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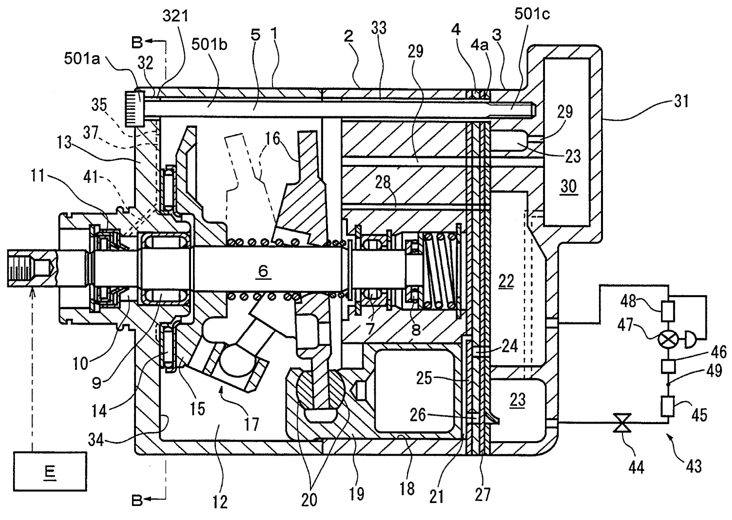
(54) **Lubricating oil feeding mechanism in a swash type compressor**

(57) Lubricating oil feeding mechanism has an oil-collecting recess and an oil-supplying groove formed on the wall of the housing. The oil-collecting recess connects a gap defined between the through hole and the bolt to the oil-supplying groove, the gap being in the upper position with respect to a sliding part to be lubricated in the housing in an operating state of the mounted compressor. The oil-collecting recess extends from the gap in the circumferential direction of the drive shaft, and the oil-supplying groove upwardly extends toward the oil-collecting recess. The oil-supplying groove is arranged so as to guide lubricating oil to the sliding part. Lubricating oil adhered on the bolt can be collected to the oil-collecting recess via the gap, and is fed to the sliding part through the oil-supplying groove. Therefore, a large amount of lubricating oil in a swash plate chamber can be utilized to lubricate the sliding part.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a swash type compressor and, more particularly, to an improved lubricating oil feeding mechanism for such compressors.

2. Description of the Related Art

[0002] In general, swash type compressors with variable or fixed displacement mechanism have a swash plate chamber to arrange a swash plate therein. The compressors also have a bearing for supporting a drive shaft coupled to the swash plate and a shaft seal for preventing refrigerant gas in the swash plate chamber from leaking outside. The bearing and the shaft seal are to be lubricated by lubricating oil contained in refrigerant gas in the swash plate chamber.

[0003] Japanese Utility Model Application Laid-Open Publication No. 57-112082 discloses a swash type compressor having a cylinder block forming cylinder bores and a swash plate chamber therein; a drive shaft rotatably supported on the cylinder block via radial bearings; a swash plate coupled to the drive shaft and arranged in the swash plate chamber; and pistons slidably arranged in the cylinder bores and operatively engaged with the swash plate via shoes in FIGS. 5 and 6 thereof. Further, the compressor, for lubricating the radial bearings, has passages formed on the cylinder block for arranging bolts therein, the passages being used for connection between the swash plate chamber and suction chambers; oil-collecting recesses formed on end faces of the swash plate chamber, the recesses being connected to the passages; and apertures formed in the cylinder block, the apertures being connected to the recesses. In such a compressor, lubricating oil flowing on the end faces is trapped by the recesses and guided to the radial bearing through the apertures.

[0004] Furthermore, Japanese Patent Application Laid-Open Publication No. 2005-171851 discloses a variable displacement swash type compressor having a front housing forming a shaft seal chamber therein; an oil-guiding passage formed on the front housing, the oil-guiding passage including an oil-guiding groove and a recess connected to the oil-guiding groove, the recess having a side wall; a aperture formed in the front housing, the aperture connecting the shaft seal chamber to the oil-guiding groove; a wall formed on the front housing, the wall protruding from the bottom surface of the recess so as to divide the recess into small areas in FIGS. 1 and 2 thereof. In such a compressor, lots of lubricating oil flowing along the front housing inside of the compressor is trapped by the recess and guided to the shaft seal chamber through the oil-guiding groove and the aperture due to the fact that some lubricating oil colliding with the side wall is collected by one area of recess, while the other lubricating oil going beyond the wall is collected by the other area of recess.

[0005] In the conventional arts as mentioned above, some of the solutions are disclosed to conduct lubricating oil in the swash plate chamber toward a sliding part to be lubricated such as the shaft seal or the bearing. These solutions are, however, not sufficient in view of utilizing limited lubricating oil in the swash plate chamber more efficiently to obtain sufficient lubrication of the sliding part in the compressor. In general, lubricating oil in the swash plate chamber is splashed and circulated therein by the rotation of the swash plate during compressor operation. In such a state some amount of lubricating oil adheres to a side wall of the swash plate chamber, and then, flows downwardly along the side wall due to its own weight. The compressors as mentioned above are compressors which have mechanism for the collection of such lubricating oil flowing downwardly along the side wall. In this connection, the inventors have found a particularity of lubricating oil distribution in the swash plate chamber that a large amount of lubricating oil in the swash plate chamber tends to adhere to bolts arranged through the swash plate chamber to fasten each housing elements, due to the fact that it is easy for lubricating oil splashed and circulated by the rotation of the swash plate to collide with the bolts arranged in the area of the circulation of lubricating oil. In the compressors as mentioned above, such the lubricating oil adhered on the bolts cannot positively be used for the lubrication of the sliding part.

SUMMARY OF THE INVENTION

[0006] An object of the present invention is to provide a lubricating oil feeding mechanism in a swash type compressor, which can efficiently conduct a large amount of lubricating oil in the swash plate chamber to the sliding part in the compressor so that the sliding part can become more reliable.

[0007] In accordance with an aspect of the present invention, there is provided a lubricating oil feeding mechanism in a swash type compressor having a housing comprising a plurality of housing elements, in which a swash plate chamber is formed for receiving a swash plate therein, and which defines a cylinder bore therein; a plurality of bolts arranged through the swash plate chamber and in through holes formed on a wall of the housing for fastening the housing elements to form the housing; a drive shaft rotatably supported by the housing, the drive shaft being coupled to the swash plate; a piston accommodated in the cylinder bore so as to define a compression chamber in the cylinder bore, the piston being coupled to the swash plate; and a suction chamber and a discharge chamber formed in the housing respectively, both being connectable to the compression chamber. The lubricating oil feeding mechanism comprises an oil-collecting recess and an oil-supplying groove formed respectively on a side wall surface being defined on the wall of the housing and facing the swash plate chamber. The oil-collecting recess connects a gap defined between the through hole and the bolt to the oil-supplying groove, the gap being in the upper position with respect to a sliding part to be lubricated in the housing in an operating state of the mounted compressor. The oil-collecting recess extends from the gap in the circumferential direction of the drive shaft. The oil-supplying groove extends upwardly toward the oil-collecting recess. The oil-supplying groove is arranged so that oil guided along the oil-supplying groove is led to the sliding part.

[0008] In the aspect of the present invention, lubricating oil adhered on the bolts is collected to the gap defined between the through holes and the bolts due to its own weight. The oil-collecting recess collects not only lubricating oil flowing downwardly on the side wall surface of the housing but also such lubricating oil gathered in the gap, and then feeds the lubricating oil collected therein by the oil-supplying groove. Lubricating oil guided to the oil-supplying groove is, then, led to the sliding part. Therefore, a large amount of lubricating oil in the swash plate chamber can efficiently be conducted to the sliding part of the compressor. Namely, this positive utilization of lubricating oil in the swash plate chamber enables the sliding part to be come more reliable during compressor operation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] Other features and advantages of the invention will be apparent from the following description taken in connection with the accompanying drawing wherein:

FIG. 1 is a longitudinal cross-sectional view, taken along the line A-A of FIG. 2, of a variable displacement compressor to which the present invention is applied, as a first embodiment thereof;
FIG. 2 is a cross-sectional view taken along the line B-B of FIG. 1;
FIG. 3 is a cross-sectional view taken along the line C-C of FIG. 2;
FIG. 4 is a cross-sectional view of a variable displacement compressor showing a second embodiment of the present invention;
FIG. 5 is a cross-sectional view of a variable displacement compressor showing a third embodiment of the present invention;
FIG. 6 is a cross-sectional view of a variable displacement compressor showing a fourth embodiment of the present invention;
FIG. 7A is a partial and schematic view of lubricating oil feeding mechanism showing another embodiment of the present invention.
FIG. 7B is a partial and schematic view of lubricating oil feeding mechanism showing another embodiment of the present invention.
FIG. 7C is a partial and schematic view of lubricating oil feeding mechanism showing another embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0010] Referring to FIGS. 1, 2 and 3, a first embodiment of the present invention is described hereinafter. FIG. 1 shows a variable displacement swash plate type compressor whose housing comprises a front housing 1, a cylinder block 2, a rear housing 3 and a valve plate unit 4 interposed between the cylinder block 2 and the rear housing 3. These housing elements 1, 2, 3 and 4 are fastened together as one body with a plurality(nine) of bolts 5 as shown in FIG. 2. The front housing 1 and the cylinder block 2 define a swash plate chamber 12 as a control chamber therebetween.

[0011] The front housing 1 and cylinder block 2 have a central axial bore formed therein respectively for receiving a drive shaft 6 which is rotatably supported by a pair of radial bearings 7 and 9 provided in the central axial bore, wherein one end of which is further supported by a thrust bearing 8 provided in the central axial bore of the cylinder block 2. Furthermore, in the central axial bore, a shaft seal 11 is disposed between the drive shaft 6 and the front housing 1 in a certain space 10 outside the radial bearing 9 and prevents refrigerant gas in the swash plate chamber 12 from leaking outside. The drive shaft 6 is engaged with engine E as a motor of the vehicle at the other end thereof and can be driven by the engine E.

[0012] There are disposed a lug plate 15 and a swash plate 16 coupled to the lug plate 15 through a hinge mechanism 17 in the swash plate chamber 12. The lug plate 15 is fixed on the drive shaft 6 and is supported on a side wall 13 of the front housing 1 via a thrust bearing 14 provided therebetween. The swash plate 16 is supported on the drive shaft 6 slidably and movably in the direction along the axis thereof and is connected to the hinge mechanism 17 to be allowed to incline with respect to the axis of drive shaft 6. Therefore, the swash plate 16 rotates together with the lug plate 15 when the drive shaft 6 rotates, while the inclination of the swash plate 16 changes in accordance with the pressure control of the swash plate chamber 12. It is here noted that each of the radial bearings 7 and 9, the thrust bearings 8 and 14, and the shaft seal 11 represents a sliding part in accordance with the definition of the present invention.

[0013] As can be seen from FIG. 2, the cylinder block 2 has nine cylinder bores 18 formed therein. The same number of single headed pistons 19 is slidably accommodated in the cylinder bores 18 respectively. Each piston 19 is engaged with the swash plate 16 at the outside thereof via a pair of shoes 20. Therefore, the rotation motion of the drive shaft 6 is converted into the reciprocation motion of pistons 19 through the swash plate 16 and the shoes 20.

[0014] A compression chamber 21 is defined in the cylinder bore 18 on the right side of FIG. 1 in association with piston 19 and the valve plate unit 4. There are provided a suction chamber 22 as a suction pressure region and a discharge chamber 23 as a discharge pressure region respectively in the rear housing 3.

[0015] As each piston 19 moves from the top dead center to the bottom dead center in the associated cylinder bore 18, the refrigerant gas in the suction chamber 22 is sucked up into the compression chamber 21 through an associated suction port 24 formed on the valve plate unit 4, causing an associated suction valve 25 disposed in the valve plate unit 4 to flex to an open position. Further, as each piston 19 moves from the bottom dead center to the top dead center in the associated cylinder bore 18, the refrigerant gas in the compression chamber 21 is compressed to a certain pressure level and is discharged out into the discharge chamber 23 through an associated discharge port 26 formed on the valve plate unit 4, causing an associated discharge valve 27 disposed in the valve plate unit 4 to flex to an open position.

[0016] The suction chamber 22 is connected with the swash plate chamber 12 by a release passage 28 which is formed in the cylinder block 2 and the valve plate unit 4. The discharge chamber 23 is connected with the swash plate chamber 12 by a supply passage 29 which is formed in the cylinder block 2, the valve plate unit 4 and the rear housing 3. The supply passage 29 is regulated by a displacement control device 31 including a control valve 30, which is accommodated in the rear housing 3.

[0017] Therefore, the pressure in the swash plate chamber 12 can be controlled by the control valve 30. When the control valve 30 opens the supply passage 29, the refrigerant gas in the discharge chamber 23 is permitted to flow into the swash plate chamber 12 via the supply passage 29 and to make the pressure in the swash plate chamber 12 be high. On the other hand, when the control valve 30 closes the supply passage 29, the refrigerant gas in the discharge chamber 23 is not permitted to flow into the swash plate chamber 12 via the supply passage 29. Thus, the refrigerant gas in the swash plate chamber 12 flows out to the suction chamber 22. This makes the pressure in the swash plate chamber 12 be low. The inclination of the swash plate 16 is determined by the pressure difference between the pressure in the swash plate chamber 12 and the pressure in the compression chamber 21. Therefore, the displacement of the compressor can be controlled based on the inclination of swash plate 16.

[0018] As shown in FIG. 1, when the pressure in the swash plate chamber 12 is relatively low, the swash plate 16 can be at a maximum inclination angle as indicated by a double dotted line in the state that the swash plate 16 abuts on the lug plate 15. On the other hand, when the pressure in the swash plate chamber 12 is relatively high, the swash plate 16 can be at a minimum inclination angle as indicated by a solid line.

[0019] As shown in FIG. 1, the bolt 5 has a head portion 501a, a shank portion 501b, and a threaded end portion 501c. The head portion 501a is sealingly engaged with the front housing 1, while the threaded end portion 501c is threaded into a threaded bore formed in the rear housing 3. The shank portion 501b is arranged so as to extend through a first bore 32 as a through hole which is formed in the front housing 1, the swash plate chamber 12, a second bore 33 as the through hole which is formed in the cylinder block 2, and a third bore 4a which is formed in the valve plate unit 4. As can be seen from FIG. 2, each through hole is arranged to be in between the cylinder bores 18. The first bore 32 has a diameter wider than the diameter of the shank portion 501b such that a gap 321 is defined therebetween. In this preferred embodiment, although the gap 321 is defined by the shank portion 501b and the first bore 32the gap 321 may be defined between the shank portion 501b and a first bore having a different shape from the first bore 32. In addition, a first bore may be shaped into other cross-sectional configurations than circular cross-sectional configurations.

[0020] As shown in FIGS. 2 and 3, the side wall 13 has a side wall surface 34 which faces the swash plate chamber 12. Oil-collecting recesses 35, 36 and oil-supplying grooves 37, 38 are formed on the side wall surface 34. The oil-collecting recess 35 is connected with a gap 321a defined by the shank portion 501b of the bolt 5a, while the oil-collecting recess 36 is connected with a gap 321b defined by the shank portion 501b of the bolt 5b which is adjacent to the bolt 5a and at a backward position in the rotational direction of the drive shaft 6 with respect to the bolt 5a. These gaps 321a, 321b are in the upper position with respect to the shaft seal 11 as the sliding part to be lubricated in the housing in an operating state of the compressor mounted on the vehicle.

[0021] The oil-collecting recess 35 is formed so as to have an arched shape and extends from the gap 321a in the rotational direction of the drive shaft 6 as indicated by an arrow shown in FIG. 2. A sub oil-collecting recess 39 is formed on the side wall surface 34 and is connected with the gap 321a in the opposite side of the oil-collecting recess 35 with respect to the gap 321a. The sub oil-collecting recess 39 is formed so as to have an arched shape and extends, with a relatively short length as compared with the oil-collecting recess 35, from the gap 321a in the opposite direction of the rotational direction of the drive shaft 6.

[0022] On the other hand, the oil-collecting recess 36 is formed so as to have an arched shape and extends from the gap 321b in the opposite direction of the rotational direction of the drive shaft 6. A sub oil-collecting recess 40 is formed on the side wall surface 34 and is connected with the gap 321b in the opposite side of the oil-collecting recess 36 with respect to the gap 321b. The sub oil-collecting recess 40 is formed so as to have an arched shape and extends, with a relatively short length as compared with the oil-collecting recess 36, from the gap 321b in the rotational direction of the drive shaft 6. Further, the oil-collecting recesses 35, 36 and the sub oil-collecting recesses 39, 40 extend so that their width is substantially the same as the diameter of the first bore

32 along the longitudinal direction thereof.

[0023] The oil-supplying groove 37 extends in the radial direction of the drive shaft 6 and is, at the top end thereof, connected to a forward position of the oil-collecting recess 35 in the rotation direction of the drive shaft 6. As can be seen in FIG. 3, the oil-supplying groove 37 is formed deeper than the oil-collecting recess 35 to promote oil flow from the oil-collecting recess 35 to the oil-supplying groove 37. On the other hand, the oil-supplying groove 38 extends in the radial direction of the drive shaft 6 and is, at the top end thereof, connected to a backward position of the oil-collecting recess 36 in the rotation direction of the drive shaft 6. Likewise, the oil-supplying groove 38 is formed deeper than the oil-collecting recess 36 to promote oil flow from the oil-collecting recess 36 to the oil-supplying groove 38. As shown in FIGS. 1 and 2, the side wall 13 has oil-supplying apertures 41, 42 which connect the swash plate chamber 12 to the certain space 10. The oil-supplying groove 37, 38 are, at the bottom thereof, connected with the oil-supplying apertures 41, 42 respectively so that lubricating oil guided along the oil-supplying grooves 37, 38 and the oil-supplying apertures 41, 42 is led to the radial bearing 9 and the shaft seal 11 defined as the sliding part.

[0024] As shown in FIG. 1, there is provided a refrigerant circuit 43 incorporating the above-mentioned compressor in vehicle air conditioners. It is here noted that the refrigerant gas such as a natural refrigerant gas like CO_2 gas (carbon dioxide) or freon gas is used in the compressor. The refrigerant circuit 43 has, in turn, a gas pressure reducing valve 44 connected to the discharge chamber 23, a condenser 45, a receiver 46, an expansion valve 47, and an evaporator 48 connected to the suction chamber 22. There is provided a pressure sensor 49 in a conduit between the condenser 45 and the receiver 46. The pressure sensor 49 detects the pressure in the conduit and issues signals relating to the detected pressure to a controller (not shown). The controller is also connected to the displacement control device 31 and controls it.

[0025] The operation of the compressor having the lubricating oil feeding mechanism will now be described.

[0026] When the drive shaft 6 of the compressor is rotated by the engine E, the swash plate 16 is also rotated for receiving rotational power of the drive shaft 6 through the lug plate 15 and the hinge mechanism 17. Rotation of the swash plate 16 gets each of the piston 19 to be reciprocated in the cylinder bore 18 so that refrigerant gas in the suction chamber 22 is sucked into the compression chamber 21, and then refrigerant gas in the compression chamber 21 is compressed and is discharged into the discharge chamber 23.

[0027] The hinge mechanism 17 serves as an agitator so as to agitate or splash lubricating oil contained in refrigerant gas in the swash plate chamber 12 while the swash plate 16 is rotating because the hinge mechanism 17 corresponds to a portion which partially protrudes from the lug plate 15 and the swash plate 16. When the swash plate 16 is rotated, the hinge mechanism 17 makes lubricating oil stayed in/under the swash plate chamber 12 be circulated therein. By that agitation, some amount of the circulated lubricating oil in the swash plate chamber 12 adheres to the side wall 13, an inner peripheral surface of the swash plate chamber 12 and an end face of the cylinder block 2.

[0028] On the other hand, however, a large amount of lubricating oil in the swash plate chamber 12 tends to adhere on the bolts 5 arranged through the swash plate chamber 12, due to the fact that it is easy for lubricating oil splashed and circulated by the rotation of the hinge mechanism 17 to collide with the bolts 5 as an obstacle in the direction of the circulation of lubricating oil. The lubricating oil adhered on the bolts 5 largely drops downwardly toward the bottom of the swash plate chamber 12 directly due to its own weight. The lubricating oil adhered on the bolt 5, a position of which is located near the side wall, tends to drop into the gap 321 due to surface tension.

[0029] Lubricating oil gathered in the gaps 321a, 321b flows by its own weight and is led to the oil-collecting recesses 35, 36. Besides, lubricating oil adhered on the side wall surface 34 of the side wall 13 flows downwardly by its own weight and a part of that is collected by the oil-collecting recesses 35, 36, the sub oil-collecting recesses 39, 40 and oil-supplying grooves 37, 38 efficiently due to their configuration. Here, lubricating oil gathered in the sub oil-collecting recesses 39, 40 is led to the oil-collecting recesses 35, 36 through the gaps 321a, 321b respectively. After being collected into the oil-collecting recesses 35, 36, lubricating oil flows in the circumferential direction of the drive shaft 6 along the oil-collecting recesses 35, 36 by its own weight. The oil-supplying grooves 37, 38 are formed further deeper than the oil-collecting recesses 35, 36 whereby feeding lubricating oil from the oil-collecting recesses 35, 36 to the oil-supplying groove 37, 38 can be ensured.

[0030] In addition, the revolution of the hinge mechanism 17 with the rotation of the swash plate 16 makes not only lubricating oil in the swash plate chamber 12 be splashed or be circulated but also lubricating oil adhere on the side wall surface 34, in the oil-collecting recesses 35, 36, and in the sub oil-collecting recesses 39, 40 as well as lubricating oil gathered in the gap 321a, 321b flow in the rotational direction of the drive shaft 6 by gas streams accompanied with the circulation of lubricating oil in the swash plate chamber 12. For this reason, lubricating oil adhered on the side wall surface 34 and gathered in the gaps 321a, 321b can easily be collected in the oil-collecting recesses 35, 36 and the sub oil-collecting recesses 39, 40. Especially, when the drive shaft 6 is rotated in the direction as indicated by the arrow shown in FIG. 2, lubricating oil in the oil-collecting recess 35 and lubricating oil below the oil-collecting recess 35 can easily be fed to the oil-supplying groove 37 as compared with that in the oil-collecting recess 36. In contrast to that, in case where the drive shaft 6 is rotated in the opposite direction of the rotational direction as indicated by the arrow shown in FIG. 2, lubricating oil in the oil-collecting recess 36 and lubricating oil below the oil-collecting recess 36 can easily be fed to the oil-supplying groove 38 as compared with that in the oil-collecting recess 35.

[0031] Lubricating oil supplied in the oil-supplying grooves 37, 38 are further guided to the certain space 10 through the oil-supplying apertures 41, 42 so that the certain space 10 can be filled with a large amount of lubricating oil. Therefore, the shaft seal 11 can sufficiently be lubricated. Also, the radial bearing 9 can sufficiently be lubricated. This makes the sliding part such as the shaft seal 11 and the radial bearing 9 much more durable.

[0032] The first embodiment of the present invention has the following advantages.

[0033] The oil-collecting recesses 35, 36 is connected with the gap 321a, 321b so that lubricating oil collided with the bolts 5 in the route of the circulation of lubricating oil caused by the revolution of the hinge mechanism 17, a portion of which is located near the gap 321a, 321b can effectively be collected into the oil-collecting recesses 35, 36. Therefore, such the lubricating oil adhered on the bolts 5 can positively be utilized for lubrication of the sliding part.

[0034] The oil-collecting recesses 35, 36 are arranged extending in the circumferential direction of the drive shaft 6. Therefore, lubricating oil gathered in the gaps 321a, 321b and adhered on the side wall surface 34 can efficiently be collected by the oil-collecting recesses 35, 36. As a result, lubrication for the sliding part can be ensured.

[0035] The oil-supplying groove 37 is connected to the oil-collecting recess 35 at the forward position in the rotational direction of the drive shaft 6 with respect to the gap 321a. Due to the revolution of the hinge mechanism 17 with the rotation of the swash plate 16, lubricating oil flows in the rotational direction of the drive shaft 6 led by gas streams accompanied with the circulation of lubricating oil in the swash plate chamber 12, thus, lubricating oil in the oil-collecting recess 35 and lubricating oil below the oil-collecting recess 35 can more easily be fed to the oil-supplying groove 37.

[0036] While the oil-collecting recess 35 is arranged extending downwardly from the gap 321a in the rotational direction of the drive shaft 6, the oil-collecting recess 36 is arranged extending downwardly from the gap 321b in the opposite direction of the rotational direction of the drive shaft 6. Therefore, lubricating oil collecting ability of the bolts 5 can be ensured due to the own weight of lubricating oil.

[0037] The lubricating oil feeding mechanism comprising the oil-collecting recesses 35, 36 and the oil-supplying grooves 37, 38 can easily be provided due to the fact that a recess and a groove have only to be formed on the side wall 13.

[0038] The present invention may be alternatively embodied in the following forms:

[0039] FIG. 4 shows a lubricating oil feeding mechanism according to a second embodiment. In the second embodiment, component parts and elements corresponding to those of the above first embodiment are indicated by identical reference numerals, and a description thereof is omitted. There is provided an oil-collecting recess 50 formed on the side wall 13, the oil-collecting recess 50 extending from the gap 321a in the rotational direction of the drive shaft 6. The oil-collecting recess 50 has a connection groove 51 as a part thereof, the connection groove 51 connecting the gap 321a to the rest of the oil-collecting recess 50. The width of the connection groove 51 is arranged narrower than the diameter of the first bore 32 as well as the width of the rest of the oil-collecting recess 50 in view of the radial direction of the drive shaft 6. There are also provided an oil-supplying groove 52 and an oil-supplying aperture 53 on the side wall 13. The oil-supplying groove 52 is connected to the oil-collecting recess 50 at approximately the middle point thereof. The oil-supplying aperture 53 connects the oil-supplying groove 52 to the certain space 10 shown in FIG. 1.

[0040] Since stress concentration is likely to take place around the first bore 32 under strong fastening power by the bolts 5, in this case, it may be difficult in view of the strength required for the front housing 1 that an oil-collecting recess 50 is formed being connected to all around the circumference of the first bore 32 with a cutting process. According to the second embodiment, however, the connection groove 51 connected with the first bore 32 is arranged narrower than the diameter of the first bore 32. Therefore, the stress concentration to be generated around the first bore 32 can be reduced.

[0041] FIG. 5 shows a lubricating oil feeding mechanism according to a third embodiment. In the third embodiment, component parts and elements corresponding to those of the above first embodiment are indicated by identical reference numerals, and a description thereof is omitted. What is different from the first embodiment is that a sub oil-collecting recess 54 extends over two of the gaps 321a, 321b to connect the gap 321a to the gap 321b. The sub oil-collecting recess 54 extends from the gap 321a in the opposite direction of the extending direction of the oil-collecting recess 35 with respect to the gap 321a. According to the third embodiment, since the length of the sub oil-collecting recess 54 becomes long, lubricating oil collecting ability on the side wall surface 34 can be enhanced.

[0042] FIG. 6 shows a lubricating oil feeding mechanism according to a fourth embodiment. In the fourth embodiment, component parts and elements corresponding to those of the above first embodiment are indicated by identical reference numerals, and a description thereof is omitted. There is provided an oil-collecting recess 55 extending from a gap 321c defined by the first bore 32 and the shank portion 501b of the bolt 5c in the rotational direction of the drive shaft 6, the gap 321c being adjacent to the gap 321a and being in the upper position with respect to the shaft seal 11 as the sliding part to be lubricated in the housing in an operating state of the mounted compressor. There are further provided a first sub oil-collecting recess 56 and a second sub oil-collecting recess 57 on the side wall 13. The first sub oil-collecting recess 56 extends over two of the gaps 321a, 321c to connect the gap 321a to the gap 321c, and has an arched shape. The second sub oil-collecting recess 57 extends from the gap 321a in the opposite direction of the rotation of the drive shaft 6. There is provided an oil-supplying groove 58 which connects the oil-collecting recess 55 to the oil-supplying aperture 41. The oil-supplying groove 58 is arranged to be connected with the oil-supplying recess 55 at a forward position thereof in the rotational direction of the drive shaft 6.

[0043] According to the fourth embodiment, lubricating oil adhered on the bolt 5a flows to the first sub oil-collecting recess 56 through the gap 321a. Also, lubricating oil adhered on the bolt 5c flows to the oil-collecting recess 55 through the gap 321c together with lubricating oil flowing in the first sub oil-collecting recess 56. On the other hand, the second sub oil-collecting recess 57 collects lubricating oil adhering on the side wall surface 34 and guides the lubricating oil to the oil-collecting recess 55 through the gap 321a, the first sub oil-collecting recess 56 and the gap 321c in turn. The oil-collecting recess 55 as well as the first sub oil-collecting 56 can collect lubricating oil adhering on the side wall surface 34 as same as in the first embodiment described above.

[0044] Lubricating oil collected in the oil-collecting recess 55 is guided along the oil-supplying groove 58 and is led to the certain space 10 shown in FIG. 1 through the oil-supplying aperture 41. Since the first sub oil-collecting recess 56 is arranged over the gaps 321a, 321c, therefore, the lubricating oil collecting ability can be improved. Furthermore, since lubricating oil collected in the oil-collecting recess 55 can be guided by the oil-supplying groove 58 only, lubricating oil feeding mechanism can further be simplified.

[0045] The present invention may further be embodied in the following forms:

[0046] FIGS. 7A, 7B and 7C show some other lubricating oil feeding mechanism than those described above, in that the relationship between an oil-collecting recess and an oil-supplying groove is modified. In the modification described below, component parts and elements corresponding to those of the above first embodiment are indicated by identical reference numerals, and description thereof is omitted.

[0047] FIG. 7A shows an oil-collecting recess 59 extending from the gap 321a not only in the rotational direction of the drive shaft 6 shown in FIG. 1 but also downwardly in the radial direction of the drive shaft 6 so as to be sloped with respect to an oil-supplying groove 60. Furthermore, the oil-collecting recess 59 extends so that its width is substantially the same as the diameter of the first bore 32 along the longitudinal direction of the oil-collecting recess 59. In addition, the oil-collecting recess 59 is formed so that its depth is substantially the same as that of the oil-supplying groove 60. The oil-supplying groove 60 is, at the middle point thereof, connected with the oil-collecting recess 59.

[0048] FIG. 7B shows an oil-collecting recess 61 extending from the gap 321a and spreading over at the point of the connection between the oil-collecting recess 61 and an oil-supplying groove 64. The oil-collecting recess 61 has an upper wall 62 and a lower wall 63, the upper wall 62 being formed straight and being connected to an upper wall of the oil-supplying groove 64, and the lower wall 63 being formed away from the upper wall 62 as closing with the oil-supplying groove 64.

[0049] FIG. 7C shows an oil-collecting recess 65 extending from the gap 321a in the rotational direction of the drive shaft 6 shown in FIG. 1 and being formed bent downwardly in the radial direction of the drive shaft 6. There is provided an oil-supplying groove 66 extending to a forward position of the oil-collecting recess 65 in the radial direction of the drive shaft 6.

[0050] In addition, it is possible to omit the sub oil-collecting recesses 39, 40 in the first embodiment, and also possible to omit the sub oil-collecting recess 57 in the fourth embodiment.

[0051] In the first embodiment, the oil-supplying grooves 37, 38 may be connected to the oil-collecting recesses 35, 36 at approximately the middle point thereof respectively.

[0052] In the first embodiment, it is not necessarily required to make the oil-supplying grooves 37, 38 deeper than the oil-collecting recesses 35, 36. it may be implemented that both of the grooves 37, 38 and recesses 35, 36 have the same depth.

[0053] In the fourth embodiment, in addition to the lubricating oil feeding mechanism described before, a first sub oil-collecting recess connects the gap 321b to a gap 321d which is in the upper position with respect to the shaft seal 11 as sliding part to be lubricated in the housing in an operating state of the mounted compressor. Also, a second sub oil-collecting recess is connected to the gap 321b, and an oil-collecting recess is connected to the gap 321d, the oil-collecting recess being connected to an oil-supplying groove. Although both of those mechanism are adopted together so as to collect lubricating oil gathered in the gaps 321a, 321b, 321c and 321d, only one of the described mechanism might be used to improve the lubricativity.

[0054] In the fourth embodiment, the oil-supplying groove 58 is connected to the sub oil-collecting recess 56. In this embodiment, the sub oil-collecting recess 56 represents an oil-collecting recess, and the oil-collecting recess 55 represents a sub oil-collecting recess.

[0055] In each embodiment described above, the shape of each oil-collecting recess 35, 36, 50 and 55, each sub oil-collecting recess 39, 40, 54 and 56, and the connection groove 51 is formed arched. It may, however, be possible to form each recess and the groove mentioned above to a straight shape or a wave shape.

[0056] The present invention may be embodied in compressors other than the compressors of FIG. 1. For example, the present invention may be embodied in fixed displacement swash type compressor, double-headed piston swash type compressor.

[0057] Finally, it will be understood by those skilled in the art that the foregoing description is of preferred embodiments of the disclosed invention, and that various changes and modifications may be made to the present invention without departing from the spirit and scope thereof.

[0058] Lubricating oil feeding mechanism has an oil-collecting recess and an oil-supplying groove formed on the wall of the housing. The oil-collecting recess connects a gap defined between the through hole and the bolt to the oil-supplying groove, the gap being in the upper position with respect to a sliding part to be lubricated in the housing in an operating state of the mounted compressor. The oil-collecting recess extends from the gap in the circumferential direction of the drive shaft, and the oil-supplying groove upwardly extends toward the oil-collecting recess. The oil-supplying groove is arranged so as to guide lubricating oil to the sliding part. Lubricating oil adhered on the bolt can be collected to the oil-collecting recess via the gap, and is fed to the sliding part through the oil-supplying groove. Therefore, a large amount of lubricating oil in a swash plate chamber can be utilized to lubricate the sliding part.

Claims

1. Lubricating oil feeding mechanism in a swash type compressor having:

    a housing comprising a plurality of housing elements (1, 2, 3, 4), in which a swash plate chamber (12) is formed for receiving a swash plate (16) therein, and which defines a cylinder bore (18) therein;
    a plurality of bolts (5, 5a, 5b) arranged through the swash plate chamber (12) and in through holes (32, 33) formed on a wall (13) of the housing for fastening the housing elements (1, 2, 3, 4) to form the housing;
    a drive shaft (6) rotatably supported by the housing (1, 2), the drive shaft (6) being coupled to the swash plate (16);
    a piston (19) accommodated in the cylinder bore (18) so as to define a compression chamber (21) in the cylinder bore (18), the piston (19) being coupled to the swash plate (16); and
    a suction chamber (22) and a discharge chamber (23) formed in the housing respectively, both being connectable to the compression chamber (21);

    characterized in that the lubricating oil feeding mechanism comprising an oil-collecting recess (35, 36, 50, 55, 59, 61, 65) and an oil-supplying groove (37, 38, 52, 58, 60, 64, 66) formed respectively on a side wall surface (34) being defined on the wall (13) of the housing and facing the swash plate chamber (12),
    and **in that** the oil-collecting recess (35, 36, 50, 55, 59, 61, 65) connects a gap (321a, 321b, 321c, 321d) defined between the through hole (32, 33) and the bolt (5, 5a, 5b) to the oil-supplying groove (37, 38, 52, 58, 60, 64, 66), the gap (321a, 321b, 321c, 321d) being in the upper position with respect to a sliding part (9, 11) to be lubricated in the housing in an operating state of the mounted compressor,
    wherein the oil-collecting recess (35, 36, 50, 55, 59, 61, 65) extends from the gap (321a, 321b, 321c, 321d) in the circumferential direction of the drive shaft (6), and wherein the oil-supplying groove (37, 38, 52, 58, 60, 64, 66) extends upwardly toward the oil-collecting recess (35, 36, 50, 55, 59, 61, 65),
    and **in that** the oil-supplying groove (37, 38, 52, 58, 60, 64, 66) is arranged so that oil guided along the oil-supplying groove (37, 38, 52, 58, 60, 64, 66) is led to the sliding part (9, 11).

2. Lubricating oil feeding mechanism according to claim 1, wherein the oil-collecting recess extends (35, 50, 55, 59, 61, 65) from the gap (321a, 321c) in the rotational direction of the drive shaft (6).

3. Lubricating oil feeding mechanism according to claim 1, wherein the oil-collecting recess (36) extends from the gap (321b) in the opposite direction of the rotational direction of the drive shaft (6).

4. Lubricating oil feeding mechanism according to one of claims 1 to 3, wherein the oil-collecting recess (50) has a connection groove (51) as a part thereof, the connection groove (51) connecting the gap (321a) to the rest of the oil-collecting recess (50),
    wherein the width of the connection groove (51) is narrower than the diameter of the through hole (32).

5. Lubricating oil feeding mechanism according to one of claims 1 to 4, wherein the oil-collecting recess (59, 61, 65) further extends downwardly from the through hole (32) in an operating state of the mounted compressor.

6. Lubricating oil feeding mechanism according to one of claims 1 to 4, wherein the oil-collecting recess (35, 36, 55, 59, 65) extends so that the width of the oil-collecting recess is substantially the same as the diameter of the through hole (32) along the longitudinal direction of the oil-collecting recess (35, 36, 55, 59, 65).

7. Lubricating oil feeding mechanism according to one of claims 1 to 6, further comprising a sub oil-collecting recess (39, 40, 54, 56) extending from the gap (321a,

321b, 321c) in the opposite direction of the extending direction of the oil-collecting recess (35, 36, 55) with respect to the gap (321a, 321b, 321c) from which the oil-collecting recess (35, 36, 55) extends.

8. Lubricating oil feeding mechanism according to claim 7,
wherein the sub oil-collecting recess (56) extends over two of the gaps (321a, 321c) to connect the gaps (321a, 321c) to each other.

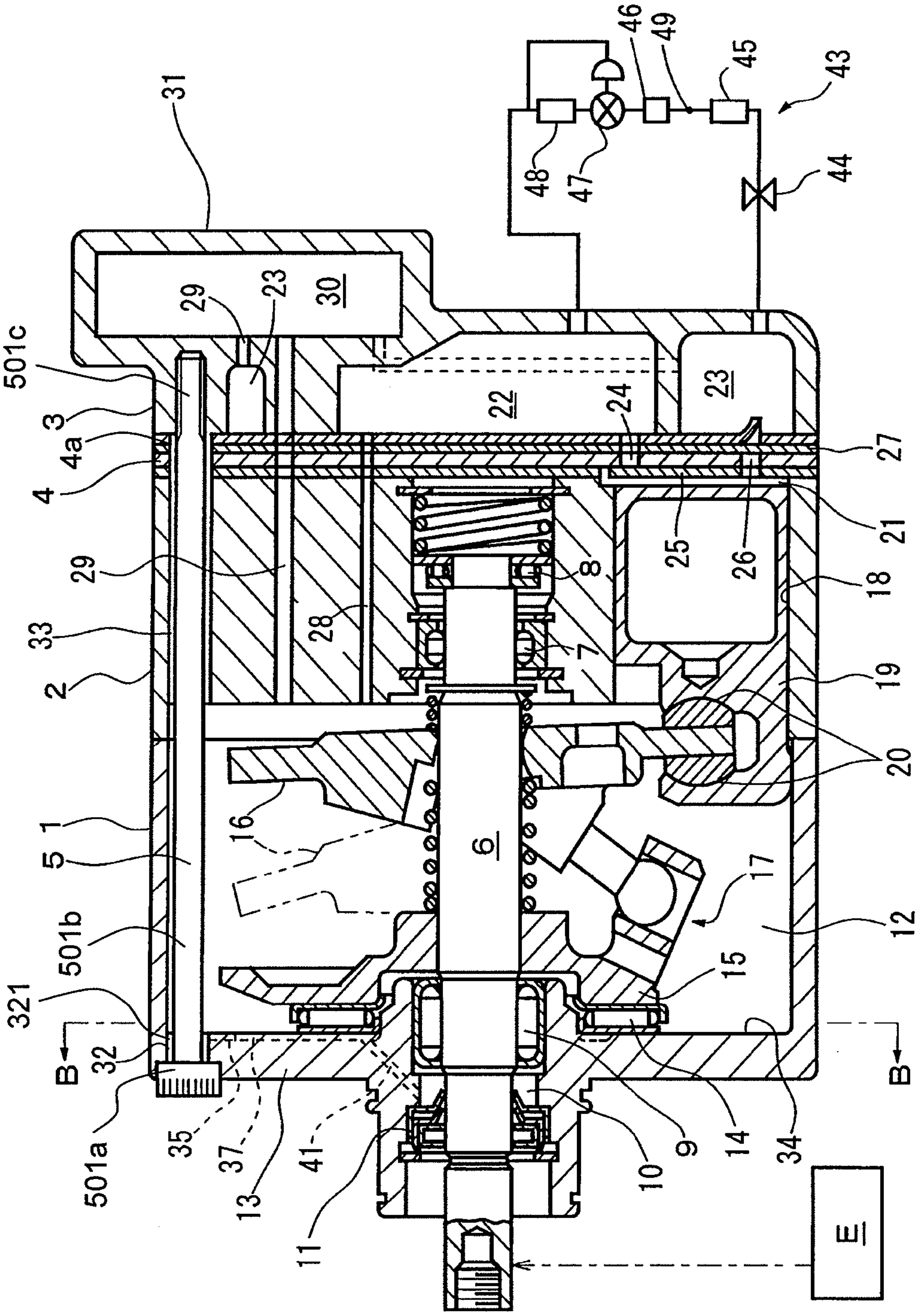
9. Lubricating oil feeding mechanism according to one of claims 1 to 8, wherein the oil-supplying groove (37, 38, 64) is formed deeper than the oil-collecting recess (35, 36, 61) to promote oil flow from the oil-collecting recess (35, 36, 61) to the groove (37, 38, 64).

10. Lubricating oil feeding mechanism according to claim 1,
wherein the oil-collecting recess (35, 36) has a first oil-collecting recess (35) and a second oil-collecting recess (36), the first oil-collecting recess (35) extending from one of the gaps (321a) in the rotational direction of the drive shaft (6), the second oil-collecting recess (36) extending from another one of the gaps (321b) in the opposite direction of the rotational direction of the drive shaft (6),
wherein the oil-supplying groove (37, 38) has a first oil-supplying groove (37) and a second oil-supplying groove (38), the first oil-supplying groove (37) being connected to the first oil-collecting recess (35) at a forward position in the rotational direction of the drive shaft (6) with respect to the gap (321a) connected to the first oil-collecting recess (35), the second oil-supplying groove (38) being connected to the second oil-collecting recess (36) at a backward position in the rotational direction of the drive shaft (6) with respect to the gap (321b) connected to the second oil-collecting recess (36).

11. Lubricating oil feeding mechanism in the swash type compressor according to one of claims 1 to 10, wherein the housing elements (1) include a front housing (1) in which the oil-collecting recess (35, 36, 50, 55, 59, 61, 65) and the oil-supplying groove (37, 38, 52, 58, 60, 64, 66) are formed respectively, wherein the front housing (1) supports the sliding part (9, 11), and
the lubricating oil feeding mechanism includes a oil-supplying aperture (41, 42, 53) formed in the front housing (1),
wherein the oil-supplying aperture (41, 42, 53) is connected to the oil-supplying groove (37, 38, 52, 58, 60, 64, 66) and extends toward the sliding part (9, 11) so that oil guided along the oil-supplying groove (37, 38, 52, 58, 60, 64, 66) and the oil-supplying aperture (41, 42, 53) is led to the sliding part (9, 11).

12. Lubricating oil feeding mechanism in the swash type compressor according to claim 11, the compressor having a shaft seal (11) disposed between the front housing (1) and the drive shaft (6) to prevent refrigerant gas in the swash plate chamber (12) from leaking outside;
wherein the sliding part (11) is the shaft seal (11).

FIG. 1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33
2
19
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16
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6
17
12
501b
321
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11
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9
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34
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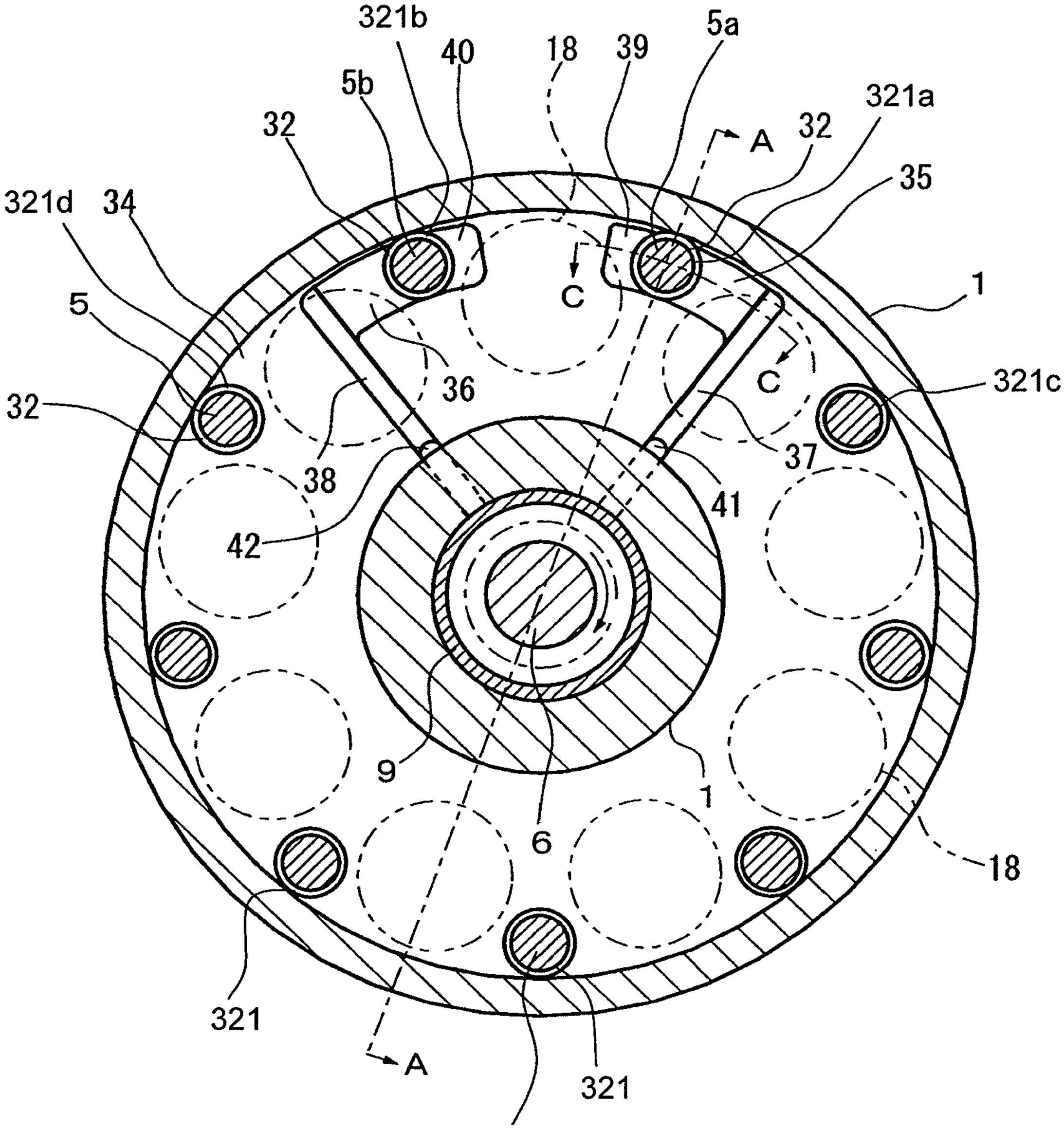
E

FIG. 2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1
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18
321
A
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5

FIG. 3

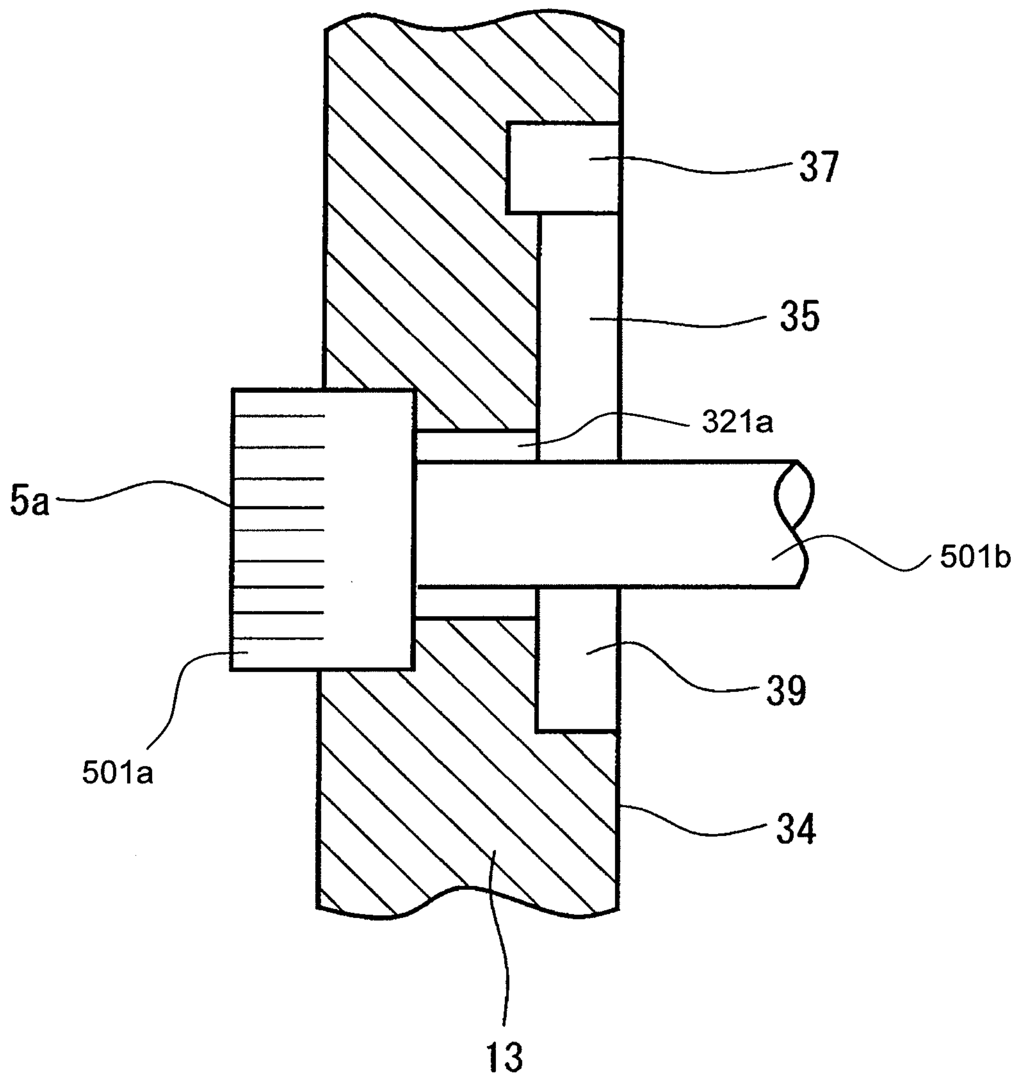
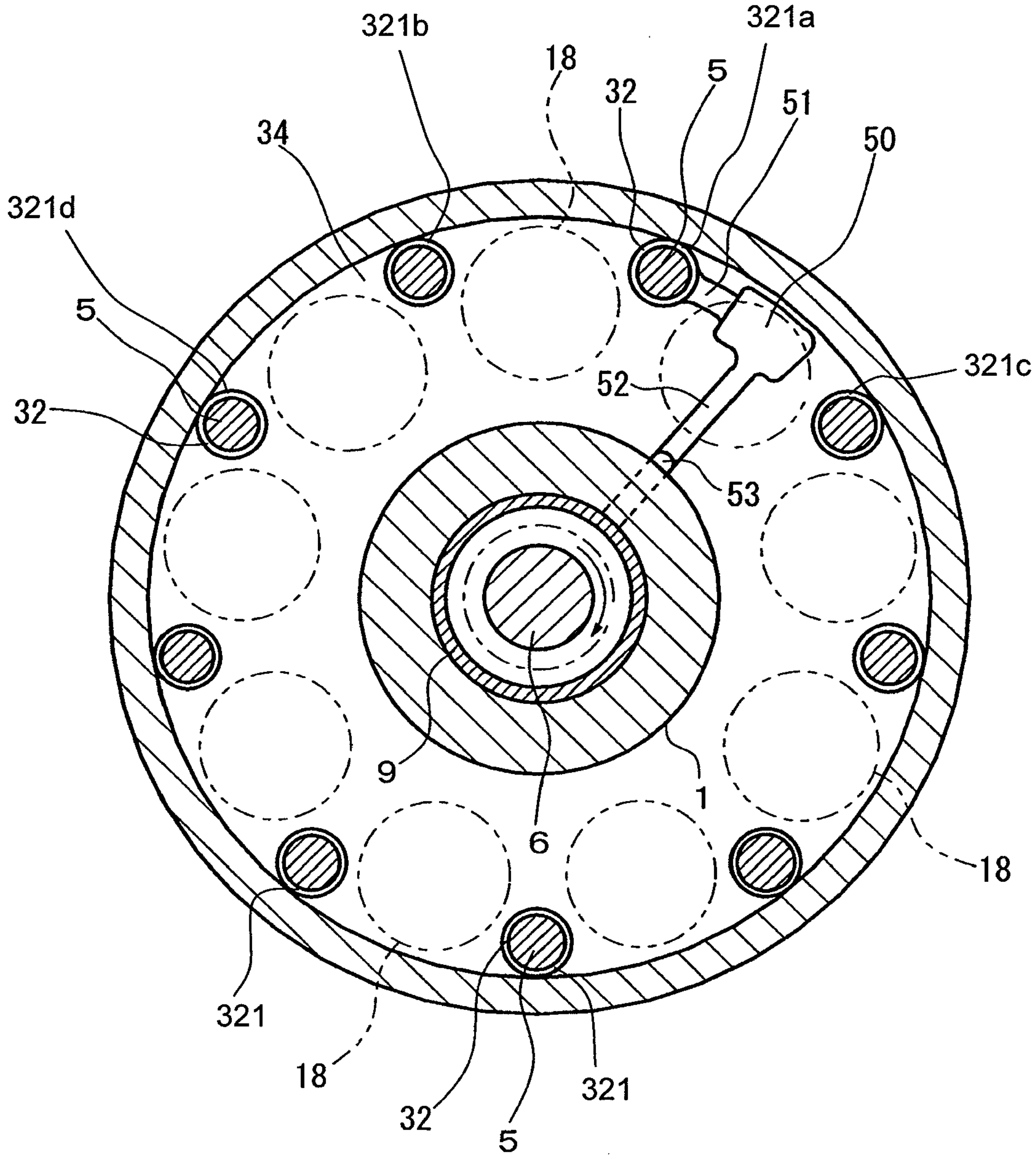


FIG. 4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32
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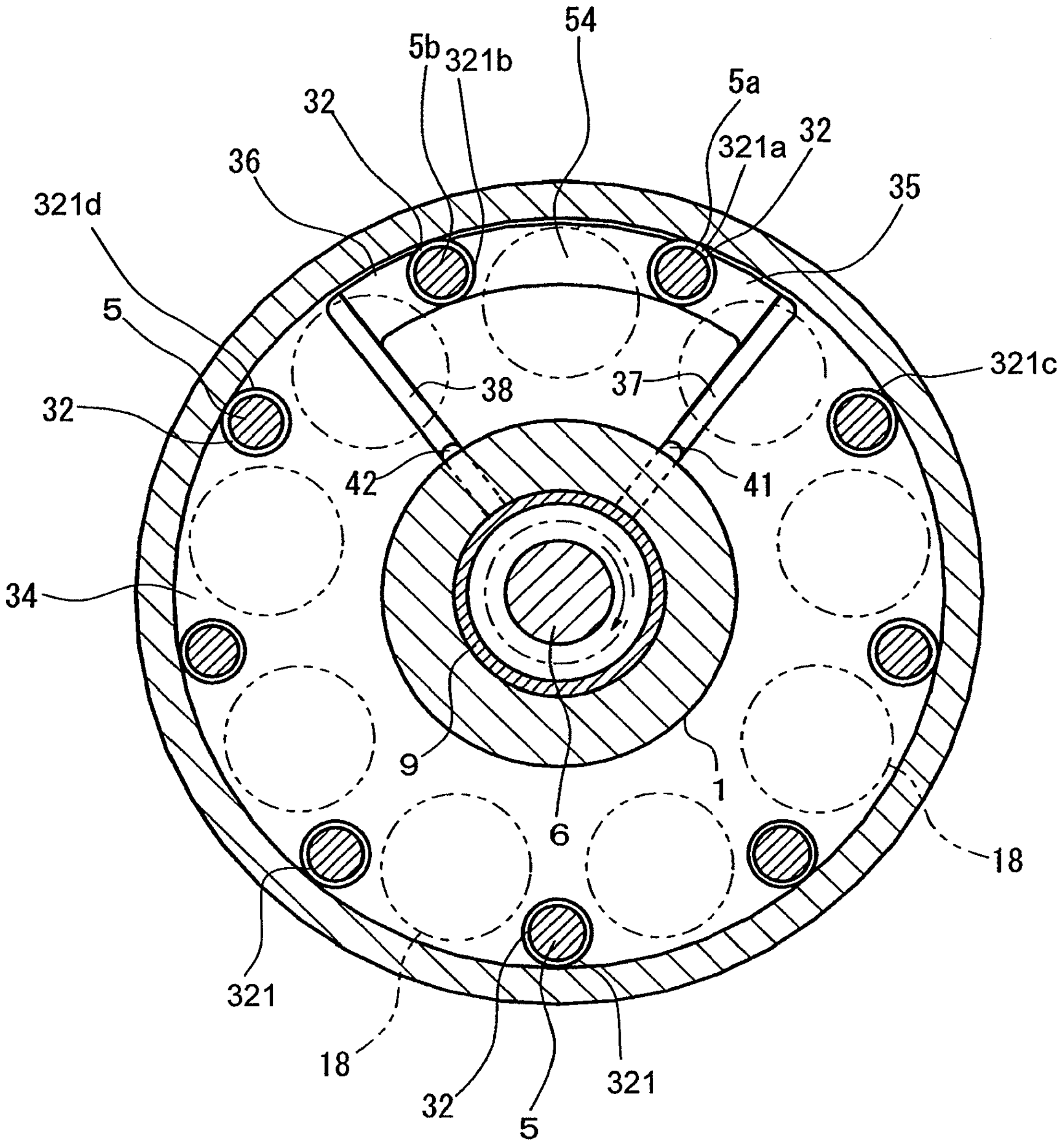
321

FIG. 5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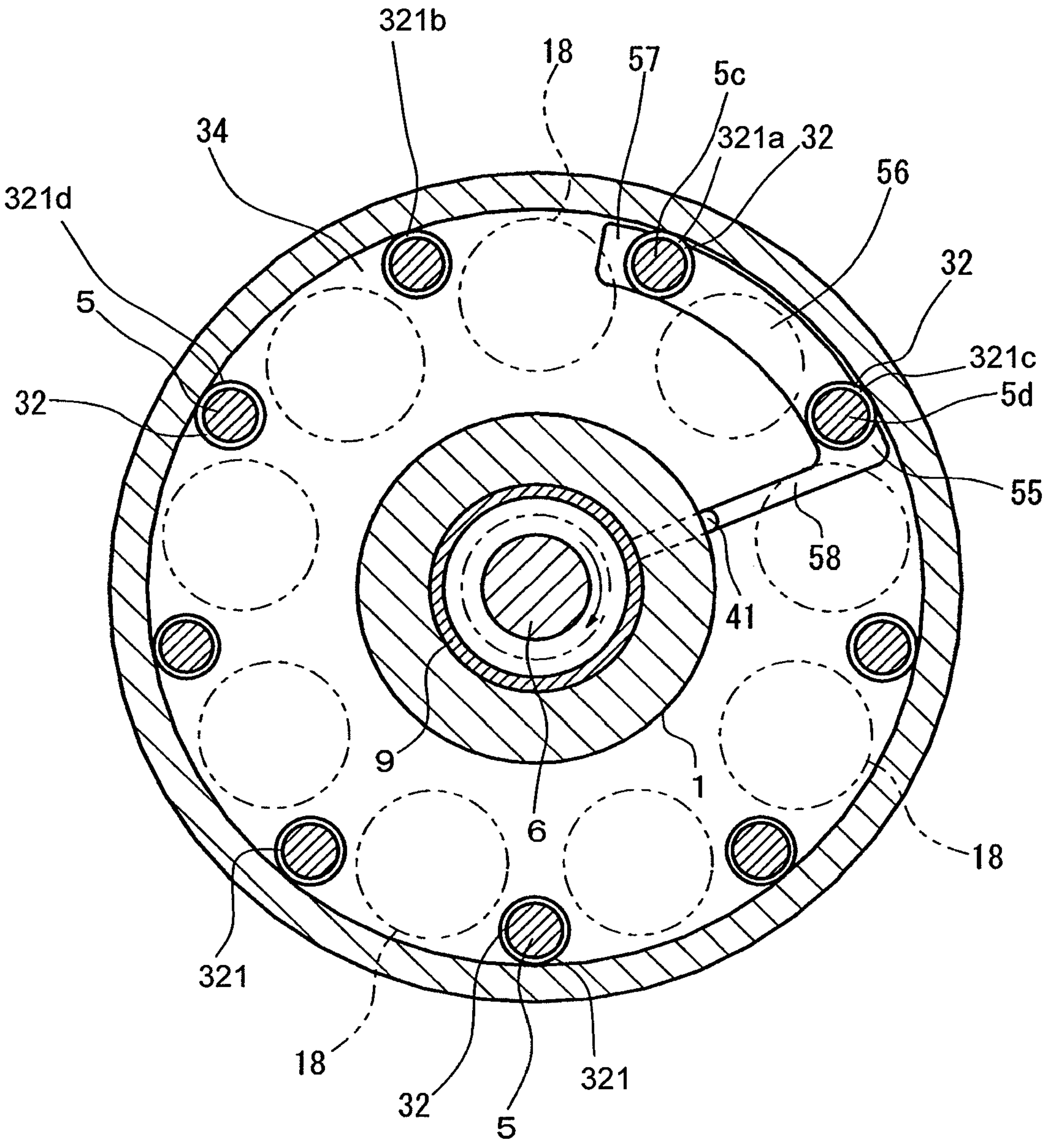
321
18
321
32
5

FIG. 6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32
34
56
321d
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58
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9
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1
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321
18
32
5
321

FIG. 7A

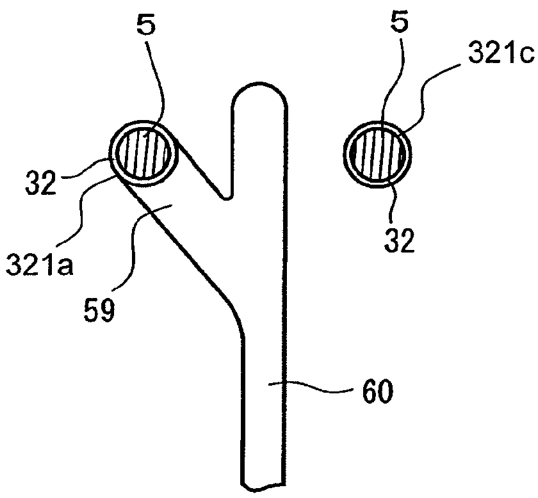


FIG. 7B

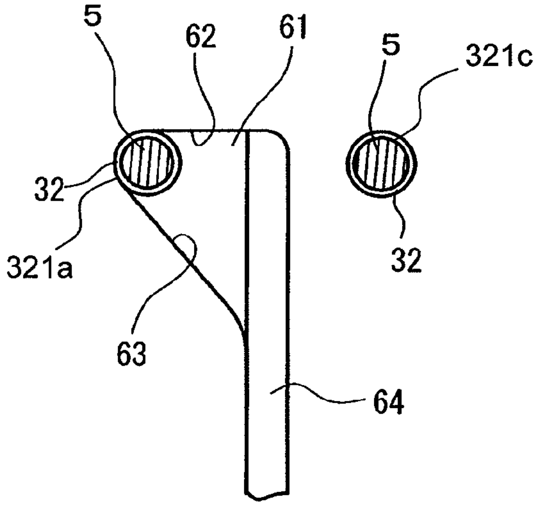
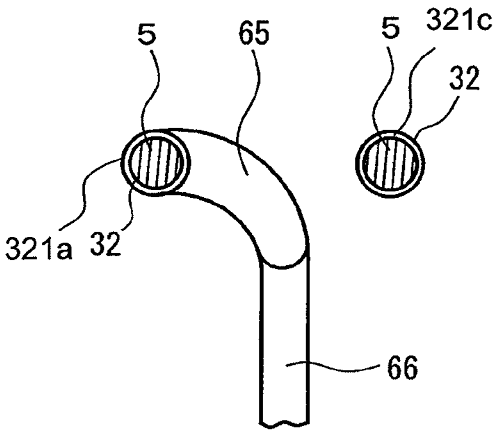


FIG. 7C



REFERENCES CITED IN THE DESCRIPTION

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- JP 2005171851 A **[0004]**