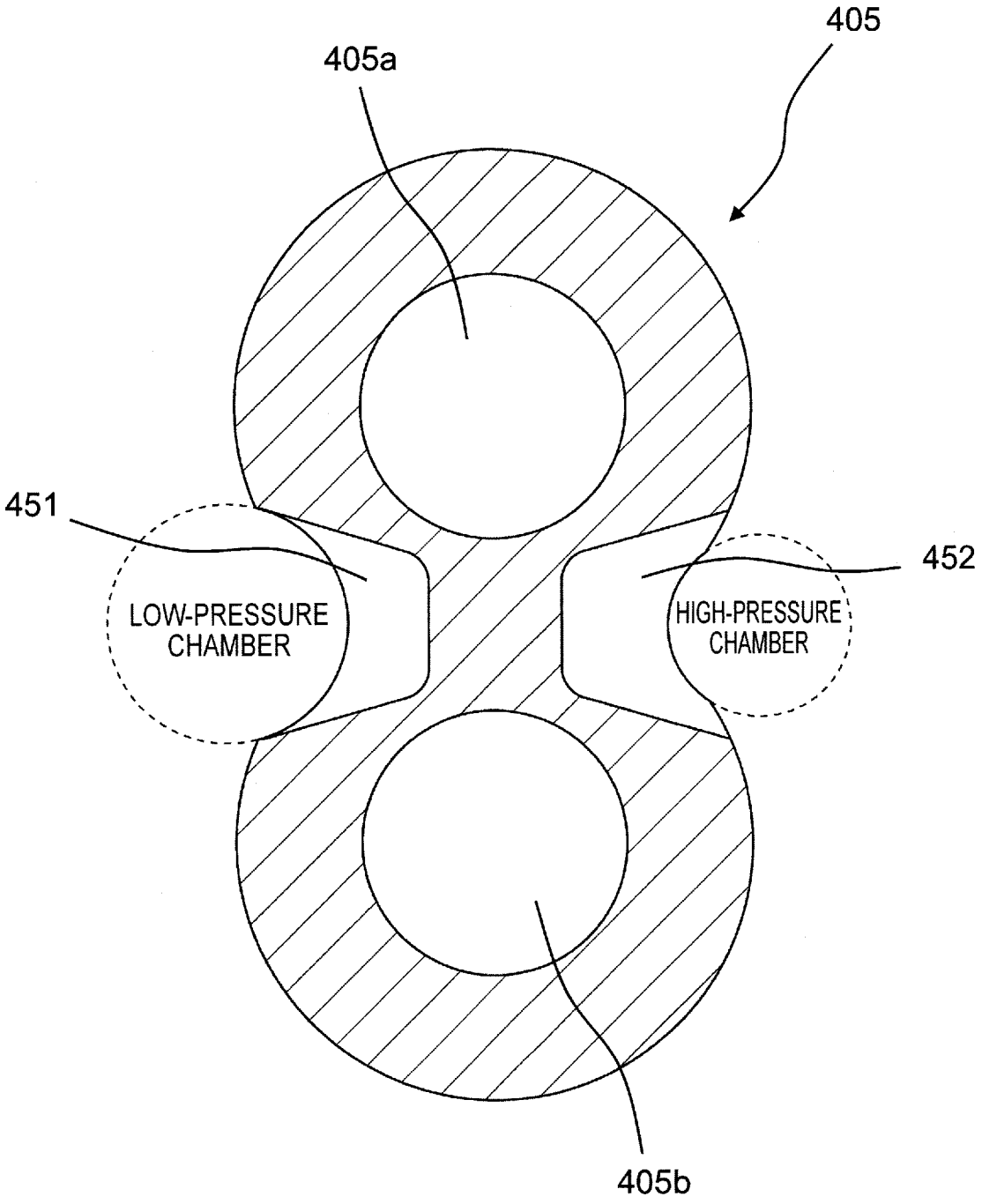


Fig.6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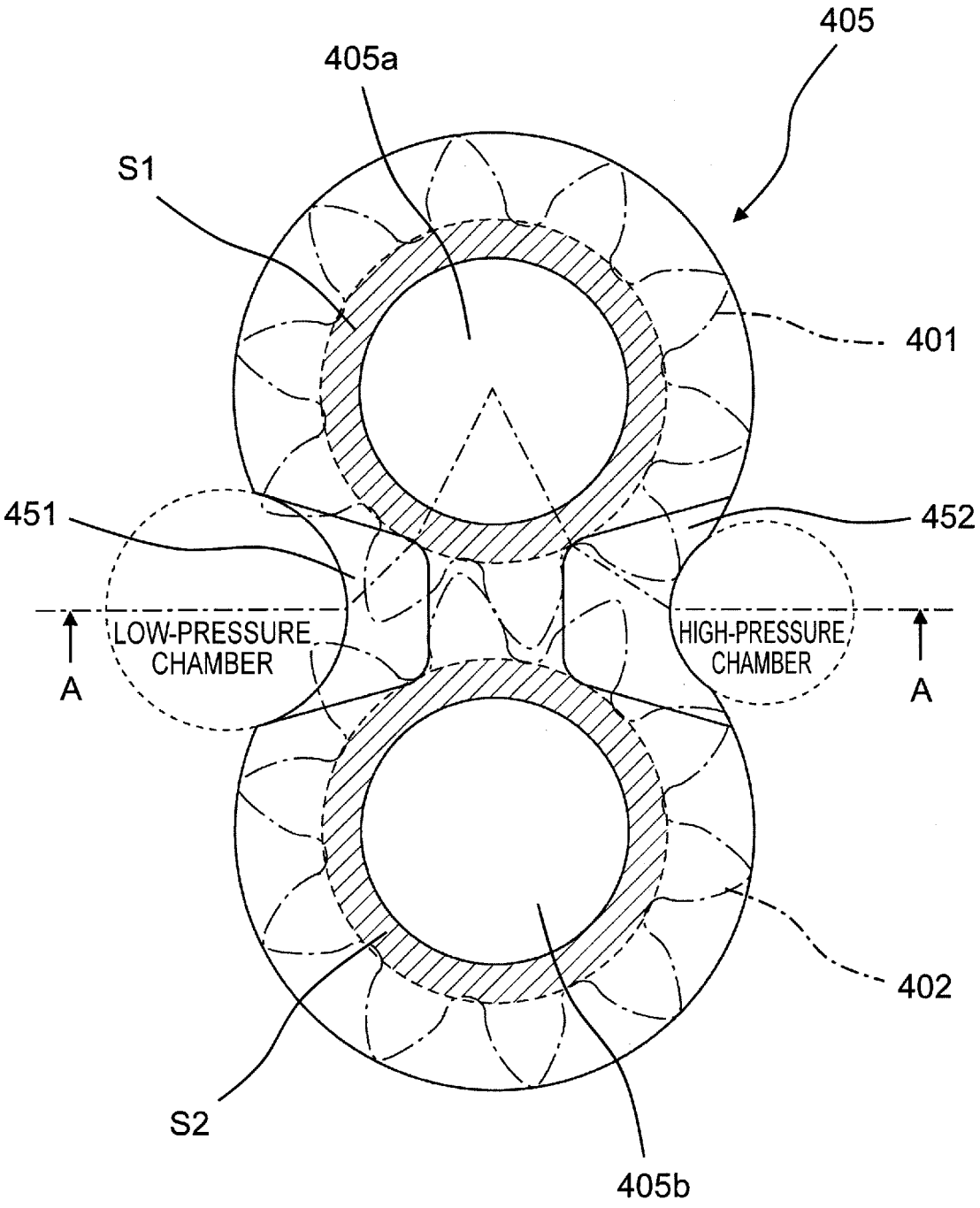
405a
451
452
LOW-PRESSURE CHAMBER
HIGH-PRESSURE CHAMBER
405b

Fig.7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A
402
S2
405b

Fig.8

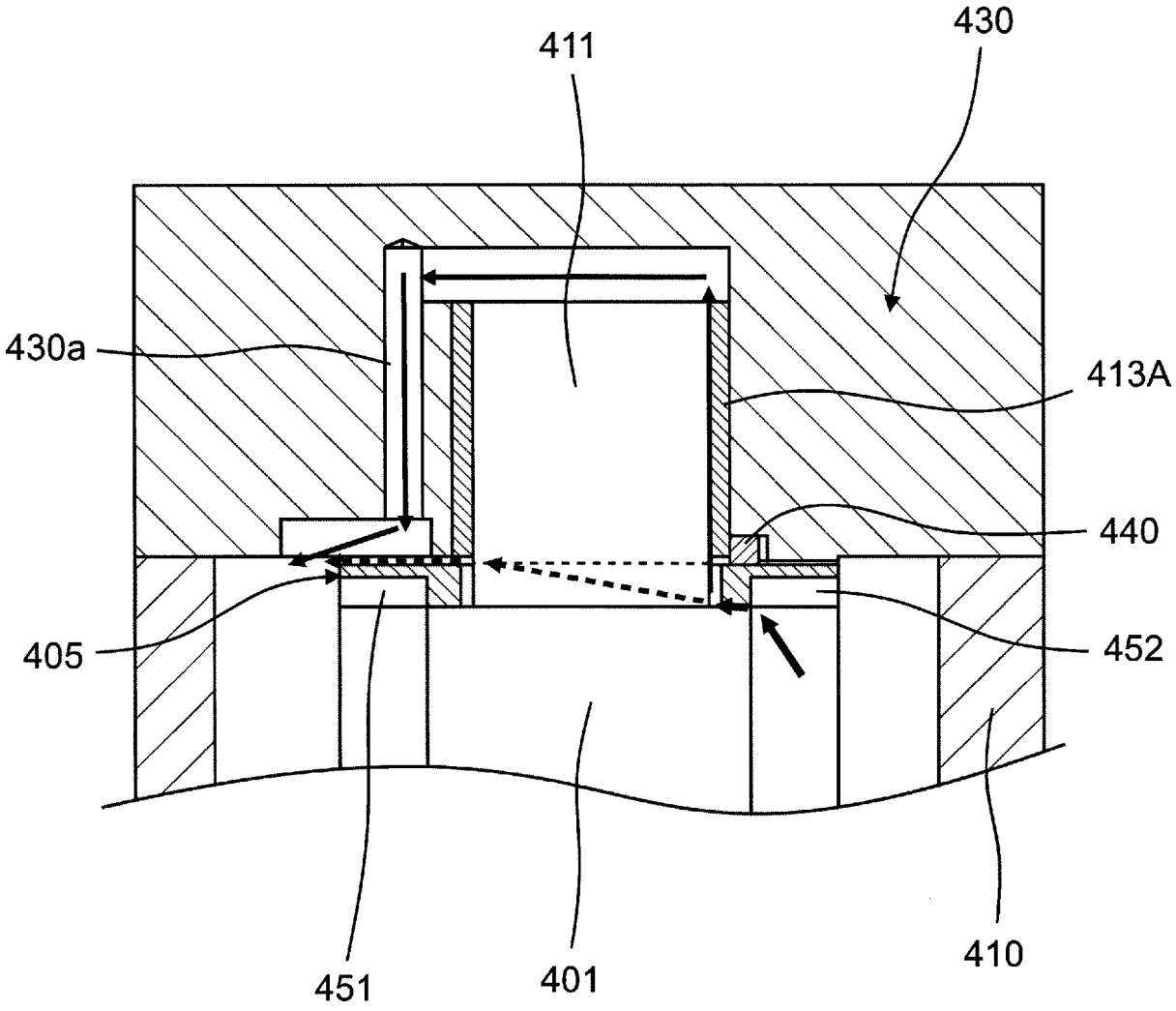
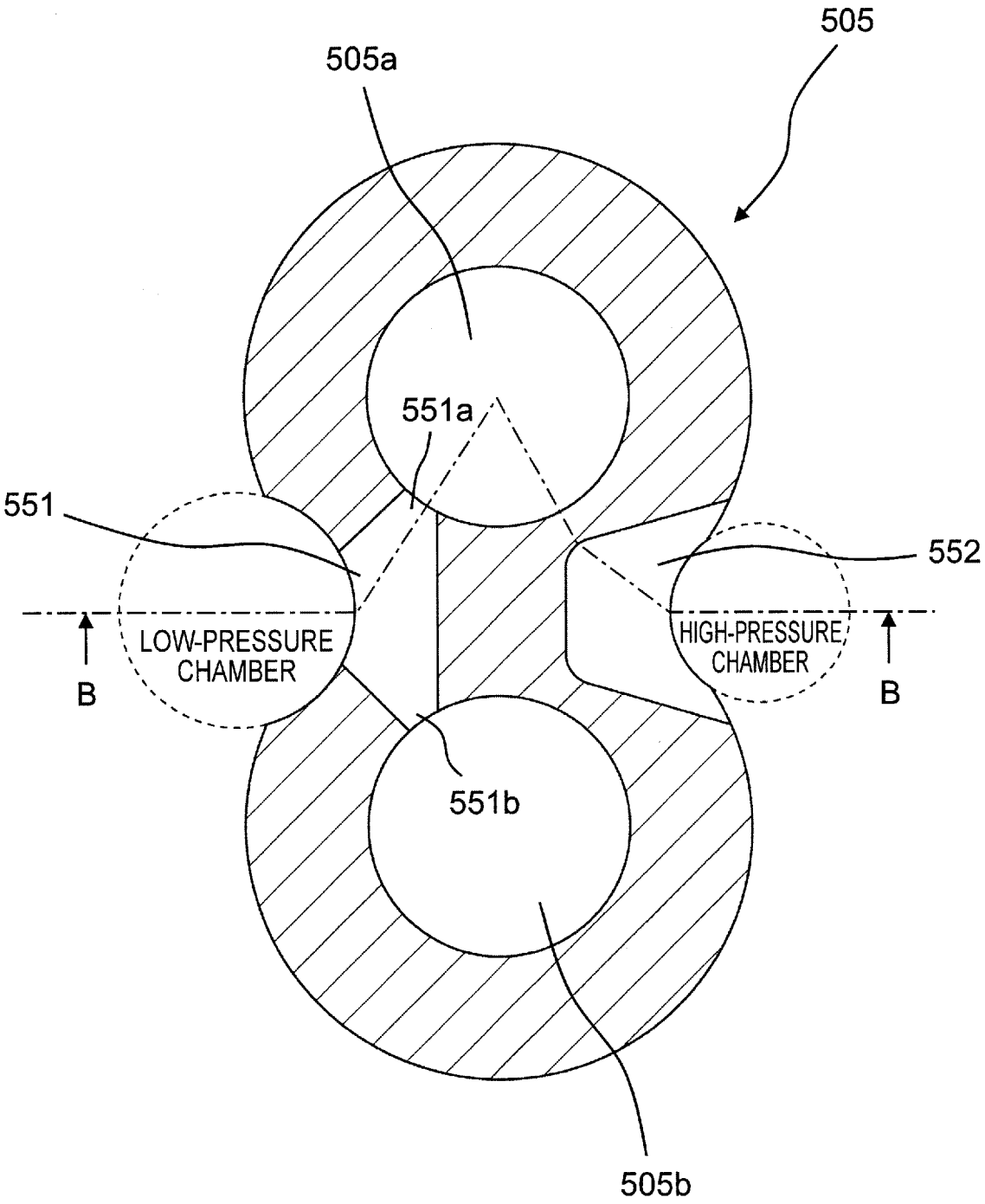


Fig.9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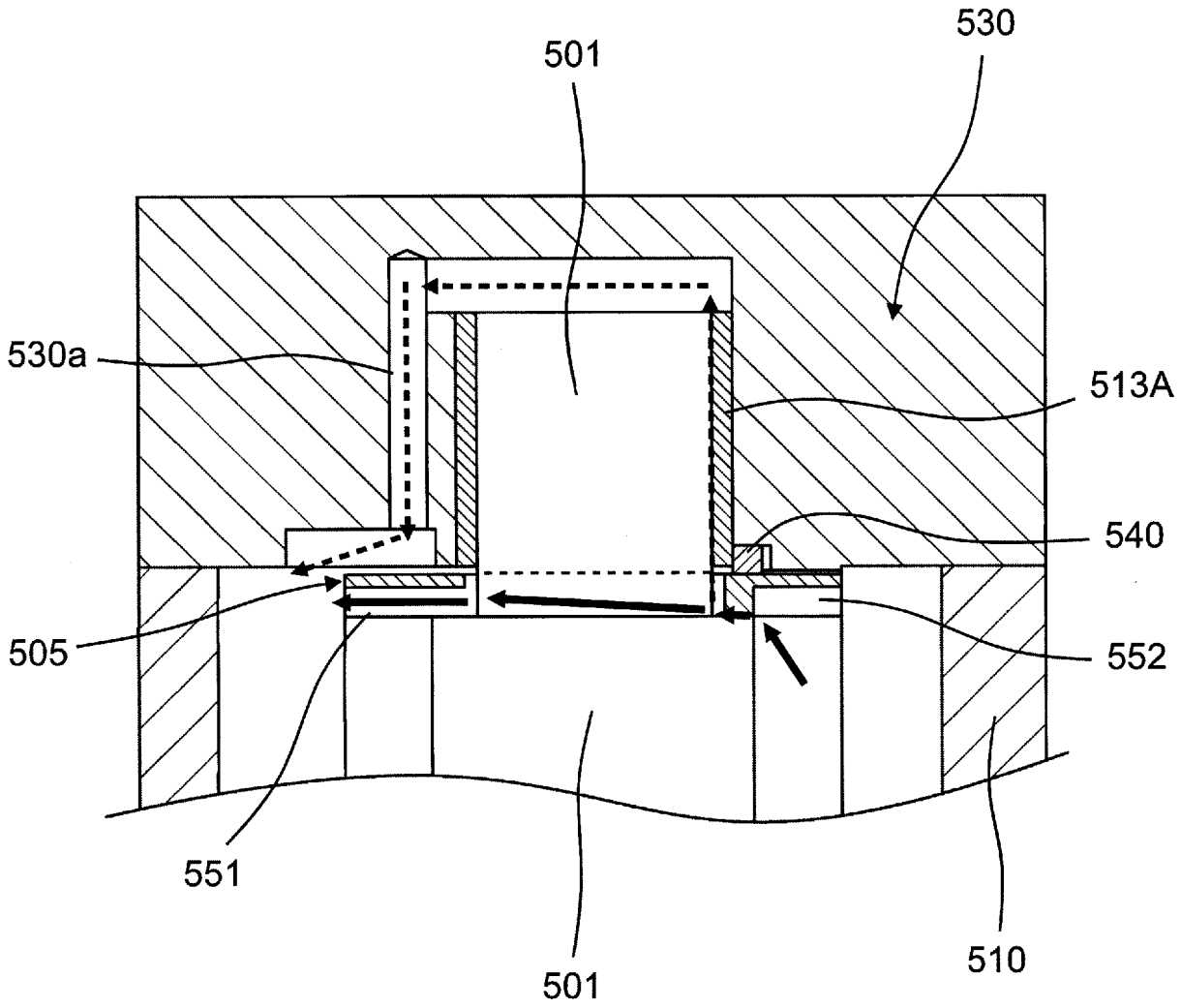
LOW-PRESSURE CHAMBER
HIGH-PRESSURE CHAMBER
B
B
551b
505b

Fig.10



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/071332

A. CLASSIFICATION OF SUBJECT MATTER
F04C2/18(2006.01)i, *F03C2/08*(2006.01)i, *F04C15/00*(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04C2/18, F03C2/08, F04C15/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2014
Kokai Jitsuyo Shinan Koho 1971-2014 Toroku Jitsuyo Shinan Koho 1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 49-43605 B1 (Dowty Hydraulic Units Ltd.), 22 November 1974 (22.11.1974), page 1, right column, line 36 to page 3, right column, line 20; fig. 1 to 4 & US 3490382 A & GB 1232590 A & DE 1775401 A1 & FR 1597458 A1	1-6
X A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 118330/1978(Laid-open No. 36919/1980) (Kayaba Industry Co., Ltd.), 10 March 1980 (10.03.1980), page 3, line 1 to page 8, line 7; fig. 1, 2 (Family: none)	1-5 6

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
08 October, 2014 (08.10.14)	21 October, 2014 (21.10.14)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/071332

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X A	JP 61-265372 A (Kayaba Industry Co., Ltd.), 25 November 1986 (25.11.1986), page 2, upper right column, line 14 to page 3, upper right column, line 4; fig. 1, 2 (Family: none)	1-3 4-6
X A	JP 4-325785 A (Shimadzu Corp.), 16 November 1992 (16.11.1992), paragraphs [0011] to [0022]; fig. 1 to 5 (Family: none)	1-3 4-6
A	JP 2007-522384 A (Argo-Tech Corp.), 09 August 2007 (09.08.2007), entire text; all drawings & US 2008/0240968 A1 & WO 2005/079302 A2	1-6

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REFERENCES CITED IN THE DESCRIPTION

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- JP H8121352 A **[0002] [0014]**
- JP H6317261 A **[0002] [0014]**