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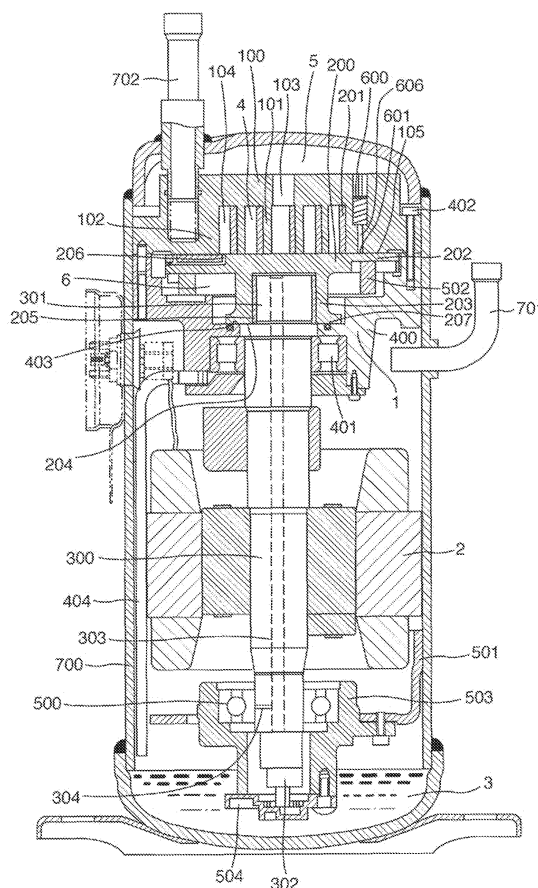
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(54) **Scroll compressor**

(57) A scroll compressor includes: an orbiting scroll (200) and a fixed scroll (100) which mesh with each other so as to compress a refrigerant; a discharge pressure space (5) into which the refrigerant is discharged from the compression chamber (4); an orbiting scroll end plate surface (202) on which the orbiting scroll comes into sliding contact with the fixed scroll; a fixed scroll end plate surface (102) on which the fixed scroll comes into sliding contact with the orbiting scroll; a groove-shaped pressurizing pocket space (601) which is provided in the orbiting scroll end plate surface or the fixed scroll end plate surface so as to be located on the outer peripheral side of the compression chamber; a pressure adjusting valve (600) which is provided in a passageway connecting the discharge pressure space with the pressurizing pocket space; and a pressurizing passageway (606) which is provided between the pressure adjusting valve and the pressurizing pocket space, wherein the refrigerant flows from the discharge pressure space to the pressurizing pocket space in the case where the differential pressure between the discharge pressure space and the pressurizing passageway is equal to a predetermined value.

FIG.1



Description

Field of the Invention

[0001] The present invention relates to a scroll compressor suitable for a refrigerating and airconditioning refrigerant compressor or the like, and more particularly, to a scroll compressor which adjusts the pressing force between an orbiting scroll and a fixed scroll.

Description of Related Art

[0002] In a scroll compressor, a refrigerant compression operation is performed between a fixed scroll and an orbiting scroll, which generates force for separating both scrolls from each other. On the other hand, a high-pressure refrigerant compressed between both scrolls is discharged to the inside of a compression container, which generates force for pressing both scrolls into each other by means of the discharge pressure of the refrigerant. At this time, if the scrolls are separated from each other, the compression efficiency of the refrigerant deteriorates. For this reason, the pressing force is set to be larger than the separating force.

[0003] A space formed on a rear surface side of an orbiting scroll member is divided by a seal member into a discharge pressure space which is provided at the center portion of the scroll in the vicinity of a main shaft and an intermediate pressure (between a suction pressure and a discharge pressure) space which is provided in the outer periphery of the scroll. The pressing force generated by the discharge pressure space provided at the center portion of the rear surface of the orbiting scroll is determined in accordance with the inner diameter dimension of a seal ring, and the separating force generated on a compression chamber side is determined by a scroll wrap. However, the pressing force becomes excessively larger than the separating force in some cases. In this case, frictional sliding loss between the end plate surfaces of the fixed scroll and the orbiting scroll increases, which increases the power consumed by the compressor. In addition, when a pressing load is excessively large, a problem may arise in that the scroll end plate surfaces become abraded or seize up.

[0004] In a scroll compressor disclosed in JP-A-2005-307989, the scroll compressor includes: a communication passageway which is used for communication between a compression chamber and a back pressure space provided in a rear part of an orbiting scroll and a back pressure control valve which opens or closes the communication passageway, where the communication passageway is opened or closed by the difference between the suction pressure and the pressure of the back pressure space. Accordingly, it is possible to operate the compressor without making large changes to the pressing force of the orbiting scroll.

[0005] However, in recent years, the compressor has been required to be operated with high efficiency in a

broad operation range. For example, in an airconditioner for a cold place or the like operated under a high pressure ratio condition, that is, a pressure condition having a large pressure difference between the suction pressure and the discharge pressure, the compressor has to be operated in a heating mode when the external air temperature is extremely low. For this reason, it is required to broaden the operation range of the compressor and to improve the performance thereof under the high pressure ratio condition, but in JP-A-2005-307989, operation under the high pressure ratio condition is not sufficiently considered.

Summary of the Invention

[0006] An object of the invention is to obtain a scroll compressor capable of pressing an orbiting scroll and a fixed scroll to each other with a good balance even under a high pressure ratio condition.

[0007] In order to achieve the above-described object, according to an aspect of the invention, there is provided a scroll compressor including: an orbiting scroll and a fixed scroll, each of which includes a spiral wrap uprightly formed in an end plate; a compression chamber which compresses a refrigerant in such a manner that the orbiting scroll and the fixed scroll mesh with each other; a discharge pressure space into which the refrigerant is discharged from the compression chamber; an orbiting scroll end plate surface on which the orbiting scroll comes into sliding contact with the fixed scroll; and, a fixed scroll end plate surface on which the fixed scroll comes into sliding contact with the orbiting scroll, the scroll compressor further comprising a groove-shaped pressurizing pocket space which is provided in the orbiting scroll end plate surface or the fixed scroll end plate surface so as to be located on the outer peripheral side of the compression chamber; a pressure adjusting valve which is provided in a passageway connecting the discharge pressure space with the pressurizing pocket space; and a pressurizing passageway which is provided between the pressure adjusting valve and the pressurizing pocket space, wherein the refrigerant is flown from the discharge pressure space to the pressurizing pocket space in the case where the differential pressure between the discharge pressure space and the pressurizing passageway is equal to a predetermined value.

[0008] In the scroll compressor having the above-described configuration, the scroll compressor may further include: a back pressure space which is provided on the opposite side of the discharge pressure space with the orbiting scroll and the fixed scroll interposed therebetween; and an intermediate pressure space which is provided on the outer peripheral side of the pressurizing pocket space so as to communicate with the back pressure space.

[0009] In the scroll compressor having the above-described configuration, a plurality of the pressurizing pocket spaces, a plurality of the pressure adjusting valves,

and a plurality of the pressurizing passageways may be provided.

[0010] In the scroll compressor having the above-described configuration, the scroll compressor may further include an injection pipe which injects a high-pressure liquid refrigerant or a humid refrigerant inside a refrigerating cycle into the compression chamber.

[0011] According to the invention, since the discharge pressure is used as the urging force for separating the fixed scroll and the orbiting scroll from each other, it is advantageous in that the fixed scroll and the orbiting scroll are capable of pressing each other with a good balance even under a high pressure ratio condition.

Brief Description of Several Views of Drawing

[0012]

Fig. 1 is a vertical cross-sectional view showing a scroll compressor according to a first embodiment of the present invention.

Figs. 2A and 2B are views showing a fixed scroll shown in Fig. 1, where Fig. 2A is a plan view when viewed from a wrap side, and Fig. 2B is an enlarged cross-sectional view showing a portion attached with a pressure adjusting valve.

Fig. 3 is a cross-sectional view showing a combined state of a fixed scroll and an orbiting scroll according to the first embodiment of the invention, the cross-sectional view corresponding to a schematic view illustrating pressing force applied to the orbiting scroll.

Fig. 4 is a plan view showing the orbiting scroll according to a second embodiment of the invention when viewed from the wrap side.

Fig. 5 is a plan view showing the fixed scroll according to the second embodiment of the invention when viewed from the wrap side.

Fig. 6 is a cross-sectional view showing a combined state of the fixed scroll and the orbiting scroll according to the second embodiment of the invention.

Fig. 7 is a cross-sectional view showing a combined state of a fixed scroll and an orbiting scroll according to a third embodiment of the invention.

Fig. 8 is a cross-sectional view showing a combined state of a fixed scroll and an orbiting scroll according to a fourth embodiment of the invention.

Fig. 9 is a plan view showing a fixed scroll according to a fifth embodiment of the invention when viewed from the wrap side.

Fig. 10 is a cross-sectional view showing a scroll compressor according to a sixth embodiment of the invention.

Detailed Description of the Invention

[0013] Hereinafter, a scroll compressor according to embodiments of the present invention will be described

with reference to the drawings.

[Embodiment 1]

[0014] Fig. 1 is a cross-sectional view showing a scroll compressor according to a first embodiment of the invention. Inside a hermetic case 700, a compression mechanism 1 is disposed in the upper portion thereof, an electric machinery 2 is disposed in the center portion thereof, and an oil storage tank 3 is disposed in the lower portion thereof, where the compression mechanism 1 is connected to the electric machinery 2 via a rotary shaft 300. The compression mechanism 1 basically includes a fixed scroll 100, an orbiting scroll 200, and a frame 400. The frame 400 is fixed to the hermetic case 700, and forms a member where a rolling bearing 401 is disposed. The fixed scroll 100 basically includes a spiral wrap 101, an end plate 102, and a discharge port 103, and is fixed to the frame 400 via a bolt 402. The wrap 101 is uprightly formed on one side of the end plate 102 in a perpendicular direction. The orbiting scroll 200 basically includes a spiral wrap 201, an end plate 202, a shaft support portion 203, and a shaft support portion end surface 204. The wrap 201 is uprightly formed on one side of the end plate 202 in the perpendicular direction. The shaft support portion 203 is formed on the other side of the end plate 202 (on the opposite side of the wrap) so as to protrude in the perpendicular direction.

[0015] In a compression chamber 4 formed by meshing the wraps of the fixed scroll 100 and the orbiting scroll 200 with each other, a compression operation for reducing the volume of the compression chamber 4 is carried out by the orbiting movement of the orbiting scroll 200. The rotary shaft 300 is supported by the rolling bearing 401 provided in the upper portion of the electric machinery 2 and a sub-bearing 500 provided in the lower portion of the electric machinery 2. The sub-bearing 500 is fixed to the hermetic case 700 via a housing 503 and a lower half frame 501. The front end of the rotary shaft 300 is provided with a crank pin 301, and the crank pin 301 is inserted into the shaft support portion 203 protruding toward the lower portion of the end plate 202 of the orbiting scroll 200. A slewing bearing 205 is provided inside the shaft support portion 203, and is adapted to slide on the crank pin 301. An Oldham coupling 502 is disposed on the rear surface of the end plate 202 of the orbiting scroll 200. The Oldham coupling 502 corresponds to a coupling as a rotation preventing mechanism which rotates the orbiting scroll 200 relative to the fixed scroll 100 but does not rotate the orbiting scroll 200 on its axis when the crank pin 301 eccentrically rotates due to the rotation of the rotary shaft 300 connected to the electric machinery 2.

[0016] By means of the above orbiting movement, working fluid is sucked to the compression chamber 4 via a suction pipe 702 and a suction chamber 104, the volume of the compression chamber is reduced to compress gas while it moves to the center portion, and then the compression chamber discharges the compressed

gas from the discharge port 103 to a discharge pressure space 5. The gas discharged to the discharge pressure space 5 circulates around the compression mechanism 1 and the electric machinery 2, and then, is discharged to the outside of the compressor via the discharge pipe 701 attached to the hermetic case 700. Accordingly, the space inside the hermetic case 700 is maintained to have a discharge pressure. In addition, the end plate 202 of the orbiting scroll 200 is provided with a back pressure hole 206 which communicates with the compression chamber 4, formed by combining the wraps 101 and 201 with each other, with a back pressure space 6 provided in the rear surface of the end plate 202 of the orbiting scroll 200, where the pressure of the back pressure space 6 is maintained to be a pressure (intermediate pressure) between the suction pressure and the discharge pressure. By means of the total force including the intermediate pressure and the discharge pressure acting on the inside of a seal ring 403, the orbiting scroll 200 is pressed from the rear surface thereof to the fixed scroll 100.

[0017] The seal ring 403 provided in the frame 400 serves to seal a portion where the intermediate pressure acts on the rear surface of the orbiting scroll 200 and a portion where the discharge pressure acts on the inside of the seal ring 403, thereby preventing the discharged gas from entering the back pressure space 6.

[0018] Next, an oil feeding path will be described. A pump portion 504 is provided at the lower end of the housing 503, and is driven through a pump coupling 302 provided at the lower end of the rotary shaft 300. When the rotary shaft 300 is rotated, the oil stored in the oil storage tank 3 is supplied to an oil passageway 303 inside the rotary shaft by the pump portion 504. A part of the oil flows to the sub-bearing 500 via a transverse hole 304, and returns to the oil storage tank 3. The oil arriving at the upper portion of the crank pin 301 via the oil passageway 303 flows to the rolling bearing 401 via the slewing bearing 205. The oil lubricating the rolling bearing 401 returns to the oil storage tank 3 via an oil discharge pipe 404.

[0019] In addition, the shaft support portion end surface 204 of the orbiting scroll is provided with an oil feeding pocket 207. By means of the orbiting movement of the orbiting scroll 200, the oil feeding pocket 207 reciprocates between the outside and inside of the seal ring 403 to thereby transport a part of the oil existing between the slewing bearing 205 and the rolling bearing 401 to the back pressure space 6. The transported oil is fed to the Oldham coupling 502, and then, is fed to the sliding surfaces of the end plate 102 of the fixed scroll 100 and the end plate 202 of the orbiting scroll 200. The oil passes through the back pressure hole 206 or a minute gap of the end plate sliding surfaces to thereby flow into the compression chamber.

[0020] Here, a pressure adjusting valve 600 according to the embodiment will be described with reference to Figs. 2A and 2B. The pressure adjusting valve 600 is attached to the fixed scroll 100, and includes a valve plate

602, a spring 603, and a valve holding portion 604. The valve holding portion 604 is press-fitted and fixed to the fixed scroll 100, into which the valve plate 602 and the spring 603 are inserted, in a direction from the discharge pressure space 5. A hole passageway 605 penetrates the valve holding portion 604, and the pressure from the discharge pressure space 5 is applied from the valve holding portion 604 to the valve plate 602. The spring 603 is provided in the lower portion of the valve plate 602, and applies a load for lifting the valve plate 602. The valve plate 602 separates the pressure of the discharge pressure space 5 and the pressure of a pressurizing passageway 606 and a pressurizing pocket space 601. The pressurizing pocket space 601 communicates with the pressurizing passageway 606, and is provided in an end plate surface of the fixed scroll 100 in a circular-arc shape.

[0021] The hole passageway 605 is provided in the center portion of the valve holding portion 604, and a load generated by the discharge pressure is applied to the upper portion of the valve plate 602. The total load including the elastic force of the spring 603 and the pressure of the pressurizing passageway 606 is applied to the lower portion of the valve plate 602, thereby opening or closing the valve plate 602 by means of the resultant force between the downward load and the upward load. Since the elastic force of the spring 603 is defined to a constant amount in accordance with a contraction amount in the assembled condition, the opening or closing state of the valve plate 602 is determined by a pressure difference (differential pressure) between the discharge pressure space 5 and the pressurizing passageway 606 (or the pressurizing pocket space 601). In the case where the discharge pressure is larger, since the pressing-down load applied to the valve plate 602 becomes larger than the pressing-up load applied thereto, the valve plate 602 moves downward. The valve plate 602 is not formed in a disc shape which exactly closes the perforation passageway of the fixed scroll 100, but is formed in a shape in which the portion except for the portion coming into contact with the hole passageway 605 is omitted in a plan view. Accordingly, when the valve plate 602 is pressed down to be opened, the hole passageway 605 closed by the valve plate 602 is opened. Subsequently, the gas and oil under the discharge pressure flows via the gap between the wall of the fixed scroll 100 and the valve plate 602, and flows into the pressurizing pocket space 601 of the fixed scroll via the pressurizing passageway 606. In the case where the discharge pressure is smaller, since the pressing-up load applied to the valve plate 602 becomes larger than the pressing-down load applied thereto, the valve is maintained in a closed state. The pressurizing pocket space 601 is provided in the end plate surface of the fixed scroll 100. In addition, the end plate surface of the fixed scroll 100 may be provided with an oil feeding groove 105 which leads the oil supplied from the back pressure space 6 to the end plate surface in order to ensure the satisfactory

sliding action of the end plate surface. The oil feeding groove 105 is formed in a circular-arc shape at a position where it does not communicate with the pressurizing pocket space 601. The pressurizing pocket space 601 is formed as a closed groove in the end plate surface of the fixed scroll. In the embodiment, the pressurizing pocket space 601 is formed in a circular-arc shape, but may be formed in an annular shape. In any case, when the pressurizing pocket space 601 is formed at a position which is equally distanced in a radial direction from the outermost periphery of the spiral of the fixed scroll 100 forming the compression chamber 4, it is possible to uniformly apply a load to the end plate surface of the orbiting scroll 200.

[0022] Next, the axial load applied to the orbiting scroll 200 will be described with reference to Fig. 3. Fig. 3 is a cross-sectional view showing the combined state of the orbiting scroll 200 and the fixed scroll 100, where the load applied to the orbiting scroll 200 on the opposite side to the wrap thereof is depicted by the arrow. Here, the load acting on the orbiting scroll 200 in an axial direction is defined as below. The load acting in a direction in which the orbiting scroll 200 moves away from the fixed scroll 100 is defined as the pressing-down force, and the load acting in a direction in which the orbiting scroll 200 is pressed to the fixed scroll 100 is defined as the pressing-up force. The resultant force between the pressing-down force and the pressing-up force serves as the orbiting scroll pressing force. In a normal operation, the orbiting scroll 200 is pressed to the fixed scroll 100 by the pressing-up force acting on the rear surface of the end plate 202 so that the end plate surfaces come into close contact with each other. In the case where the load for separating the orbiting scroll 200 from the fixed scroll 100 is larger, a separation phenomenon of the orbiting scroll 200 and leakage of the compression chamber can cause a large deterioration in the performance and efficiency of the compressor. For this reason, the pressing-up force is required to be larger than the pressing-down force under the pressure condition of the compressor for the entire operation.

[0023] Among the plural compression chambers caused by the wraps of the scrolls meshing with each other, the inner the compression chamber is, the higher the pressure in the compression chamber is, and the pressure is applied in the radial direction from the inner compression chambers toward the outer compression chambers. Accordingly, as the pressing-down force, the moment load generated by the pressure acting in the radial direction as well as the axial load act on. The pressing-up force corresponds to the resultant force including the discharge pressure (depicted by the white arrow in Fig. 3) acting on the inside of the slewing bearing 205 (an inner diameter portion of the seal ring 403) and the shaft support portion end surface 204 of the rear surface of the orbiting scroll 200 and the intermediate pressure (depicted by the arrow in Fig. 3) from the back pressure space 6 applied to parts having a larger diameter than

the inner diameter of the seal ring 403. In each of the above-described loads, the load is determined by the suction pressure and the discharge pressure which are the pressure condition of the compressor. In the case where the inner diameter of the seal ring 403 is comparatively large, the load generated by the discharge pressure applied to the inner diameter portion of the seal ring 403 corresponds to the main load of the pressing-up force. Accordingly, in the case of an external air temperature of -20 degrees Celsius to -30 degrees Celsius, that is, in the case of a high pressure ratio condition in which the difference between the suction pressure and the discharge pressure becomes large, the pressing-up load generated by the discharge pressure acting on the inner diameter portion of the seal ring 403 tends to be excessively large compared to the pressing-down load generated by the inner pressure of the compression chamber 4.

[0024] Since the pressurizing pocket space 601 according to the embodiment faces the end plate 202 of the orbiting scroll 200, a load obtained by multiplying the pressure in the pressurizing pocket space 601 by the area thereof is applied to the end plate surface of the orbiting scroll 200 in the form of the added pressing-down load. The orbiting scroll 200 may not rotate on the same surface, but shake due to the pressure variation inside the compression chamber during the compression operation. Also, the pressing-up force applied to the end plate surface of the fixed scroll 100 changes according to the degree of the pressing-up load. For these reasons, even when the pressing-up force is large, the pressurizing pocket space 601 can not be changed to a closed space, and a minute gap may be formed between both end plates in some cases. In addition, in the case where the pressing-up force is not excessively large or the pressing-down force is larger, the valve plate 602 is closed. Even in this case, a minute gap may be formed. At this time, since a refrigerant of the intermediate pressure flows from an intermediate pressure space 7 into the pressurizing pocket space 601 via the gap, the pressure in the pressurizing pocket space 601 corresponds to the pressure between the pressures of a suction pressure space 8 and the intermediate pressure space 7 located on both sides of the pressurizing pocket space 601. When the pressing-up force is excessively large, the valve plate 602 is opened, and the gas and oil of the discharge pressure flow into the pressurizing pocket space 601 as described above. Accordingly, the pressure in the pressurizing pocket space is substantially equal to the discharge pressure and the pressing-down force applied to the orbiting scroll 200 can be increased. At the time when the refrigerant of the discharge pressure flows into the pressurizing pocket space, a pressure loss is caused by the hole passageway 605 or the valve plate 602. For this reason, it is difficult for the pressure of the pressurizing pocket space 601 to be equal to the discharge pressure.

[0025] Likewise, a part of the pressing-up force is used as the urging force for separating the scrolls from each other instead of the structure in which the pressing-up

force is caused to be small simply by releasing the pressure in the back pressure space having an excessively high pressure. Accordingly, it is possible to further reduce the pressing load applied to the orbiting scroll even under the high pressure ratio condition in which the compressor operation range is expanded, and thus to prevent the end plate surface from becoming abraded or seized up. In addition, since the sliding friction loss of the end plate surface also reduces, it is possible to reduce the power consumed by the compressor, and to improve the efficiency of the compressor.

[0026] In the embodiment, the orbiting scroll 200 is adapted to be pressed to the fixed scroll 100, but the fixed scroll may be pressed to the orbiting scroll if the fixed scroll is movable in a vertical direction.

[Embodiment 2]

[0027] Figs. 4, 5, and 6 show a second embodiment according to the invention. In the embodiment, the pressurizing pocket space 601 is provided in the orbiting scroll 200. Fig. 4 is a view showing the orbiting scroll 200 when viewed from the wrap, and Fig. 5 is a view showing the fixed scroll 100 when viewed from the wrap. Fig. 6 is a cross-sectional view showing the combined state of the orbiting scroll 200 and the fixed scroll 100. Since the pressurizing pocket space 601 is provided in the end plate surface of the orbiting scroll 200, the pressurizing pocket space 601 is rotated together with the orbiting movement of the orbiting scroll 200. The pressurizing pocket space 601 may constantly or intermittently communicate with the pressurizing passageway 606. Since the pressurizing pocket space 601 is provided in the end plate surface of the orbiting scroll 200, it is possible to always apply the pressing-down force to the same position of the orbiting scroll 200, and thus to easily suppress the shaking of the orbiting scroll 200.

[Embodiment 3]

[0028] Fig. 7 shows a third embodiment according to the invention. In the embodiment, the pressure adjusting valve 600 is provided in the orbiting scroll 200, and the pressurizing pocket space 601 is provided in the fixed scroll 100. A communication passageway connecting the inside of the slewing bearing 205 with the end plate surface is provided in the orbiting scroll 200, and the communication passageway is provided with the pressure adjusting valve 600. The pressure adjusting valve 600 includes the valve 602, the spring 603, and the valve holding portion 604. In the embodiment, the valve 602 is formed in a spherical shape, but may also be formed in a plate shape as in the above-described embodiment. The inside of the slewing bearing 205 is caused to have the discharge pressure since the oil passing through the oil passageway 303 inside the rotary shaft 300 flows thereinto. Accordingly, as in the embodiment, it is possible to provide the pressure adjusting valve 600 in the

communication passageway connecting the inside of the slewing bearing 205 with the end plate surface. Thus, in the pressure adjusting valve 600, the valve is opened or closed by a pressure difference (differential pressure) between the discharge pressure and the pressure in the pressurizing passageway 606 (or the pressurizing pocket space 601). The hole passageway 605 penetrating the valve holding portion 604 is not provided, and a high-pressure refrigerant flows into the pressurizing pocket space 601 via the discharge pressure space 5 and the pressurizing passageway 606. Since the discharge pressure space 5 inside the slewing bearing 205 is filled with oil, the oil flows into the pressurizing passageway 606 and the pressurizing pocket space 601 in the case where the valve 602 is opened. Accordingly, it is advantageous in that the sliding action of the end plate surfaces of the orbiting scroll 200 and the fixed scroll 100 is satisfactory.

[Embodiment 4]

[0029] Fig. 8 shows a fourth embodiment according to the invention. In the embodiment, the pressure adjusting valve 600 and the pressurizing pocket space 601 are provided in the orbiting scroll 200. The fourth embodiment is different from the third embodiment in that the pressurizing pocket space 601 is provided in a different portion. In the structure, since the oil flows into the pressurizing passageway 606 and the pressurizing pocket space 601 in the case where the valve 602 is opened, the sliding action of the end plate surfaces of the orbiting scroll 200 and the fixed scroll 100 becomes satisfactory. In addition, since it is possible to apply the pressing-down force to the same position of the orbiting scroll 200, it is possible to easily suppress the shaking of the orbiting scroll 200.

[Embodiment 5]

[0030] Fig. 9 shows a fifth embodiment of the invention, and shows the arrangement relationship of the fixed scroll 100, the pressure adjusting valve 600, the pressurizing pocket space 601, and the like. In the embodiment, plural pressure adjusting valves 600, plural pressurizing pocket spaces 601, and plural pressurizing passageways 606 are provided. In Fig. 9, the pressurizing adjusting valve 600 and the pressurizing pocket space 601 are provided at each of three positions of the fixed scroll 100. However, as in the above-described embodiment, the pressure adjusting valves 600 and the pressurizing pocket spaces 601 may be provided to either the fixed scroll 100 or the orbiting scroll 200. In addition, the pressurizing pocket spaces 601 are arranged in the form of circular-arc grooves, but may be arranged in an annular shape. In any case, when the pressurizing pocket spaces 601 are respectively provided at positions which are equally distanced in the radial direction from the outermost periphery of the wrap, it is possible to easily apply uniform pressing-down force to the orbiting scroll 200. In addition,

when the plural pressurizing pocket spaces 601 are equally arranged in the circumference, even in this case, it is possible to easily apply the uniform pressing-down force to the orbiting scroll 200, which is preferable.

[0031] Since plural pressure adjusting valves 600 and plural pressurizing pocket spaces 601 are provided, it is advantageous in that the shaking of the orbiting scroll 200 is effectively suppressed during the orbiting movement thereof due to the respective actions of the valves in the pressure adjusting valves 600. For example, when the orbiting scroll 200 shakes, there are caused the places where the end plate surface of the orbiting scroll 200 moves away from the end plate surface of the fixed scroll 100 and is pressed to the end plate surface thereof. At this time, at the place where the end plate surfaces move away from each other, since the gas and oil of each pressurizing pocket space 601 leak to the intermediate pressure space 7 and the suction pressure space 8 via the gap of the end plate surfaces, the pressure in the pressurizing pocket space 601 decreases. On the contrary, at the place where the end plate surfaces are excessively pressed into each other, since the leakage of the end plate surface hardly occurs, the pressure adjusting valve 600 is opened and the pressure of the pressurizing pocket space 601 is maintained to be high, thereby applying the appropriate pressing-down load to the end plate surface of the orbiting scroll. As a result, it is possible to prevent the end plate surface from becoming abraded or seized up and to reduce the excessive sliding friction loss by suppressing the shaking of the orbiting scroll 200.

[0032] In addition, one pressure adjusting valve 600 may be provided for each pressurizing pocket space 601. This is because the high pressure generated from the discharge pressure space 5 is instantly applied to the entire part of the pocket when one pressure adjusting valve 600 is provided. Accordingly, it is possible to prevent the pressing-down force from being biased.

[Embodiment 6]

[0033] Fig. 10 is a cross-sectional view showing a structure of the scroll compressor according to a sixth embodiment of the invention. In the embodiment, an injection pipe 703 is provided so as to inject a liquid refrigerant or a gas-liquid refrigerant into the compression chamber 4. Although it is possible to reduce the pressing-up force applied to the orbiting scroll 200 under the high pressure ratio condition by using the pressure adjusting valve 600 according to the embodiment, as a more effective combination for operation under the high pressure ratio condition, the injection pipe 703 can be combined so as to decrease the temperature inside the compression chamber. The injection pipe 703 is inserted into the fixed scroll 100 via the discharge pressure space 5 of the fixed scroll 100, and injects a high-pressure liquid refrigerant or a humid refrigerant from a portion between a condenser (not shown) and an expansion valve (not shown) in a refrigerating cycle to the compression cham-

ber 4.

[0034] Since the differential pressure between the suction pressure and the discharge pressure becomes large under the high pressure ratio condition, temperature variation of the refrigerant before and after the compression operation of the compression chamber is large, and the wrap is deformed by the temperature difference between the suction pressure space and the discharge pressure space. Accordingly, since the leakage in the wraps between plural compression chambers becomes large, deterioration in the volume efficiency occurs. In addition, since local contact of the wrap occurs, the wrap may easily become abraded or seized up. In this case, since the high-pressure liquid refrigerant or the humid refrigerant in the refrigerating cycle is injected into the compression chamber 4 during the compression operation, it is possible to decrease the temperature inside the wrap, and thus to suppress the temperature increase of the discharge gas. Accordingly, it is possible to further expand the compressor operation range. Also, since the liquid refrigerant is cooler than the gas refrigerant, it is possible to obtain superior cooling when the liquid ratio in the injected refrigerant is large.

[0035] Features, components and specific details of the structures of the above-described embodiments may be exchanged or combined to form further embodiments optimized for the respective application. As far as those modifications are readily apparent for an expert skilled in the art they shall be disclosed implicitly by the above description without specifying explicitly every possible combination, for the sake of conciseness of the present description.

Claims

1. A scroll compressor comprising:

an orbiting scroll (200) and a fixed scroll (100), each of which includes a spiral wrap (201, 101) uprightly formed in an end plate (202, 102);
a compression chamber (4) which compresses a refrigerant in such a manner that the orbiting scroll and the fixed scroll mesh with each other;
a discharge pressure space (5) into which the refrigerant is discharged from the compression chamber;
an orbiting scroll end plate surface (202) on which the orbiting scroll comes into sliding contact with the fixed scroll;
a fixed scroll end plate surface (102) on which the fixed scroll comes into sliding contact with the orbiting scroll;
a groove-shaped pressurizing pocket space (601) which is provided in the orbiting scroll end plate surface or the fixed scroll end plate surface so as to be located on the outer peripheral side of the compression chamber;

a pressure adjusting valve (600) which is provided in a passageway communicating the discharge pressure space with the pressurizing pocket space; and

a pressurizing passageway (606) which is provided between the pressure adjusting valve and the pressurizing pocket space,

wherein the refrigerant is flown from the discharge pressure space to the pressurizing pocket space in the case where the differential pressure between the discharge pressure space and the pressurizing passageway is equal to a predetermined value.

2. The scroll compressor according to claim 1, further comprising:

a back pressure space (6) which is provided on the opposite side of the discharge pressure space with the orbiting scroll and the fixed scroll interposed therebetween; and

an intermediate pressure space (7) which is provided on an outer peripheral side of the pressurizing pocket space so as to communicate with the back pressure space.

3. The scroll compressor according to claim 1 or 2, wherein a plurality of the pressurizing pocket spaces, a plurality of the pressure adjusting valves, and a plurality of the pressurizing passageways are provided.

4. The scroll compressor according to any one of claims 1 to 3, further comprising:

an injection pipe (703) which injects a high-pressure liquid refrigerant or a humid refrigerant inside a refrigerating cycle into the compression chamber.

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FIG.1

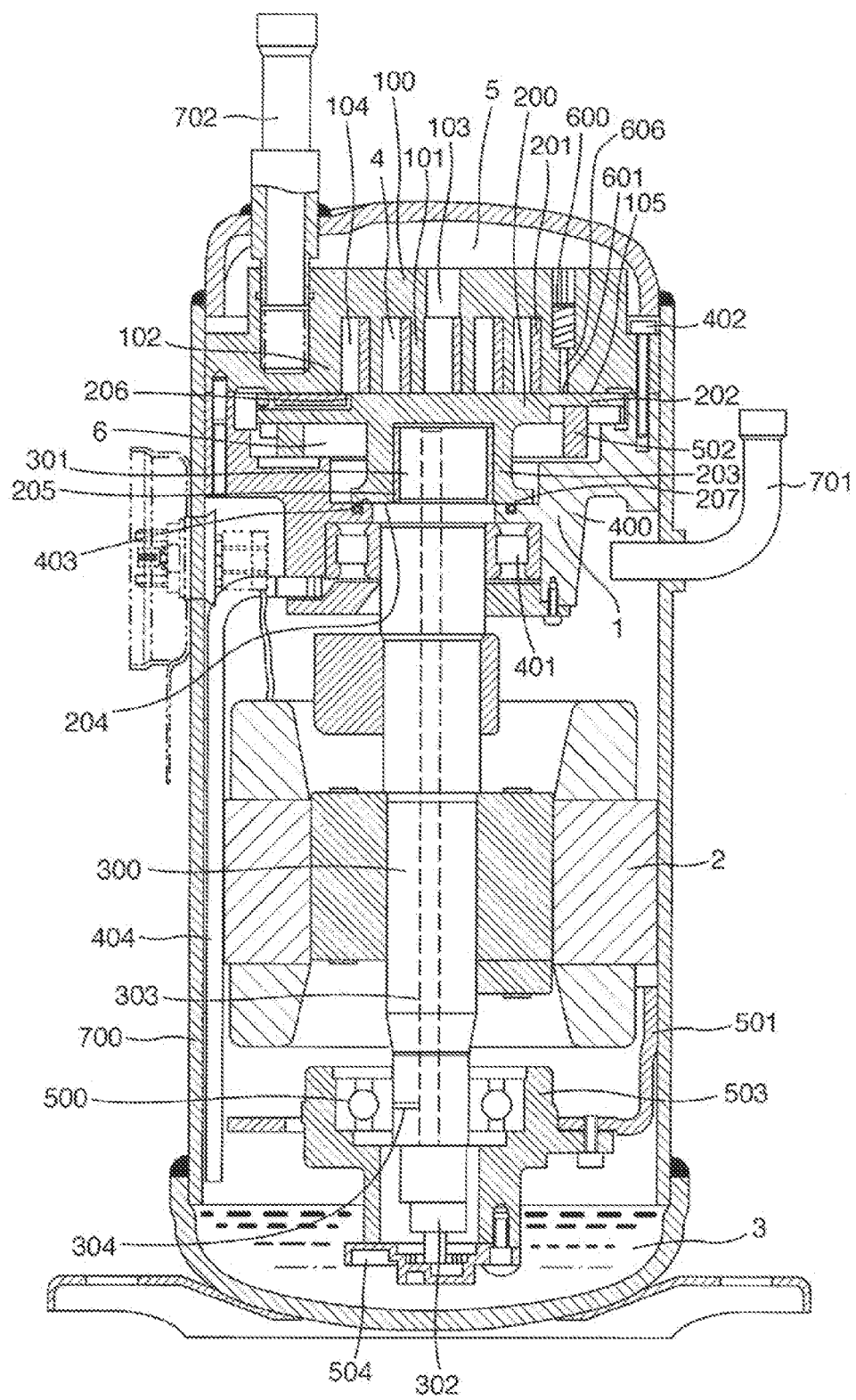


FIG. 2A

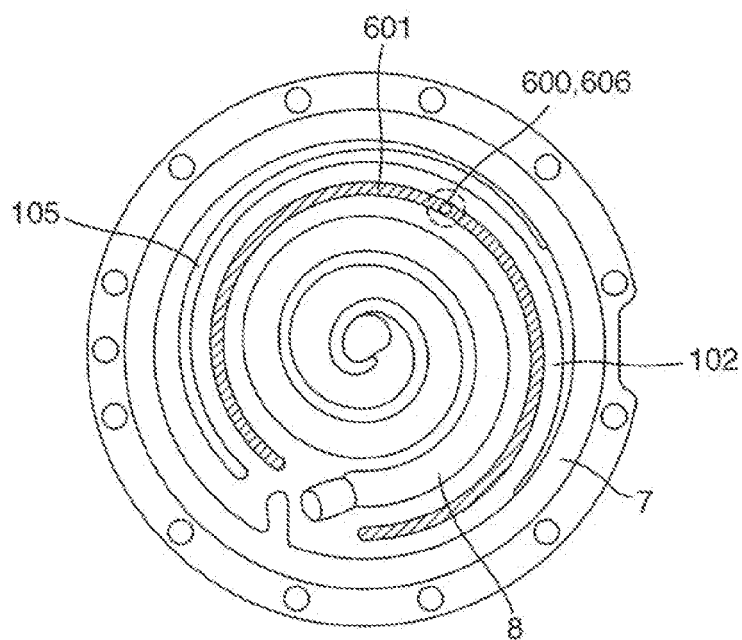


FIG. 2B

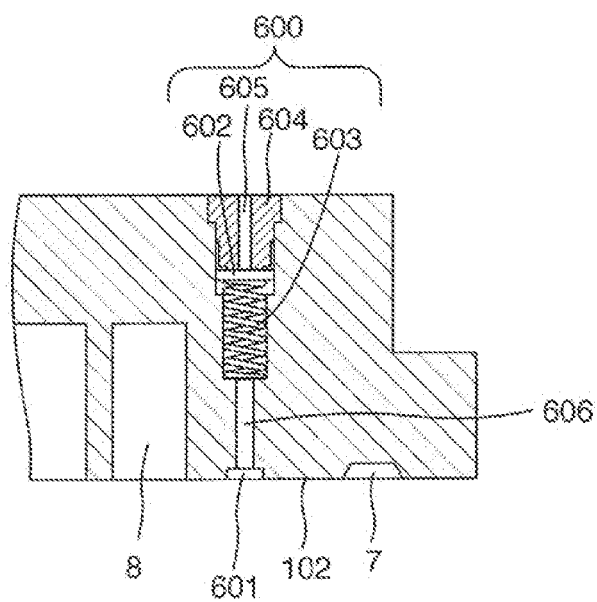


FIG. 3

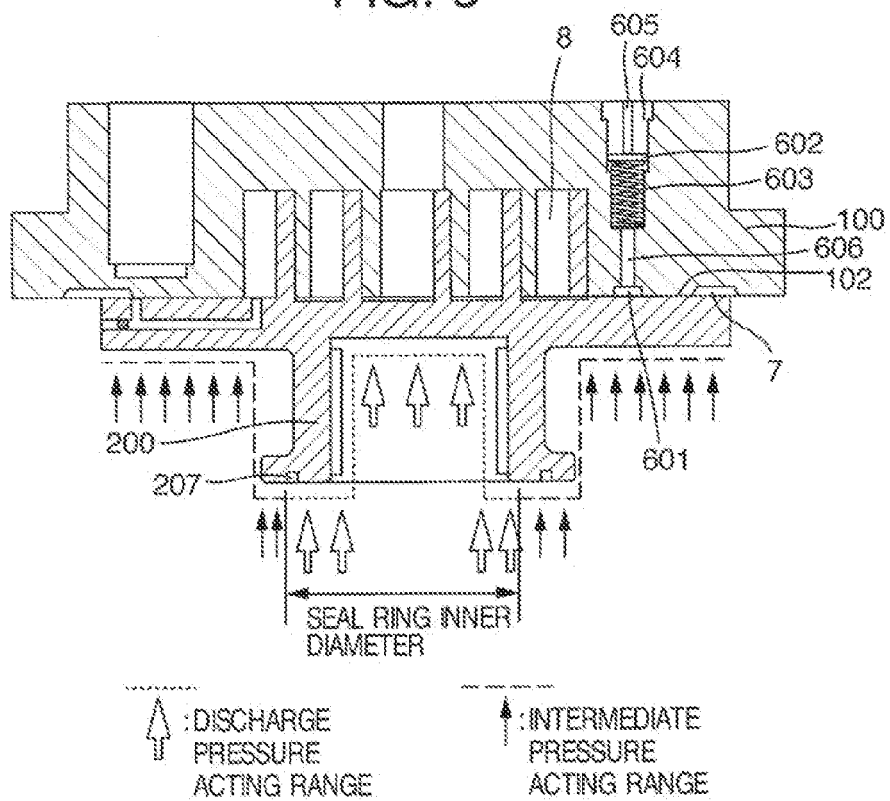


FIG. 4

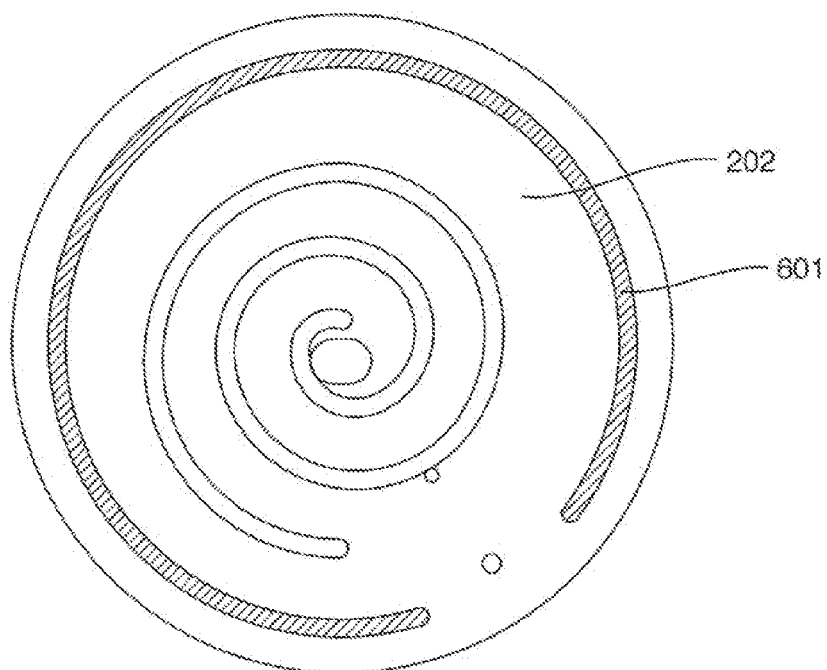


FIG. 5

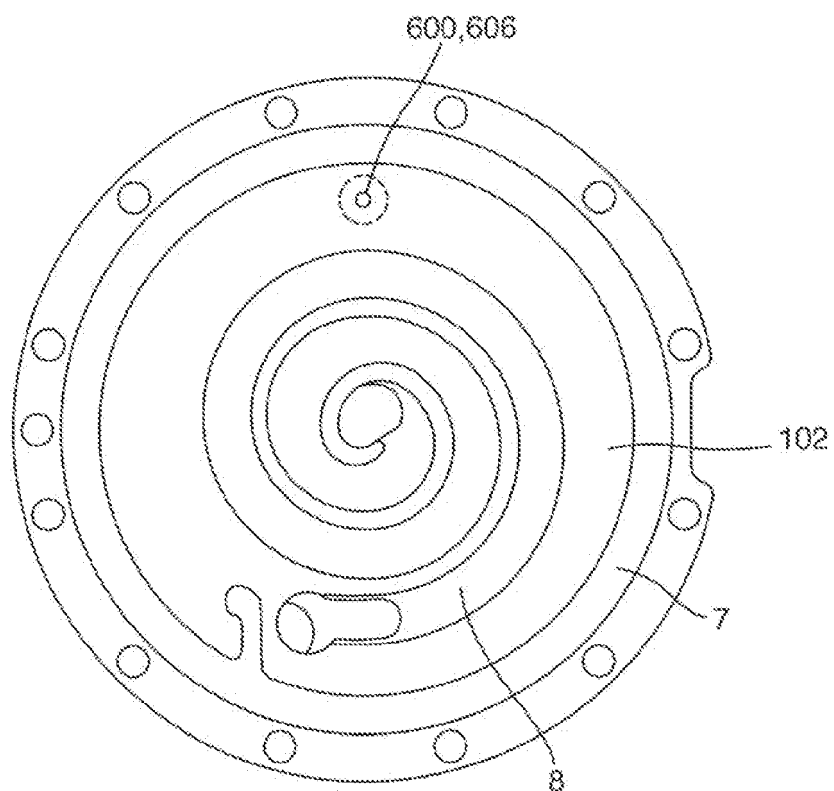


FIG. 6

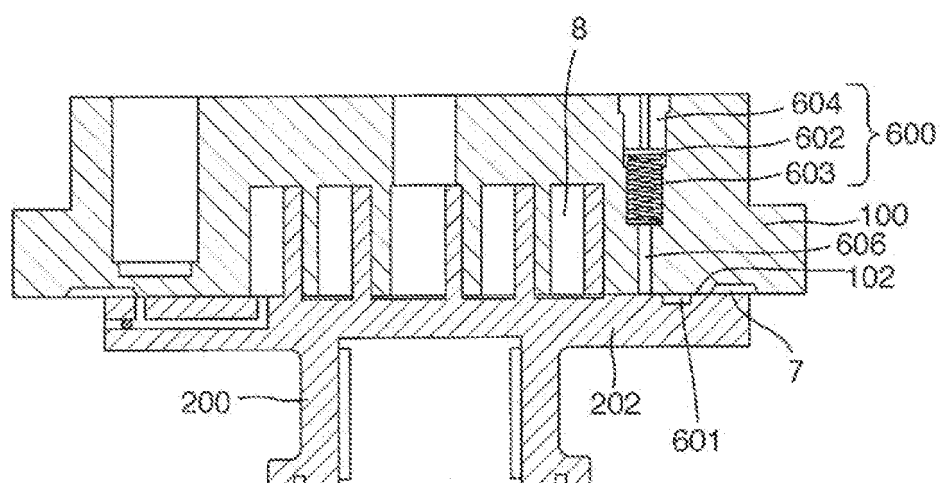


FIG. 7

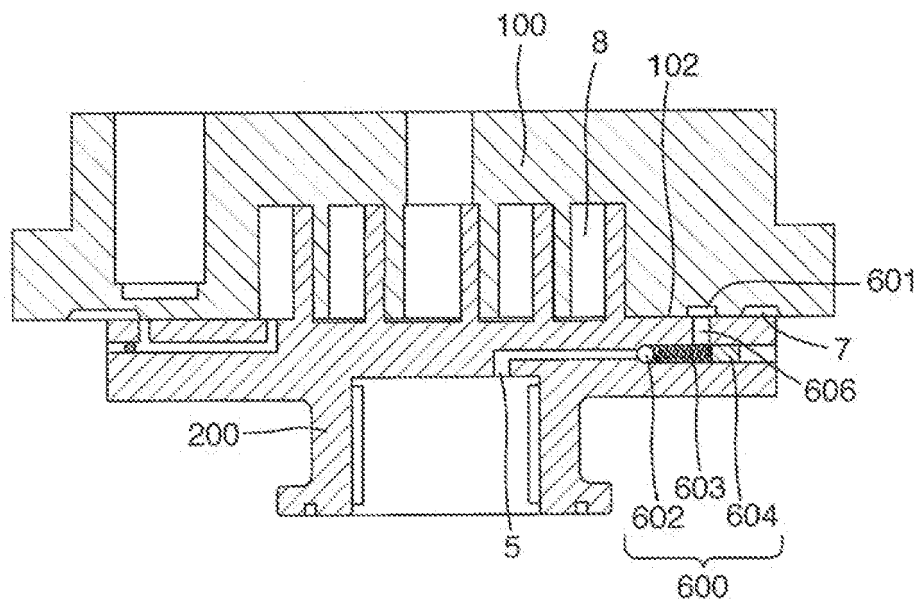


FIG. 8

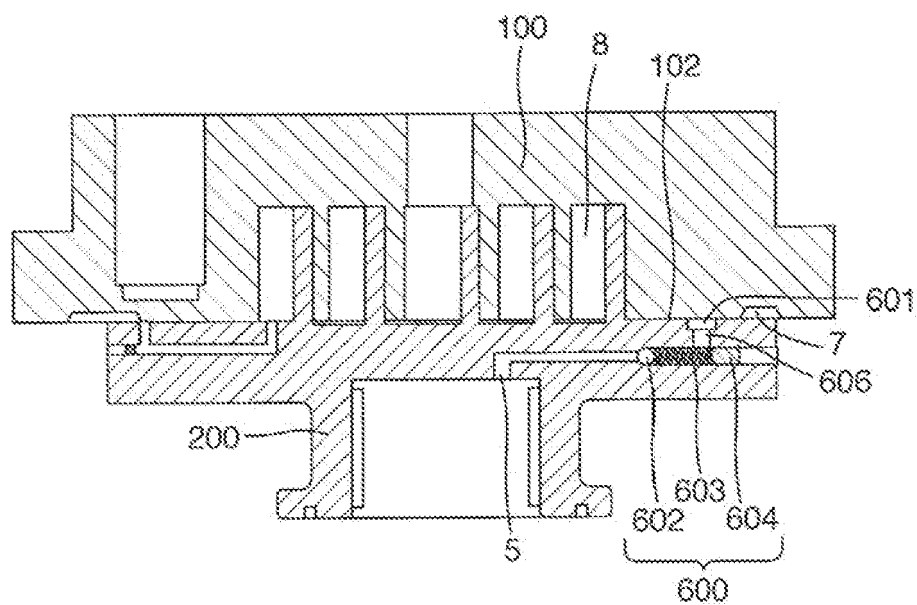


FIG. 9

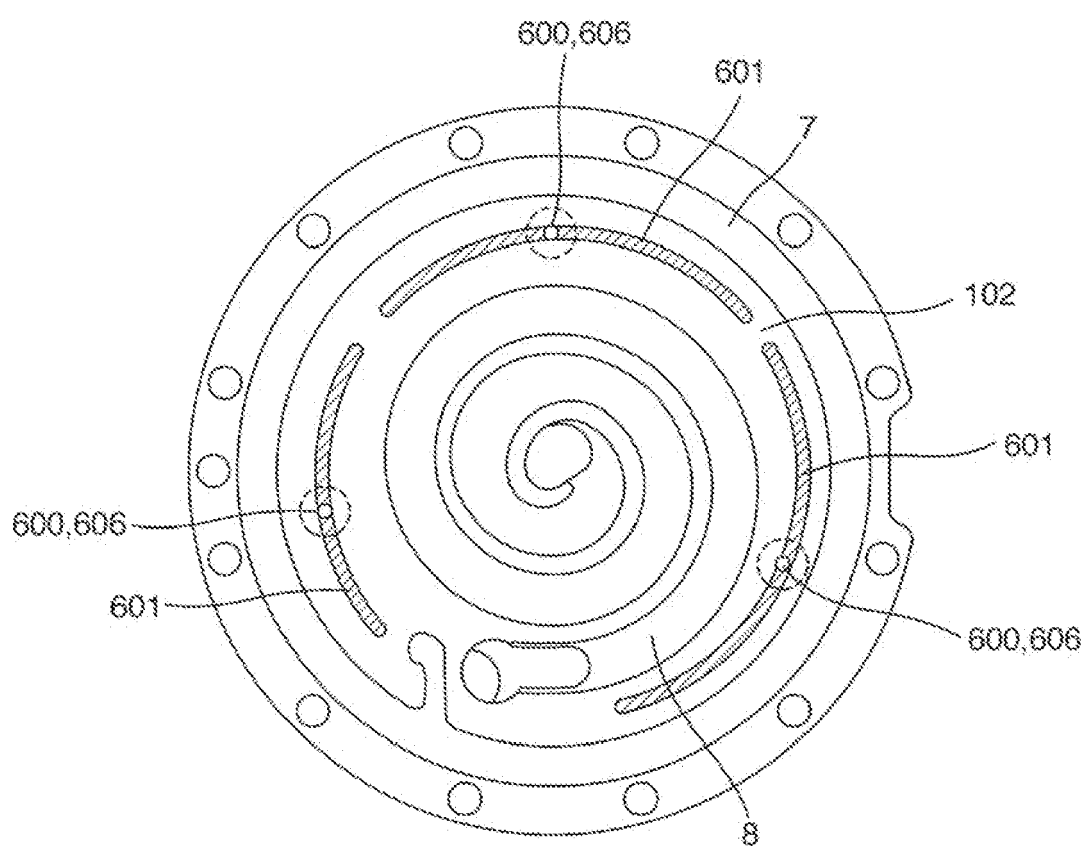
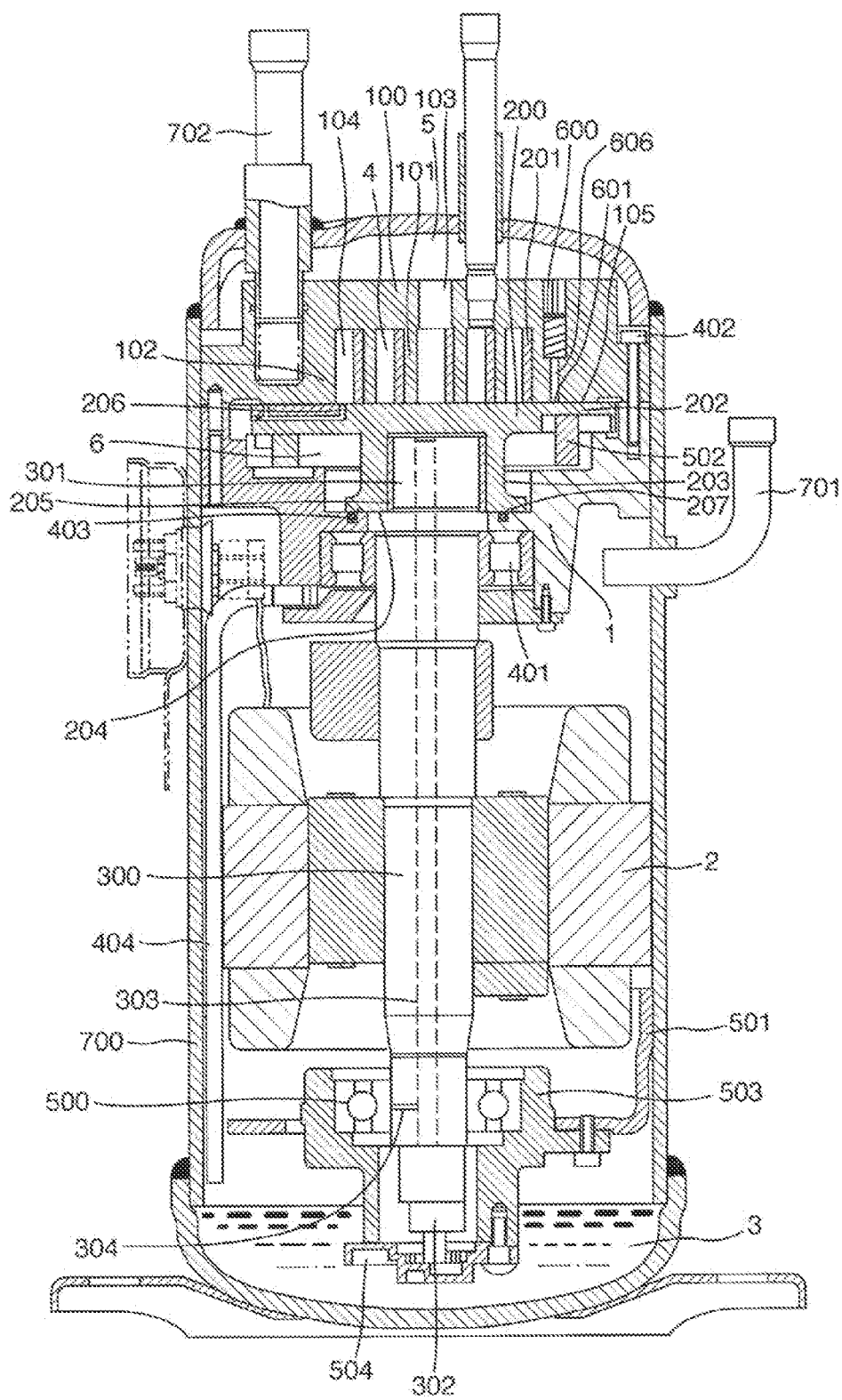


FIG. 10



REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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