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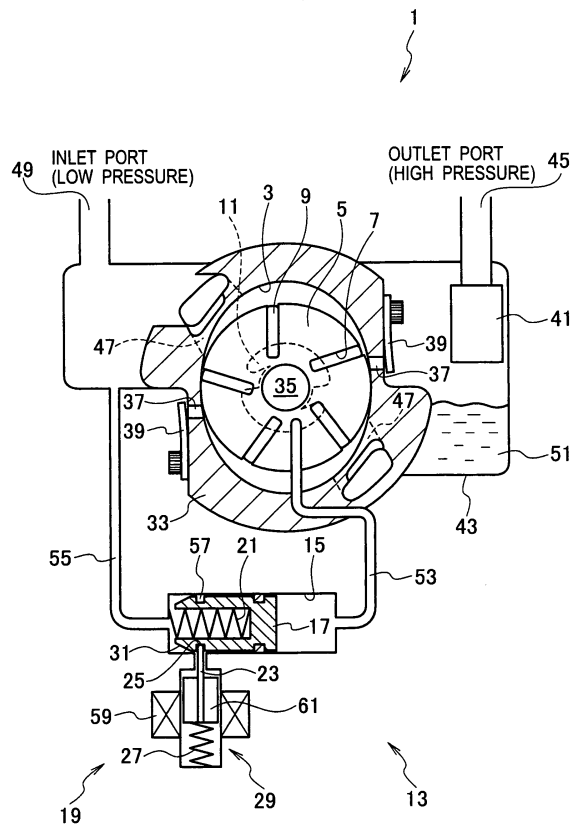
(54) **Vane compressor**

(57) A vane compressor (1) including: a cylinder chamber (3); a rotor (5) rotatably arranged in the cylinder chamber (3); vane grooves (7) provided in the rotor (5) at equal intervals in the circumferential direction thereof; vanes (9) arranged in the vane grooves (7) in a way that the vanes (9) are capable of protruding to, and retracting from, the cylinder chamber (3); and the vane back-pressure chamber (11) communicating with the bottom portions of the vane grooves (7), and configured to apply the back pressure to the vanes (9); and a back-pressure supplying unit (13) configured to transmit the pressure to the vane back-pressure chamber (11), and to push up the vanes to the sliding surface of the cylinder chamber (3) once the activation mode for rotating the rotor (5) is selected.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to a vane compressor with a compression chamber being formed in a cylinder chamber by use of vanes which protrude out of a rotor.

2. Description of the Related Art

[0002] An example of a current type of vane compressor is disclosed in Japanese Patent Application, Laid-Open No. 2004-190509. In this type of vane compressor, when a rotor rotates, a centrifugal force and a back pressure stemming from a discharge pressure raise the vanes in the vane grooves up until the vanes come into intimate contact with the sliding surface of a cylinder chamber. Thereby, the vane compressor starts to compress the gas. For the purpose of facilitating the movement and intimate contact of the vanes under start-up operation, the vane compressor is provided with a volute pump driven by the rotation of the rotor. This volute pump transmits the back pressure to a vane back-pressure chamber.

[0003] Only after the compressor is activated, the volute pump starts to rotate, and the discharge pressure of the compressor starts to rise. There is a time lag between the activation of the compressor and the actual compression which starts with the application of a desired back pressure to the vane back-pressure chamber. Because of this, the real compression lags behind.

[0004] On the other hand, once the compressor stops its operation, the vanes sometimes retract to the bottom portions of the vane grooves due to the gravitation and the differential pressure generated by the reverse rotation of the rotor. This is because the discharge pressure and the vane back pressure generated by the volute pump disappear. Once the compressor is activated again under this state, the vanes repeatedly hit the cylinder chamber during their incomplete compression and discharge strokes due to a centrifugal force until a stable pressure is supplied to the vane back-pressure chamber. This causes the vanes to chatter under the start-up operation, and accordingly causes continuous impulsive sounds.

[0005] In the case of the vane compressor using the pressure generated by the volute pump and the discharge pressure of itself, as described above, the vane back pressure starts to rise only after the compressor is activated. For this reason, the start of real compression lags the activation of the compressor more, and the vanes continue to chatter under the start-up operation for a longer time.

SUMMARY OF THE INVENTION

[0006] The present invention has been made with the foregoing problem taken into consideration. An object of the present invention is to provide a vane compressor which causes the compression to start without delay, and which prevents the vanes from chattering under its start-up operation.

[0007] A first aspect of the present invention is a vane compressor characterized by including: a cylinder chamber; a rotor rotatably arranged in the cylinder chamber; vane grooves provided in the rotor at equal intervals in the circumferential direction of the rotor; vanes arranged in the respective vane grooves in a way that the vanes are capable of protruding to, and retracting from, the cylinder chamber; a vane back-pressure chamber communicating with the bottom portions of the respective vane grooves, and configured to apply a back pressure to the vanes; and a back-pressure supplying unit configured to push up the vanes to the sliding surface of the cylinder chamber by transmitting the back pressure to the vane back-pressure chamber when an activation mode for rotating the rotor.

[0008] In the vane compressor according to the first aspect, once the activation mode is selected, the back-pressure supplying unit transmits the back pressure to the vane back-pressure chamber, as well as the vanes are thus pushed up to, and brought into intimate contact with, the sliding surface of the cylinder chamber, before the rotor starts to rotate. For this reason, the start of real compression does not lag the activation of the compressor, unlike the vane compressor of the current type in which a pressure starts to be applied to the vane back-pressure chamber after the rotor starts to rotate. As a result, the compressor is no sooner activated than the compression starts. This increases the compression performance.

[0009] In addition, the rotor starts to rotate only after the vanes are at once pushed up to, and brought into intimate contact with, the sliding surface of the cylinder chamber due to the pressure supplied by the back-pressure supplying unit. For this reason, the vanes no longer chatter as a consequence of repeated hit of the vanes against the cylinder chamber under the start-up operation.

[0010] A second aspect of the present invention is the vane compressor according to the first aspect, characterized in that the back-pressure supplying unit includes: a back-pressure cylinder communicating with the vane back-pressure chamber; an activation piston configured to generate the back pressure by moving in the back-pressure cylinder; an activation spring configured to bias the activation piston in a direction in which the back pressure is generated (hereinafter referred to as a "back-pressure generating direction"); and a position holding module configured to hold the activation piston in its resting position against the activation spring.

[0011] In the vane compressor according to the second aspect, once the activation mode is selected, the activation piston is released from the position at which the activation piston has been held by the position holding module, and the activation spring thus moves the activation piston in the back-pressure generating direction of the cylinder. Thereby, the back pressure is supplied to the vane back-pressure chamber, and brings the vanes into intimate contact with the sliding surface of the cylinder chamber.

[0012] A third aspect of the present invention is the vane compressor according to the second aspect, characterized in that the position holding module includes: an engagement part provided between the activation piston and a stopper member, and configured to hold the activation piston in its resting position; an engagement spring configured to bias the stopper member in an engagement direction of the engagement part; and an electromagnetic solenoid configured to release the engagement part from its engagement against the engagement spring.

[0013] In the vane compressor according to the third aspect, the engagement spring holds the engagement part in the holding condition until the activation mode is selected. Once the activation mode is selected, the electromagnetic solenoid moves the stopper member against the engagement spring, and thus releases the engagement part from the engagement. Thereby, the activation spring moves the activation piston in the back-pressure generating direction, and the back pressure is thus supplied to the vane back-pressure chamber. The back pressure brings the vanes into intimate contact with the sliding surface of the cylinder chamber.

[0014] Furthermore, the electromagnetic solenoid is operated only a moment at which the engagement part is released from the engagement by moving the stopper member. For this reason, the electromagnetic solenoid consumes only a very small amount of electric power.

[0015] A fourth aspect of the present invention is the vane compressor according to the third aspect, characterized in that: the activation piston is provided with a cam configured to cause the stopper member to retract against the engagement spring when the activation piston retracts due to a return pressure which is transmitted from the vane back-pressure chamber after the completion of the activation thereof; and the engagement spring is that configured to cause the engagement part to engage by pressing the stopper member once retracted.

[0016] In the vane compressor according to the fourth aspect, after the completion of the activation, the activation piston and the activation spring as well as the engagement spring and the engagement part of the position holding module are automatically reset in their respective resting positions where they rest before the activation mode is selected in accordance with the following scheme. That is because, when the activation piston retracts to its resting position side with the return pressure being applied from the vane back-pressure chamber, the cam provided to the activation piston causes the stopper member to retract against the engagement spring in the middle of its retraction. Subsequently, the engagement spring presses the stopper member once retracted, and thus causes the engagement part to engage.

[0017] A fifth aspect of the present invention is the vane compressor according to any one of the second to fourth aspects, characterized in that the low-pressure side of the back-pressure cylinder communicates with the inlet port.

[0018] In the vane compressor according to the fifth aspect, the low-pressure side of the back-pressure cylinder communicates with the inlet port. For this reason, after the completion of the activation, when the activation piston returns to its resting position side with the return pressure being applied from the vane back-pressure chamber, the activation piston is assuredly returned to its resting position by the suction effect of the low pressure coming from the inlet port.

[0019] A sixth aspect of the present invention is the vane compressor according to the first aspect, characterized in that the back-pressure supplying unit includes: a high-pressure tank communicating with the vane back-pressure chamber, and filled with a highly-pressurized fluid; a valve configured to allow and shut off the flow of the fluid between the vane back-pressure chamber and the high-pressure tank; an opening/closing module configured to open the valve, and thus to cause the back pressure to be transmitted from the high-pressure tank to the vane back-pressure chamber, once the activation mode is selected.

[0020] In the vane compressor according to the sixth aspect, once the activation mode is selected, before the rotor starts to rotate, the valve opens the high-pressure tank, and the back pressure is thus transmitted to the vane back-pressure chamber. Thereby, the vanes are pushed up, and brought into intimate contact with, the sliding surface of the cylinder chamber. For this reason, the start of real compression does not lag the activation of the compressor. As a result, the compressor is no sooner activated than the compression starts. This increases the compression performance.

[0021] In addition, the rotor starts to rotate only after the vanes are at once pushed up to, and brought into intimate contact with, the sliding surface of the cylinder chamber due to the pressure coming from the high-pressure tank. For this reason, the vanes no longer chatter as a consequence of repeated hit of the vanes against the cylinder chamber under the start-up operation.

[0022] Furthermore, only immediately after the activation mode is selected, the electromagnetic solenoid needs to be operated. For this reason, the electromagnetic solenoid consumes only a very small amount of electric power.

[0023] A seventh aspect of the present invention is the vane compressor according to the sixth aspect, characterized in that the opening/closing module includes: a stopper spring configured to close the valve; and an electromagnetic solenoid configured to cause the back pressured to be transmitted from the high-pressure tank to the vane back-pressure chamber by opening the valve against the stopper spring once the activation mode is selected.

[0024] In the vane compressor according to the seventh aspect, before the activation mode is selected, the valve is stopped by the stopper spring. Once the activation mode is selected, the electromagnetic solenoid releases the valve against the stopper spring, and the back pressure is thus transmitted to the vane back-pressure chamber.

[0025] Moreover, the valve is configured in such a way as to be released against the stopper spring. For this reason, once the vane compressor starts a compression operation, the valve is released against the stopper spring with the return pressure being applied from the vane back-pressure chamber, and the high-pressure tank is thus filled with the oil. Additionally, once the internal pressure of the high-pressure tank becomes equal to the pressure of the vane back-pressure chamber, the valve is stopped by the stopper spring, and is thus reset to its resting position at which the valve is located before the activation mode is selected.

[0026] In this manner, the valve can be reset to the resting position without use of an external force or electric power.

[0027] In addition, the valve is reset to the resting position without operating the electromagnetic solenoid. All the more for this, the electromagnetic solenoid saves its power consumption.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

[0028] Fig. 1 shows a first embodiment, and is a configuration diagram of a chief section of a vane compressor which is put in a resting condition before an activation mode is selected.

[0029] Fig. 2 shows the first embodiment, and is a configuration diagram of the chief section of the vane compressor in which a back pressure is being transmitted to a vane back-pressure chamber after the activation mode is selected.

[0030] Fig. 3 shows the first embodiment, and is a configuration diagram of the chief section of the vane compressor in which a back-pressure supplying unit and a position holding module are reset after a compression operation starts.

[0031] Fig. 4 shows a second embodiment, and is a configuration diagram of a chief section of a vane compressor which is put in a resting condition before an activation mode is selected.

[0032] Fig. 5 shows the second embodiment, and is a configuration diagram of the chief section of the vane compressor in which a back pressure is being transmitted to a vane back-pressure chamber after the activation mode is selected.

[0033] Fig. 6 shows the second embodiment, and is a configuration diagram of the chief section of the vane compressor in which a back-pressure supplying unit and an opening/closing module are reset after a compression operation starts.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0034] Descriptions will be provided hereinbelow for the embodiments of the present invention by referring to the drawings.

(First Embodiment)

[0035]

Figs. 1 to 3 each show a first embodiment of the present invention.

Fig. 1 is a cross-sectional view of a chief section of a vane compressor 1 which is put in the resting condition. Fig. 2 is a cross-sectional view of the chief section of the vane compressor 1 in the condition when an activation mode is selected. Fig. 3 is a cross-sectional view of the chief section of the vane compressor 1 in the condition when a back-pressure supplying unit 13 and a position holding module 19 are reset.

[0036] The vane compressor 1 includes: a cylinder chamber 3; a rotor 5 rotatably arranged in the cylinder chamber 3; vane grooves 7 provided in the rotor 5 at equal intervals in a circumferential direction thereof; vanes 9 arranged in the vane grooves 7 in a way that the vanes 9 are capable of protruding to, and retracting from, the cylinder chamber 3; a vane back-pressure chamber 11 communicating with the bottom portions of the vane grooves 7, and configured to apply a back pressure to the vanes 9; and a back-pressure supplying unit 13 configured to push up the vanes 9 to a sliding surface of the cylinder chamber 3 by transmitting the back pressure to the vane back-pressure chamber 11 when an activation mode for rotating the rotor 5 is selected.

[0037] The back-pressure supplying unit 13 includes: a back-pressure cylinder 15 communicating with the vane back-pressure chamber 11; an activation piston 17 configured to generate the back pressure by moving in the back-pressure cylinder 15; an activation spring 21 configured to bias the activation piston 17 in a back-pressure generating direction; and a position holding module 19 configured to hold the activation piston 17 in its resting position against the activation spring 21.

[0038] The position holding module 19 includes: an engagement part 25 provided between the activation piston 17 and a stopper member 23, and configured to hold the activation piston 17 in a position where the activation piston 17 rests before being pushed into the activation piston 17; an engagement spring 27 configured to bias the stopper member 23 in an engagement direction of the engagement part 25; and an electromagnetic solenoid 29 configured to release the engagement part 25 from its engagement against the engagement spring 27.

[0039] The activation piston 17 is provided with a cam 31 configured to cause the stopper member 23 to retract against the engagement spring 27 when the activation piston 17 retracts due to a return pressure from the vane back-pressure chamber 11 after the completion of the activation thereof. The engagement spring 27 causes the engagement part 25 to engage by pressing the stopper member 23 once retracted.

[0040] In addition, the low-pressure side of the back-pressure cylinder 15 communicates with the inlet port 49.

[0041] The cylinder chamber 3 is almost elliptical, and is formed in a position inside a front-side block (not illustrated), a cylinder block 33 and a rear-side block (not illustrated). The rotor 5 is fixed to a rotor shaft 35, and is arranged coaxial with the cylinder chamber 3. The vane back-pressure chamber 11 is provided, for example, between the front-side block (not illustrated) and the cylinder block 33, and between the rear-side block (not illustrated) and the cylinder block 33. The vane back-pressure chamber 11 communicates with the bottom portions of the vane grooves 7 of the rotor 5. When the coolant starts to be compressed in response to the rotation of the rotor 5, the back pressure which occurs due to the discharge pressure is designed to work on the vane back-pressure chamber 11.

[0042] The cylinder block 33 is provided with two cylinder outlet ports 37 in its two portions. Each cylinder outlet port 37 is provided with a check valve 39. Each cylinder outlet port 37 communicates with the outlet port 45 of the compressor housing 43 through an oil separator 41. The outlet port 45 communicates with a condenser (not illustrated).

[0043] Two cylinder inlet ports 47 are provided in a position between the front-side block (not illustrated) and the cylinder block 33, and in a position between the rear-side block (not illustrated) and the cylinder block 33. Each cylinder inlet port 47 communicates with the inlet port 49 of the compressor housing 43. The inlet port 49 communicates with an evaporator (not illustrated). The compressor housing 43 is filled with a predetermined amount of oil 51. Part of this oil 51 is mixed with the coolant.

[0044] The cylinder 15 in the back-pressure supplying unit 13 communicates with the vane back-pressure chamber 11 through an oil passage 53. The activation spring 21 biases the activation piston 17 in the back-pressure generating direction (or the direction indicated by an arrow 71 in Fig. 2). In addition the low-pressure side of the cylinder 15 (or the opposite side of the oil passage 53) communicates with the cylinder inlet ports 47 through the communicating passage 55.

[0045] The engagement part 25 of the position holding module 19 is constituted of: a concave part 57 formed in the outer periphery of the activation piston 17; and the tip portion of the stopper member 23. The electromagnetic solenoid 29 includes an electromagnetic coil 59 and an armature 61. The armature 61 and the stopper member 23 are integrated into a single unit. The engagement spring 27 biases the stopper member 23 to the concave part 57 in the activation piston 17 with the armature 61 being interposed in between.

[0046] In addition, after the cam 31 provided to the activation piston 17 comes into contact with the tip of the stopper member 23, the cam 31 causes the stopper member 23 to retract against the engagement spring 27 to a position at which the stopper member 23 releases the engagement part 25 from the engagement.

[0047] Next, descriptions will be provided for how the vane compressor 1 operates. While the vane compressor 1 is in its resting status, as shown in

> Fig. 1, before the activation mode is selected, the rotor 1 rests, and the electromagnetic solenoid 29 is in the OFF state. The activation piston 17 is held in its resting position with the tip portion of the stopper member 23 engaging with the concave part 57 of the activation piston 17 while pressed by the engagement spring 27. Thereby, no back pressure is transmitted to the vane back-pressure chamber 11. As a result, the vanes 9 retract back to the bottom portions of the respective vane grooves 7 due to the gravitation and the differential pressure generated by the reverse rotation of the rotor.

[0048] Once the activation mode is selected, as shown in Fig. 2, the electromagnetic solenoid 29 is turned on immediately. Once the electromagnetic solenoid 29 is turned on, the stopper member 23 retracts from its engagement position, and the engagement part 25 is thus released from the engagement. Once the engagement part 25 is released from the engagement, the activation spring 21 moves the activation piston 17 in the back-pressure generating direction, and the hydraulic pressure (or the back pressure) is thus generated. Thereby, the back pressure is supplied to the vane back-pressure chamber 11 through the oil passage 53 as indicated by an arrow 73. In response to this, the vanes 9 are pushed up to, and brought into intimate contact with, the sliding surface of the cylinder chamber 3.

[0049] The electrical solenoid 29 is turned on momentarily when the activation mode is selected. After that, the electromagnetic solenoid 20 is turned off immediately.

[0050] After the rotor 5 starts to rotate with the vanes 9 being in intimate contact with the sliding surface of the cylinder chamber 3, the vanes 9 continue to be held in the state of being in intimate contact with the cylinder chamber 3 due to the centrifugal force generated by the rotation of the rotor 5 and the discharge pressure (or the back pressure) supplied to the vane back-pressure chamber 11, as described below, even when the electromagnetic solenoid 29 is turned off and the electromagnetic coil 59 stops being excited.

[0051] Once, as shown in Fig. 3, the vanes 9 come into intimate contact with the sliding surface of the cylinder chamber 3, the rotor 5 is driven to rotate as indicated by the arrow 75, and the vane compressor 1 is thus activated. The coolant is taken in through the inlet port 49 as indicated by the arrow 77, and is subsequently compressed. The resultant coolant is discharged through the outlet port 45 as indicated by the arrow 79.

[0052] At this time, as described above, the electromagnetic solenoid 29 is turned off. The highly-pressurized oil (or the return pressure) which occurs due to the discharge pressure flows into the back-pressure cylinder 15 from the oil passage 53 as indicated by an arrow 81. The highly-pressurized oil (or the return pressure) moves the activation piston 17 to its resting position against the activation spring 21. In the middle of the movement of the activation piston 17, the cam operates, and causes the stopper member 23 to retract against the engagement spring 27. Thereafter, when the concave part 57 in the activation piston 17 moves to a position at which the concave part 57 is opposite to the tip of the stopper member 23, the stopper member 23 engages with the concave part 57 due to the biasing force of the engagement spring 27. Thereby, the activation piston 17 is reset to its resting position.

[0053] In addition, when, as described above, the activation piston 17 retracts due to the discharge pressure, the compression of the activation spring 21, the operation of the cam 31 and the compression of the engagement spring 27 are facilitated by the negative pressure applied to the low-pressure side of the back-pressure cylinder 15 from the communicating passage 55 communicating with the inlet ports 47 on the low-pressure side. Thereby, the activation piston 17 is assuredly reset to its resting position.

[0054] In the vane compressor 1, as described above, the start of the real compression does not lag the activation of the compressor. That is because, before the rotor 5 starts to rotate, the back-pressure supplying unit 13 transmits the back pressure to the vane back-pressure chamber 11, and the vanes 9 are thus pushed up to, and brought into intimate contact with, the sliding surface of the cylinder chamber 3. As a result, the vane compressor 1 starts a compression operation immediately after the vane compressor 1 is activated. This increases the compression performance.

[0055] In addition, because the rotor 5 starts to rotate only after the vanes 9 come into intimate contact with the sliding surface of the cylinder chamber 3, the vanes 9 do not chatter under the start-up operation, either.

[0056] Furthermore, when the activation piston 17 moves to its resting position with the return pressure being applied from the vane back-pressure chamber 11 after the completion of the activation, the cam 31 provided to the activation piston 17 causes the stopper member 23 to retract against the engagement spring 27 in the middle of the movement of the activation piston 17. Subsequently, the engagement spring 27 causes the engagement part 25 to engage by pressing the retracted stopper member 23. Thereby, the activation piston 17 is automatically reset to its resting position at which the activation piston 17 rests before the activation mode is selected. The activation piston 17 can be reset thereto without use of an external power or electric power.

[0057] Additionally, the electromagnetic solenoid 29 only needs to be on in a moment at which the engagement part 25 is released from the engagement by moving the stopper member 23 after the activation mode is selected. The electromagnetic solenoid 29 need not be operated after the vane compressor 1 starts a compression operation and when the vane compressor 1 resets the activation piston 17 to its resting position. For this reason, the electromagnetic coil 59 consumes only a very small amount of electric power.

[0058] Moreover, because the low-pressure side of the back-pressure cylinder 15 communicates with the cylinder inlet ports 47 through the communicating passage 55, the retraction of the activation piston 17 and the operation of the cam 31 are facilitated by the negative pressure applied to the low-pressure side of the back-pressure cylinder 15 from the cylinder inlet ports 47. Thereby, the activation piston 17 is assuredly reset to its resting position. (Second Embodiment)

Figs. 4 to 6 each show a second embodiment of the present invention. Fig. 4 is a cross-sectional view of a chief section of a vane compressor 101 which is put in the resting condition. Fig. 5 is a cross-sectional view of the chief section of the vane compressor 101 which is activated after an activation mode is selected. Fig. 6 is a cross-sectional view of the chief section of the vane compressor 101 in which a back-pressure supplying unit 103 and an opening/closing module 109 are reset.

The vane compressor 101 includes: a cylinder chamber 3; a rotor 5 rotatably arranged in the cylinder chamber 3; vane grooves 7 provided in the rotor 5 at equal intervals in a circumferential direction of the rotor 5; vanes 9 arranged in the vane grooves 7 in a way that the vanes 9 are capable of protruding to, and retracting from, the cylinder chamber 3; a vane back-pressure chamber 11 communicating with the bottom portions of the vane grooves 7, and configured to apply a back pressure to the vanes 9; and a back-pressure supplying unit 103 configured to push up the vanes 9 to a sliding surface of the cylinder chamber 3 by transmitting the pressure to the vane back-pressure chamber 11 when an activation mode for driving to rotate the rotor 5 is selected.

The back-pressure supplying unit 103 includes: a high-pressure tank 105 communicating with the vane back-pressure chamber 11, and filled with highly-pressurized oil (or a fluid) 51 mixed with a coolant gas; a solenoid valve (valve) 107 configured to allow and shut off a flow of the oil 51 between the vane back-pressure chamber 11 and the high-pressure tank 105; an opening/closing module 109 configured to open the solenoid valve 107, and thus to cause the pressure (or the back pressure) to be transmitted from the high-pressure tank 105 to the vane back-pressure chamber 11, once the activation mode is selected.

The opening/closing module 109 includes: a stopper spring 111 configured to close the solenoid valve 107; and an electromagnetic solenoid 113 configured to cause the back pressure to be transmitted from the high-pressure tank 105 to the vane back-pressure chamber 11 by opening the solenoid valve 107 against the stopper spring 111 once the activation mode is selected.

While the following descriptions are provided, functional parts and functional members which are the same as those of the vane compressor 1 according to the first embodiment are denoted by the same reference numerals. Duplicated descriptions will be omitted. The descriptions which have been provided for the first embodiment will be referred to whenever deemed necessary.

The high-pressure tank 105 in the back-pressure supplying unit 103 communicates with the vane back-pressure chamber 11 through an oil passage 53. The solenoid valve 107 is provided in a location at which the high-pressure tank 105 is opened to, and closed from, the oil passage 53.

The stopper spring 111 in the opening/closing module 109 is arranged in a direction in which the solenoid valve 107 is opened against the stopper spring 111.

In addition, the electromagnetic solenoid 113 includes an electromagnetic coil 115 and an armature 117. The armature 117 is connected to the solenoid valve 107 with a shaft 119 being interposed in between.

Next, descriptions will be provided for how the vane compressor 101, the back-pressure supplying unit 103 and the opening/closing module 109 operate.

As shown in Fig. 4, while the vane compressor 101 is in a resting status until the activation mode is selected, the electromagnetic solenoid 113 is turned off. The solenoid valve 107 is stopped by the inner pressure of the high-pressure tank 105 and the biasing force of the stopper spring 111. No back pressure is transmitted to the vane back-pressure chamber 11. Accordingly, the vanes 9 retract back to the bottom portions of the vane grooves 7 due to the gravitation and the differential pressure generated by the reverse rotation of the rotor.

Once the activation mode is selected, as shown in Fig. 5, the electromagnetic solenoid 113 is turned on, and the solenoid valve 107 is thus opened against the stopper spring 111. Once the solenoid valve 107 is opened, the hydraulic pressure (or the back pressure) is supplied from the high-pressure tank 105 to the vane back-pressure chamber 11 through the oil passage 53 as indicated by an arrow 73. The vanes 9 are pushed up to, and brought into intimate contact with, the sliding surface of the cylinder chamber 3 by this back pressure.

The electromagnetic solenoid 113 is turned on momentarily when the activation mode is selected. After that, the electromagnetic solenoid 113 is immediately turned off.

After the rotor 5 starts to rotate with the vanes 9 being in intimate contact with the cylinder chamber 3, the vanes 9 continue to be held in the state of being in intimate contact with the cylinder chamber 3 due to the centrifugal force generated by the rotation of the rotor 5 and the discharge pressure (or the back pressure) supplied to the vane back-pressure chamber 11, as described below, even when the electromagnetic solenoid 113 is turned off.

Once, as shown in Fig. 6, the vanes 9 come into intimate contact with the cylinder chamber 3, the rotor 5 is driven to rotate as indicated by an arrow 75, and the vane compressor 101 is thus activated. The coolant is taken in through the inlet port 49 as indicated by an arrow 77, and is subsequently compressed. The resultant coolant is discharged through the outlet port 45 as indicated by the arrow 79.

At this time, as described above, the electromagnetic solenoid 113 is turned off. The highly-pressurized oil (or the return pressure) which occurs due to the discharge pressure flows from the oil passage 53 as indicated by an arrow 81. The solenoid valve 107 is opened against the stopper spring 111, and the highly-pressurized oil (or the return pressure) thus flows into the high-pressure tank 105 as indicated by an arrow 83. Subsequently, once the pressure of the high-pressure tank 105 becomes equal to the pressure of the vane back-pressure chamber 11, the solenoid valve 107 is stopped by the stopper spring 111, and is thus reset to its resting position at which the solenoid valve 107 is located before the activation mode is selected.

In the vane compressor 101, as described above, the start of the real compression does not lag the activation of the compressor. That is because, before the rotor 5 starts to rotate, the back pressure is transmitted to the vane back-pressure chamber 11 from the high-pressure tank 105, and the vanes 9 are thus pushed up to, and brought into intimate contact with, the sliding surface of the cylinder chamber 3. As a result, the vane compressor 101 starts a compression operation immediately after the vane compressor 101 is activated. This increases the compression performance.

In addition, because the rotor 5 starts to rotate only after the vanes 9 come into intimate contact with the sliding surface of the cylinder chamber 3, the vanes 9 do not chatter under the start-up operation, either.

Furthermore, the solenoid valve 107 is configured to be opened against the stopper spring 111. For this reason, after the vane compressor 101 starts a compression operation, the solenoid valve 107 is automatically opened against the stopper spring 111 by the return pressure from the vane back-pressure chamber 11, and the high-pressure tank 105 is filled with the oil. Subsequently, once the pressure of the high-pressure tank 105 becomes equal to the pressure of the vane back-pressure chamber 11, the solenoid valve 107 is closed by the stopper spring 111, and is reset to its resting position. The solenoid valve 107 is reset thereto without use of an external force or electric power.

Additionally, the electromagnetic solenoid 113 is operated only in a moment at which the solenoid valve 107 is opened after the activation mode is selected. The electromagnetic solenoid 113 need not be operated after the vane compressor 1 starts a compression operation and when the vane compressor 1 resets the solenoid valve 107 to its resting position. For this reason, the electromagnetic coil 115 consumes only a very small amount of electric power.

(Other Embodiments Included in the Scope of Claims)

[0059] It should be noted that the present invention shall not be construed as being limited to only the foregoing embodiments, and that the present invention can be variously modified within the technical scope of the present invention.

[0060] In addition, the vane compressor according to the present invention is applicable to any type of scheme for inputting driving torque. For example, the present invention is capable of being operated as an integrated motor-driven compressor obtained by assembling the vane compressor and an electric motor together, and as a pulley-driven compressor driven by driving torque inputted through a pulley.

[0061] Furthermore, the application of the vane compressor according to the present invention is not limited to a cooling system in a vehicle air-conditioning apparatus.

[0062] The entire contents of the Japanese Patent Application No. 2007-208016 (filed on August 9, 2007) are incorporated in the description by reference.

Claims

1. A vane compressor (1, 101), comprising:

a cylinder chamber (3);
a rotor (5) rotatably arranged in the cylinder chamber (3);
vane grooves (7) provided in the rotor (5) at equal intervals in a circumferential direction of the rotor (5);
vanes (9) arranged in the vane grooves (7) in a manner such that the vanes (9) are capable of protruding to, and retracting from, the cylinder chamber (3);
a vane back-pressure chamber (11) communicating with bottom portions of the vane grooves (7), and configured to apply a back pressure to the vanes (9); and
a back-pressure supplying unit (13) configured to push up the vanes (9) to a sliding surface of the cylinder chamber (3) by transmitting the back pressure to the vane back-pressure chamber (11) when an activation mode for rotating the rotor (5) is selected.

2. The vane compressor (1) according to claim 1, wherein the back-pressure supplying unit (13) comprises:

a back-pressure cylinder (15) communicating with the vane back-pressure chamber (11);
an activation piston (17) configured to generate the back pressure by moving in the back-pressure cylinder (15);
an activation spring (21) configured to bias the activation piston (17) in a back-pressure generating direction; and
a position holding module (19) configured to hold the activation piston (17) in its resting position against the activation spring (21).

3. The vane compressor (1) according to claim 2, wherein the position holding module (19) comprises:

an engagement part (25) provided between the activation piston (17) and a stopper member (23), and configured to hold the activation piston (17) in its resting position;
an engagement spring (27) configured to bias the stopper member (23) in an engagement direction of the engagement part (25); and
an electromagnetic solenoid (29) configured to release the engagement part (25) from its engagement against the engagement spring (27).

4. The vane compressor (1) according to claim 3, wherein

the activation piston (17) is provided with a cam (31) configured to cause the stopper member (23) to retract against the engagement spring (27) when the activation piston (17) retracts due to a return pressure which is transmitted from the vane back-pressure chamber (11) after the completion of the activation thereof; and
the engagement spring (27) is configured to cause the engagement part (25) to engage by pressing the stopper member (23) once retracted.

5. The vane compressor according to claim 2, wherein a low-pressure side of the back-pressure cylinder (15) communicates with the inlet port (49).

6. The vane compressor according to claim 3, wherein a low-pressure side of the back-pressure cylinder (15) communicates with the inlet port (49).

7. The vane compressor according to claim 4, wherein a low-pressure side of the back-pressure cylinder (15) communicates with the inlet port (49).

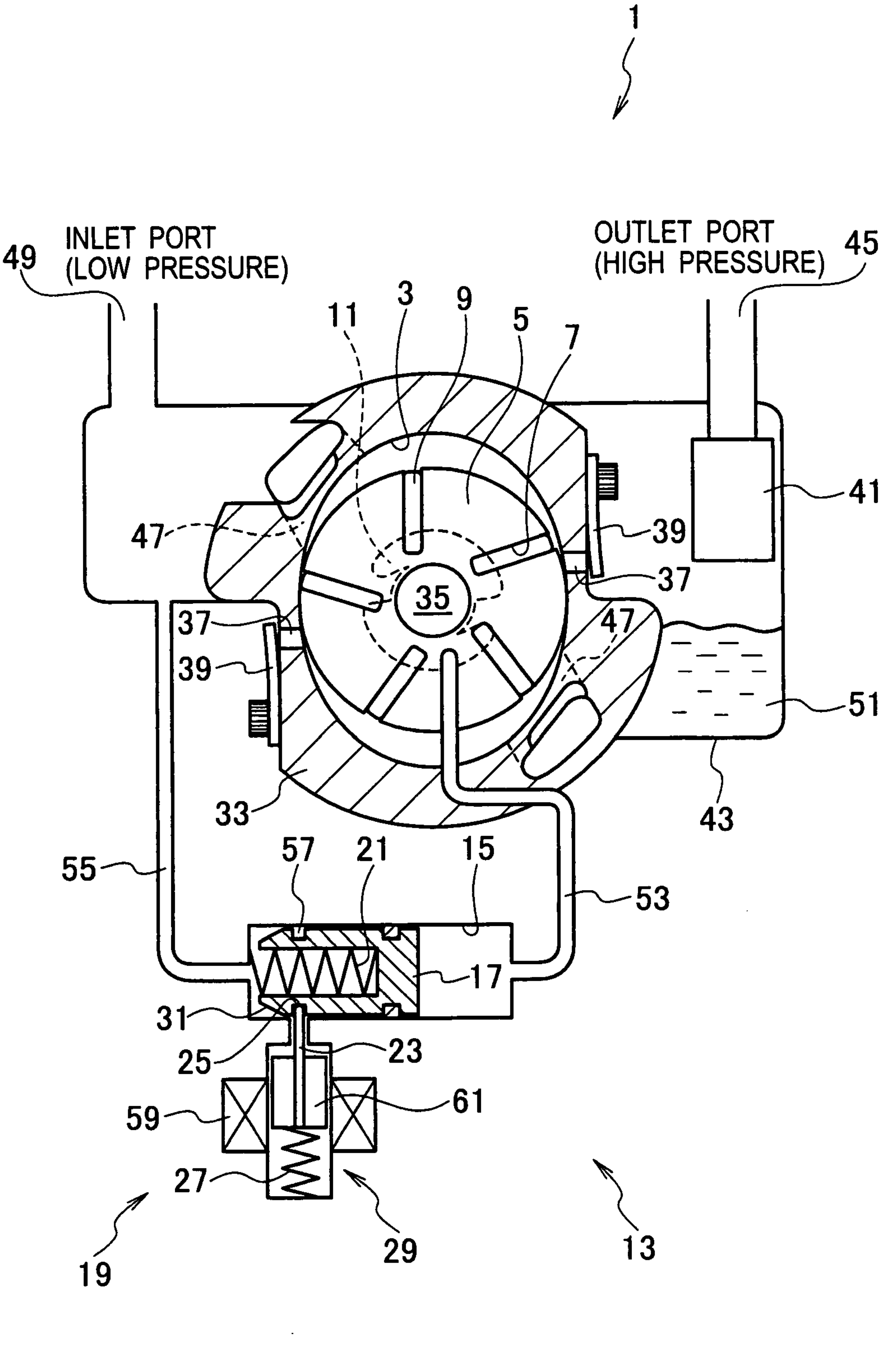
8. The vane compressor (101) according to claim 1, wherein the back-pressure supplying unit (103) comprises:

a high-pressure tank (105) communicating with the vane back-pressure chamber (11), and filled with a highly-pressurized fluid (51);
a valve (107) configured to allow and shut off a flow of the fluid (51) between the vane back-pressure chamber (11) and the high-pressure tank (105); and
an opening/closing module (109) configured to open the valve (107), and thus to cause the back pressure to be transmitted from the high-pressure tank (105) to the vane back-pressure chamber (11), once the activation mode is selected.

9. The vane compressor (101) according to claim 8, wherein the opening/closing module (109) comprises:

a stopper spring (111) configured to close the valve (107); and
an electromagnetic solenoid (113) configured to cause the back pressure to be transmitted from the high-pressure tank (105) to the vane back-pressure chamber (11) by opening the valve (107) against the stopper spring (111) once the activation mode is selected.

FIG. 1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(LOW PRESSURE)
49
OUTLET PORT
(HIGH PRESSURE)
45
11
3
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5
7
41
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35
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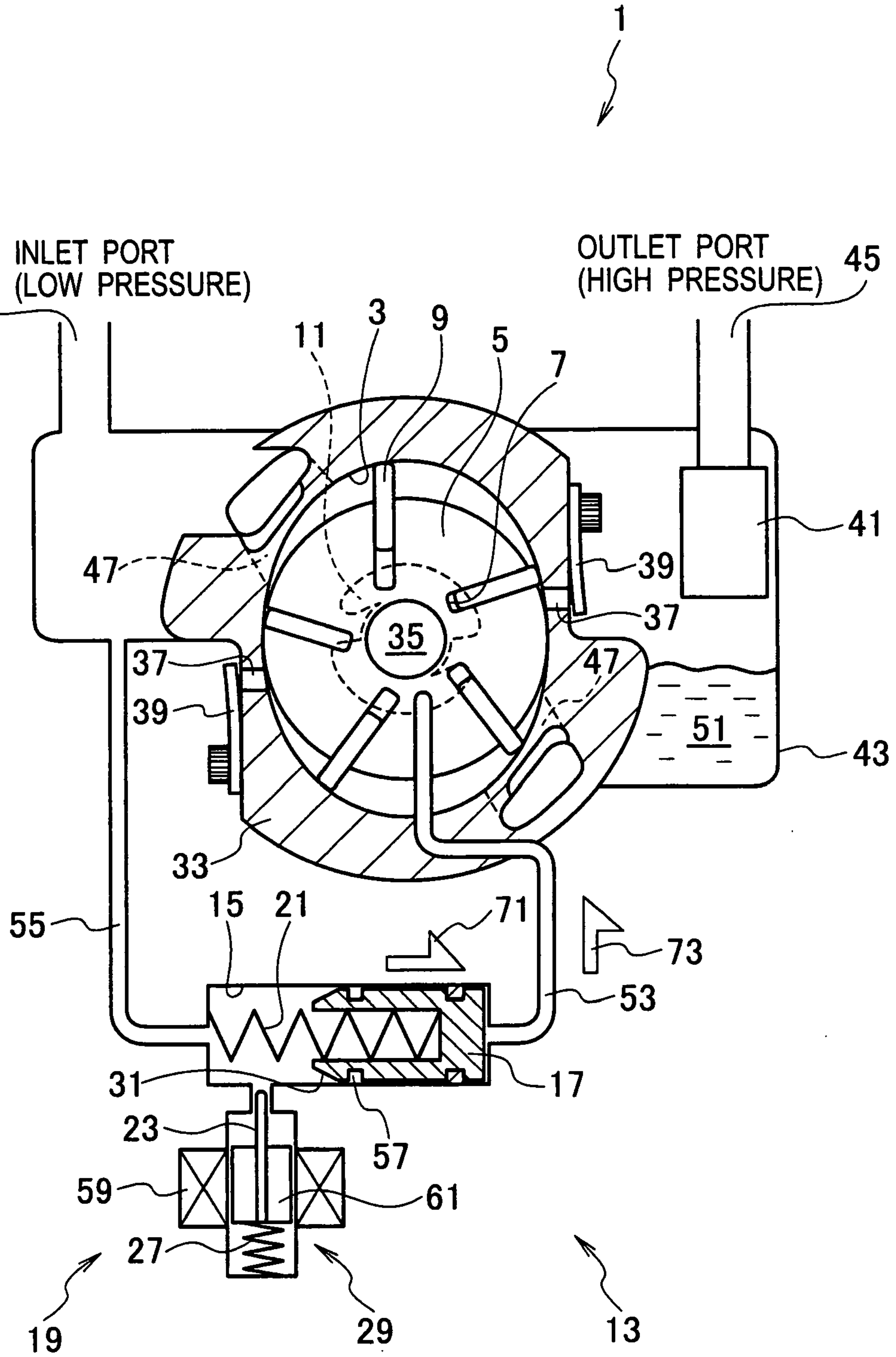
13

FIG. 2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OUTLET PORT
(HIGH PRESSURE)
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15
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71
73
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31
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23
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59
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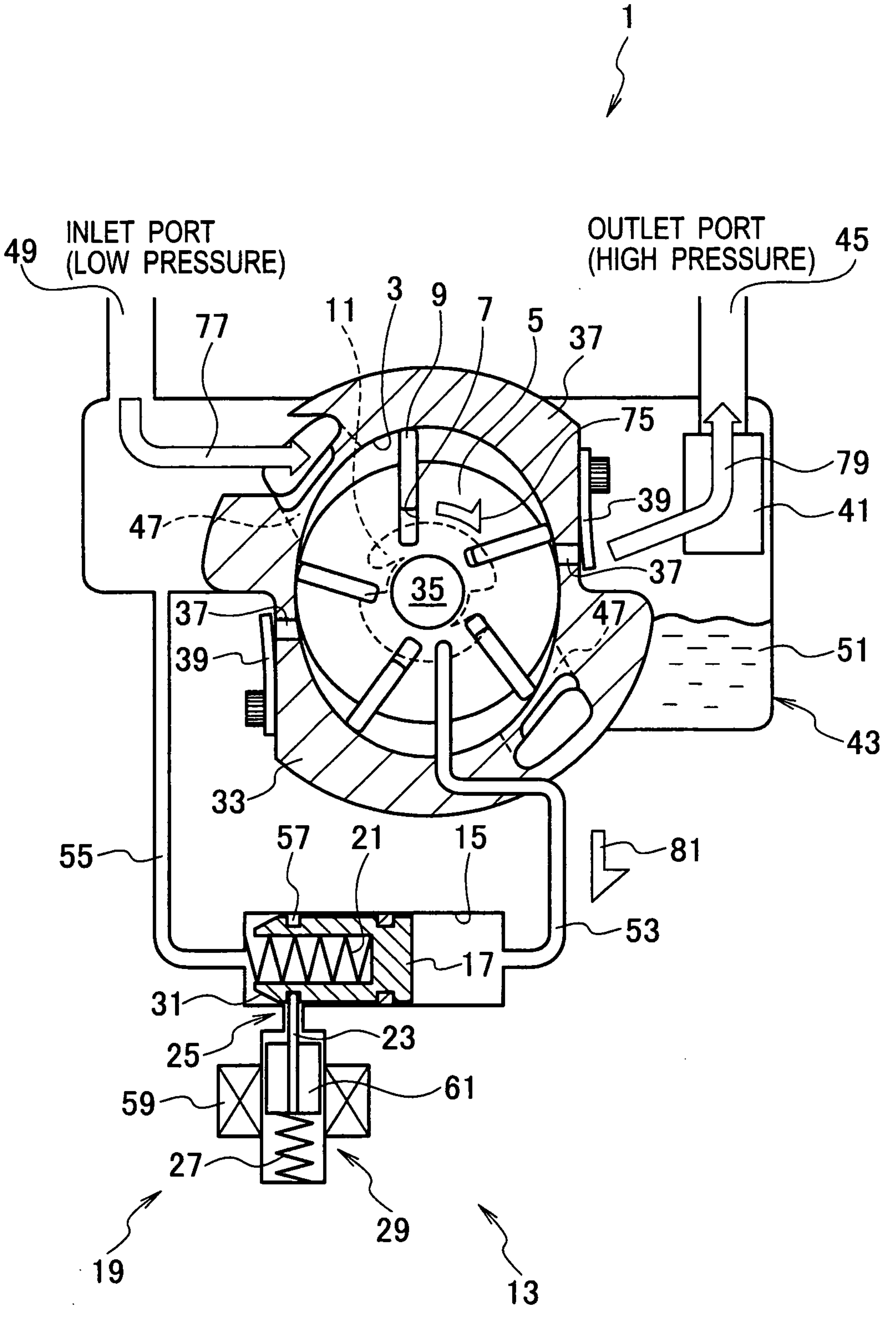
13

FIG. 3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OUTLET PORT
(HIGH PRESSURE)
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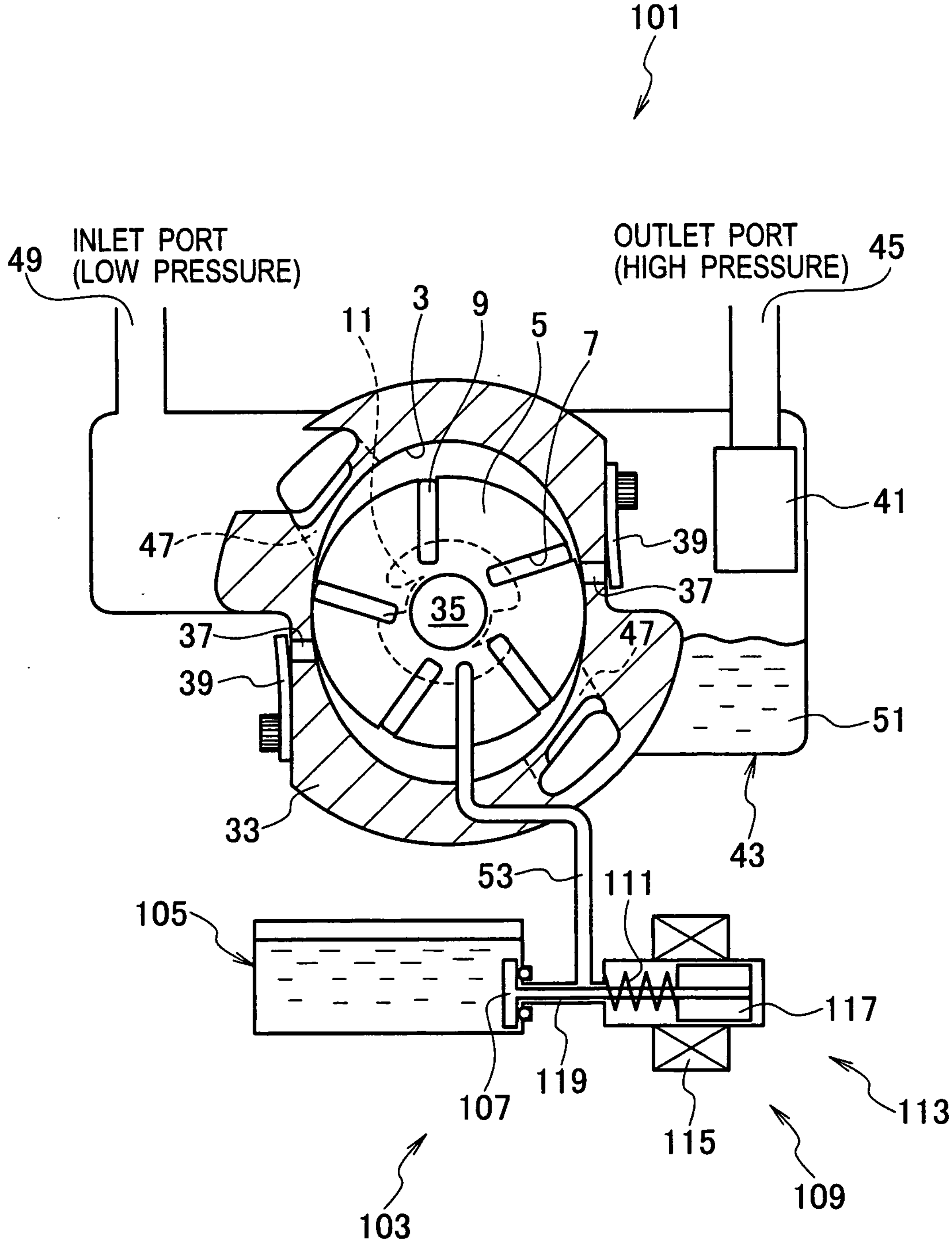
19
13

FIG. 4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OUTLET PORT
(HIGH PRESSURE)
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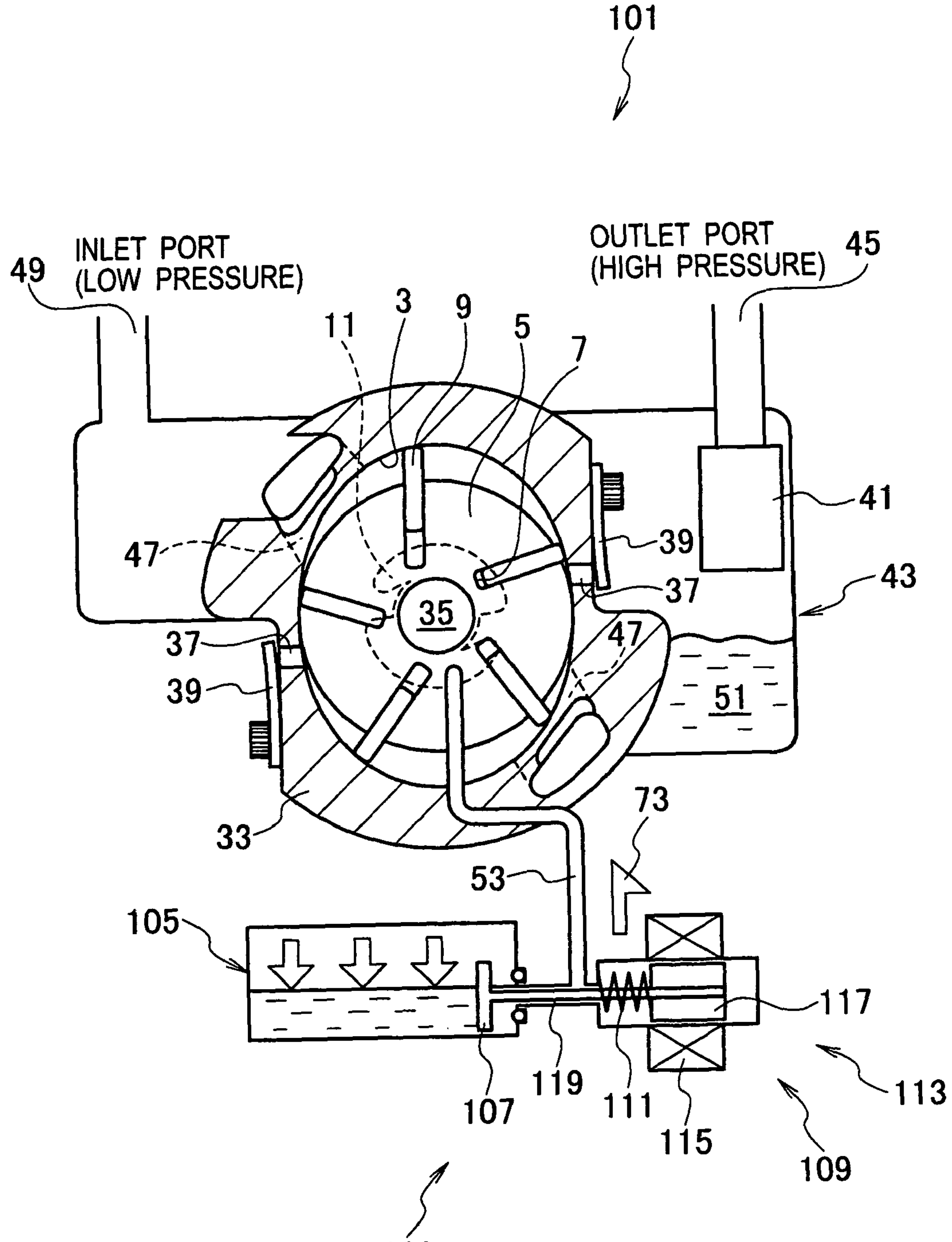
103

FIG. 5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OUTLET PORT
(HIGH PRESSURE)
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111
107
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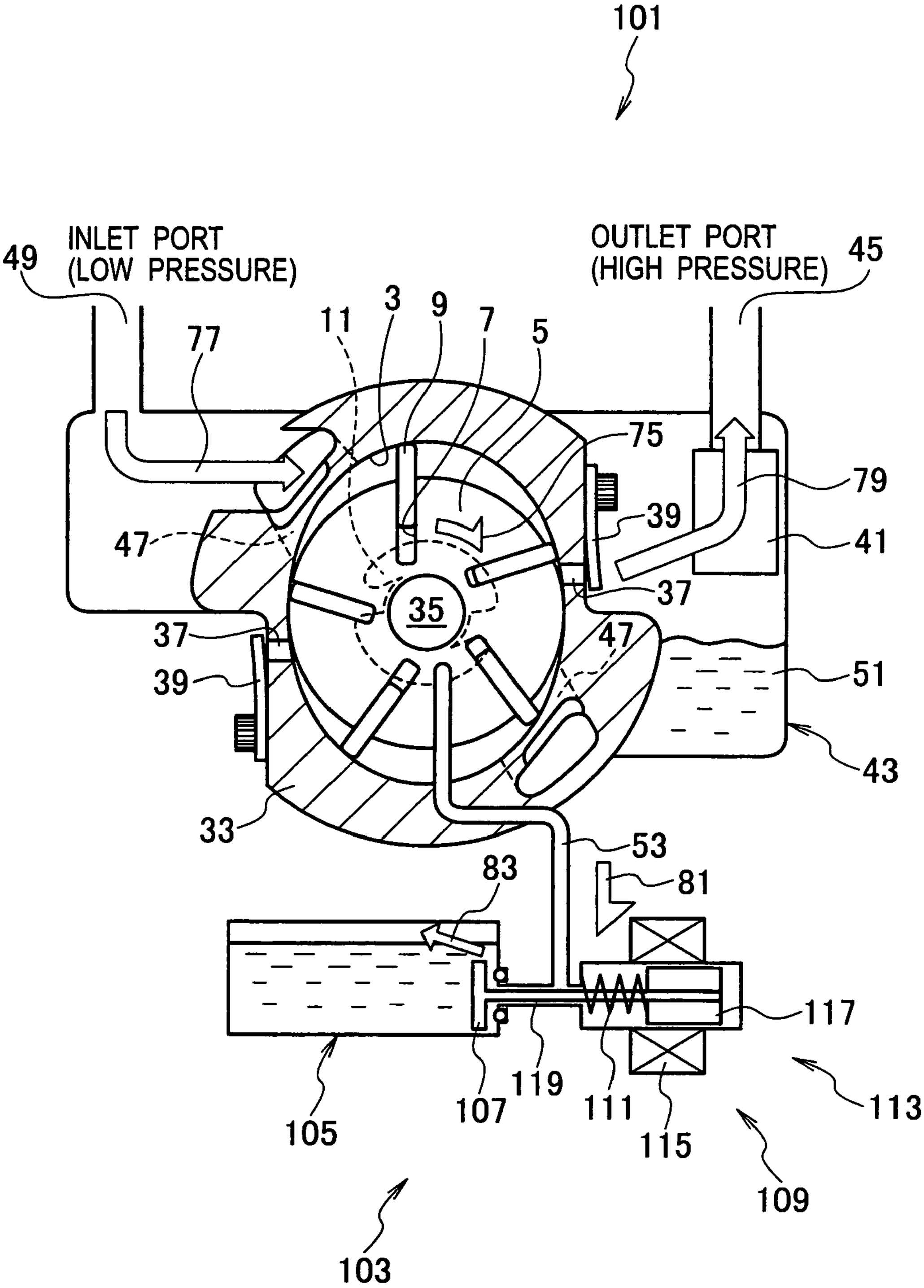
113
109
103

FIG. 6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(LOW PRESSURE)
OUTLET PORT
(HIGH PRESSURE)
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109
103

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2004190509 A **[0002]**
- JP 2007208016 A **[0062]**