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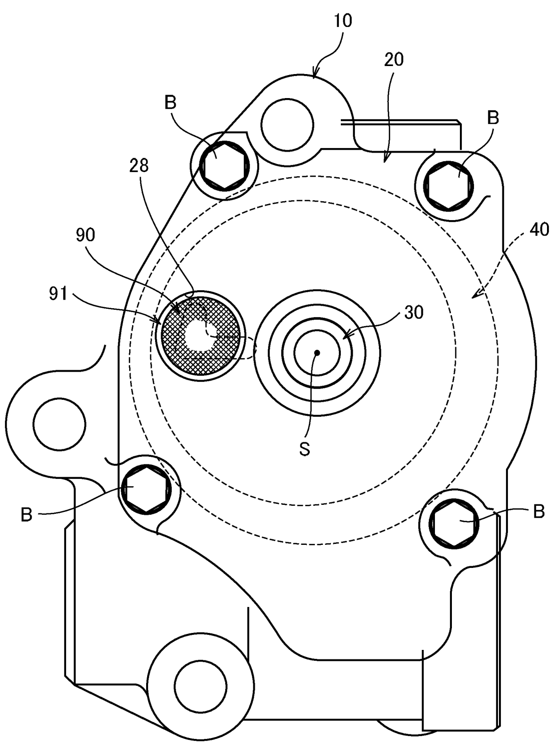
(54) **OIL PUMP**

(57) An oil pump of the present invention includes a housing (10, 20) which includes an inlet port (44b) to suck oil, a discharge port (52) to discharge oil, and a purge port (24) to eject air-mixed oil, an inner rotor (71, 81) which is arranged in the housing as being rotatable about a predetermined axis line (S), an outer rotor (72, 82) which is arranged in the housing to be rotated as being interlocked with the inner rotor, and a filter member (90) which is arranged at the housing from the outside thereof to prevent foreign matter from entering through the purge port. According to the above, entering of foreign matter and the like can be prevented even when oil is sucked through the purge port.

Fig.1



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Description

TECHNICAL FIELD

[0001] The present invention relates to an oil pump which sucks and discharges oil (lubricant oil) of an internal combustion engine (an engine) or the like, and in particular, relates to a trochoid type oil pump including an inner rotor and an outer rotor.

BACKGROUND ART

[0002] There has been known a trochoid type oil pump including a housing which has an inlet port for sucking oil, a discharge port for discharging oil, a purge port (an air vent port, a bubble ejection port, or a deairing port) for ejecting air mixed with oil, and the like, an outer rotor which has internal teeth as being rotatably arranged in the housing, an inner rotor which has external teeth engaged with the internal teeth of the outer rotor and which defines a volume-varying pump chamber in cooperation with the outer rotor, a rotary shaft which is rotatably supported by the housing to rotate the inner rotor, and the like. Here, pumping action is obtained by rotating the inner rotor via the rotary shaft and rotating the outer rotor as being coordinated with the rotation of the inner rotor, so that oil sucked through the inlet port is pressurized and discharged through the discharge port while air (bubble) and the like mixed with oil is ejected through the purge port (for example, see Patent Literature 1, Patent Literature 2, Patent Literature 3, and the like).

[0003] By the way, in the abovementioned oil pump, the purge port (an air vent port, a bubble ejection port, or a deairing port) is arranged at a portion corresponding to a pressurizing chamber (compression process) at a side close to the discharge port. Accordingly, in a normal revolution range of an engine, oil is not sucked conversely through the purge port while air-mixed oil may be ejected therethrough.

[0004] Here, during development of an oil pump having characteristics to work in a wide engine revolution range, the inventor has acknowledged occurrence of a case that the pump chamber communicates with the purge port as well concurrently with the inlet port depending on settings such as a ratio between an oil discharge rate and a purge ejection rate (an ejection rate of air-mixed oil through the purge port) and rotor size difference, causing a phenomenon of sucking oil through the purge port at engine starting or sucking oil through the purge port due to following delay of an intake process at high engine revolution range.

Cited Literature

Patent Literature

[0005]

Patent Literature 1: Japanese Patent Application Laid-Open No. 9-203308

Patent Literature 2: Japanese Patent Application Laid-Open No. 6-167278

Patent Literature 2: Japanese Utility-model Application No. 2-107738 (Japanese Utility-model Application Laid-open No. 4-65974) (Microfilm)

SUMMARY OF THE INVENTION

[0006] To address the above issues, an object of the present invention is to provide an oil pump capable of ensuring desired pump performance while preventing sticking and the like due to entering of foreign matter and the like even when oil is sucked through a purge port, and capable of achieving improvement of pump performance, improvement of durability, and the like in a wide engine revolution range from a low revolution range to a high revolution range including a revolution range having less air mixing, a revolution range having less emphasis on air mixing, and the like.

[0007] An oil pump according to the present invention includes a housing which includes an inlet port to suck oil, a discharge port to discharge oil, and a purge port to eject air-mixed oil with air mixed; an inner rotor which is arranged in the housing as being rotatable about a predetermined axis line; an outer rotor which is arranged in the housing to be rotated as being interlocked with the inner rotor; and a filter member which is arranged at the housing from the outside thereof to prevent foreign matter from entering through the purge port.

[0008] According to the configuration, for example, in a case that the oil pump is mounted on an engine (in an oil pan thereof), under normal operational conditions, oil (lubricant oil) is sucked into the pump chamber due to pumping action of the inner rotor and the outer rotor, and then, the sucked air-mixed oil is pressurized. Subsequently, a part of the air-mixed oil is ejected to the outside of the housing (into the oil pan) through the purge port, and then, remaining oil is discharged through the discharge port and pressure-fed toward various lubrication areas.

[0009] On the other hand, owing to a high oil level in the oil pan at engine starting or following delay of an intake process at high speed revolution, there may be a case that oil is sucked through the purge port. In this case, since oil is sucked into the pump chamber through the filter member, sticking and the like due to entering of foreign matter and the like can be prevented and desired pump performance can be ensured accordingly. Further, improvement of pump performance, improvement of durability, and the like can be achieved in a wide engine revolution range.

[0010] In the above configuration, it is possible to adopt a configuration that the purge port is arranged at a range capable of providing communication, concurrently with the inlet port, with a pump chamber defined by the inner rotor and the outer rotor.

[0011] According to the configuration, when oil is sucked into the pump chamber P through the inlet port, oil is sucked through the purge port as well depending on revolution speed. Accordingly, even in a revolution range having less contained amount of air or a revolution range having less emphasis on air discharging, the oil pump can be used as a pump to suck and discharge oil.

[0012] In the above configuration, it is possible to adopt a configuration that the housing includes a housing body including a concave portion for containing the inner rotor and the outer rotor and a housing cover which is connected to the housing body to close an opening of the housing body, the purge port is formed at the housing cover, and the filter member is attached to the housing cover from the outside.

[0013] According to the configuration, attaching and detaching of the filter member can be easily performed from the outside of the housing. Therefore, replacement operation and the like of the filter member can be easily performed as well without disassembling the housing.

[0014] In the above configuration, it is possible to adopt a configuration that the inner rotor and the outer rotor include an upstream rotor including a first inner rotor and a first outer rotor and a downstream rotor including a second inner rotor and a second outer rotor, the upstream rotor and the downstream rotor being arranged adjacently in a direction of the axis line, the housing includes a spacer member which is interposed between the upstream rotor and the downstream rotor, the inlet port is arranged to be faced to the upstream rotor, the discharge port is arranged to be faced to the downstream rotor, the purge port is arranged to be faced to the upstream rotor, and a communication port which introduces oil discharged from the upstream rotor to the downstream rotor is arranged at the spacer member.

[0015] According to the configuration, owing to that the two-stage trochoid pump including the upstream rotor and the downstream rotor is adopted, desired pumping characteristics can be ensured while achieving downsizing in an outer diameter dimension of the apparatus. Further, since the inlet port, the purge port, and the discharge port are arranged as described above, pump efficiency can be improved.

[0016] In the above configuration, it is possible to adopt a configuration that the inlet port is arranged at the spacer member between the upstream rotor and the downstream rotor to be faced to the upstream rotor.

[0017] According to the configuration, oil sucked through the inlet port can be reliably pressurized in the upstream rotor and supplied to the downstream rotor through the communication port. As a whole, pumping performance can be improved.

[0018] In the above configuration, it is possible to adopt a configuration that the inner rotor and the outer rotor are formed in four blades and five nodes.

[0019] According to the configuration, with a structure being likely to have arrangement that the inlet port and the purge port concurrently communicate with the pump chamber, pump performance and durability can be improved while ensuring a desired discharge rate.

[0020] In the above configuration, it is possible to adopt a configuration that the purge port is formed to be opened in an approximate L-shape as being elongated in the radial direction passing through the axis line and being elongated in a rotation direction of the inner rotor and the outer rotor at an outer edge thereof in the radial direction.

[0021] According to the configuration, ejection of air through the purge port can be effectively performed.

[0022] According to an oil pump having the abovementioned structure, even when oil is sucked through a purge port, sticking and the like due to entering of foreign matter and the like can be prevented and desired pump performance can be ensured. Further, in a wide engine revolution range including a revolution range having less air mixing, a revolution range having less emphasis on air mixing, and the like, improvement of pump performance, improvement of durability, and the like can be achieved.

BRIEF DESCRIPTION OF THE DRAWINGS

[0023]

FIG. 1 is a front view illustrating an embodiment of an oil pump according to the present invention.

FIG. 2 is a sectional view illustrating the inside of the oil pump illustrated in FIG. 1.

FIG. 3 is a front view illustrating a housing body which structures a part of the oil pump illustrated in FIG. 1.

FIG. 4A is a plane view of a housing cover which structures a part of the oil pump illustrated in FIG. 1 viewed from the rear R side (inner surface side).

FIG. 4B is a sectional view of the housing cover which structures a part of the oil pump illustrated in FIG. 1 at E1-E1 in FIG. 4A.

FIG. 5 is an exploded sectional view of the housing cover, a filter member, and a fixing ring structuring a part of the oil pump illustrated in FIG. 1.

FIG. 6 is a sectional view illustrating a rotor case which structures a part of the oil pump illustrated in FIG. 1.

FIG. 7A is an end view of the rotor case illustrated in FIG. 6 viewed from the front F side.

FIG. 7B is an end view of the rotor case illustrated in FIG. 6 viewed from the rear R side.

FIG. 8A is a plane view of a side plate which structures a part of the oil pump illustrated in FIG. 1 viewed from the front F side.

FIG. 8B is a sectional view of the side plate which structures a part of the oil pump illustrated in FIG. 1 at E2-E2 in FIG. 8A.

FIG. 9A is a plane view illustrating an inner rotor and an outer rotor structuring a part of the oil pump illustrated in FIG. 1 viewing an upstream rotor including a first inner rotor and a first outer rotor from the rear R side.

FIG. 9B is a plane view illustrating an inner rotor and an outer rotor structuring a part of the oil pump illustrated in FIG. 1 viewing a downstream rotor including a second inner rotor and a second outer rotor from the front F side.

FIG. 10 is a plane view viewing from the rear R side as illustrating a relation of an inlet port and a purge port against a pump chamber defined by the first inner rotor and the first outer rotor which structure the upstream rotor.

FIG. 11 is an exploded sectional view illustrating another embodiment of a method for attaching a filter member which structures a part of the oil pump illustrated in FIG. 1.

EMBODIMENT OF THE INVENTION

[0024] In the following, embodiments of the present invention will be described with reference to the attached drawings.

[0025] As illustrated in FIGs. 1 and 2, an oil pump according to an embodiment includes a housing body 10 and a housing cover 20 which constitute a housing, a rotary shaft 30 which is supported by the housing as being rotatable about an axis line S, a rotor case 40 which is assembled in the housing, a side plate 50 which is in contact with an end face of the rotor case 40, an O-ring 60 as an urging member which urges the side plate 50 toward the rotor case 40 in the direction of the axis line S, an upstream rotor 70, including a first inner rotor 71 and a first outer rotor 72, which is contained in the rotor case 40, a downstream rotor 80, including a second inner rotor 81 and a second outer rotor 82, which is contained in the rotor case 40 as being adjacent to the upstream rotor 70 in the direction of the axis line S, a filter member 90 which is attached to the housing cover 20, and the like.

[0026] The housing body 10 made of aluminum material for weight saving and the like is configured to form a concave portion for containing the upstream rotor 70 and the downstream rotor 80 along with the rotor case 40. As illustrated in FIGs. 2 and 3, the housing body 10 includes a bearing hole 11 for roratably supporting one end portion 31 of the rotary shaft 30 via a bearing G, a cylindrical inner circumferential face 12 to which the rotor case 40 is fitted, two circular end faces 13 which are formed around the bearing hole 11 as having diameters lessened to form a stepped portion at a back side of the inner circumferential face 12, an inlet passage 14 through which oil is sucked as being formed by removing a part of the inner circumferential face 12 and drilling thereat outward in the radial direction, a discharge passage 15 through which pressurized oil is discharged as being formed at a bottom side, a positioning hole 16 for positioning the side plate 50, a joint face 17 for joining the housing cover 20, screw holes 18 into which bolts B are screwed for fastening the housing cover 20, positioning holes 19 for positioning the housing cover 20, and the like.

[0027] The housing cover 20 is made of aluminum material being the same as the housing body 10 for weight saving and the like. As illustrated in FIGs. 1, 2, 4A, 4B, and 5, the housing cover 20 includes a bearing hole 21 for rotatably supporting the other end portion 32 of the rotary shaft 30 via a bearing G, a concave portion 22 which is faced to a later-mentioned inlet port 44b in the direction of the axis line S, a concave portion 23 which is faced to a later-mentioned communication port 44e in the direction of the axis line S, a purge port 24 through which air mixed with sucked oil (air-mixed oil) is ejected, circular holes 25 through which the bolts B pass, positioning holes 26 for performing positioning to the housing cover 10, a positioning hole 27 for positioning the rotor case 40, a counterbore portion 28 to which a filter member 90 and a fixing ring 91 are fitted, and the like.

[0028] The housing cover 20 is joined to the joint face 17 to close an opening of the housing body 10 while a positioning pin fitted into the positioning hole 19 is fitted into the positioning hole 26 and a positioning pin fitted into a positioning hole 45a of the rotor case 40 is fitted into the positioning hole 27. Then, the housing cover 20 is connected to the housing body 10 by screwing the bolts B into the screw holes 18 as passing through the circular holes 25 from the outer side.

[0029] As illustrated in FIGs. 4A and 9A, the purge port 24 is opened to be approximately L-shaped as being elongated in the radial direction passing through the axis line S and being elongated in a rotation direction (an arrow direction) of the first inner rotor 71 and the first outer rotor 72 at an outer edge thereof in the radial direction. According to the above, ejection of air through the purge port 24 can be effectively performed.

[0030] Here, the purge port 24 is not limited to have the abovementioned shape. It is also possible to adopt an appropriate shape in accordance with a target purge ejection rate and the like.

[0031] As illustrated in FIG. 2, the rotary shaft 30 made of steel or the like is formed as being elongated in the direction of the axis line S. The rotary shaft 30 includes the one end portion 31 which is supported by the bearing hole 11 of the housing body 10 via the bearing G, the other end portion 32 which is supported by the bearing hole 21 of the housing cover 20 via the bearing G, a shaft portion 33 which integrally rotates the first inner rotor 71 of the upstream rotor 70, a shaft portion 34 which integrally rotates the second inner rotor 81 of the downstream rotor 80, a shaft portion 35 which is supported by the bearing G, and the like.

[0032] The rotary shaft 30 is configured to be rotationally driven as being connected to a rotary member or the like which structures a part of an engine.

[0033] The rotor case 40 is made of steel, casting iron, sintered steel, or the like. As illustrated in FIGs. 2, 6, 7A, and 7B, the rotor case 40 includes a cylindrical portion 41 which is centered at the axis line S, an inner circumferential face 42 centered at an axis line L1 which is shifted by a predetermined amount from the axis line S at the inner side of the cylindrical portion 41, an inner circumferential face 43 centered at an axis line L2 which is shifted by a predetermined amount from the axis line S at the inner side of the cylindrical portion 41, a middle wall portion 44 as a spacer member formed between the inner circumferential face 42 and the inner circumferential face 43 in the direction of the axis line S, a bearing hole 44a arranged at the middle wall portion 44, an inlet port 44b which is arranged at the middle wall portion 44, an upstream rotor discharge port 44c which is arranged at the middle wall portion 44, a downstream rotor inlet port 44d which is arranged at the middle wall portion 44, the communication port 44e through which the upstream rotor discharge port 44c and the downstream rotor inlet port 44d are mutually connected, an end face 45 with which the housing cover 20 is in contact, a positioning hole 45a which is formed at the end face 45, an end face 46 with which the side plate 50 is in contact, a positioning hole 46a which is formed at the end face 46, and the like.

[0034] The cylindrical portion 41 is formed to have an outer diameter dimension so that the cylindrical portion 41 is fitted into the housing body 10 as being capable of relatively moving in the direction of the axis line S in accordance with difference between thermal deformation (expansion and contraction) amounts of the housing body 10 and the rotor case 40 while being intimately contacted to the inner circumferential face 12 of the housing body 10.

[0035] The inner circumferential face 42 is formed to have a dimension so that the first outer rotor 72 of the upstream rotor 70 is in contact with the inner circumferential face 42 rotatably (slidably) about the axis line L1.

[0036] The inner circumferential face 43 is formed to have a dimension so that the second outer rotor 82 of the downstream rotor 80 is in contact with the inner circumferential face 43 rotatably (slidably) about the axis line L2.

[0037] The inlet port 44b is formed so as to be faced to (a pump chamber P of) the upstream rotor 70 while communicating with the inlet passage 14.

[0038] Thus, the inlet port 44b is arranged between the upstream rotor 70 and the downstream rotor 80 so as to be faced to the upstream rotor 70. Accordingly, oil sucked through the inlet port 44b can be reliably pressurized in the upstream rotor 70 and is supplied to the downstream rotor 80 through the communication port 44e. As a whole, pumping performance can be improved.

[0039] The communication port 44e is configured to cause communication between the upstream rotor discharge port 44c and the downstream rotor inlet port 44d so that oil discharged from the upstream rotor 70 is introduced to the downstream rotor 80.

[0040] The rotor case 40 is assembled (fitted) to the inner circumferential face 12 of the housing body 10 in a state of containing the upstream rotor 70 at the inner circumferential face 42 and the downstream rotor 80 at the inner circumferential face 43 along with the rotary shaft 30 while the positioning pin fitted into the positioning hole 16 is fitted into the positioning hole 46a as sandwiching the O-ring 60 and the side plate 50 in cooperation with the end face 13.

[0041] The side plate 50 is formed disc-shaped as being made of steel, casted iron, sintered steel, aluminum alloy, or the like. As illustrated in FIGs. 2 and 8, the side plate 50 includes a circular hole 51 through which the rotary shaft 30 passes, a discharge port 52 through which oil pressurized by the downstream rotor 80 is discharged, a positioning hole 53, a concave portion 54 which receives one end side of the bearing G, and the like.

[0042] The side plate 50 is configured to be assembled to the housing body 10 as sandwiching the O-ring 60 at a space against the end face 13 while a positioning pin fitted into the positioning hole 16 of the housing body 10 passes through the positioning hole 53.

[0043] The O-ring 60 is formed circularly as being made of elastically-deformable rubber material or the like and is arrange between the end face 13 of the housing body 10 and the side plate 50. The O-ring 60 is assembled as being compressed by a predetermined compression amount in the direction of the axis line S to urge the side plate 50 toward the end face 46 of the rotor case 40.

[0044] The upstream rotor 70 is made of steel, sintered steel, or the like. As illustrated in FIG. 9A, the upstream rotor 70 includes the first inner rotor 71 and the first outer rotor 72.

[0045] The first inner rotor 71 is formed as an external gear which has four crests and roots (cavities) while including a fitting hole 71a into which the shaft portion 33 of the rotary shaft 30 is fitted.

[0046] The first outer rotor 72 is formed as an internal gear which has five crests (inner teeth) and roots (cavities) to be engaged with the four crests (external teeth) and roots (cavities) of the first inner rotor 71 at the inner circumference thereof while including an outer circumferential face 72a which is slidably fitted to the inner circumferential face 42 of the rotor case 40.

[0047] That is, the upstream rotor 70 (the first inner rotor 71 and the first outer rotor 72) is a trochoid pump having four blades and five nodes.

[0048] When the first inner rotor 71 is rotated along with the rotary shaft 30 in an arrow direction about the axis line S (counterclockwise in FIG. 9A), the first outer rotor 72 is coordinated and rotated in an arrow direction about the axis line L1 (counterclockwise in FIG. 9A). Accordingly, volume of the pump chamber P defined by both thereof is varied and oil is sucked through the inlet port 44b and pressurized subsequently. Air-mixed oil is ejected through the purge port 24 in the pressurization process, and subsequently, remaining oil is discharged through the upstream rotor discharge port 44c to the downstream rotor 80. Then, the above processes are to be continuously repeated.

[0049] Further, as illustrated in FIG. 10, , the purge port 24 is arranged at a range to be capable of communicating, concurrently with the inlet port 44b, with the pump chamber P which is defined by the first inner rotor 71 and the first outer rotor 72. Accordingly, in a case that an oil level in an oil pan at engine starting is high or a case that following delay of an intake process occurs at high speed revolution, there is a possibility that oil may be sucked into the pump chamber P through the purge port 24.

[0050] That is, when oil is sucked into the pump chamber P through the inlet port 44b, oil is sucked through the purge port 24 as well depending on revolution speed. Accordingly, even in a revolution range having less contained amount of air or a revolution range having less emphasis on air discharging, the oil pump can be used as a pump to suck and discharge oil.

[0051] The downstream rotor 80 is made of steel, sintered steel, or the like. As illustrated in FIG. 9B, the downstream rotor 80 includes the second inner rotor 81 and the second outer rotor 82.

[0052] The second inner rotor 81 is formed as an external gear which has four crests and roots (cavities) at the outer circumferential face thereof while including a fitting hole 81a into which the shaft portion 34 of the rotary shaft 30 is fitted.

[0053] The second outer rotor 82 is formed as an internal gear which has five crests (inner teeth) and roots (cavities) to be engaged with the four crests (external teeth) and roots (cavities) of the second inner rotor 81 at the inner circumference thereof while including an outer circumferential face 82a which is slidably fitted to the inner circumferential face 43 of the rotor case 40.

[0054] That is, the downstream rotor 80 (the second inner rotor 81 and the second outer rotor 82) is a trochoid pump having four blades and five nodes.

[0055] When the second inner rotor 81 is rotated along with the rotary shaft 30 in an arrow direction (clockwise in FIG. 9B) about the axis line S, the second outer rotor 82 is coordinated and rotated in an arrow direction (clockwise in FIG. 9B) about the axis line L2. Accordingly, volume of the pump chamber P defined by both thereof is varied and oil is sucked through the downstream inlet port 44d and pressurized subsequently. Then, oil is discharged through the discharge port 52 toward an external lubrication area. The above processes are to be repeated continuously.

[0056] Owing to that the two-stage trochoid pump including the upstream rotor 70 and the downstream rotor 80 is adopted as described above, desired pumping characteristics can be ensured while achieving downsizing in an outer diameter dimension of the apparatus. Further, since the inlet port 44b, the purge port 24, and the discharge port 52 are arranged as described above, pump efficiency can be improved.

[0057] Further, the rotor case 40 and the side plate 50 structures a second housing which contains the upstream rotor 70 and the downstream rotor 80 at the inside of the housing (the housing body 10 and the housing cover 20).

[0058] The rotor case 40 and the side plate 50 are made of the same material (steel, sintered steel, or the like) as the upstream rotor 70 and the downstream rotor 80. Here, even in a case that a gap is to be generated in the direction of the axis line S with thermal expansion of the housing (the housing body 10 and the housing cover 20) formed of aluminum, the rotor case 40 and the side plate 50 are urged to one side in the direction of the axis line S with an urging force of the O-ring 60. Accordingly, desired pump performance (discharge characteristics) can be ensured by preventing a gap from being generated at both side faces of the upstream rotor 70 and both side faces of the downstream rotor 80.

[0059] As illustrated in FIGs. 1 and 5, the filter member 90 is formed to have a hemispherical shape with a ring-shaped brim portion as being meshed to a predetermined size to eliminate foreign matter mixed in oil.

[0060] The filter member 90 is fitted to the counterbore portion 28 to cover the purge port 24 of the housing cover 20, and then, a ring-shaped fixing ring 91 is fitted thereto from the above. Accordingly, the filter member 90 is attached to the housing cover 20 from the outside.

[0061] Thus, attaching and detaching of the filter member 90 can be easily performed from the outside of the housing (the housing body 10 and the housing cover 20). Therefore, replacement operation and the like of the filter member 90 can be easily performed as well without disassembling the housing (the housing body 10 and the housing cover 20).

[0062] Here, not limited to the meshed filter member 90 having a hemispherical shape and the fixing ring 91 for fixing thereof, it is possible to adopt a filter member whose structure and shape are different and a fixing way therefor.

[0063] For example, as illustrated in FIG. 11, it is possible to adopt a C-shaped snap ring 91' instead of the fixing ring 91 and to arrange a ring-shaped groove 28' at the inner circumferential face of the counterbore portion 28 of the housing cover 20.

[0064] According to the above, the filter member 90 is fitted to the counterbore portion 28 to cover the purge port 24 of the housing cover 20, and then, a C-shaped snap ring 91' is fitted into the ring-shaped groove 28'. Thus, the filter member 90 is attached to the housing cover 20 from the outside.

[0065] Similarly in this case as well, attaching and detaching of the filter member 90 can be easily performed from the outside of the housing (the housing body 10 and the housing cover 20). Therefore, replacement operation and the like of the filter member 90 can be easily performed as well without disassembling the housing (the housing body 10 and the housing cover 20).

[0066] Next, operation of the oil pump will be described with reference to FIGs. 9A, 9B and 10.

[0067] First, in a state that an engine is in a normal revolution range (in a state that oil is not sucked through the purge port 24), the upstream rotor 70 (the first inner rotor 71 and the first outer rotor 72) is rotated counterclockwise in FIG. 9A and oil is sucked into the pump chamber P of the upstream rotor 70 through the inlet passage 14 and the inlet port 44b.

[0068] Owing to continuous rotation of the upstream rotor 70, the oil sucked into the pump chamber P is pressurized. In the pressurization process, air-mixed oil is forcedly ejected outside through the purge port 24. Further, the remaining oil is introduced to the downstream rotor 80 through the upstream rotor discharge port 44c, the communication port 44e, and the downstream rotor inlet port 44d.

[0069] Subsequently, the oil is sucked into the pump chamber P of the downstream rotor 80 through the downstream rotor inlet port 44d with clockwise rotation in FIG. 9B of the downstream rotor 80 (the second inner rotor 81 and the second outer rotor 82).

[0070] Owing to continuous rotation of the downstream rotor 80, the oil sucked into the pump chamber P is pressurized and supplied to an external lubrication area through the discharge port 52 and the discharge passage 15.

[0071] Practically, cooperative action of the upstream rotor 70 (the first inner rotor 71 and the first outer rotor 72) and the downstream rotor 80 (the second inner rotor 81 and the second outer rotor 82) causes the respective pump chambers to continuously perform sucking of oil, pressurizing of oil, ejecting of mixed air (air-mixed oil), and discharging of oil.

[0072] On the other hand, at engine starting (when an oil level in an oil pan is high) or at high speed revolution (when following delay of an intake process occurs against a normal pump process), oil is sucked into the pump chamber P (defined by the first inner rotor 71 and the first outer rotor 72) of the upstream rotor 70 not only through the inlet port 44b but also through the purge port 24, as illustrated in FIG. 10. That is, when oil is sucked into the pump chamber P through the inlet port 44b, oil is also sucked through the purge port 24. Accordingly, even in a revolution range having less contained amount of air or a revolution range having less emphasis on air discharging, the oil pump can be used as a pump to suck and discharge oil.

[0073] In this case, since the filter member 90 is arranged at the purge port 24, foreign matter and the like accumulated in an oil pan can be prevented from being sucked into the pump P. Therefore, sticking and the like of the upstream rotor 70 and the downstream rotor 80 can be prevented and desired pump performance can be ensured. Further, improvement of pump performance, improvement of durability, and the like can be achieved in a wide engine revolution range.

[0074] In the description of the above embodiment, the present invention is applied to the structure in which the rotor case 40, the side plate 50, and the like are arranged at the inside of the housing (the housing body 10 and the housing cover 20) as a second housing. However, not limited to the above, the present invention may be applied to a structure without including the rotor case 40, the side plate 50, and the like.

[0075] In the description of the above embodiment, the present invention is applied to the two-stage trochoid pump which includes the upstream rotor 70 (the first inner rotor 71 and the first outer rotor 72) and the downstream rotor 80 (the second inner rotor 81 and the second outer rotor 82). However, not limited to the above, the present invention may be applied to a structure including one pair of an inner rotor and an outer rotor.

[0076] In the description of the above embodiment, the present invention is applied to a structure in which the housing is separated into the housing body and the housing cover. However, not limited to the above, the present invention may be applied to a structure in which a dual partitioning housing includes a first housing half body and a second housing half body which define a concave portion respectively.

[0077] In the description of the above embodiment, the oil pump is a trochoid pump. However, not limited to the above, the present invention may be adopted to an internal gear type oil pump, an external gear type oil pump, or the like.

INDUSTRIAL APPLICABILITY

[0078] As described above, according to an oil pump of the present invention, even when oil is sucked through a purge port, sticking and the like due to entering of foreign matter and the like can be prevented and desired pump performance can be ensured. Further, in a wide engine revolution range from a low revolution range to a high revolution range including a revolution range having less air mixing, a revolution range having less emphasis on air mixing, and the like, improvement of pump performance, improvement of durability, and the like can be achieved. Accordingly, in addition to be naturally adopted to an engine which is mounted on an automobile or the like, an oil pump of the present invention is useful for motorcycles, other vehicles having an engine mounted, other mechanisms requiring pressured feeding of lubricant oil, and the like.

EXPLANATION OF REFERENCES

[0079]

10	Housing body (Housing)
11	Bearing hole
12	Inner circumferential face
13	End face
14	Inlet passage
15	Discharge passage
16	Positioning hole
17	Joint face
18	Screw hole
19	Positioning hole
20	Housing cover (Housing)
21	Bearing hole
22	Concave portion
23	Concave portion
24	Purge port
25	Circular hole
26	Positioning hole

27	Positioning hole
28	Counterbore portion
28’	Ring-shaped groove
30	Rotary shaft
S	Axis line
31	One end portion
32	Other end portion
33, 34, 35	Shaft portion
40	Rotor case
41	Cylindrical portion
42	Inner circumferential face
43	Inner circumferential face
44	Middle wall portion (Spacer member)
44a	Bearing hole
44b	Inlet port
44c	Upstream rotor discharge port
44d	Downstream rotor inlet port
44e	Communication port
45	End face
45a	Positioning hole
46	End face
46a	Positioning hole
50	Side plate
51	Circular hole
52	Discharge port
53	Positioning hole
54	Concave portion
60	O-ring
70	Upstream rotor
P	Pump chamber
71	First inner rotor
71a	Fitting hole
72	First outer rotor
L1	Axis line
72a	Outer circumferential face
80	Downstream rotor
P	Pump chamber
81	Second inner rotor
81a	Fitting hole
82	Second outer rotor
L2	Axis line
82b	Outer circumferential face
90	Filter member
91	Fixing ring
91’	Snap ring

Claims

1. An oil pump, comprising:

    a housing which includes an inlet port to suck oil, a discharge port to discharge oil, and a purge port to eject air-mixed oil with air mixed;
    an inner rotor which is arranged in the housing as being rotatable about a predetermined axis line;
    an outer rotor which is arranged in the housing to be rotated as being interlocked with the inner rotor; and
    a filter member which is arranged at the housing from the outside thereof to prevent foreign matter from entering through the purge port.

2. The oil pump according to claim 1, wherein the purge port is arranged at a range capable of providing communication, concurrently with the inlet port, with a pump chamber defined by the inner rotor and the outer rotor.

3. The oil pump according to claim 1 or claim 2, wherein the housing includes a housing body including a concave portion for containing the inner rotor and the outer rotor, and a housing cover which is connected to the housing body to close an opening of the housing body,
the purge port is formed at the housing cover, and the filter member is attached to the housing cover from the outside.

4. The oil pump according to any one of claims 1 to 3, wherein the inner rotor and the outer rotor include an upstream rotor including a first inner rotor and a first outer rotor and a downstream rotor including a second inner rotor and a second outer rotor, the upstream rotor and the downstream rotor being arranged adjacently in a direction of the axis line,
the housing includes a spacer member which is interposed between the upstream rotor and the downstream rotor,
the inlet port is arranged to be faced to the upstream rotor,
the discharge port is arranged to be faced to the downstream rotor,
the purge port is arranged to be faced to the upstream rotor, and
a communication port which introduces oil discharged from the upstream rotor to the downstream rotor is arranged at the spacer member.

5. The oil pump according to claim 4, wherein the inlet port is arranged at the spacer member between the upstream rotor and the downstream rotor to be faced to the upstream rotor.

6. The oil pump according to one of claims 1 to 5, wherein the inner rotor and the outer rotor are formed in four blades and five nodes.

7. The oil pump according to one of claims 1 to 5, wherein the purge port is formed to be opened in an approximate L-shape as being elongated in the radial direction passing through the axis line and being elongated in a rotation direction of the inner rotor and the outer rotor at an outer edge thereof in the radial direction.

Fig.1

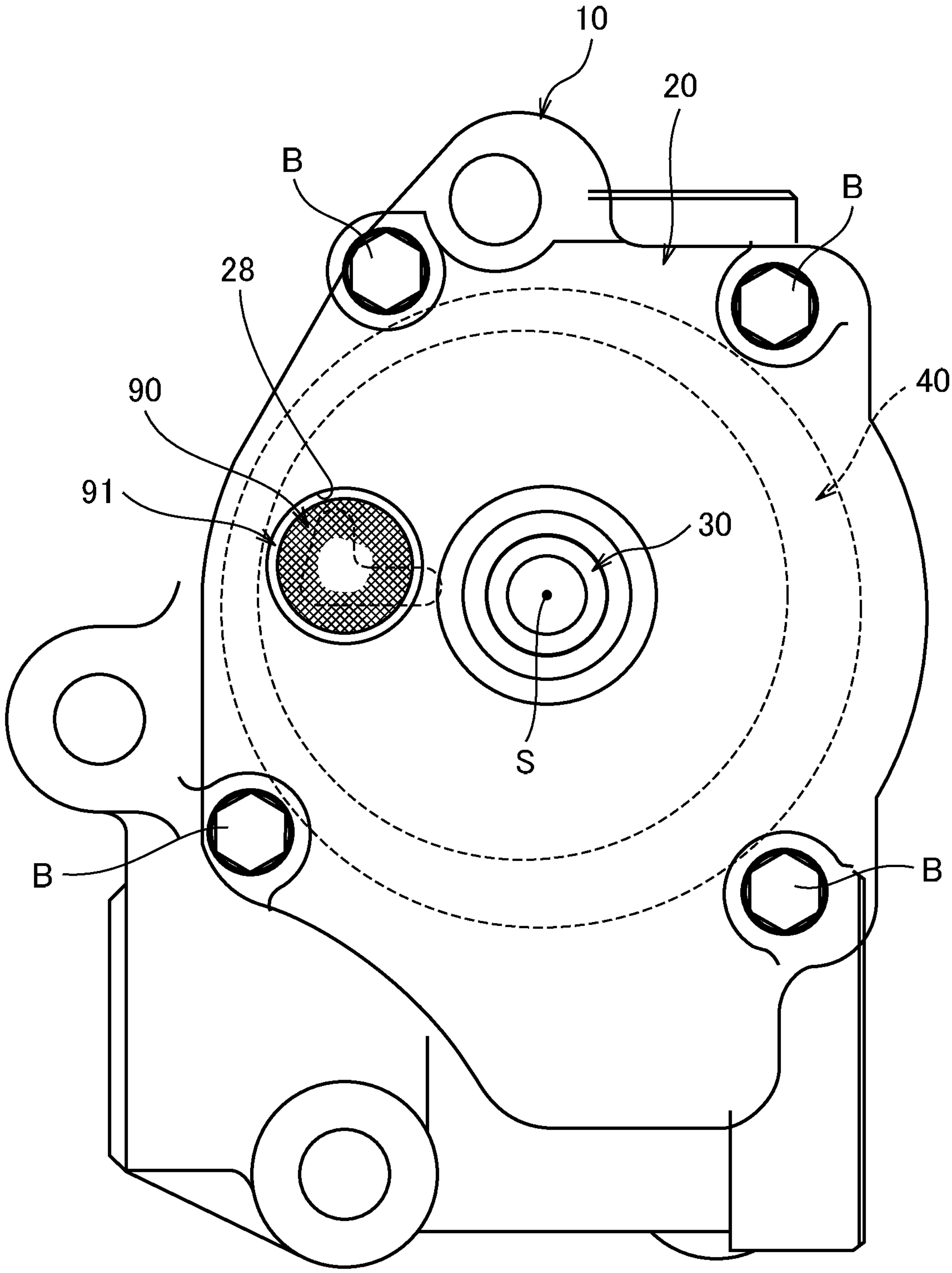
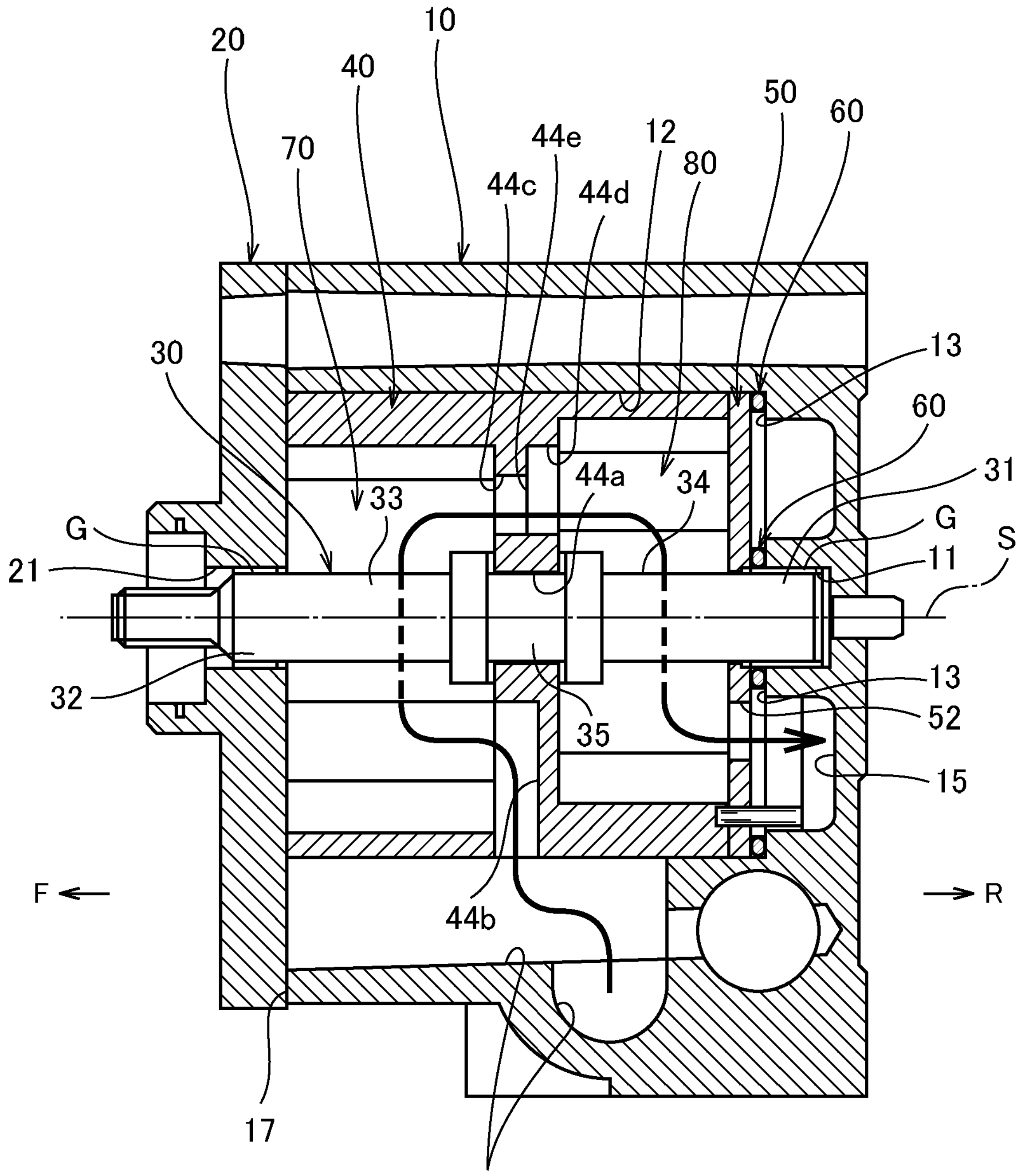


Fig.2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44a
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G
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S
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32
13
52
35
15
F
R
44b
17
14

Fig.3

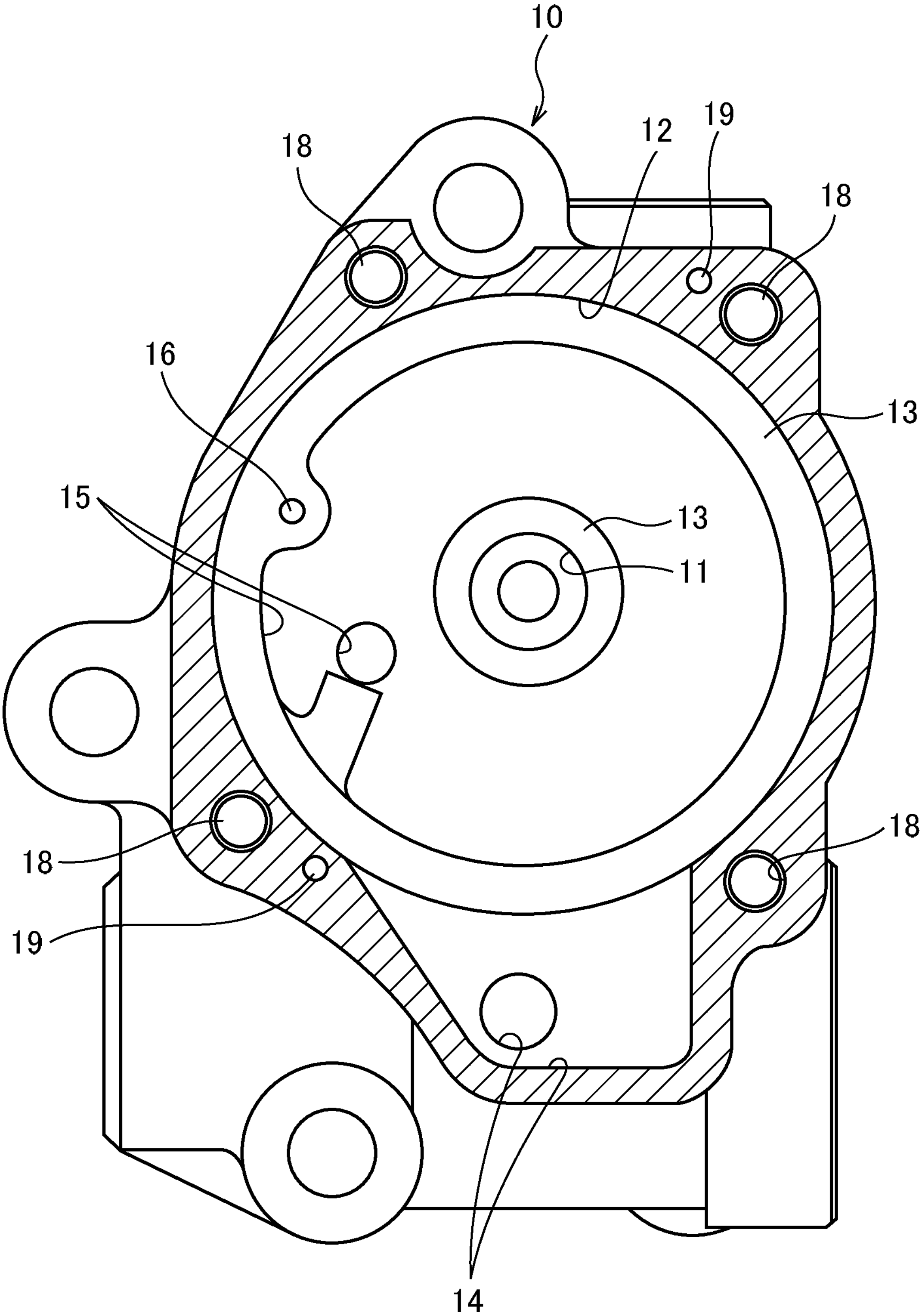


Fig.4A

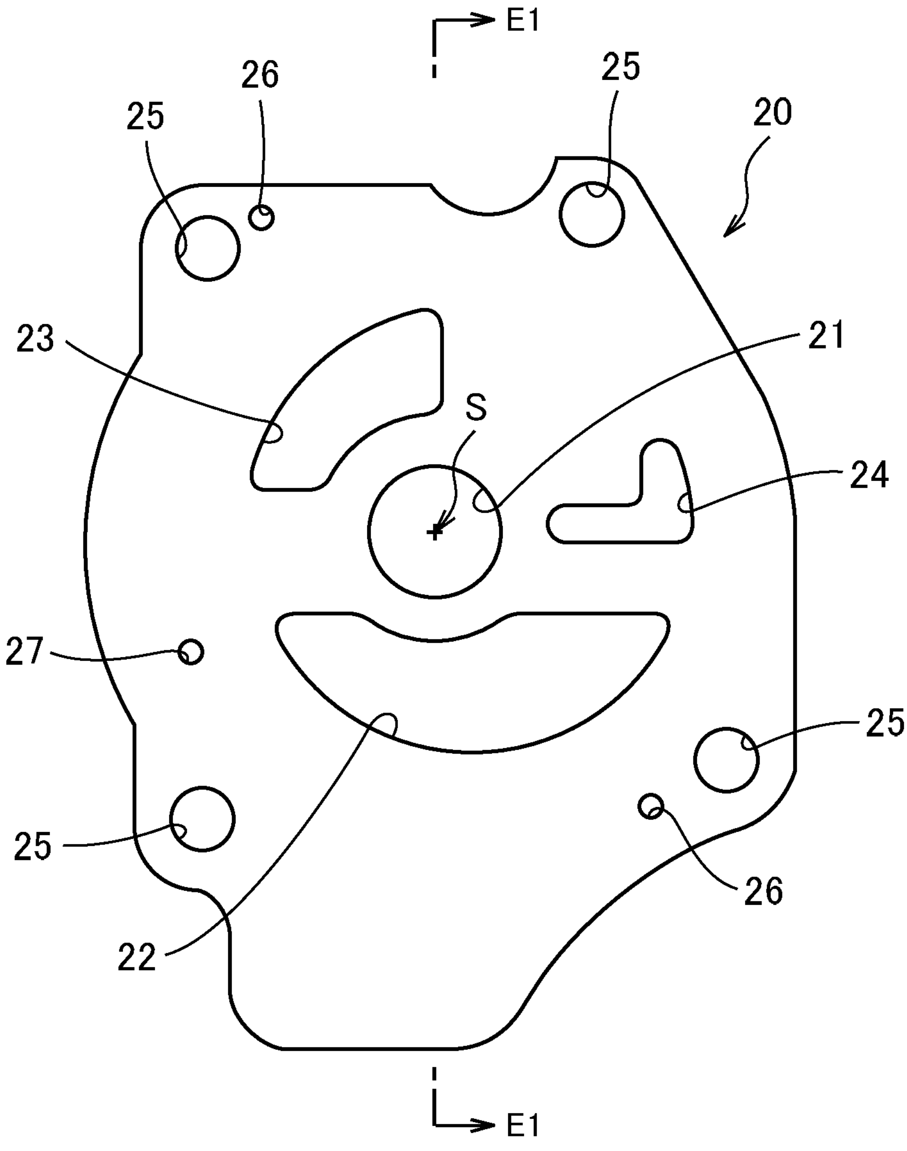


Fig.4B

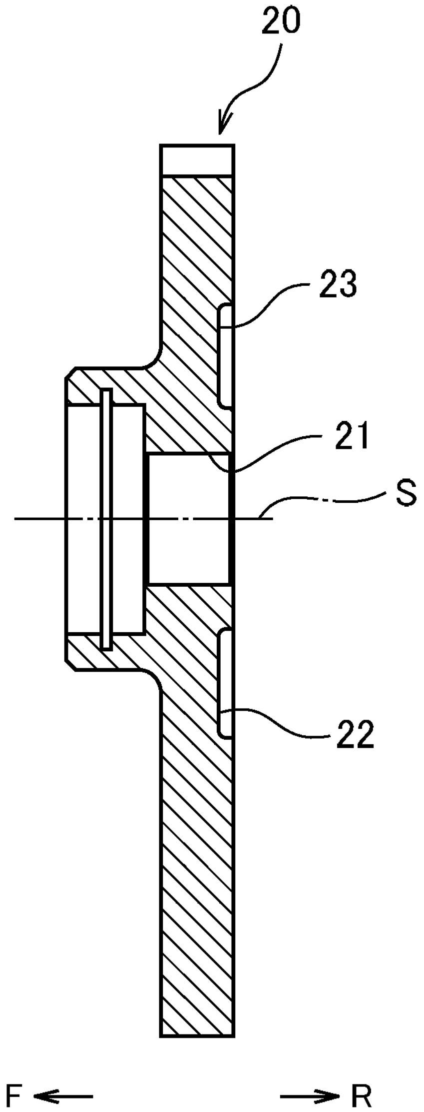


Fig.5

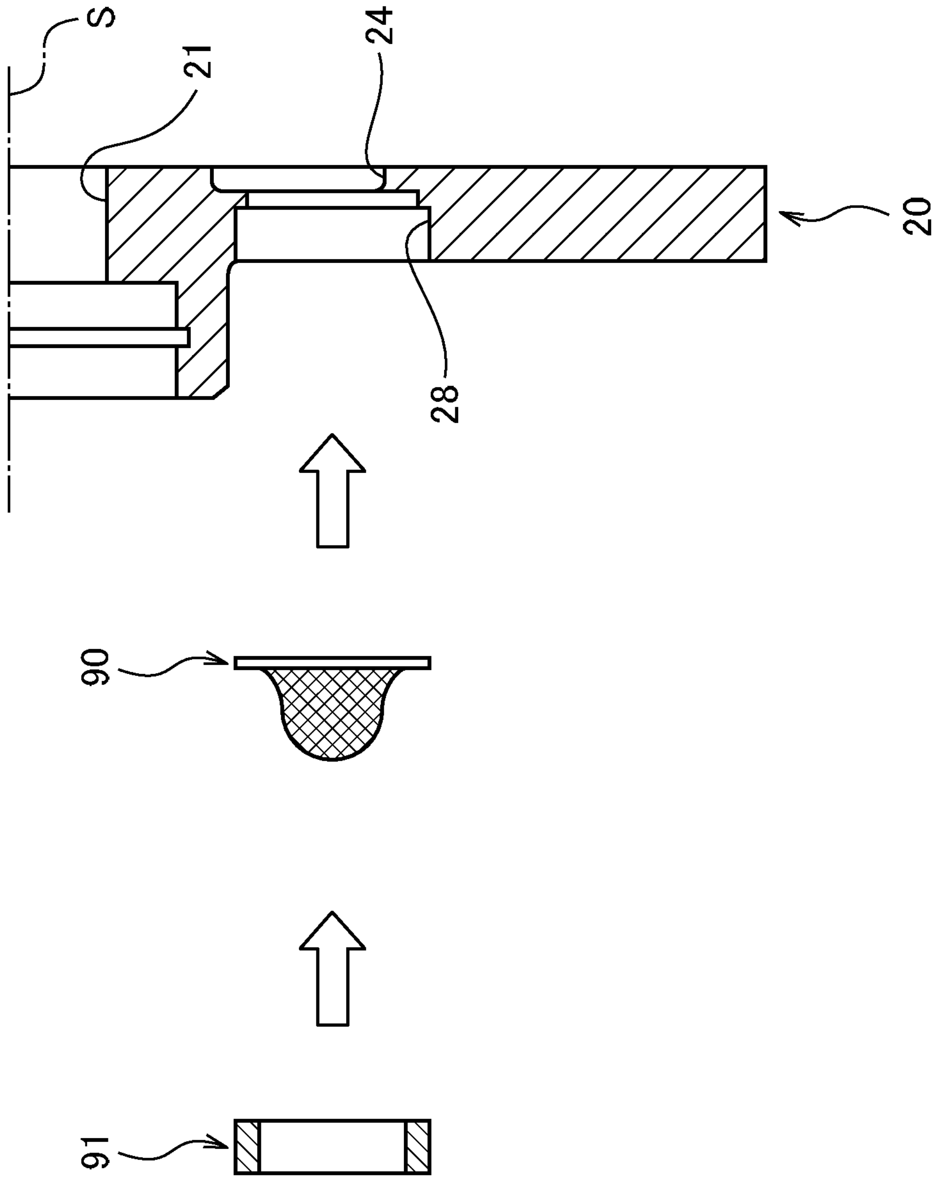


Fig.6

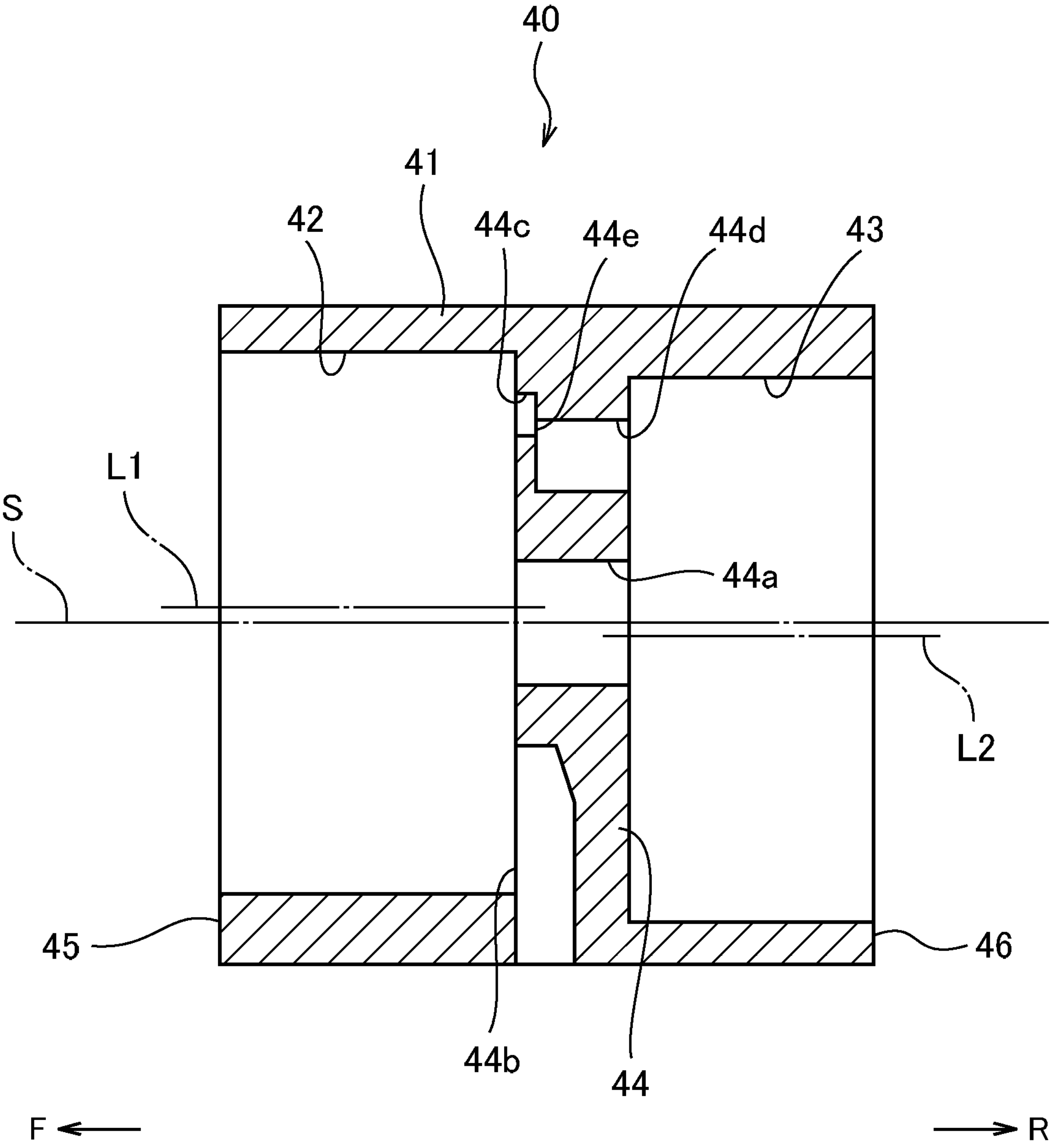
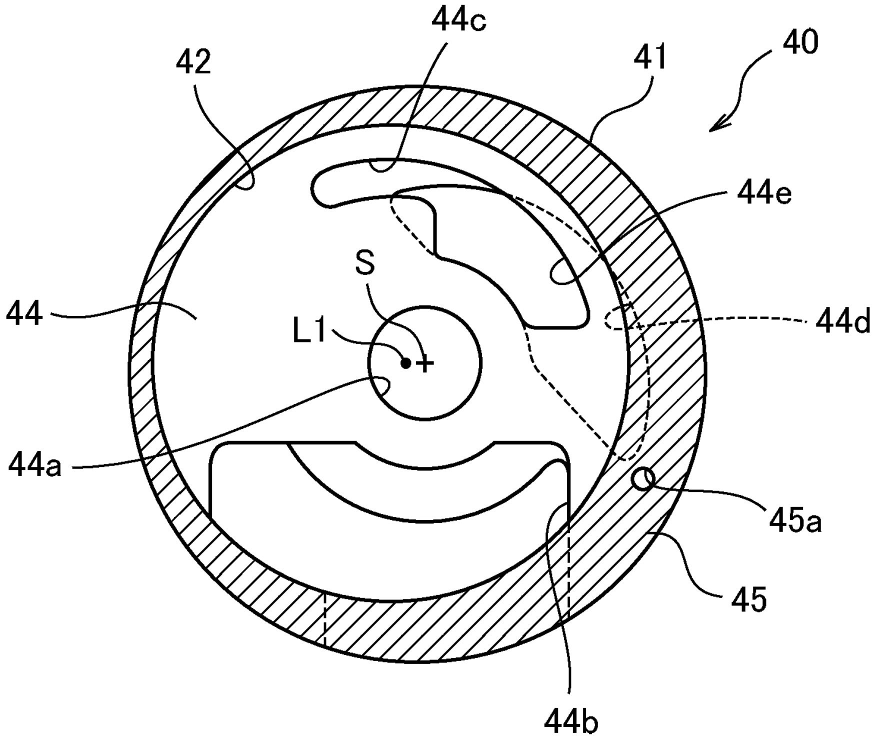


Fig.7A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L1
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44a
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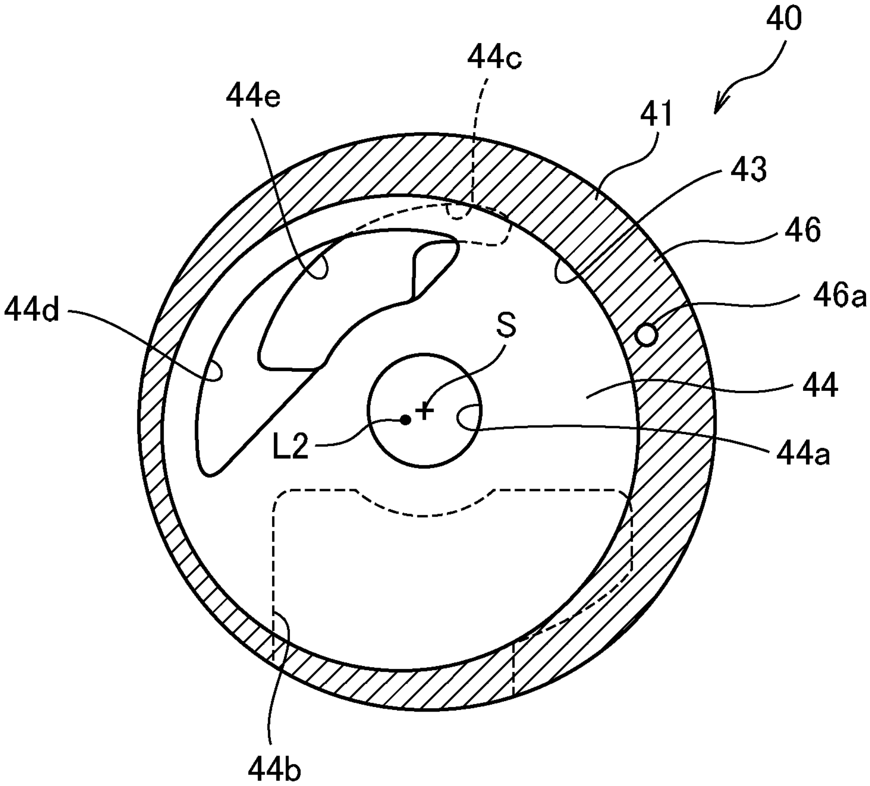
45
44b

Fig.7B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L2
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44b

Fig.8A

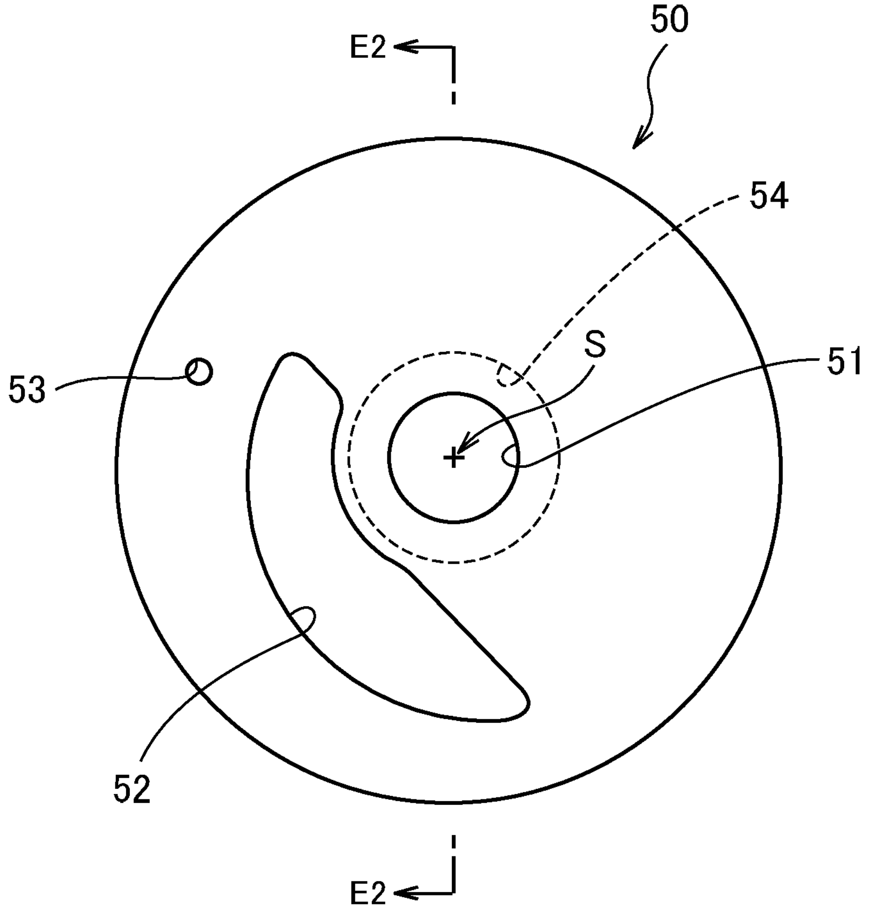


Fig.8B

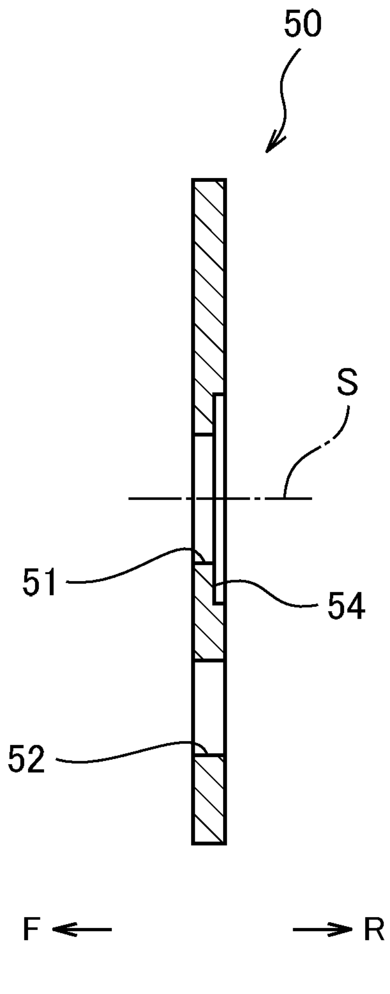


Fig.9A

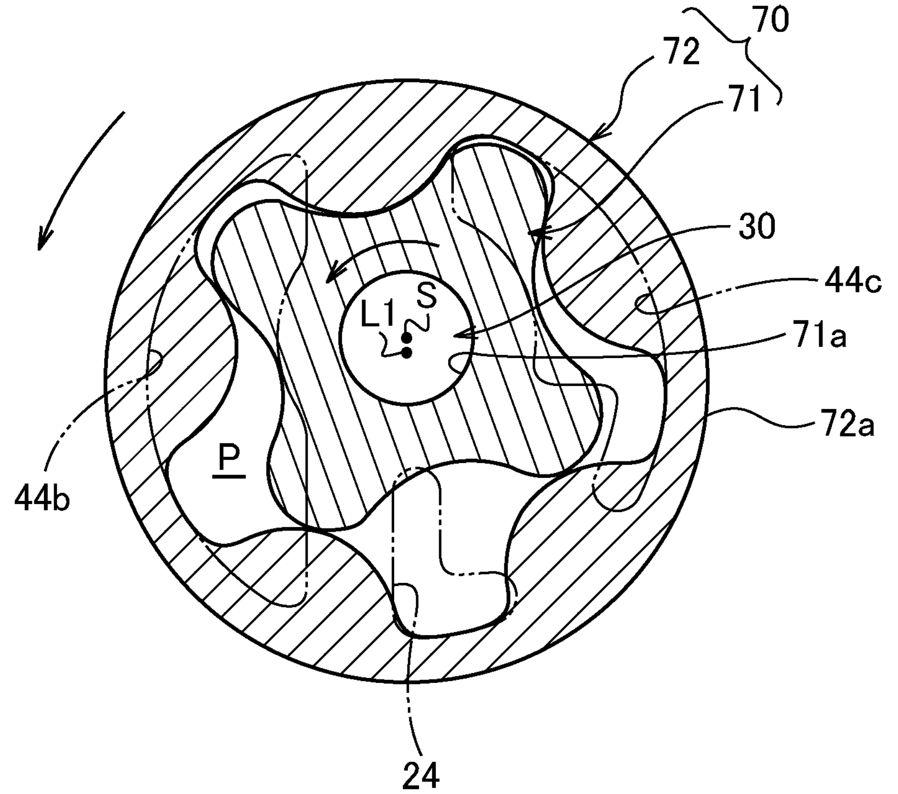


Fig.9B

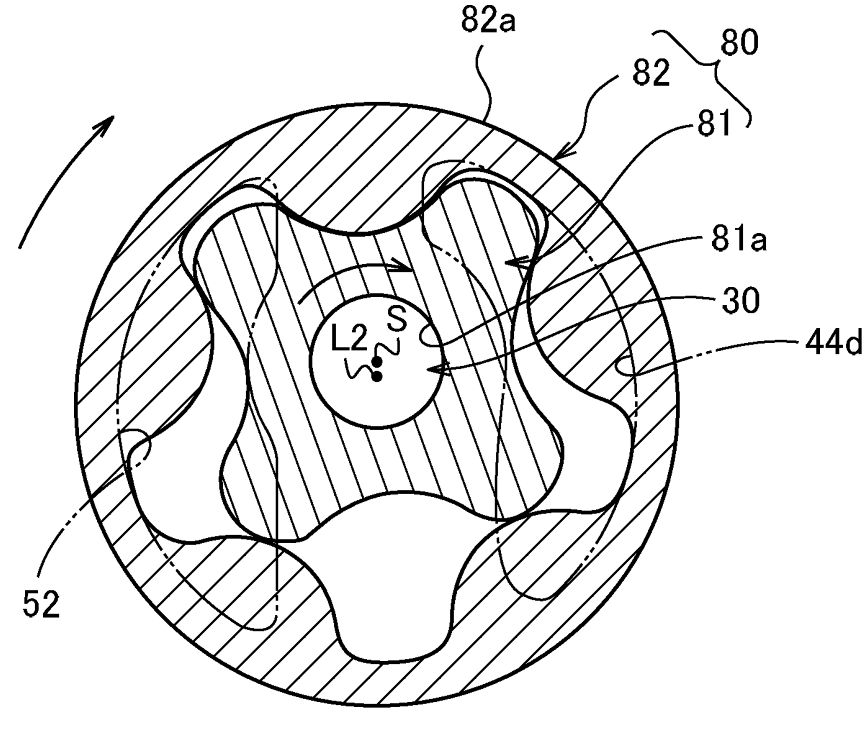


Fig.10

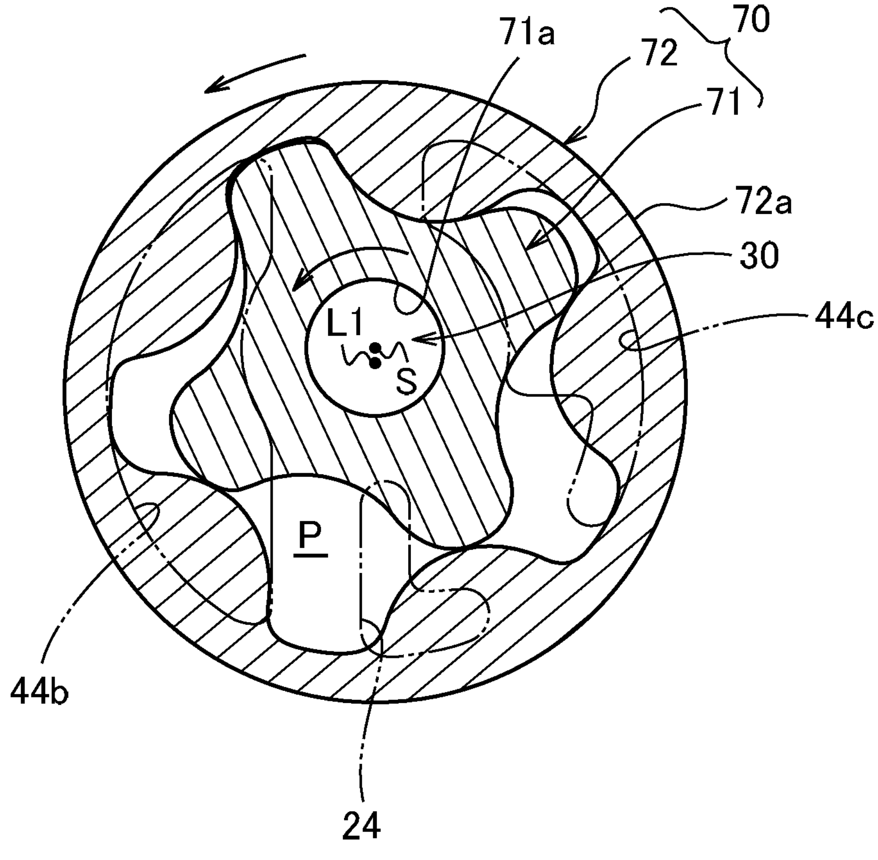
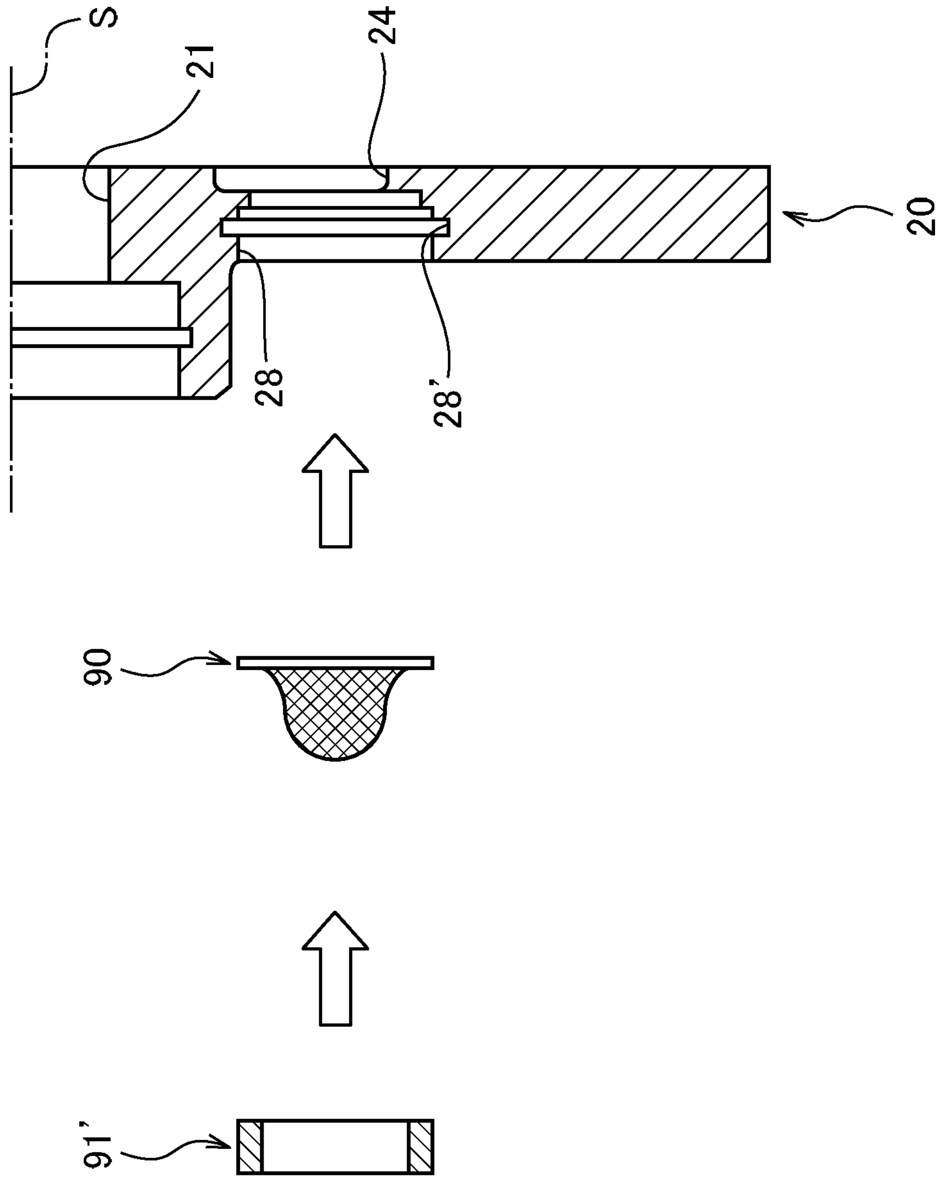


Fig.11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/052131

A. CLASSIFICATION OF SUBJECT MATTER
F04C2/10(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)
F04C2/10

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	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

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.
A	JP 2006-348750 A (Mikuni Corp.), 28 December 2006 (28.12.2006), entire text; all drawings & WO 2005/010369 A1	1-7
A	JP 6-213093 A (Robert Bosch GmbH), 02 August 1994 (02.08.1994), entire text; all drawings & US 5364246 A & DE 4240593 A1	1-7
A	JP 53-30524 B2 (Nippon G Rotor Kabushiki Kaisha), 28 August 1978 (28.08.1978), entire text; all drawings (Family: none)	1-7

☐ 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
23 April, 2013 (23.04.13)	07 May, 2013 (07.05.13)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

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

REFERENCES CITED IN THE DESCRIPTION

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- JP 9203308 A **[0005]**
- JP 6167278 A **[0005]**
- JP 2107738 A **[0005]**
- JP 4065974 A **[0005]**