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(54) **capacity control for a screw compressor**

Leistungsregelung für einen Schraubenverdichter

Contrôle du capacité pour un compresseur à vis

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Description

BACKGROUND OF THE INVENTION

(1) Field of the Invention

[0001] The present invention relates to a screw compressor that is preferably applicable to an air conditioner, a chiller unit, a refrigerator, and other machines forming a refrigeration cycle. A screw compressor with the features of the preamble portion of patent claim 1 has been known, e.g., from WO 2010/035592 A1.

(2) Description of the Related Art

[0002] When a screw compressor is used for an air conditioner or a chiller unit, wide ranges of suction pressure and discharge pressure are used. Therefore, the pressure within a screw rotor tooth groove may be higher than the discharge pressure depending on operating conditions (this phenomenon is hereinafter referred to as over-compression). Consequently, a screw compressor for reducing the degree of over-compression is proposed (refer, for instance, to JP 1986-79886 A).

[0003] The screw compressor described in JP 1986-79886 A includes a male rotor (main rotor), a female rotor (auxiliary rotor), a bore, a main casing (housing), and a discharge casing (housing wall). The male rotor and female rotor rotate while meshing with each other. The rotation axes of these rotors are substantially parallel to each other. The bore houses the teeth of these rotors. The main casing has an end face to which the rotor axis direction discharge side of the bore is open. The discharge casing is connected to the rotor axis direction discharge side of the main casing. The discharge casing includes a discharge side end face, a discharge port (discharge window), a discharge chamber, a valve hole (hole), and a bypass flow path. The discharge side end face abuts on the end face of the main casing to cover the opening of the bore. The discharge port is formed on the discharge side end face. The discharge chamber is configured so that a compression operation chamber formed on tooth grooves in the male and female rotors discharges a compressed gas through the discharge port. The valve hole is disposed near the discharge port on the discharge side end face and open at a position opposite the direction of rotor rotation toward at least either the male rotor and the female rotor. The bypass flow path establishes communication between the valve hole and the discharge chamber. A valve device (over-flow valve) is mounted on the discharge casing to open and close the valve hole.

[0004] The valve device includes a valve disc and a spring (pressing spring). The valve disc is disposed inside the valve hole. The spring presses the valve disc toward the main casing. When, for instance, the valve hole is closed with the valve disc moved toward main casing, the compression operation chamber discharges

the compressed gas to the discharge chamber through the discharge port. When, on the other hand, the valve hole is opened with the valve disc moved away from the main casing, the compressed gas is discharged to the discharge chamber not only through the discharge port but also through the valve hole and bypass flow path. This reduces the degree of over-compression.

[0005] As a valve disc stopper, a stepped portion is provided for the valve disc and valve hole. Therefore, when, for instance, the valve disc is moved toward the main casing, the leading end face of the valve disc is flush with the end face of the discharge casing. This prevents the valve disc from coming into contact with the end face of a rotor tooth.

[0006] WO 2010/035592 A1 and WO 89/10489 A1 both disclose a screw compressor having a male rotor and a female rotor that have rotation axes substantially parallel to each other and rotate while meshing with each other; a main casing that has a bore for housing the male rotor and the female rotor; a discharge casing that is connected to the rotor axis direction discharge side of the main casing and provided with a discharge side end face which abuts on the end face of the main casing to cover the opening of the bore; a discharge chamber or a discharge flow path that discharges a compressed gas from a compression operation chamber formed by the male rotor and the female rotor through a discharge port formed in at least either the main casing or the discharge casing; a valve hole that is disposed on the female rotor side of the discharge port, formed in the discharge side end face of the discharge casing toward at least either the male rotor or the female rotor, and open to the compression operation chamber; a bypass flow path that establishes communication between the valve hole and the discharge chamber or the discharge flow path; and a valve disc that is disposed in the valve hole; the screw compressor comprising: a valve disc drive device that opens and closes the valve disc; and a control device that detects whether the compression operation chamber is over-compressed, and if the compression operation chamber is over-compressed, controls the valve disc drive device so as to open the valve disc.

SUMMARY OF THE INVENTION

[0007] However, the conventional technology described above has the following problem.

[0008] When the above-described conventional technology is used, the pressure from the compression operation chamber is exerted on the valve disc. Therefore, the compression operation chamber is over-compressed (compression operation chamber pressure > discharge chamber pressure (discharge pressure)). Consequently, when the pressure exerted on the valve disc overcomes the pressing force of the spring, the valve disc opens. However, when the valve disc opens, the compression operation chamber side pressure on the valve disc is immediately equal to the pressure on the discharge

chamber side. Meanwhile, the back pressure on the valve disc is constantly equal to the discharge chamber pressure. Therefore, the pressure exerted on the valve disc is immediately brought into equilibrium. Consequently, the valve disc immediately closes due to the action of the spring, which presses the valve disc toward the main casing. As a result, when the compression operation chamber is over-compressed, the valve disc repeatedly opens and closes each time the compression operation chamber passes through the valve disc due to rotor rotation. The valve disc then hits the stopper to generate a hammering sound and vibrates.

[0009] The present invention has been made in view of the above circumstances and it is an object of the present invention to provide a screw compressor that is capable of reducing the hammering sound and vibration of the valve disc, which reduces the degree of over-compression.

[0010] According to the present invention, this object is accomplished with a screw compressor having the features of claim 1.

[0011] Dependent claims are directed on features of preferred embodiments of the invention.

[0012] The present invention provides a screw compressor that is capable of reducing the hammering sound and vibration of the valve disc, which reduces the degree of over-compression.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] An embodiment of the present invention will be described in detail based on the following figures, in which:

FIG. 1 is a longitudinal cross-sectional view illustrating a screw compressor according to a first embodiment of the present invention;
 FIG. 2 is a right side view of FIG. 1;
 FIG. 3 is a cross-sectional view taken along the line III-III of FIG. 1;
 FIG. 4 is a cross-sectional view taken along the line IV-IV of FIG. 1;
 FIG. 5 is a diagram illustrating the positional relationship between a compression operation chamber, a discharge port, a valve hole, and a bypass flow path in the first embodiment of the present invention;
 FIG. 6 is a cross-sectional view taken along the line VI-VI of FIG. 2 to illustrate a closed valve disc;
 FIG. 7 is a cross-sectional view taken along the line VI-VI of FIG. 2 to illustrate an open valve device;
 FIG. 8 is a cross-sectional view taken along the line VIII-VIII of FIG. 6;
 FIG. 9 shows a discharge side end face of a discharge casing to illustrate a first modification of the first embodiment;
 FIG. 10 corresponds to FIG. 9 and illustrates a second modification of the first embodiment;
 FIG. 11 corresponds to FIG. 9 and illustrates a third

modification of the first embodiment; and
 FIG. 12 is a refrigeration cycle configuration diagram illustrating a chiller unit having the screw compressor according to the first embodiment.

DETAILED DESCRIPTION OF THE INVENTION

[0014] An embodiment of the present invention will now be described with reference to the accompanying drawings.

First Embodiment

[0015] A screw compressor according to a first embodiment of the present invention will be described below with reference to FIGS. 1 to 8.

[0016] FIG. 1 is a longitudinal cross-sectional view illustrating the screw compressor according to the first embodiment of the present invention. FIG. 2 is a right side view of FIG. 1. FIG. 3 is a cross-sectional view taken along the line III-III of FIG. 1 (FIG. 3 shows a discharge side end face of a discharge casing and the position of a bore in an end face of a main casing is indicated by a two-dot chain line). FIG. 4 is a cross-sectional view taken along the line IV-IV of FIG. 1 (FIG. 4 shows the end face of the main casing and the position of a valve hole in the discharge side end face of the discharge casing is indicated by a two-dot chain line). FIG. 5 is a diagram illustrating the positional relationship between a compression operation chamber, a discharge port, a valve hole, and a bypass flow path in the first embodiment of the present invention.

[0017] Referring to FIG. 1, the screw compressor includes a compressor main body 1, a motor (electric motor) 2 for driving the compressor main body 1, and a motor casing 13 for housing the motor 2. The motor casing 13 forms a suction chamber (low-pressure chamber) 5 on the side away from the compressor main body in such a manner that an inlet 6 allows a gas to flow into the suction chamber 5 through a strainer 7. The motor 2 includes a rotor 11, which is mounted on a rotation shaft 10, and a stator 12, which is disposed on the outer circumferential side of the rotor 11. The stator 12 is secured to the inner surface of the motor casing 13.

[0018] The compressor main body 1 is connected to the motor casing 13, and includes a main casing and a discharge casing 16. The main casing 13 incorporates a screw rotor 14. The discharge casing 16 is connected to the discharge side of the main casing 15.

[0019] A cylindrical bore 20 is formed in the main casing 15 to house the tooth portion of the screw rotor 14. The rotor axis direction discharge side of the bore 20 is open. A radially-oriented discharge port 23 is formed toward an end face of the main casing 15, which forms the above opening. Further, a discharge flow path 90 is formed and connected to the discharge port 23.

[0020] As shown in FIG. 4, the screw rotor 14 includes a male rotor 14A and a female rotor 14B, which have

rotation axes parallel to each other and rotate while meshing with each other. The bore 20 includes a bore 20A and a bore 20B. The bore 20A houses the male rotor, whereas the bore 20B houses the female rotor. The discharge port 23 includes a discharge port 23A, which is positioned toward the male rotor, and a discharge port 23B, which is positioned toward the female rotor.

[0021] The rotor axis direction suction side (the left-hand side of FIG. 1) of the main casing 15 is connected to the motor casing 13. A space, such as a gap, between the rotor 11 and stator 12 within the motor casing 13 is used as a suction pass that establishes communication between the suction chamber 5 and the compressor main body 1.

[0022] As shown in FIG. 4, compression operation chambers 36A, 36B are formed on tooth grooves in the male rotor 14A and female rotor 14B. The compression operation chambers sequentially change their function in accordance with screw rotor rotation. More specifically, the compression operation chambers operate as a compression operation chamber for an intake stroke that communicates with a suction port 22 formed on the suction side (motor casing 13 side) of the main casing 15, as a compression operation chamber for a compression stroke that compresses a gas taken in, or as a compression operation chamber for a discharge stroke that communicates with discharge ports 23, 25 and discharges a compressed gas. The discharge ports 23A, 23B are formed on the radially outer side (upper side of FIG. 1) of the male or female rotor relative to the compression operation chamber for the discharge stroke.

[0023] As shown in FIGS. 1 and 3, a discharge port 25 and a discharge chamber 26, which are both axially-oriented, are formed on a discharge side end face 24 of the discharge casing 16. In other words, the discharge casing 16 includes the discharge side end face 24, which abuts on an end face 21 of the main casing 15 and covers the opening of the bores 20A, 20B; a male rotor side discharge port 25A and a female rotor side discharge port 25B, which are formed on the discharge side end face 24; and the discharge chamber 26 into which the compressed gas discharged from the compression operation chambers through the discharge ports 23A, 23B, 25A, 25B flows.

[0024] As shown in FIG. 1, the suction side shaft portion of the male rotor 14A is supported by a roller bearing 17, which is provided for the main casing 15, and by a ball bearing 91, which is provided for the motor casing 13. The discharge side shaft portion of the male rotor 14A is supported by a roller bearing 18 and a ball bearing 19, which are provided for the discharge casing 16. The suction side shaft portion of the female rotor 14B is supported by a roller bearing (not shown) provided for the main casing 15. The discharge side shaft portion of the female rotor 14B is supported by a roller bearing (not shown) and a ball bearing (not shown), which are provided for the discharge casing 16. The suction side shaft portion of the male rotor 14A is directly coupled to the

rotation shaft 10 of the motor 2 so that the male rotor 14A rotates when the motor 2 is driven. When the male rotor 14A rotates, the female rotor 14B rotates while meshing with the male rotor 14A.

[0025] The gas compressed by the screw rotor 14 flows into the discharge chamber 26 or the discharge flow path 90 through the discharge ports 23, 25, is forwarded to an outlet 9 provided for the main casing 15 through the discharge flow path 90, and is delivered to an oil separator 92 through a discharge pipe 94 connected to the outlet 9. The oil separator 92 separates oil from the gas compressed in the compressor main body 1. The oil separated by the oil separator 92 returns to an oil tank 95, which is positioned below the compressor main body 1, through an oil return pipe 93. After being retained in the oil tank 95, the oil is supplied again as a lubricant to the bearings 17, 18, 19, 91, which support the shaft portion of the screw rotor 14 and the rotation shaft 10 of the motor 2. Meanwhile, the compressed gas from which the oil is separated by the oil separator 92 is supplied to the outside (e.g., a condenser that is a part of the refrigeration cycle) through a pipe 96.

[0026] The gas taken into the suction chamber 5 through the inlet 6 cools the rotor 11 and the stator 12 when it passes through the inside of the motor casing 13. Subsequently, the gas flows into the compression operation chambers 36A, 36B, which are formed by the screw rotor 14, through the suction port 22 of the compressor main body 1. As the male rotor 14A and the female rotor 14B rotate, the compression operation chambers 36A, 36B decrease their volume during their movement in the direction of the rotor axis to compress the gas. The gas compressed in the compression operation chambers flows into the discharge flow path 90 through the discharge ports 23A, 23B, 25A, 25B and the discharge chamber 26, and then moves into the discharge pipe 94 through the outlet 9.

[0027] As shown in FIG. 3, a valve hole (cylinder) 28 is formed near the discharge port 25B on the female rotor 14B side of the discharge side end face 24 of the discharge casing 16, and open at a position opposite the direction of rotation of the female rotor 14B (the right-hand side of FIG. 3). A substantial center of the valve hole 28 is positioned at the opening border of the bore 20B that is positioned toward the female rotor 14B on the end face 21 of the main casing 15. Further, a bypass groove 29 is formed on the discharge casing 16. The bypass groove 29 is positioned between the radially outer circumference of the female rotor 14B and the opening border of the bore 20B positioned on the female rotor 14B side of the end face 21 of the main casing 15 to establish communication between the valve hole 28 and the discharge chamber 26. A bypass flow path is formed by the bypass groove 29 and the end face 21 of the main casing 15 that covers the bypass groove 29. The valve hole 28 is provided with a valve disc 31 that opens and closes the valve hole 28.

[0028] A valve disc drive device for driving the valve

disc 31 will now be described with reference to FIGS. 6 to 8.

[0029] FIGS. 6 and 7 are cross-sectional views taken along the line VI-VI of FIG. 2 to illustrate the structure of the valve disc drive device for driving the valve disc 31. FIG. 6 shows the valve disc 31 in a closed state. FIG. 7 shows the valve disc 31 in an open state. FIG. 8 is a cross-sectional view taken along the line VIII-VIII of FIG. 6.

[0030] Referring to FIGS. 6 and 7, the valve disc drive device 30 includes a rod 53, a piston 51, and a cylinder 35. One end of the rod 53 is connected to the rear of the valve disc 31 (the right-hand side of FIG. 6), which is slidably disposed in the valve hole 28. The piston 41 is connected to the other end of the rod 53 through a bolt 52. The cylinder 35 houses the piston 51 in such a manner as to permit the piston 51 to slide. The cylinder 35 is formed on the discharge casing 16. The discharge casing 16 is provided with a rod hole 101 that slidably supports the rod 53. The rod hole 101 is provided with a seal ring 50 that provides sealing between an inner chamber of the cylinder 35 and a back pressure chamber 28a of the valve disc 31. The pressure on the compressor discharge side is introduced into the back pressure chamber 28a through a continuous hole 102 formed in the discharge casing 16. More specifically, one end of the continuous hole 102 is open to the back pressure chamber 28a and the other end of the continuous hole 102 is open to the discharge chamber 26 (see FIG. 3), as shown in FIGS. 6 and 8.

[0031] A seal ring 54 is mounted on the outer circumference of the piston 51 to prevent leakage between cylinder chambers 35A, 35B, which are formed on both sides of the piston 51. In the cylinder chamber 35A (in the cylinder 35 positioned on the side away from the valve disc), one end of a continuous hole 32 is open to a region outside the movement range of the piston 51 (open to the right-hand end of the cylinder chamber 35A). The other end of the continuous hole 32 is open to the discharge chamber 26 as shown in FIG. 8. In other words, the cylinder chamber 35A communicates with the discharge chamber 26 (see FIG. 3) through the continuous hole 32 so that the pressure on the compressor discharge side is constantly introduced into the cylinder chamber 35A.

[0032] In the cylinder chamber 35B (in the cylinder 35 positioned on the side toward the valve disc), one end of a continuous hole 34 is open to a region outside the movement range of the piston 51 (open to the left-hand end of the cylinder chamber 35B). The other end of the continuous hole 34 communicates with the oil tank 95 through a capillary tube 120, as shown in FIG. 2, to form an oil pressure supply path. Further, the continuous hole 34 also communicates with a low-pressure space (the suction port 22 in FIG. 6) through a continuous path (oil pressure relief path) 80. A solenoid valve 42 is positioned in the middle of the continuous path 80 to open and close the continuous path 80. As the above-described config-

uration is employed, opening and closing the solenoid valve 42 makes it possible to introduce high-pressure oil in the oil tank 95 into the cylinder chamber 35B and discharge oil in the cylinder chamber 35B toward the suction port 22 through the continuous path 80 and solenoid valve 42. Further, the cylinder chamber 35B is provided with a spring 33 that presses the piston 51 toward an end cover 60 (which is positioned on the side away from the valve disc 31 and on the right-hand side of FIG. 6).

[0033] When the compression operation chambers 36A, 36B are not over-compressed, control is exercised so that the valve disc 31 is closed. The solenoid valve 42 opens to close the valve disc 31. The cylinder chamber 35B is then placed under a low pressure as it communicates with the suction port 22 through the continuous hole 34 and the continuous path 80. Meanwhile, the gas pressure on the compressor discharge side is constantly exerted in the cylinder chamber 35A. Therefore, as shown in FIG. 6, the piston 51 overcomes the pressing force of the spring 33 and moves toward the main casing 15. The valve disc 31 is then pressed against the end face 21 of the main casing 15 to close the valve hole 28.

[0034] The continuous hole 34 side of the capillary tube 120 also communicates with the suction port 22. However, as the flow of oil is restricted by the capillary tube 120, the amount of oil discharged from the oil tank 95 to the suction port 22 can be adequately decreased. This reduces the amount of oil that may overheat the gas (e.g., refrigerant gas) suctioned into the compressor. Consequently, a decrease in volumetric efficiency is inhibited. Further, the present embodiment is configured so that the oil is discharged to the suction port 22. This makes it possible to minimize the period of time during which the refrigerant gas suctioned into the compressor is overheated by the oil. In this respect, too, it is possible to reduce the degree of refrigerant gas heating by the oil. Thus, the decrease in volumetric efficiency can be inhibited.

[0035] When the compression operation chambers 36A, 36B are over-compressed, control is exercised to open the valve disc 31. In this instance, closing the solenoid valve 42 introduces the high-pressure oil in the oil tank 95 into the cylinder chamber 35B. More specifically, when the solenoid valve 42 closes, the high-pressure oil in the oil tank 95 is introduced into the cylinder chamber 35B through the capillary tube 120 so that the pressure in the cylinder chamber 35B is substantially equal to discharge pressure. Therefore, the pressure exerted on the piston 51 remains substantially unchanged no matter whether it is exerted relative to the cylinder chamber 35A or the cylinder chamber 35B. Therefore, the force of pressing the piston 51 to the side away from the valve disc (toward the end cover 60) is greater by the pressing force generated by the spring 33 provided in the cylinder chamber 35B. Consequently, the piston 51 moves toward the end cover 60 as shown in FIG. 7. The valve disc 31 then leaves the main casing 15 to open the valve hole 28.

[0036] The valve disc drive device 30 for opening and

closing the valve disc 31 is configured as described above. However, the present embodiment further includes a control device that detects whether the compression operation chambers 36A, 36B are over-compressed, and if over-compression is detected, controls the valve disc drive device 30 so as to open the valve disc 31. The control device will now be described with reference to FIG. 1.

[0037] Referring to FIG. 1, the reference numeral 110 denotes a suction pressure sensor that detects the pressure of gas suctioned from the inlet 6, whereas the reference numeral 111 denotes a discharge pressure sensor that detects the pressure of compressed gas discharged from the compressor main body 1. Signals from these pressure sensors are transmitted to the control device 112. In accordance with the signals from the pressure sensors 110, 111, the control device 112 calculates a pressure ratio (discharge pressure/suction pressure) prevailing during a current operation. Further, the control device 112 stores a predetermined pressure ratio and compares the calculated pressure ratio against the predetermined pressure ratio.

[0038] If the result of comparison indicates that the calculated pressure ratio, which prevails during the current operation, is equal to or higher than the predetermined pressure ratio, the control device 112 concludes that there is no over-compression, and opens the solenoid valve 42. The valve disc 31 then moves toward the main casing 15 and becomes depressed to close the valve hole 28.

[0039] If, on the other hand, the result of comparison indicates that the calculated pressure ratio, which prevails during the current operation, is lower than the predetermined pressure ratio, the control device 112 concludes that the compression operation chambers 36A, 36B are over-compressed, and closes the solenoid valve 42. The valve disc 31 then moves away from the main casing 15 (moves toward the right-hand side of FIG. 6) to open the valve hole 28. This ensures that compressed gas is discharged from the compression operation chambers 36A, 36B to the discharge chamber 26 through the valve hole 28 and the bypass flow path (bypass groove 29). Consequently, the pressure in the compression operation chambers is reduced until it is substantially equal to the pressure in the discharge chamber 26. This makes it possible to reduce the degree of over-compression and suppress the unnecessary consumption of motive power.

[0040] The present embodiment is configured so that a set volume ratio V_s/V_d , which is the ratio between a compression operation chamber volume V_s prevailing during suction confinement and a compression operation chamber volume V_d prevailing at the beginning of discharge, is within the range between 1.5 and 3.0.

[0041] Further, the present embodiment is configured so that a substantial center of the valve hole 28 in the discharge side end face 24 of the discharge casing 16 is positioned at the opening border of the bore 20B in the end face 21 of the main casing 15. More specifically, the

inner portion of the valve hole 28, which is positioned between the radially inside of the rotor section and the opening border of the bore 20B, is open to the compression operation chamber 36B as shown in FIG. 3. Therefore, a large opening area is obtained while the outer portion, which is positioned between the radially outside of the rotor section and the opening border of the bore 20B, is covered with the end face 21 of the main casing 15. This ensures that the end face 21 of the main casing 15, which covers the outer portion of the valve hole 28, functions as a stopper for the valve disc 31 (that is, the valve disc 31 does not tilt because it comes into contact with the end face 21). In a conventional case, a stepped portion is provided for the valve disc and valve hole and used as a stopper for positioning the valve disc. In contrast to such a conventional case, the present embodiment is configured to use a simplified stopper for positioning the valve disc. Thus, the present embodiment does not require high-precision machining unlike in the conventional case and makes it possible to provide increased productivity.

[0042] Furthermore, the valve disc drive device 30 can be positioned toward the radially inside of the rotor section in contrast to a case where a substantial center of the valve hole 28 is positioned between the radially inside of the rotor section and the opening border of the bore 20B. This ensures that the valve disc drive device 30 does not interfere with the roller bearing 18 and the ball bearing 19, which are provided for the discharge casing 16 to support the discharge side shaft portion of the female rotor 14B. As this eliminates the necessity of lengthening the discharge side shaft portion of the screw rotor 14, it is possible to suppress an increase in the size of the compressor.

[0043] Moreover, the present embodiment is configured so that the bypass flow path is formed by the bypass groove 29, which is formed in the discharge side end face 24 of the discharge casing 16, and by the end face 21 of the main casing 15, which covers the bypass groove 29. This makes it possible to form the bypass groove 29 at the stage of casting. The number of machining steps can be decreased as compared to a case where, for example, a bypass hole is formed as the bypass flow path.

[0044] Modifications of the first embodiment, which has been described above, will now be described. In the first embodiment, it is assumed that one valve hole 28 is provided on the female rotor 14B side of the discharge side end face 24 of the discharge casing 16 as shown in FIG. 3. However, the number of valve holes and their positions are not limited to those described in connection of the first embodiment. For example, the configuration may be modified as described below in connection with three different modifications shown in FIGS. 9 to 11.

[0045] FIG. 9 shows a first modification. In the first modification, one valve hole 37 is provided on the male rotor 14A side of the discharge side end face 24 of the discharge casing 16. More specifically, the valve hole 37 is disposed near the male rotor 14A side discharge port

25A on the discharge side end face 24 of the discharge casing 16 and open at a position opposite the rotation direction of the male rotor 14A. The reference numeral 38 denotes a bypass groove that permits the valve hole 37 to communicate with the discharge chamber 26. In the same manner as indicated in FIGS. 6 to 8, the valve hole 37 is provided with the valve disc 31 and the valve disc drive device 30, which opens and closes the valve disc 31. Further, the set volume ratio V_s/V_d , which is the ratio between the compression operation chamber volume V_s prevailing during suction confinement and the compression operation chamber volume V_d prevailing at the beginning of discharge, is within the range between 1.5 and 3.0, as is the case with the first embodiment, which has been described earlier. In addition, a substantial center of the valve hole 37 in the discharge side end face 24 of the discharge casing 16 is positioned at the opening border of the bore 20B in the end face 21 of the main casing 15, as is the case with the first embodiment, which has been described earlier. Consequently, the first modification, which has been described with reference to FIG. 9, provides virtually the same advantages as the first embodiment.

[0046] FIG. 10 shows a second modification. In the second modification, the male rotor 14A side and female rotor 14B side of the discharge side end face 24 of the discharge casing 16 are provided respectively with a valve hole 28 and a valve hole 37. More specifically, the female rotor 14B side of the discharge casing 16 is provided, for instance, with the valve hole 28, the bypass groove 29, and the valve disc drive device 30 in the same manner as indicated in FIG. 3, whereas the male rotor 14A side of the discharge casing 16 is provided, for instance, with the valve hole 37, the bypass groove 38, and the valve disc drive device in the same manner as indicated in FIG. 9. The second modification may be configured so that the valve hole 28 and the valve hole 37 may be equal to each other or different from each other in the set volume ratio V_s/V_d , which is the ratio between the compression operation chamber volume V_s prevailing during suction confinement and the compression operation chamber volume V_d prevailing at the beginning of discharge through each valve hole.

[0047] The second modification, which has been described above, provides the same advantages as the first embodiment. In addition, as the male rotor 14A side and female rotor 14B side are provided respectively with the valve hole 28 and the valve hole 37, an over-compressed gas can be discharged from the compression operation chambers to the discharge side with increased promptness in the event of over-compression. This makes it possible to virtually avoid over-compression and further suppress the unnecessary consumption of motive power.

[0048] FIG. 11 shows a third modification. In the foregoing examples, either the female rotor 14B side or the male rotor 14A side is provided with a valve hole 28 or a valve hole 38, or the female rotor 14B side and the male rotor 14A side are respectively provided with a valve hole

28 or a valve hole 38. Meanwhile, the third modification is configured so that either the female rotor 14B side or the male rotor 14A side is provided with a plurality of valve holes or the female rotor 14B side and the male rotor 14A side are both provided with a plurality of valve holes. For example, as shown in FIG. 11, the discharge casing 16 is configured so that the female rotor 14B side is provided with two valve holes 28A, 28B, and that a bypass groove 29A is formed to let the valve holes 28A, 28B communicate with the discharge chamber 26. As is the case with the present embodiment, valve discs are provided respectively for the valve holes 28A, 28B while a valve disc drive device is provided to open and close the valve discs.

[0049] In the third modification, the set volume ratio V_s/V_d , which is the ratio between the compression operation chamber volume V_s prevailing during suction confinement and the compression operation chamber volume V_d prevailing at the beginning of discharge through the valve holes 28A, 28B, is within the range between 1.5 and 3.0 for both the valve hole 28A side and the valve hole 28B side. However, as the valve hole 28A side and the valve hole 28B side are disposed differently relative to the direction of female rotor rotation, they differ in the set volume ratio V_s/V_d . In the third modification, too, substantial centers of the valve holes 28A, 28B in the discharge side end face 24 of the discharge casing 16 are positioned at the opening border of the bore 20B in the end face 21 of the main casing 15.

[0050] The third modification, which has been described above, also provides the same advantages as the present embodiment. In addition, a plurality of valve holes is disposed differently relative to the rotor rotation direction. Therefore, the total pass area of the valve holes can be efficiently enlarged without causing interference with the rotors.

[0051] FIG. 12 is a refrigeration cycle configuration diagram illustrating a chiller unit having the screw compressor according to the first embodiment of the present invention.

[0052] Referring to FIG. 12, the reference numeral 130 denotes the screw compressor according to the first embodiment. The refrigerant gas discharged from the screw compressor 130 enters the oil separator 92 through the discharge pipe 94. After the oil is separated from the refrigerant gas in the oil separator 92, the refrigerant gas is forwarded to a condenser 140 through the pipe (refrigerant pipe) 96. In the condenser 140, the refrigerant gas is cooled by ambient air, condensed, and turned into a liquid refrigerant. The liquid refrigerant is then forwarded to an electronic expansion valve 142 and expanded. The expanded refrigerant is forwarded to an evaporator 141 installed downstream of the electronic expansion valve 142. In the evaporator 141, the expanded refrigerant is evaporated as it draws heat, for instance, from external cooling water. The evaporated refrigerant is then taken back into the screw compressor 130. The cooling water cooled by the evaporator 141 is used, for instance, for

cooling purposes.

[0053] The suction side of the screw compressor 130 is provided with a suction pressure sensor 110. The discharge side of the screw compressor 130 is provided with a discharge pressure sensor 111. The suction pressure sensor 110 and the discharge pressure sensor 111 detect a refrigerant gas suction pressure and a refrigerant gas discharge pressure, respectively. The reference numeral 42 denotes a solenoid valve that is identical with the solenoid valve 42 shown in FIGS. 6 and 7. This solenoid valve 42 opens and closes in accordance with a command from the control device 112. The control device 112 determines a pressure ratio prevailing during an operation in accordance with the suction pressure relative to the screw compressor 130 and the discharge pressure of the screw compressor 130, and compares the determined pressure ratio against a stored preset pressure ratio. If the pressure ratio prevailing during the operation is smaller than the preset pressure ratio, the control device 112 concludes that over-compression has occurred, and then controls the solenoid valve 42 in such a manner that the valve disc drive device 30 opens the valve disc 31 as shown in FIG. 7.

[0054] In the chiller unit, control is usually exercised in such a manner that the temperature of cooling water reaches a target value. Therefore, the cooling water temperature does not cause the suction pressure to significantly vary. However, condensation pressure exerted by the condenser decreases when the temperature of ambient air lowers. Therefore, the discharge side pressure of the condenser, which is detected by the discharge pressure sensor 111, varies. Consequently, over-compression is likely to occur in the screw compressor 130. However, using the screw compressor according to the present embodiment makes it possible to reduce the possibility of over-compression and obtain a chiller unit that does not suffer a significant motive power loss.

[0055] If the pressure ratio (discharge pressure/suction pressure) calculated from a measured suction pressure and discharge pressure is higher than the preset pressure ratio, the present embodiment, which has been described above, closes the valve disc by relieving the oil pressure within a cylinder on the valve disc side of the piston to the suction side of the screw compressor. If, on the other hand, the pressure ratio calculated from the measured suction pressure and discharge pressure is lower than the preset pressure ratio, the present embodiment opens the valve disc by confining the oil pressure within the cylinder. Therefore, the valve disc can be opened and closed with certainty to reduce the degree of over-compression. As a result, the unnecessary consumption of motive power can be suppressed to provide improved performance. In contrast to a conventional case where a valve is opened and closed in accordance with the balance between compression operation chamber pressure exerted on the valve disc, discharge side pressure, and spring force, the present embodiment opens and closes the valve disc with increased certainty

and prevents the valve disc from being rattled by pressure changes in the compression operation chambers. This makes it possible to obtain a screw compressor that is capable of reducing the hammering sound and vibration of the valve disc.

[0056] Particularly, the cylinder on the valve disc side of the piston is provided with a spring that presses the piston to the side away from the valve disc. Therefore, even when the pressure changes in the compression operation chambers, the spring prevents the valve disc from hitting the stopper. As the valve disc does not hit the stopper, the hammering sound and vibration of the valve disc can be eliminated. In addition, the reliability of the valve disc can be enhanced because the spring provided in the cylinder does not repeat its violent expansion and contraction.

[0057] Moreover, in a conventional type described, for instance, in JP-A No. 1986-79886, flow restriction occurs to increase fluid friction when the valve disc opens or closes to let a gas pass through a valve section. Therefore, the degree of over-compression cannot be adequately reduced. In the present embodiment, on the other hand, the control device provides control so that the valve disc is either fully open or fully closed. This makes it possible to avoid the restriction of a gas flow from a valve disc section, which may conventionally occur due to changes in the valve disc opening, and prevent an increase in fluid friction. Therefore, the degree of over-compression can be adequately reduced.

[0058] It should be understood by those skilled in the art that various modifications, combinations, sub-combinations, and alterations may occur depending on design requirements and other factors insofar as they are within the scope of the appended claims or the equivalents thereof.

Claims

1. A screw compressor having a male rotor (14A) and a female rotor (14B) that have rotation axes substantially parallel to each other and rotate while meshing with each other; a main casing (15) that has a bore (20) for housing the male rotor (14A) and the female rotor (14B); a discharge casing (16) that is connected to the rotor axis direction discharge side of the main casing (15) and provided with a discharge side end face which abuts on the end face of the main casing (15) to cover the opening of the bore (20); a discharge chamber (26) or a discharge flow path (90) that discharges a compressed gas from a compression operation chamber (36A, 36B) formed by the male rotor (14A) and the female rotor (14B) through a discharge port (23A, 23B; 25A, 25B) formed in at least either the main casing (15) or the discharge casing (16); a valve hole (28) that is disposed on the female rotor (14B) side of the discharge port (23A, 23B; 25A, 25B), formed in the discharge side end

face (24) of the discharge casing (16) toward at least either the male rotor (14A) or the female rotor (14B), and open to the compression operation chamber (36A, 36B); a bypass flow path that establishes communication between the valve hole and the discharge chamber (26) or the discharge flow path (90); and a valve disc (31) that is disposed in the valve hole (28); the screw compressor comprising:

a valve disc drive device (30) that opens and closes the valve disc (31); and
a control device (112) that detects whether the compression operation chamber (36A, 36B) is over-compressed, and if the compression operation chamber (36A, 36B) is over-compressed, controls the valve disc drive device (30) so as to open the valve disc (31),

characterized in that

the valve disc drive device (30) includes a cylinder (35) that is mounted on the rear side of the valve disc (31), a piston (51) that reciprocates in the cylinder (35), and a rod (53) that connects the piston (51) to the valve disc (31),

a cylinder (35B) on the valve disc side of the piston (51) is provided with a spring that presses the piston (51) to the side away from the valve disc (31) so that a compressed gas on the discharge side of the screw compressor is introduced into a cylinder (35A) on the side away from the valve disc (31) of the piston (51); and a path with a capillary tube (120) is used to connect the valve disc side cylinder (35B) of the piston (51) to the discharge side of the screw compressor; wherein a continuous path (80) is provided to establish communication between the cylinder side of the path with the capillary tube (120) and a low-pressure space of the screw compressor; wherein a solenoid valve (42) is installed in the middle of the continuous path (80) to open and close the continuous path (80); and wherein the pressure on the discharge side of the screw compressor is applied into the cylinder (35B) on the valve disc side of the piston (51) to open the valve disc (31) by opening the continuous path when no over-compression has occurred and by closing the continuous path (80) when over-compression has occurred.

2. The screw compressor according to claim 1, wherein the control device (112) is suitably configures for determining a pressure ratio prevailing during an operation in accordance with a suction pressure relative to the screw compressor and a discharge pressure of the screw compressor (14), is suitably configured for comparing the determined pressure ratio against a stored preset pressure ratio, and if the pressure ratio prevailing during the operation is smaller than the preset pressure ratio, it is suitably configured for

concluding that over-compression has occurred and for controlling the valve disc drive device (30) so as to open the valve disc (31).

3. The screw compressor according to claim 1, wherein, in the event of over-compression, the valve disc drive device (30) applies pressure to the piston (51) to open the valve disc (31).
4. The screw compressor according to claim 3, wherein, when no over-compression has occurred, the valve disc (31) closes; and wherein, when over-compression has occurred, the pressure on the discharge side of the screw compressor is applied into the cylinder (35) on the valve disc side of the piston (51) to move the piston (51) away from the valve disc (31) and open the valve disc (31).
5. The screw compressor according to claim 1, wherein a substantial center of the valve hole (28) in the discharge side end face of the discharge casing (16) is positioned at the opening border of the bore (20B) in the end face (21) of the main casing (15).
6. The screw compressor according to claim 1, wherein the path with the capillary tube (120) is open to a cylinder chamber (35A, 35B) in a region outside the movement range of the piston (51); and wherein the continuous path (80), which communicates with the low-pressure space, is open to a suction port (22) of the screw compressor.
7. The screw compressor according to claim 6, wherein the path with the capillary tube (120) is an oil pressure supply path that is open to an oil tank (95) whose upstream end communicates with the discharge side of the screw compressor.
8. The screw compressor according to claim 4, wherein a gas pressure supply path is formed on the discharge casing to connect a cylinder internal end on the side away from of the valve disc (31) of the piston (51) to the discharge side of the screw compressor.
9. The screw compressor according to claim 1, wherein the bypass flow path is formed by a bypass groove (29), which is formed in the discharge side end face (24) of the discharge casing (16), and by the end face (21) of the main casing (15), which covers the bypass groove (29).
10. The screw compressor according to claim 1, wherein the valve hole (28) is formed so that a set volume ratio V_s/V_d , which is the ratio between a compression operation chamber volume V_s prevailing during suction confinement and a compression operation chamber volume V_d prevailing at the beginning of discharge through the valve hole (28), is within the

range between 1.5 and 3.0.

11. The screw compressor according to claim 1, wherein a plurality of units of the valve hole (37) are formed but different from each other in the set volume ratio V_s/V_d , which is the ratio between the compression operation chamber volume V_s prevailing during suction confinement and the compression operation chamber volume V_d prevailing at the beginning of discharge through each unit of the valve hole (37). 5 10
12. The screw compressor (130) according to claim 2, further comprising:
a suction pressure sensor (110) that detects a suction pressure; and
a discharge pressure sensor (111) that detects a discharge pressure. 15
13. The screw compressor according to claim 1, wherein the discharge port (23A, 23B; 25A, 25B) includes a radially-oriented discharge port (23A, 23B), which is formed on the discharge side end of the main casing (15), and an axially-oriented discharge port, which is formed on the discharge side end face of the discharge casing (16). 20 25

Patentansprüche

1. Schraubenkompressor mit einem Hauptrotor (14A) und einem Nebenrotor (14B), deren Rotationsachsen im Wesentlichen parallel zueinander verlaufen und sich drehen, während sie ineinander eingreifen, mit einem Hauptgehäuse (15), welches eine Bohrung (20) aufweist zur Aufnahme des Hauptrotors (14A) und des Nebenrotors (14B), einem Auslassgehäuse (16), das mit der Auslassseite in der Rotorachsenrichtung des Hauptgehäuses (15) verbunden ist und mit einer auslassseitigen Endfläche versehen ist, die gegen die Endfläche des Hauptgehäuses (15) anschlägt, um die Öffnung der Bohrung (20) abzudecken, mit einer Auslasskammer (26) oder einem Auslassströmungspfad (90), über die/den komprimiertes Gas von einer Kompressionskammer (36A, 36B) ausgelassen wird, die gebildet wird durch den Hauptrotor (14A) und den Nebenrotor (14B) durch einen Auslassstutzen (23A, 23B; 25A, 25B), der mindestens entweder in dem Hauptgehäuse (15) oder dem Auslassgehäuse (16) ausgebildet ist, mit einer Ventilöffnung (28), die auf der Nebenrotor(14B)seite des Auslassstutzens (23A, 23B; 25A, 25B) angeordnet ist, in der auslassseitigen Endfläche (24) des Auslassgehäuses (16) in Richtung auf mindestens entweder den Hauptrotor (14A) oder den Nebenrotor (14B) ausgeformt ist und zur Kompressionskammer (36A, 36B) hin offen ist, mit einem Nebenströmungspfad, der eine Verbindung zwi- 30 35 40 45 50

schen der Ventilöffnung und der Auslasskammer (26) oder dem Auslassströmungspfad (90) herstellt, und mit einer Ventilscheibe (31), die in der Ventilöffnung (28) angeordnet ist, wobei der Schraubenkompressor aufweist:

eine Ventilscheibenantriebsvorrichtung (30), die die Ventilscheibe (31) öffnet und schließt, und eine Steuervorrichtung (112), die erfasst, ob die Kompressionskammer (36A, 36B) überkomprimiert ist, und wenn die Kompressionskammer (36A, 36B) überkomprimiert ist, die Ventilscheibenantriebsvorrichtung (30) so steuert, dass die Ventilscheibe (31) geöffnet wird,

dadurch gekennzeichnet, dass

die Ventilscheibenantriebsvorrichtung (30) einen Zylinder (35) aufweist, der auf der Rückseite der Ventilscheibe (31) montiert ist, einen Kolben (51), der sich in dem Zylinder (35) hin- und herbewegt, und eine Stange (53), die den Kolben (51) mit der Ventilscheibe (31) verbindet, wobei ein Zylinder (35B) auf der Ventilscheiben- seite des Kolbens (51) mit einer Feder versehen ist, die den Kolben (51) auf die von der Ventilscheibe (31) entfernte Seite presst, sodass ein komprimiertes Gas auf der Auslassseite des Schraubenkompressors in einen Zylinder (35A) auf der von der Ventilscheibe (31) entfernten Seite des Kolbens (51) eingeführt wird, und wobei ein Pfad mit einem Kapillarrohr (120) verwendet wird, um den ventilscheibenseitigen Zylinder (35B) des Kolbens (51) mit der Auslass- seite des Schraubenkompressors zu verbinden, wobei ein durchgehender Pfad (80) vorgesehen ist, um eine Verbindung zwischen der Zylinder- seite des Pfads mit dem Kapillarrohr (120) und einem Niederdruckraum des Schraubenkom- pressors herzustellen, wobei ein Magnetventil (42) in der Mitte des durchgehenden Pfads (80) eingebaut ist, um den durchgehenden Pfad (80) zu öffnen und zu schließen, und wobei der Druck auf der Auslassseite des Schraubenkompres- sors in den Zylinder (35B) auf der Ventilschei- benseite des Kolbens (51) eingeführt wird, um die Ventilscheibe (31) durch Öffnung des durch- gehenden Pfads zu öffnen, wenn keine Über- kompression aufgetreten ist, und durch Schlie- ßen des durchgehenden Pfads (80), wenn eine Überkompression aufgetreten ist.

2. Schraubenkompressor nach Anspruch 1, wobei die Steuervorrichtung (112) geeignet ausgebildet ist zur Bestimmung eines Druckverhältnisses, welches während eines Betriebs in Übereinstimmung mit einem Saugdruck relativ zu dem Schraubenkompres- 55

- 5 sor und einem Auslassdruck des Schraubenkompressors (14) herrscht, und die geeignet ausgebildet ist zum Vergleichen des bestimmten Druckverhältnisses mit einem gespeicherten, zuvor festgelegten Druckverhältnis, und wenn das während des Betriebs herrschende Druckverhältnis kleiner als das zuvor festgelegte Druckverhältnis ist, die Vorrichtung geeignet ausgebildet ist zum Folgern, dass eine Überkompression aufgetreten ist, und zum Steuern der Ventilscheibenantriebsvorrichtung (30) derart, dass sie die Ventilscheibe (31) öffnet.
- 10 3. Schraubenkompressor nach Anspruch 1, wobei im Falle einer Überkompression die Ventilscheibenantriebsvorrichtung (30) einen Druck auf den Kolben (51) ausübt, um die Ventilscheibe (31) zu öffnen.
- 15 4. Schraubenkompressor nach Anspruch 3, wobei, wenn keine Überkompression aufgetreten ist, die Ventilscheibe (31) schließt, und wobei, wenn eine Überkompression aufgetreten ist, der Druck auf der Auslassseite des Schraubenkompressors an den Zylinder (35) auf der Ventilscheibenseite des Kolbens (51) angelegt wird, um den Kolben (51) von der Ventilscheibe (31) wegzubewegen und die Ventilscheibe (31) zu öffnen.
- 20 5. Schraubenkompressor nach Anspruch 1, wobei im Wesentlichen die Mitte der Ventilöffnung (28) auf der auslassseitigen Endfläche des Auslassgehäuses (16) an dem Öffnungsrand der Bohrung (20B) in der Endfläche (21) des Hauptgehäuses (15) positioniert ist.
- 25 6. Schraubenkompressor nach Anspruch 1, wobei der Pfad mit dem Kapillarrohr (120) sich zu einer Zylinderkammer (35A, 35B) in einem Bereich außerhalb des Bewegungsbereichs des Kolbens (51) öffnet, und wobei der durchgehende Pfad (80), der mit dem Niederdruckraum verbunden ist, sich zu einem Ansaugstutzen (22) des Schraubenkompressors öffnet.
- 30 7. Schraubenkompressor nach Anspruch 6, wobei der Pfad mit dem Kapillarrohr (120) ein Öldruckzufuhrpfad ist, der sich zu einem Öltank (95) öffnet, dessen stromauf gelegenes Ende mit der Auslassseite des Schraubenkompressors verbunden ist.
- 35 8. Schraubenkompressor nach Anspruch 4, wobei ein Gasdruckzufuhrpfad in dem Auslassgehäuse ausgebildet ist, um ein zylinderinnenseitiges Ende auf der von der Ventilscheibe (31) des Kolbens (51) entfernt gelegenen Seite mit der Auslassseite des Schraubenkompressors zu verbinden.
- 40 9. Schraubenkompressor nach Anspruch 1, wobei der Nebenströmungspfad durch eine Bypassnut (29), die in der auslassseitigen Endfläche (24) des Auslassgehäuses (16) ausgeformt ist, und durch die Endfläche (21) des Hauptgehäuses (15), welche die Bypassnut (29) abdeckt, gebildet wird.
- 45 10. Schraubenkompressor nach Anspruch 1, wobei die Ventilöffnung (28) so geformt ist, dass ein festgelegtes Volumenverhältnis V_s/V_d , welches das Verhältnis zwischen einem Kompressionskammervolumen V_s , welches während des Saug einschlusses herrscht, und einem Kompressionskammervolumen V_d , welches zu Beginn des Auslasses durch die Ventilöffnung (28) herrscht, ist, in einem Bereich zwischen 1,5 und 3,0 liegt.
- 50 11. Schraubenkompressor nach Anspruch 1, wobei eine Mehrzahl von Einheiten der Ventilöffnung (37) ausgebildet sind, die verschieden voneinander bezüglich des festgelegten Volumenverhältnisses V_s/V_d sind, welches das Verhältnis zwischen dem Kompressionskammervolumen V_s , welches während des Saug einschlusses herrscht, und dem Kompressionskammervolumen V_d , welches zu Beginn des Auslasses durch jede Einheit der Ventilöffnung (37) herrscht, ist.
- 55 12. Schraubenkompressor (130) nach Anspruch 2, der ferner aufweist:
- einen Saugdrucksensor (110), der einen Saugdruck erfasst, und
- einen Auslassdrucksensor (111), der einen Auslassdruck erfasst.
13. Schraubenkompressor nach Anspruch 1, wobei der Auslassstutzen (23A, 23B; 25A, 25B) einen radial ausgerichteten Auslassstutzen (23A, 23B) umfasst, der an dem auslassseitigen Ende des Hauptgehäuses (15) ausgebildet ist, und einen axial ausgerichteten Auslassstutzen, der auf der auslassseitigen Endfläche des Auslassgehäuses (16) angeordnet ist.

Revendications

1. Compresseur à vis ayant un rotor mâle (14A) et un rotor femelle (14B) qui ont des axes de rotation sensiblement parallèles l'un à l'autre et tournent tout en s'engrenant l'un avec l'autre ; un carter principal (15) qui a un alésage (20) pour loger le rotor mâle (14A) et le rotor femelle (14B) ; un carter d'évacuation (16) qui est connecté au côté évacuation dans le sens d'axe de rotor du carter principal (15) et prévu avec une face d'extrémité de côté évacuation qui vient buter sur la face d'extrémité du carter principal (15) pour recouvrir l'ouverture de l'alésage (20) ; une chambre d'évacuation (26) ou un chemin d'écoulement

ment d'évacuation (90) qui évacue un gaz comprimé d'une chambre d'opération de compression (36A, 36B) formée par le rotor mâle (14A) et le rotor femelle (14B) à travers un orifice d'évacuation (23A, 23B ; 25A, 25B) formé dans au moins le carter principal (15) ou le carter d'évacuation (16) ; un trou de clapet (28) qui est disposé sur le côté rotor femelle (14B) de l'orifice d'évacuation (23A, 23B ; 25A, 25B), formé dans la face d'extrémité de côté évacuation (24) du carter d'évacuation (16) vers au moins le rotor mâle (14A) ou le rotor femelle (14B), et ouvert sur la chambre d'opération de compression (36A, 36B) ; un chemin d'écoulement de dérivation qui établit une communication entre le trou de clapet et la chambre d'évacuation (26) ou le chemin d'écoulement d'évacuation (90) ; et un disque de clapet (31) qui est disposé dans le trou de clapet (28) ; le compresseur à vis comprenant :

un dispositif d'entraînement (30) de disque de clapet qui ouvre et ferme le disque de clapet (31) ; et

un dispositif de commande (112) qui détecte si la chambre d'opération de compression (36A, 36B) est en surcompression, et si la chambre d'opération de compression (36A, 36B) est en surcompression, commande le dispositif d'entraînement (30) de disque de clapet de manière à ouvrir le disque de clapet (31),

caractérisé en ce que

le dispositif d'entraînement (30) de disque de clapet inclut un cylindre (35) qui est monté sur le côté arrière du disque de clapet (31), un piston (51) qui effectue un mouvement de va-et-vient dans le cylindre (35), et une tige (53) qui connecte le piston (51) au disque de clapet (31), un cylindre (35B) sur le côté disque de clapet du piston (51) est prévu avec un ressort qui presse le piston (51) sur le côté à l'opposé du disque de clapet (31) de telle manière qu'un gaz comprimé sur le côté évacuation du compresseur à vis est introduit dans un cylindre (35A) sur le côté à l'opposé du disque de clapet (31) du piston (51) ; et

un chemin avec un tube capillaire (120) est utilisé pour connecter le cylindre (35B) de côté disque de clapet du piston (51) au côté évacuation du compresseur à vis ; dans lequel un chemin continu (80) est prévu pour établir une communication entre le côté cylindre du chemin avec le tube capillaire (120) et un espace basse pression du compresseur à vis ; dans lequel une électrovanne (42) est installée au milieu du chemin continu (80) pour ouvrir et fermer le chemin continu (80) ; et dans lequel la pression sur le côté évacuation du compresseur à vis est appliquée dans le cylindre (35B) sur le côté disque de clapet du piston (51) pour ouvrir le disque de

clapet (31) en ouvrant le chemin continu lorsqu'aucune surcompression n'est survenue et en fermant le chemin continu (80) lorsqu'une surcompression est survenue.

- 5 2. Compresseur à vis selon la revendication 1, dans lequel le dispositif de commande (112) est configuré de façon appropriée pour déterminer un rapport de pression prévalant lors d'une opération en fonction d'une pression d'aspiration par rapport au compresseur à vis et d'une pression d'évacuation du compresseur à vis (14), est configuré de façon appropriée pour comparer le rapport de pression déterminé à un rapport de pression prédéfini stocké, et si le rapport de pression prévalant lors de l'opération est plus petit que le rapport de pression prédéfini, il est configuré de façon appropriée pour conclure qu'une surcompression est survenue et pour commander le dispositif d'entraînement (30) de disque de clapet de manière à ouvrir le disque de clapet (31).
- 10 3. Compresseur à vis selon la revendication 1, dans lequel, en cas de surcompression, le dispositif d'entraînement (30) de disque de clapet applique une pression au piston (51) pour ouvrir le disque de clapet (31).
- 15 4. Compresseur à vis selon la revendication 3, dans lequel, lorsqu'aucune surcompression n'est survenue, le disque de clapet (31) se ferme ; et dans lequel, lorsqu'une surcompression est survenue, la pression sur le côté évacuation du compresseur à vis est appliquée dans le cylindre (35) sur le côté disque de clapet du piston (51) pour écarter le piston (51) du disque de clapet (31) et ouvrir le disque de clapet (31).
- 20 5. Compresseur à vis selon la revendication 1, dans lequel sensiblement un centre du trou de clapet (28) dans la face d'extrémité de côté évacuation du carter d'évacuation (16) est positionné à la bordure d'ouverture de l'alésage (20B) dans la face d'extrémité (21) du carter principal (15).
- 25 6. Compresseur à vis selon la revendication 1, dans lequel le chemin avec le tube capillaire (120) est ouvert sur une chambre de cylindre (35A, 35B) dans une région à l'extérieur d'une plage de mouvement du piston (51) ; et dans lequel le chemin continu (80), qui communique avec l'espace basse pression, est ouvert sur un orifice d'aspiration (22) du compresseur à vis.
- 30 7. Compresseur à vis selon la revendication 6, dans lequel le chemin avec le tube capillaire (120) est un chemin d'alimentation de pression d'huile qui est ouvert sur un réservoir d'huile (95) dont l'extrémité amont communique avec le côté évacuation du com-

presseur à vis.

8. Compresseur à vis selon la revendication 4, dans lequel un chemin d'alimentation de pression de gaz est formé sur le carter d'évacuation pour connecter une extrémité interne de cylindre sur le côté opposé au disque de clapet (31) du piston (51) au côté évacuation du compresseur à vis. 5

9. Compresseur à vis selon la revendication 1, dans lequel le chemin d'écoulement de dérivation est formé par une goulotte de dérivation (29), qui est formée dans la face d'extrémité de côté évacuation (24) du carter d'évacuation (16), et par la face d'extrémité (21) du carter principal (15), qui recouvre la goulotte de dérivation (29). 10
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10. Compresseur à vis selon la revendication 1, dans lequel le trou de clapet (28) est formé de telle manière qu'un rapport volumique défini V_s/V_d , qui est le rapport entre un volume de chambre d'opération de compression V_s prévalant lors d'un confinement d'aspiration et un volume de chambre d'opération de compression V_d prévalant au début de l'évacuation par le trou de clapet (28), est dans la plage entre 1,5 et 3,0. 20
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11. Compresseur à vis selon la revendication 1, dans lequel une pluralité d'unités du trou de clapet (37) sont formées, mais différentes les unes des autres en termes du rapport volumique défini V_s/V_d , qui est le rapport entre le volume de chambre d'opération de compression V_s prévalant lors d'un confinement d'aspiration et le volume de chambre d'opération de compression V_d prévalant au début de l'évacuation par chaque unité du trou de clapet (37). 30
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12. Compresseur à vis (130) selon la revendication 2, comprenant en outre : 40
 - un capteur de pression d'aspiration (110) qui détecte une pression d'aspiration ; et
 - un capteur de pression d'évacuation (111) qui détecte une pression d'évacuation. 45

13. Compresseur à vis selon la revendication 1, dans lequel l'orifice d'évacuation (23A, 23B ; 25A, 25B) inclut un orifice d'évacuation (23A, 23B) orienté radialement, qui est formé sur l'extrémité de côté évacuation du carter principal (15), et un orifice d'évacuation orienté axialement, qui est formé sur la face d'extrémité de côté évacuation du carter d'évacuation (16). 50
55

FIG. 1

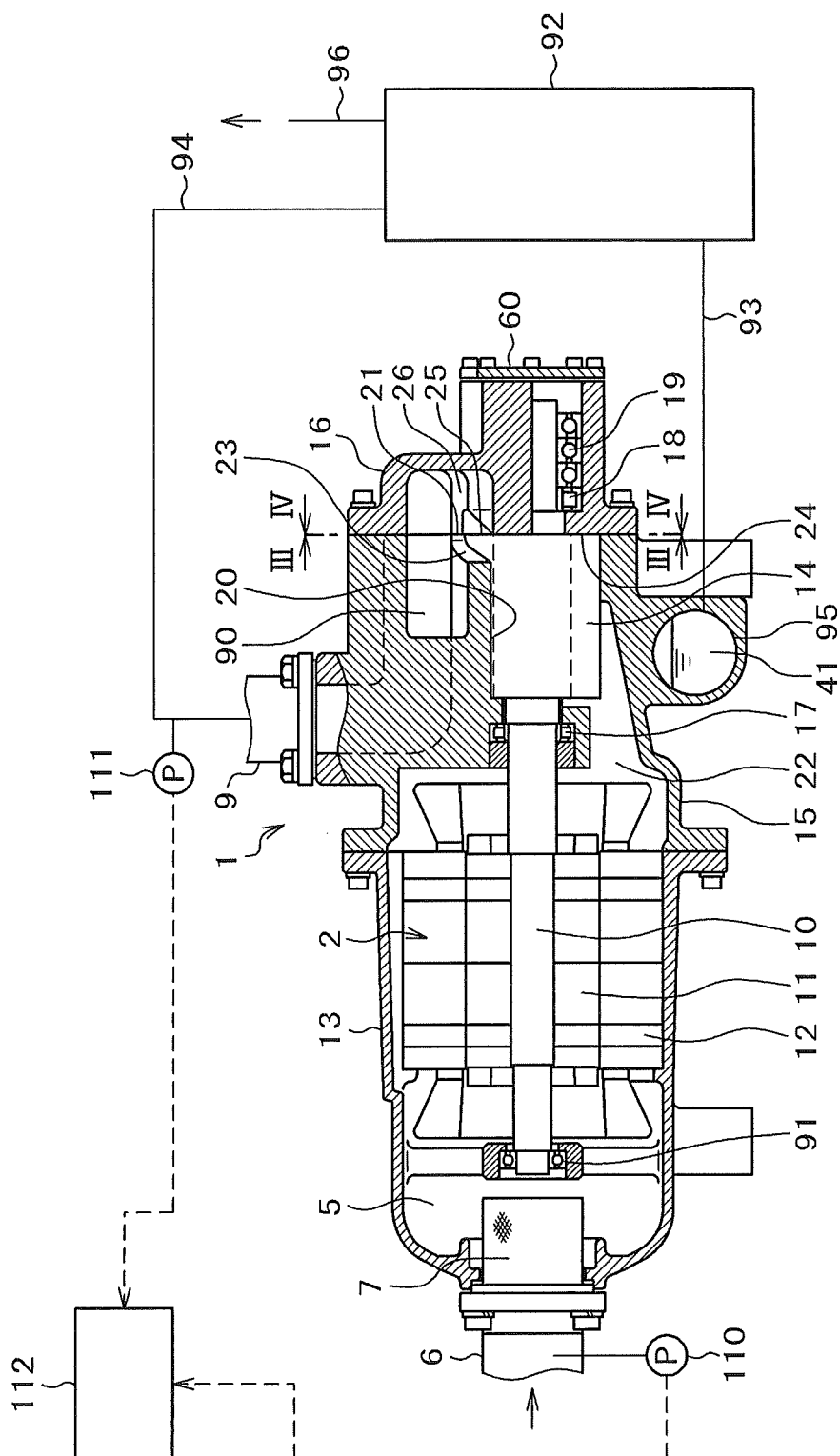


FIG. 2

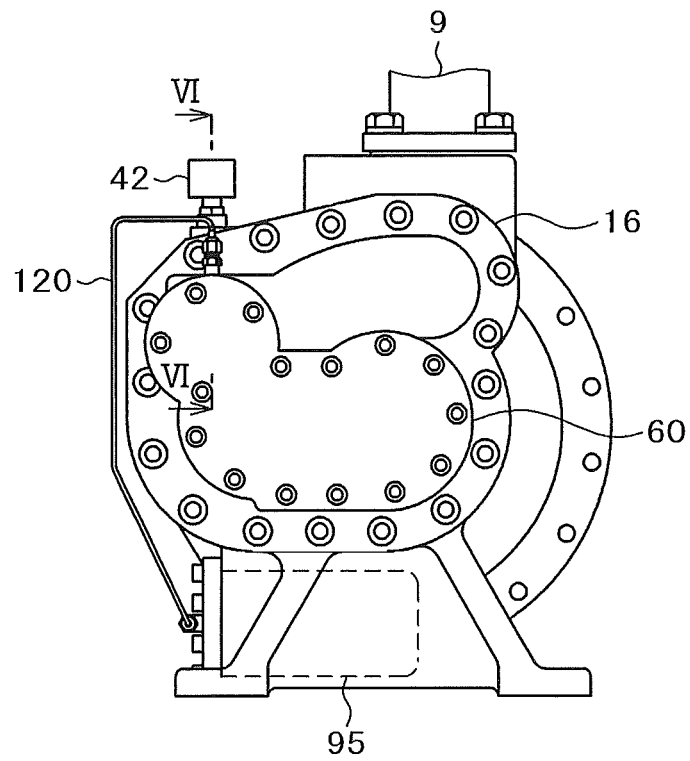


FIG. 3

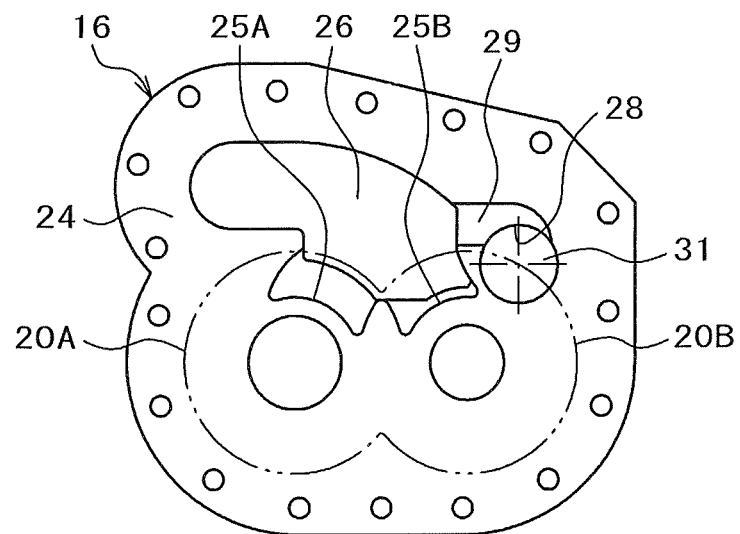


FIG. 4

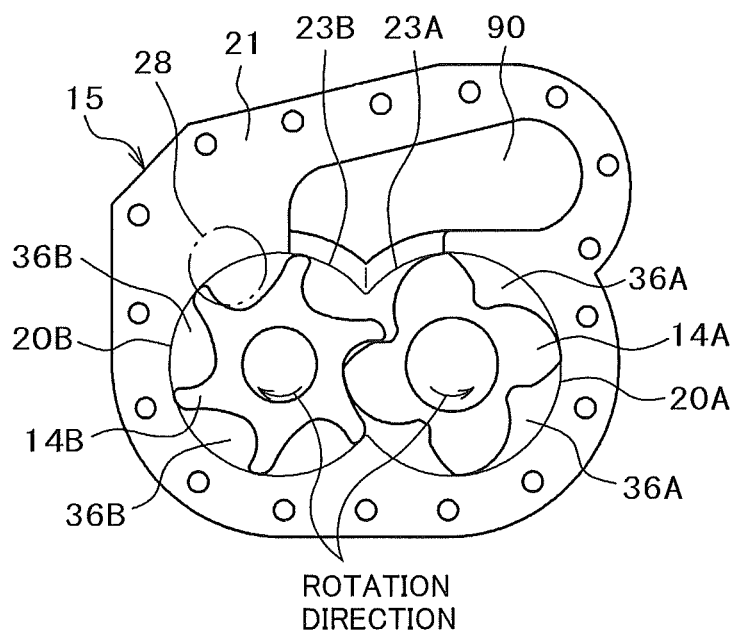


FIG. 5

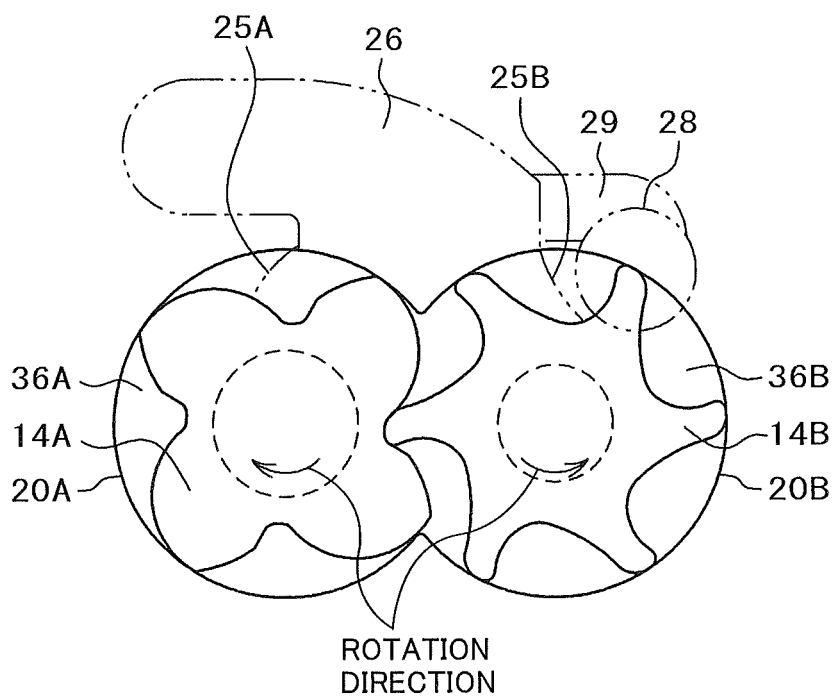


FIG. 6

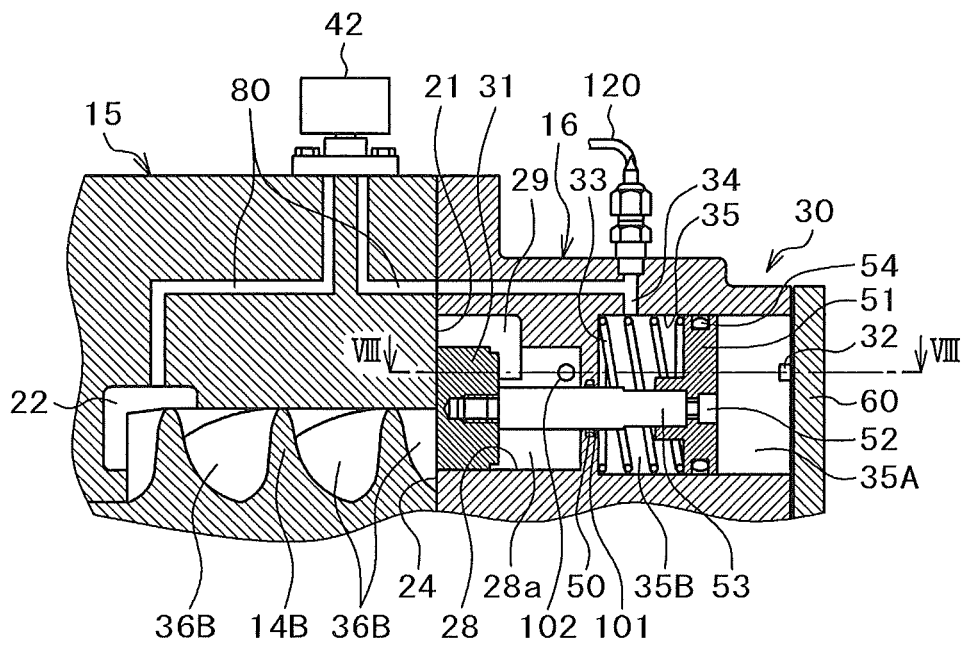


FIG. 7

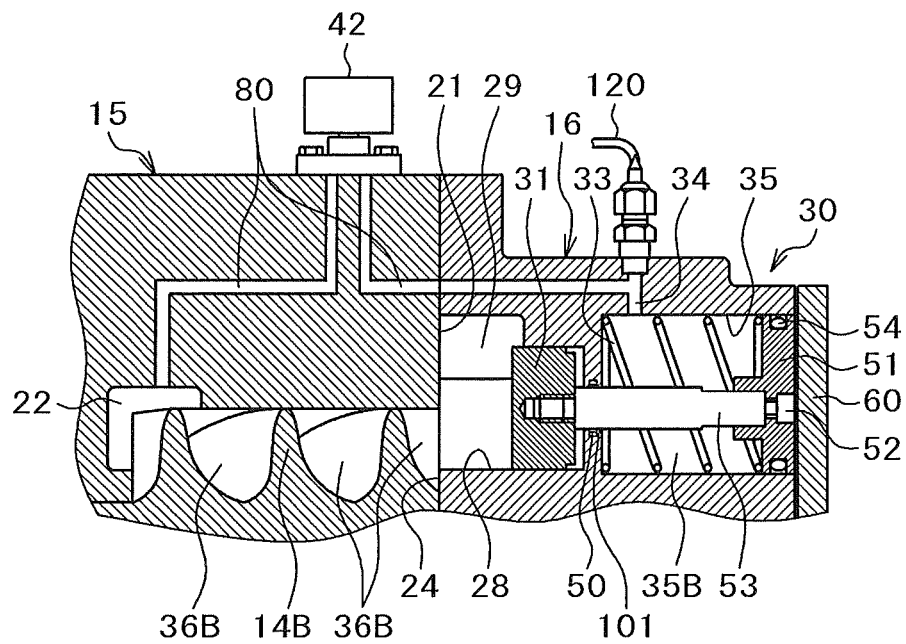


FIG. 8

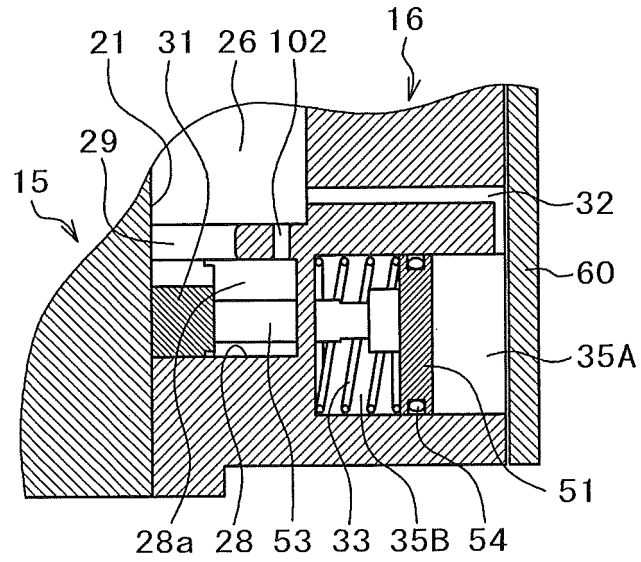


FIG. 9

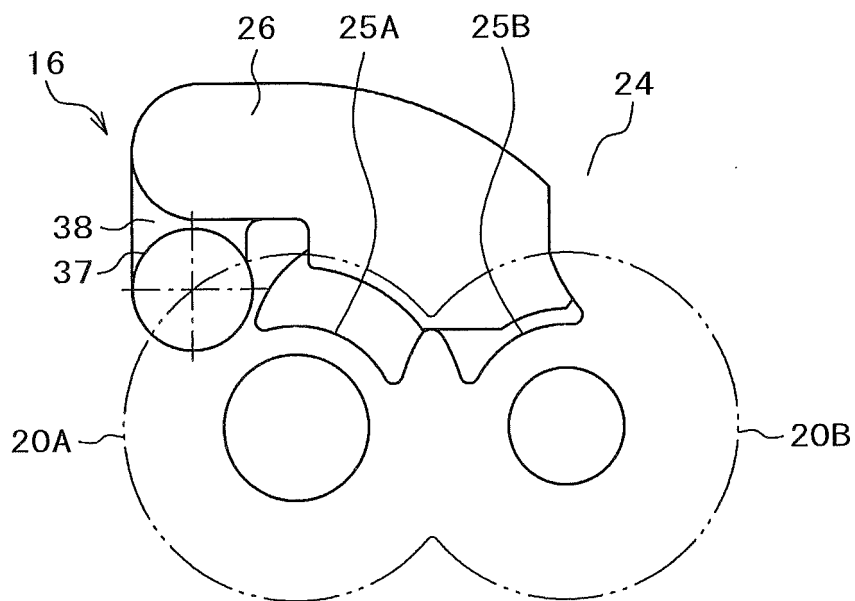


FIG. 10

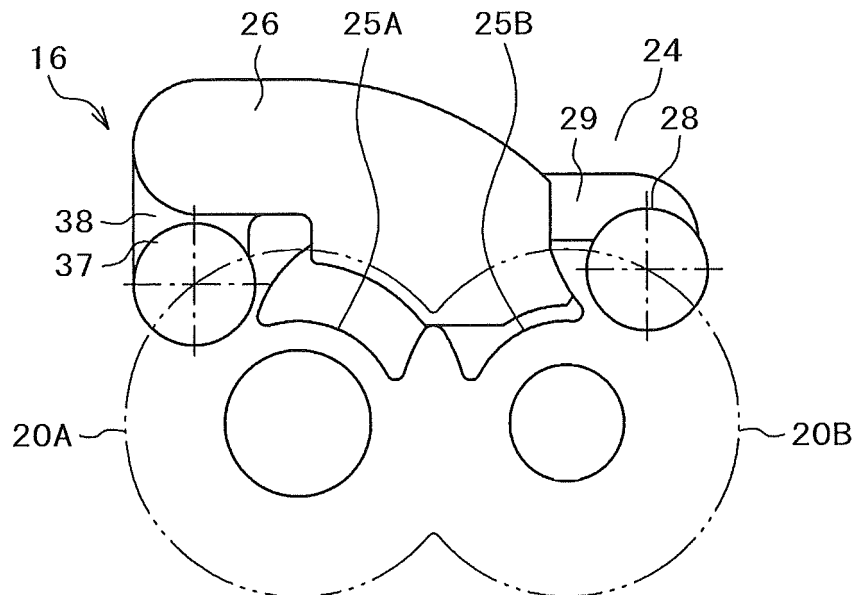


FIG. 11

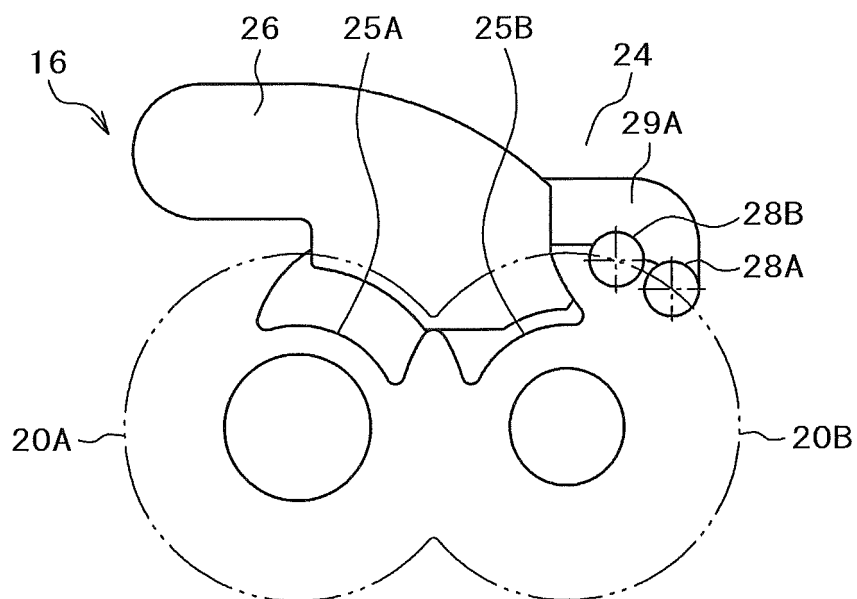
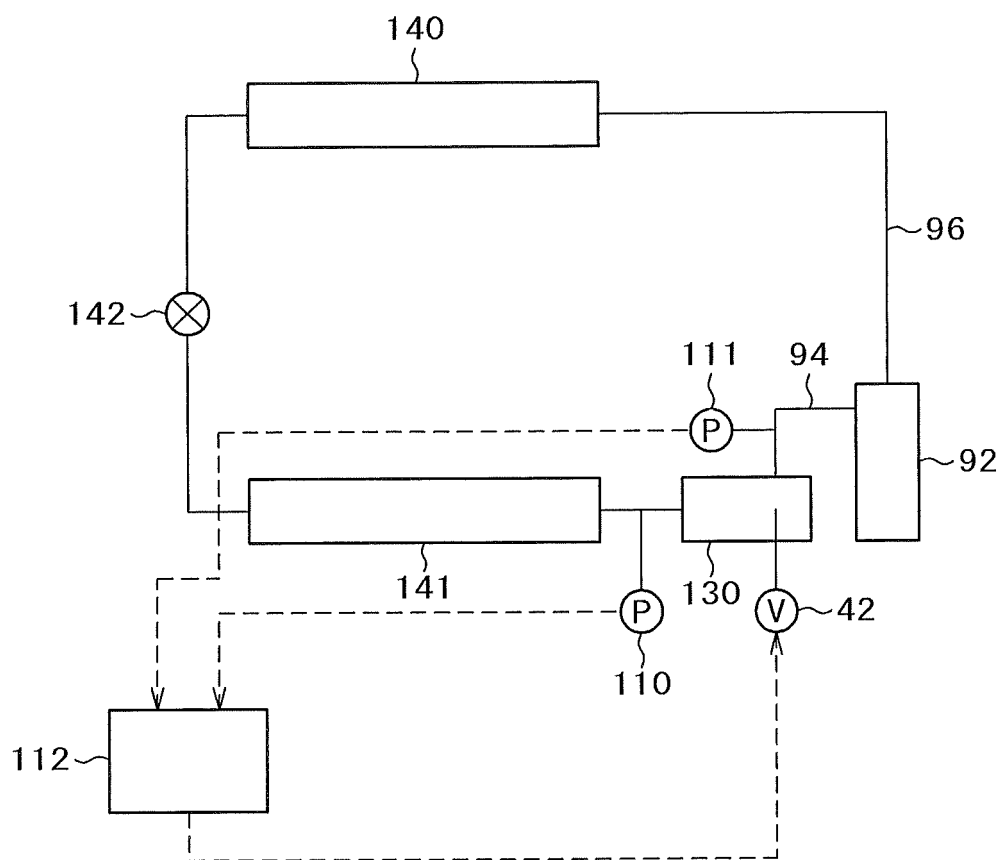


FIG. 12



REFERENCES CITED IN THE DESCRIPTION

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