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

(11) **EP 3 339 647 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
27.06.2018 Bulletin 2018/26

(21) Application number: **16863812.0**

(22) Date of filing: **24.10.2016**

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

(86) International application number:
PCT/JP2016/004676

(87) International publication number:
WO 2017/081845 (18.05.2017 Gazette 2017/20)

(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:
MA MD

(30) Priority: **11.11.2015 JP 2015220912**

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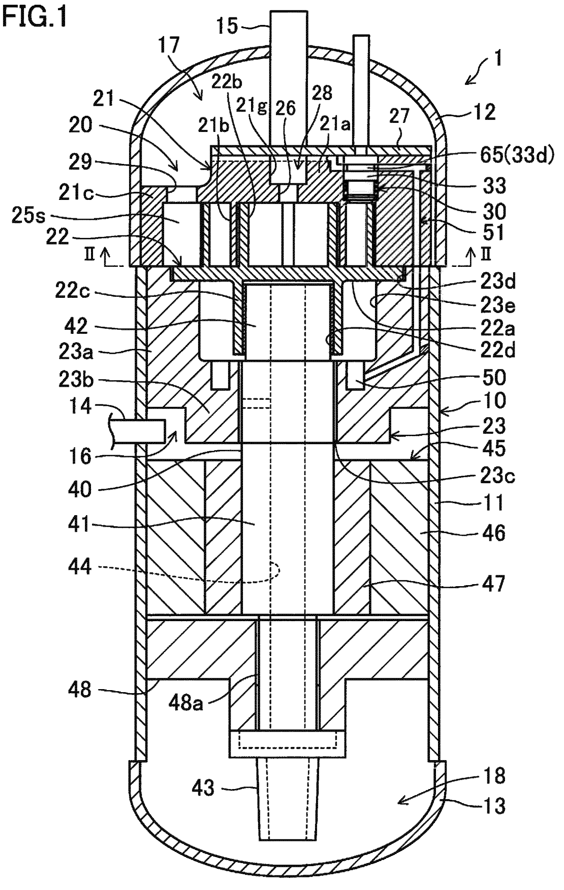
(54) **COMPRESSOR**

(57) An oil passage (51) is formed to communicate with an oil reservoir (50) formed inside a casing (10) and a suction space (25s) of a compression chamber. A plunger (33) of a suction volume adjustment mechanism (30) is disposed midway of the oil passage (51). The plunger (33) includes a switching portion (65) closing the oil passage (51) in a situation where a suction completion position is moved to a first position to allow the oil reservoir (50) not to communicate with the suction space (25s), and opening the oil passage (51) in a situation where the suction completion position is moved to a second position in which a suction volume is smaller than in the first position to allow the oil reservoir (50) to communicate with the suction space (25s).

FIG.1



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Description

TECHNICAL FIELD

[0001] The present disclosure is directed to a compressor including a suction bypass mechanism configured to change a position at which a suction process is completed and a compression process is started (hereinafter referred to as "suction completion position") to adjust a suction volume. The present disclosure relates to a technique of solving lubricant shortage in a compression mechanism.

BACKGROUND ART

[0002] In conventional compressors, inverters are widely used to allow the compressors to be used in various operations ranging from an operation at a high rotational speed to an operation at a low rotational speed. Generally, during an operation at a high rotational speed, the flow rate of a refrigerant inside a compressor is increased. This increases the amount of refrigerating machine oil to be sucked together with the refrigerant to be supplied to a compression mechanism of the compressor, resulting in an increase in the amount of the refrigerating machine oil to be discharged together with the refrigerant compressed. Therefore, it has been desired to reduce the amount of refrigerating machine oil to be supplied to the interior of the compression mechanism.

[0003] It has been suggested to provide a capacity adjusting mechanism to a compression mechanism in order to achieve performance of inverter control not only when a compressor is operated at a high rotational speed (hereinafter referred to as "the operation at the high operation capacity") but also when the compressor is operated at a low rotational speed (hereinafter referred to as "the operation at the low operation capacity" (See Patent Document 1). At the low operation capacity, the operation is generally performed at a low rotational speed, and its performance is lower at the low rotational speed than at the high rotational speed. In order to reduce performance degradation at the low rotational speed, it is preferable to allow the capacity adjusting mechanism to reduce the suction volume to increase the rotational speed.

[0004] For example, Patent Document 1 discloses a suction bypass mechanism which adjusts a suction volume by changing a suction completion position in a scroll compressor. The suction bypass mechanism of Patent Document 1 includes a plunger (valve) serving as an opening/closing mechanism allowing first and second compression chambers to switch between a communicating state and a shut-off state, the first compression chamber being provided between the inner peripheral surface of a fixed scroll and the outer peripheral surface of an orbiting scroll, and the second compression chamber being provided between the outer peripheral surface of the fixed scroll and the inner peripheral surface of the orbiting scroll. If this suction bypass mechanism allows the first and second compression chambers to communicate with each other, the suction completion position is changed from the position of the shut-off state to a position in which the suction volume is reduced. According to this configuration, in a situation where the operation capacity is substantially constant, a smaller suction volume allows the compression mechanism to be operated at a high rotational speed. This can achieve its performance.

CITATION LIST

PATENT DOCUMENT

[0005] [Patent Document 1] Japanese Unexamined Patent Publication No. 2007-154761

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0006] However, in a situation where the compressor is controlled at a low operation capacity, if the compressor is tried to be rotated at a higher speed than a situation where the capacity is not controlled, its performance can be less reduced than the situation where the capacity is not controlled. However, oil to be supplied to the compression chamber is insufficient due to the low operation capacity, and an oil film is not sufficiently formed inside the compression mechanism, resulting in insufficient performance.

[0007] That is to say, if oil loss at the high rotation capacity is reduced, oil supply necessary for forming the oil film inside the compression mechanism at the low operation capacity is also insufficient. Thus, in the compressor, it is actually difficult to reduce performance degradation at the low operation capacity and oil loss at the high operation capacity.

[0008] In view of the foregoing background, it is therefore an object of the present disclosure to provide a technique of improving performance of a compressor at a low operation capacity while reducing oil loss at a high operation capacity.

SOLUTION TO THE PROBLEM

[0009] A first aspect of the present disclosure is directed to a compressor including: a compression mechanism (20); and a casing (10) housing the compression mechanism (20), the compression mechanism (20) including a suction volume adjustment mechanism (30) capable of switching a suction completion position of a compression chamber (25a, 25b) in a suction process between a first position and a second position in which the suction volume is smaller than in the first position, the suction volume adjustment mechanism (30) including a plunger (33) switchable between a closed position in which the suction completion position is moved to the first position and an open position in which the suction completion position is moved to the second position.

[0010] This compressor further includes an oil passage (51) to allow an oil reservoir (18, 50) formed inside the casing (10) and a suction space (25s) of the compression chamber (25a, 25b) to communicate with each other, and the plunger (33) is disposed midway of the oil passage (51), and includes a switching portion (65) closing the oil passage (51) in the closed position to allow the oil reservoir (18, 50) not to communicate with the suction space (25s) of the compression chamber (25a, 25b), and opening the oil passage (51) in the open position to allow the oil reservoir (50) to communicate with the suction space (25s) of the compression chamber (25a, 25b).

[0011] According to the first aspect, if the suction completion position is in the first position, the plunger (33) is in the closed position. At that time, the oil passage (51) is blocked, and thus, no oil is supplied from the oil reservoir (18, 50) to the suction space (25s) of the compression chamber (25a, 25b). In contrast, if the suction completion position is in the second position, in which the suction volume is reduced, the plunger (33) is in the open position. At that time, the oil passage (51) is opened, and thus, oil is supplied from the oil reservoir (18, 50) to the suction space (25s) of the compression chamber (25a, 25b) by a negative pressure in the suction space (25s).

[0012] A second aspect of the present disclosure is an embodiment of the first aspect of the present disclosure. In the second aspect, the compression mechanism (20) is a compression mechanism (20) including a fixed scroll (21), and an orbiting scroll (22) meshing with the fixed scroll (21) and compressing a working fluid.

[0013] According to the second aspect, if in the scroll compressor, the suction completion position is in the first position and the plunger (33) is in the closed position, the oil passage (51) is blocked. Thus, no oil is supplied from the oil reservoir (18, 50) to the suction space (25s) of the compression chamber (25a, 25b). If the suction completion position is in the second position and the plunger (33) is in the open position in which the suction volume is reduced, the oil passage (51) is opened. Thus, oil is supplied from the oil reservoir (18, 50) to the suction space (25s) of the compression chamber (25a, 25b) by the negative pressure.

[0014] A third aspect of the present disclosure is an embodiment of the second aspect of the present disclosure. In the third aspect, the oil passage (51) has one end communicating with the oil reservoir (50) formed in a crank chamber (23e) that is a space inside the housing (23) of the compression mechanism (20), and the other end communicating with the suction space (25s) of the compression mechanism (20).

[0015] According to the third aspect, if the suction completion position is in the second position and the suction volume is reduced, the plunger (33) is in the open position and the oil passage (51) is opened. Thus, oil is supplied from the oil reservoir (18, 50) formed in the space (the crank chamber (23e)) inside the housing of the compression mechanism (20) to the suction space (25s) of the compression chamber (25a, 25b) by the negative pressure.

[0016] A fourth aspect of the present disclosure is an embodiment of the second aspect of the present disclosure. In the fourth aspect, the oil passage (51) includes an orbiting-scroll-side oil passage (55) and a fixed-scroll-side oil passage (52) communicating with the orbiting-scroll-side oil passage (55), the orbiting-scroll-side oil passage (55) has one end communicating with the fixed-scroll-side oil passage (52), and the other end opposite to one end and communicating with the oil reservoir (50), and the fixed-scroll-side oil passage (52) has one end communicating with the orbiting-scroll-side oil passage (55), and the other end opposite to one end and communicating with the suction space (25s) of the compression mechanism (20).

[0017] According to the fourth aspect, if the suction completion position is in the second position and the suction volume is reduced, the plunger (33) is in the open position and the oil passage (51) comprised of the orbiting-scroll-side oil passage (55) and the fixed-scroll-side oil passage (52) is opened. Thus, oil is supplied from the oil reservoir (18, 50) to the suction space (25s) of the compression chamber (25a, 25b) by the negative pressure.

[0018] A fifth aspect of the present disclosure is an embodiment of the second aspect of the present disclosure. In the fifth aspect, the oil passage (51) has an oil supply pipe (56) having one end communicating with the oil reservoir (18) formed inside the casing (10), and the other end communicating with the suction space (25s) of the compression mechanism (20).

[0019] According to the fifth aspect, if the suction completion position is in the second position and the suction volume is reduced, the plunger (33) is in the open position and the oil passage (51) is opened. Thus, oil is supplied from the oil reservoir (18, 50) formed in the casing (10) to the suction space (25s) of the compression chamber (25a, 25b) by the negative pressure.

[0020] A sixth aspect of the present disclosure is an embodiment of the second aspect of the present disclosure. In the sixth aspect, the oil passage (51) has an oil supply pipe (57) having one end communicating with an oil supply pump (43a) provided to a drive shaft of the compression mechanism (20), and the other end communicating with the suction space (25s) of the compression mechanism (20).

[0021] According to the sixth aspect, if the suction completion position is in the second position and the suction volume is reduced, the plunger (33) is in the open position and the oil passage (51) is opened. Thus, oil is supplied from the oil supply pump (43a) to the suction space (25s) of the compression chamber (25a, 25b).

[0022] A seventh aspect of the present disclosure is an embodiment of any one of the third to sixth aspects of the present disclosure. In the seventh aspect, the oil passage (51) has a fixed scroll inner passage (53) passing through an interior of the fixed scroll (21) to communicate with the plunger (33) and the suction space (25s) of the compression mechanism (20).

[0023] According to the seventh aspect, if the suction completion position is in the second position and the suction volume is reduced, the plunger (33) is in the open position and the oil passage (51) is opened. Thus, oil is supplied to the suction space (25s) of the compression chamber (25a, 25b) through the fixed scroll inner passage (53) in the interior of the fixed scroll (21).

[0024] An eighth aspect of the present disclosure is an embodiment of any one of the third to sixth aspects of the present disclosure. In the eighth aspect, the oil passage (51) has a fixed scroll outer passage (58) passing through a space formed outside the fixed scroll (21) and inside the casing (10) to communicate with the plunger (33) and the suction space (25s) of the compression mechanism (20).

[0025] According to the eighth aspect, if the suction completion position is in the second position and the suction volume is reduced, the plunger (33) is in the open position and the oil passage (51) is opened. Thus, oil is supplied from the oil reservoir (18, 50) formed in the casing (10) to the suction space (25s) of the compression chamber (25a, 25b) through the space formed outside the fixed scroll (21) and inside the casing (10).

[0026] A ninth aspect of the present disclosure is an embodiment of any one of the third to sixth aspects of the present disclosure. In the ninth aspect, the suction volume adjustment mechanism (30) has a discharge passage (60) discharging the working fluid from the plunger (33) in the second position into a space formed outside the fixed scroll (21) and inside the casing (10), and the oil passage (51) has an oil mix passage (53a) having one end communicating with the plunger (33), and the other end communicating with the discharge passage (60).

[0027] According to the ninth aspect, if the suction completion position is in the second position and the suction volume is reduced, the plunger (33) is in the open position and the oil passage (51) including the oil mix passage (53a) communicating with the discharge passage (60) is opened. Thus, oil is supplied from the oil reservoir (18, 50) formed in the casing (10) to the suction space (25s) of the compression chamber (25a, 25b) through the space formed outside the fixed scroll (21) and inside the casing (10).

[0028] A tenth aspect of the present disclosure is an embodiment of any one of the one to ninth aspects of the present disclosure. In the tenth aspect, the plunger (33) is a cylindrical valve body, and has an outer surface provided with a circumferential groove (33d) that is disposed on the oil passage (51) in the second position and is deviated from the oil passage (51) in the first position.

[0029] An eleventh aspect of the present disclosure is an embodiment of the tenth aspect of the present disclosure. In the eleventh aspect, the plunger (33) includes a sealing member (33e) at both sides of the circumferential groove (33d) formed in the outer surface of the plunger (33).

ADVANTAGES OF THE INVENTION

[0030] According to the first aspect of the present disclosure, if the suction completion position is in the first position and no capacity control is performed, the plunger (33) is in the closed position to block the oil passage (51). This operation is the operation performed a high operation capacity, and the flow rate of the refrigerant inside the compressor is increased. Thus, oil is sufficiently sucked into the compression chambers (25a, 25b) and excessive oil is not supplied from the oil passage (51) to the compression chambers (25a, 25b). This reduces oil loss while maintaining its performance.

[0031] In contrast, if the suction completion position is in the second position and the capacity is controlled such that the suction volume is reduced, the plunger (33) is in the open position and the oil passage (51) is opened. This operation is the operation performed a low operation capacity, and the flow rate of the refrigerant inside the compressor is decreased. Therefore, although oil mixed in the refrigerant is insufficiently sucked into the compression chambers (25a, 25b), oil is supplied from the oil passage (51) to the compression chambers (25a, 25b) as well. According to the first aspect of the present disclosure, at that time, the oil film can be sufficiently formed in the interior of the compression mechanism, compared to the case where the capacity of the compressor is not controlled. This can improve performance of the compressor.

[0032] According to the second aspect of the present disclosure, in the scroll compressor, if the suction completion position is in the first position and no capacity control is performed, the plunger (33) is in the closed position to block the oil passage (51). This operation is the operation performed a high operation capacity, and the flow rate of the refrigerant inside the compressor is increased. Thus, oil is sufficiently sucked into the compression chambers (25a, 25b) and excessive oil is not supplied from the oil passage (51) to the compression chambers (25a, 25b). This reduces oil loss while maintaining its performance.

[0033] In contrast, if the suction completion position is in the second position and the capacity is controlled such that the suction volume is reduced, the plunger (33) is in the open position and the oil passage (51) is opened. This operation is the operation performed a low operation capacity, and the flow rate of the refrigerant inside the compressor is decreased. Therefore, although oil mixed in the refrigerant is insufficiently sucked into the compression chambers (25a, 25b), oil is supplied from the oil passage (51) to the compression chambers (25a, 25b) as well. According to the second aspect of the present disclosure, at that time, the oil film can be sufficiently formed in the interior of the compression mechanism, compared to the case where the capacity of the compressor is not controlled. This can improve performance of the compressor.

[0034] According to the third aspect of the present disclosure, oil can be supplied to the compression chambers (25a, 25b) during adjustment of the suction volume using the oil passage (51) having one end communicating with the oil reservoir (18, 50) formed in the space inside the housing (23) of the compression mechanism (20) (the crank chamber (23e)), and the other end communicating with the suction space (25s) of the compression mechanism (20). Therefore, this can improve performance of the scroll compressor with a simple configuration.

[0035] According to the fourth aspect of the present disclosure, oil can be supplied to the compression chambers (25a, 25b) during adjustment of the suction volume, using the oil passage (51) comprised of the orbiting-scroll-side oil passage (55) and the fixed-scroll-side oil passage (52), and having one end communicating with the oil reservoir (18, 50) and the other end communicating with the suction space (25s) of the compression mechanism (20). Therefore, this can reduce performance degradation of the scroll compressor and oil loss with a simple configuration.

[0036] According to the fifth aspect of the present disclosure, oil can be supplied to the compression chambers (25a, 25b) during adjustment of the suction volume using the oil passage (51) having one end communicating with the oil reservoir (18, 50) formed in the casing (10) of the compressor, and the other end communicating with the suction space (25s) of the compression mechanism (20). Therefore, this can improve performance of the scroll compressor with a simple configuration.

[0037] According to the sixth aspect of the present disclosure, oil can be supplied to the compression chambers (25a, 25b) during adjustment of the suction volume using the oil passage (51) having one end communicating with the oil supply pump (43a), and the other end communicating with the suction space (25s) of the compression mechanism (20). Therefore, this can improve performance of the scroll compressor with a simple configuration.

[0038] According to the seventh aspect of the present disclosure, oil can be supplied to the compression chambers (25a, 25b) during adjustment of the suction volume using the oil passage (51) having the fixed scroll inner passage (53) passing through the inside of the fixed scroll (21) to communicate with the plunger (33) and the suction space (25s) of the compression mechanism (20). Therefore, this can improve performance of the scroll compressor with a simple configuration.

[0039] According to the eighth aspect of the present disclosure, oil can be supplied to the compression chambers (25a, 25b) during adjustment of the suction volume using the oil passage (51) having the fixed scroll outer passage (58) passing through the space formed outside the fixed scroll (21) and inside the casing (10) to communicate with the plunger (33) and the suction space (25s) of the compression mechanism (20). Therefore, this can improve performance of the scroll compressor with a simple configuration.

[0040] According to the ninth aspect of the present disclosure, oil can be supplied to the compression chambers (25a, 25b) during adjustment of the suction volume using the oil passage (51) having the oil mix passage (53a) communicating with the discharge passage (60) discharging the working fluid from the plunger (33) into the space formed outside the fixed scroll (21) and inside the casing (10). Therefore, this can improve performance of the scroll compressor with a simple configuration.

[0041] According to the tenth aspect of the present disclosure, a suction volume adjustment mechanism (30) can be provided with a simple configuration having the plunger (33) that is a cylindrical valve body. According to the eleventh aspect of the present disclosure, the plunger (33) is provided with the sealing member (33e), thereby making it possible to reduce oil leakage.

BRIEF DESCRIPTION OF THE DRAWINGS

[0042]

[FIG. 1] FIG. 1 is a vertical cross-sectional view of a compressor according to a first embodiment.

[FIG. 2] FIG. 2 illustrates the shape of a fixed scroll and the shape of an orbiting scroll in a cross-section taken along line II-II of FIG. 1.

[FIG. 3] FIG. 3 is an enlarged cross-sectional view of a compression mechanism.

[FIG. 4] FIG. 4 illustrates a cross-sectional structure of an opening/closing mechanism.

[FIG. 5] FIG. 5 is an enlarged front view of a plunger.

[FIG. 6] FIG. 6 is a plan view illustrating the shape of a transverse passage of an oil passage.

[FIG. 7] FIG. 7 illustrates the compression mechanism in a first operation state.

[FIG. 8] FIG. 8 illustrates the compression mechanism in a second operation state.

[FIG. 9] FIG. 9 illustrates the compression mechanism in a third operation state.

[FIG. 10] FIG. 10 illustrates the compression mechanism in a fourth operation state.

[FIG. 11] FIG. 11 illustrates the compression mechanism in a fifth operation state.

[FIG. 12] FIG. 12 illustrates the compression mechanism in a sixth operation state.

[FIG. 13] FIG. 13 illustrates a cross-sectional structure of a compression mechanism according to a variation of the first embodiment.

[FIG. 14] FIG. 14 is a plan view of the fixed scroll of the compression mechanism of FIG. 3.

[FIG. 15] FIG. 15 is a vertical cross-sectional view of a compressor according to a second embodiment.

[FIG. 16] FIG. 16 is an enlarged cross-sectional view of a compression mechanism in FIG. 15.

[FIG. 17] FIG. 17 is a vertical cross-sectional view of a compressor according to a third embodiment.

[FIG. 18] FIG. 18 is a vertical cross-sectional view of a compressor according to a fourth embodiment.

[FIG. 19] FIG. 19 is a plan view of a compressor according to a fifth embodiment.

[FIG. 20] FIG. 20 is a cross-sectional view illustrating a first state of a plunger of the compression mechanism of FIG. 19.

[FIG. 21] FIG. 21 is a cross-sectional view illustrating a second state of the plunger of the compression mechanism of FIG. 19.

[FIG. 22] FIG. 22 is a plan view of a compressor according to a sixth embodiment.

[FIG. 23] FIG. 23 is a cross-sectional view illustrating a configuration for the plunger of the compression mechanism of FIG. 22.

[FIG. 24] FIG. 24 is an enlarged view of a plunger according to a variation.

DESCRIPTION OF EMBODIMENTS

[0043] Embodiments of the present disclosure will now be described in detail with reference to the drawings.

«First Embodiment»

[0044] A first embodiment of the present disclosure is now described.

[0045] A scroll compressor according to this embodiment is provided to, e.g., a refrigerant circuit of an air conditioner performing a vapor compression refrigeration cycle, and compresses a low-pressure refrigerant that has been sucked from an evaporator to discharge it into a condenser.

[0046] As illustrated in FIG. 1, the scroll compressor (1) is a so-called hermetic compressor. This scroll compressor (1) includes a casing (10) that is a hermetically-sealed container with a vertically oriented cylindrical shape. The casing (10) includes a body (11) with a vertically oriented cylindrical shape, an upper end plate (12) fixed to the upper end of the body (11), and a lower end plate (13) fixed to the lower end of the body (11).

[0047] This casing (10) houses a compression mechanism (20) compressing a refrigerant, and an electric motor (45) driving the compression mechanism (20). The electric motor (45) is disposed below the compression mechanism (20), and is coupled to the compression mechanism (20) through a drive shaft (40) that is a rotational shaft. The electric motor (45) is implemented as a brushless DC motor controlled by an inverter to adjust a rotational speed to be variable.

[0048] A discharge pipe (15) passes through and is attached to the upper end plate (12) that is a top of the casing (10). This discharge pipe (15) has its terminal end (the lower end in the figure) connected to the compression mechanism (20). A suction pipe (14) passes through and is attached to the body (11) of the casing (10). This suction pipe (14) has its terminal end (the right end in the figure) open toward a space between the compression mechanism (20) and the electric motor (45) in the casing (10).

[0049] The drive shaft (40) is disposed on the vertical center line of the casing (10). The drive shaft (40) is a crank shaft including a main shaft portion (41) and an eccentric portion (42). The eccentric portion (42) has a smaller diameter than the main shaft portion (41), and is formed on the upper surface of the main shaft portion (41). The eccentric portion (42) is eccentric from the axial center of the main shaft portion (41) by a predetermined dimension, and constitutes an eccentric pin. FIGS. 1 and 2 show a state where the main shaft portion (41) and the eccentric portion (42) are coaxially disposed. That is because FIGS. 1 and 2 are cross-sections viewed from a position in which the center of the main shaft portion (41) and the center of the eccentric portion (42) are on the same line. For example, if the compressor is viewed from its lateral direction of FIGS. 1 and 2, the center of the main shaft portion (41) and the center of the eccentric portion (42) are eccentric from each other.

[0050] A lower bearing holder (48) is fixed to a portion adjacent to the lower end of the body (11) of the casing (10). This lower bearing holder (48) rotatably supports the lower end of the main shaft portion (41) of the drive shaft (40) through a sliding bearing (48a).

[0051] The interior of the drive shaft (40) is provided with an oil supply passage (44) extending vertically. The lower end of the main shaft portion (41) is provided with an oil supply pump (43). This oil supply pump (43) sucks refrigerating machine oil from the bottom of the casing (10). The refrigerating machine oil passes through the oil supply passage (44) of the drive shaft (40) to be supplied to the sliding portion of the compression mechanism (20) and the bearing of the drive shaft (40).

[0052] The electric motor(45) is comprised of a stator (46) and a rotor (47). The stator (46) is fixed to the body (11) of the casing (10). The rotor (47) is coupled to the main shaft portion (41) of the drive shaft (40) to drive the drive shaft (40) in rotation.

[0053] The compression mechanism (20) includes a fixed scroll (21), an orbiting scroll (22), and a housing (23) fixing and supporting the fixed scroll (21). The fixed scroll (21) and the orbiting scroll (22) respectively include spiral laps (21b, 22b) meshing with each other on end plates (21a, 22a), which will be described later. The compression mechanism (20) is configured such that the orbiting scroll (22) rotates eccentrically relative to the fixed scroll (21).

[0054] The housing (23) is comprised of a body (23a) and a bearing holder (23b). The body (23a) is formed to be vertically continuous with the bearing holder (23b), and the body (23a) is fitted into and coupled to the body (11) of the casing (10). The bearing holder (23b) has a smaller diameter than the body (23a), and protrudes downward from the body (23a). The bearing holder (23b) rotatably supports the main shaft portion (41) of the drive shaft (40) through a sliding bearing (23c).

[0055] The fixed scroll (21) is comprised of a fixed end plate (21a), a fixed lap (21b), and an edge portion (21c).

The fixed end plate (21a) is formed to have a substantially disk shape. The fixed lap (21b) stands near the middle portion of the lower surface of the fixed end plate (21a), and is integrally formed with the fixed end plate (21a). The fixed lap (21b) is formed to have a spiral wall shape with a constant height. The edge portion (21c) is a wall extending downward from the outer peripheral portion of the fixed end plate (21a), and has a lower surface overlapping with the upper surface of the body (23a) of the housing (23) to be fixed to the housing (23).

[0056] The orbiting scroll (22) is comprised of an orbiting end plate (22a), an orbiting lap (22b), and a boss (22c). The orbiting end plate (22a) is formed to have a substantially disk shape. The orbiting lap (22b) stands on the upper surface of the orbiting end plate (22a), and is integrally formed with the orbiting end plate (22a). The orbiting lap (22b) is formed to have a spiral wall shape with a constant height, and to mesh with the fixed lap (21b) of the fixed scroll (21). The boss (22c) extends downwardly from the lower surface of the orbiting end plate (22a), and integrally formed with the orbiting end plate (22a).

[0057] The eccentric portion(42) of the drive shaft (40) is inserted into the boss (22c) through a sliding bearing (22d). Therefore, if the drive shaft (40) rotates, the orbiting scroll (22) revolves around the axial center of the main shaft portion (41). The revolution radius of the orbiting scroll (22) is the same as the eccentricity of the eccentric portion(42), i.e., a distance from the axial center of the main shaft portion (41) to the axial center of the eccentric portion (42).

[0058] The orbiting end plate (22a) is disposed in a first recess (23d) provided to the upper end of the housing (23). The boss (22c) is disposed in a second recess (a crank chamber) (23e) provided to the body (23a) of the housing (23). Although not shown, the Oldham coupling is disposed between the orbiting end plate (22a) and the housing (23) to prevent the orbiting scroll (22) from rotating on its axis. The first recess (23d) is formed large enough to allow the orbiting end plate (22a) to rotate eccentrically, and the second recess (23e) is formed large enough to allow the boss (22c) to rotate eccentrically (the size relation therebetween is not considered on the figures).

[0059] FIG. 2 illustrates the shape of the fixed scroll and the shape of the orbiting scroll in a cross-section taken along line II-II of FIG. 1. As shown in FIG. 2, the scroll compressor (1) in this embodiment has a so-called asymmetrical spiral structure. The number of turns or windings of the spiral (the length of the spiral) differs between the fixed lap (21b) and the orbiting lap (22b). Specifically, the number of turns or windings of the spiral of the fixed lap (21b) is longer than that of the orbiting lap (22b) by about a half turn. However, the outermost periphery, i.e., the last turn or winding of the fixed lap (21b) has no outer surface, and the portion of the fixed lap (21b) corresponding to the outer surface of the outermost periphery is continuous with the edge portion (21c) of the fixed scroll (21). The spiral of the fixed lap (21b) is ended such that its outer peripheral end faces its inner peripheral end longer than the outer peripheral end by one turn, and is located near the outer peripheral end (turn or winding end) of the orbiting lap (22b).

[0060] The compression mechanism (20) includes a plurality of compression chambers (25a, 25b) in a space between the fixed end plate (21a) and the orbiting end plate (22a). The compression chambers (25a, 25b) are defined by allowing the fixed lap (21b) to mesh with the orbiting lap (22b). The plurality of the compression chambers (25a, 25b) include a plurality of first compression chambers (25a) and a plurality of second compression chambers (25b). The first compression chamber (25a) is defined by a space between the inner peripheral surface of the fixed lap (21b) and the outer peripheral surface of the orbiting lap (22b). The second compression chamber (25b) is defined by a space between the outer peripheral surface of the fixed lap (21b) and the inner peripheral surface of the orbiting lap (22b). In this embodiment, the number of turns or windings of the fixed lap (21b) is greater than that of the orbiting lap (22b), and thus, the maximum capacity of the first compression chamber (25a) is larger than that of the second compression chamber (25b).

[0061] As shown in FIGS. 1 and 2, the outer periphery of the fixed scroll (21) is provided with a suction port (29). This suction port (29) is open toward a space above the compression mechanism (20). The suction port (29), along with the revolution of the orbiting scroll (22), intermittently communicates with the first compression chamber (25a) and the second compression chamber (25b).

[0062] The upper end of the fixed end plate (21a) is provided with a depression (21g), and a discharge cover (27) is attached to the upper surface of the fixed end plate (21a) to cover a depression (21g). A space where the depression (21g) is covered with the discharge cover (27) is a discharge chamber (28) communicating with the discharge pipe (15). A middle lower portion of the fixed end plate (21a) is provided with a discharge port (26) communicating with the discharge chamber (28). The discharge port (26), along with the revolution of the orbiting scroll (22), intermittently communicates with the first compression chamber (25a) and the second compression chamber (25b). In this embodiment, in the interior of the casing (10), both upper and lower spaces (16) and (17) of the housing (23) are low-pressure spaces filled with a low-pressure refrigerant.

[0063] In this embodiment, as shown in FIG. 3 that is an enlarged view of the compression mechanism (20), a suction volume adjustment mechanism (30) is provided to adjust a suction completion position of the compression chambers (25a, 25b) in the suction process of the compression mechanism (20) to adjust the suction volume. This suction volume adjustment mechanism (30) is configured to adjust the suction completion position (at which the suction process is completed and a compression process is started) in both the first and second compression chambers (25a) and (25b). Only one suction volume adjustment mechanism (30) is provided to the outer spiral periphery within one turn, as shown in FIG. 2. The suction volume adjustment mechanism (30) is configured to adjust the suction volume by switching the suction completion position of the compression chambers (25a, 25b) in the suction process between a first position and a second position in which the suction volume is smaller than in the first position. The suction volume adjustment mechanism (30) is an opening/closing mechanism (31) allowing the first and second compression chambers (25a) and (25b) to switch between a communicating state and a shut-off state.

[0064] The opening/closing mechanism (31), as shown in FIG. 4 illustrating its cross-sectional structure, specifically includes a communication passage (32), a plunger (33), and an opening/closing drive mechanism (34). The communication passage (32) allows the refrigerant to flow between the first and second compression chambers (25a) and (25b) when the first and second compression chambers (25a) and (25b) communicate with each other. The plunger (33) is switchable between a closed position in which the communication passage (32) is closed to move the suction completion position to the first position, and an open position in which the communication passage (32) is open to move the suction completion position to the second position. The opening/closing drive mechanism (34) switches the position of the plunger (33) between the open position and the closed position.

[0065] As shown in FIG. 5, the plunger (33) is a cylindrical valve body, and has an outer surface provided with a circumferential groove (33d) that is disposed on the oil passage (44) in the second position and is deviated from the oil passage (44) in the first position.

[0066] The communication passage (32) is a stepped hole (32) formed in the fixed end plate (21a). As shown in FIGS. 2 and 3, this stepped hole (32) is formed in the outer periphery of the spiral within one turn, and in an obliquely lower left position of the spiral center in the figure. As shown in FIGS. 2 and 3, this stepped hole (32) is comprised of a larger-diameter portion (32a) opening toward the upper surface of the fixed end plate (21a), and a smaller-diameter portion (32b) having a smaller diameter than the larger-diameter portion (32a). The smaller-diameter portion (32b) constitutes the communication passage (32). This stepped hole (32) is formed such that the smaller-diameter portion (32b) is located between teeth of the fixed lap (21b). The smaller-diameter portion (32b) is a circular hole having a larger diameter than the thickness of the tooth of the orbiting lap (22b).

[0067] A compression coil spring (a biasing member) (35) and the plunger (33)(see FIG. 5) having a tip end for opening/closing the smaller-diameter portion (32b) are fitted in the stepped hole (32). As shown in FIG. 5, the plunger (33) includes a plug (33a) fitted into the smaller-diameter portion (32b), a spring holder (33b) having a larger diameter than the plug (33a) and mounting the compression coil spring (35) therein, and a sealing portion (33c) having a larger diameter than the spring holder (33b), the plug (33a), the spring holder (33b), and the sealing portion (33c) being continuously, integrally formed with one another from a tip end (the lower end of the figure). The sealing portion (33c) is provided with the circumferential groove (33d).

[0068] As shown in FIGS. 3 and 4, the opening/closing drive mechanism (34) is comprised of the compression coil spring (35) and a switching valve (a switching member) (36). The compression coil spring (35) biases the plunger (33) toward its open position. The switching valve (36) switches the state of the plunger (33) between a state in which a low pressure is applied to the plunger (33) and a state in which a high pressure is applied to the plunger (33) against the biasing force of the compression coil spring (35). If the switching valve (36) is switched to apply a low pressure to the rear end surface (the upper surface) of the plunger (33), a force of the compression coil spring (35) trying to raise the plunger (33) is superior to a force trying to depress the plunger (33), and the communication passage (32) is opened. As a result, the first compression chamber (25a) communicates with the second compression chamber (25b). If the switching valve (36) is switched to apply a high pressure to the rear end surface of the plunger (33), the force trying to depress the plunger (33) is superior to the force of the compression coil spring (35) trying to raise the plunger (33), and the communication passage (32) is closed. As a result, the first compression chamber (25a) does not communicate with the second compression chamber (25b).

[0069] Although the specific operation of the suction volume adjustment mechanism (30) (opening/closing mechanism (31)) will be described later, if the suction volume adjustment mechanism (30) is operated with the plunger (33) in the closed position, the first and second compression chambers (25a) and (25b) do not communicate with each other. Thus, a normal operation in which the refrigerant is compressed with a set suction volume is performed. In contrast, if the suction volume adjustment mechanism (30) is operated with the plunger (33) in the open position, the first and second compression chambers (25a) and (25b) communicate with each other. Thus, an adjustment operation is performed in which the refrigerant is compressed with a less suction volume than a set value. In this embodiment, the rotational speed of the electric motor (45) is faster during this adjustment operation than during the normal operation.

[0070] In the casing (10), an oil reservoir (50) is formed in the bottom of the second recess (the crank chamber) (23e) to reserve oil that has lubricated the bearing of the drive shaft (41) and other components. The compression mechanism (20) in this embodiment is provided with an oil passage (51) communicating with the oil reservoir (50) and a suction space (25s) of the compression chambers (25a, 25b). The oil passage (51) has one end communicating with the oil reservoir (50) formed in the crank chamber (23e) in the housing (23) of the compression mechanism (20), and the other end communicating with the suction space (25s) of the compression mechanism (20). The oil passage (51), as shown in FIGS. 3 and 6, is comprised of a lengthwise passage (52) adjacent to the oil reservoir, and a transverse passage (an arc-shaped passage) (53) adjacent to the suction space (25s) of the compression mechanism (20).

[0071] The plunger (33) is disposed midway of the transverse passage (53) of the oil passage (51). The plunger (33) includes a switching portion (55). This switching valve (55) closes the oil passage (51) in the closed position to allow the oil reservoir (50) not to communicate with the suction space (25s) of the compression chambers (25a, 25b), and opens the oil passage (51) in the open position to allow the oil reservoir (50) to communicate with the suction space (25s) of the compression chambers (25a, 25b). This switching portion (55) is configured as the circumferential groove (33d) formed in the sealing portion (33c). That is to say, in the open position in FIG. 3, the oil passage (51) communicates with the oil reservoir (50) and the suction space (25s) of the compression chambers (25a, 25b) through the circumferential groove (33d). In contrast, in the closed position which is not shown, the sealing portion (33c) blocks the oil passage (51), and thus, the oil reservoir (50) does not communicate with the suction space (25s) of the compression chambers (25a, 25b), and no oil is supplied from the oil reservoir (50) to the suction space (25s) of the compression chambers (25a, 25b).

-Operation-

[0072] Next, it will be described how the scroll compressor (1) stated above is operated.

[0073] First, if the electric motor (45) is driven, the drive shaft (40) rotates and the orbiting scroll (22) revolves relative to the fixed scroll (21). At that time, the Oldham coupling (not shown) prevents the fixed scroll (21) from rotating on its axis.

[0074] Along with the revolution of the orbiting scroll (22), volumes of the compression chambers (25a, 25b) increase and decrease repeatedly and periodically. In the compression chambers (25a, 25b), the refrigerant in the refrigerant circuit is sucked from the suction pipe (14) through a suction passage (not shown) and the suction port (29) into the compression chambers (25a, 25b) when the volume of a portion, communicating with the suction port (29), of the compression chambers (25a, 25b) is increased, and the refrigerant in the refrigerant circuit is compressed and discharged from the discharge port (26) to the discharge chamber (28) when the volume of a portion in which a suction side is closed decreases. The refrigerant in the discharge chamber (28) is supplied from the discharge pipe (15) to the condenser in the refrigerant circuit.

(Operation of Compression Mechanism During Normal Operation)

[0075] The refrigerant suction and compression operations of the compression mechanism (20) when the suction volume adjustment mechanism (30) is not operated (during the normal operation) will be described with reference to FIGS. 7 to 12. During the normal operation, the plunger (33) of the opening/closing mechanism (31) is in the closed position, and closes the communication passage (32), and the first compression chamber (25a) does not communicate with the second compression chamber (25b). FIGS. 7 to 12 are cross-sectional views of six stages of the operation state of the compression mechanism (20), and illustrate that the orbiting scroll (22) revolves at a predetermined angle in the clockwise direction in the figures.

[0076] First, in the first operation state shown in FIG. 7, the spiral of the orbiting lap (22b) is ended between the teeth of the fixed lap (21b), and both the first compression chamber (25a-0) and the second compression chamber (25b-0) which are in the outermost periphery communicate with a low-pressure side and the suction port (29). Regarding the first compression chamber (25a), the outer peripheral surface of the orbiting lap (22b) is substantially in contact with the inner peripheral surface of the fixed lap (21b) at the point P on the center line Y of the figure. "Contact" in this context means a state where, although there is a gap of submicron order, even if the refrigerant is leaked, no problem occurs because of formation of the oil film. The compression process is started in a portion (25a-1) that is in the inner side (a side closer to the start point of the spiral) relative to the contact point (sealing point) P1.

[0077] From this state, the orbiting scroll (22) revolves in the clockwise direction in the figure to be in the second operation state in FIG. 8. At that time, the inner peripheral surface of the spiral end of the orbiting lap (22b) is in contact with the outer peripheral surface of the fixed lap (21b), and its contact point (sealing point) P2 is the suction completion position of the second compression chamber (25b-1). At that time, the suction process in which the volume is increased is still being performed in the first compression chamber (25a-0) that is in the outermost periphery, and no sealing point at the spiral end is formed.

[0078] From this state, if the orbiting scroll (22) revolves to be in the third operation state in FIG. 9, the volume of the second compression chamber (25b-1) is reduced to start the compression process of the refrigerant in the second compression chamber (25b-1), and the volume of the first compression chamber (25a-0) that is in the outermost periphery is further expanded to allow the suction process of the refrigerant to proceed in the first compression chamber (25a-0). In the fourth operation state in FIG. 10, the compression process further proceeds in the second compression chamber (25b-1), and the suction process further proceeds in the first compression chamber (25a-0) that is in the outermost periphery. Regarding the second compression chamber (25b), the second compression chamber (25b-0) is newly formed at a portion closer to the turn or winding end of the spiral relative to the second compression chamber (25b-1) in which the compression process is being performed, and the suction process is started in the newly formed second compression chamber (25b-0).

[0079] In the fifth operation state shown in FIG. 11, the suction process further proceeds in the second compression chamber (25b-0) that is in the outermost periphery, the outer peripheral surface of the turn or winding end of the spiral of the orbiting lap (22b) is in contact with the inner peripheral surface of the fixed lap (21b), and its contact point (sealing point) P1 is the suction completion position of the first compression chamber (25a-1). In the sixth operation state shown in FIG. 12, the compression process proceeds in the first compression chamber (25a-1) formed in the state of FIG. 11, and the suction process proceeds in the second compression chamber (25b-0) that is in the outermost periphery. Then, the process goes back to the first operation state shown in FIG. 7, the first compression chamber (25a-0) is newly formed at a portion closer to the outer periphery (the turn or winding end of the spiral) of the first compression chamber (25a-1) in which the compression process is being performed.

[0080] Thereafter, the operations in FIGS. 7 to 12 are repeatedly performed, the first compression chamber (25a-1) in the middle of compression and the second compression chamber (25b-1) are moved toward the inner side of the spiral while reducing its volume, and the first compression chamber (25a-2) and the second compression chamber (25b-2) change to the state immediately before the discharge. When the first compression chamber (25a-2) and the second compression chamber (25b-2) are moved to the innermost peripheral side to have the minimum volume, they communicate with the discharge port (26), and the refrigerant is discharged from the compression mechanism (20).

[0081] During the normal operation, in the suction volume adjustment mechanism (30), the plunger (33) is in the closed position and the oil passage (51) is blocked. As a result, the oil reservoir (50) does not communicate with the suction space (25s) of the compression chambers (25a, 25b). Therefore, during the normal operation at the high operation capacity, the discharge of the oil is small, and along with this, no oil is supplied from the oil reservoir (50) to the compression chambers (25a, 25b), and oil is not excessively supplied to the compression chambers.

(Operation of Compression Mechanism During Adjustment Operation)

[0082] Likewise, the refrigerant suction and compression operations of the compression mechanism (20) when the suction volume adjustment mechanism (30) is operated (during the adjustment operation) will be described with reference to FIGS. 7 to 12. During the adjustment operation, in the opening/closing mechanism (31) that is the suction volume adjustment mechanism (30), the plunger (33) is in the open position and opens the smaller-diameter portion (32b) of the communication passage (32). This allows the first compression chamber (25a) to communicate with the second compression chamber (25b).

[0083] First, in the first operation state shown in FIG. 7, both the first compression chamber (25a-0) and the second compression chamber (25b-0) in the outermost periphery communicate with the low-pressure side and the suction port (29), which is the same as the normal operation. During the normal operation, the outer peripheral surface of the orbiting lap (22b) is in contact with the inner peripheral surface of the fixed lap (21b) at the point P1 on the center line Y of the figure, and the first compression chamber (25a-1) in the inner side (the side closer to the winding start point of the spiral) relative to the contact point (sealing point) P1 is already closed. In contrast, the first compression chamber (25a-1) during this operation communicates with the second compression chamber (25b-0) that is in the outermost periphery in the middle of the suction process through the communication passage (32). Accordingly, the first compression chamber (25a-1) is in a position prior to the suction completion position, and is in the middle of the suction process as well as the second compression chamber (25b).

[0084] In the second operation state in FIG. 8, the contact point P1 between the inner peripheral surface of the fixed lap (21b) and the outer peripheral surface of the orbiting lap (22b) is displaced to a position immediately rearward of the communication passage (32) of the opening/closing mechanism (31). Therefore, the contact point (sealing point) P1 at that time is the suction completion position of the first compression chamber (25a-1). In this position, the second compression chamber (25b-1) that is located in the outermost periphery and is closed during the normal operation communicates with the first compression chamber (25a-0) that is located in the outermost periphery and is formed in the outside of the spiral of the first compression chamber (25a-1) that is in the compression process through the communication passage (32). The first compression chamber (25a-0) that is located in the outermost periphery is in the middle of the suction process, and thus, the second compression chamber (25b) is in a position prior to the suction completion position.

[0085] This position is also seen in the third operation state shown in FIG. 9 and the fourth operation state shown in FIG. 10. The second compression chamber (25b-1) is in the position prior to the suction completion position, and a sealing point closer to the turn or winding end is not formed yet. At that time, the first compression chamber (25a-0) that is the outermost periphery is also in the middle of the suction process. In the fourth operation state shown in FIG. 10, the second compression chamber (25b-0) is started to be newly formed in the outside of the spiral of the second compression chamber (25b-1).

[0086] In the fifth operation state shown in FIG. 11, the contact point P2 between the outer peripheral surface of the fixed lap (21b) and the inner peripheral surface of the orbiting lap (22b) passes through the communication passage (32) of the opening/closing mechanism (31). Therefore, the contact point P2 at that time is the sealing point of the second compression chamber (25b-1), and the compression process is started in the second compression chamber (25b-1). In this state, although the suction process in the first compression chamber (25a-1) that is in the outermost periphery is completed in the normal operation, the first compression chamber (25a-1) that is in the outermost periphery in the adjustment operation communicates with the low-pressure side through the second compression chamber (25b-0) that is in the outermost periphery, and thus, is in the middle of the suction process. This also occurs in the sixth operation state in FIG. 12, and the same occurs if the process goes back to the first operation state in FIG. 7.

[0087] As can be seen, the communication passage (32) of the opening/closing mechanism (31) is opened, and thus, the volume of the first compression chamber (25a) and the volume of the second compression chamber (25b) is smaller than during the normal operation. As a result, a compression ratio is smaller than during the normal operation, and if its suction pressure is the same as during the normal operation, the discharge pressure is decreased.

[0088] During this adjustment operation, the rotational speed of the electric motor (45) is faster than during the normal operation, and thus, substantially the same performance of the scroll compressor (1) as in the normal operation can be achieved.

[0089] During the adjustment operation, in the suction volume adjustment mechanism (30), the plunger (33) is in the open position and the oil passage (51) is opened to allow the oil reservoir (50) to communicate with the suction space (25s) of the compression chambers (25a, 25b). Therefore, during the adjustment operation at the low operation capacity, the performance is adjusted to provide the same capacity, and thus, the rotational speed is faster than in the case where no adjustment is made. This increases the supply amount of the oil to the compression chambers (25a, 25b), and in addition, allows oil from the oil reservoir (18, 50) to the compression chambers (25a, 25b). As a result, oil is sufficiently supplied to the compression chambers (25a, 25b).

-Advantages of First Embodiment-

[0090] According to this embodiment, if only the adjustment operation at the low operation capacity is performed, oil is not sufficiently supplied to the compression chambers (25a, 25b), and the oil film having a thickness necessary for the compression mechanism (20) is not formed, resulting in performance degradation. However, if the oil passage (51) is opened and the oil reservoir (50) communicates with the suction space (25s) of the compression chambers (25a, 25b), oil is sufficiently supplied to the compression chambers (25a, 25b). Thus, this can improve performance during the adjustment operation.

-Variation of First Embodiment-

[0091] As shown in FIGS. 13 and 14, the oil passage (51) may include a passage (fixed scroll inner passage (53)) entirely passing through the inside of the fixed scroll (21) to communicate with the plunger (33) and the suction space (25s) of the compression mechanism (20). In this variation, the suction pipe (14) is connected to the suction port (29), and the transverse passage (53) of the oil passage (51) communicates with the suction port (29). Such a configuration allows the oil in the oil reservoir (50) to mix with the suction refrigerant and to be supplied to the compression chamber (25).

[0092] According to this variation, if only the adjustment operation at the low operation capacity is performed, oil is not sufficiently supplied to the compression chambers (25a, 25b), and the oil film having a thickness necessary for the compression mechanism is less likely to be formed, resulting in performance degradation. However, in this variation, if the oil passage (51) is in the state in FIG. 13 to be opened and the oil reservoir (50) communicates with the suction space (25s) of the compression chambers (25a, 25b), oil is sufficiently supplied to the compression chambers (25a, 25b). Thus, this can improve performance during the adjustment operation.

«Second Embodiment»

[0093] Next, a second embodiment will be described.

[0094] In the second embodiment, as shown in FIGS. 15 and 16, the oil passage (51) includes an oil passage (55) closer to the orbiting scroll (hereinafter referred to as "the orbiting-scroll-side oil passage (55)"), and an oil passage (52) closer to the fixed scroll (hereinafter referred to as "the fixed-scroll-side oil passage (52)") communicating with the orbiting-scroll-side oil passage (55). The orbiting-scroll-side oil passage (55) has one end communicating with the fixed-scroll-side oil passage (51), and the other end opposite to one end and communicating with the oil reservoir (18). Specifically, the end of the orbiting-scroll-side oil passage (55), which is opposite to one end communicating with the fixed-scroll-side oil passage (52), communicates with the oil reservoir (18) in the lower portion of the casing (10) through the oil supply passage (44) formed inside the drive shaft (41). An end of the fixed-scroll-side oil passage (52), which is opposite to an end communicating with the orbiting-scroll-side oil passage (55), communicates with the suction space (25s) of the compression mechanism (20).

[0095] According to this second embodiment, if only the adjustment operation at the low operation capacity is performed, oil is not sufficiently supplied to the compression chambers (25a, 25b), and the oil film having a thickness necessary for the compression mechanism is less likely to be formed, resulting in performance degradation. However, in the second embodiment, if the oil passage (51) is in the state in FIG. 16 to be opened and the oil reservoir (18) communicates with the suction space (25s) of the compression chambers (25a, 25b), oil is sufficiently supplied to the compression chambers (25a, 25b). Thus, this can improve performance during the adjustment operation.

«Third Embodiment»

[0096] Next, a third embodiment will be described.

[0097] In the third embodiment, as shown in FIG. 17, the oil passage (51) has one end communicating with the oil reservoir (18) formed inside the casing (10), and the other end communicating with the suction space (25s) of the compression mechanism (20). Specifically, the oil passage (51) has an oil supply pipe (56) extending upward from the oil reservoir (18) inside the casing (10) and communicating with the plunger (33). This oil supply pipe (56) communicates with the transverse passage (53). In the oil passage (51), a space (the transverse passage (53)) between the plunger (33) and a suction side of the compression chamber (25) is the same as, or similar to, that of the variation of the first embodiment and the second embodiment.

[0098] The other configuration of this embodiment is the same as, or similar to, that of the second embodiment.

[0099] According to this third embodiment, if only the adjustment operation at the low operation capacity is performed, oil is not sufficiently supplied to the compression chambers (25a, 25b), and the oil film having a thickness necessary for the compression mechanism is less likely to be formed, resulting in performance degradation. However, in the third embodiment, if the oil passage (51) is in the state in FIG. 17 to be opened and the oil reservoir (18) communicates with the suction space (25s) of the compression chambers (25a, 25b), oil is sufficiently supplied to the compression chambers (25a, 25b). Thus, this can improve performance during the adjustment operation.

«Fourth Embodiment»

[0100] Next, a fourth embodiment will be described.

[0101] In the fourth embodiment, as shown in FIG. 18, the oil passage (51) has one end communicating with an oil supply pump (43a) provided to the drive shaft (41), and the other end communicating with the suction space (25s) of the compression mechanism (20). Specifically, the oil passage (51) has an oil supply pipe (57) extending upward from the oil supply pump (43a) provided to the lower end of the drive shaft (41) and communicating with the plunger (33). This oil supply pipe (57) communicates with the transverse passage (53). In the oil passage (51), a space (the transverse passage (53)) between the plunger (33) and a suction side of the compression chamber (25) is the same as, or similar to, that of the variation of the first embodiment and the second embodiment.

[0102] The other configuration of this embodiment is the same as, or similar to, that of the third embodiment.

[0103] According to this fourth embodiment, if only the adjustment operation at the low operation capacity is performed, oil is not sufficiently supplied to the compression chambers (25a, 25b), and the oil film having a thickness necessary for the compression mechanism is less likely to be formed, resulting in performance degradation. However, in the fourth embodiment, if the oil passage (51) is in the state in FIG. 18 to be opened and the oil reservoir (18) communicates with the suction space (25s) of the compression chambers (25a, 25b), oil is sufficiently supplied to the compression chambers (25a, 25b). Thus, this can improve performance during the adjustment operation.

«Fifth Embodiment»

[0104] Next, a fifth embodiment will be described.

[0105] In the fifth embodiment, as shown in FIGS. 19 to 21, the oil passage (51) includes a fixed scroll outer passage (58) passing through the space (17) formed outside the fixed scroll (21) inside the casing (10) to communicate with the plunger (33) and the suction space (25s) of the compression mechanism (20). In the fifth embodiment, the fixed scroll (21) is provided with a gas discharge passage (60) through which the refrigerant gas is discharged from the compression chambers (25a, 25b) to the space (17).

[0106] According to this configuration, as shown in FIG. 20, when the plunger (33) is open, the refrigerant gas is discharged from the compression chambers and oil is also discharged from the transverse passage (53) to the space (17). The refrigerant gas and the oil are mixed with each other and sucked into the suction space (25s). In contrast, as shown in FIG. 21, when the plunger (33) is closed, no refrigerant gas is discharged from the compression chambers (25a, 25b) to the space (17), and no oil is discharged from the transverse passage (53) to the space (17).

[0107] According to this fifth embodiment, if only the adjustment operation at the low operation capacity is performed, oil is not sufficiently supplied to the compression chambers (25a, 25b), and the oil film having a thickness necessary for the compression mechanism is less likely to be formed, resulting in performance degradation. However, in the fifth embodiment, if the oil passage (51) is in the state in FIG. 20 to be opened and the oil reservoir (18) communicates with the suction space (25s) of the compression chambers (25a, 25b), oil is sufficiently supplied to the compression chambers (25a, 25b). Thus, this can improve performance during the adjustment operation. The high speed operation can reduce performance degradation and oil loss.

«Sixth Embodiment»

[0108] A sixth embodiment of the present disclosure is an example and has the same configuration as the fifth embodiment, except the configuration for the oil passage (51). Specifically, as shown in FIGS. 22 and 23, the oil passage (51) includes a fixed scroll outer passage (58) passing through the space (17) formed outside the fixed scroll (21) inside the casing (10) to communicate with the plunger (33) and the suction space (25s) of the compression mechanism (20). In the sixth embodiment, the fixed scroll (21) is provided with a gas discharge passage (60) through which the refrigerant gas is discharged from the compression chambers (25a, 25b) to the space (17). In this sixth embodiment, the end of the transverse passage (53) is closed and the transverse passage (53) communicates with the gas discharge passage (60) through an oil mix passage (53a).

[0109] According to this configuration, as shown in FIG. 23, when the plunger (33) is open, the refrigerant gas is discharged from the compression chambers, and the oil is mixed with the gas flowing through the gas discharge passage (60) to be discharged into the space (17). The refrigerant gas and the oil are mixed together, and are sucked into the suction space (25s). Although not shown, when the plunger (33) is closed, no gas is discharged from the compression chambers (25a, 25b) into the space (17).

[0110] According to this sixth embodiment, if only the adjustment operation at the low operation capacity is performed, oil is not sufficiently supplied to the compression chambers (25a, 25b), and the oil film having a thickness necessary for the compression mechanism is less likely to be formed, resulting in performance degradation. However, in the sixth embodiment, if the oil passage (51) is in the state in FIG. 23 to be opened and the oil reservoir (18) communicates with the suction space (25s) of the compression chambers (25a, 25b), oil is sufficiently supplied to the compression chambers (25a, 25b). Thus, this can improve performance during the adjustment operation.

«Other Embodiments»

[0111] The above-described embodiment may be modified as follows.

[0112] For example, the above embodiments are the examples where the present disclosure is applied to the asymmetrical spiral structure. The present disclosure may also be applied to a scroll compressor having a symmetrical spiral structure. In this case, the suction volume adjustment mechanism (30) having the same or similar configuration as or to those in the above embodiments may be provided to each symmetrical position relative to the center of the spiral. Such a configuration allows the compression mechanism (20) having the symmetrical spiral structure to adjust the suction completion positions of the first and second compression chambers (25a) and (25b) relative to the center of the spiral, while controlling the flow of the oil. As a result, the same or similar advantages in the above embodiments can also be obtained.

[0113] In the above embodiments, the present disclosure is applied to the scroll compressor. However, the present disclosure is not limited to the scroll compressor. For example, the present disclosure may also be applied to a rolling piston compressor or an oscillating piston compressor.

[0114] Further, in the above embodiments, as shown in FIG. 24, a sealing member (33e) may be provided to both sides of the circumferential groove (33d) in the outer peripheral surface of the plunger (33). In this case, the sealing portion (33c) of the plunger (33) has a sealing mount groove (33f) at both sides of the circumferential groove (33d) in the circumferential direction, and the ring-shaped sealing member (33e) is mounted on the sealing mount groove (33f).

[0115] Note that the foregoing description of the embodiments is a merely preferred example in nature, and is not intended to limit the scope, application, or uses of the present disclosure.

INDUSTRIAL APPLICABILITY

[0116] As can be seen from the foregoing description, the present disclosure is useful for, in a compressor including a suction bypass mechanism configured to change a suction completion position to adjust a suction volume, a technique of solving lubricant shortage in a compression mechanism.

DESCRIPTION OF REFERENCE CHARACTERS

[0117]

1	Scroll Compressor
10	Casing
18	Oil Reservoir
21	Fixed Scroll
22	Orbiting Scroll
23	Housing
23e	Crank Chamber
25a	Compression Chamber
25b	Compression Chamber
25s	Suction Space
30	Suction Volume Adjustment Mechanism
33	Plunger
33d	Circumferential Groove
33e	Sealing Member
43a	Oil Supply Pump
50	Oil Reservoir
51	Oil Passage
52	Fixed-scroll-side Oil Passage (Fixed Scroll Inner Passage)
53	Fixed-scroll-side Oil Passage (Fixed Scroll Inner Passage)
53a	Oil Mix Passage

55 Orbiting-scroll-side Oil Passage
56 Oil Supply Pipe
57 Oil Supply Pipe
58 Fixed Scroll Outer Passage
60 Gas Discharge Passage
65 Switching Portion

Claims

1. A compressor comprising:

a compression mechanism (20); and
a casing (10) housing the compression mechanism (20),
the compression mechanism (20) including a suction volume adjustment mechanism (30) capable of switching a suction completion position of a compression chamber (25a, 25b) in a suction process between a first position and a second position in which the suction volume is smaller than in the first position,
the suction volume adjustment mechanism (30) including a plunger (33) switchable between a closed position in which the suction completion position is moved to the first position and an open position in which the suction completion position is moved to the second position, wherein
the compressor further includes an oil passage (51) to allow an oil reservoir (18, 50) formed inside the casing (10) and a suction space (25s) of the compression chamber (25a, 25b) to communicate with each other, and
the plunger (33) is disposed midway of the oil passage (51), and includes a switching portion (65) closing the oil passage (51) in the closed position to allow the oil reservoir (18, 50) not to communicate with the suction space (25s) of the compression chamber (25a, 25b), and opening the oil passage (51) in the open position to allow the oil reservoir (50) to communicate with the suction space (25s) of the compression chamber (25a, 25b).

2. The compressor of claim 1, wherein
the compression mechanism (20) is a compression mechanism (20) including a fixed scroll (21), and an orbiting scroll (22) meshing with the fixed scroll (21) and compressing a working fluid.

3. The compressor of claim 2, wherein
the oil passage (51) has one end communicating with the oil reservoir (50) formed in a crank chamber (23e) that is a space inside the housing (23) of the compression mechanism (20), and the other end communicating with the suction space (25s) of the compression mechanism (20).

4. The compressor of claim 2, wherein
the oil passage (51) includes an orbiting-scroll-side oil passage (55) and a fixed-scroll-side oil passage (52) communicating with the orbiting-scroll-side oil passage (55),
the orbiting-scroll-side oil passage (55) has one end communicating with the fixed-scroll-side oil passage (52), and the other end opposite to one end and communicating with the oil reservoir (50), and
the fixed-scroll-side oil passage (52) has one end communicating with the orbiting-scroll-side oil passage (55), and the other end opposite to one end and communicating with the suction space (25s) of the compression mechanism (20).

5. The compressor of claim 2, wherein
the oil passage (51) has an oil supply pipe (56) having one end communicating with the oil reservoir (18) formed inside the casing (10), and the other end communicating with the suction space (25s) of the compression mechanism (20).

6. The compressor of claim 2, wherein
the oil passage (51) has an oil supply pipe (57) having one end communicating with an oil supply pump (43a) provided to a drive shaft of the compression mechanism (20), and the other end communicating with the suction space (25s) of the compression mechanism (20).

7. The compressor of any one of claims 3 to 6, wherein the oil passage (51) has a fixed scroll inner passage (53) passing through an interior of the fixed scroll (21) to communicate with the plunger (33) and the suction space (25s) of the compression mechanism (20).

8. The compressor of any one of claims 3 to 6, wherein the oil passage (51) has a fixed scroll outer passage (58) passing through a space formed outside the fixed scroll (21) and inside the casing (10) to communicate with the plunger (33) and the suction space (25s) of the compression mechanism (20).

9. The compressor of any one of claims 3 to 6, wherein the suction volume adjustment mechanism (30) has a discharge passage (60) discharging the working fluid from the plunger (33) in the second position into a space formed outside the fixed scroll (21) and inside the casing (10), and
the oil passage (51) has an oil mix passage (53a) having one end communicating with the plunger (33), and the other end communicating with the discharge passage (60).

10. The compressor of any one of claims 1 to 9, wherein the plunger (33) is a cylindrical valve body, and has an outer surface provided with a circumferential groove (33d) that is disposed on the oil passage (51) in the second position and is deviated from the oil passage (51) in the first position.

11. The compressor of claim 10, wherein
the plunger (33) includes a sealing member (33e) at both sides of the circumferential groove (33d) formed in the outer surface of the plunger (33).

FIG.1

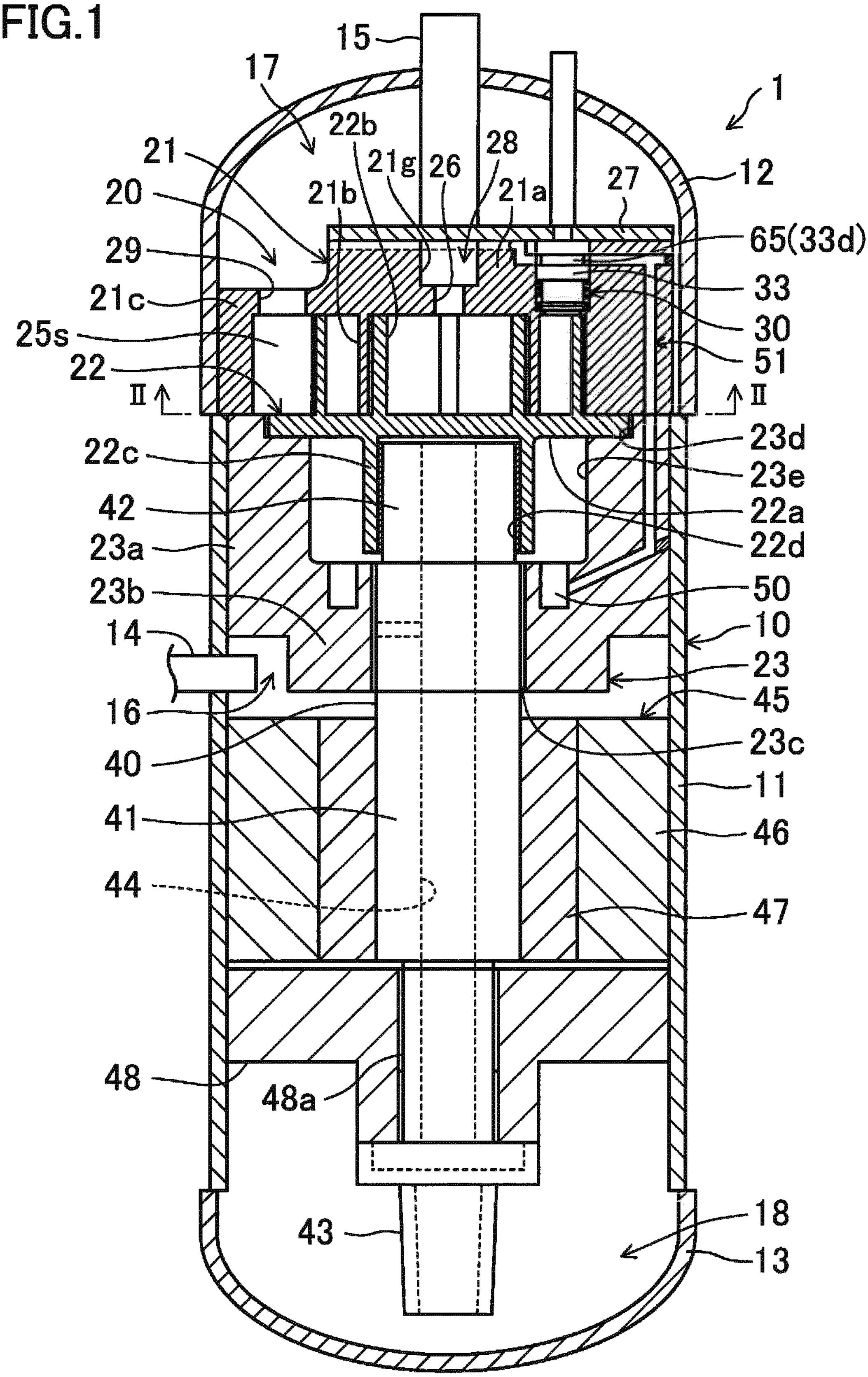

15
17
1
22b
21
28
21g
26
27
12
21b
21a
20
65(33d)
29
33
21c
30
25s
51
22
II
II
22c
23d
23e
42
22a
23a
22d
23b
50
14
10
23
16
45
40
23c
11
41
46
44
47
48
48a
43
18
13

FIG.2

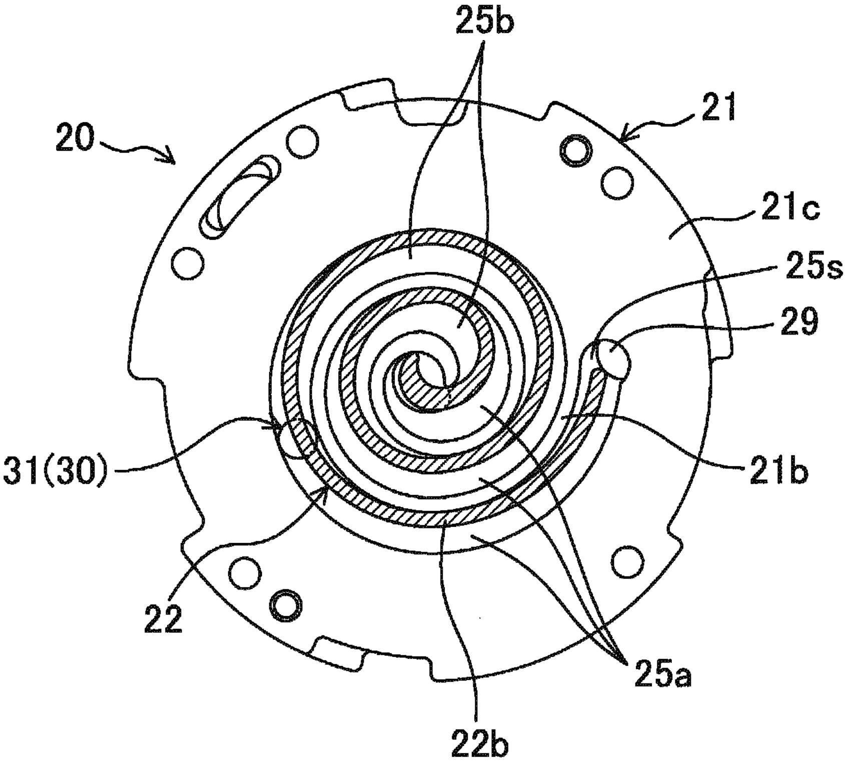


FIG.3

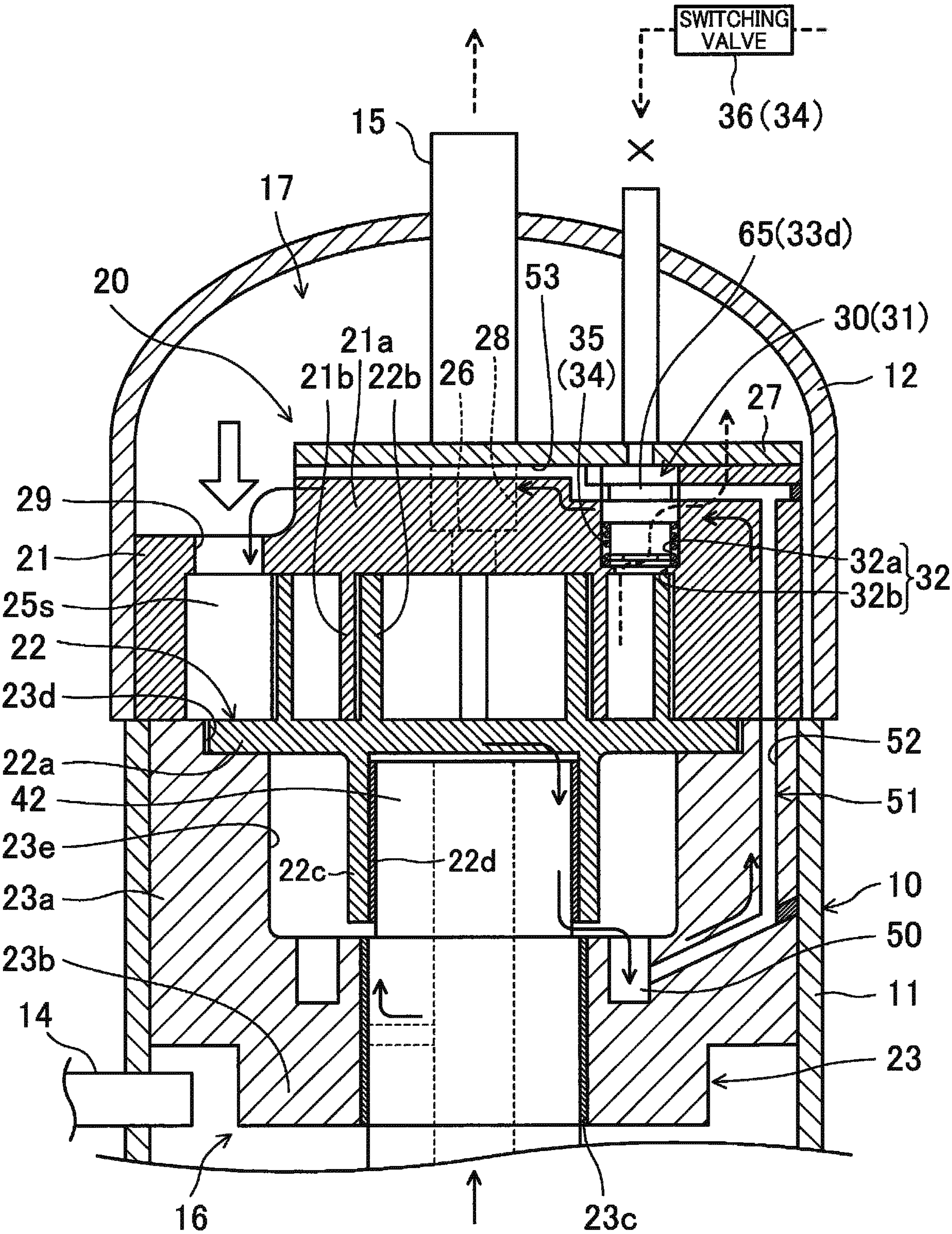

SWITCHING VALVE
36(34)
15
17
20
53
65(33d)
30(31)
21a
28
35
(34)
21b
22b
26
12
27
29
21
32a
32
32b
25s
22
23d
52
22a
42
51
23e
22c
22d
10
23a
50
23b
11
14
23
16
23c

FIG.4

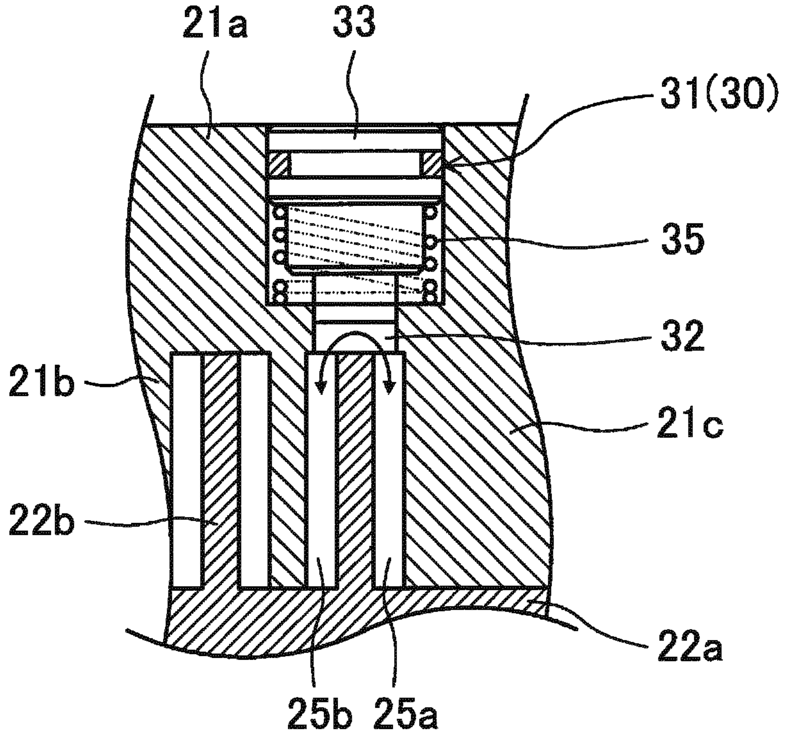


FIG.5

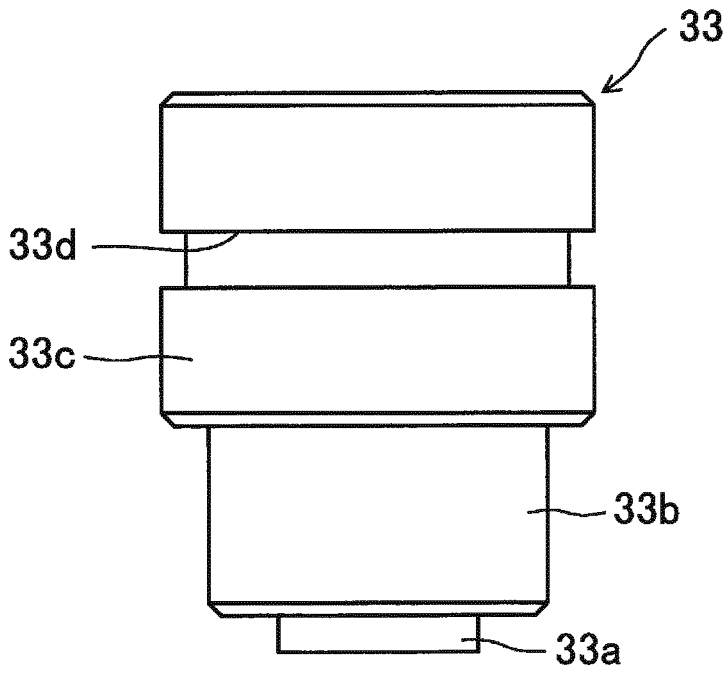


FIG.6

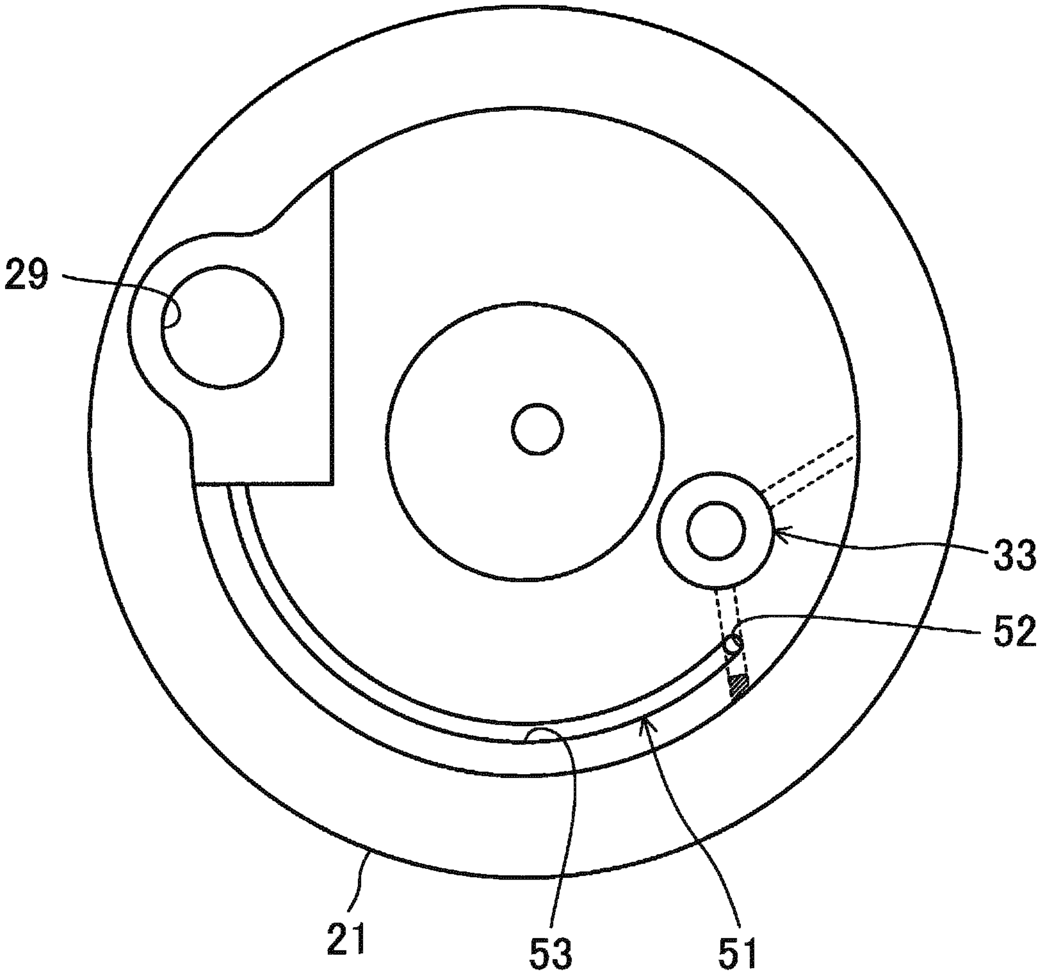


FIG.7

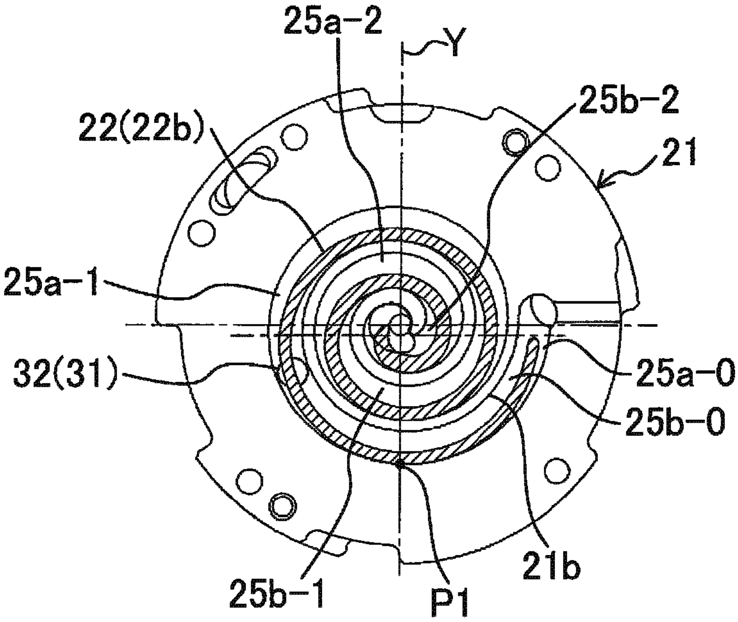

25a-2
Y
25b-2
22(22b)
21
25a-1
32(31)
25a-0
25b-0
21b
25b-1
P1

FIG.8

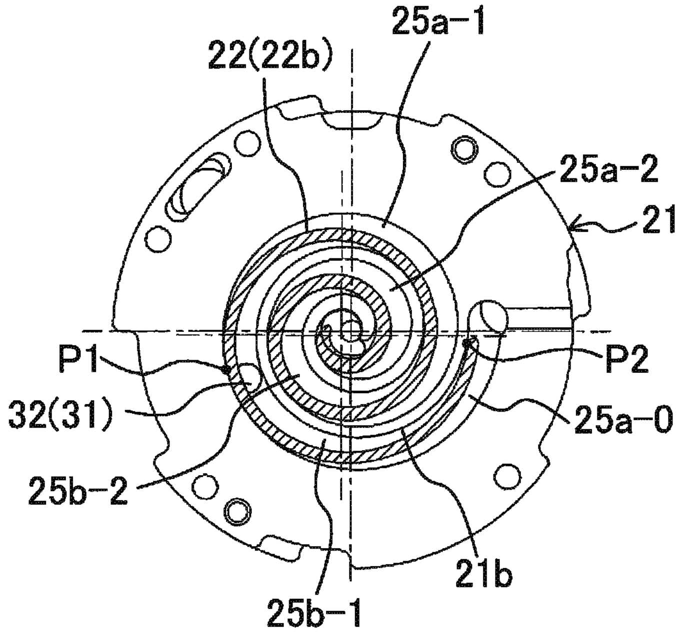

25a-1
22(22b)
25a-2
21
P1
P2
32(31)
25a-0
25b-2
21b
25b-1

FIG.9

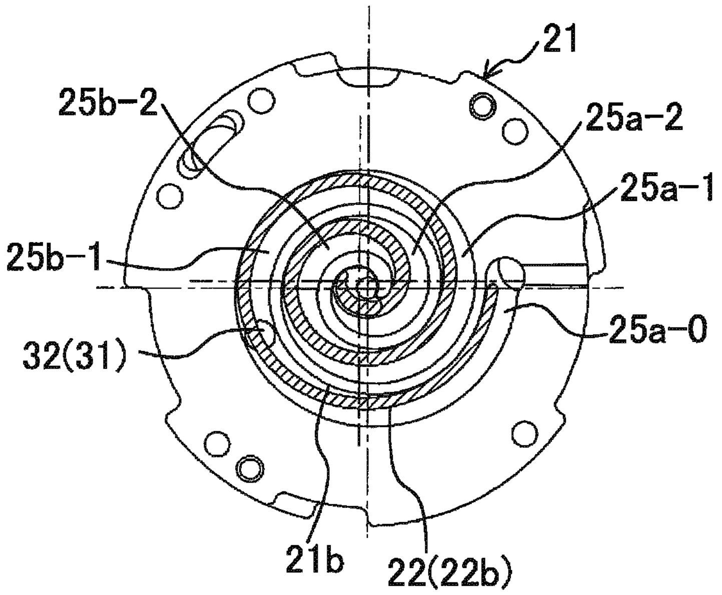

21
25b-2
25a-2
25a-1
25b-1
25a-0
32(31)
21b
22(22b)

FIG.10

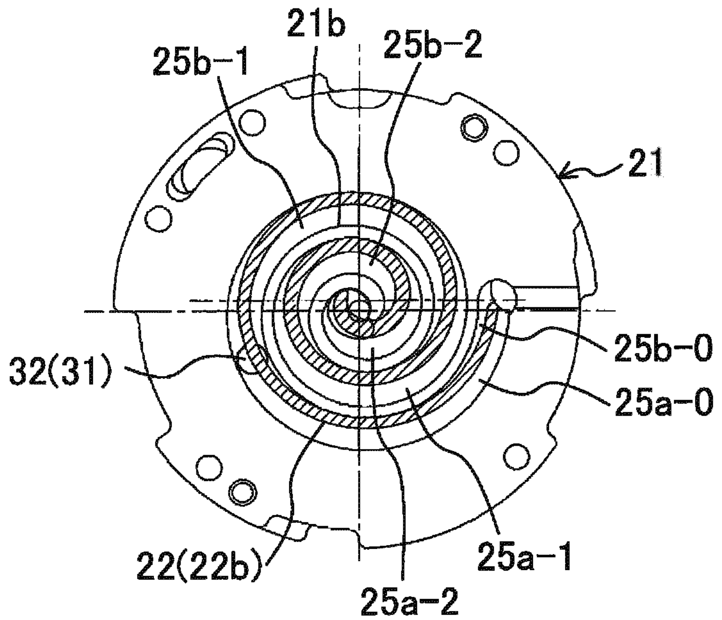

21b
25b-2
25b-1
21
25b-0
32(31)
25a-0
22(22b)
25a-1
25a-2

FIG.11

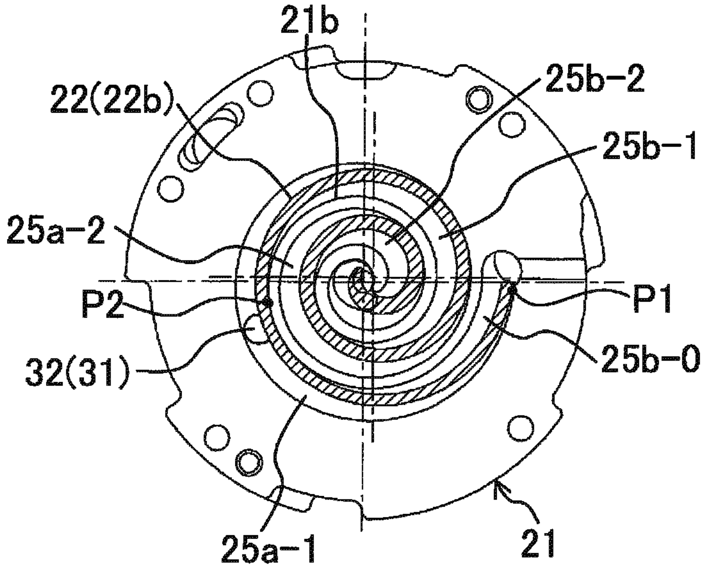

21b
22(22b)
25b-2
25b-1
25a-2
P2
P1
32(31)
25b-0
25a-1
21

FIG.12

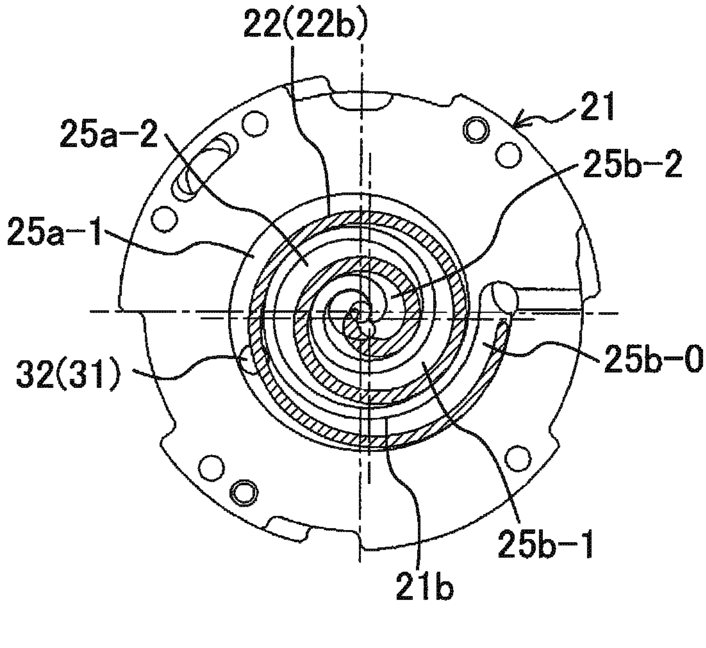

22(22b)
21
25a-2
25b-2
25a-1
32(31)
25b-0
25b-1
21b

FIG.13

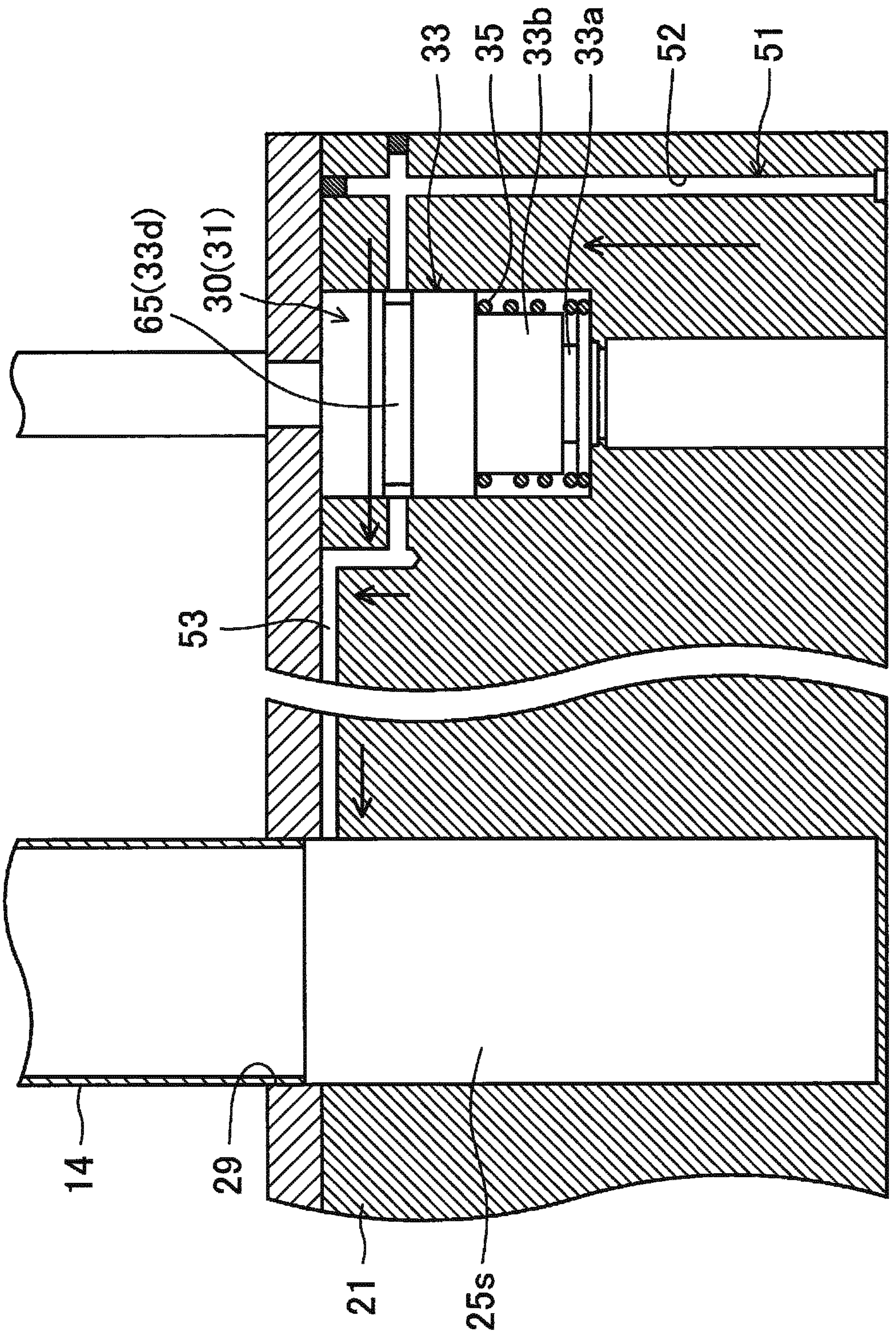


FIG.14

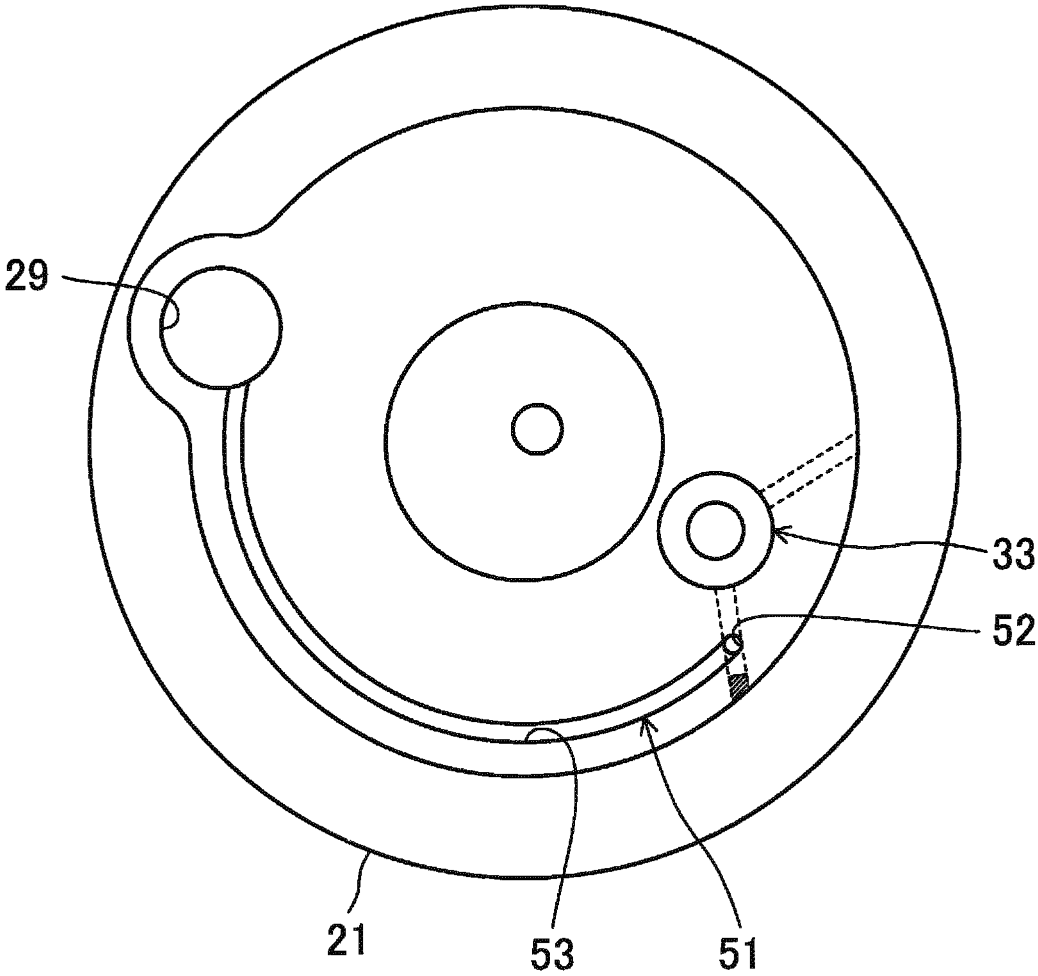


FIG.15

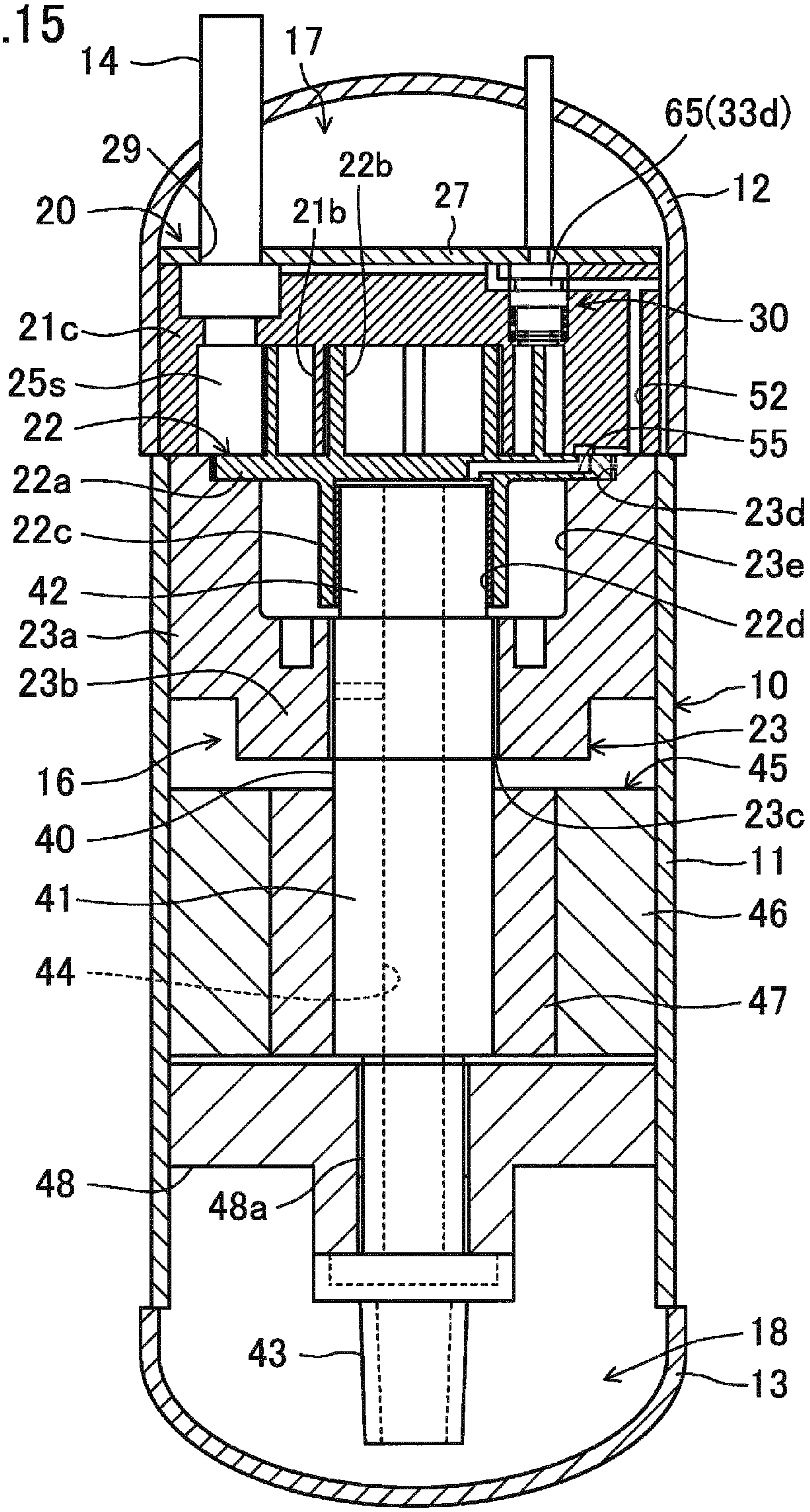
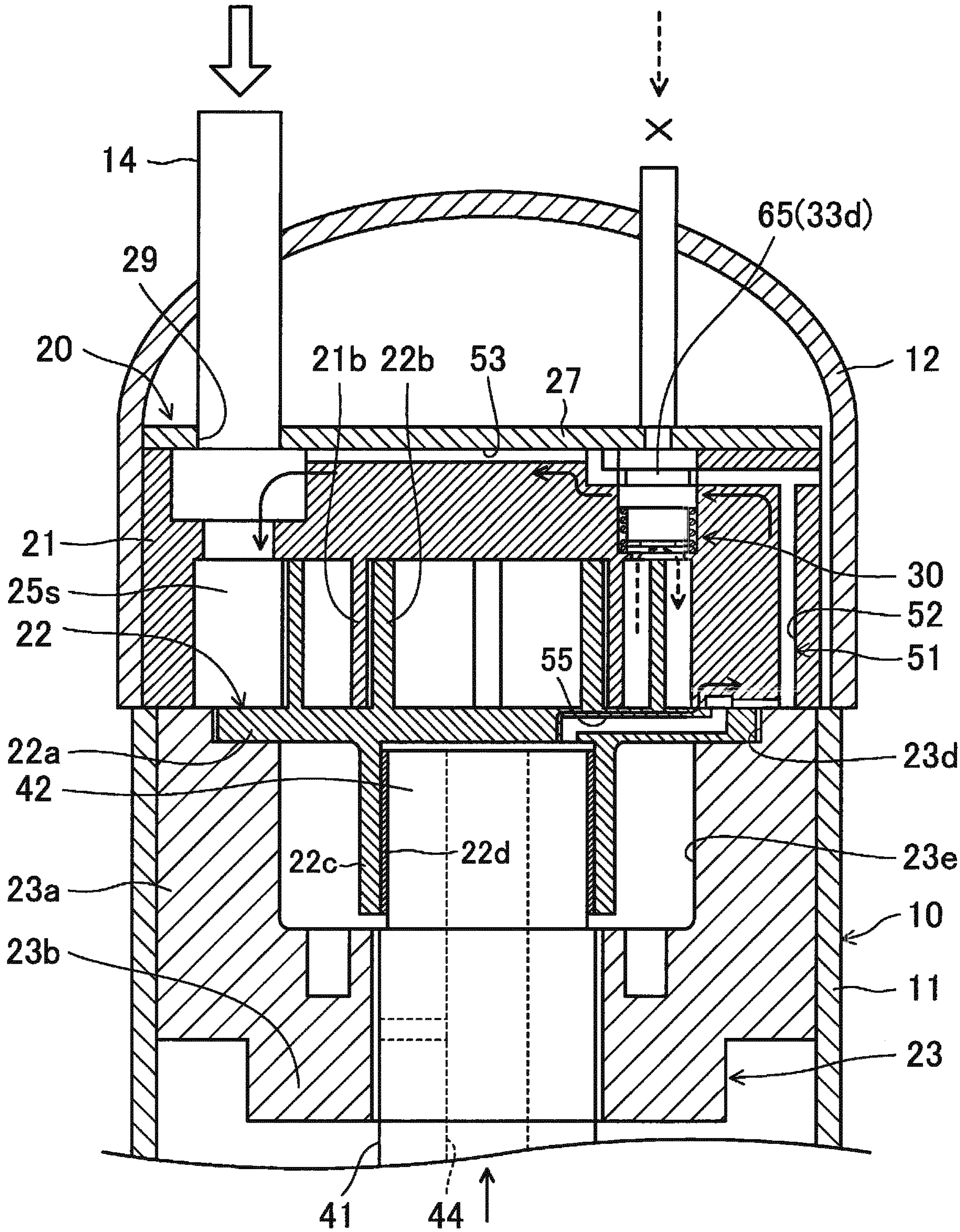
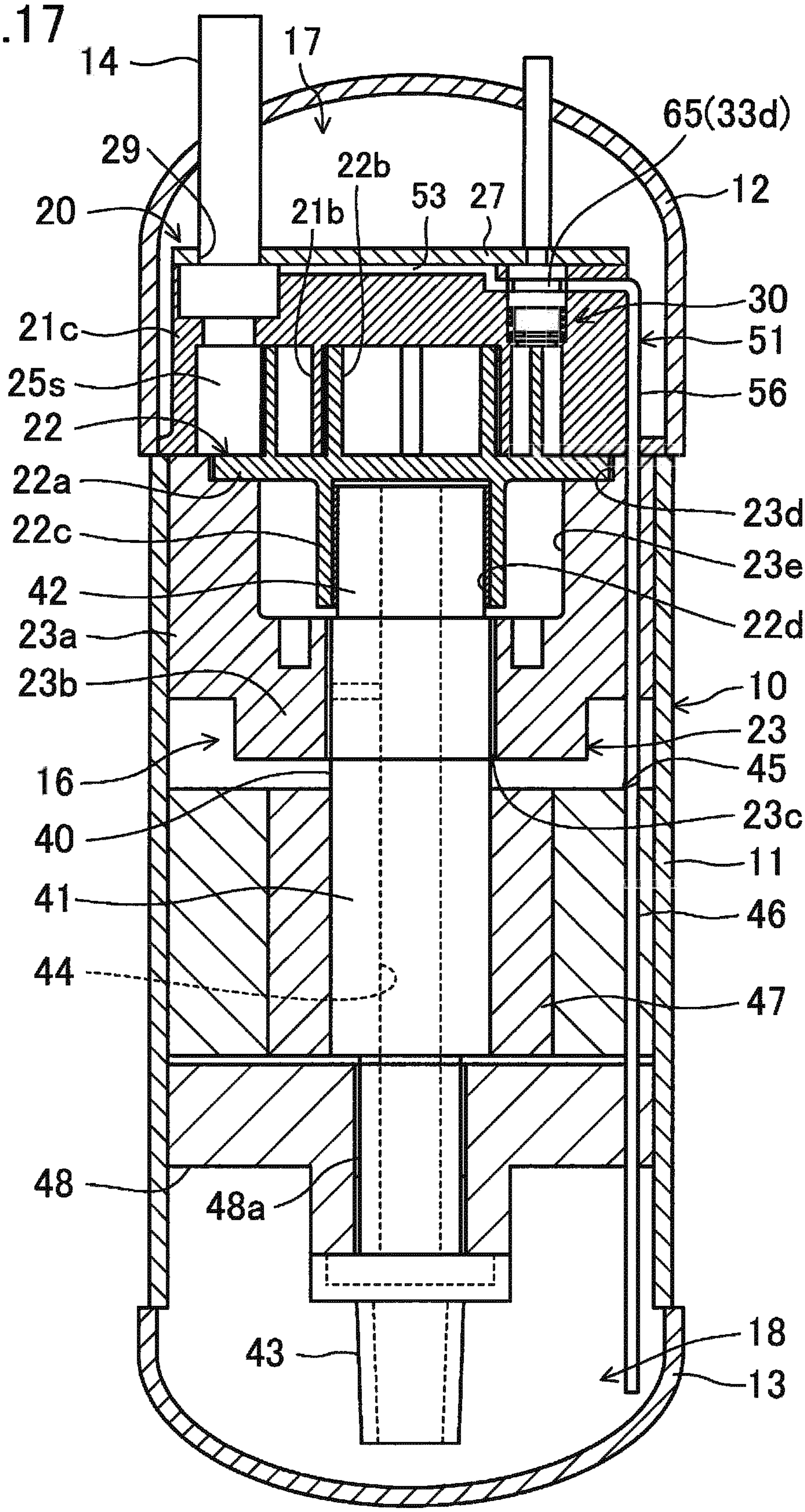

14
17
29
20
22b
27
21b
65(33d)
12
21c
30
25s
52
22
55
22a
23d
22c
23e
42
22d
23a
23b
10
23
16
45
40
23c
11
41
46
44
47
48
48a
43
18
13

FIG.16



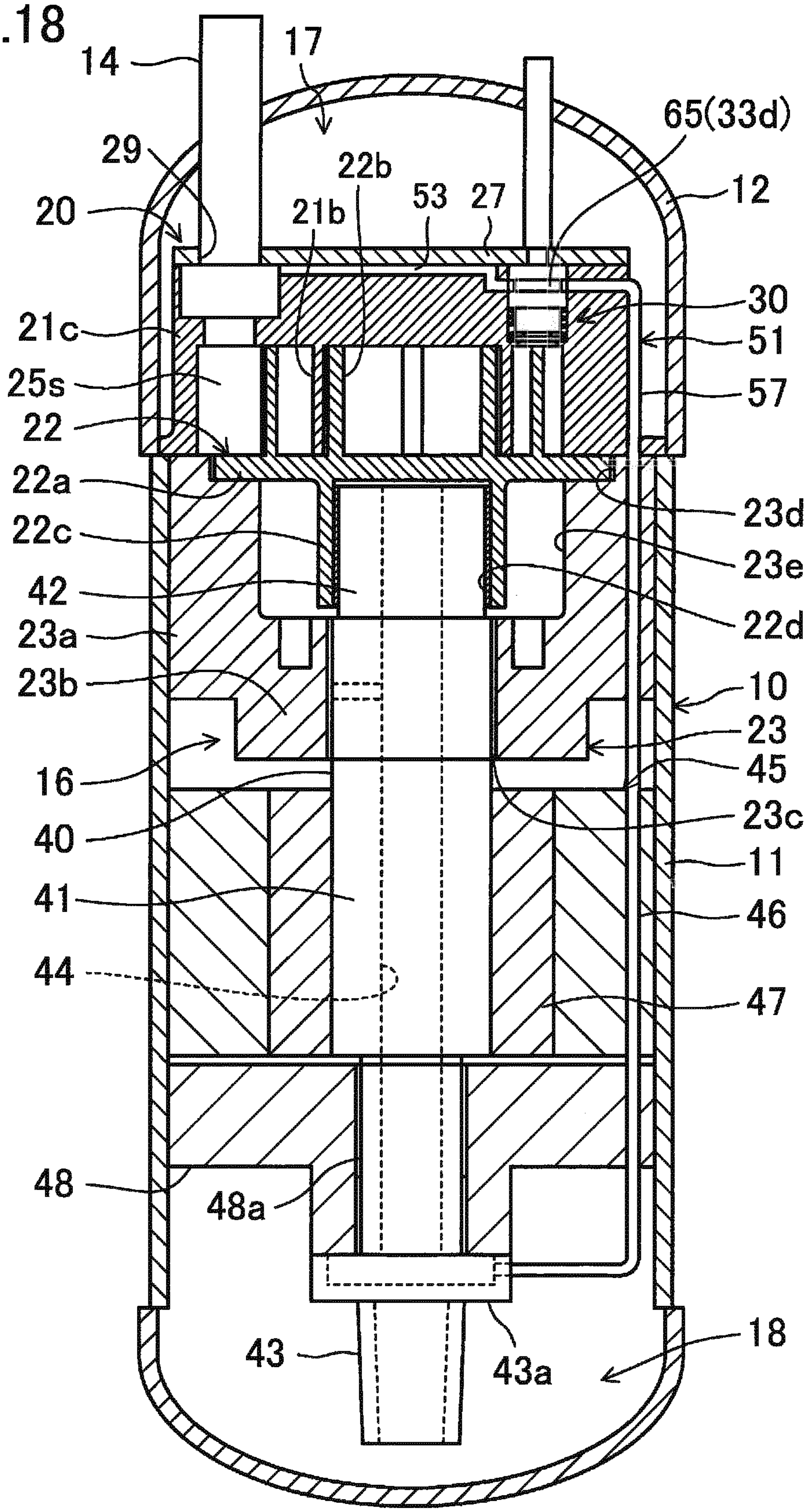
14
29
20
21b
22b
53
27
65(33d)
12
21
25s
22
30
52
51
55
22a
42
23d
22c
22d
23e
23a
10
23b
11
23
41
44

FIG.17



14
17
29
22b
65(33d)
20
21b
53
27
12
30
21c
51
25s
56
22
22a
23d
22c
23e
42
22d
23a
23b
10
23
16
45
40
23c
41
11
46
44
47
48
48a
43
18
13

FIG.18


14
17
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22b
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27
65(33d)
12
20
21b
30
21c
51
25s
57
22
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23d
22c
23e
42
22d
23a
23b
10
23
16
45
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23c
11
41
46
44
47
48
48a
43
43a
18

FIG.19

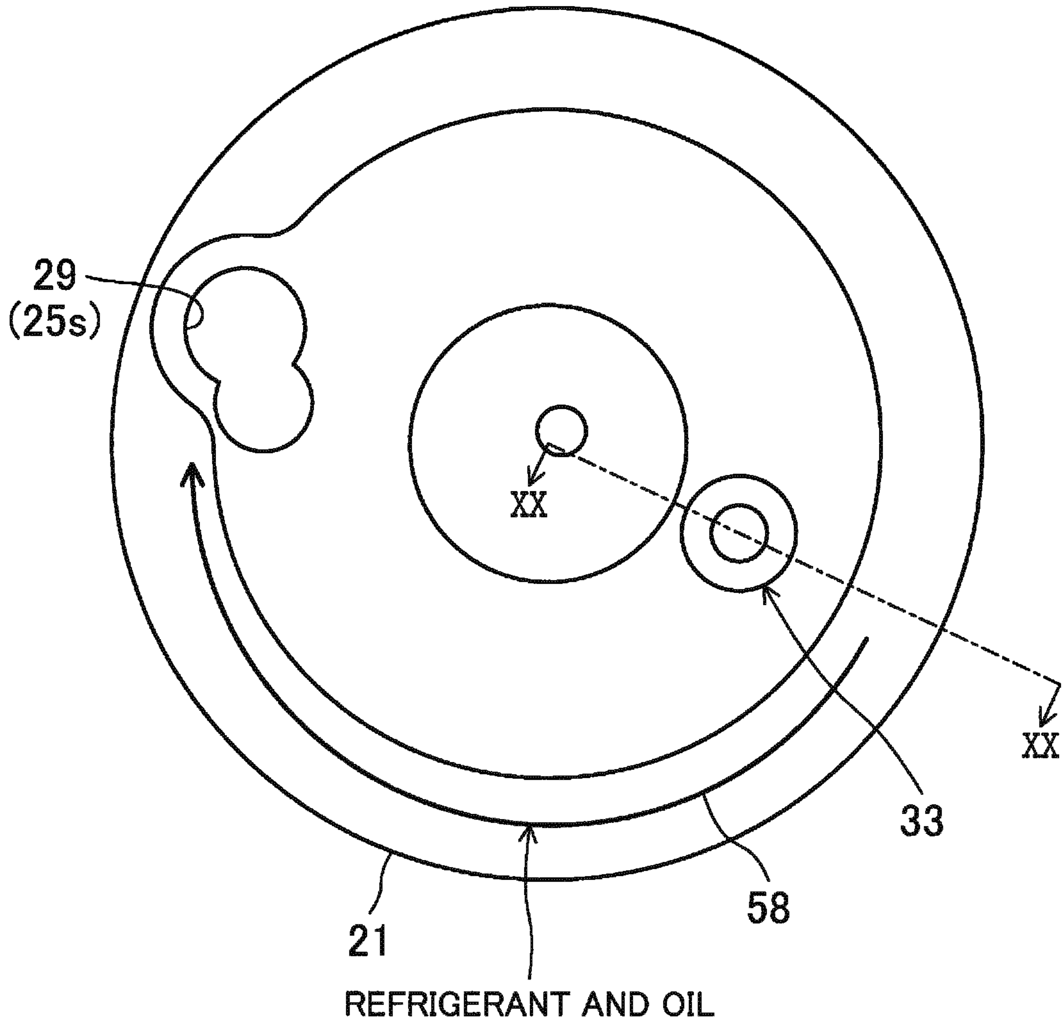


FIG.20

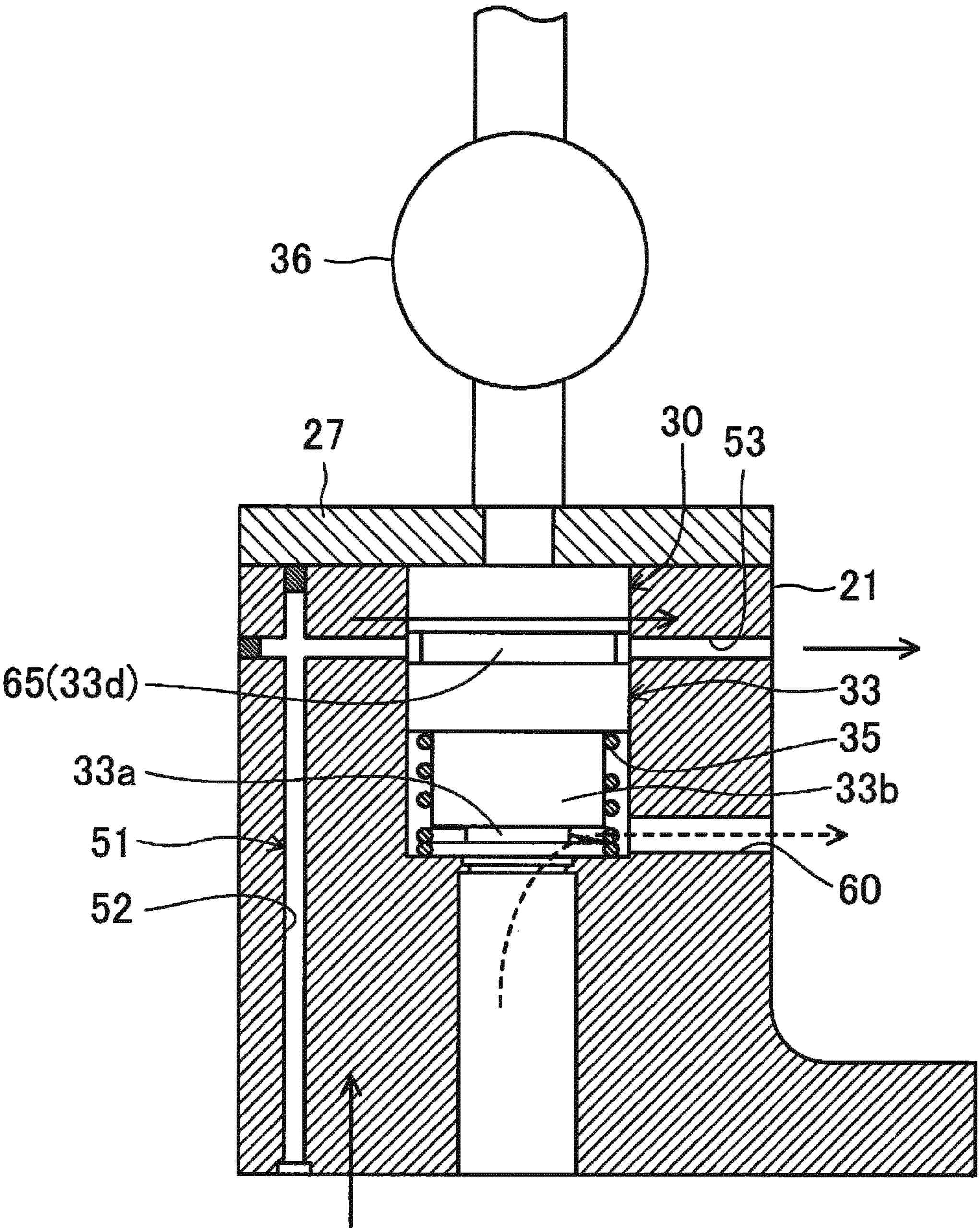


FIG.21

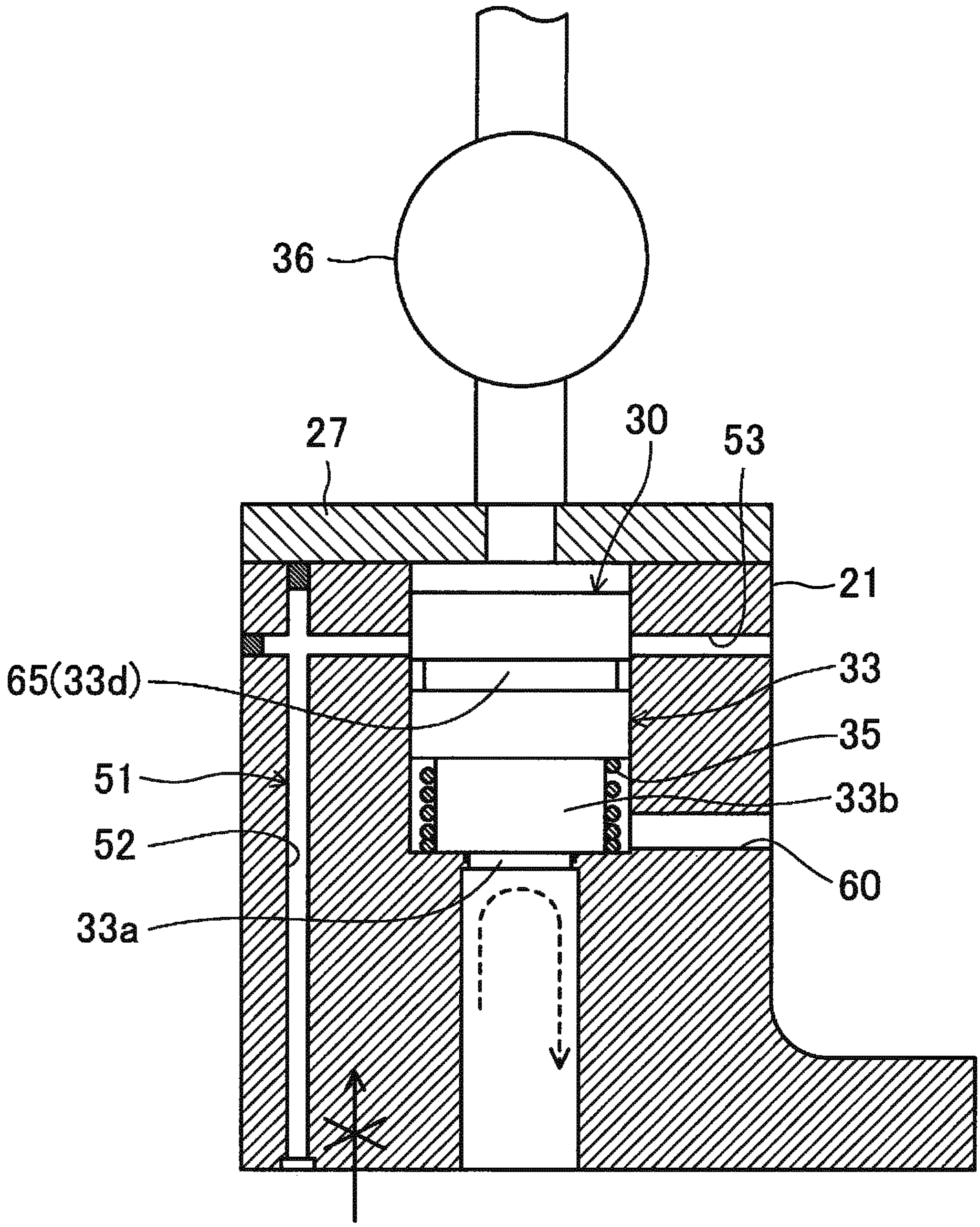


FIG.22

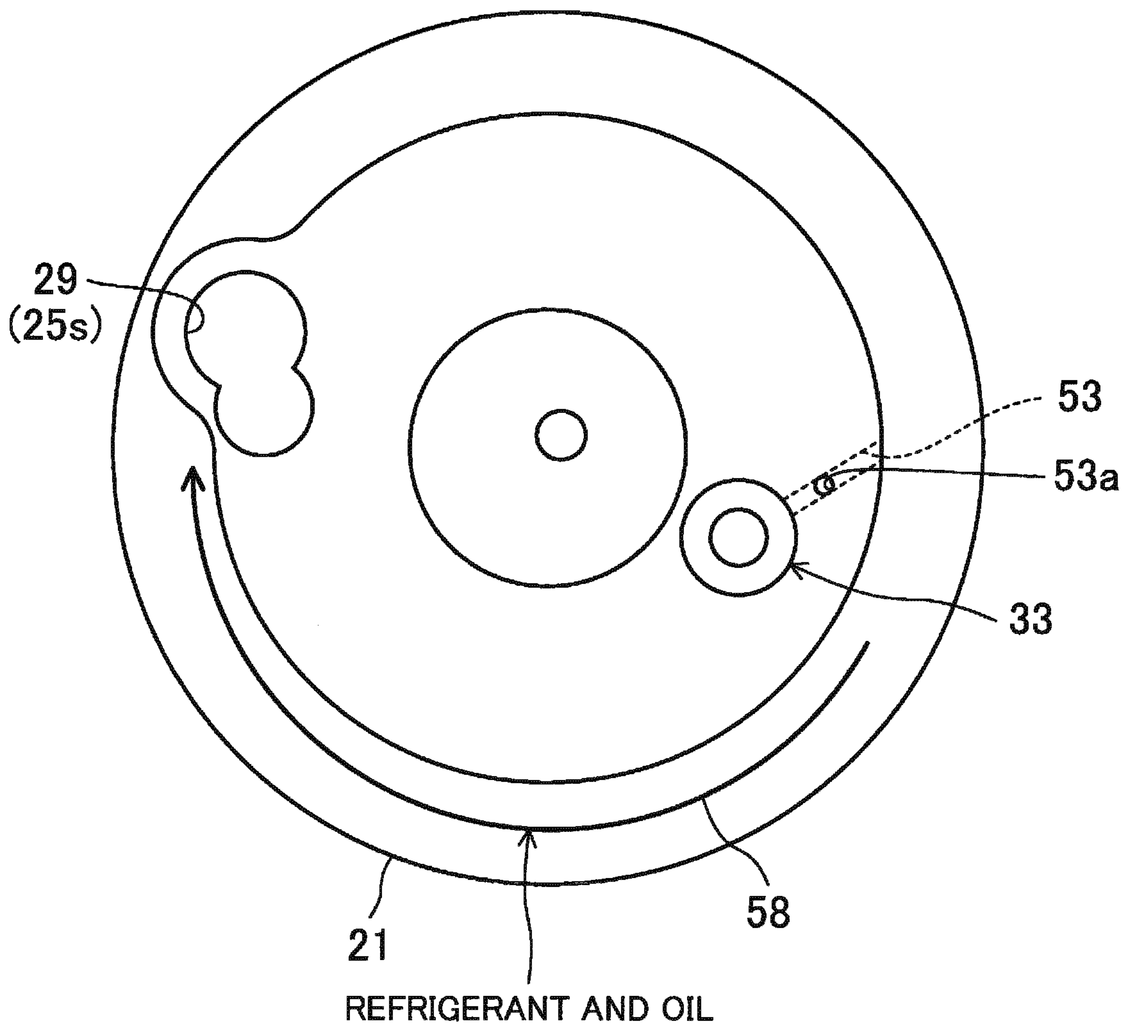


FIG.23

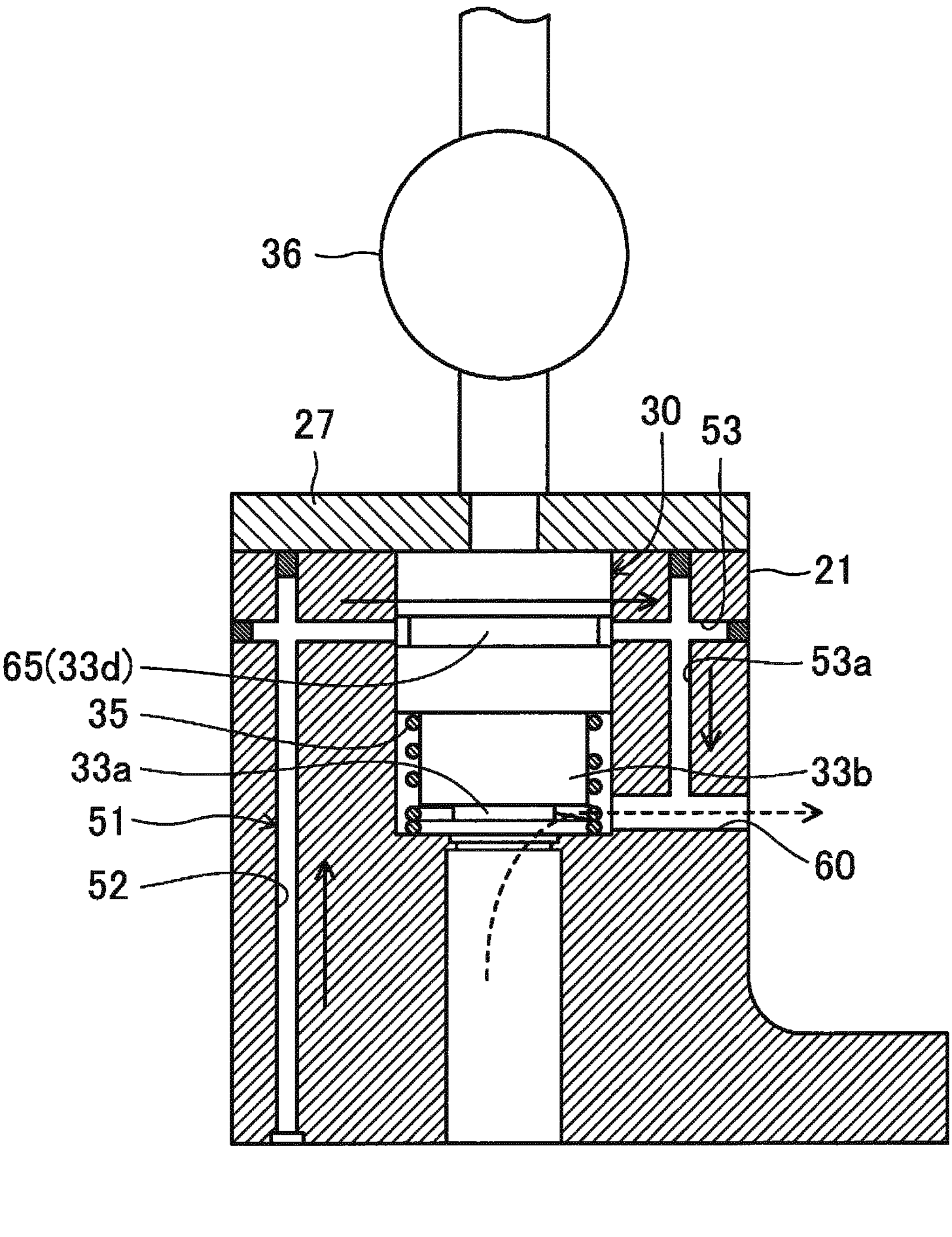
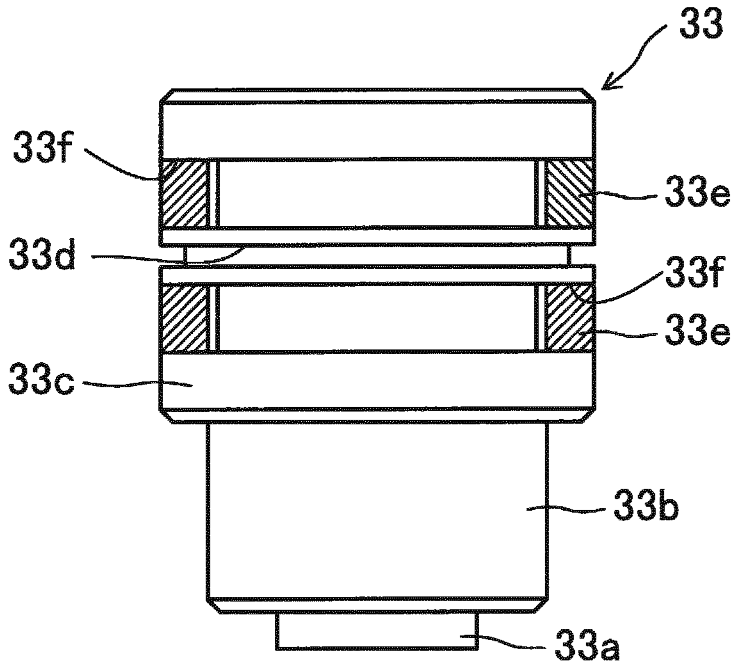


FIG.24



INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2016/004676

A. CLASSIFICATION OF SUBJECT MATTER
F04C29/02(2006.01)i, *F04C18/02*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04C29/02, F04C18/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2016
Kokai Jitsuyo Shinan Koho	1971-2016	Toroku Jitsuyo Shinan Koho	1994-2016

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2007-154761 A (Daikin Industries, Ltd.), 21 June 2007 (21.06.2007), paragraphs [0084] to [0085]; fig. 1 to 3 & WO 2007/066463 A1	1-11
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 001370/1990(Laid-open No. 092581/1991) (Toyoda Automatic Loom Works, Ltd.), 20 September 1991 (20.09.1991), specification, page 3, line 12 to specification, page 4, line 5; fig. 1 (Family: none)	1-11

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

* Special categories of cited documents:
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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed
- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 December 2016 (27.12.16)	10 January 2017 (10.01.17)

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- JP 2007154761 A **[0005]**