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(54) **HERMETIC COMPRESSOR AND REFRIGERATION DEVICE WITH SAME**

(57) A hermetic compressor according to the present invention includes: an electric element (103); a compression element (105) driven by the electric element (103); and a sealed container (101) accommodating the electric element (103) and the compression element (105), the sealed container (101) storing an oil (113). The compression element (105) includes: a crank shaft (119) including a main shaft (129), an eccentric shaft (127), and an oil supply mechanism (131); a cylinder block (121) including a main bearing (137) and a cylinder (135), the main bearing (137) pivotally supporting the main shaft (129) of the crank shaft (119), the cylinder (135) forming a compression chamber (133); a piston (123) configured to move inside the cylinder (135) in a reciprocating manner; and a connector (125) connecting the eccentric shaft (127) and the piston (123). A first oil groove (139A) extending in a circumferential direction of the cylinder (135) is provided on at least part of an upper outer peripheral surface of the cylinder (135).

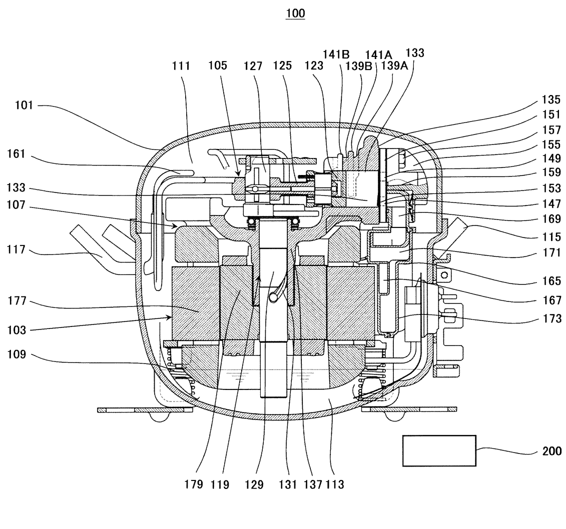

Fig.7

EP 2 940 300 A1

Description

Technical Field

[0001] The present invention relates to a hermetic compressor for use in household electrical refrigerator-freezers, showcases, or the like, and to a refrigeration apparatus including the hermetic compressor.

Background Art

[0002] In recent years, demands for global environment conservation have been increasing more and more, and there is a strong demand for hermetic compressors for use in, for example, household electrical refrigerator-freezers or other refrigeration cycle apparatuses to have high efficiency.

[0003] One of conventional hermetic compressors of such kind is configured such that an oil reservoir is formed at the upper outer peripheral side of a cylinder, and the oil reservoir is provided with protruding portions each extending along the center line of the cylinder (see Patent Literature 1, for example).

[0004] Fig. 15 is a longitudinal sectional view of a hermetic compressor disclosed in Patent Literature 1. Fig. 16 is a front view showing a cylinder and a cylinder block of the hermetic compressor shown in Fig. 15.

[0005] As shown in Fig. 15 and Fig. 16, a hermetic compressor 2 disclosed in Patent Literature 1 includes a sealed container 11. In the sealed container 11, a frame 12 is elastically supported via a spring 13. An electric motor 8 is disposed under the frame 12, and a compression mechanism 7 is disposed over the frame 12. A refrigerant gas 5 is encapsulated in the sealed container 11, and a refrigerating machine oil 14 is stored in the bottom of the sealed container 11.

[0006] The electric motor 8 includes: a rotary shaft 17 including a main shaft 15 and an eccentric shaft 16 eccentric relative to the main shaft 15; a rotor 18; and a stator 19. An oil pump 22 is mounted to the lower end of the main shaft 15. An oil supply path 23 is formed in the rotary shaft 17.

[0007] The compression mechanism 7 includes: a cylinder 27 formed in a cylinder block 28; a cylinder chamber 29, which is the internal space of the cylinder 27; and a piston 6. An oil reservoir 41 is formed on a part of the cylinder block 28, such that the oil reservoir 41 is positioned at the upper outer peripheral side of the cylinder 27.

[0008] The oil reservoir 41 is provided with a plurality of plate-shaped protruding portions 43 each extending along the center line of the cylinder 27. As shown in Fig. 16, the protruding portions 43 are formed such that their height gradually increases in the rotation direction of the rotary shaft 17.

[0009] The oil reservoir 41 is provided with recesses 45, each of which is formed between adjoining protruding portions 43. As shown in Fig. 15, the bottom surface 38 of each of the recesses 45 slopes such that the refrigerating machine oil 14 flows in a manner to run down from the top dead center side to the bottom dead center side of the cylinder 27.

[0010] Accordingly, after flowing through the oil supply path 23 and splashing from the upper end of the eccentric shaft 16, the refrigerating machine oil 14 is stored in the recesses 45. The refrigerating machine oil 14 stored in the recesses 45 is easily supplied to the sliding portion between the cylinder 27 and the piston 6.

Citation List

Patent Literature

[0011] PTL 1: Japanese Laid-Open Patent Application Publication No. 2010-65589

Summary of Invention

Technical Problem

[0012] Since the cylinder 27 is heated by frictional heat due to reciprocating movement of the piston 6 and compression heat of the refrigerant gas 5, the refrigerating machine oil 14 stored in the oil reservoir 41 positioned at the upper outer peripheral side of the cylinder 27 receives heat transferred from the cylinder 27, and thereby the temperature of the refrigerating machine oil 14 becomes high.

[0013] Therefore, the hermetic compressor 2 disclosed in Patent Literature 1 has a problem in that the high-temperature refrigerating machine oil 14 enters the cylinder chamber 29, and the refrigerant gas 5 that has been sucked in in a low-temperature state is heated by the heat of the refrigerating machine oil 14 and expands, which causes a decrease in volumetric efficiency.

[0014] The present invention has been made to solve the above conventional problems. An object of the present invention is to suppress an increase in the temperature of a cylinder and suppress the entry of a high-temperature oil that has been heated by heat transferred from the cylinder into a compression chamber, thereby making it possible to provide a highly efficient hermetic compressor.

Solution to Problem

[0015] In order to solve the above conventional problems, a hermetic compressor according to the present invention includes: an electric element; a compression element driven by the electric element; and a sealed container accommodating the electric element and the compression element, the sealed container storing an oil. The compression element includes: a crank shaft including a main shaft, an eccentric shaft, and an oil supply mechanism; a cylinder block including a main bearing and a cylinder, the main bearing pivotally supporting the main shaft of the crank shaft, the cylinder forming a compression chamber; a piston configured to move inside the cylinder in a reciprocating manner; and a connector connecting the eccentric shaft and the piston. A first oil groove extending in a circumferential direction of the cylinder is provided on at least part of an upper outer peripheral surface of the cylinder.

[0016] According to this configuration, the oil that is spread from the eccentric shaft is supplied also to the first oil groove formed on the upper outer peripheral surface of the cylinder. Therefore, heat can be effectively absorbed from the cylinder by means of the oil flowing through the first oil groove. Since the high-temperature oil that has absorbed heat from the cylinder flows along the first oil groove in the circumferential direction of the cylinder and falls onto the bottom of the sealed container, the high-temperature oil is suppressed from flowing into a gap formed between the piston and the cylinder. In this manner, the entry of the high-temperature oil into the compression chamber can be suppressed. This makes it possible to suppress an increase in the temperature of a refrigerant gas sucked into the compression chamber and improve the volumetric efficiency of the refrigerant gas.

Advantageous Effects of Invention

[0017] The hermetic compressor according to the present invention and a refrigeration apparatus including the hermetic compressor are capable of suppressing an increase in the temperature of the refrigerant gas sucked into the compression chamber and improving the volumetric efficiency of the refrigerant gas, thereby making it possible to improve the hermetic compressor efficiency.

Brief Description of Drawings

[0018]

Fig. 1 is a longitudinal sectional view of a hermetic compressor according to Embodiment 1.
Fig. 2 is a cross-sectional view of the hermetic compressor according to Embodiment 1.
Fig. 3 is a sectional view showing, in an enlarged manner, a compression element and the vicinity thereof of the hermetic compressor shown in Fig. 1 and Fig. 2.
Fig. 4 is a sectional view showing, in an enlarged manner, a cylinder and the vicinity thereof of the hermetic compressor shown in Fig. 1 and Fig. 2.
Fig. 5 is a schematic diagram showing a schematic configuration of a cylinder block of a hermetic compressor according to Variation 1 of Embodiment 1 when the cylinder block is seen from above.
Fig. 6 is a schematic diagram showing a cylinder block of a hermetic compressor according to Variation 2 of Embodiment 1.
Fig. 7 is a longitudinal sectional view of a hermetic compressor according to Embodiment 2.
Fig. 8 is a sectional view showing, in an enlarged manner, a cylinder and the vicinity thereof of the hermetic compressor shown in Fig. 7.
Fig. 9 is a longitudinal sectional view of a hermetic compressor according to Embodiment 3.
Fig. 10 is a perspective view of a cylinder block in the hermetic compressor shown in Fig. 9 when the cylinder block is seen from above.
Fig. 11 is a longitudinal sectional view of a hermetic compressor according to Embodiment 4.
Fig. 12 is a perspective view of a cylinder block in the hermetic compressor shown in Fig. 11 when the cylinder block is seen from below.
Fig. 13 is a perspective view of a rotor in the hermetic compressor shown in Fig. 12.
Fig. 14 is a schematic diagram showing a schematic configuration of a refrigeration apparatus according to Embodiment 5.
Fig. 15 is a longitudinal sectional view of a hermetic compressor disclosed in Patent Literature 1.
Fig. 16 is a front view showing a cylinder and a cylinder block of the hermetic compressor shown in Fig. 15.

Description of Embodiments

[0019] Hereinafter, embodiments of the present invention are described with reference to the drawings. It should be noted that the present invention is not limited by the embodiments described below. In the drawings, the same or corresponding components are denoted by the same reference signs, and repeating the same descriptions is avoided below. In the drawings, in some cases, only the components necessary for describing the present invention are shown and the other components are omitted.

(Embodiment 1)

[0020] A hermetic compressor according to Embodiment 1 includes: an electric element; a compression element driven by the electric element; and a sealed container accommodating the electric element and the compression element, the sealed container storing an oil. The compression element includes: a crank shaft including a main shaft, an eccentric shaft, and an oil supply mechanism; a cylinder block including a main bearing and a cylinder, the main bearing pivotally supporting the main shaft of the crank shaft, the cylinder forming a compression chamber; a piston configured to move inside the cylinder in a reciprocating manner; and a connector connecting the eccentric shaft and the piston. A first oil groove extending in a circumferential direction of the cylinder is provided on at least part of an upper outer peripheral surface of the cylinder.

[0021] According to this configuration, the oil that is spread from the eccentric shaft is supplied also to the first oil groove formed on the upper outer peripheral surface of the cylinder. Therefore, heat can be effectively absorbed from the cylinder by means of the oil flowing through the first oil groove. Since the high-temperature oil that has absorbed heat from the cylinder flows through the first oil groove and falls onto the bottom of the sealed container, the high-temperature oil is suppressed from flowing into a gap formed between the piston and the cylinder. In this manner, the entry of the high-temperature oil into the compression chamber can be suppressed. This makes it possible to suppress an increase in the temperature of a refrigerant gas sucked into the compression chamber and improve the volumetric efficiency of the refrigerant gas.

[0022] In the hermetic compressor according to Embodiment 1, the eccentric shaft of the crank shaft may be provided with a first oil spreading mechanism configured to spread the oil to the first oil groove and a second oil spreading mechanism configured to spread the oil to a gap formed between the piston and the cylinder.

[0023] According to this configuration, the oil spread by the second oil spreading mechanism improves the lubrication between the piston and the cylinder, and thereby sliding loss can be reduced, and also, the sealing performance between the piston and the cylinder can be improved, which makes it possible to improve the volumetric efficiency of the refrigerant gas. Consequently, the efficiency of the hermetic compressor can be further improved.

[0024] In the hermetic compressor according to Embodiment 1, the compression element may include: a discharge pipe, through which a refrigerant compressed in the compression chamber is discharged; and a discharge chamber provided on a non-end portion of the discharge pipe.

[0025] According to this configuration, the discharge chamber and the cylinder are provided separately. Therefore, the refrigerant gas in a high-temperature state that passes through the discharge chamber is discharged to the outside of the sealed container through the discharge pipe without heating the cylinder. This makes it possible to further reduce an increase in the temperature of the cylinder and improve the volumetric efficiency. This consequently makes it possible to further improve the efficiency of the hermetic compressor.

[0026] Further, in the hermetic compressor according to Embodiment 1, the electric element may be configured to be driven by an inverter at multiple operating frequencies.

[0027] According to this configuration, during high-speed rotation, in which the amount of refrigerant gas circulating per unit time is large and the temperature of the discharged refrigerant gas tends to increase, the amount of oil to be spread increases. In this manner, the temperature of the cylinder can be reduced effectively. In addition, during low-speed rotation, in which the amount of heat transferred from the cylinder to the sucked refrigerant gas increases, since the oil flowing through the first oil groove effectively absorbs heat from the cylinder, the temperature of the cylinder can be reduced.

[0028] Hereinafter, one example of the hermetic compressor according to Embodiment 1 is described with reference to Fig. 1 to Fig. 4.

[Configuration of Hermetic Compressor]

[0029] Fig. 1 is a longitudinal sectional view of the hermetic compressor according to Embodiment 1. Fig. 2 is a cross-sectional view of the hermetic compressor according to Embodiment 1. Fig. 3 is a sectional view showing, in an enlarged manner, a compression element and the vicinity thereof of the hermetic compressor shown in Fig. 1 and Fig. 2. Fig. 4 is a sectional view showing, in an enlarged manner, a cylinder and the vicinity thereof of the hermetic compressor shown in Fig. 1 and Fig. 2.

[0030] As shown in Fig. 1 and Fig. 2, a hermetic compressor 100 according to Embodiment 1 includes a sealed container 101 and a compressor body 107 accommodated in the sealed container 101. The compressor body 107 includes an electric element 103 and a compression element 105 driven by the electric element 103. The compressor body 107 is elastically supported in the sealed container 101 by a suspension spring 109.

[0031] The sealed container 101 is formed by draw forming of a metal plate. The sealed container 101 is provided with a suction pipe 115 and a discharge pipe 117, through which the inside and the outside of the sealed container 101 are in communication with each other. The suction pipe 115 is configured to introduce a refrigerant gas supplied from a refrigeration apparatus (see Fig. 14) into the sealed container 101. The discharge pipe 117 is configured to supply a refrigerant gas 111 compressed by the compression element 105 to the refrigeration apparatus.

[0032] The refrigerant gas 111, which is a hydrocarbon-based gas having a low global warming potential, for example, R600a, is encapsulated in the sealed container 101 in a low-temperature state at a pressure that is the same as the pressure in the low-pressure side of the refrigeration apparatus. At the bottom of the interior of the sealed container 101, a lubrication oil 113 is encapsulated.

[0033] The electric element 103 is disposed under the compression element 105 (i.e., disposed in the lower part of the sealed container 101), and an inverter 200 is electrically connected to the electric element 103 via suitable wiring (not shown). Accordingly, the electric element 103 is driven by the inverter at multiple operating frequencies.

[0034] The electric element 103 includes a stator 177 and a rotor 179. The stator 177 is fixed to a cylinder block 121 by bolts (not shown). The cylinder block 121 will be described below. Inside the stator 177, the rotor 179, which is a columnar rotor with a hollow center, is fixed to a main shaft 129 of a crank shaft 119 described below by shrinkage fitting or the like, such that the rotor 179 is positioned on the same axis as that of the stator 177.

[0035] The compression element 105 includes, for example, the crank shaft 119, the cylinder block 121, a piston 123, and a connector 125.

[0036] The crank shaft 119 includes: the main shaft 129; a flange portion provided on the upper end of the main shaft 129; and an eccentric shaft 127 extending from the upper surface of the flange portion. The main shaft 129 and the eccentric shaft 127 are arranged such that their central axes extend vertically.

[0037] The lower end of the crank shaft 119 (to be precise, the lower end of the main shaft 129) is immersed in the oil 113. The crank shaft 119 is provided with an oil supply mechanism 131 configured to supply the oil 113 to the upper end of the eccentric shaft 127.

[0038] The oil supply mechanism 131 includes, for example, a hole (not shown) formed in the main shaft 129 and extending upward, a helical groove formed in the surface of the main shaft 129, and a connecting hole 130 (see Fig. 3) formed in the eccentric shaft 127.

[0039] As shown in Fig. 3, the eccentric shaft 127 of the crank shaft 119 is provided with a first oil spreading mechanism 143 and a second oil spreading mechanism 145. The first oil spreading mechanism 143 is disposed at a position higher than that of the second oil spreading mechanism 145.

[0040] The opening of the connecting hole 130 provided at the upper end of the eccentric shaft 127 serves as the first oil spreading mechanism 143. A hole formed in the side surface of the eccentric shaft 127, the hole being in communication with the connecting hole 130, serves as the second oil spreading mechanism 145.

[0041] Accordingly, the oil 113 is, after being delivered to the eccentric shaft 127 by the oil supply mechanism 131, spread by the first oil spreading mechanism 143 to first oil grooves 139 described below, and spread by the second oil spreading mechanism 145 to a gap formed between the piston 123 and a cylinder 135.

[0042] Although in the above description of Embodiment 1 the opening provided at the upper end of the eccentric shaft 127 serves as the first oil spreading mechanism 143, the present embodiment is not thus limited. The first oil spreading mechanism 143 may be provided on the side surface of the eccentric shaft 127, so long as the first oil spreading mechanism 143 is disposed at a higher position than that of the second oil spreading mechanism 145.

[0043] The cylinder block 121 is provided with a bearing (main bearing) 137 having a cylindrical inner surface and a vertically extending central axis. The main shaft 129 of the crank shaft 119 is rotatably inserted in the bearing 137.

[0044] The cylinder block 121 is also provided with the cylindrical cylinder 135, whose central axis extends horizontally. The piston 123 is inserted in the cylinder 135 in an advanceable and retractable manner. The eccentric shaft 127 of the crank shaft 119 is connected to the piston 123 via the connector 125.

[0045] A valve plate 151 including a suction hole 147 and a discharge hole 149 is disposed on the far-side end surface of the cylinder 135 relative to the crank shaft 119 (i.e., the end surface of the cylinder 135 at the top dead center side). The valve plate 151 is provided with a suction valve 153 configured to open and close the suction hole 147. The valve plate 151 forms a compression chamber 133 together with the piston 123.

[0046] The valve plate 151 is, together with a cylinder head 155 disposed in a manner to cover the valve plate 151, fixed to the cylinder block 121 by head bolts 157.

[0047] The cylinder head 155 includes a discharge space 159, into which the refrigerant gas 111 is discharged. The discharge space 159 is in communication with the discharge pipe 117 via a discharge pipe 161. The discharge pipe 117 is fixed in such a manner that the discharge pipe 117 extends through the sealed container 101. It should be noted that a discharge chamber 163 with a hollow center is provided on a non-end portion of the discharge pipe 161.

[0048] A suction muffler 165 is held between the valve plate 151 and the cylinder head 155. The suction muffler 165 is mainly formed of a synthetic resin such as PBT (polybutylene terephthalate) to which glass fiber is added. The suction muffler 165 includes a muffler body 173, a tail pipe 167, and a communication pipe 169.

[0049] A silencing space 171 is formed inside the muffler body 173. One end of the tail pipe 167 is in communication with the silencing space 171, and the other end of the tail pipe 167 includes a suction opening 175, which is open to the inside of the sealed container 101. The tail pipe 167 is configured to lead the refrigerant gas 111 into the suction muffler 165. The communication pipe 169 is disposed such that one end of the communication pipe 169 is open to the silencing space 171, and the other end of the communication pipe 169 is in communication with the compression chamber 133. The communication pipe 169 is configured to lead the refrigerant gas 111 in the suction muffler 165 into the compression chamber 133.

[0050] As shown in Fig. 1 to Fig. 4, side walls 141A and 141B, each of which extends in the radial direction and circumferential direction of the cylinder 135, are arranged on the upper outer peripheral surface of the cylinder 135. A first oil groove 139A extending in the circumferential direction of the cylinder 135 is formed between the side wall 141A and the far-side end portion of the cylinder 135 relative to the crank shaft 119. A first oil groove 139B extending in the circumferential direction of the cylinder 135 is formed between the side wall 141A and the side wall 141B.

[0051] The shape of each of the side walls 141A and 141B as seen in the direction of the central axis of the cylinder 135 may be set arbitrarily. The shape may be rectangular or semicircular, for example. When seen from above the hermetic compressor 100, each of the side walls 141A and 141B is formed to have a substantially straight shape.

[0052] The height (dimension) of each of the side walls 141A and 141B may be set arbitrarily within such a range that the oil 113 spread from the first oil spreading mechanism 143 is supplied to the first oil groove 139A and the first oil groove 139B. In Embodiment 1, the height of the first oil groove 139A is set to be the same as the height of the first oil groove 139B.

[0053] Although in the above description of Embodiment 1 the side walls are provided at two positions, the present embodiment is not thus limited. For example, from the viewpoint of making the manufacturing of the hermetic compressor 100 easier and reducing the temperature of the cylinder 135, the side wall may be provided at one position, or may be provided at four positions.

[0054] Moreover, from the viewpoint of preventing the oil 113 spread over the cylinder 135 from entering the gap formed between the piston 123 and the cylinder 135, the side walls may be provided on the end portion of the cylinder 135 at the bottom dead center side.

[0055] In the case of adopting a configuration where the side walls are provided at two or more positions, the interval between adjoining side walls may be set arbitrarily. The side walls may be arranged at regular intervals or irregular intervals.

[0056] The first oil groove 139A and the first oil groove 139B are each formed in an arc shape along the outer peripheral surface of the cylinder 135, such that each groove slopes downward from the central portion thereof toward both ends thereof. It should be noted that, in Embodiment 1, the first oil groove 139A and the first oil groove 139B are each formed in a semicircular shape, which is concentric with the cylinder 135.

[Operations and Functional Advantages of Hermetic Compressor]

[0057] Next, operations and functional advantages of the hermetic compressor 100 according to Embodiment 1 are described.

[0058] First, the inverter 200 supplies electric power from a commercial power supply to the electric element 103. As a result, a current flows to the stator 177 of the electric element 103, and the stator 177 generates a magnetic field, which causes the rotor 179 fixed to the main shaft 129 to rotate. Consequently, the main shaft 129 of the crank shaft 119 rotates.

[0059] Eccentric rotation of the eccentric shaft 127, which is caused by the rotation of the main shaft 129, is converted by the connector 125 such that the piston 123 makes reciprocating movement inside the cylinder 135. Then, the compression chamber 133 performs, through its volumetric change, a compression operation of sucking the refrigerant gas 111 in the sealed container 101 into the compression chamber 133 and compressing the sucked refrigerant gas 111.

[0060] Next, a suction stroke and a compression stroke of the hermetic compressor 100 are described in more detail.

[0061] First, when the piston 123 moves in such a direction that the volume of the compression chamber 133 increases, the refrigerant gas 111 in the compression chamber 133 expands. Then, when the pressure in the compression chamber 133 has fallen below a suction pressure, the suction valve 153 starts opening due to a difference between the pressure in the compression chamber 133 and the pressure in the suction muffler 165.

[0062] As a result of this operation, the refrigerant gas 111 that has returned from the refrigeration cycle and that is in a low-temperature state is temporarily released into the sealed container 101 through the suction pipe 115. Thereafter, the refrigerant gas 111 is sucked in through the suction opening 175 of the suction muffler 165 and introduced into the silencing space 171 through the tail pipe 167. Then, the introduced refrigerant gas 111 flows into the compression chamber 133 through the communication pipe 169.

[0063] Subsequently, when the piston 123 moves from the bottom dead center in such a direction that the volume in the compression chamber 133 decreases, the refrigerant gas 111 in the compression chamber 133 is compressed, causing an increase in the pressure in the compression chamber 133. Then, when the pressure in the compression chamber 133 has exceeded the pressure in the suction muffler 165, the suction valve 153 closes.

[0064] Next, when the pressure in the compression chamber 133 has exceeded a discharge pressure, a discharge valve (not shown) starts opening due to a difference between the pressure in the compression chamber 133 and the pressure in the discharge space 159.

[0065] As a result of this operation, until the piston 123 reaches the top dead center, the refrigerant gas 111 that is in a compressed state is discharged to the discharge space 159 through the discharge hole 149. Then, the refrigerant gas 111 discharged to the discharge space 159 passes through the discharge pipe 161, the discharge chamber 163, and the discharge pipe 117 sequentially, and is thereby fed to the refrigeration apparatus (not shown).

[0066] Thereafter, when the piston 123 moves from the top dead center again in such a direction that the volume in the compression chamber 133 increases, the refrigerant gas 111 in the compression chamber 133 expands and the pressure in the compression chamber 133 decreases. The discharge valve (not shown) closes when the pressure in the compression chamber 133 has fallen below the pressure in the discharge space 159.

[0067] The above-described suction, compression, and discharge strokes are repeated each time the crank shaft 119 rotates one revolution, and thereby the refrigerant gas 111 circulates inside the refrigeration apparatus (not shown).

[0068] Next, movement of the oil 113 is described.

[0069] When the crank shaft 119 rotates, the oil 113 stored at the bottom inside the sealed container 101 is sucked from the lower part of the crank shaft 119 owing to centrifugal force. Thereafter, the oil 113 is delivered to the upper part of the compression element 105 by the oil supply mechanism 131. The oil 113 delivered to the compression element 105 lubricates sliding portions, such as the crank shaft 119 and the bearing 137, and is then delivered to the eccentric shaft 127 through the connecting hole 130. Then, as indicated by arrows in Fig. 3, the oil 113 is spread by the first oil spreading mechanism 143 and the second oil spreading mechanism 145 of the eccentric shaft 127.

[0070] The oil 113 spread by the first oil spreading mechanism 143 is supplied to the first oil groove 139A and the first oil groove 139B, both of which are formed on the upper outer peripheral surface of the cylinder 135. The oil 113 spread by the second oil spreading mechanism 145 is supplied to the gap formed between the piston 123 and the cylinder 135.

[0071] In a reciprocating hermetic compressor as in the present embodiment, the cylinder 135 is heated to a high temperature due to frictional heat caused by the reciprocating movement of the piston 123 and compression heat of the refrigerant gas 111. Therefore, in general, even if the refrigerant gas 111 that is in a low-temperature and high-density state is sucked into the compression chamber 133, the refrigerant gas 111 is heated by the high-temperature cylinder 135. Consequently, there is a risk that, by the time the operation reaches a compression stroke, the density of the refrigerant gas 111 may decrease, resulting in lowered volumetric efficiency.

[0072] However, in the hermetic compressor 100 according to Embodiment 1, the side wall 141A and the side wall 141B are arranged on the upper outer peripheral surface of the cylinder 135, and thereby the first oil groove 139A and the first oil groove 139B are formed.

[0073] Accordingly, the oil 113 spread from the eccentric shaft 127 (in Embodiment 1, from the first oil spreading mechanism 143) adheres to the side wall 141A and the side wall 141B, and flows along the side wall 141A and the side wall 141B such that the oil 113 is supplied to the first oil groove 139A and the first oil groove 139B.

[0074] The oil 113 supplied to the first oil groove 139A and the first oil groove 139B absorbs heat from the cylinder 135 while flowing through the first oil groove 139A and the first oil groove 139B, thereby reducing the temperature of the cylinder 135. Also while the oil 113 is flowing along the side wall 141A and the side wall 141B, the oil 113 absorbs heat from the cylinder 135, and the side wall 141A and the side wall 141B function as radiation fins.

[0075] Accordingly, the hermetic compressor 100 according to Embodiment 1 is capable of reducing the amount of heat to be added (i.e., the amount of heat to be transferred) to the refrigerant gas 111 that has been sucked into the compression chamber 133, thereby improving the volumetric efficiency of the refrigerant gas 111, and thus the efficiency of the hermetic compressor can be improved.

[0076] In the hermetic compressor 100 according to Embodiment 1, the first oil groove 139A and the first oil groove 139B are each formed in an arc shape. Accordingly, the high-temperature oil 113 that has flowed through the first oil grooves 139A and 139B and absorbed heat from the cylinder 135 tends to pass by the side of the cylinder 135 and fall downward. In this manner, the high-temperature oil 113 is suppressed from flowing into the gap formed between the piston 123 and the cylinder 135. This makes it possible to suppress the high-temperature oil 113 from entering the compression chamber 133.

[0077] Therefore, the heating, by the high-temperature oil 113, of the refrigerant gas 111 that has been sucked into the compression chamber 133 can be suppressed, which makes it possible to improve the volumetric efficiency of the refrigerant gas 111 and further improve the efficiency of the hermetic compressor.

[0078] The oil 113 spread by the second oil spreading mechanism 145 is supplied to the gap formed between the piston 123 and the cylinder 135. In this manner, the lubrication between the piston 123 and the cylinder 135 can be improved and sliding loss can be reduced, and also, the sealing performance between the piston 123 and the cylinder 135 can be improved. This makes it possible to improve the volumetric efficiency of the refrigerant gas 111 and further improve the efficiency of the hermetic compressor.

[0079] Generally speaking, in a reciprocating hermetic compressor as in the present embodiment, it is often the case that the discharge chamber 163 is integrated with the cylinder block 121 for the purpose of improving the productivity.

[0080] However, in such a general configuration, the refrigerant gas 111 in a high-temperature state that is discharged from the compression chamber 133 passes through the discharge chamber integrated with the cylinder block 121. Therefore, the cylinder 135 is heated by heat transferred from the discharge chamber. Consequently, in a suction stroke, the refrigerant gas 111 in a low-temperature state that has been sucked into the compression chamber 133 is heated by the high-temperature cylinder 135, and this may cause lowered volumetric efficiency.

[0081] However, in the hermetic compressor 100 according to Embodiment 1, the discharge chamber 163 is formed separately from the cylinder block 121. In this manner, heat transfer from the discharge chamber 163 to the cylinder 135 can be suppressed, and the temperature of the cylinder 135 can be further reduced. This makes it possible to improve the volumetric efficiency of the refrigerant gas 111 and further improve the efficiency of the hermetic compressor.

[0082] In the case of adopting inverter-driven operation as in the present embodiment, during high-speed rotation, the amount of refrigerant gas 111 circulating per unit time is large, and also, the temperature of the refrigerant gas 111 discharged from the compression chamber 133 tends to increase.

[0083] However, in the hermetic compressor 100 according to Embodiment 1, the amount of oil 113 spread from the first oil spreading mechanism 143 increases during high-speed rotation. This makes it possible to reduce the temperature of the cylinder 135 more effectively.

[0084] In addition, during low-speed rotation, the volumetric change is slow, and thereby the refrigerant gas 111 tends to receive heat from the cylinder 135. Therefore, during low-speed rotation, the functional advantages of the hermetic compressor 100 according to Embodiment 1 are exerted more prominently.

[Variation 1]

[0085] Next, variations of the hermetic compressor 100 according to Embodiment 1 are described.

[0086] Fig. 5 is a schematic diagram showing a schematic configuration of a cylinder block of a hermetic compressor according to Variation 1 of Embodiment 1 when the cylinder block is seen from above.

[0087] As shown in Fig. 5, the fundamental configuration of the hermetic compressor 100 according to Variation 1 is the same as that of the hermetic compressor 100 according to Embodiment 1. However, the hermetic compressor 100 according to Variation 1 is different from the hermetic compressor 100 according to Embodiment 1 in that the side wall 141A and the side wall 141B of the hermetic compressor 100 according to Variation 1 are each formed in a V shape as seen from above. Specifically, the side wall 141A and the side wall 141B are each formed in a V shape such that their top dead center side protrudes. In other words, the first oil groove 139A and the first oil groove 139B are also formed in a V shape as seen from above such that their top dead center side protrudes.

[0088] The hermetic compressor 100 according to Variation 1 of Embodiment 1 with the above configuration provides the same functional advantages as those provided by the hermetic compressor 100 according to Embodiment 1.

[0089] In the hermetic compressor 100 according to Variation 1 with the above configuration, the side wall 141A and the side wall 141B are formed such that these side walls extend in the rotation direction of the eccentric shaft 127.

[0090] Accordingly, the oil 113 spread from the first oil spreading mechanism 143 is easily supplied to the first oil groove 139A and the first oil groove 139B. Therefore, the hermetic compressor 100 according to Variation 1 makes it possible to further reduce the temperature of the piston 123 and further improve the compression efficiency of the hermetic compressor 100.

[0091] Although in the above description of Variation 1 the side wall 141A and the side wall 141B are each formed in a V shape such that their top dead center side protrudes, the present variation is not thus limited. The side wall 141A and the side wall 141B may be each formed in a V shape such that their bottom dead center side protrudes. In this case, the oil 113 spread from the first oil spreading mechanism 143 easily adheres to the side wall 141A and the side wall 141B, which allows the side wall 141A and the side wall 141B to exert their function as radiation fins more effectively. This makes it possible to further reduce the temperature of the piston 123 and further improve the compression efficiency of the hermetic compressor 100.

[Variation 2]

[0092] Fig. 6 is a schematic diagram showing a cylinder block of a hermetic compressor according to Variation 2 of Embodiment 1.

[0093] As shown in Fig. 6, the fundamental structure of the hermetic compressor 100 according to Variation 2 is the same as that of the hermetic compressor 100 according to Embodiment 1. However, the hermetic compressor 100 according to Variation 2 is different from the hermetic compressor 100 according to Embodiment 1 in that the side wall 141A and the side wall 141B of the hermetic compressor 100 according to Variation 2 are each formed in an arc shape (i.e., bent in an arc shape; formed in a parabolic manner) as seen from above. Specifically, the side wall 141A and the side wall 141B are each formed in an arc shape such that their top dead center side protrudes. Accordingly, the first oil groove 139A and the first oil groove 139B are also formed in an arc shape such that their top dead center side protrudes as seen from above.

[0094] The hermetic compressor 100 according to Variation 2 with the above configuration provides the same functional advantages as those provided by the hermetic compressor 100 according to Variation 1 of Embodiment 1.

(Embodiment 2)

[0095] A hermetic compressor according to Embodiment 2 is configured such that, in the hermetic compressor according to Embodiment 1 (including Variation 1 and Variation 2), side walls forming the first oil groove are formed such that a height of the side walls gradually increases from a bottom dead center side to a top dead center side of the cylinder.

[0096] According to this configuration, compared to the hermetic compressor according to Embodiment 1, the oil spread from the eccentric shaft is more easily supplied to the first oil groove positioned at the top dead center side. Therefore, an increase in the temperature of the refrigerant gas sucked into the compression chamber can be more suppressed, and the volumetric efficiency of the hermetic compressor can be further improved.

[0097] It should be noted that, other than the above feature, the configuration of the hermetic compressor according to Embodiment 2 may be the same as the configuration of the hermetic compressor according to Embodiment 1 (including Variation 1 and Variation 2).

[0098] Hereinafter, one example of the hermetic compressor according to Embodiment 2 is described with reference to Fig. 7 and Fig. 8.

[0099] Fig. 7 is a longitudinal sectional view of the hermetic compressor according to Embodiment 2. Fig. 8 is a sectional view showing, in an enlarged manner, a cylinder and the vicinity thereof of the hermetic compressor shown in Fig. 7.

[0100] As shown in Fig. 7 and Fig. 8, the fundamental configuration of the hermetic compressor 100 according to Embodiment 2 is the same as that of the hermetic compressor 100 according to Embodiment 1. However, the hermetic compressor 100 according to Embodiment 2 is different from the hermetic compressor 100 according to Embodiment 1 in that the side walls forming the first oil grooves are formed such that the height of the side walls gradually increases from the bottom dead center side to the top dead center side of the cylinder 135. Specifically, the side walls are formed such that the side wall 141A positioned at the top dead center side of the cylinder 135 is higher than the side wall 141B positioned at the bottom dead center side of the cylinder 135.

[0101] The hermetic compressor 100 according to Embodiment 2 with the above configuration provides the same functional advantages as those provided by the hermetic compressor 100 according to Embodiment 1.

[0102] In the hermetic compressor 100 according to Embodiment 2, the side walls forming the first oil grooves are formed such that the height of the side walls gradually increases from the bottom dead center side to the top dead center side of the cylinder 135. Therefore, the oil 113 spread from the first oil spreading mechanism 143 can be supplied to the first oil groove 139A more easily compared to the hermetic compressor 100 according to Embodiment 1.

[0103] Therefore, an increase in the temperature of the refrigerant gas 111 sucked into the compression chamber 133 can be further suppressed, and the volumetric efficiency of the hermetic compressor 100 can be further improved.

(Embodiment 3)

[0104] A hermetic compressor according to Embodiment 3 is configured such that, in the hermetic compressor according to Embodiment 1 (including Variation 1 and Variation 2) or in the hermetic compressor according to Embodiment 2, a second oil groove extending in a direction of a central axis of the cylinder is further provided in at least part of the upper outer peripheral surface of the cylinder, the second oil groove being formed such that a bottom thereof slopes downward from a bottom dead center side to a top dead center side of the cylinder, the second oil groove being in communication with the first oil groove.

[0105] According to this configuration, the oil spread from the eccentric shaft is evenly supplied to the second oil groove. This makes it possible to effectively absorb heat from the entire cylinder by means of the oil flowing through the second oil groove. Since the high-temperature oil that has absorbed heat from the cylinder flows from the second oil groove to the first oil groove, and flows in a manner to fall onto the bottom of the sealed container, the high-temperature oil is suppressed from flowing into the gap formed between the piston and the cylinder. In this manner, the entry of the high-temperature oil into the compression chamber can be suppressed. This makes it possible to suppress an increase in the temperature of the refrigerant gas sucked into the compression chamber and improve the volumetric efficiency of the refrigerant gas.

[0106] It should be noted that, other than the above feature, the configuration of the hermetic compressor according to Embodiment 3 may be the same as the configuration of the hermetic compressor according to Embodiment 1 (including Variation 1 and Variation 2) or the configuration of the hermetic compressor according to Embodiment 2.

[0107] Hereinafter, one example of the hermetic compressor according to Embodiment 3 is described with reference to Fig. 9 and Fig. 10.

[Configuration of Hermetic Compressor]

[0108] Fig. 9 is a longitudinal sectional view of the hermetic compressor according to Embodiment 3. Fig. 10 is a perspective view of a cylinder block in the hermetic compressor shown in Fig. 9 when the cylinder block is seen from above.

[0109] As shown in Fig. 9 and Fig. 10, the fundamental configuration of the hermetic compressor 100 according to Embodiment 3 is the same as that of the hermetic compressor 100 according to Embodiment 1. However, the hermetic compressor 100 according to Embodiment 3 is different from the hermetic compressor 100 according to Embodiment 1 in that, in the hermetic compressor 100 according to Embodiment 3, a plurality of side walls 202 each extending in the direction of the central axis of the cylinder 135 and second oil grooves 201 each formed between the side walls 202 are provided on the upper outer peripheral surface of the cylinder 135.

[0110] Specifically, the side walls 202 are formed in a manner to extend in the direction of the central axis of the cylinder 135 as seen from above the hermetic compressor 100. The plurality of (in this example, six) side walls 202 are arranged side by side and parallel to each other in a direction perpendicular to the direction of the central axis of the cylinder 135.

[0111] It should be noted that the intervals between adjoining side walls 202 may be either regular or irregular. The height of the side walls 202 may be set arbitrarily, so long as the oil 113 can be supplied to the second oil grooves 201. The upper end of the side walls 202 may be formed to be horizontal, or may be formed to slope downward from the bottom dead center to the top dead center of the cylinder 135, or may be formed to slope downward from the top dead center to the bottom dead center of the cylinder 135. Further, the number of side walls 202 to arrange for forming the second oil grooves 201 may be set arbitrarily, so long as the number of side walls 202 is two or more.

[0112] The bottom surface of each second oil groove 201 is formed to slope downward from the bottom dead center to the top dead center of the cylinder 135.

[0113] The second oil grooves 201 are formed such that the end of the second oil grooves 201 at the top dead center side of the cylinder 135 is in communication with the first oil groove 139A. To be more specific, a gap is formed between the end of the side walls 202 at the top dead center side of the cylinder 135 and the far-side end portion of the cylinder 135 relative to the crank shaft 119. The gap serves as the first oil groove 139A extending in the circumferential direction of the cylinder 135.

[0114] It should be noted that the bottom surface of the first oil groove 139A may be formed to be flush with the bottom surface of each second oil groove 201, or may be recessed inward relative to the bottom surface of each second oil groove 201.

[0115] Although in the above description of Embodiment 3 the second oil grooves 201 are formed such that the end of the second oil grooves 201 at the top dead center side of the cylinder 135 is in communication with the first oil groove, the present embodiment is not thus limited. For example, the second oil grooves 201 may be formed such that the central portions of the respective second oil grooves 201 in the direction of the central axis of the cylinder 135 are in communication with the first oil groove. Further, although in the above-described configuration one first oil groove is in communication with the second oil grooves 201, the present embodiment is not thus limited. Alternatively, a configuration in which the plurality of first oil grooves are in communication with the second oil grooves 201 may be adopted.

[Functional Advantages of Hermetic Compressor]

[0116] In the hermetic compressor 100 according to Embodiment 3 with the above configuration, the oil 113 spread from the eccentric shaft 127 (in Embodiment 3, from the first oil spreading mechanism 143) adheres to the side walls 202 and flows along the side walls 202, such that the oil 113 is supplied to the second oil grooves 201. Then, the oil 113 supplied to the second oil grooves 201 absorbs heat from the cylinder 135 while flowing through the second oil grooves 201, thereby reducing the temperature of the cylinder 135. Also while the oil 113 is flowing along the side walls 202, the oil 113 absorbs heat from the cylinder 135, and the side walls 202 function as radiation fins.

[0117] Accordingly, the hermetic compressor 100 according to Embodiment 3 is capable of reducing the amount of heat to be added to the refrigerant gas 111 that has been sucked into the compression chamber 133, thereby improving the volumetric efficiency of the refrigerant gas 111, and thus the efficiency of the hermetic compressor can be improved.

[0118] In the hermetic compressor 100 according to Embodiment 3, the second oil grooves 201 are formed such that each second oil groove 201 extends in the direction of the central axis of the cylinder 135. Accordingly, the oil 113 spread from the first oil spreading mechanism 143 can be evenly supplied to each of the second oil grooves 201. This makes it possible to further improve the effect of cooling the cylinder 135.

[0119] Further, in the hermetic compressor 100 according to Embodiment 3, the bottom surface of each second oil groove 201 is formed to slope downward from the bottom dead center side to the top dead center side of the cylinder 135, and also, the second oil grooves 201 are in communication with the first oil groove 139A extending in the circumferential direction of the cylinder 135. Accordingly, the high-temperature oil 113 that has flowed through the second oil grooves 201 and absorbed heat from the cylinder 135 is suppressed from flowing into the gap formed between the piston 123 and the cylinder 135. In this manner, the entry of the high-temperature oil 113 into the compression chamber 133 can be suppressed. Therefore, the heating, by the high-temperature oil 113, of the refrigerant gas 111 that has been sucked into the compression chamber 133 can be suppressed, which makes it possible to improve the volumetric efficiency of the refrigerant gas 111 and improve the efficiency of the hermetic compressor.

(Embodiment 4)

[0120] A hermetic compressor according to Embodiment 4 is configured such that, in the hermetic compressor according to any one of Embodiment 1 (including Variation 1 and Variation 2) to Embodiment 3, a radiation fin is provided on at least part of a lower outer peripheral surface of the cylinder.

[0121] According to this configuration, heat can be radiated also from the lower part of the cylinder, and thereby the temperature of the cylinder can be further reduced. This makes it possible to improve the volumetric efficiency of the refrigerant gas and further improve the efficiency of the hermetic compressor.

[0122] In the hermetic compressor according to Embodiment 4, the electric element may include a stator fixed to the cylinder block and a rotor fixed to the crank shaft, and an air-blowing fin may be provided on an end portion of the rotor at the cylinder block side.

[0123] According to this configuration, by feeding air to the cylinder by the air-blowing fin, the radiation of heat from the cylinder can be further facilitated. This makes it possible to improve the volumetric efficiency of the refrigerant gas and further improve the efficiency of the hermetic compressor.

[0124] It should be noted that, other than the above feature, the configuration of the hermetic compressor according to Embodiment 4 may be the same as the configuration of the hermetic compressor according to any one of Embodiment 1 (including Variation 1 and Variation

2) to Embodiment 3.

[0125] Hereinafter, one example of the hermetic compressor according to Embodiment 4 is described with reference to Fig. 11 to Fig. 13.

[Configuration of Hermetic Compressor]

[0126] Fig. 11 is a longitudinal sectional view of the hermetic compressor according to Embodiment 4. Fig. 12 is a perspective view of a cylinder block in the hermetic compressor shown in Fig. 11 when the cylinder block is seen from below. Fig. 13 is a perspective view of a rotor in the hermetic compressor shown in Fig. 12.

[0127] As shown in Fig. 11 to Fig. 13, the fundamental configuration of the hermetic compressor 100 according to Embodiment 4 is the same as that of the hermetic compressor 100 according to Embodiment 1. However, the hermetic compressor 100 according to Embodiment 4 is different from the hermetic compressor 100 according to Embodiment 1 in that, in the hermetic compressor 100 according to Embodiment 4, a plurality of radiation fins 142 are provided on at least part of the lower outer peripheral surface of the cylinder 135, and a plurality of air-blowing fins 181 are provided on the end surface of the rotor 179 at the cylinder block 121 side.

[0128] Specifically, as shown in Fig. 12, the radiation fins 142 are each formed in a plate shape extending in the direction of the central axis of the cylinder 135. As seen from below the hermetic compressor 100, the radiation fins 142 are each formed in a straight shape. The plurality of (in this example, four) radiation fins 142 are arranged side by side in a direction perpendicular to the direction of the central axis of the cylinder 135.

[0129] Although in the above description of Embodiment 4 the four radiation fins 142 are formed on the outer surface of the cylinder 135, the present embodiment is not thus limited. The number of radiation fins 142 may be set arbitrarily, and also, the interval between adjoining radiation fins 142 may be set arbitrarily.

[0130] Although in the above description of Embodiment 4 the radiation fins 142 are each formed in a straight shape as seen from below the hermetic compressor 100, the present embodiment is not thus limited. The radiation fins 142 may be each formed in an arc shape or in a wavy shape as seen from below the hermetic compressor 100.

[0131] As shown in Fig. 13, plate-shaped air-blowing fins 181, each of which extends in the direction of the main shaft 129 of the crank shaft 119, are provided on the end surface of the rotor 179 at the cylinder block 121 side (i.e., the upper end surface of the rotor 179). The air-blowing fins 181 are each formed in a straight shape as seen from above the hermetic compressor 100. The plurality of (in this example, eight) air-blowing fins 181 are arranged at regular intervals in the circumferential direction. Specifically, the air-blowing fins 181 are formed such that they are radially arranged on the upper part of the rotor 179.

[0132] Although in the above description of Embodiment 4 the eight air-blowing fins 181 are formed on the upper end surface of the rotor 179, the present embodiment is not thus limited. The number of air-blowing fins 181 may be set arbitrarily, and also, the interval between adjoining air-blowing fins 181 may be set arbitrarily.

[0133] Although in the above description of Embodiment 4 the air-blowing fins 181 are each formed in a straight shape as seen from above the hermetic compressor 100, the present embodiment is not thus limited. The air-blowing fins 181 may be each formed in an arc shape or in a wavy shape as seen from above the hermetic compressor 100.

[Functional Advantages of Hermetic Compressor]

[0134] The hermetic compressor 100 according to Embodiment 4 with the above configuration provides the same functional advantages as those provided by the hermetic compressor 100 according to Embodiment 1.

[0135] Further, since the hermetic compressor 100 according to Embodiment 4 includes the radiation fins 142 provided on the lower outer peripheral surface of the cylinder 135, heat from the cylinder 135 can be radiated from the radiation fins 142. In this manner, the temperature of the cylinder 135 can be further reduced. This makes it possible to improve the volumetric efficiency of the refrigerant gas 111 and further improve the efficiency of the hermetic compressor.

[0136] Still further, since the hermetic compressor 100 according to Embodiment 4 includes the air-blowing fins 181 provided on the upper end surface of the rotor 179, when the rotor 179 rotates, air is fed to the cylinder 135 (specifically, to the radiation fins 142 of the cylinder 135), and thereby the radiation of heat from the cylinder 135 can be further facilitated. In this manner, the temperature of the cylinder 135 can be further reduced. This makes it possible to improve the volumetric efficiency of the refrigerant gas 111 and further improve the efficiency of the hermetic compressor.

(Embodiment 5)

[0137] Fig. 14 is a schematic diagram showing a schematic configuration of a refrigeration apparatus according to Embodiment 5.

[0138] The refrigeration apparatus herein is configured such that the hermetic compressor 100 according to Embodiment 1 is installed in a refrigerant circuit. Hereinafter, the fundamental configuration of the refrigeration apparatus is described.

[0139] As shown in Fig. 14, a refrigeration apparatus 300 according to Embodiment 5 includes: a body 301 including a heat-insulating box whose one face is open and a door configured to open and close the opening; a dividing wall 307, which divides the interior of the body 301 into an article storage space 303 and a machine chamber 305; and a refrigerant circuit 309 configured to cool down the inside of the storage space 303.

[0140] The refrigerant circuit 309 is configured such that the hermetic compressor 100 according to Embodiment 1, a radiator 313, a decompressor 315, and a heat absorber 317 are connected through piping in an annular manner. The heat absorber 317 is disposed in the storage space 303, in which an air blower (not shown) is provided. Cooling heat of the heat absorber 317 is, as indicated by arrows in Fig. 14, agitated by the air blower in such a manner that the cooling heat is circulated within the storage space 303.

[0141] Since the refrigeration apparatus 300 according to Embodiment 5 with the above configuration includes the hermetic compressor 100 according to Embodiment 1, the refrigeration apparatus 300 according to Embodiment 5 provides the same functional advantages as those provided by the hermetic compressor 100 according to Embodiment 1. This makes it possible to reduce the power consumption of the refrigeration apparatus 300 and realize energy saving.

[0142] Although in the above description the refrigeration apparatus 300 according to Embodiment 5 includes the hermetic compressor 100 according to Embodiment 1, the configuration of the refrigeration apparatus 300 is not thus limited. Alternatively, the refrigeration apparatus 300 may adopt a configuration that includes any one of the following hermetic compressors 100: the hermetic compressors 100 according to Variations 1 and 2 of Embodiment 1 and the hermetic compressors 100 according to Embodiments 2 to 4.

[0143] From the foregoing description, numerous modifications and other embodiments of the present invention are obvious to one skilled in the art. Therefore, the foregoing description should be interpreted only as an example and is provided for the purpose of teaching the best mode for carrying out the present invention to one skilled in the art. The structural and/or functional details may be substantially altered without departing from the spirit of the present invention. In addition, various inventions can be made by suitable combinations of a plurality of components disclosed in the above embodiments.

Industrial Applicability

[0144] The hermetic compressor according to the present invention and the refrigeration apparatus including the hermetic compressor realize improved hermetic compressor efficiency. Therefore, the hermetic compressor according to the present invention and the refrigeration apparatus including the hermetic compressor are not limited to household use, such as household electric refrigerators and household air conditioners, but are widely applicable to various refrigeration apparatuses such as professional-use showcases and vending machines.

Reference Signs List

[0145]

2	hermetic compressor
5	refrigerant gas
6	piston
7	compression mechanism
8	electric motor
11	sealed container
12	frame
13	spring
14	refrigerating machine oil
15	main shaft
16	eccentric shaft
17	rotary shaft
18	rotor
19	stator
22	oil pump
23	oil supply path
27	cylinder
28	cylinder block
29	cylinder chamber
41	oil reservoir
43	protruding portion
45	recess
100	hermetic compressor
101	sealed container
103	electric element
105	compression element
107	compressor body
109	suspension spring
111	refrigerant gas
113	oil
115	suction pipe
117	discharge pipe
119	crank shaft
121	cylinder block
123	piston
125	connector
127	eccentric shaft
129	main shaft
130	connecting hole
131	oil supply mechanism
133	compression chamber
135	cylinder
137	bearing
139	first oil groove
139A	first oil groove
139B	first oil groove
141A	side wall
141B	side wall
142	radiation fin
143	first oil spreading mechanism
145	second oil spreading mechanism
147	suction hole
149	discharge hole
151	valve plate
153	suction valve
155	cylinder head
157	head bolt
159	discharge space

161	discharge pipe
163	discharge chamber
165	suction muffler
167	tail pipe
169	communication pipe
171	silencing space
173	muffler body
175	suction opening
177	stator
179	rotor
181	air-blowing fin
200	inverter
201	second oil groove
202	side wall
300	refrigeration apparatus
301	body
303	storage space
305	machine chamber
307	dividing wall
309	refrigerant circuit
313	radiator
315	decompressor
317	heat absorber

Claims

1. A hermetic compressor comprising:

an electric element;
a compression element driven by the electric element; and
a sealed container accommodating the electric element and the compression element, the sealed container storing an oil, wherein
the compression element includes:

a crank shaft including a main shaft, an eccentric shaft, and an oil supply mechanism;
a cylinder block including a main bearing and a cylinder, the main bearing pivotally supporting the main shaft of the crank shaft, the cylinder forming a compression chamber;
a piston configured to move inside the cylinder in a reciprocating manner; and
a connector connecting the eccentric shaft and the piston, and

a first oil groove extending in a circumferential direction of the cylinder is provided on at least part of an upper outer peripheral surface of the cylinder.

2. The hermetic compressor according to claim 1, wherein side walls forming the first oil groove are formed such that a height of the side walls gradually increases from a bottom dead center side to a top dead center side of the cylinder.

3. The hermetic compressor according to claim 1, wherein
a second oil groove extending in a direction of a central axis of the cylinder is further provided on at least part of the upper outer peripheral surface of the cylinder, the second oil groove being formed such that a bottom thereof slopes downward from a bottom dead center side to a top dead center side of the cylinder, the second oil groove being in communication with the first oil groove.

4. The hermetic compressor according to any one of claims 1 to 3, wherein
the eccentric shaft of the crank shaft is provided with a first oil spreading mechanism configured to spread the oil to the first oil groove and a second oil spreading mechanism configured to spread the oil to a gap formed between the piston and the cylinder.

5. The hermetic compressor according to any one of claims 1 to 4, wherein
a radiation fin is provided on at least part of a lower outer peripheral surface of the cylinder.

6. The hermetic compressor according to any one of claims 1 to 5, wherein
the electric element includes a stator fixed to the cylinder block and a rotor fixed to the crank shaft, and an air-blowing fin is provided on an end portion of the rotor at the cylinder block side.

7. The hermetic compressor according to any one of claims 1 to 6, wherein
the compression element includes:

a discharge pipe, through which a refrigerant compressed in the compression chamber is discharged; and
a discharge chamber provided on a non-end portion of the discharge pipe.

8. The hermetic compressor according to any one of claims 1 to 7, wherein
the electric element is configured to be driven by an inverter at multiple operating frequencies.

9. A refrigeration apparatus comprising the hermetic compressor according to any one of claims 1 to 8.

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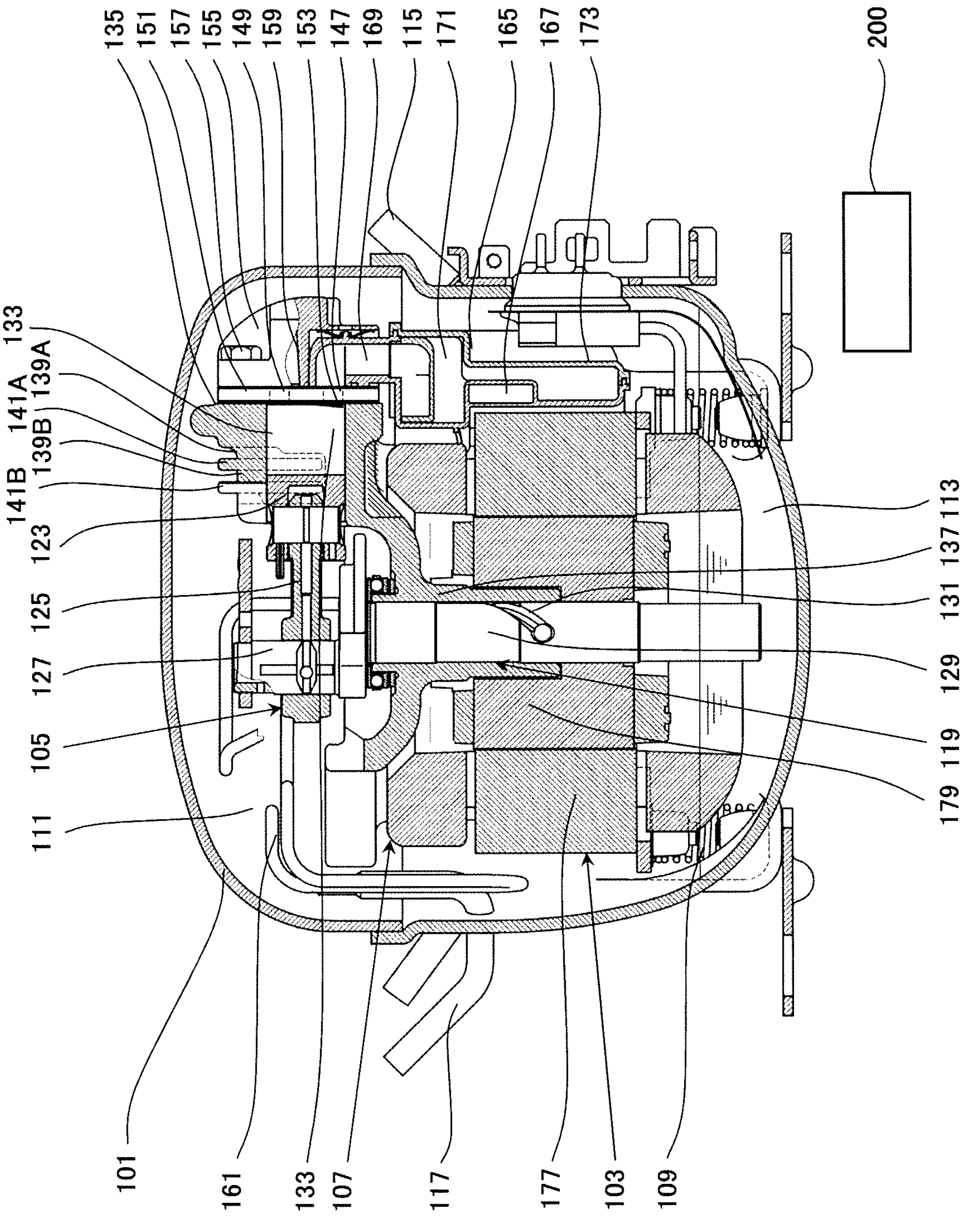
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Fig.1

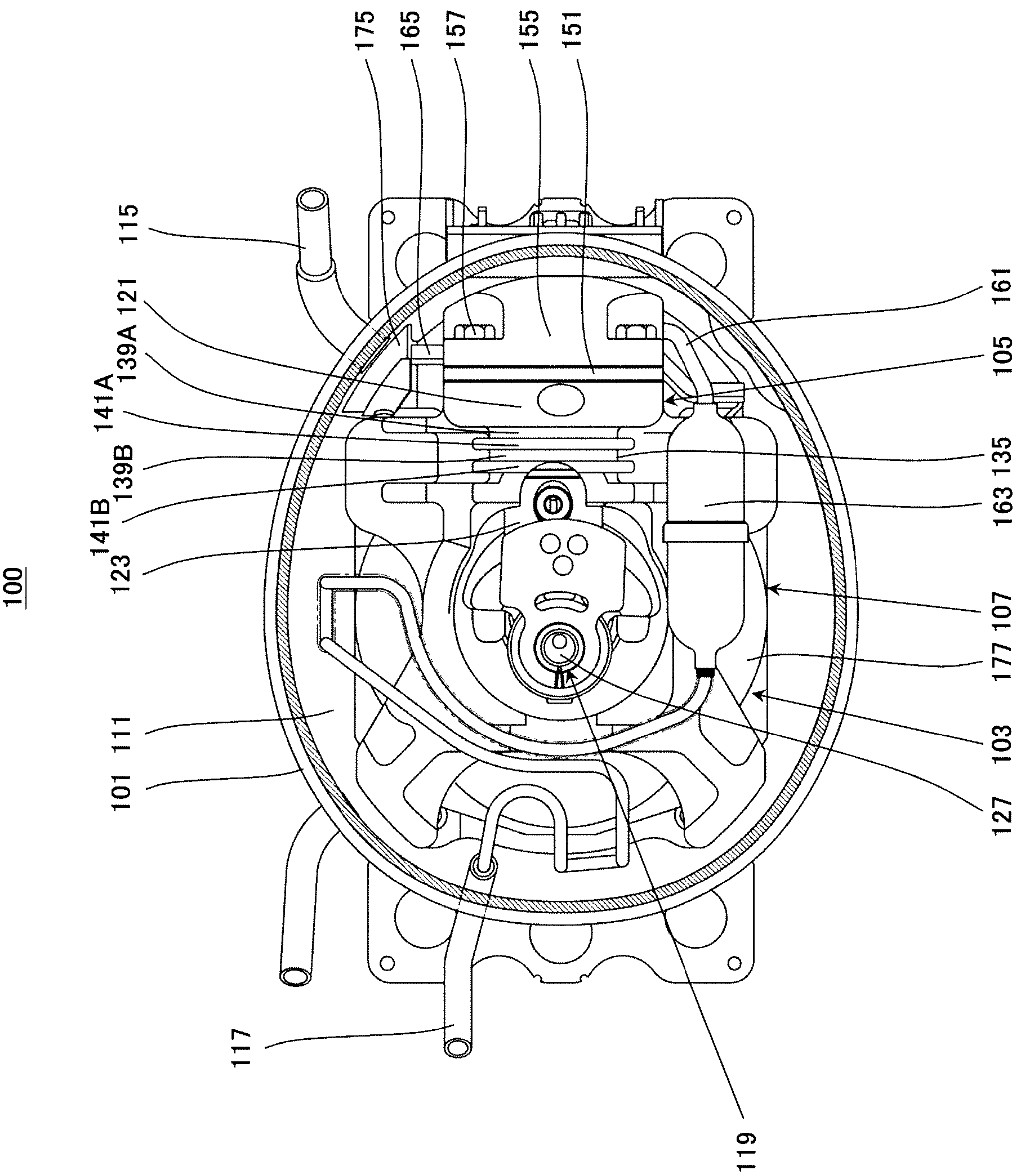
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Fig.2

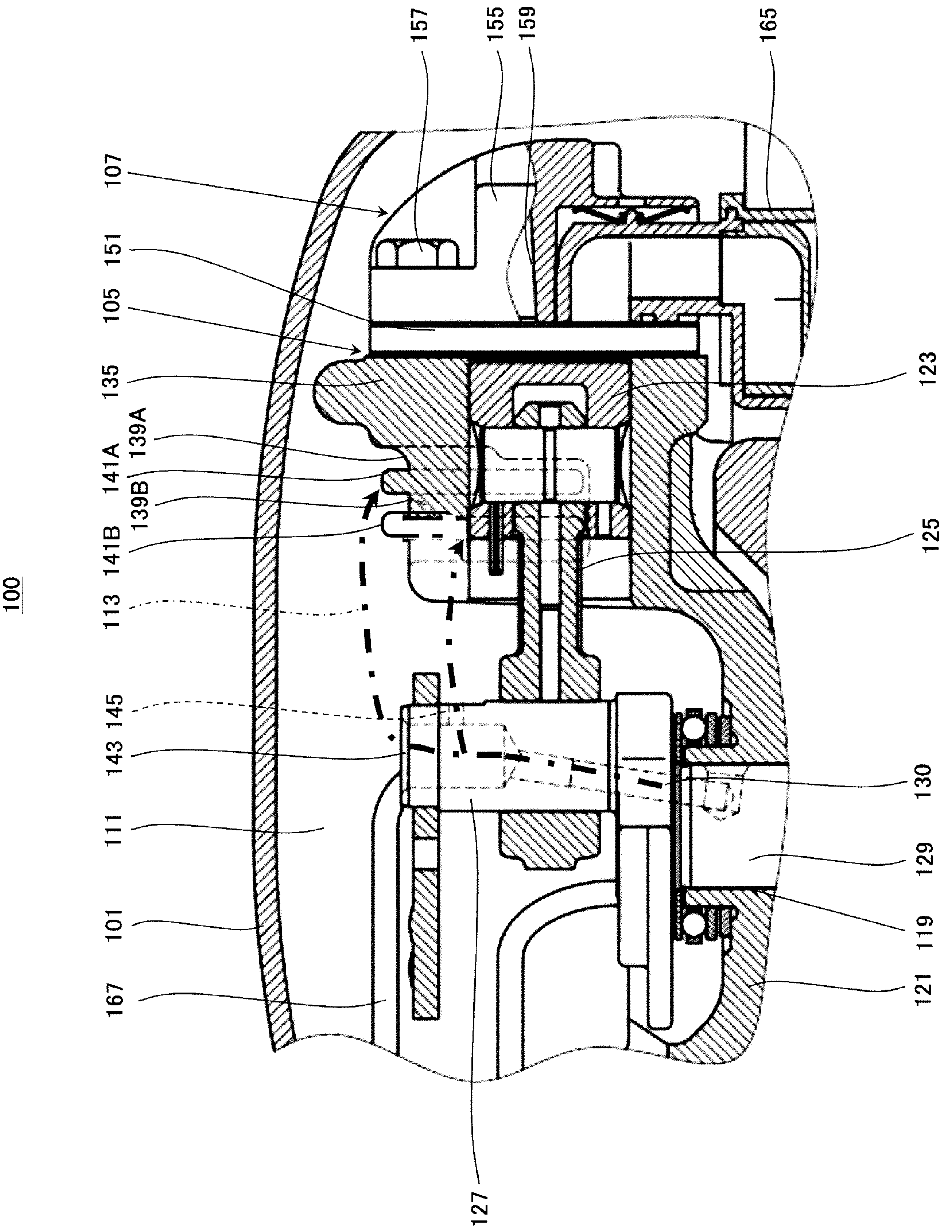
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Fig.3

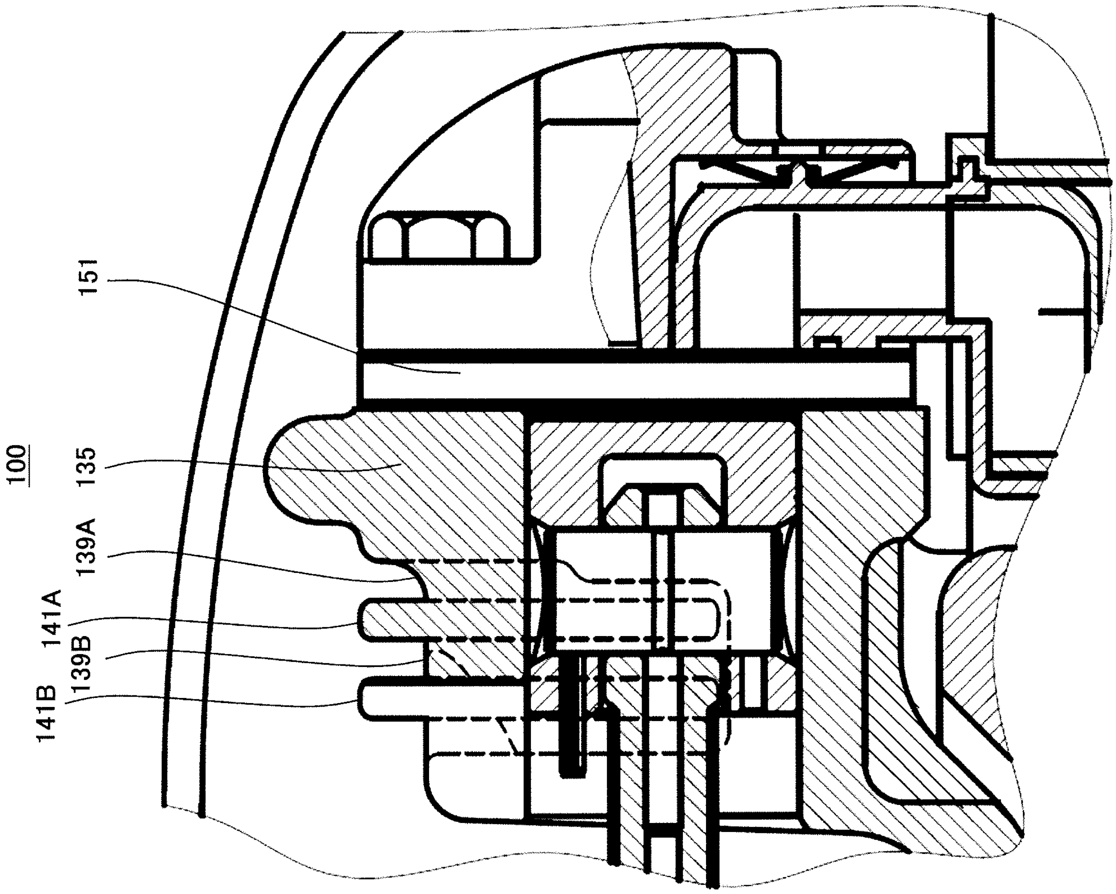

Fig.4

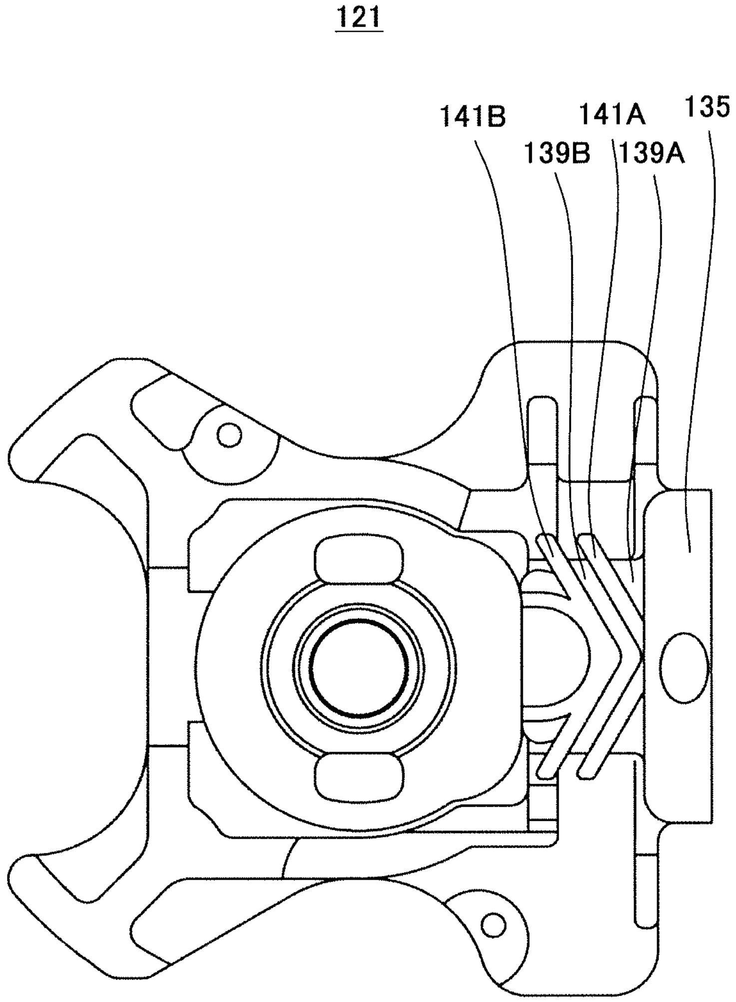

Fig.5

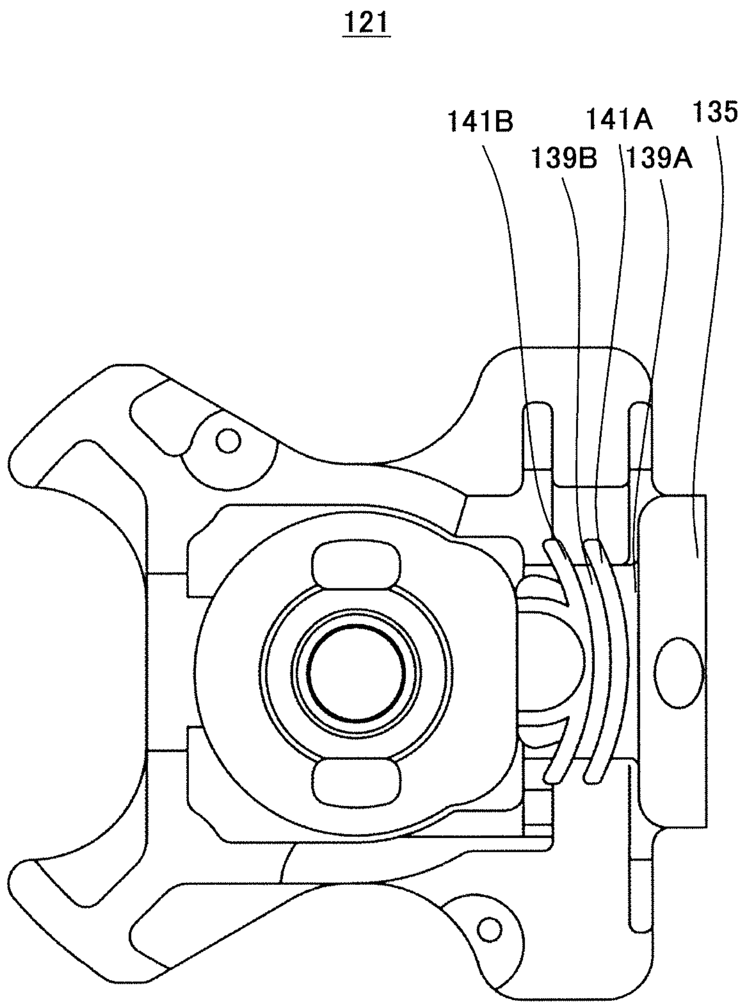

Fig.6

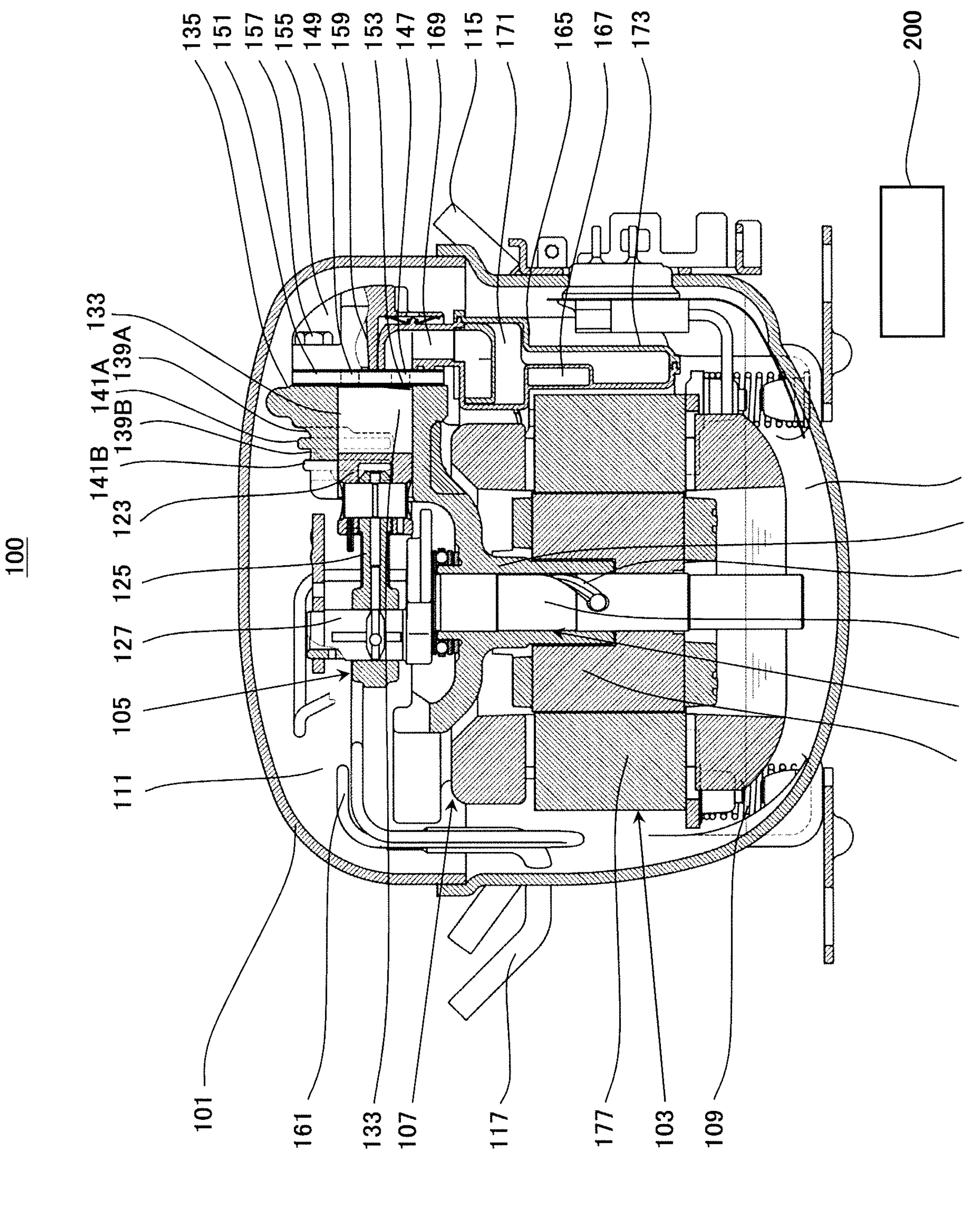
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Fig.7

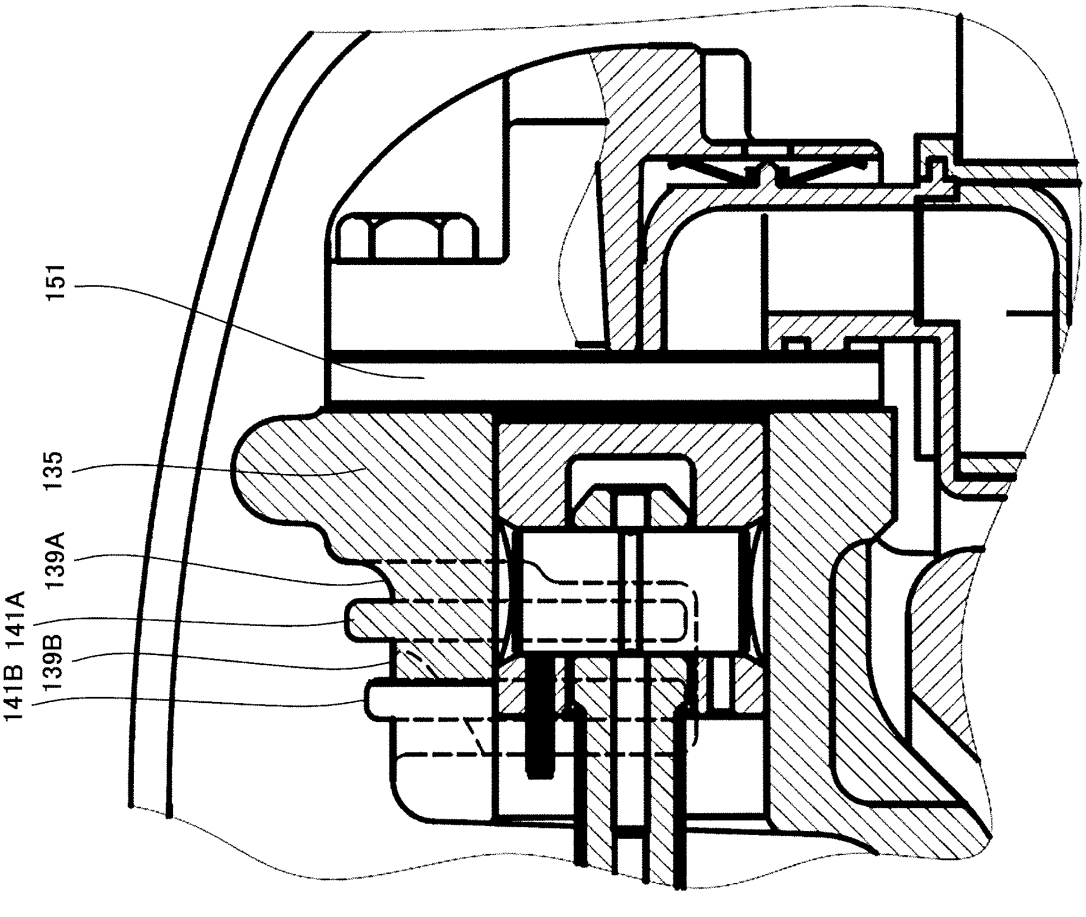

Fig.8

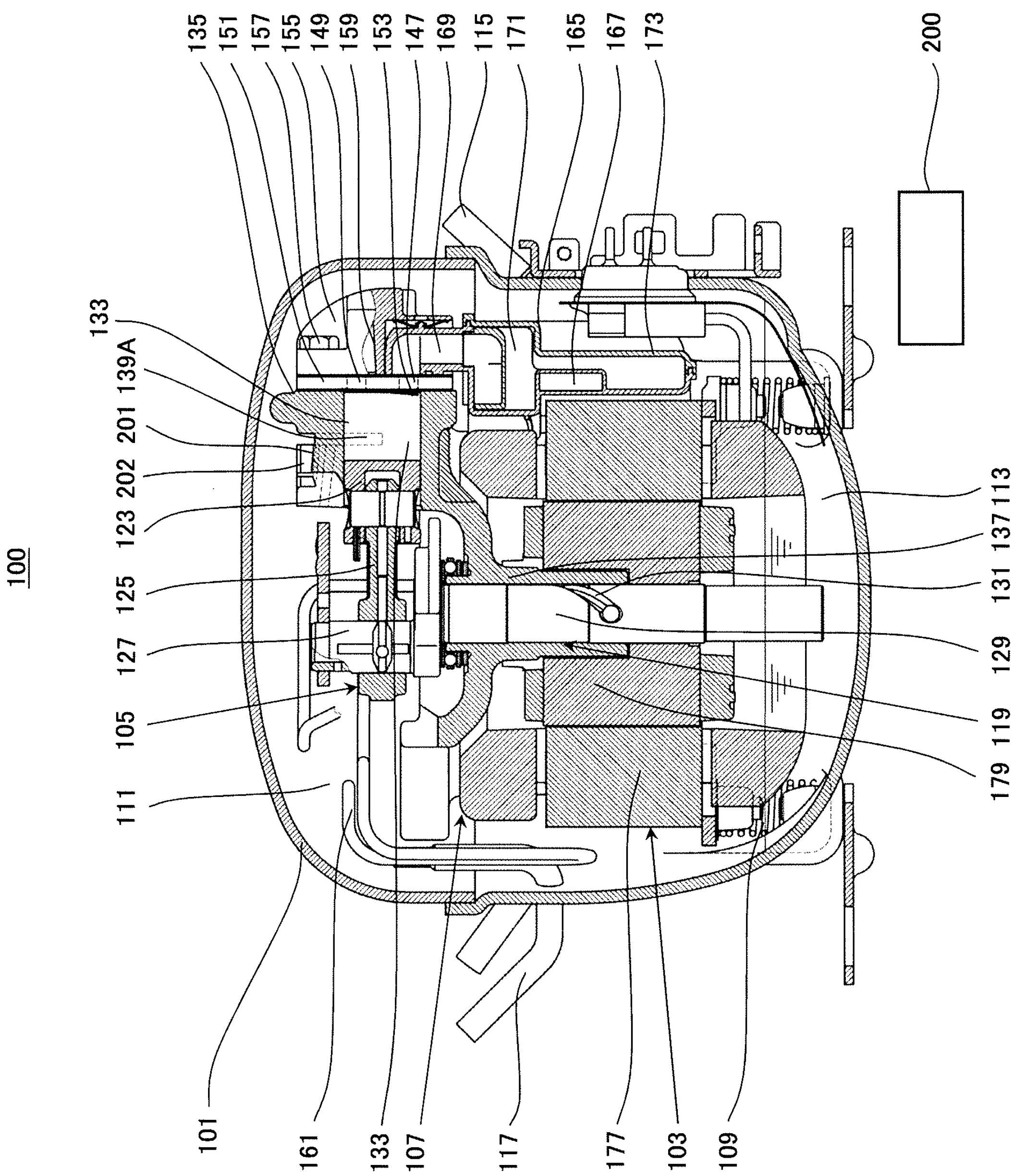
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Fig.9

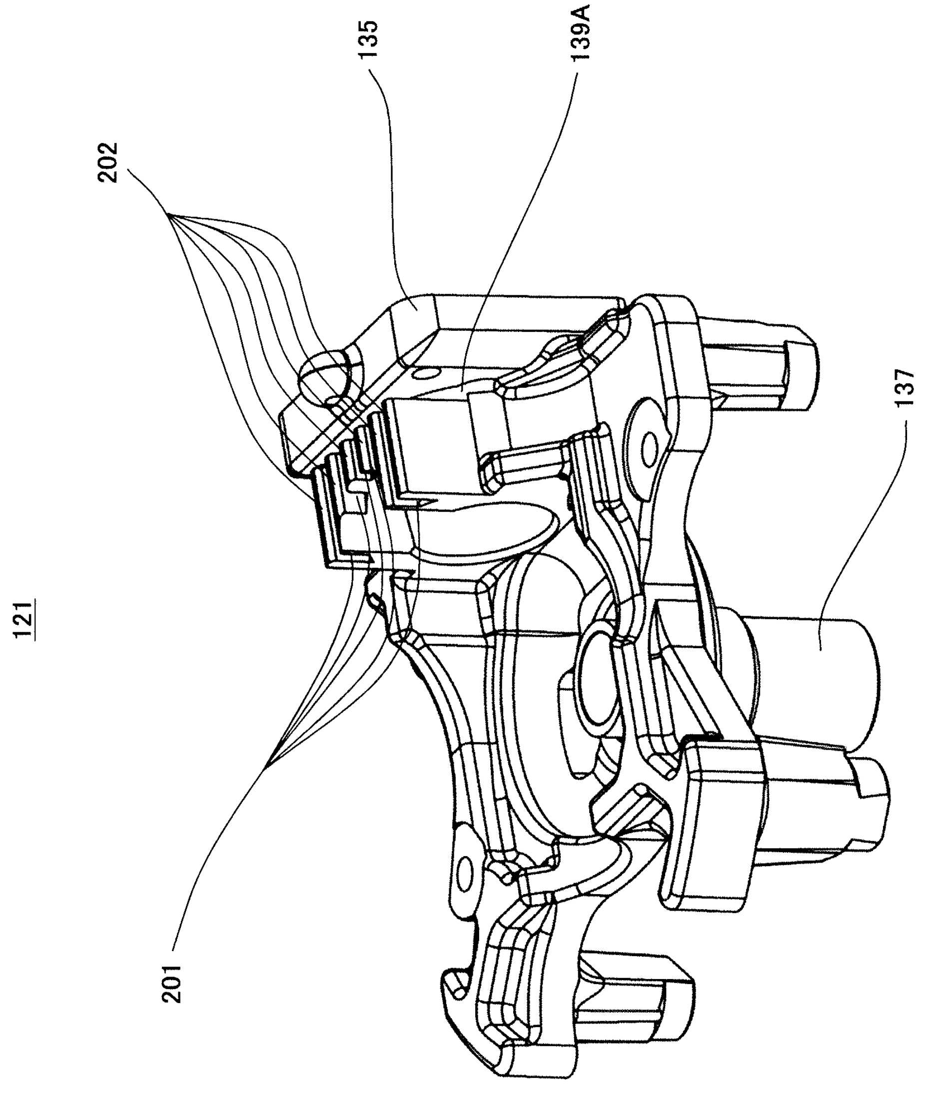

Fig.10

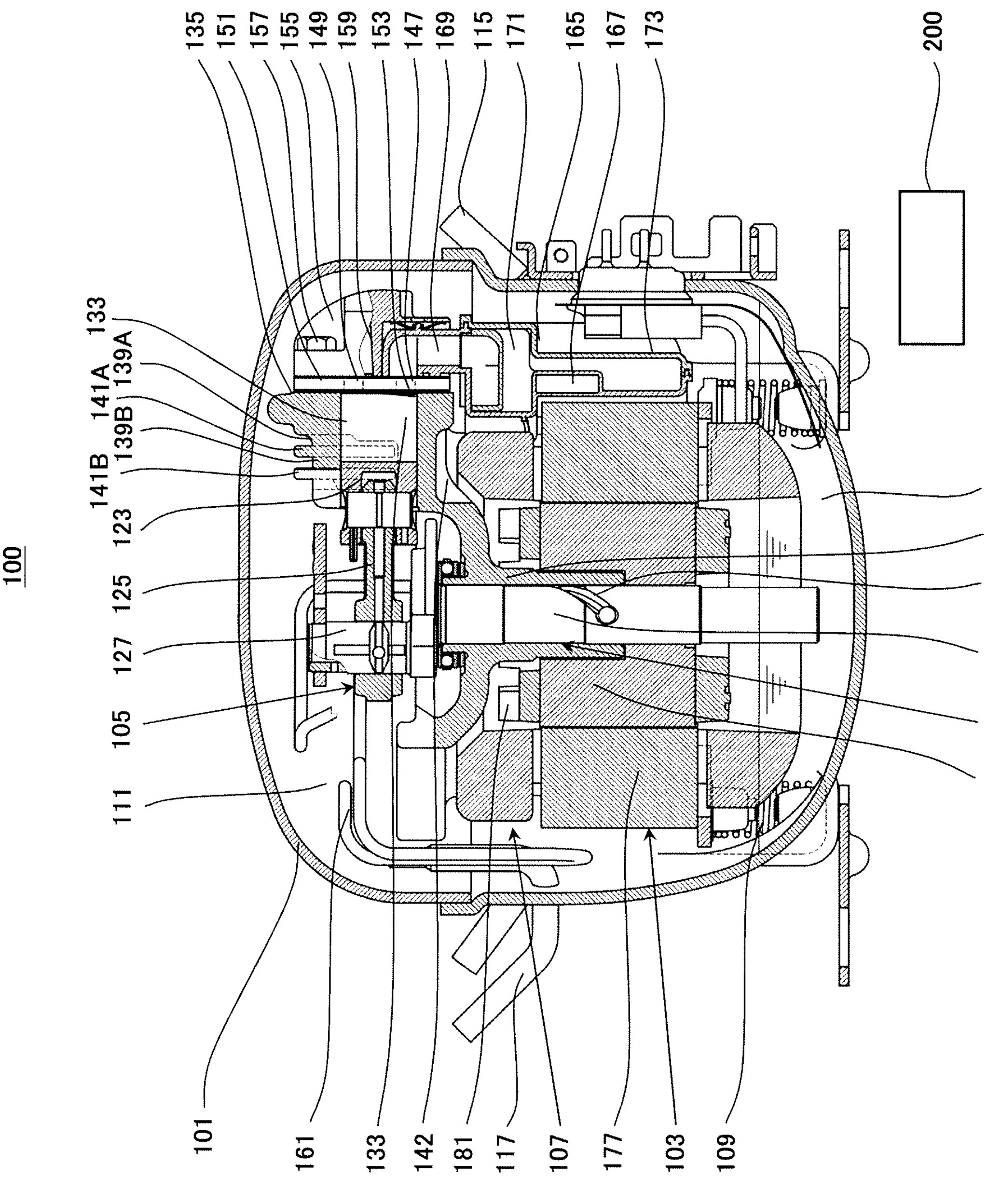
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Fig.11

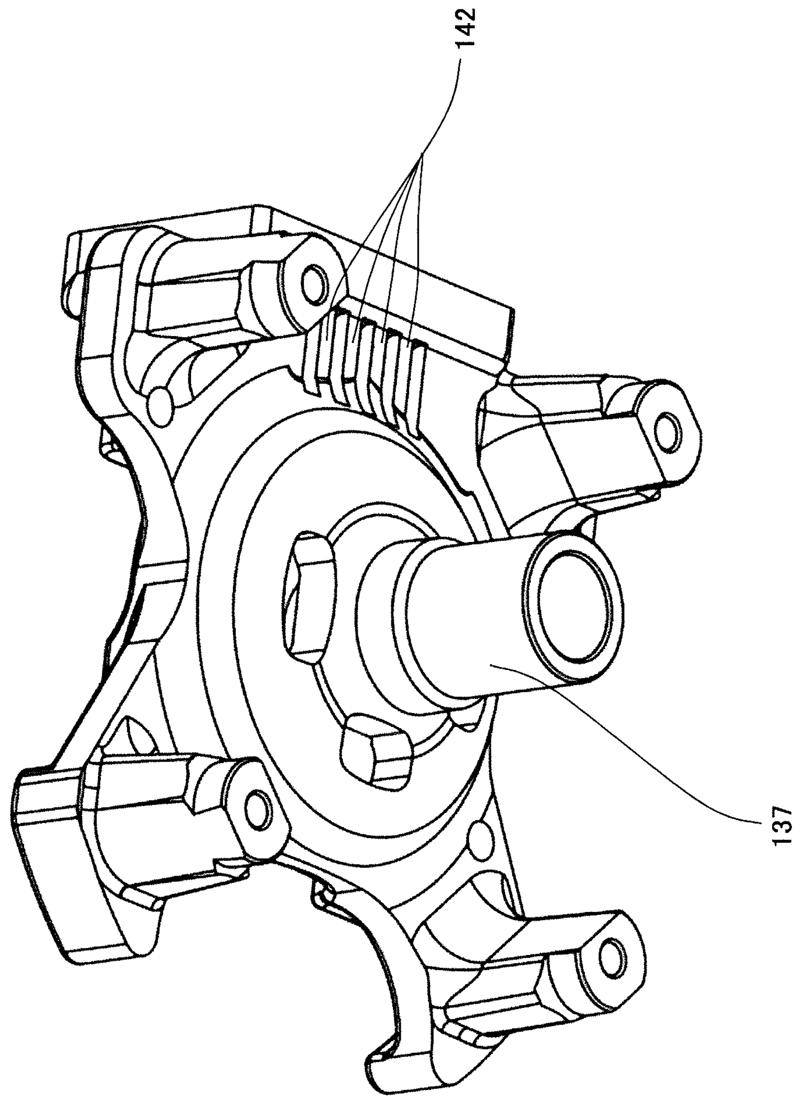

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Fig.12

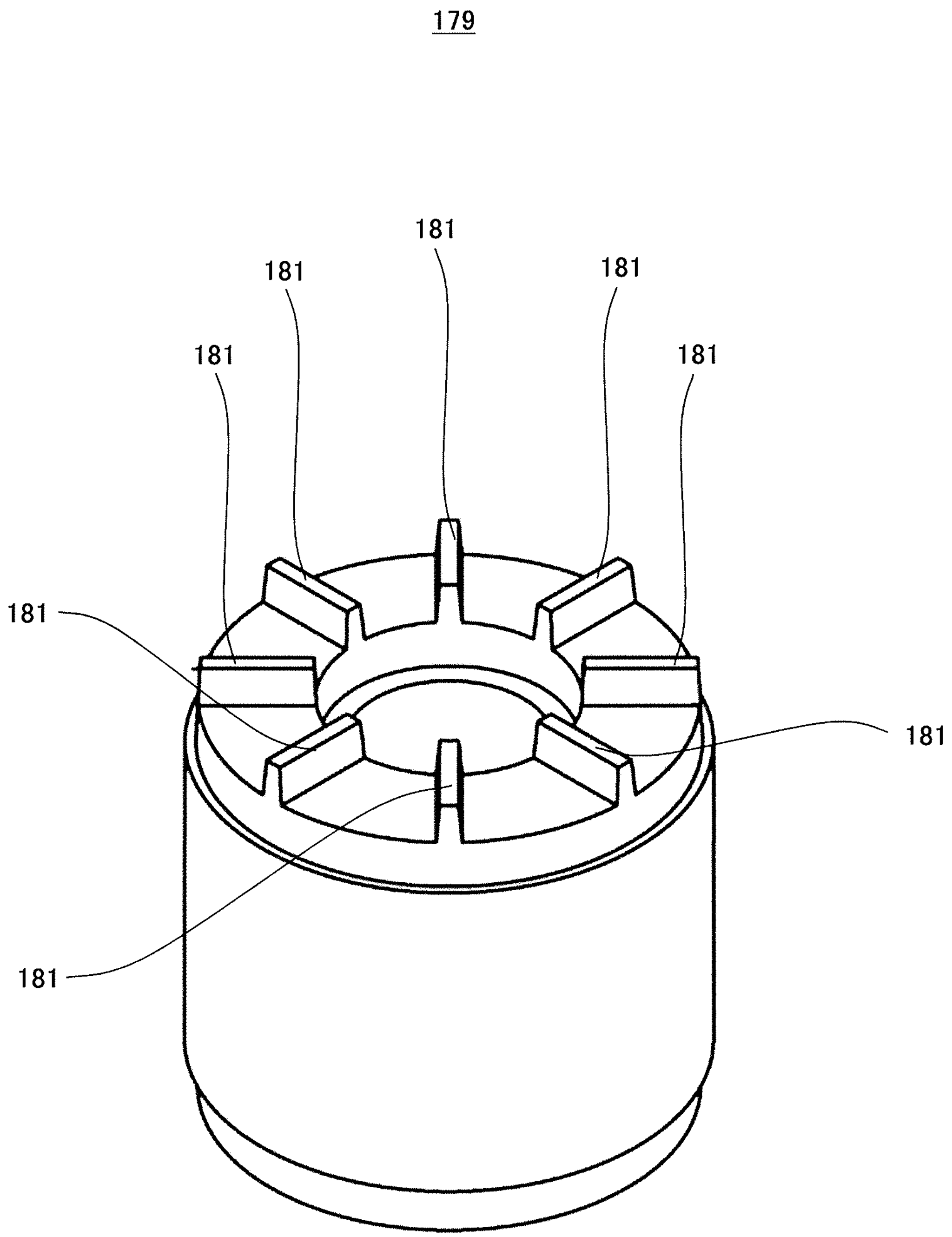

Fig.13

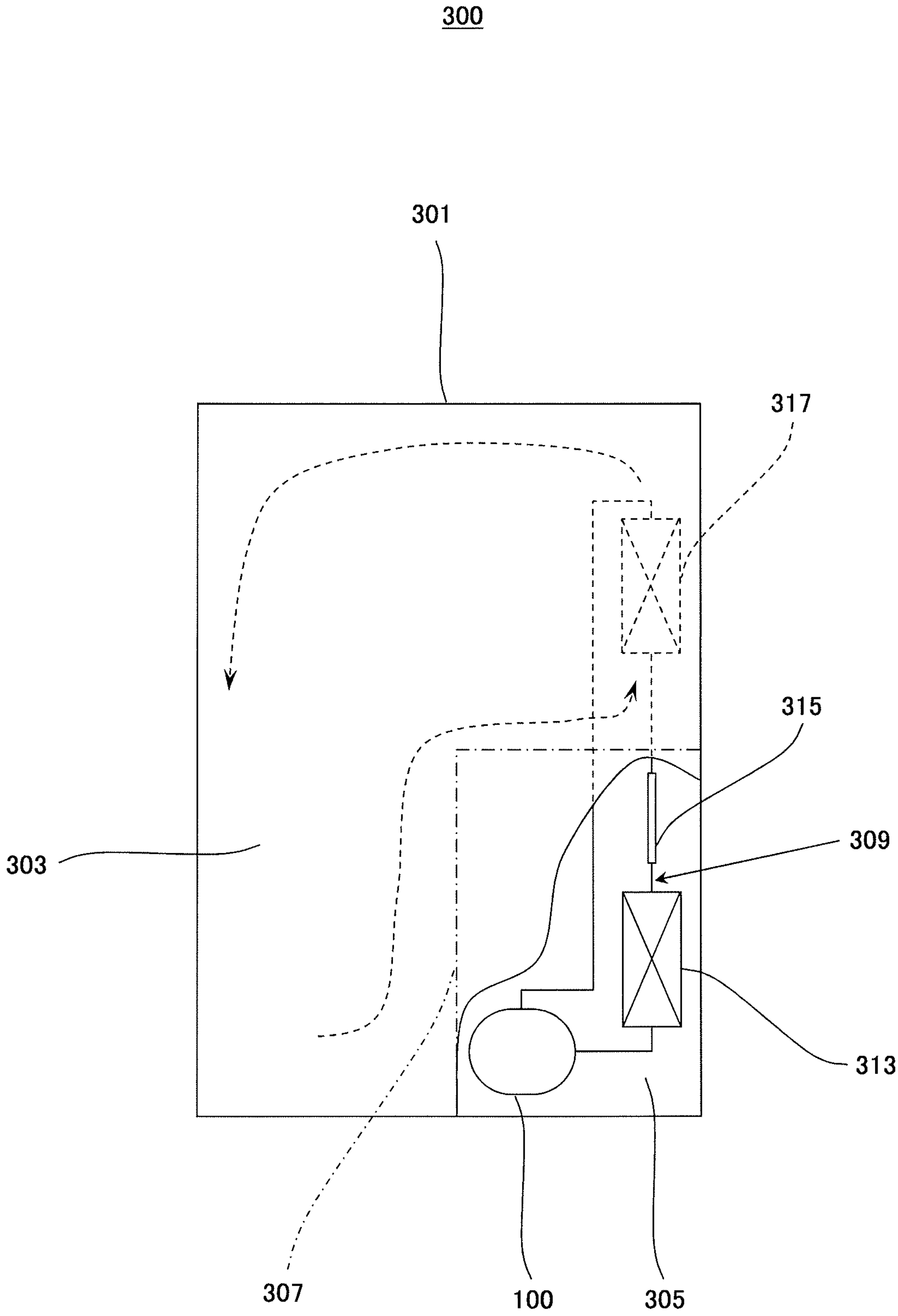

Fig.14

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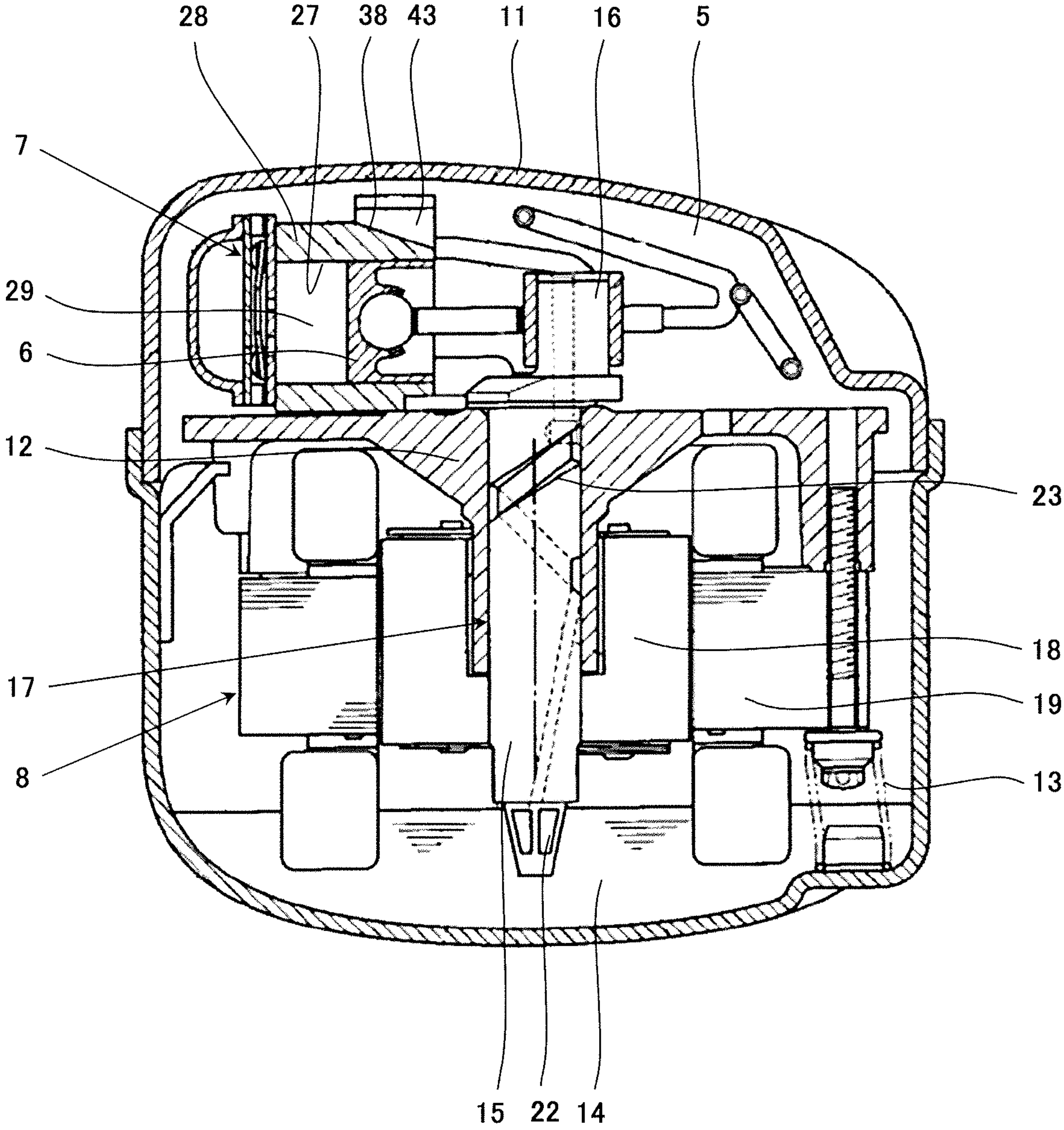

Fig.15

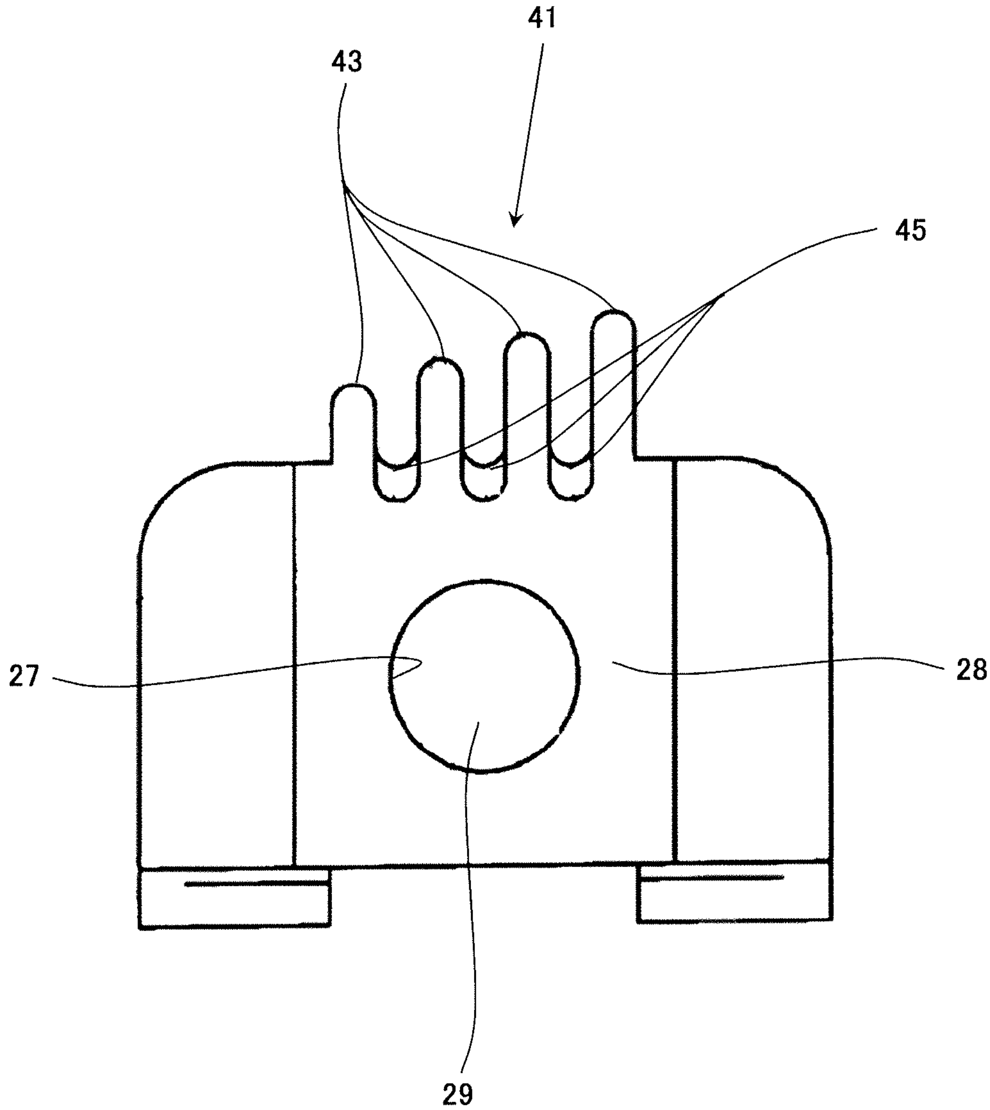

Fig.16

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2013/007639

A. CLASSIFICATION OF SUBJECT MATTER
F04B39/06(2006.01)i, *F04B39/02*(2006.01)i, *F04B39/12*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04B39/06, F04B39/02, F04B39/12

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2014
Kokai Jitsuyo Shinan Koho	1971-2014	Toroku Jitsuyo Shinan Koho	1994-2014

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2010-65589 A (Toshiba Carrier Corp.), 25 March 2010 (25.03.2010), fig. 1 to 2 (Family: none)	1-9
A	JP 54-137707 A (Hitachi, Ltd.), 25 October 1979 (25.10.1979), fig. 2 to 4 (Family: none)	1-9
A	JP 60-147581 A (Matsushita Refrigeration Co.), 03 August 1985 (03.08.1985), page 1, right column, line 11 to page 2, upper left column, line 8; fig. 2 (Family: none)	1-9

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

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 February, 2014 (27.02.14)	11 March, 2014 (11.03.14)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2013/007639

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2011-111987 A (Hitachi Appliances, Inc.), 09 June 2011 (09.06.2011), fig. 4 (Family: none)	1-9
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 25608/1984(Laid-open No. 139085/1985) (Toshiba Corp.), 13 September 1985 (13.09.1985), specification, page 4, line 1 to page 5, line 4; fig. 6 (Family: none)	1-9
A	EP 2500567 A1 (WHIRLPOOL S.A.), 19 September 2012 (19.09.2012), fig. 1, 4, 9 & US 2013/0045119 A1 & WO 2011/057373 A1 & BRA PI0904785 & CN 102667157 A & KR 10-2012-0103605 A	1-9

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Patent documents cited in the description

- JP 2010065589 A **[0011]**