(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 524 819 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
14.08.2019 Bulletin 2019/33

(21) Application number: **19154627.4**

(22) Date of filing: **30.01.2019**

(51) Int Cl.:
F04C 23/00 *(2006.01)* ***F04C 29/02*** *(2006.01)*
F04C 29/12 *(2006.01)* ***F04C 18/02*** *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **13.02.2018 JP 2018022976**

(71) Applicant: **MITSUBISHI HEAVY INDUSTRIES THERMAL SYSTEMS, LTD.**
108-8215 Tokyo (JP)

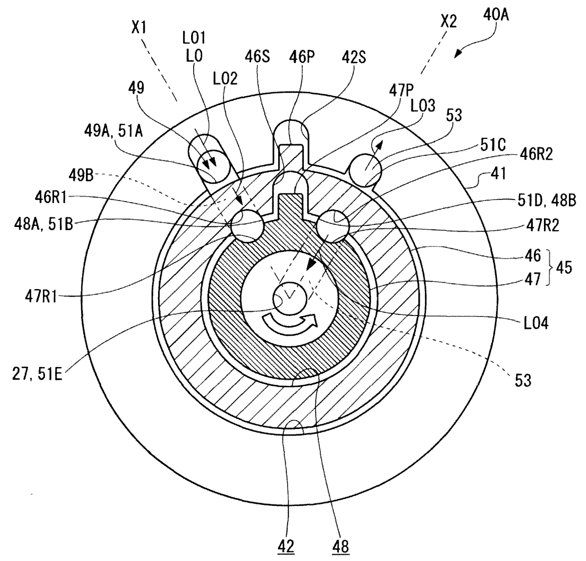
(72) Inventors:
- **OKADA, Yoshiyuki**
  Tokyo, 100-8332 (JP)
- **YAMASHITA, Takuma**
  Tokyo, 100-8332 (JP)
- **WATANABE, Takashi**
  Tokyo, 100-8332 (JP)
- **SATO, Hajime**
  Tokyo, 108-8215 (JP)
- **TATEISHI, Taichi**
  Tokyo, 100-8332 (JP)

(74) Representative: **Henkel, Breuer & Partner**
Patentanwälte
Maximiliansplatz 21
80333 München (DE)

(54) COMPRESSOR WITH A POSITIVE DISPLACEMENT OIL SUPPLY PUMP

(57) A compressor is provided capable of ensuring an opening area of a suction port in an oil supply pump even when a lubricant flows in a thickness direction of a pump rotor. An oil supply pump (40A) of a scroll compressor (1) includes: a first suction port (51A) through which a lubricant flows into a first oil suction chamber (42A); a second suction port (51B) through which the lubricant flows into a second oil suction chamber (48A); a first discharge port (51C) through which the lubricant flows from a first oil discharge chamber (42B); a second discharge port (51D) through which the lubricant flows from a second oil discharge chamber (48B); oil introducing channels (46R1, 47R1) provided correspondingly to the second suction port (51B) by concaving peripheral edge surfaces of an outer rotor (46) and an inner rotor (47); and oil lead-out channels (46R2, 47R2) provided correspondingly to the second discharge port (51D) by concaving peripheral edge surfaces of the outer rotor (46) and the inner rotor (47).

FIG. 3



EP 3 524 819 A2

Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a pump that circulates a lubricant, the pump being applied to, for example, a scroll compressor.

Description of the Related Art

[0002] Generally, a scroll compressor including a scroll compression mechanism housed in a housing, and an electric motor that drives the scroll compression mechanism has been widely known. The scroll compression mechanism includes a fixed scroll member and an orbiting scroll member each having a spiral lap on one side of a disk-like end plate. The fixed scroll and the orbiting scroll are faced with their laps engaging to cause revolution of the orbiting scroll relative to the fixed scroll. Then, revolution of the orbiting scroll reduces a volume of a compression space formed between the laps to compress a gas refrigerant in the space.

[0003] The scroll compressor requires lubricating slide portions to prevent seizure of and cool the scroll compression mechanism and a bearing. A fluid leaking from a minute gap between the laps of the fixed scroll and the orbiting scroll may lead to reduced performance of the compressor. Thus, a configuration is adopted in which a lubricant is stored in a bottom of a housing, and an oil supply pump is provided near a lower end of a rotation axis of an electric motor, and rotation of the rotation axis causes the oil supply pump to pump the lubricant and supply the lubricant to the slide portions (for example, see JP 9-264281 A) .

SUMMARY OF THE INVENTION

[0004] As described in JP 9-264281 A, it is proposed that pump rotors (i.e., two large and small ones) are radially overlapped to provide two outer and inner oil supply pumps in order to provide a dual lubricant circulation circuit in an oil supply mechanism of the compressor. A suction port of the outer pump can be provided on a radially outer side of the pump rotor. However, due to the presence of the outer pump, a suction port of the inner pump is only provided in a thickness direction of the pump rotor. Thus, from limitations of an amount of eccentricity of a rotation axis, a diameter of the suction port on the inner side, or the like, an insufficient opening area of the suction port of the inner pump causes an insufficient circulation amount of the lubricant and a reduction in performance and reliability of the compressor.

[0005] From the above, the present invention has an object to provide a compressor that can ensure an opening area of a suction port of an oil supply pump even if a lubricant flows in a thickness direction of a pump rotor.

[0006] A compressor according to the present invention includes: a compression mechanism; an electric motor that drives the compression mechanism; and a positive-displacement oil supply pump that includes a pump rotor operated by a drive force of the electric motor and circulates a lubricant.

[0007] The oil supply pump in the present invention includes: a suction port and a discharge port through which the lubricant flows in a thickness direction of the pump rotor; an oil suction chamber into which the lubricant flows through the suction port; an oil discharge chamber from which the lubricant flows toward a discharge port; an oil introducing channel that is provided correspondingly to the suction port and has a larger channel for the lubricant than the oil suction chamber; and an oil lead-out channel that is provided correspondingly to the discharge port and has a larger channel for the lubricant than the oil discharge chamber.

[0008] There are at least two types of oil supply pumps in the present invention. The first type of oil supply pump includes one pump rotor, and the second type of oil supply pump includes two pump rotors.

[0009] The first type of oil supply pump includes: a cylinder; the pump rotor revolving inside the cylinder; the suction port through which the lubricant flows into the oil suction chamber provided between the cylinder and the pump rotor; the discharge port through which the lubricant flows from the oil discharge chamber formed between the cylinder and the pump rotor; the oil introducing channel provided correspondingly to the suction port by concaving a peripheral edge surface of one or both of the cylinder and the pump rotor; and the oil lead-out channel provided correspondingly to the discharge port by concaving a peripheral edge surface of one or both of the cylinder and the pump rotor.

[0010] The second type of oil supply pump includes: a cylinder; an outer rotor revolving inside the cylinder; an inner rotor revolving inside the outer rotor; a first suction port through which the lubricant flows into a first oil suction chamber formed between the cylinder and the outer rotor; a second suction port through which the lubricant flows into a second oil suction chamber formed between the outer rotor and the inner rotor; a first discharge port through which the lubricant flows from a first oil discharge chamber formed between the cylinder and the outer rotor; a second discharge port through which the lubricant flows from a second oil discharge chamber formed between the outer rotor and the inner rotor; the oil introducing channel provided correspondingly to the second suction port by concaving a peripheral edge surface of one or both of the outer rotor and the inner rotor; and the oil lead-out channel provided correspondingly to the second discharge port by concaving a peripheral edge surface of one or both of the outer rotor and the inner rotor.

[0011] In the first and second types of oil supply pumps, the oil introducing channel and the oil lead-out channel may extend through the cylinder or the pump rotor in the thickness direction or only in a predetermined range in the thickness direction.

[0012] In the first type of oil supply pump, the oil introducing channel and the oil lead-out channel may be provided only in the cylinder, or the oil introducing channel and the oil lead-out channel may be provided only in the pump rotor. The oil introducing channel and the oil lead-out channel may be provided in both the cylinder and the pump rotor.

[0013] In the second type of oil supply pump, the oil introducing channel and the oil lead-out channel may be provided only in the outer rotor, or the oil introducing channel and the oil lead-out channel may be provided only in the inner rotor. The oil introducing channel and the oil lead-out channel may be provided in both the outer rotor and the inner rotor.

[0014] In the first and second types of oil supply pumps, the oil introducing channel and the oil lead-out channel may each have an opening with a circumferential size smaller than a radial size.

[0015] With the oil supply pump according to the present invention, the oil introducing channel corresponding to the suction port through which the lubricant flows into the oil suction chamber and the oil lead-out channel corresponding to the discharge port through which the lubricant flows from the oil discharge chamber are provided. This can ensure an opening area of the channel for the lubricant flowing into the oil suction chamber and an opening area of the channel for the lubricant flowing from the oil discharge chamber. Thus, according to the present invention, an amount of oil supplied to the oil suction chamber and an amount of oil discharged from the oil discharge chamber are increased, thereby allowing a required amount of lubricant to be supplied to necessary places and improving performance and reliability of the compressor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

FIG. 1 is a vertical sectional view of a scroll compressor according to a first embodiment of the present invention;
FIG. 2 is a vertical sectional view of an oil supply pump according to the first embodiment, taken along the line X1-X2 in FIG. 3;
FIG. 3 is a cross sectional view of the oil supply pump according to the first embodiment;
FIGS. 4A, 4B, 4C and 4D are a cross sectional view showing an operation of the oil supply pump according to the first embodiment;
FIG. 5 is a vertical sectional view of an oil supply pump according to a second embodiment;
FIG. 6 is a cross sectional view of the oil supply pump according to the second embodiment;
FIGS. 7A and 7B show an oil supply pump according to a third embodiment, FIG. 7A is a cross sectional view, and FIG. 7B is a graph showing variations of an opening area of a suction port of the oil supply pump according to the third embodiment, or the like;
FIG. 8 is a cross sectional view of an oil supply pump according to a fourth embodiment;
FIG. 9 is a cross sectional view of an oil supply pump according to a fifth embodiment; and
FIGS. 10A, 10B and 10C illustrate a favorable condition in this embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] Now, with reference to the accompanying drawings, the present invention will be described based on embodiments.

[0018] A scroll compressor 1 according to this embodiment compresses and discharges a sucked fluid, for example, a refrigerant, and is provided in a refrigerant channel through which a refrigerant is circulated in an air conditioner or a refrigerator.

[0019] In the scroll compressor 1, a positive-displacement oil supply pump 40A includes two pump rotors: an outer rotor 46 and an inner rotor 47, and a large opening area of a suction port for a lubricant can be ensured particularly in the inner rotor 47. Five embodiments of the scroll compressor 1 will be described below in sequence.

[First embodiment]

[0020] As shown in FIG. 1, the scroll compressor 1 includes an electric motor 30 and a scroll compression mechanism 60 driven by the electric motor 30 in a sealed housing 10.

[Sealed housing 10]

[0021] The sealed housing 10 includes a vertically extending cylindrical housing body 11, a bottom lid 13 that closes a lower end of the housing body 11, and a top lid 15 that closes an upper end of the housing body 11, and is a generally sealed pressure container.

[0022] The housing body 11 includes, on its side, a suction pipe 17 through which a low pressure gas refrigerant is introduced into the sealed housing 10. The top lid 15 includes, on its top, a discharge pipe 19 through which a high pressure gas refrigerant compressed by a scroll compression mechanism 60 is discharged.

[0023] In the sealed housing 10, a discharge cover 12 is provided between the housing body 11 and the top lid 15, and an inside of the sealed housing 10 is partitioned into a low pressure chamber 10A below the discharge cover 12 and a high pressure chamber 10B above the discharge cover 12. The discharge cover 12 includes a discharge port 14 that provides communication between the low pressure chamber 10A and the high pressure chamber 10B, and a discharge reed valve 16 that opens/closes the discharge port 14.

[0024] A bottom of the low pressure chamber 10A in the sealed housing 10 is formed as an oil reservoir 37 that stores a lubricant LO.

[Electric motor 30]

[0025] The electric motor 30 includes a stator 31, a rotor 33, and an output shaft 35.

[0026] The stator 31 is secured to an inner wall surface of the housing body 11 substantially at a middle of the housing body 11 in a vertical direction. The rotor 33 is provided rotatably relative to the stator 31. The output shaft 35 is integral with the rotor 33, and rotates with rotation of the rotor 33 to output a drive force. The output shaft 35 extends through the rotor 33 in the vertical direction, that is, a direction of a rotation axis.

[0027] By power supplied to the electric motor 30 from outside the sealed housing 10, the electric motor 30 rotates the rotor 33, and the output shaft 35 rotates with the rotor 33. In this embodiment, the electric motor 30 can control an operation frequency with, for example, an inverter, and can operate in a wide range from a low rotation speed range to a high rotation speed range.

[0028] The output shaft 35 has ends protruding upward and downward of the rotor 33, and is supported rotatably around a vertically extending rotation axis CE relative to the housing body 11, with the upper end being supported by an upper bearing 21 and the lower end being supported by a lower bearing 23.

[0029] The output shaft 35 includes, at its upper end, an eccentric pin 25 eccentric with respect to the rotation axis CE. The scroll compression mechanism 60 is connected to the upper end of the output shaft 35 having the eccentric pin 25.

[0030] The output shaft 35 and the eccentric pin 25 have therein a vertically extending oil supply hole 27. The oil supply hole 27 extends through the output shaft 35 and an eccentric shaft 35A in the direction of the rotation axis CE to provide communication between the upper end and the lower end.

[0031] The oil supply hole 27 includes, at heights corresponding to the upper bearing 21 and the lower bearing 23, an upper oil supply hole 27A and a lower oil supply hole 27B communicating with the oil supply hole 27 and radially extending through the output shaft 35.

[0032] At the lower end of the output shaft 35, an oil supply pump 40A arranged in the oil reservoir 37 is provided. The oil supply pump 40 pumps the lubricant LO stored in the oil reservoir 37 with rotation of the output shaft 35. The pumped lubricant is supplied through the oil supply hole 27, the upper oil supply hole 27A, and the lower oil supply hole 27B in the output shaft 35 to slide portions between the upper bearing 21 and the lower bearing 23 and the output shaft 35 as well as the scroll compression mechanism 60. The oil supply pump 40 will be described later in detail.

[0033] The upper bearing 21 rotatably supports the output shaft 35 with the upper end of the output shaft 35 extending through the upper bearing 21. The upper bearing 21 includes, in its upper surface, a recess 21A surrounding the upper end of the output shaft 35 extending through the upper bearing 21. The recess 21A houses a slide bush 67 described later, and stores the lubricant LO fed through the oil supply hole 27 by the oil supply pump 40. Then, the stored lubricant LO is supplied to the scroll compression mechanism 60.

[0034] The upper bearing 21 includes a notch 21B in a part of an outer periphery to have a gap from the inner wall surface of the housing body 11 of the sealed housing 10, and an oil discharge hole 21C that provides communication between the notch 21B and the recess 21A is formed. A cover plate 36 is provided below the notch 21B in the upper bearing 21. The cover plate 36 vertically extends. The cover plate 36 is curved to surround the notch 21B with opposite ends facing the inner wall surface of the housing body 11 and has a lower end that is bent to be gradually closer to the inner wall surface of the housing body 11. The oil discharge hole 21C discharges the lubricant LO excessively stored in the recess 21A from the notch 21B to an outer periphery of the upper bearing 21. The cover plate 36 receives the lubricant LO discharged from the notch 21B and guides the lubricant LO toward the inner wall surface of the housing body 11. The lubricant LO guided toward the inner wall surface by the cover plate 36 is returned along the inner wall surface to the oil reservoir 37 at the bottom in the sealed housing 10 by the cover plate 36.

[Scroll compression mechanism 60]

[0035] The scroll compression mechanism 60 is arranged in the low pressure chamber 10A below the discharge cover 12 and above the upper bearing 21 in the sealed housing 10, and includes a fixed scroll 61, an orbiting scroll 63, and a slide bush 67.

[0036] The fixed scroll 61 includes a spiral fixed side lap 61B on an inner surface (lower surface in FIG. 1) of a fixed side end plate 61A fixed in the sealed housing 10. The fixed side end plate 61A includes a discharge hole 61C in its center.

[0037] The orbiting scroll 63 includes a spiral movable side lap 63B on an inner surface (upper surface in FIG. 1) of a movable side end plate 63A facing the inner surface of the fixed side end plate 61A of the fixed scroll 61. The movable side lap 63B of the orbiting scroll 63 engages the fixed side lap 61B of the fixed scroll 61 with shifted phases to form a compression chamber defined by the fixed side end plate 61A, the movable side end plate 63A, the fixed side lap 61B, and the movable side lap 63B.

[0038] The orbiting scroll 63 includes, on an outer surface (lower surface in FIG. 1) of the movable side end plate 63A, a cylindrical boss 63C to which the eccentric pin 25 of the output shaft 35 is connected and eccentric rotation of the eccentric pin 25 is transferred. The orbiting scroll 63 revolves while being prevented from rotating based on the eccentric rotation of the eccentric pin 25 by a rotation preventing mechanism such as a well-known Oldham's link arranged between an outer surface of the movable side end plate 63A and the upper bearing 21.

[0039] The slide bush 67 is housed in the recess 21A in the upper bearing 21 described above, placed between the eccentric pin 25 of the output shaft 35 and the boss 63C of the orbiting scroll 63 to transfer rotation of the eccentric pin 25 as revolution of the orbiting scroll 63. The slide bush 67 is slidable radially of the eccentric pin 25 to maintain engagement between the movable side lap 63B of the orbiting scroll 63 and the fixed side lap 61B of the fixed scroll 61.

[0040] In the scroll compression mechanism 60, the low pressure refrigerant introduced through the suction pipe 17 into the low pressure chamber 10A in the sealed housing 10 is sucked into the compression chamber between the fixed scroll 61 and the orbiting scroll 63 and compressed by revolution of the orbiting scroll 63.

[0041] A part of the lubricant LO discharged through the oil discharge hole 21C into the sealed housing 10 is raised by the low pressure refrigerant in the low pressure chamber 10A, thus mixed into the low pressure refrigerant and sucked between the fixed scroll 61 and the orbiting scroll 63, and supplied to a slide portion between the fixed scroll 61 and the orbiting scroll 63. Thus, the lubricant LO mixed into the refrigerant seals a minute gap between the laps 61B, 63B to prevent the refrigerant from leaking from the gap, thereby preventing a reduction in operation efficiency of the scroll compressor 1.

[0042] The compressed high pressure gas refrigerant is discharged through the discharge hole 61C in the fixed scroll 61 to an outer surface side of the fixed side end plate 61A, opens the discharge reed valve 16 in the discharge cover 12 by its own pressure to reach the high pressure chamber 10B through the discharge port 14, and is discharged through the discharge pipe 19 to the outside of the sealed housing 10.

[Oil supply pump 40]

[0043] Next, with reference to FIGS. 2 and 3, the oil supply pump 40A that is a characteristic part of the first embodiment will be described. FIGS. 2 and 3 show centers of the outer rotor 46 and the inner rotor 47 being aligned with a center of the cylinder 41, but in an actual operation, the centers of the outer rotor 46 and the inner rotor 47 are shifted from the center of the cylinder 41 as shown in FIGS. 4A to 4D.

[0044] The oil supply pump 40 includes a cylinder 41, a pump rotor 45 revolvably housed in the cylinder 41, a cover plate 44 that revolvably supports the pump rotor 45 together with the cylinder 41, and a thrust plate 43 held between the cylinder 41 and the cover plate 44. In this embodiment, the pump rotor 45 corresponds to a dual lubricant circulation circuit as the pump rotor 45 includes two pump rotors: the outer rotor 46 and the inner rotor 47.

[0045] The cylinder 41 is arranged at a bottom of the sealed housing 10, and includes a first cylinder chamber 42 with an open lower surface. The cylinder 41 is supported by the sealed housing 10 via the lower bearing 23 integrally formed with the cylinder 41 as a stay. The open lower surface of the first cylinder chamber 42 is closed by the thrust plate 43 and the cover plate 44 mounted to the cylinder 41.

[0046] The lower end of the output shaft 35 of the electric motor 30 is inserted into the cylinder 41, and the lower end located in the first cylinder chamber 42 includes the eccentric shaft 35A. The pump rotor 45 is an annular member arranged in the first cylinder chamber 42. The pump rotor 45 is rotatably mated with an outer peripheral portion of the eccentric shaft 35A, and has an outer peripheral surface in contact with an inner peripheral surface of the first cylinder chamber 42 to form a crescent space in the first cylinder chamber 42 (see FIGS. 4A to 4D) .

[0047] The pump rotor 45 includes the outer rotor 46 and the inner rotor 47 each of which is an annular member. The outer rotor 46 has a larger diameter than the inner rotor 47, and the inner rotor 47 is arranged in a hollow part inside an inner periphery of the outer rotor 46. The hollow part of the outer rotor 46 forms a second cylinder chamber 48.

[0048] As shown in FIG. 3, a radially extending blade-like protrusion 46P is integrally formed on an outer peripheral portion of the outer rotor 46, and the protrusion is slidably inserted into a slot 42S radially formed in the inner peripheral surface of the first cylinder chamber 42. The protrusion 46P partitions the crescent space formed in the first cylinder chamber 42 into a first oil suction chamber 42A and a first oil discharge chamber 42B (see FIGS. 4A to 4D), and prevents rotation of the outer rotor 46. An outer periphery of the outer rotor 46 forms an arc except the protrusion 46P.

[0049] As shown in FIGS. 2 and 3, the outer rotor 46 includes an oil introducing channel 46R1 and an oil lead-out channel 46R2 of a semicircular shape in plan view. The oil introducing channel 46R1 and the oil lead-out channel 46R2 are concaved radially inward in an inner peripheral edge surface of the outer rotor 46. The oil introducing channel 46R1 and the oil lead-out channel 46R2 are concaved radially outward in an inner peripheral side of the outer rotor 46. The oil introducing channel 46R1 and the oil lead-out channel 46R2 extend through the outer rotor 46 in the thickness direction.

[0050] The oil introducing channel 46R1 is provided correspondingly to a second oil suction chamber 48A in a second cylinder chamber 48, and the oil lead-out channel 46R2 is provided correspondingly to a second oil discharge chamber 48B in the second cylinder chamber 48. The oil introducing channel 46R1 cooperates with the oil introducing channel 47R1 to configure an oil introducing channel that guides the lubricant LO flowing through a lateral channel 49B in a suction channel 49 to the second oil suction chamber 48A. The oil introducing channel has a larger channel for the lubricant than the second cylinder chamber 48. The oil lead-out channel 46R2 cooperates with the oil lead-out channel 47R2 to configure an oil lead-out channel that guides the lubricant LO flowing through the second oil discharge chamber 48B to a second discharge channel 53. The oil lead-out channel also has a larger channel for the lubricant than the second cylinder chamber 48.

[0051] As shown in FIG. 3, a radially extending blade-like protrusion 47P is integrally formed on an outer peripheral portion of the inner rotor 47, and the protrusion is slidably inserted into the slot 46S radially formed in the inner peripheral surface of the second cylinder chamber 48. The protrusion 47P partitions a crescent space formed in the second cylinder chamber 48 into the second oil suction chamber 48A and the second oil discharge chamber 48B (see FIG. 3), and prevents rotation of the inner rotor 47. An outer periphery of the inner rotor 47 forms an arc except the protrusion 47P.

[0052] As shown in FIGS. 2 and 3, the inner rotor 47 includes an oil introducing channel 47R1 and an oil lead-out channel 47R2 of a semicircular shape in plan view. The oil introducing channel 47R1 faces the oil introducing channel 46R1 in the outer rotor 46, and the oil lead-out channel 47R2 faces the oil lead-out channel 46R2 in the outer rotor 46. The oil introducing channel 47R1 and the oil lead-out channel 47R2 are concaved radially inward in an outer edge surface of the inner rotor 47. The oil introducing channel 47R1 and the oil lead-out channel 47R2 extend through the inner rotor 47 in the thickness direction.

[0053] The oil introducing channel 47R1 is provided correspondingly to the second oil suction chamber 48A in the second cylinder chamber 48, and the oil lead-out channel 47R2 is provided correspondingly to the second oil discharge chamber 48B in the second cylinder chamber 48. The oil introducing channel 47R1 cooperates with the oil introducing channel 46R1 to configure an oil introducing channel that guides the lubricant LO flowing through the lateral channel 49B in the suction channel 49 to the second oil suction chamber 48A. The oil lead-out channel 47R2 cooperates with the oil lead-out channel 46R2 to configure an oil lead-out channel that guides the lubricant LO flowing through the second oil discharge chamber 48B to the second discharge channel 53.

[0054] The cover plate 44 includes the suction channel 49 located below the first oil suction chamber 42A in the first cylinder chamber 42 described above. The suction channel 49 communicates with an inner bottom of the sealed housing 10 that stores the lubricant LO. The suction channel 49 includes a vertical channel 49A extending in a thickness direction of the cylinder 41 and the lateral channel 49B extending radially of the cylinder 41.

[0055] The thrust plate 43 includes a first suction port 51A communicating with the vertical channel 49A in the cover plate 44 and the first oil suction chamber 42A in the first cylinder chamber 42. The thrust plate 43 includes a second suction port 51B communicating with the lateral channel 49B in the cover plate 44 and the second oil suction chamber 48A in the second cylinder chamber 48.

[0056] The cover plate 44 includes the second discharge channel 53 in addition to the suction channel 49 described above. The second discharge channel 53 extends radially of the cylinder 41. The lubricant supplied from the second cylinder chamber 48 to the oil supply hole 27 in the output shaft 35 flows through the second discharge channel 53.

[0057] The thrust plate 43 includes a third discharge port 51E communicating with the second discharge channel 53 in the cover plate 44 and the oil supply hole 27 in the output shaft 35. The thrust plate 43 includes a second discharge port 51D communicating with the second discharge channel 53 in the cover plate 44 and the second oil discharge chamber 48B in the second cylinder chamber 48.

[0058] The cover plate 44 includes a first discharge channel 52 in addition to the second discharge channel 53. The first discharge channel 52 extends in the thickness direction of the cylinder 41. The lubricant LO from the first oil discharge chamber 42B in the first cylinder chamber 42 is supplied through the first discharge channel 52 to an object to be lubricated. Any object may be lubricated, and for example, the Oldham's link and the electric motor 30 described above may be lubricated. In this case, the lubricant LO may be supplied to the object to be lubricated through an oil cooler for cooling in addition to lubricating.

[0059] The thrust plate 43 includes a first discharge port 51C communicating with the first discharge channel 52 in the cover plate 44 and the first oil discharge chamber 42B in the first cylinder chamber 42.

[0060] A circular opening area surrounded by the oil introducing channel 46R1 and the oil introducing channel 47R1 is equal to an opening area of the second suction port 51B, and the second suction port 51B, the oil introducing channel 46R1, and the oil introducing channel 47R1 extend through the outer rotor 46 and the inner rotor 47 in the thickness direction.

[0061] Similarly, a circular opening area surrounded by the oil lead-out channel 46R2 and the oil lead-out channel 47R2 is equal to an opening area of the second discharge port 51D, and the second discharge port 51D, the oil lead-out channel 46R2, and the oil lead-out channel 47R2 extend through the outer rotor 46 and the inner rotor 47 in the thickness direction.

[0062] The lubricant LO flows in the manner described below in the oil supply pump 40A configured as described above.

[0063] The lubricant LO having flowed through the vertical channel 49A in the suction channel 49 is divided into a lubricant LO1 flowing into the first oil suction chamber 42A in the first cylinder chamber 42 and a lubricant LO2 flowing into the lateral channel 49B. The lubricant LO flowing through the lateral channel 49B flows through the second suction port 51B to the second oil suction chamber 48A in the second cylinder chamber 48.

[0064] The lubricant LO1 having reached the first oil suction chamber 42A flows through the first oil discharge chamber 42B during revolution of the outer rotor 46 and the inner rotor 47, and further flows from the first discharge channel 52 as a lubricant LO3 toward a target object to be lubricated.

[0065] The lubricant LO2 having reached the second oil suction chamber 48A flows through the second oil discharge chamber 48B during revolution of the outer rotor 46 and the inner rotor 47 and reaches the second discharge channel 53 as a lubricant LO4. The lubricant LO4 further flows from the oil supply hole 27 in the output shaft 35 toward the object to be lubricated.

[0066] In the oil supply pump 40 configured as described above, rotation of the pump rotor 45 (the outer rotor 46 and the inner rotor 47) together with the output shaft 35 rotated by the electric motor 30 causes eccentric rotation of the eccentric shaft 35A.

[0067] The outer rotor 46 is pressed by the eccentrically rotating eccentric shaft 35A, and revolves with the outer peripheral surface thereof being in slide contact with the inner peripheral surface of the first cylinder chamber 42 formed in the cylinder 41. The revolution of the outer rotor 46 causes relative increase and decrease of volumes of the first oil suction chamber 42A and the first oil discharge chamber 42B in the first cylinder chamber 42.

[0068] Similarly to the outer rotor 46, the inner rotor 47 is pressed by the eccentrically rotating eccentric shaft 35A, and revolves with the outer peripheral surface thereof being in slide contact with the inner peripheral surface of the outer rotor 46. The inner peripheral surface of the outer rotor 46 faces the second cylinder chamber 48 formed inside the outer rotor 46. The revolution of the inner rotor 47 causes relative increase and decrease of volumes of the second oil suction chamber 48A and the second oil discharge chamber 48B in the second cylinder chamber 48.

[0069] FIGS. 4A to 4D show the above operations stepwise. Specifically, FIG. 4A shows the pump rotor 45 (the outer rotor 46 and the inner rotor 47) starting discharge of the lubricant LO, FIGS. 4B and 4C show the pump rotor 45 sucking and discharging the lubricant LO, and FIG. 4D shows the pump rotor 45 having completed the discharge of the lubricant LO. Thereafter, the operations in FIGS. 4A to 4D as one cycle are repeated for revolution.

[0070] In this manner, the outer rotor 46 of the pump rotor 45 revolves to increase the volume of the first oil suction chamber 42A, and thus the lubricant LO stored in the inner bottom of the sealed housing 10 is sucked through the vertical channel 49A in the suction channel 49 in the cover plate 44 and the first suction port 51A in the thrust plate 43 into the first oil suction chamber 42A in the first cylinder chamber 42. The sucked lubricant LO is pressurized in the first oil discharge chamber 42B with a reduction in the volume of the first oil discharge chamber 42B, and a main stream of the lubricant LO is discharged through the first discharge port 51C in the thrust plate 43 to the first discharge channel 52.

[0071] The inner rotor 47 of the pump rotor 45 revolves to increase the volume of the second oil suction chamber 48A, and thus the lubricant LO stored in the inner bottom of the sealed housing 10 is sequentially sucked through the vertical channel 49A and the lateral channel 49B in the suction channel 49 in the cover plate 44 and the second suction port 51B into the second oil suction chamber 48A in the second cylinder chamber 48. The sucked lubricant LO is pressurized in the second oil discharge chamber 48B with a reduction in the volume of the second oil discharge chamber 48B, and a main stream of the lubricant LO is discharged through the second discharge channel 53 and the third discharge port 51E in the thrust plate 43 to the oil supply hole 27 in the output shaft 35.

[Advantages]

[0072] As described above, in the oil supply pump 40 according to the first embodiment, the outer rotor 46 includes the oil introducing channel 46R1 and the oil lead-out channel 46R2, and the inner rotor 47 includes the oil introducing channel 47R1 and the oil lead-out channel 47R2. Thus, although the oil introducing channels up to the outer rotor 46 and the inner rotor 47 are formed in the thickness direction of the rotors, the opening area of the suction port for the lubricant flowing into the first oil suction chamber 42A and the opening area of the discharge port for the lubricant flowing from the second discharge channel 53 can be ensured. Thus, the amount of the lubricant flowing into the first oil suction chamber 42A and the second discharge channel 53 can be increased, thereby allowing a required amount of lubricant to be supplied to necessary places and improving performance and reliability of the scroll compressor 1

[Second embodiment]

[0073] Next, with reference to FIGS. 5 and 6, an oil supply pump 40B according to a second embodiment of the present invention will be described. The oil supply pump 40B according to the second embodiment has the same basic configuration as the oil supply pump 40A according to the first embodiment, and thus the oil supply pump 40B will be described below mainly in term of differences. In FIGS. 5 and 6, the same components as in the oil supply pump 40A are denoted by the same reference numerals as in FIGS. 2 and 3. The same applies to a next third embodiment and thereafter.

[0074] In the oil supply pump 40B, eaves 46E and 47E close upper sides of the oil introducing channel 46R1 and the oil lead-out channel 46R2 as well as the oil introducing channel 47R1 and the oil lead-out channel 47R2, and the oil introducing channels 46R1, 47R1 and the oil lead-out channels 46R2, 47R2 are formed only in a predetermined range from lower ends of the outer rotor 46 and the inner rotor 47. Specifically, in the oil supply pump 40A, the oil introducing channels 46R1, 47R1 and the oil lead-out channels 46R2, 47R2 extend through the outer rotor 46 and the inner rotor 47 in the thickness direction, while in the oil supply pump 40B, the oil introducing channels 46R1, 47R1 and the oil lead-out channels 46R2, 47R2 do not extend through the outer rotor 46 and the inner rotor 47.

[0075] Except that the eaves 46E, 47E close the upper sides, the oil introducing channels 46R1, 47R1 and the oil lead-out channels 46R2, 47R2 are configured similarly to those in the first embodiment. Thus, since the lubricant LO is supplied up to the eaves 46E, 47E, similarly to the oil supply pump 40A, the oil supply pump 40B can ensure an opening area of the channel for the lubricant flowing into the first oil suction chamber 42A and the second oil suction chamber 48A.

[0076] The oil supply pump 40B includes the eaves 46E, 47E, and thus can prevent a reduction in rigidity of the outer rotor 46 and the inner rotor 47 as compared to the oil supply pump 40A including the oil introducing channels 46R1, 47R1 and the oil lead-out channels 46R2, 47R2 extending through the outer rotor 46 and the inner rotor 47 in the thickness direction. This can reduce deformation of the outer rotor 46 and the inner rotor 47 during the operation of the scroll compressor 1, and increase life and reliability.

[0077] When both the outer rotor 46 and the inner rotor 47 include the oil introducing channels 46R1, 47R1 and the oil lead-out channels 46R2, 47R2, angular corners are formed at boundaries between arcuate surfaces and the oil introducing channel 46R1 or the like. On the other hand, the oil supply pump 40B includes the eaves 46E, 47E, and the inner peripheral surface of the outer rotor 46 and the outer peripheral surface of the inner rotor 47 in contact with each other are both formed of arcuate surfaces only, thereby preventing contact between corners causing scoring.

[Third embodiment]

[0078] Next, with reference to FIGS. 7A and 7B, an oil supply pump 40C according to a third embodiment of the present invention will be described.

[0079] As shown in FIG. 7A, the oil supply pump 40C includes the oil introducing channel 46R1 and the oil lead-out channel 46R2 only in the outer rotor 46. In other words, the oil supply pump 40C has a structure in which the oil introducing channel 47R1 and the oil lead-out channel 47R2 in the inner rotor 47 in the oil supply pump 40A are closed.

[0080] Even with only the outer rotor 46 including the oil introducing channel 46R1 and the oil lead-out channel 46R2, the oil supply pump 40C can ensure an opening area of the channel for the lubricant flowing into the second oil suction chamber 48A as in the first embodiment.

[0081] The oil supply pump 40C is unlikely to cause scoring even in the case of contact between the outer rotor 46 and the inner rotor 47 as compared to both the outer rotor 46 and the inner rotor 47 including the oil introducing channels 46R1, 47R1 and the oil lead-out channels 46R2, 47R2.

[0082] As compared to only the inner rotor 47 including the oil introducing channel 47R1 and the oil lead-out channel 47R2, as shown in FIG. 7B, an amount of eccentricity of the outer rotor 46 is smaller than that of the inner rotor 47, thereby reducing an opening area formed by the oil introducing channel 46R1 and the oil lead-out channel 46R2 crossing the second suction port 51B. This can ensure a larger opening area for the lubricant LO even with the same amount of notch and opening area.

[Fourth embodiment]

[0083] Next, with reference to FIG. 8, an oil supply pump 40D according to a fourth embodiment of the present invention will be described.

[0084] As shown in FIG. 8, in contrast with the oil supply pump 40C according to the third embodiment, in the oil supply pump 40D, only the inner rotor 47 includes the oil introducing channel 47R1 and the oil lead-out channel 47R2. In other words, the oil supply pump 40D has a structure in which the oil introducing channel 46R1 and the oil lead-out channel 46R2 in the outer rotor 46 in the oil supply pump 40A are closed.

[0085] Even with only the inner rotor 47 including the oil introducing channel 47R1 and the oil lead-out channel 47R2, the oil supply pump 40D can ensure an opening area of the channel for the lubricant flowing into the second oil suction chamber 48A as in the first embodiment.

[0086] The oil supply pump 40D is unlikely to cause scoring even in the case of contact between the outer rotor 46 and the inner rotor 47 as compared to both the outer rotor 46 and the inner rotor 47 including the oil introducing channels 46R1, 47R1 and the oil lead-out channels 46R2, 47R2.

[0087] During the operation, a load is applied to the outer rotor 46 around the oil introducing channel 46R1 and the oil lead-out channel 46R2 in a direction expanding the oil introducing channel 46R1 and the oil lead-out channel 46R2. On the other hand, as shown by arrows in FIG. 8, a load is applied to the oil introducing channel 47R1 and the oil lead-out channel 47R2 in the inner rotor 47 in a direction closing the oil introducing channel 47R1 and the oil lead-out channel 47R2. Thus, as compared to only the outer rotor 46 including the oil introducing channel 46R1 and the oil lead-out channel 46R2, only the inner rotor 47 including the oil introducing channel 47R1 and the oil lead-out channel 47R2 can reduce breakage of the rotor.

[Fifth embodiment]

[0088] Next, with reference to FIG. 9, an oil supply pump 40E according to a fifth embodiment of the present invention will be described.

[0089] As shown in FIG. 9, in the oil supply pump 40E, the oil introducing channels 46R1, 47R1 and the oil lead-out channels 46R2, 47R2 each have an opening with a smaller circumferential size than a radial size.

[0090] These characteristic oil introducing channels 46R1, 47R1 and the oil lead-out channels 46R2, 47R2 can advance shut off of the oil supply pump 40 and delay finish of discharge of the lubricant, thereby increasing an amount of supplied oil per opening area.

[0091] The present invention has been described based on the preferred embodiments. However, the configurations in the embodiments may be chosen or changed to other configurations without departing from the gist of the present invention. Some variations will be described below.

[0092] The first to fifth embodiments are directed to the oil supply pump including the two pump rotors, but the present invention may be applied to an oil supply pump including only one pump rotor with lubricant suction and discharge directions being in a thickness direction of the pump rotor. This oil supply pump includes a cylinder, and a pump rotor revolving inside the cylinder. An oil introducing channel is provided by concaving a peripheral edge surface of one or both of the cylinder and the pump rotor.

[0093] The oil introducing channels 46R1, 47R1 and the oil lead-out channels 46R2, 47R2 described above each have a constant opening area in the axial direction. The present invention is not limited to this, but the opening area may vary in the axial direction.

[0094] Next, with reference to FIGS. 10A, 10B and 10C, preferred limiting conditions for opening areas of some openings through which the lubricant flows in the oil supply pump 40 will be described. FIG. 10A shows an example without the oil introducing channels 46R1, 47R1 of the embodiments, while FIGS. 10B and 10C show conditions for preventing a reduction in the amount of supplied oil due to an insufficient opening area. Description will be made below on the oil introducing channels 46R1, 47R1, but the same applies to the oil lead-out channels 46R2, 47R2.

[0095] FIG. 10A shows a relationship between an opening area A1 of a gap between the outer rotor 46 and the inner rotor 47 in plan view in a projection plane of the second suction port 51B and an opening area A2 of the gap between the outer rotor 46 and the inner rotor 47 in a vertical section.

[0096] On the left in FIG. 10A, the opening area A1 is filled in an arcuate shape, and on the right in FIG. 10A, the opening area A2 is filled in a rectangular shape. The opening areas A1 and A2 each vary between a minimum value and a maximum value by revolution of the outer rotor 46 and the inner rotor 47. The same applies to FIGS. 10B and 10C.

[0097] When a minimum value ($A1_{min}$) of the opening area A1 is larger than a maximum value ($A2_{max}$) of the opening area A2, that is, Almin > $A2_{max}$, the amount of supplied oil can be easily ensured as compared to when Almin ≤ $A2_{max}$. However, without the oil introducing channels 46R1, 47R1, the preferred condition $A1_{min} > A2_{max}$ is not satisfied, or even if satisfied, a sufficient amount of supplied oil cannot be ensured because of a small difference between $A1_{min}$ and $A2_{max}$.

[0098] Then, as shown in FIG. 10B, in the first embodiment, the oil introducing channels 46R1, 47R1 are provided to extend through the pump rotors in the thickness direction.

[0099] Thus, comparing an opening area A3 formed by the oil introducing channels 46R1, 47R1 and the opening area A2 described above, a minimum value ($A3_{min}$) of the opening area A3 can be easily made larger than the maximum value ($A2_{max}$) of the opening area A2.

[0100] Also, as shown in FIG. 10C, the same applies to the second embodiment in which the oil introducing channels

46R1, 47R1 do not extend through the pump rotors in the thickness direction.

[0101] Specifically, as shown in FIG. 10C, comparing the opening area A3 and the opening area A2, the minimum value ($A3_{min}$) of the opening area A3 can be easily made larger than the maximum value ($A2_{max}$) of the opening area A2. In the case where the oil introducing channels 46R1, 47R1 do not extend through the pump rotors in the thickness direction, the opening area A3 is defined without the eaves 46E, 47E, and the opening area A2 is defined without the oil introducing channels 46R1, 47R1.

Reference Signs List

[0102]

1	scroll compressor
10	sealed housing
10A	low pressure chamber
10B	high pressure chamber
16	discharge reed valve
17	suction pipe
19	discharge pipe
30	electric motor
31	stator
33	rotor
35	output shaft
35A	eccentric shaft
37	oil reservoir
40, 40A, 40B, 40C, 40D, 40E	oil supply pump
41	cylinder
42	first cylinder chamber
42A	first oil suction chamber
42B	first oil discharge chamber
42S	slot
43	thrust plate
44	cover plate
45	pump rotor
46	outer rotor46E eaves
46P	protrusion
46S	slot
46R1	oil introducing channel
46R2	oil lead-out channel
47	inner rotor
47E	eaves
47P	protrusion
47R1	oil introducing channel
47R2	oil lead-out channel
48	second cylinder chamber
48A	second oil suction chamber
48B	second oil discharge chamber
49	suction channel
49A	vertical channel
49B	lateral channel
51A	first suction port
51B	second suction port
51C	first discharge port
51D	second discharge port
51E	third discharge port
52	first discharge channel
53	second discharge channel
60	scroll compression mechanism
61	fixed scroll

63	orbiting scroll

Claims

1. A compressor comprising:

    a compression mechanism;
    an electric motor that is configured to drive the compression mechanism; and
    a positive-displacement oil supply pump that is configured to include a pump rotor operated by a drive force of the electric motor and circulate a lubricant,
    wherein the oil supply pump includes:

        a suction port and a discharge port through which the lubricant flows in a thickness direction of the pump rotor;
        an oil suction chamber into which the lubricant flows through the suction port;
        an oil discharge chamber from which the lubricant flows toward a discharge port;
        an oil introducing channel that is provided correspondingly to the suction port and has a larger channel for the lubricant than the oil suction chamber; and
        an oil lead-out channel that is provided correspondingly to the discharge port and has a larger channel for the lubricant than the oil discharge chamber.

2. The compressor according to claim 1, wherein the oil supply pump includes:

    a cylinder;
    the pump rotor revolving inside the cylinder;
    the suction port through which the lubricant flows into the oil suction chamber provided between the cylinder and the pump rotor;
    the discharge port through which the lubricant flows from the oil discharge chamber provided between the cylinder and the pump rotor;
    the oil introducing channel provided correspondingly to the suction port by concaving a peripheral edge surface of one or both of the cylinder and the pump rotor; and
    the oil lead-out channel provided correspondingly to the discharge port by concaving a peripheral edge surface of one or both of the cylinder and the pump rotor.

3. The compressor according to claim 1, wherein the oil supply pump includes:

    a cylinder;
    an outer rotor revolving inside the cylinder;
    an inner rotor revolving inside the outer rotor;
    a first suction port through which the lubricant flows into a first oil suction chamber formed between the cylinder and the outer rotor;
    a second suction port through which the lubricant flows into a second oil suction chamber formed between the outer rotor and the inner rotor;
    a first discharge port through which the lubricant flows from a first oil discharge chamber formed between the cylinder and the outer rotor;
    a second discharge port through which the lubricant flows from a second oil discharge chamber formed between the outer rotor and the inner rotor;
    the oil introducing channel provided correspondingly to the second suction port by concaving a peripheral edge surface of one or both of the outer rotor and the inner rotor; and
    the oil lead-out channel provided correspondingly to the second discharge port by concaving a peripheral edge surface of one or both of the outer rotor and the inner rotor.

4. The compressor according to claim 2 or 3, wherein the oil introducing channel and the oil lead-out channel extend through the cylinder or the pump rotor in the thickness direction.

5. The compressor according to claim 2 or 3, wherein the oil introducing channel and the oil lead-out channel are provided only in a predetermined range in the thickness direction.

6. The compressor according to claim 2, wherein the oil introducing channel and the oil lead-out channel are provided only in the cylinder, or the oil introducing channel and the oil lead-out channel are provided only in the pump rotor.

7. The compressor according to claim 3, wherein the oil introducing channel and the oil lead-out channel are provided only in the outer rotor, or the oil introducing channel and the oil lead-out channel are provided only in the inner rotor.

8. The compressor according to any one of claims 1 to 7, wherein the oil introducing channel and the oil lead-out channel each have an opening with a circumferential size smaller than a radial size.

FIG. 1

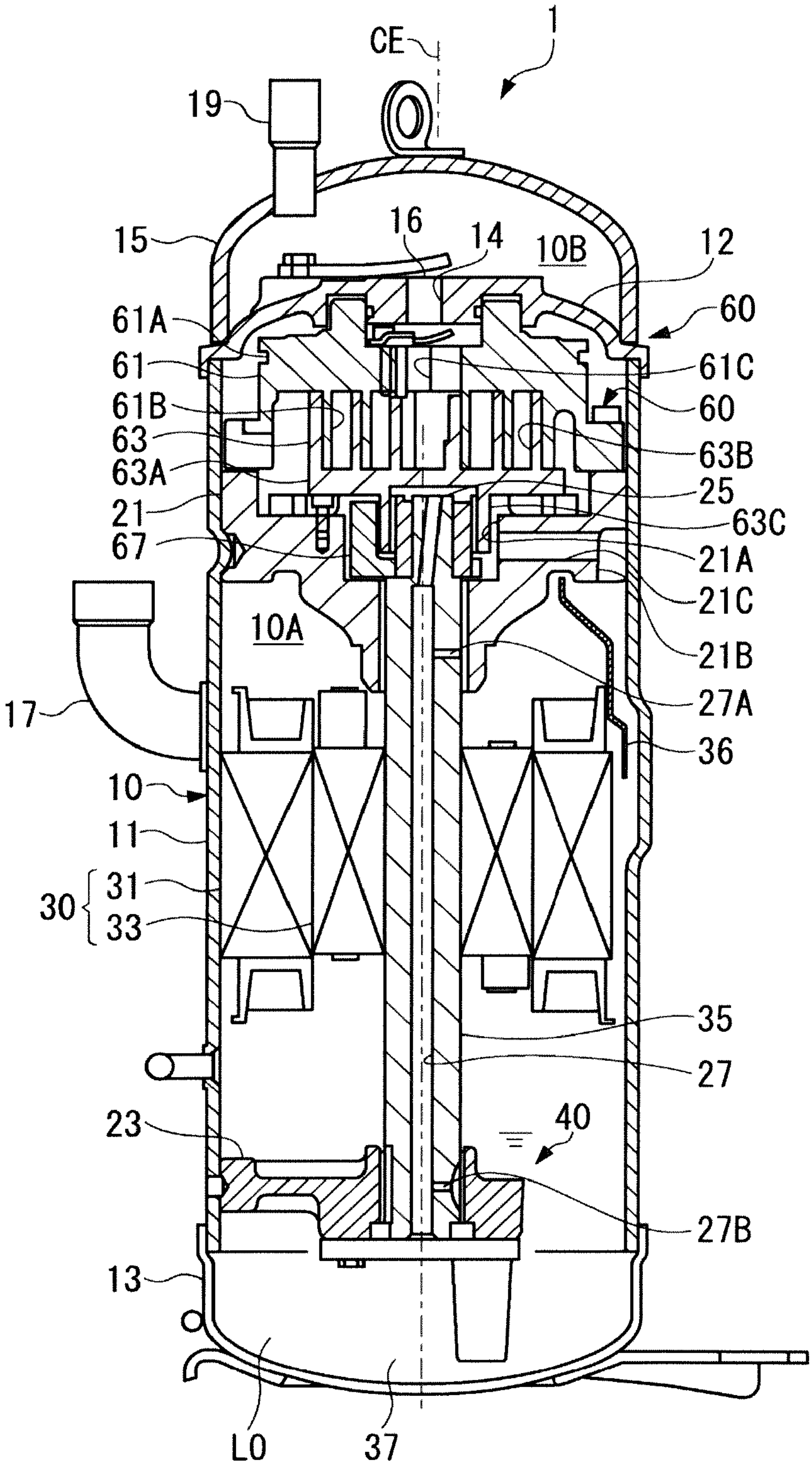

CE
1
19
16
14
10B
12
15
60
61A
61
61C
60
61B
63
63B
63A
25
21
63C
67
21A
21C
10A
21B
27A
17
36
10
11
30
31
33
35
27
23
40
27B
13
LO
37

FIG. 2

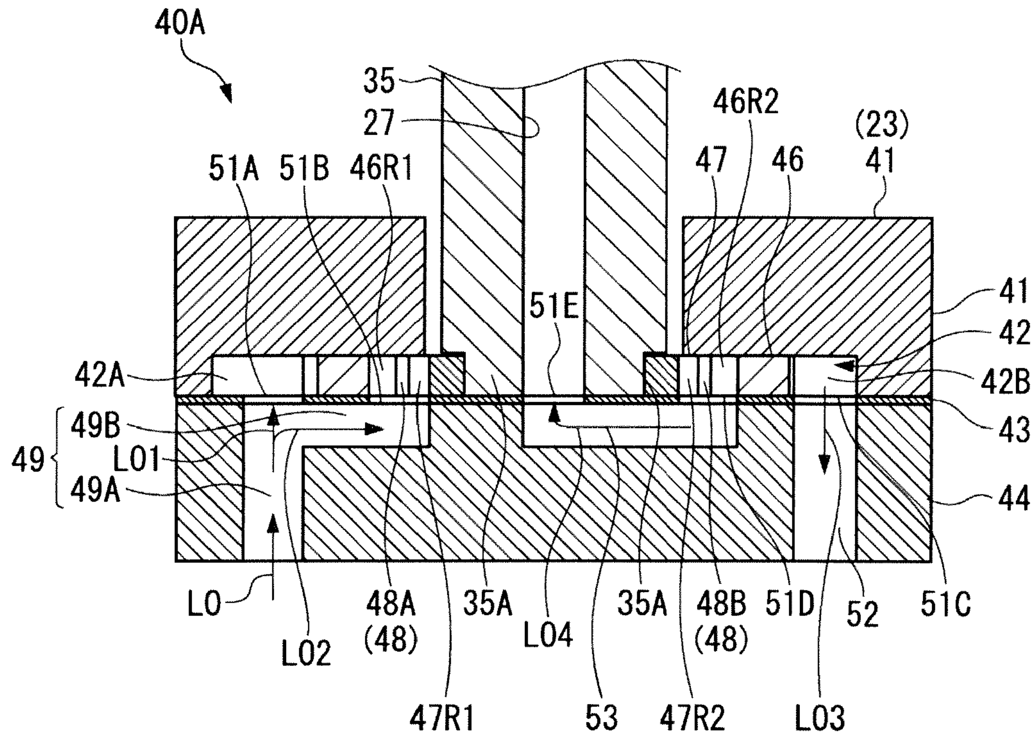

40A
35
27
46R2
(23)
41
51A
51B
46R1
47
46
41
51E
42
42A
42B
49B
43
49
L01
49A
44
L0
L02
48A
(48)
35A
L04
35A
48B
(48)
51D
52
51C
47R1
53
47R2
L03

FIG. 3

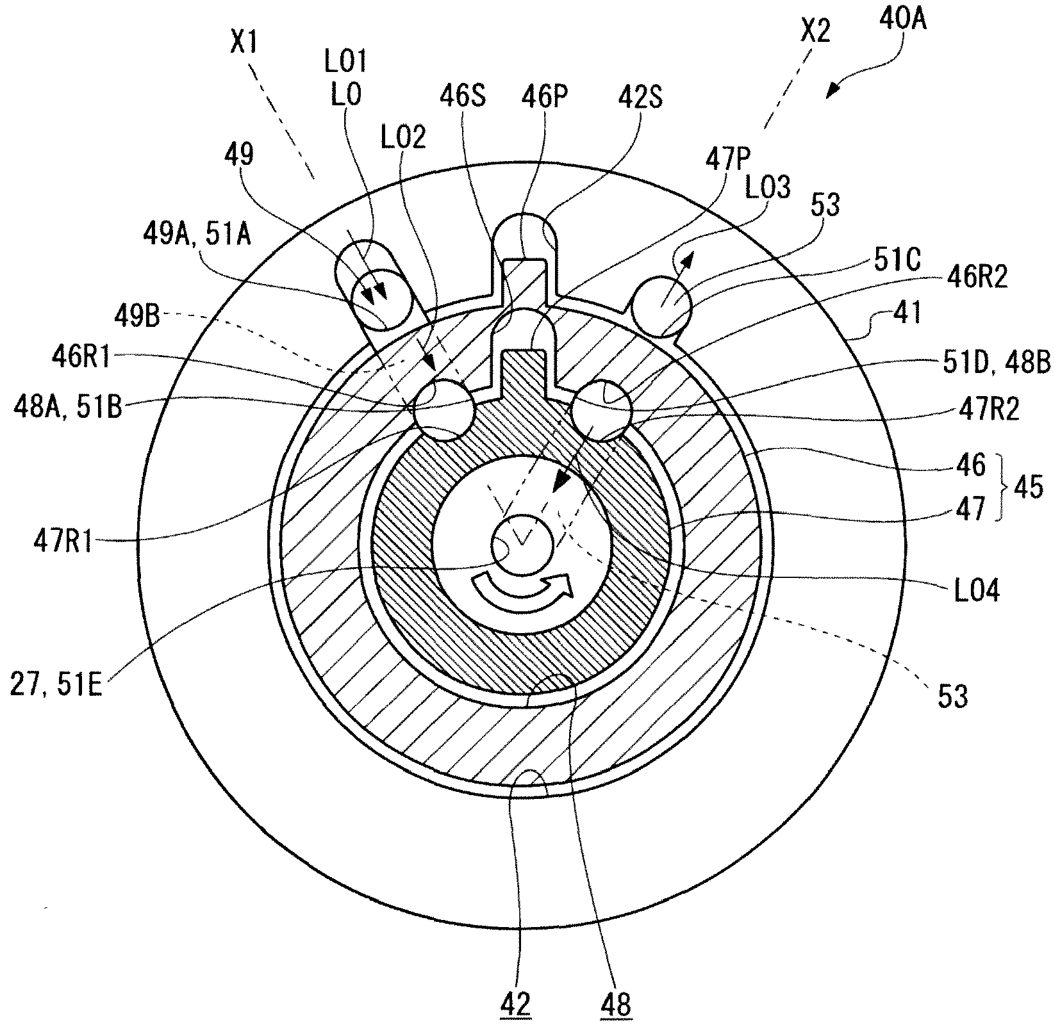

X1
L01
L0
46S
46P
42S
X2
40A
L02
49
47P
L03
53
49A, 51A
51C
46R2
41
49B
46R1
51D, 48B
48A, 51B
47R2
46
45
47
47R1
L04
27, 51E
53
42
48

FIG. 4A

FIG. 4D

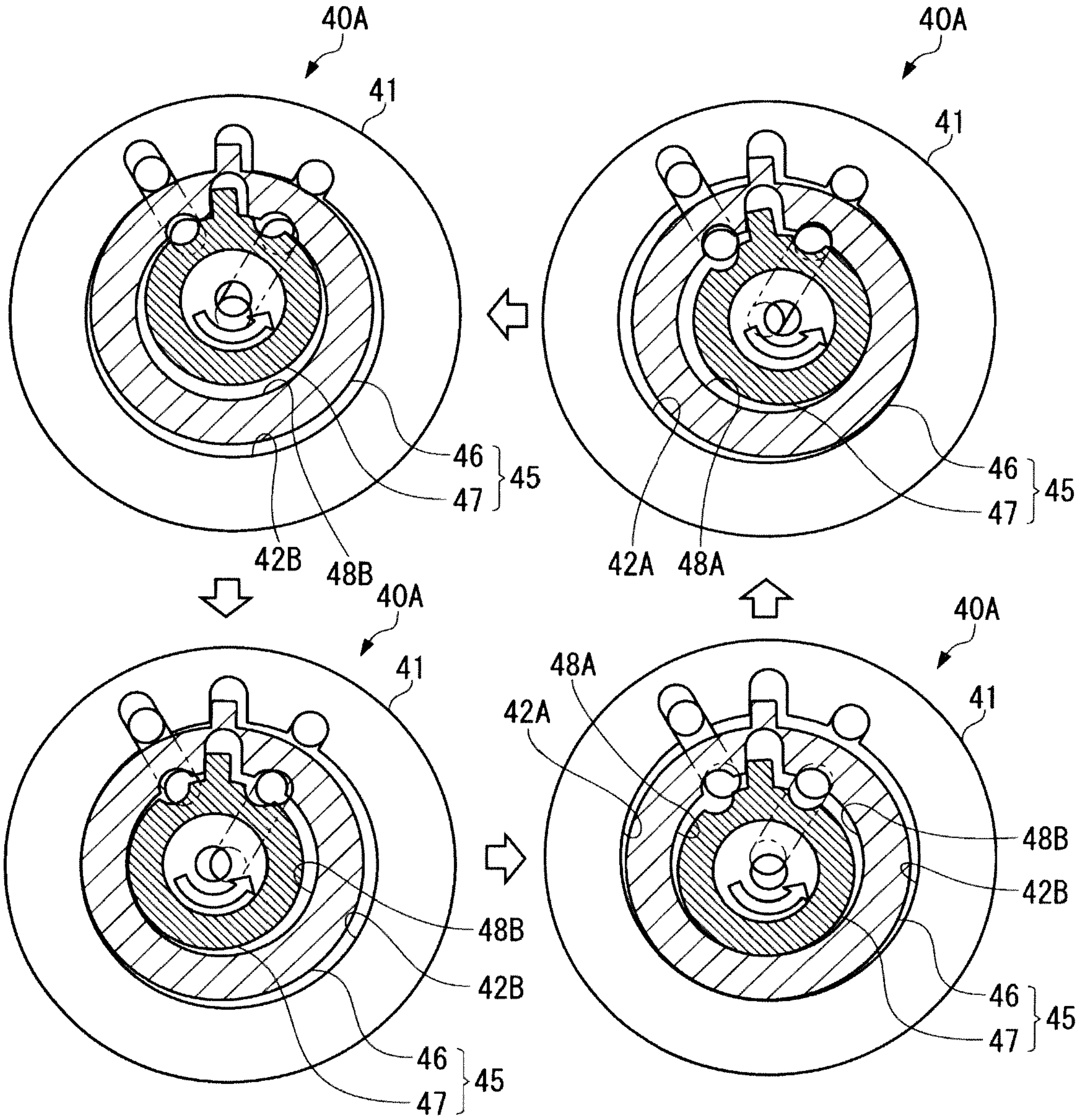


FIG. 4B

FIG. 4C

FIG. 5

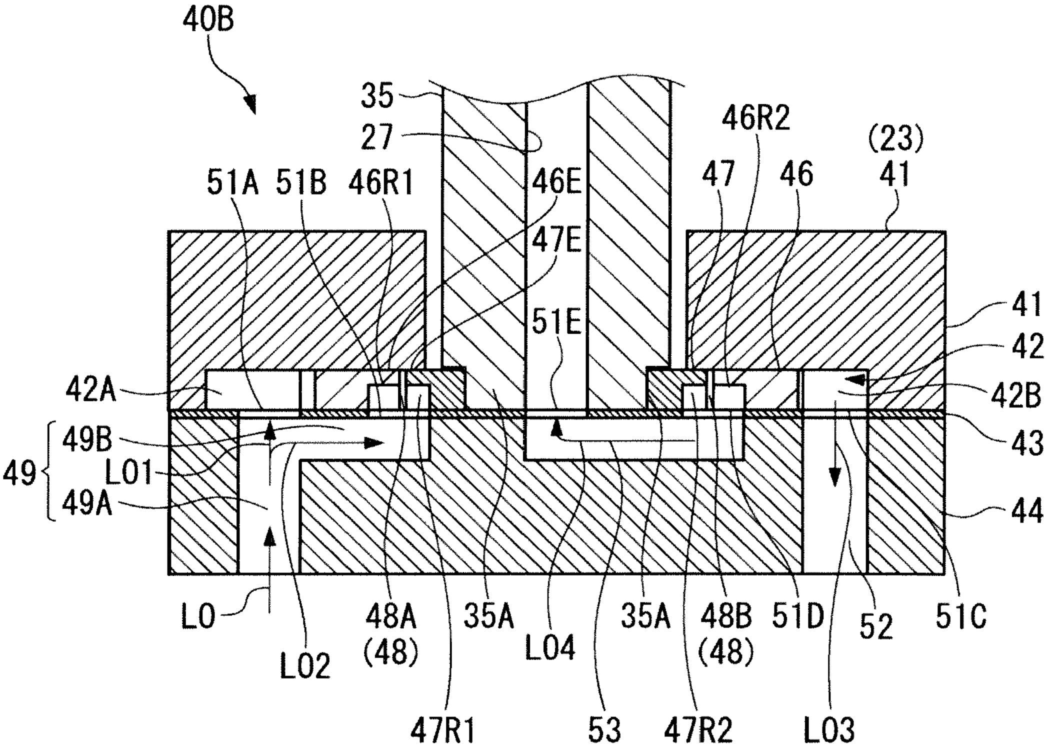
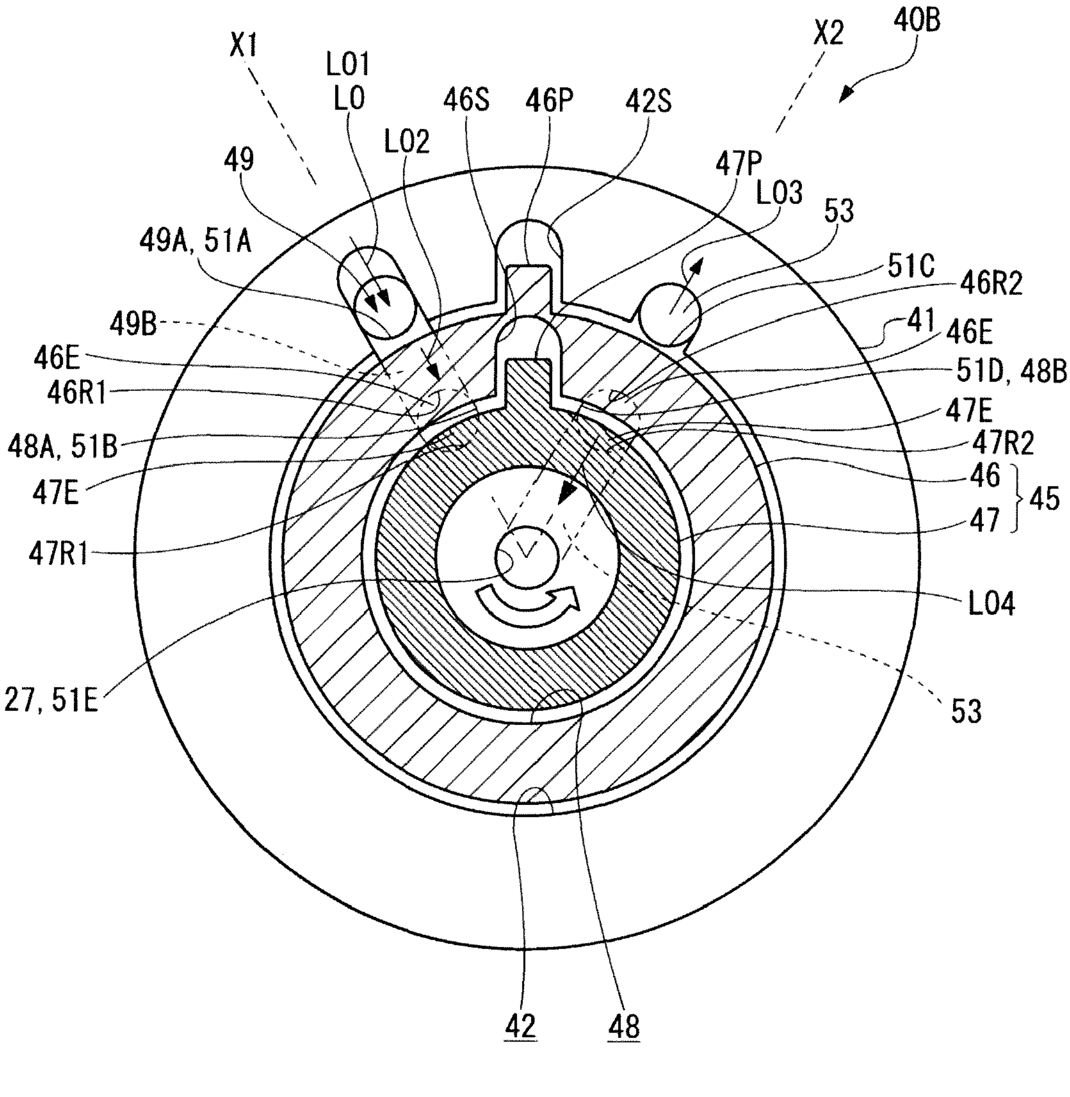
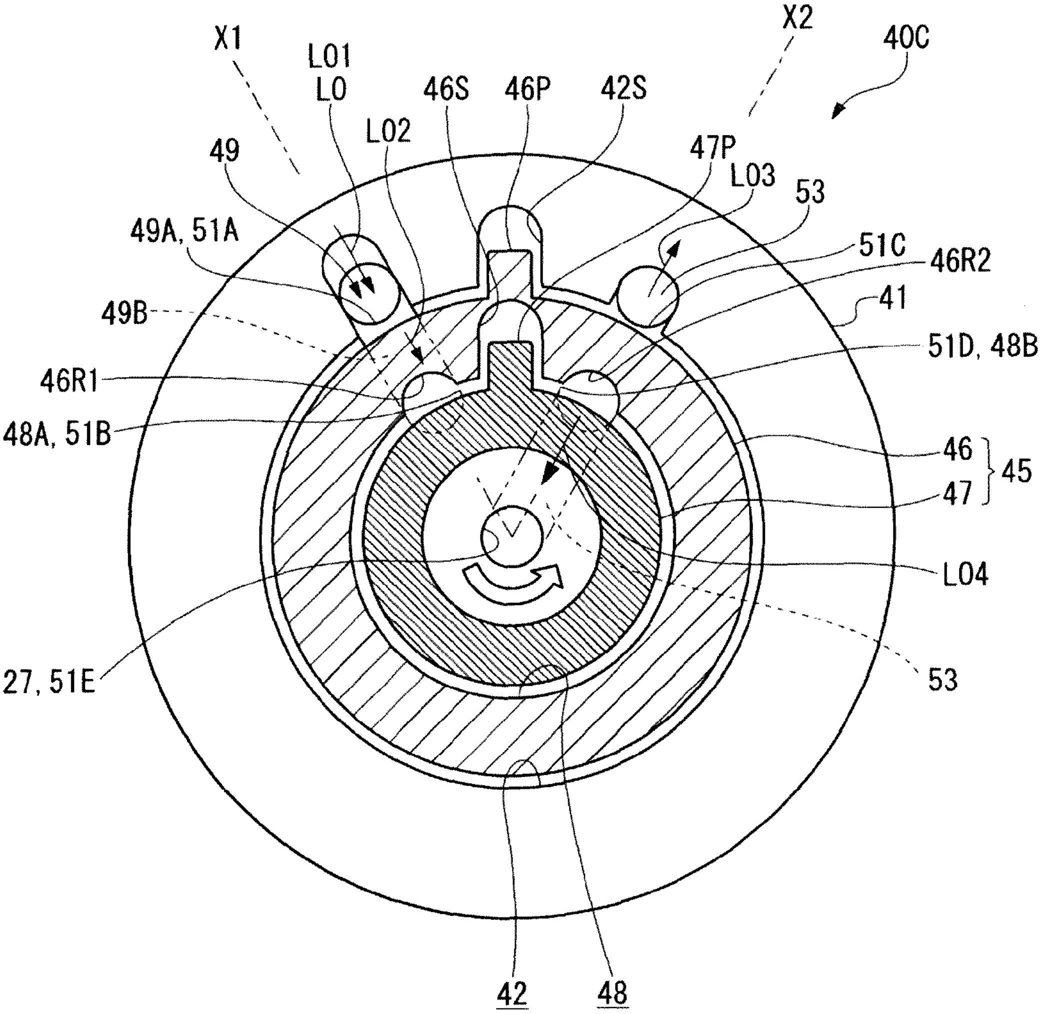

40B
35
27
46R2
(23)
41
51A
51B
46R1
46E
47
46
47E
41
51E
42
42A
42B
43
49B
49
L01
49A
44
L0
L02
48A
(48)
35A
L04
35A
48B
(48)
51D
52
51C
47R1
53
47R2
L03

FIG. 6



X1
L01
L0
46S
46P
42S
X2
40B
L02
49
47P
L03
53
49A, 51A
51C
46R2
49B
41
46E
46E
51D, 48B
46R1
47E
48A, 51B
47R2
46
45
47E
47
47R1
L04
27, 51E
53
42
48

FIG. 7A


X1
L01
L0
46S
46P
42S
X2
40C
L02
49
47P
L03
53
49A, 51A
51C
46R2
41
49B
51D, 48B
46R1
48A, 51B
46
45
47
L04
27, 51E
53
42
48

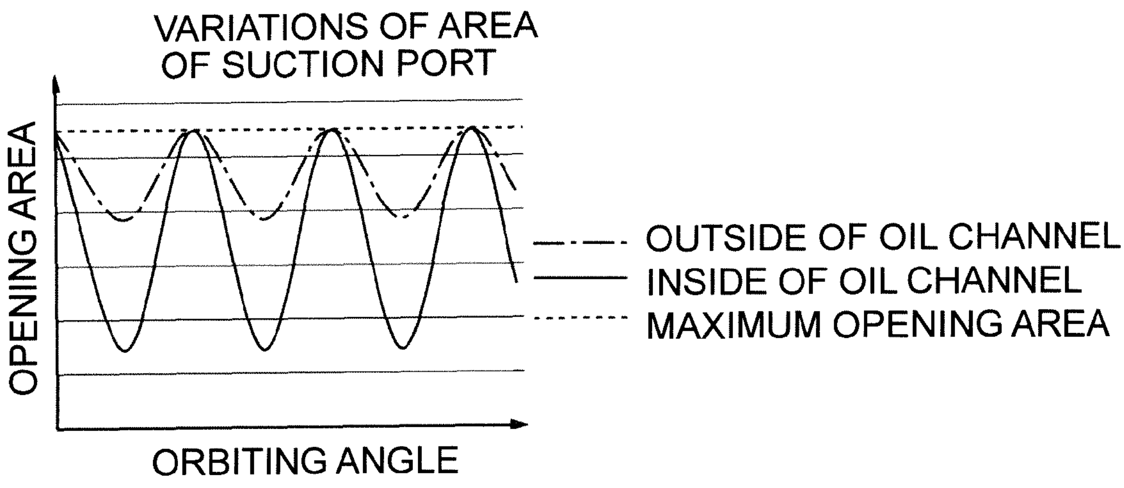
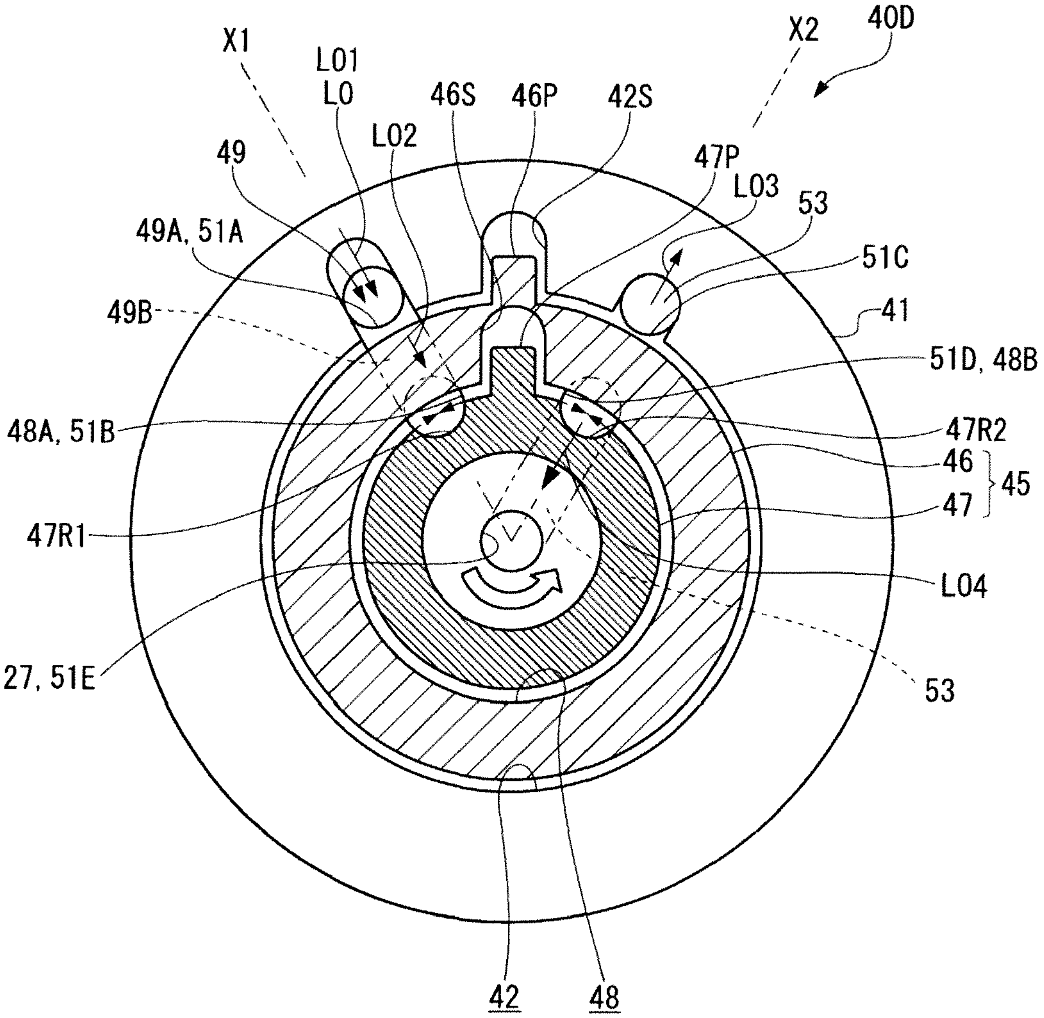

VARIATIONS OF AREA OF SUCTION PORT
OPENING AREA
ORBITING ANGLE
OUTSIDE OF OIL CHANNEL
INSIDE OF OIL CHANNEL
MAXIMUM OPENING AREA

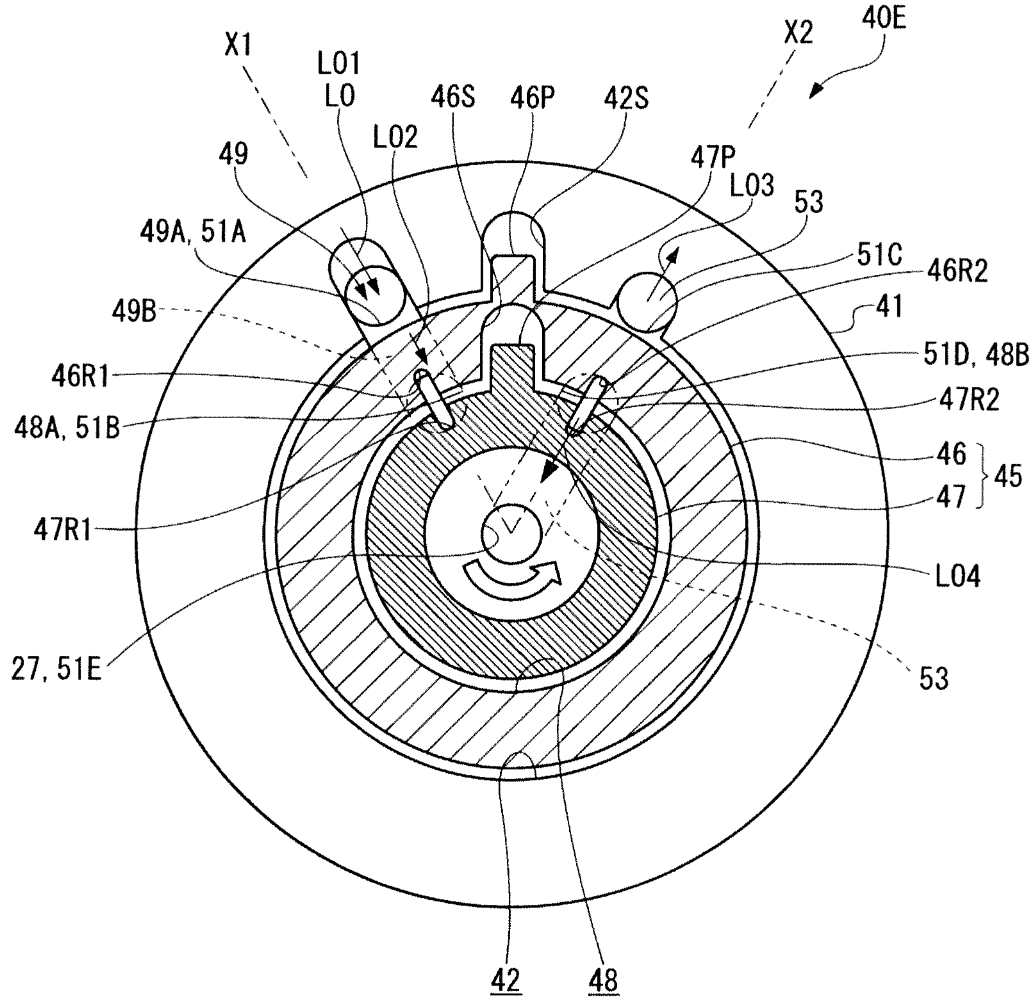
FIG. 7B

FIG. 8



X1
L01
L0
46S
46P
42S
X2
40D
49
L02
47P
L03
53
49A, 51A
51C
49B
41
51D, 48B
48A, 51B
47R2
46
45
47
47R1
L04
27, 51E
53
42
48

FIG. 9



X1
L01
L0
L02
46S
46P
42S
X2
40E
49
47P
L03
53
49A, 51A
51C
46R2
49B
41
51D, 48B
46R1
47R2
48A, 51B
46
45
47
47R1
L04
27, 51E
53
42
48

FIG. 10A

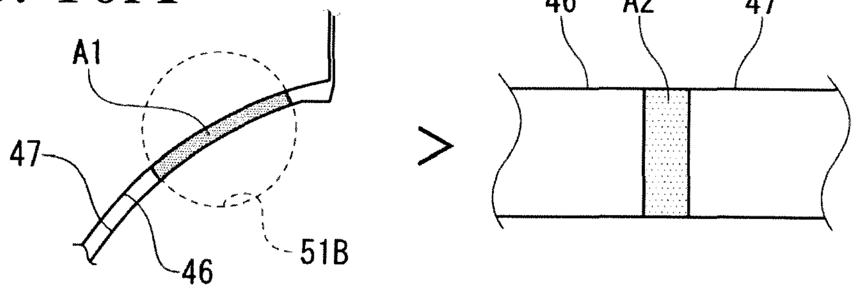


FIG. 10B

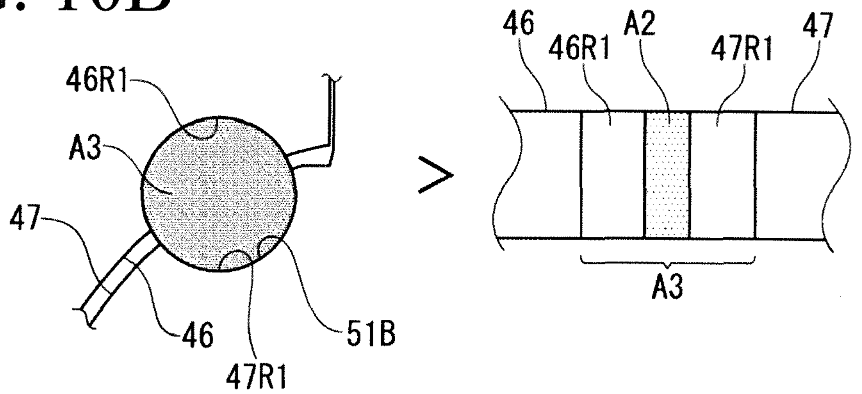
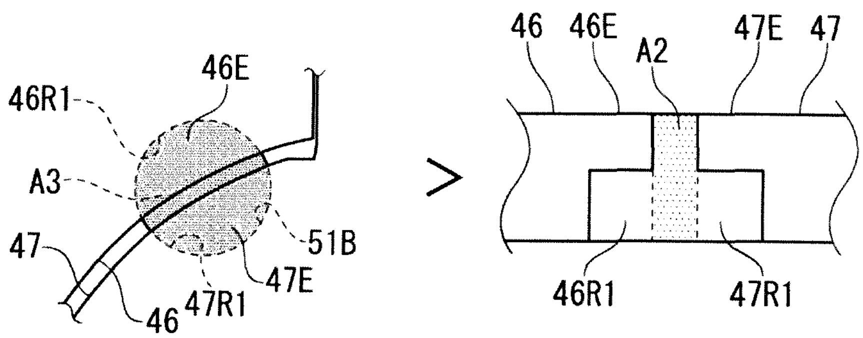


FIG. 10C



REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 9264281 A **[0003] [0004]**