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(54) **COMPONENTS FOR SEALING AND SEALING CONCEPT FOR A HYDRAULIC AXIAL PISTON MACHINE**

(57) The present invention relates to a thrust pad (1) for a port flange (101) of a hydraulic axial piston machine (1000). The thrust pad (1) is provided to improve a sealing concept of hydraulic axial piston machines. In this regard, the thrust pad (1) comprises a top surface (2), a lateral surface (3) and a bottom surface (4). Further, the thrust pad (1) comprises a curved shape configured to be arranged at least partially between the port flange (101) and a port plate (103) of the hydraulic axial piston machine (1000). The thrust pad (1) extends in a first direction (X), a second direction (Y) and a third direction (Z). The second direction (Y) is defined orthogonal with respect to the first direction (X) and the third direction (Z) is defined orthogonal with respect to the first direction (X) and the second direction (Y). Furthermore, the thrust pad (1) extends in the third direction (Z) less than in the first direction (X) and the second direction (Y), wherein the thrust pad (1) extends in the first direction (X) more than in the second direction (Y). The thrust pad (1) comprises a through hole (9), wherein the through hole (9) is configured to fluidically connect a first port (109) of the port flange (101) to a control hole (102) of the port plate (103). In addition, the present invention relates to a port flange, an assembly, and a hydraulic axial piston machine.

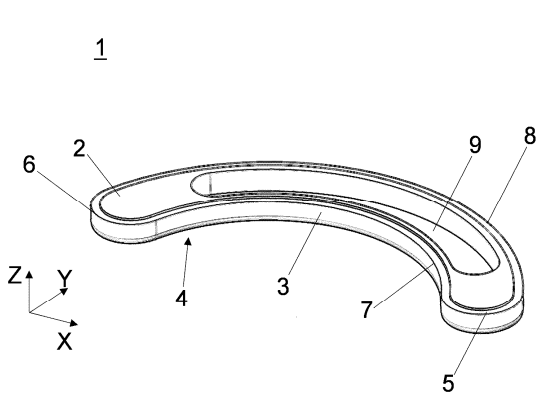

Fig. 1A

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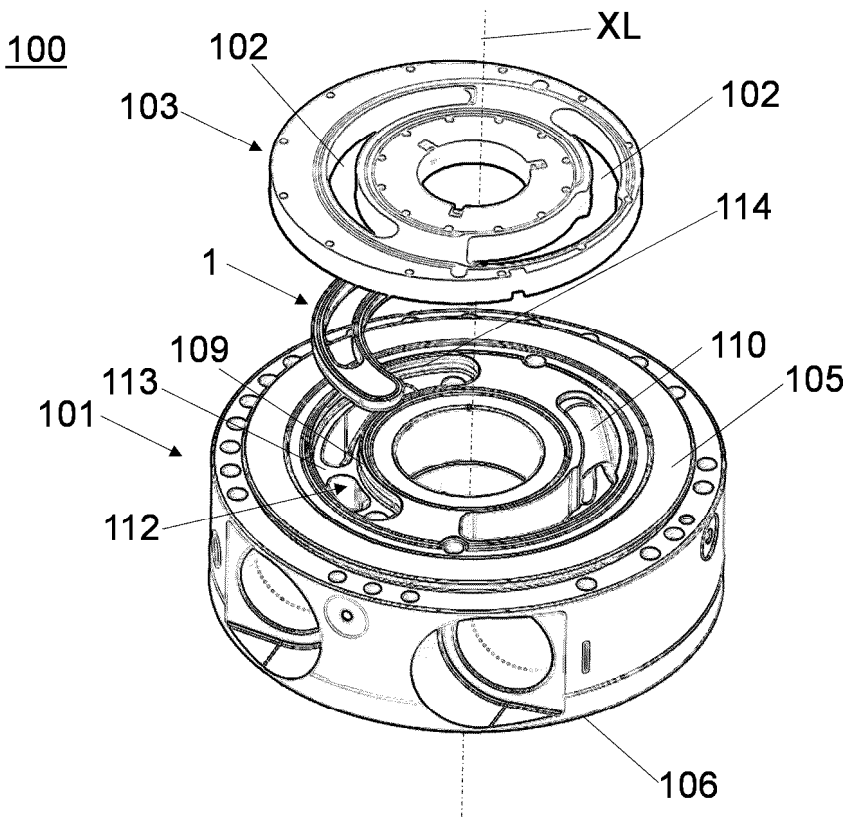


Fig. 2A

Description

[0001] The present invention relates to a thrust pad for a port flange of a hydraulic axial piston machine. Further, the present invention relates to a port flange, to an assembly of a port plate, a thrust pad and a port flange as well as to a hydraulic axial piston machine.

[0002] Hydraulic axial piston machines are well-known in the art. In hydraulic axial piston machines, pistons are guided in cylinders of a cylinder drum and rotate around a drive shaft of the hydraulic axial piston machine. Further, each piston is coupled to a sliding shoe which is retained in a retainer plate, wherein the pistons perform a complete stroke with each revolution of the cylinder drum. The term "hydraulic axial piston machine" refers to a hydraulic axial piston pump and a hydraulic axial piston motor. The hydraulic axial piston pump converts mechanical energy into hydraulic energy, while the hydraulic axial piston motor converts hydraulic energy into mechanical energy. In this respect, hydraulic axial piston machines are thus for example often used in hydraulic systems of construction machinery, agricultural machinery and industrial plants. The excellent reliability, high power density and precise controllability make hydraulic axial piston machines a preferred choice for hydraulic systems.

[0003] Typically, hydraulic axial piston machines are thus integrated into complex hydraulic fluid systems and fluidically connected to ducts, channels, passages, pipes or the like which transport fluid under high pressure or fluid under low pressure to and from the hydraulic axial piston machine. Leakages in the hydraulic fluid system, especially in a transition area between fluid transportation means and, for example a cylinder drum of the hydraulic axial piston machine may cause energy losses. Consequently, hydraulic axial piston machine known in the art are provided with a sealing concept to allow high-pressure fluid to enter or exit the hydraulic axial piston machine, preferably without leakage, however, typically with limited leakage, which decrease the efficiency of the hydraulic axial piston machine. In other words, leakages during supply and discharge of fluid in the cylinders of the cylinder drum may lead to efficiency losses of the hydraulic axial piston machine.

[0004] Thus, to prevent excessive leakage, it is known to arrange sealing elements in the hydraulic axial piston machine. However, known sealing concepts often require alternating sealings, i.e. sealing elements or surfaces alternating between the high and low pressure side, have large dimensions, need many parts, are complex, heavy or simply not suitable for high pressures. In particular, handling high pressures that deform sealing surfaces, such as sealing surfaces of a port flange or port plate of a hydraulic axial piston machine, may pose difficulties.

[0005] Consequently, improved sealing concepts for hydraulic axial piston machines are required. Therefore, it is the object of the present invention to improve the sealing concept of hydraulic axial piston machines. In particular, it is the object of the present invention to provide an improved sealing concept for hydraulic axial piston machines that reduces leakage while for example allowing to operate the system at higher pressures and with higher volume flows.

[0006] The object is solved by a thrust pad according to claim 1. Further, the object is solved by a port flange according to claim 7, by an assembly according to claim 10 as well as by a hydraulic axial piston machine according to claim 13.

[0007] Typically, hydraulic axial piston machines comprise a port plate also known as a valve plate, a distributor plate or a control plate. The port plate comprises control holes that allow fluid to flow, for example from a port flange via said port plate into cylinders of a cylinder drum of the hydraulic axial piston machine. The thrust pad according to the invention is for a port flange of a hydraulic axial piston machine and in other words configured to be used with said port flange in order to improve the sealing.

[0008] The thrust pad comprises a top surface, a bottom surface and a lateral surface. The top surface may be arranged on an opposite side to the bottom surface. When the thrust pad may be arranged in a recess of a port flange, the bottom surface may be facing towards the port flange, wherein the top surface may be facing towards a port plate. The bottom surface may comprise first apertures which may align with second apertures of the port flange, when the thrust pad is arranged in the recess of the port flange. In one aspect, the thrust pad comprises two apertures, one at each tip portion of the thrust pad.

[0009] The first apertures and the second apertures may be provided by blind holes. Resilient elements, for example spring elements, may be arranged inside the first and second apertures in order to push the thrust pad towards the port plate. Further, the top surface may be a substantially flat surface and may at least partially be in abutment with the port plate, for example a protrusion of the port plate as explained below, when the thrust pad is used for example in an assembly according to the invention.

[0010] According to one aspect of the invention, the top surface of the thrust pad in an area surrounding the through hole may protrude from an area not directly adjacent to the through hole. This protrusion as aforementioned may be in contact or abutment with the thrust pad. In this regard, also the port plate may be pushed towards the thrust pad, for example by a spring of the hydraulic axial piston machine, as will be explained below.

[0011] Further, the thrust pad comprises a curved shape configured to be arranged at least partially between the port flange and a port plate of the hydraulic axial piston machine. The curvature of the thrust pad may correspond to a circular arc at least in some areas.

[0012] In one aspect, the shape of the thrust pad may at least substantially be a semilunar, curved shape. According to the invention, a "semilunar shape" may comprise a crescent shape or a croissant-like shape. In one aspect,

the thrust pad may comprise an axially symmetrical shape.

[0013] The lateral surface of the thrust pad may extend between the bottom surface and the top surface. A distance between the top surface and the bottom surface of the thrust pad may be the same for all areas of the thrust pad (excluding possible first apertures) or may be different, i.e. the distance between the top surface and the bottom surface may be different in different areas of the thrust pad, for example due to projections on the top surface and/or the bottom surface. Thus, there may be some areas of the thrust pad in which a distance between the top surface and the bottom surface is smaller compared to other areas of the thrust pad.

[0014] Furthermore, the thrust pad extends in a first direction, e.g. a first planar direction, a second direction, e.g. a second planar direction, and a third direction, for example a third normal direction. In other words, the first direction and the second direction may be arranged in a plane to which the third direction may be oriented normally. Therefore, the second direction is defined orthogonally with respect to said first direction and the third direction is defined orthogonally with respect to said first direction and said second direction. The curvature of the thrust pad may be in a plane spanned by the first direction and the second direction. In one aspect, the curvature may be analyzed by a parallel projection of the thrust pad on a plane spanned by the first direction and the second direction.

[0015] According to one aspect, "curved shape" may mean that the thrust pad may protrude at different positions along the first direction or the second direction to different extents from a plane spanned by the third direction and the first direction or spanned by the third direction and the second direction, and wherein the first direction or the second direction run through the thrust pad. In one aspect, the third direction may be at least partially parallel to the lateral surface.

[0016] In addition, the thrust pad extends in the third direction less than in the first direction and the thrust pad extends in the third direction less than in the second direction. In other words, the thrust pad may be thinner than the thrust pad is wide and long. Further, the thrust pad extends in the first direction more than in the second direction. In other words, the thrust pad comprises a smaller extension in the third direction than an extension of the thrust pad in the first direction and the thrust pad comprises a smaller extension in the third direction than an extension of the thrust pad in the second direction. In addition, an extension of the thrust pad in the first direction is bigger than an extension of the thrust pad in the second direction.

[0017] Furthermore, the thrust pad comprises a through hole. The through hole may comprise at least a similar shape as the thrust pad. In one aspect, the through hole may comprise the same shape as the thrust pad. The size of the through hole may however be smaller compared to the size of the thrust pad. The through hole may extend along the third direction so that fluid may flow from the top surface of the thrust pad to the bottom surface of the thrust pad and vice versa through the through hole of the thrust pad.

[0018] When the thrust pad is arranged between the port flange and the port plate, i.e. when the thrust pad is used in an assembly according to the invention, the through hole is configured to fluidically connect a port, especially the first port, of the port flange to a control hole of the port plate. In this regard, the through hole, i.e. the cross-section of the through hole, of the thrust pad, the first port, i.e. the cross-section of the first port, of the port flange and the control hole, i.e. the cross-section of the control hole, of the port plate may overlap. The thrust pad may thus be configured to feed hydraulic fluid into and out of the cylinder drum through the control holes of the port plate. In this regard, the port plate may comprise at least two control holes.

[0019] The thrust pad may therefore be a fluid-conducting element between the port plate and the port flange, which at the same time enables sealing.

[0020] Arrangement of the thrust pad, for example, arrangement of the thrust pad at least partially between the port plate and the port flange, may thus allow to improve sealing of a hydraulic axial piston machine. Therefore, the thrust pad may improve the cost versus flow ratio as it allows to decrease the leakage of a hydraulic axial piston machine compared to known sealing concepts and sealing elements. Further, when arranged in a hydraulic axial piston machine, the thrust pad allows to improve the efficiency of the hydraulic axial piston machine.

[0021] In one aspect, for example, the thrust pad may be configured to transmit an axial force parallel to a longitudinal axis of the port flange between the port plate and port flange during sealing.

[0022] In one embodiment, the lateral surface of the thrust pad may be partially provided by an inner curved contour and partially provided by an outer curved contour extending between a first tip portion and a second tip portion. A radius of curvature of the inner curved contour or the outer curved contour may change along the respective contour. The inner curved contour and the outer curved contour respectively may converge at a first end point and a second end point of the respective tip portions of the thrust pad. The thrust pad may thus be configured to be arranged on a port flange, for example in a recess of the port flange, of a hydraulic axial piston machine so that the thrust pad may at least partially circumferent, embrace or surround a rotational axis defining an axis of rotation of a cylinder drum and/or a drive shaft of the hydraulic axial piston machine. The rotational axis may be in line with the longitudinal axis described below. The shape of the thrust pad may thus allow to optimize a sealing functionality of the thrust pad with respect to a contact surface of the thrust pad with, for example, the port plate and/or the port flange. The thrust pad may thus allow to decrease the diameter of the port plate, which

allows to decrease material, weight and costs of the port plate as well as the respective other components.

[0023] In addition, or alternatively, and as aforementioned, the thrust pad may comprise a semilunar, curved shape. The shape of the thrust pad and a shape of a recess in the port flange and/or a shape of a control hole of the port plate and a shape of the through hole of the thrust pad may be adapted to one another.

[0024] Further, in one embodiment, the through hole may extend partially along the curved shape of the thrust pad. In one aspect, the through hole may comprise a bigger extension in the first direction than in the second direction. Hence, the through hole may extend along the curved shape of the thrust pad. The through hole may thus also comprise a curved shape or a semilunar, curved shape. In one aspect, the through hole of the thrust pad according to the invention, in particular its shape and size relative to the thrust pad, may contribute to a larger area of a cylinder drum's end face, i.e. a face of the cylinder drum pointing in the direction of the port plate and the port flange, being provided with channels, i.e. cylinder or cylinder channels, which may reduce weight of the cylinder drum. Further, the number of cylinders in the cylinder drum may be increased, wherein a cross-section of each cylinder may be reduced which avoids cavitation even when a respective cylinder drum is used at high pressures.

[0025] In addition or alternatively, the through hole may be a curved slotted hole in one embodiment. In other words, the through hole may be a slotted hole which may be curved. The curvature of the through hole may be chosen with respect to the curvature of the thrust pad. The use of a curved slotted hole may enhance the advantages described above and, in particular, help to ensure that the thrust pad and thus the sealing has only a negligible effect on the flow of fluid into and out of the cylinder chambers of the cylinder drum while at the same time providing for an improved sealing.

[0026] Further, in another embodiment, the thrust pad may comprise a thickness defined by an extension of the thrust pad along the third direction. In this regard, the thickness, i.e. the extension along the third direction, may be at least 10 times smaller than the extension of the thrust pad in the first direction. The dimensions of the thrust pad allow to improve the sealing when the thrust pad is used under high pressures.

[0027] Further, according to one aspect the thrust pad may be made of ceramic.

[0028] The object of the invention is also solved by a port flange for a hydraulic axial piston machine according to the aforementioned aspects. The port flange extends along a longitudinal axis between a cylinder drum side surface and an opposite surface, i.e. a surface directed away from the cylinder drum. In one aspect, the port flange may comprise a substantially cylindrical shape. The cylinder drum side surface and the opposite side surface may provide end faces of a said substantially cylinder-shaped port flange.

[0029] Further, the port flange may comprise a first port and a second port each of which are configured to fluidically connect the port flange to a cylinder, i.e. a cylinder chamber or (cylinder) channels, of a cylinder drum of a hydraulic axial piston machine. In this regard, the first port and the second port may be arranged on the cylinder drum side surface. Further, the port flange may be fluidically connected to a hydraulic system by further ports fluidically connected to the first and/or second ports, wherein the further ports are for example arranged on a lateral surface of the substantially cylinder-shaped port flange. Fluid may thus flow from these ports on the lateral surface of the port flange to the first port and the second port of the cylinder drum side surface respectively.

[0030] Furthermore, the cylinder drum side surface of the port flange may further comprise a recess at least partially surrounding one of the ports, for example the first port, on the cylinder drum side surface. In other words, the cylinder drum side surface may have a recess in an area of the first port so that the first port is larger at the cylinder drum side surface than a duct at a point along the longitudinal axis offset in the direction of the opposite surface, i.e. inside the port flange. In one aspect, the recess may thus comprise a step portion having a contact surface offset along the longitudinal axis with respect to the cylinder drum side surface of the port flange. Further, the recess may be configured to at least partially receive the thrust pad according to the aforementioned aspects. In other words, the thrust pad may at least partially be recessed in the recess of the port flange. The contact surface may thus be configured to abut or to at least limit a possible movement of the thrust pad along the longitudinal axis, when the thrust pad is received in the recess of the port flange. The contact surface may for example limit relative movement of the thrust pad with respect to the port flange towards the opposite surface, i.e. away from the cylindrical drum side surface.

[0031] In addition, when the thrust pad may be received in the recess of the port flange, the through hole of the thrust pad and the first port at least partially overlap, so that the first port, when the port flange is fluidically connected to a cylinder of the cylinder drum of the hydraulic axial piston machine, may be fluidically connected by the through hole of the thrust pad. In other words, the cross-section of the respective ports may overlap. In yet other words, the fluid may pass through the through hole in order to enter the duct inside the port flange. Providing a recess for the thrust pad allows to reduce the size of the hydraulic axial piston machine when a port flange according to the aforementioned aspect is used. This is due in particular to the fact that the thrust pad may be at least partially recessed in the port flange. The port flange may thus allow for a simple structure, while still be especially suitable for hydraulic axial piston machines operating at high pressures.

[0032] In one embodiment, the recess may comprise a groove which extends orthogonal to the longitudinal axis. Hence, the groove may extend inside the recess in a

direction towards a circumference of the port flange, i.e. for example towards the lateral surface of the port flange. In this regard, the recess may provide a side wall in which the groove may be arranged. In order to fully receive the thrust pad in the recess, the side wall of the recess may be longer than the thickness of the thrust pad, i.e. longer than the extension of the thrust pad in the third direction. A gap between the contact surface and the bottom surface of the thrust pad may thus be filled with fluid so that the thrust pad is pushed towards the port plate, i.e. away from the opposite side of the port flange. In this regard, spring elements, which may for example be arranged in apertures of the thrust pad may provide for the gap. Further, due to the aforementioned arrangement of the groove on the side wall of the recess, in a top view of the cylinder drum side surface of the port flange, the groove may not be directly visible. The groove may be configured to receive a sealing element. The sealing element may be an O-ring. Hence, a sealing element such as an O-ring may for example be arranged in the groove. Further, when the thrust pad is at least partially received within the recess, the sealing element may be configured to abut the lateral surface of the thrust pad. In other words, when the port flange is used with an assembly comprising a port plate, the thrust pad and the port flange, the sealing element may be configured to seal between the port plate and the thrust pad. Further, when the thrust pad is inserted into the recess and the sealing element may be in contact with the thrust pad, the thrust pad may be held in the recess by the frictional force resulting from a surface contact between the sealing element and the thrust pad. In addition, the sealing element may contribute to the sealing functionality of the thrust pad and may additionally prevent a flow of fluid past the contours of the thrust pad, i.e. past the lateral surface of the thrust pad.

[0033] Further, according to one aspect of the invention, the first port may provide a high-pressure port configured to supply fluid comprising high pressure to a cylinder of the cylinder drum of the hydraulic axial piston machine or to discharge fluid comprising high pressure from a cylinder of the cylinder drum of the hydraulic axial piston machine. Consequently, in one aspect, since the first port is the port used with the thrust pad, the thrust pad may preferably be used with a high pressure side of a hydraulic axial piston machine. This is mainly due to the fact that the thrust pad only deforms slightly due to its shape and design and therefore seals sufficiently without deforming under high pressure. It can also be used to compensate for deformations on the other components of the hydraulic axial piston machine, in particular deformations due to the high pressure on the port flange and/or the port plate.

[0034] According to a further aspect of the invention, the object of the invention is solved by an assembly comprising a port plate, for example according to the aforementioned aspects, a thrust pad according to the aforementioned aspects and a port flange according to the aforementioned aspects. In this regard, the thrust pad may at least partially be received, for example recessed, in the recess of the port flange so that the third direction of the thrust pad runs parallel to the longitudinal axis of the port flange. Further, the cylinder drum side surface of the port flange may be arranged in abutment with the port plate and/or the port plate may be arranged in abutment with the thrust pad so that the thrust pad may be at least partially arranged between the port flange and the port plate, when the thrust pad is received in the recess. The recess in the port flange may allow limited axial movement of the thrust pad with respect to the port flange, i.e. movement along the longitudinal axis of the port flange towards the opposite side of the port flange for example. In this regard, the port plate may be moved together with the thrust pad in order to keep the thrust pad and the port plate in abutment. The thrust pad may seal against the port flange. Therefore, (high) hydraulic pressures acting on the thrust pad and leading to deformation of the port flange and/or of the port plate may be compensated for by the thrust pad, for example together with the sealing element arranged in the groove of the recess.

[0035] In one aspect of the invention, the thrust pad is axially moveable with respect to the port flange along the longitudinal axis of the port flange at least when no port plate is arranged on the cylinder drum side surface of the port flange. In other words, the thrust pad is not fixed to the port flange. In yet other words, the thrust pad is provided as a separate component from the port flange.

[0036] In one embodiment, the recess of the port flange may form a step portion having a contact surface offset along the longitudinal axis with respect to the cylinder drum side surface of the port flange. The contact surface may thus limit axial movement of the thrust pad along the longitudinal axis with respect to the port flange, when the trust pad is received in the recess. Further, an offset between the contact surface and the cylinder drum side surface may be larger than the extension of the thrust pad along the third direction. The thrust pad may thus be configured to be fully received in the recess. In other words, the thrust pad may be recessed into the port flange so that the top surface of the thrust pad does not protrude from the cylinder drum side surface towards the port plate. The port plate may have a corresponding protrusion so that the port plate with this protrusion is still in abutment with the thrust pad, even if the thrust pad is fully recessed in the recess of the port flange and the port plate is in abutment with the cylinder drum side surface of the port flange. In other words, the protrusion may protrude into the recess if the port plate is brought up to the port flange accordingly. This can ensure improved sealing.

[0037] According to a further embodiment, the assembly may further comprise a sealing element arranged inside the groove of the recess of the port flange as aforementioned. In one aspect, the sealing element may be configured to seal between the port plate and the thrust pad. The improved sealing concept may thus allow to use a port plate which is less complicated to

produce as only a single material is required and therefore less expensive while still allowing to seal sufficiently at high pressures.

[0038] According to a further aspect of the invention, the object may be solved by a hydraulic axial piston machine comprising an assembly according to the aforementioned aspects. Further, the hydraulic axial piston machine may comprise a cylinder drum having at least one cylinder with a piston, a retainer plate mechanically coupled to the piston of the cylinder drum and a drive shaft mechanically coupled to the cylinder drum. The piston may move axially along the longitudinal axis in the at least one cylinder of the cylinder drum and may transmit force from the hydraulic fluid to the drive shaft or from the drive shaft to the hydraulic fluid. Further, the port plate, i.e. the control plate or the valve plate, may control the flow of hydraulic fluid to the at least one cylinder of the cylinder drum and thereby determined for example a direction of rotation of the drive shaft. The drive shaft may transmit the power from the piston to a connected elements connected to the drive shaft or may be used to rotate the cylinder drum. In this regard, the drive shaft may for example be splined to the cylinder drum. Further, bearings may be provided to support the drive shaft. In addition, a housing, which may for example be partially provided by the port flange accommodates (at least partially) the aforementioned components. Due to the respective arrangement of the thrust pad as aforementioned, the sealing of the hydraulic axial piston machine may be improved and may allow for the aforementioned advantages.

[0039] According to one embodiment, the hydraulic axial piston machine may further comprise a pressure plate and at least one spring, i.e. one or more springs, configured to push the pressure plate against the port plate. Thereby the port plate may be brought into abutment with the cylinder drum side surface of the port flange. In other words, the at least one spring and the pressure plate may be provided to provide sealing between the port plate and the cylinder drum side surface of the port flange. The cylinder drum may be rotating with respect to the port plate and the port flange. In one aspect, the cylinder drum may be rotating together with the pressure plate. The pressure plate and the port plate or the cylinder drum and the port plate may provide for a sliding seal. A force acting on the sliding seal may substantially be directed towards the port flange. Further, a force acting on the thrust pad in an opposite direction as the force acting towards the port flange, for example due to hydraulic pressure, may be transferred by the thrust pad onto the port plate. These forces acting in opposite directions may keep the fluid system closed and sealed. The thrust pad may thus serve to seal the hydraulic axial piston machine.

[0040] According to a further embodiment, in a first mode, when the drive shaft may be rotated by a drive motor, the hydraulic axial piston machine may be configured to suck low pressure fluid into the at least one cylinder of the cylinder drum via the second port of the port flange and may be configured to discharge high pressure fluid via the first port of the port flange. In said first mode, the hydraulic axial piston machine may be considered a hydraulic axial piston pump.

[0041] Further, in a second mode, when the drive shaft may be rotated by rotation of the cylinder drum, the hydraulic axial piston machine may be configured to supply high pressure fluid to the at least one cylinder of the cylinder drum via the first port of the port flange and may be configured to discharge low pressure fluid via the second port of the port flange. In this regard, the retainer plate may be swiveling. Therefore, the high pressure fluid entering the cylinder drum via the first port of the port flange and being discharged as low pressure fluid via the second port of the port flange drives the cylinder drum and thereby the drive shaft connected to the driver motor. In said second mode, the hydraulic axial piston machine may be considered a hydraulic axial piston motor in which the drive motor acts as a generator.

[0042] Thus, independent of the aforementioned use scenarios, i.e. the aforementioned use modes, the thrust pad may be provided at the high pressure port of the port flange in order to improve the respective sealing. In one aspect of the invention, no sealing element is provided between the port flange and the port plate at the low pressure port. In other words, sealing of the low pressure port may be purely provided by surface contact between the port plate and the port flange. Hence, only a thrust pad may be needed for the sealing of an interface between the port plate and the port flange which may reduce the costs and complexity of the hydraulic axial piston machine.

[0043] The inventive sealing concept for a hydraulic axial piston machine that is made possible in particular by the provision of the thrust pad according to the invention, may thus allow for multiple improvements, which in particular enable a more economical construction of a hydraulic axial piston machine.

[0044] Although not described in more detail, a similar sealing concept of providing a thrust pad between the port plate and the port flange may also be used for a pressure exchanger, for example for a pressure exchanger for a sea water reverse osmosis plant.

[0045] Additional features, advantages and possible applications of the invention result from the following description of exemplary embodiments and the drawings. All the features described and/or illustrated graphically here form the subject matter of the invention, either alone or in any desired combination, regardless of how they are combined in the claims or in their references back to preceding claims.

[0046] Preferred embodiments of the invention will now be described with reference to the drawings, in which:

Fig. 1A shows a perspective top view of a thrust pad according to the invention;

Fig. 1B shows a perspective bottom view of the thrust pad according to Fig. 1A;

Fig. 2A shows an exploded top view of an assembly comprising a port plate, a thrust pad and a port flange according to the invention;

Fig. 2B shows an exploded bottom view of the assembly according to Fig. 2A;

Fig. 3A shows a sectional view through an assembly, revealing arrangement of the thrust pad;

Fig. 3B shows an additional sectional view through an assembly; and

Fig. 4 shows a hydraulic axial piston machine.

[0047] In the Figures, identical elements and components as well as identical elements and components in different examples or embodiments, i.e. elements and components acting identical or provided for the same purposes but belong to different examples, are provided with the same reference signs.

[0048] In Figs. 1A and 1B a thrust pad 1 according to the invention is shown. The thrust pad 1 extends in a first direction X and a second direction Y which are arranged in a plane and orthogonal to one another. Further, the thrust pad 1 extends in a third direction Z which is orthogonally arranged to the first direction X as well as to the second direction Y. The extension of the thrust pad 1 in the third direction Z is smaller than the extension of the thrust pad 1 in the first direction X and smaller than the extension of the thrust pad 1 in the second direction Y. In other words, the thrust pad 1 is thinner than wide and long.

[0049] From the Figures, it may be noted that the thickness of the thrust pad 1 is at least 10 times smaller than the extension of the thrust pad 1 in the first direction X. The first, second and third directions X, Y and Z are indicated by respective arrows.

[0050] Further, the thrust pad 1 comprises a top surface 2, a lateral surface 3 and a bottom surface 4. The bottom surface 4 is arranged opposite the top surface 2 in the third direction Z. The lateral surface 3 extends parallel to the third direction Z.

[0051] Furthermore, the thrust pad 1 comprises a curved shape. In this regard, the thrust pad 1 comprises two tip portions, each comprising one respective end point, i.e. a first end point 5 and a second end point 6. An inner curved contour 7 and an outer curved contour 8 are formed between the two end points 5 and 6, which are defined, for example, by an edge of the thrust pad 1 next to the top surface 2. In this regard, the inner curved contour 7 may be considered the contour comprising a smaller radius compared to the outer curved contour 8. In addition, the inner curved contour 7 and the outer curved contour 8 respectively converge at the first end point 5 and the second end point 6 of the respective tip portions.

[0052] In addition, the thrust pad 1 comprises a through hole 9 which comprises at least substantially the same shape as the thrust pad 1. In the Figures the through hole 9 is a curved slotted hole.

[0053] It may be noted from the Figures that the through hole 9 may cover more than 60 % of an area of the bottom surface 4.

[0054] Further, the through hole 9 is configured to allow a fluid to pass from the top surface 2 to the bottom surface 4 of the thrust pad 1 and vice versa. When the thrust pad 1 is used in an assembly 100 as for example shown in Figs. 2A, 2B, 3A or 3B or in a hydraulic axial piston machine 1000 as for example shown in Fig. 4, the through hole 9 may allow fluid to pass from a port flange 101 to a control hole 102 of a port plate 103 and vice versa.

[0055] As can be noted from Fig. 1A, top surface 2 in an area surrounding the through hole 9 protrudes from an area not directly adjacent to the through hole 9, i.e. here next to the inner curved contour 7 and the outer curved contour 8 of the thrust pad 1. Further, in the area of each tip portion of the thrust pad 1 a first aperture 10 is arranged. In summary, there are thus two first apertures 10 arranged on the bottom surface 4 of the thrust pad 1. These first apertures 10 are arranged on the bottom surface 4 and align with second apertures 104 of the port flange 101 as can be noted from Figs. 2A and 2B. Here, the first apertures 10 and the second apertures 104 are blind holes. Although not shown, spring elements may be arranged in the first apertures 10 and second apertures 104, i.e. in the corresponding opening formed by the first apertures 10 and the second apertures 104, in order to push the thrust pad 1 away from the port flange 101 and for example towards the port plate 103.

[0056] A respective port flange 101 as shown in Figs. 2A and 2B extends along a longitudinal axis XL between a cylinder drum side surface 105 and an opposite site 106 opposite to the cylinder drum side surface 105. When being used with a cylinder drum 107 as shown for example in Fig. 4, the cylinder drum side surface 105 of the port flange 101 is facing the cylinder drum 107. In this regard, a port plate 103 and in one aspect also a pressure plate 108 are arranged between the cylinder drum side surface 105 and the cylinder drum 107.

[0057] Further, the port flange 101 comprises a first port 109 and a second port 110 each of which are configured to fluidically connect the port flange 101 to cylinders 111 of the cylinder drum 107 of the hydraulic axial piston machine 1000. The first port 109 may be a high pressure port and the second port may be a low pressure port. Further, rotation of the cylinder drum 107 fluidically connects the cylinders 111 to the respective first port 109 and second port 110 alternating depending on a rotational position of the cylinder drum 107.

[0058] Further, the port flange 101 and thus the hydraulic axial piston machine 1000 may be fluidically connected to a hydraulic system (not shown) by additional ports arranged on the lateral surface of the port

flange 101. Fluid may thus flow from these ports on the lateral surface of the port flange 101 to the first port 109 and the second port 110 of the cylinder drum side surface 105 respectively. In other words, the ports on the lateral surface of the port flange 101 may be used to supply and discharge fluid to and from the cylinders 111 of the cylinder drum 107.

[0059] Furthermore, the cylinder drum side surface 105 of the port flange 101 further comprises a recess 112 at least partially surrounding the first port 109 on the cylinder drum side surface 105. The recess 112 forms a step portion having a contact surface 113 offset along the longitudinal axis XL with respect to the cylinder drum side surface 105 of the port flange 101. The step portion and the contact surface 113 may best be seen in Figs. 3A and 3B.

[0060] Further, in Figs. 3A and 3B the thrust pad 1 is received or recessed in the recess 112. In more detail, the thrust pad 1 is partially recessed in the recess 112 of the port flange 101, wherein the contact surface 113 is configured to abut or limit a possible movement of the thrust pad 1 along the longitudinal axis XL towards the opposite side 106, i.e. away from the cylinder drum side surface 105. Furthermore, there is a gap formed between the contact surface 113 and the thrust pad 1 which may be filled with fluid so that the thrust pad 1 is pushed towards the port plate 103, i.e. away from the opposite side of the port flange 101. In other words, no contact between the contact surface 113 and the thrust pad 1 is intended. In this regard, spring elements not shown, which may for example be arranged in apertures 10 as aforementioned may provide for the gap.

[0061] In the assembly 100 shown in Figs. 3A and 3B, the through hole 9 of the thrust pad 1 and the first port 109 at least partially overlap.

[0062] Further, the recess 112 of the port flange 101 comprises a groove 114 which extends orthogonal to the longitudinal axis XL. Consequently, the groove 114 extends inside the recess 112 in a direction towards a circumference of the port flange 101. In this regard, the recess 112 provides a side wall 115 in which the groove 114 is arranged. The groove 114 is configured to receive a sealing element (not shown). The sealing element can be an O-ring. When the thrust pad 1 is partially received within the recess 112, the sealing element is configured to abut the lateral surface 3 of the thrust pad 1.

[0063] The assembly 100 as described above may be used in a hydraulic axial piston machine 1000 as shown in Fig. 4. In this regard, hydraulic fluid is fed via the two ports 109 and 110 into and out of the cylinders 111 via the through hole 9 of the thrust pad 1, the control hole 102 of the port plate 103 and the pressure plate 108. When a piston 116 inside the cylinder 111 recedes and is axially moved inside the cylinder drum 107, hydraulic fluid at low pressure may for example be sucked into the cylinder 111 via the second port 110. In other words, in order to suck fluid into the cylinder 111, the piston 116 may move away from the port flange 101. In this regard, the piston 116, which is coupled by a ball joint 117 to a sliding shoe 118 and thus to a retainer plate 119, may be pulled by the retainer plate 119 away from the port flange 101 due to rotation of a drive shaft 120 of the hydraulic axial piston machine 1000. Here, the sliding shoe 118 may be sliding or running on a swash plate 119A. Further, the retainer plate 119 may hold the sliding shoe 118 against the swash plate 119A. In this mode, the hydraulic axial piston machine 1000 is used as a hydraulic axial piston pump. Further, when the cylinder drum 107 is rotated so that the cylinder 111 comprising the sucked in fluid reaches a rotational position in which the fluid can be discharged via the first port 109, the fluid comprises high pressure. The empty cylinder 111 is then rotated back to the second port 110 position so that new fluid at lower may be sucked in again. The rotation of the cylinder drum 107 is provided by the drive shaft 120 and hence by a drive motor coupled thereto.

[0064] In this regard, torque and thus rotation is applied to the drive shaft 120 of the hydraulic axial piston machine 1000 by a drive motor (not shown). The drive shaft 120 is mechanically coupled to the cylinder drum 107, for example by splined to the cylinder drum 107. Hence, rotation of the drive shaft 120 is transferred onto the cylinder drum 107 which is hence rotated due to the rotation of the drive shaft 120. Therefore, hydraulic fluid may for example flow into the cylinder 111 as the piston 116 recedes on suction side (low pressure side). At the same time, the hydraulic fluid is pushed out of the cylinder 111 into the hydraulic system by the pistons 116 on the high-pressure side, which may for example be the first port 109 of the port flange 101. The thrust pad 1 may thus seal the high pressure side of the hydraulic axial piston machine 1000. However, the hydraulic axial piston machine 1000 may also be used as a hydraulic axial piston motor.

[0065] In addition, the hydraulic axial piston machine 1000 comprises at least one spring 121 which applies a force towards the port flange 101. In this regard, the at least one spring 121 pushes the pressure plate 108 against the port plate 103. Thereby the port plate 103 may be brought into abutment with the cylinder drum side surface 105 of the port flange 101. In other words, the at least one spring 121 and the pressure plate 108 may be provided to provide sealing between the port plate 103 and the cylinder drum side surface 105 of the port flange 101. In yet other words, the pressure plate 108 is pushed against the port plate 103 under the force of the spring 121. The pressure plate 108 may be rotating together with the cylinder drum 107. Further, the cylinder drum 107 may be rotating relative to and thus with respect to the port plate 103 and the port flange 101. The pressure plate 108 and the port plate 103 may therefore provide for a sliding seal.

[0066] When the drive shaft 120 is rotated by a drive motor, the hydraulic axial piston machine 1000 may thus suck low pressure fluid into the cylinders 111 of the cylinder drum 107 via the second port 110 of the port flange 101 and may be configured to discharge high

pressure fluid via the first port 109 of the port flange 101. Sealing of the low pressure port, i.e. the second port 110, may be purely provided by surface contact between the port plate 103 and the port flange 101 as well as between the port plate 103 and the pressure plate 108. Consequently, no sealing element is arranged with respect to the second port 110.

[0067] Further, in order to keep the thrust pad 1 and the port plate 103 into abutment, especially when the thrust pad 1 is recessed in the recess 112 of the port flange 101, the port plate 103, as shown in the Figures, has a corresponding protrusion 122 so that the port plate 103 with this protrusion 122 is still in abutment with the thrust pad, 1 even if the thrust pad 1 is fully recessed in the recess 112 of the port flange 101 and the port plate 103 abuts on the cylinder drum side surface 105 of the port flange 101. Further, the protrusion 122 ensures pressure to build-up between the thrust pad 1 and the port plate 103. The protrusion 122 thus partially protrudes into the recess 112 if the port plate 103 is brought into contact with the port flange 101, i.e. the cylinder drum side surface 105 of the port flange 101.

[0068] In addition to the aforementioned components, the hydraulic axial piston machine 1000 comprises a housing 123 at least partially housing the further components and elements of the hydraulic axial piston machine 1000. The housing 123 may for example be used to protect the components and to prevent leakage.

[0069] Further, a bearing 124, for example a radial bearing, is provided inside the housing 123 to support the cylinder drum 107 and thereby the drive shaft 120 of the hydraulic axial piston machine 1000. The cylinder drum 107 may thus rotate together with the drive shaft 120 splined thereto.

[0070] Consequently, when the hydraulic axial piston machine 1000 is used and fluid is supplied and discharged from the cylinders 111 of the cylinder drum 107, the thrust pad 1 arranged between the port flange 101 and the port plate 103, especially the thrust pad 1 being sandwiched between the port flange 101 and the port plate 103, allows for an improved sealing of the hydraulic axial piston machine 1000.

List of reference signs

[0071]

1	thrust pad
2	top surface
3	lateral surface
4	bottom surface
5	first end point
6	second end point
7	inner curved contour
8	outer curved contour
9	through hole
10	first apertures
100	assembly
101	port flange
102	control hole
103	port plate
104	second apertures
105	cylinder drum side surface
106	opposite side
107	cylinder drum
108	pressure plate
109	first port
110	second port
111	cylinder
112	recess
113	contact surface
114	groove
115	side wall
116	piston
117	ball joint
118	sliding shoe
119	retainer plate
119A	swash plate
120	drive shaft
121	spring
122	protrusion
123	housing
124	bearing
1000	hydraulic axial piston machine
X	first direction
Y	second direction
Z	third direction
XL	longitudinal axis (of the port flange)

Claims

1. Thrust pad (1) for a port flange (101) of a hydraulic axial piston machine (1000),

wherein the thrust pad (1) comprises a top surface (2), a lateral surface (3) and a bottom surface (4),

wherein the thrust pad (1) comprises a curved shape configured to be arranged at least partially between the port flange (101) and a port plate (103) of the hydraulic axial piston machine (1000),

wherein the thrust pad (1) extends in a first direction (X), a second direction (Y) and a third direction (Z), wherein the second direction (Y) is defined orthogonal with respect to said first direction (X) and the third direction (Z) is defined orthogonal with respect to said first direction (X) and said second direction (Y),

wherein the thrust pad (1) extends in the third direction (Z) less than in the first direction (X) and the second direction (Y), wherein the thrust pad

(1) extends in the first direction (X) more than in the second direction (Y),
wherein the thrust pad (1) comprises a through hole (9),
and wherein the through hole (9) is configured to fluidically connect a first port (109) of the port flange (101) to a control hole (102) of the port plate (103).

2. Thrust pad (1) according to claim 1, wherein the lateral surface (3) is partially provided by an inner curved contour (7) and partially provided by an outer curved contour (8) extending between a first tip portion and a second tip portion, and wherein the inner curved contour (7) and the outer curved contour (8) respectively converge at a first end point (5) and a second end point (6) of the respective tip portions, and/or wherein the thrust pad (1) comprises a semi-lunar, curved shape.

3. Thrust pad (1) according to any one of the preceding claims, wherein the through hole (9) extends partially along the curved shape of the thrust pad (1), and wherein the through hole (9) comprises a bigger extension in the first direction (X) than in the second direction (Y).

4. Thrust pad (1) according to any one of the preceding claims, wherein the through hole (9) is a curved slotted hole.

5. Thrust pad (1) according to any one of the preceding claims, wherein the thrust pad (1) comprises a thickness defined by an extension of the thrust pad (1) along the third direction (Z), wherein the thickness is at least 10 times smaller than the extension of the thrust pad (1) in the first direction (X).

6. Port flange (101) for a hydraulic axial piston machine (1000),

wherein the port flange (101) extends along a longitudinal axis (XL) between a cylinder drum side surface (105) and an opposite surface (106),
wherein the port flange (101) comprises a first port (109) and a second port (110) each of which are configured to fluidically connect the port flange (101) to a cylinder (111) of a cylinder drum (107) of a hydraulic axial piston machine (1000),
wherein the cylinder drum side surface (105) of the port flange (101) further comprises a recess (112) at least partially surrounding the first port (109), wherein the recess (112) is configured to at least partially receive the thrust pad (1) according to any one of claims 1 to 5,
wherein, when the thrust pad (1) is received in the recess (112) of the port flange (101), the through hole (9) of the thrust pad (1) and the first port (109) at least partially overlap, so that the first port (109), when the port flange (101) is fluidically connected to the cylinder (111) of the cylinder drum (107) of the hydraulic axial piston machine (1000), is fluidically connected by the through hole (9) of the thrust pad (1).

7. Port flange (101) according to claim 6, wherein the recess (112) comprises a groove (114) which extends orthogonal to the longitudinal axis (XL), wherein the groove (114) is configured to receive a sealing element, and wherein, when the thrust pad (1) is at least partially received within the recess (112), the sealing element is configured to abut the lateral surface (3) of thrust pad (1).

8. Port flange (101) according to any one of claims 6 or 7, wherein the first port (109) provides a high-pressure port configured to supply fluid comprising high pressure to the cylinder (111) of the cylinder drum (107) of the hydraulic axial piston machine (1000) or to discharge fluid comprising high pressure from the cylinder (111) of the cylinder drum (107) of the hydraulic axial piston machine (1000).

9. Assembly (100) of a port plate (103), the thrust pad (1) according to any one of claims 1 to 5, and the port flange (101) according to any one of claims 6 to 8,

wherein the thrust pad (1) is at least partially received in the recess (112) of the port flange (101) so that the third direction (Z) of the thrust pad (1) runs parallel to the longitudinal axis (XL) of the port flange (101),
wherein the cylinder drum side surface (105) of the port flange (101) is arranged in abutment with the port plate (103) and/or the port plate (103) is arranged in abutment with the thrust pad (1) so that the thrust pad (1) is at least partially arranged between the port flange (101) and the port plate (103), when the thrust pad (1) is received in the recess (112).

10. Assembly (100) according to claim 9, wherein the recess (112) of the port flange (101) forms a step portion having a contact surface (113) offset along the longitudinal axis (XL) with respect to the cylinder drum side surface (105) of the port flange (101), and wherein an offset between the contact surface (113) and the cylinder drum side surface (105) is greater than the extension of the thrust pad (1) along the third direction (Z).

11. Assembly (100) according to any one of claims 9 or 10, wherein the assembly (100) further comprises a sealing element arranged inside the groove (114) of the recess (112) of the port flange (101).

12. Hydraulic axial piston machine (1000) comprising an assembly according to any one of claims 9 to 11, a cylinder drum (107) having at least one cylinder (111) with a piston (116), a retainer plate (119) mechanically coupled to the piston (116) of the cylinder drum (107), and a drive shaft (120) mechanically coupled to the cylinder drum (107).

13. Hydraulic axial piston machine (1000) according to claim 12, wherein the hydraulic axial piston machine (1000) further comprises a pressure plate (108) and at least one spring (120) configured to push the pressure plate (108) against the port plate (103) thereby providing sealing between the port plate (103) and the cylinder drum side surface (105) of the port flange (101).

14. Hydraulic axial piston machine (1000) according any one of claims 12 or 13, wherein, when the drive shaft (120) is rotated by a drive motor, the hydraulic axial piston machine (1000) is configured to suck low pressure fluid into the at least one cylinder (111) of the cylinder drum (107) via the second port (110) of the port flange (101) and to discharge high pressure fluid via the first port (109) of the port flange (101), and

wherein, when the drive shaft (120) is rotated by rotation of the cylinder drum (107), the hydraulic axial piston machine (1000) is configured to supply high pressure fluid to the at least one cylinder (111) of the cylinder drum (107) via the first port (109) of the port flange (101) and to discharge low pressure fluid via the second port (110) of the port flange (101).

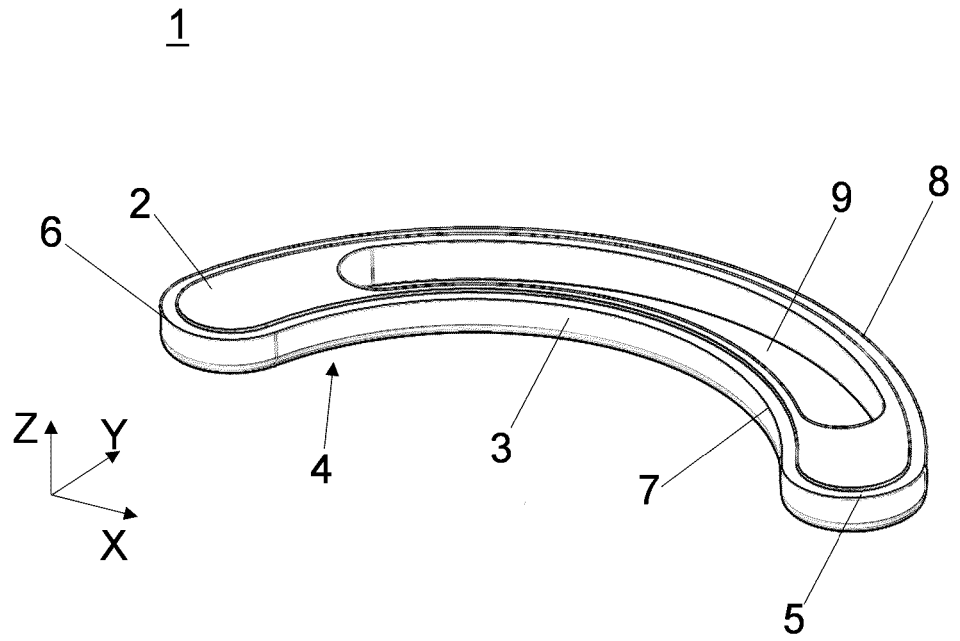


Fig. 1A

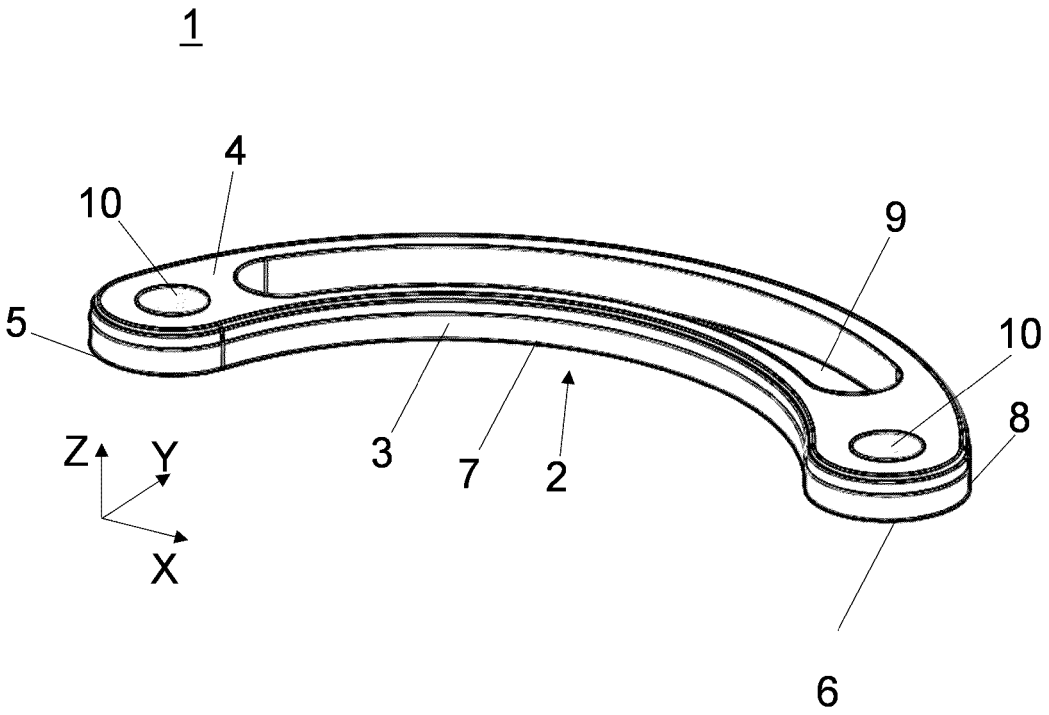


Fig. 1B

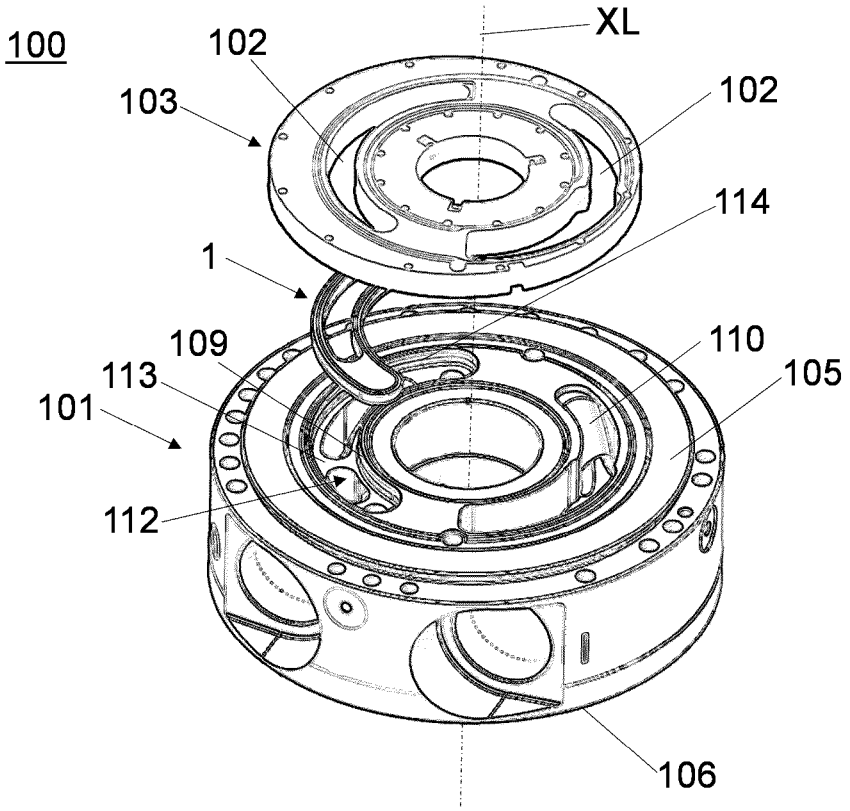
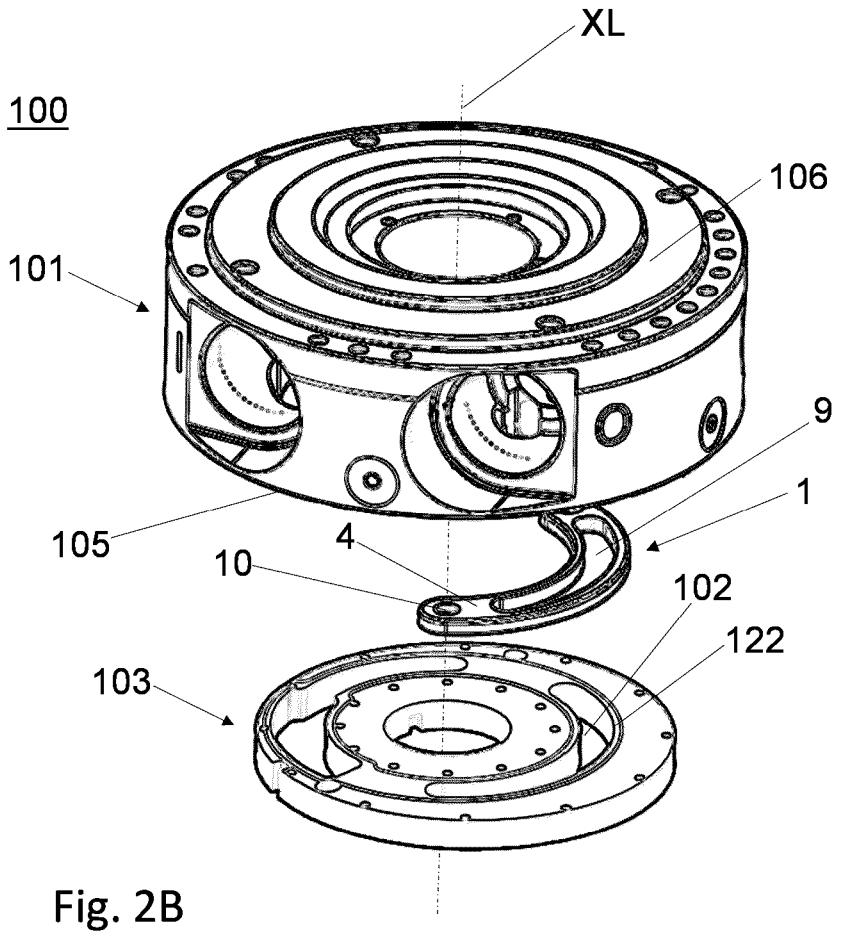

100
102
XL
103
102
114
1
109
110
113
105
101
112
106

Fig. 2A


XL
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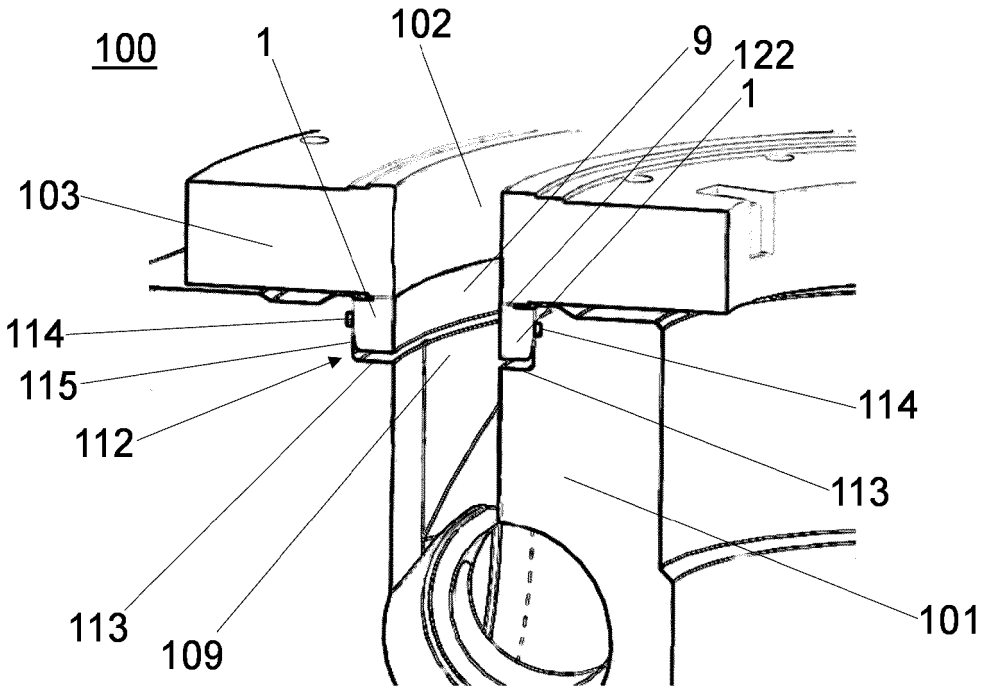
106
101
9
1
105
4
10
102
122
103

Fig. 2B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1
102
9
122
1
103
114
115
112
114
113
113
109
101

Fig. 3A

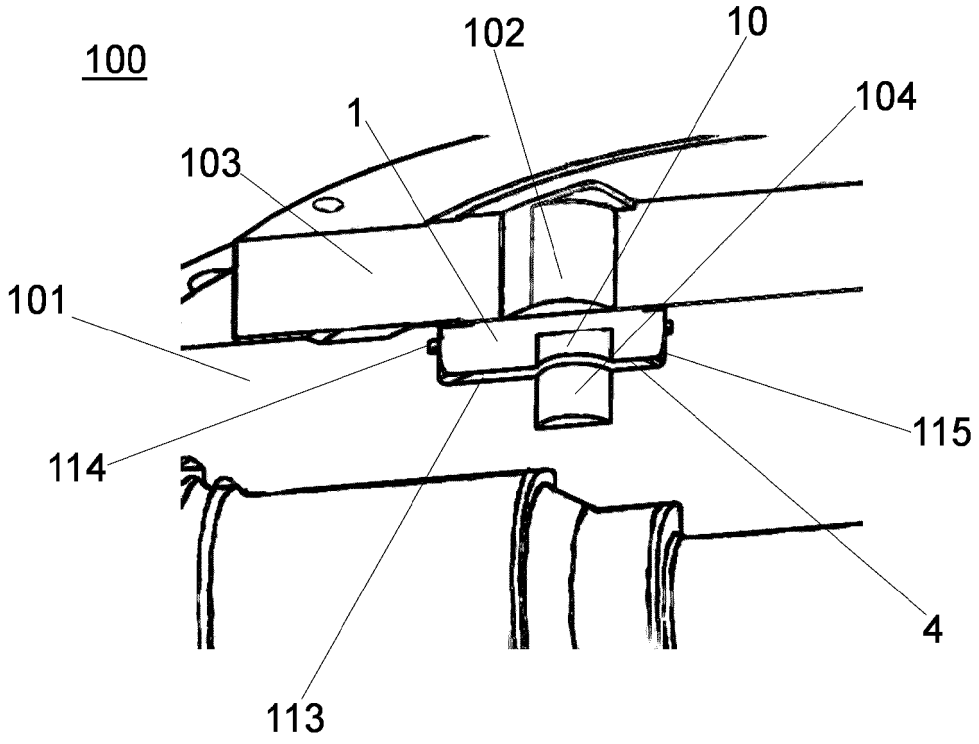
100
102
10
104
1
103
101
114
115
4
113

Fig. 3B

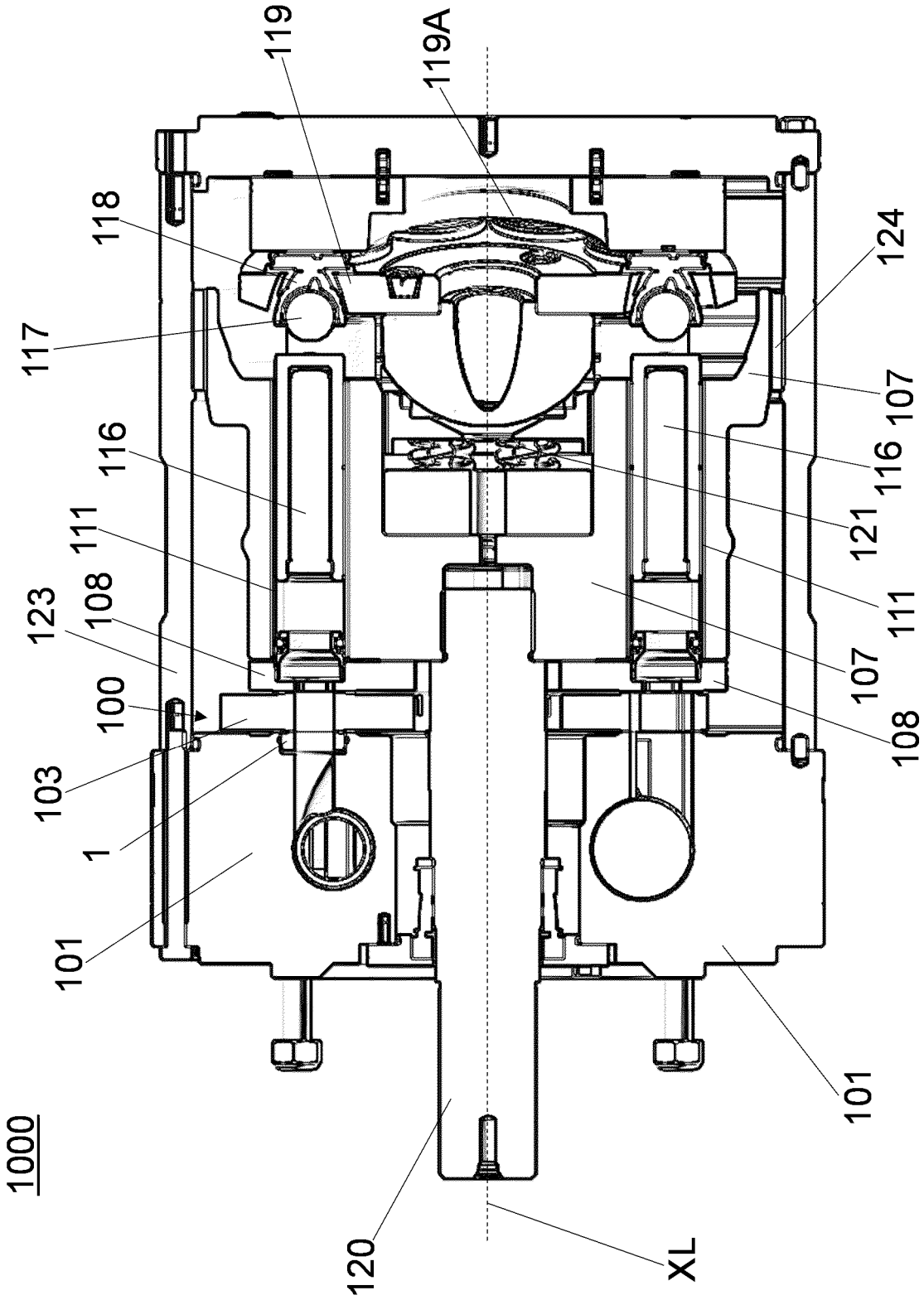
119
119A
118
124
117
107
116
116
121
111
111
123
108
107
100
108
103
1
101
101
1000
120
XL

Fig. 4

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EUROPEAN SEARCH REPORT

Application Number
EP 24 21 1414

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	FR 2 884 286 A1 (HYDRO LEDUC SOC PAR ACTIONS SI [FR]) 13 October 2006 (2006-10-13) * figures 1-7 * * page 3, line 11 - page 4, line 26 *	1-14	INV. F03C1/06 F04B1/20 F04B1/2007 F04B1/2021 F04B1/2064
A	KR 2023 0040263 A (NABTESCO CORP [JP]) 22 March 2023 (2023-03-22) * figures 1-12 * * paragraph [0039] - paragraph [0181] *	1-14	
A	US 2023/304481 A1 (IKEDA MITSUTAKA [JP] ET AL) 28 September 2023 (2023-09-28) * figures 1-16 * * paragraph [0029] - paragraph [0062] *	1-14	
A	US 2010/000401 A1 (BECK THOMAS [DE] ET AL) 7 January 2010 (2010-01-07) * figures 1-4 * * paragraph [0020] - paragraph [0036] *	1-14	TECHNICAL FIELDS SEARCHED (IPC)
A	US 2021/190066 A1 (ANDERSEN STIG KILDEGAARD [DK] ET AL) 24 June 2021 (2021-06-24) * figures 1-4 * * paragraph [0028] - paragraph [0043] *	1-14	F04B F03C
A	KR 920 010 152 A (TOSHIBA MACHINE CO LTD [JP]) 26 June 1992 (1992-06-26) * figures 1-3 *	1-14	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	17 January 2025	Ricci, Saverio

CATEGORY OF CITED DOCUMENTS

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 24 21 1414

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
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17-01-2025

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
FR 2884286 A1	13-10-2006	NONE	
KR 20230040263 A	22-03-2023	CN 115807750 A	17-03-2023
		JP 2023042732 A	28-03-2023
		KR 20230040263 A	22-03-2023
US 2023304481 A1	28-09-2023	CN 116018460 A	25-04-2023
		DE 112021003561 T5	15-06-2023
		JP 7476059 B2	30-04-2024
		JP 2022048012 A	25-03-2022
		US 2023304481 A1	28-09-2023
		WO 2022054807 A1	17-03-2022
US 2010000401 A1	07-01-2010	CN 101002019 A	18-07-2007
		DE 102004033321 A1	02-02-2006
		EP 1769157 A1	04-04-2007
		US 2010000401 A1	07-01-2010
		WO 2006005399 A1	19-01-2006
US 2021190066 A1	24-06-2021	CN 113007054 A	22-06-2021
		DE 102019135086 A1	24-06-2021
		ES 2835079 A1	21-06-2021
		GB 2592470 A	01-09-2021
		US 2021190066 A1	24-06-2021
KR 920010152 A	26-06-1992	JP 2502901 Y2	26-06-1996
		JP H0482377 U	17-07-1992
		KR 920010152 A	26-06-1992

EPO FORM P0459

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