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(71) Applicant: **Mitsubishi Heavy Industries, Ltd.**
Tokyo 108-8215 (JP)

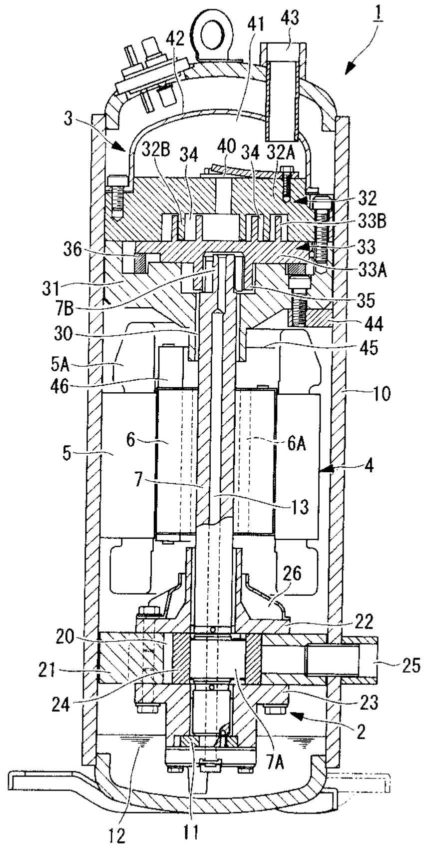
(72) Inventors:
- **SATO, Hajime**
Nagoya-shi
Aichi 453-8515 (JP)
- **KIMATA, Yoshiyuki**
Kiyosu-shi
Aichi 452-8561 (JP)

(74) Representative: **Intès, Didier Gérard André et al**
Cabinet Beau de Loménie
158, rue de l'Université
75340 Paris Cedex 07 (FR)

(54) **MULTIPLE-STAGE COMPRESSOR**

(57) The amount of lubricating oil to be sucked into a high-stage compression mechanism by being entrained in intermediate-pressure refrigerant gas discharged from a low-stage compression mechanism is reduced to reduce the oil circulation ratio, thereby enhancing system efficiency and eliminating a shortage of lubricating oil. In a multistage compressor in which an electric motor is mounted at substantially the center in a sealed housing, a low-stage compression mechanism and a high-stage compression mechanism which are driven by the electric motor via a rotating shaft are mounted below and above the electric motor, with the electric motor therebetween, and two-stage compression is performed by discharging intermediate-pressure refrigerant gas compressed by the low-stage compression mechanism into the sealed housing and then sucking the intermediate-pressure refrigerant gas into the high-stage compression mechanism, a first oil separation plate that centrifugally separates lubricating oil contained in the intermediate-pressure refrigerant gas that is to be sucked into the high-stage compression mechanism after circulating in the electric motor is provided so as to pass through a bearing that supports one end of the rotating shaft.

FIG. 1



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Description

{Technical Field}

[0001] The present invention relates to a multistage compressor in which a low-stage compression mechanism and a high-stage compression mechanism which are driven by an electric motor are mounted in a sealed housing.

{Background Art}

[0002] As an example of the multistage compressor equipped with a low-stage compression mechanism and a high-stage compression mechanism driven by an electric motor in a sealed housing, a multistage compressor is disclosed in Patent Literature 1 which is configured such that the electric motor is disposed at substantially the center in the sealed housing, the low-stage rotary compression mechanism and the high-stage scroll compression mechanism are disposed above and below the electric motor, with the electric motor therebetween, and the low-stage rotary compression mechanism and the high-stage scroll compression mechanism are driven by the electric motor via a rotating shaft.

[0003] The multistage compressor described above is configured to perform two-stage compression by taking in low-pressure refrigerant gas from a refrigerating cycle side to the low-stage rotary compression mechanism through an intake tube and compressing the gas to an intermediate pressure, thereafter temporarily discharging this intermediate-pressure refrigerant gas into the sealed housing, sucking the intermediate-pressure refrigerant gas with the high-stage scroll compression mechanism, compressing the gas into a high-temperature, high-pressure state, and discharging the gas to the outside through a discharge tube; thus, the interior of the sealed housing is an intermediate-pressure refrigerant gas atmosphere.

{Citation List}

{Patent Literature}

[0004] {PTL 1} Japanese Unexamined Patent Application, Publication No. Hei 5-87074 {Summary of Invention}

{Technical Problem}

[0005] In the multistage compressor described above, the intermediate-pressure refrigerant gas discharged into the sealed housing is in an oil-rich state, in which lubricating oil that was used to lubricate the low-stage rotary compression mechanism and was thereafter discharged into the sealed housing together with the refrigerant gas, lubricating oil that lubricated the high-stage scroll compression mechanism and thereafter dripped from the high-stage scroll compression mechanism into the sealed housing, etc. dissolve in large quantities. This intermediate-pressure refrigerant gas flows into the upper space of the electric motor through the inner passage of the electric motor and is then guided to an intake port of the high-stage scroll compression mechanism, during which a considerable amount of lubricating oil is separated due to collision with various components.

[0006] However, a large quantity of lubricating oil dissolves in the intermediate-pressure refrigerant gas in the sealed housing as described above, and the lubricating oil is sucked into the high-stage scroll compression mechanism together with the refrigerant gas, without sufficiently being separated. This lubricating oil is discharged from the high-stage scroll compression mechanism by being entrained in the compressed refrigerant gas and is circulated to the refrigerating cycle side. This results in an increase in the oil circulation ratio (OCR) of the lubricating oil circulated to the refrigerating cycle side, that is, the ratio of the mass flow rate of the lubricating oil to the total mass flow rate (refrigerant flow rate + lubricating-oil flow rate), which poses problems, such as decreasing the system efficiency by obstructing heat exchange at the refrigerating cycle side and the risk of a shortage of lubricating oil at the compressor side.

[0007] The present invention is made in consideration of such circumstances, and it is an object thereof to provide a multistage compressor in which the amount of lubricating oil sucked into the high-stage compression mechanism by being entrained in the intermediate-pressure refrigerant gas discharged from the low-stage compression mechanism is reduced to reduce the oil circulation ratio, thereby enhancing system efficiency and eliminating the problem of a shortage of lubricating oil.

{Solution to Problem}

[0008] To solve the problems described above, the present invention, adopts the following solutions.
A multistage compressor according to a first aspect of the present invention is a multistage compressor in which an electric motor is mounted at substantially the center in a sealed housing, a low-stage compression mechanism and a high-stage compression mechanism which are driven by the electric motor via a rotating shaft are mounted below and above the electric motor, with the electric motor therebetween, and two-stage compression is performed by discharging intermediate-pressure refrigerant gas compressed by the low-stage compression mechanism into the sealed housing and then sucking the intermediate-pressure refrigerant gas into the high-stage compression mechanism, wherein a first oil separation plate that centrifugally separates lubricating oil contained in the intermediate-pressure refrigerant gas that is to be sucked into the high-stage compression mechanism after circulating in the electric motor is provided so as to pass through a bearing that supports one end of the rotating shaft.

[0009] With the multistage compressor according to the first aspect of the present invention, lubricating oil that dissolves in intermediate-pressure refrigerant gas discharged from the low-stage compression mechanism, circulated in the electric motor, and thereafter sucked into the high-stage compression mechanism can be centrifugally separated by the first oil separation plate provided so as to pass through the bearing that supports one end of the rotating shaft and rotating with the rotor to thereby reduce the amount of lubricating oil contained in the intermediate-pressure refrigerant gas and can be thereafter sucked into the high-stage compression mechanism. This can reduce the amount of lubricating oil that is sucked into the high-stage compression mechanism by being entrained in the intermediate-pressure refrigerant gas and that is discharged to the outside together with the high-pressure compressed gas. This can therefore reduce the oil circulation ratio (OCR) of the lubricating oil circulated to the refrigerating cycle side, that is, the ratio of the mass flow rate of the lubricating oil to the total-mass flow rate (refrigerant flow rate + lubricating-oil flow rate), thereby enhancing system efficiency and eliminating the occurrence of a shortage of lubricating oil in the compressor.

[0010] In the multistage compressor according to the first aspect described above, it is more preferable that a second oil separation plate that centrifugally separates lubricating oil contained in the intermediate-pressure refrigerant gas that is to be sucked into the high-stage compression mechanism after circulating in the electric motor be provided at one end of the rotating shaft so as to pass through the rotating shaft.

[0011] With such a multistage compressor, lubricating oil that dissolves in intermediate-pressure refrigerant gas discharged from the low-stage compression mechanism, circulated in the electric motor, and thereafter sucked into the high-stage compression mechanism can be centrifugally separated by the first oil separation plate provided so as to pass through the bearing that supports one end of the rotating shaft and rotating with the rotor and the second oil separation plate provided at one end of the rotating shaft so as to pass through the rotating shaft and rotating with the rotor to thereby reduce the amount of lubricating oil contained in the intermediate-pressure refrigerant gas and thereafter can be sucked into the high-stage compression mechanism. This can further reduce the amount of lubricating oil that is sucked into the high-stage compression mechanism by being entrained in the intermediate-pressure refrigerant gas and is discharged to the outside together with the high-pressure compressed gas. Thus, this can further reduce the oil circulation ratio (OCR) of the lubricating oil circulated to the refrigerating cycle side, that is, the ratio of the mass flow rate of the lubricating oil to the total-mass flow rate (refrigerant flow rate + lubricating-oil flow rate), thereby further enhancing system efficiency and eliminating the occurrence of a shortage of lubricating oil in the compressor.

[0012] In the multistage compressor according to the first aspect described above, it is more preferable that a collision plate with which the intermediate-pressure refrigerant gas that is to be sucked into the high-stage compression mechanism after circulating in the electric motor collides be provided so as to pass through a bearing that supports one end of the rotating shaft.

[0013] With such a multistage compressor, lubricating oil that dissolves in intermediate-pressure refrigerant gas discharged from the low-stage compression mechanism, circulated in the electric motor, and thereafter sucked into the high-stage compression mechanism can be made to collide with the collision plate provided so as to pass through the bearing that supports one end of the rotating shaft, thereafter can be centrifugally separated by the first oil separation plate provided so as to pass through the bearing that supports one end of the rotating shaft and rotating with the rotor to thereby reduce the amount of lubricating oil contained in the intermediate-pressure refrigerant gas, and thereafter can be sucked into the high-stage compression mechanism. This can further reduce the amount of lubricating oil that is sucked into the high-stage compression mechanism by being entrained in the intermediate-pressure refrigerant gas and is discharged to the outside together with the high-pressure compressed gas. Thus, this can further reduce the oil circulation ratio (OCR) of the lubricating oil circulated to the refrigerating cycle side, that is, the ratio of the mass flow rate of the lubricating oil to the total-mass flow rate (refrigerant flow rate + lubricating-oil flow rate), thereby further enhancing system efficiency and eliminating the occurrence of a shortage of lubricating oil in the compressor.

[0014] A multistage compressor according to a second aspect of the present invention is a multistage compressor, in which an electric motor is mounted at substantially the center in a sealed housing, a low-stage compression mechanism and a high-stage compression mechanism which are driven by the electric motor via a rotating shaft are mounted below and above the electric motor, with the electric motor therebetween, and two-stage compression is performed by discharging intermediate-pressure refrigerant gas compressed by the low-stage compression mechanism into the sealed housing and then sucking the intermediate-pressure refrigerant gas into the high-stage compression mechanism, wherein an oil separation plate that centrifugally separates lubricating oil contained in the intermediate-pressure refrigerant gas that is to be sucked into the high-stage compression mechanism after circulating in the electric motor is provided at one end of the rotating shaft so as to pass through the rotating shaft.

[0015] With the multistage compressor according to the second aspect of the present invention, lubricating oil that dissolves in intermediate-pressure refrigerant gas discharged from the low-stage compression mechanism, circulated in the electric motor, and thereafter sucked into the high-stage compression mechanism can be centrifugally separated by the oil separation plate provided at one end of the rotating shaft so as to pass through the rotating shaft and rotating with the rotor to thereby reduce the amount of lubricating oil contained in the intermediate-pressure refrigerant gas and can be thereafter sucked into the high-stage compression mechanism. This can reduce the amount of lubricating oil that is sucked into the high-stage compression mechanism by being entrained in the intermediate-pressure refrigerant gas and that is discharged to the outside together with the high-pressure compressed gas. This can therefore reduce the oil circulation ratio (OCR) of the lubricating oil circulated to the refrigerating cycle side, that is, the ratio of the mass flow rate of the lubricating oil to the total-mass flow rate (refrigerant flow rate + lubricating-oil flow rate), thereby enhancing system efficiency and eliminating the occurrence of a shortage of lubricating oil in the compressor.

{Advantageous Effects of Invention}

[0016] With the multistage compressor according to the present invention, since the amount of lubricating oil that is sucked into the high-stage compression mechanism by being entrained in the intermediate-pressure refrigerant gas and that is discharged to the outside together with the high-pressure compressed gas can be reduced, the multistage compressor offers the advantage of reducing the oil circulation ratio (OCR) of the lubricating oil circulated to the refrigerating cycle side, thereby enhancing system efficiency and eliminating the occurrence of a shortage of lubricating oil in the compressor.

{Brief Description of Drawings}

[0017]

{Fig. 1} Fig. 1 is a vertical sectional view of a multistage compressor according to a first embodiment of the present invention.
{Fig. 2} Fig. 2 is an enlarged vertical sectional view of a relevant part of the multistage compressor shown in Fig. 1.
{Fig. 3} Fig. 3 is an enlarged vertical sectional view of a relevant part of a multistage compressor according to a second embodiment of the present invention.
{Fig. 4} Fig. 4 is an enlarged vertical sectional view of a relevant part of a multistage compressor according to a third embodiment of the present invention.

{Description of Embodiments}

[0018] A first embodiment of a multistage compressor according to the present invention will be described hereinbelow with reference to Figs. 1 and 2.
Fig. 1 illustrates a vertical sectional view of a refrigerating and air-conditioning multistage compressor 1 equipped with a low-stage compression mechanism 2 and a high-stage compression mechanism 3. In this embodiment, the multistage compressor 1 configured using a rotary compression mechanism as the low-stage compression mechanism 2 and a scroll compression mechanism as the high-stage compression mechanism 3 is described as a concrete example for convenience; however, the low-stage compression mechanism 2 and the high-stage compression mechanism 3 are not limited to the foregoing compression mechanisms.

[0019] As shown in Fig. 1 or 2, the multistage compressor 1 is provided with a sealed housing 10. An electric motor 4 constituted by a stator 5 and a rotor 6 is fixed at substantially the center in the sealed housing 10. A rotating shaft (crankshaft) 7 is integrally joined to the rotor 6. The low-stage rotary compression mechanism 2 is mounted below the electric motor 4. The low-stage rotary compression mechanism 2 is constituted by a known rotary compression mechanism equipped with a cylinder main body 21 having a cylinder chamber 20 and fixed in the sealed housing 10; an upper bearing 22 and a lower bearing 23 that are fixed on the top and bottom of the cylinder main body 21 to seal the top and bottom of the cylinder chamber 20; a rotor 24 fitted on a crank 7A of the rotating shaft 7 and rotating along the inner peripheral surface of the cylinder chamber 20; a blade (not shown) that partitions the interior of the cylinder chamber 20 into a sucking side and a discharge side; a blade presser spring, etc.

[0020] This low-stage rotary compression mechanism 2 is configured to suck low-pressure refrigerant gas (working gas) into the cylinder chamber 20 through an intake tube 25, to compress this refrigerant gas to intermediate pressure by the rotation of the rotor 24, and to thereafter discharge the refrigerant gas into the sealed housing 10 through a discharge chamber 26. This intermediate-pressure refrigerant gas is compressed in two stages in such a manner as to flow into a space above the electric motor 4 through a gas passage hole 6A etc. provided in the rotor 6 of the electric motor 4 and is further sucked into the high-stage scroll compression mechanism 3.

[0021] The high-stage scroll compression mechanism 3 is constituted by a known scroll compression mechanism equipped with a support member 31 (also referred to as a frame member or a bearing member) having a bearing 30 that supports the rotating shaft (crank shaft) 7 and fixed in the sealed housing 10; a fixed scroll member 32 and a rotating scroll member 33 having spiral laps 32B and 33B vertically erected on end plates 32A and 33A, respectively, and constituting a pair of compression chambers 34 by being mounted on the support member 31 by engaging the spiral laps 32B and 33B with each other; a rotating boss 35 that joins the rotating scroll member 33 and an eccentric pin 7B provided at the axial end of the rotating shaft 7 together to drive the rotating scroll member 33 so as to revolve; a rotation stopping mechanism 36, such as an Oldham ring, provided between the rotating scroll member 33 and the support member 31 to revolve the rotating scroll member 33 while stopping its rotation on its axis; a discharge valve 40 provided at the back of the fixed scroll member 32; a discharge cover 42 fixed at the back of the fixed scroll member 32 to form a discharge chamber 41 between the discharge cover 42 and the fixed scroll member 32; etc.

[0022] The high-stage scroll compression mechanism 3 described above is configured to suck the intermediate-pressure refrigerant gas that is compressed by the low-stage rotary compression mechanism 2 and is discharged into the sealed housing 10 into the compression chamber 34, to compress this intermediate-pressure refrigerant gas into a high-temperature, high-pressure state by being driven to revolve by the rotating scroll member 33, and to discharge the refrigerant gas into the discharge chamber 41 through the discharge valve 40. This high-temperature, high-pressure refrigerant gas is led out from the discharge chamber 41 through the discharge tube 43 to the outside of the compressor, that is, to the refrigerating cycle side. The above-described support member 31 constituting the high-stage scroll compression mechanism 3 is fixed to a bracket 44 provided in the sealed housing 10 with a screw.

[0023] Furthermore, a known positive displacement oil pump 11 is mounted between the lowermost end of the rotating shaft (crankshaft) 7 and the lower bearing 23 of the low-stage rotary compression mechanism 2. This oil pump 11 is configured to pump up lubricating oil 12 filling on the bottom of the sealed housing 10 and to forcibly supply the lubricating oil 12 to required lubrication portions, such as the bearings of the low-stage rotary compression mechanism 2 and the high-stage scroll compression mechanism 3, through an oil supply hole 13 provided in the rotating shaft 7.

[0024] Furthermore, an oil separation plate (first oil separation plate) 45 that is rotated together with the rotor 6 is provided at the upper end of the rotor 6 that constitutes the electric motor 4. This oil separation plate 45 is constituted by a disc mounted on a balance weight 46 provided at the upper end of the rotor 6 (mounted with a spacer or the like therebetween if there is no balance weight). The outside diameter of this oil separation plate 45 is set at a size to keep a slight gap G1 from the inner peripheral surface of a stator-coil end 5A of the electric motor 4, and the inside diameter of the oil separation plate 45 is set at a size to keep a slight gap G2 from the outer peripheral surface of the bearing 30 protruding from the center of the support member 31 downward (toward the rotor 6). The height of the balance weighs 46 is set so that, with the oil separation plate 45 mounted at the upper end thereof, the oil separation plate 45 is located higher than the lower end of the bearing 30 and lower than the upper end of the stator-coil end 5A.

[0025] With the configuration described above, this embodiment offers the following operational advantages. Low-temperature low-pressure refrigerant gas sucked into the cylinder chamber 20 of the low-stage rotary compression mechanism 2 through the intake tube 25 is compressed to intermediate pressure by the rotation of the rotor 24 and is thereafter discharged into the discharge chamber 26. This intermediate-pressure refrigerant gas is discharged from the discharge chamber 26 into a space below the electric motor 4 and is thereafter sent to the space above the electric motor 4 through the gas passage hole 6A etc. provided in the rotor 6 of the electric motor 4.

[0026] The intermediate-pressure refrigerant gas that has flowed into the space above the electric motor 4 passes through a gap between the support member 31 that constitutes the high-stage scroll compression mechanism 3 and the sealed housing 10, etc., is guided to an intake port, of the high-stage scroll compression mechanism 3, which is provided in the fixed scroll member 32, and is sucked into the compression chamber 34. This intermediate-pressure refrigerant gas is compressed in two stages into a high-temperature, high-pressure state by the high-stage scroll compression mechanism 3, is thereafter discharged through the discharge valve 40 into the discharge chamber 41, and is led out of the compressor, that is, to the refrigerating cycle side through the discharge tube 43.

[0027] In the two-stage compression process described above, part of the lubricating oil 12 used to lubricate the low-stage rotary compression mechanism 2 dissolves into the refrigerant gas and is discharged into the sealed housing 10 together with the intermediate-pressure refrigerant gas. Furthermore, this intermediate-pressure refrigerant gas entrains and dissolves part of the lubricating oil 12 that is supplied to the high-stage scroll compression mechanism 3 through the oil supply hole 13 to lubricate the high-stage scroll compression mechanism 3, and is allowed to flow down to the bottom in the sealed housing 10. The intermediate-pressure refrigerant gas in which the lubricating oil 12 dissolves collides with the oil separation plate 45 rotating with the rotor 6 when flowing into the space above the electric motor 4 through the gas passage hole 6A of the rotor 6, and the lubricating oil 12 is separated from the intermediate-pressure refrigerant gas due to the centrifugal separating action thereof.

[0028] The lubricating oil 12 that is centrifugally separated as described above is guided to the outer periphery side of the stator-coil end 5A of the electric motor 4 through the gap therealong and is allowed to flow down to the bottom along the inner peripheral surface of the sealed housing 10. On the other hand, the intermediate-pressure refrigerant gas from which the lubricating oil 12 is separated is compressed in two stages in such a manner as to be allowed to flow through the gap G1 at the outer periphery side of the oil separation plate 45 (outside in the radial direction) into the space above the electric motor 4, from which the intermediate-pressure refrigerant gas is guided to the intake port of the high-stage scroll compression mechanism 3 and is sucked into the compression chamber 34.

[0029] On the other hand, part of the lubricating oil 12 supplied to the high-stage scroll compression mechanism 3 through the oil supply hole 13 passes between the rotating shaft 7 and the bearing 30 while lubricating the bearing 30 and drips toward the upper end face of the rotor 6. Part of the lubricating oil 12 that has dripped toward the upper end face of the rotor 6 collides with the upper end face of the rotor 6, and the lubricating oil 12 that is centrifugally separated by the centrifugal separating action thereof is guided to the outer periphery side of the stator-coil end 5A of the electric motor 4 through the gap therealong and is allowed to flow down to the bottom along the inner peripheral surface of the sealed housing 10. Furthermore, part of the lubricating oil 12 that has dripped toward the upper end face of the rotor 6 dissolves in the intermediate-pressure refrigerant gas that has circulated in the gas passage hole 6A of the rotor 6 and collides with the oil separation plate 45 rotating with the rotor 6, and the lubricating oil 12 is separated from the intermediate-pressure refrigerant gas by the centrifugal separating action thereof.

[0030] The lubricating oil 12 that is centrifugally separated as described above is guided to the outer periphery side of the stator-coil end 5A of the electric motor 4 through the gap therealong and is allowed to flow down to the bottom along the inner peripheral surface of the sealed housing 10. On the other hand, the intermediate-pressure refrigerant gas from which the lubricating oil 12 is separated is compressed in two stages in such a manner as to be allowed to flow through the gap G1 at the outer periphery side of the oil separation plate 45 (outside in the radial direction) into the space above the electric motor 4, from which the intermediate-pressure refrigerant gas is guided to the intake port of the high-stage scroll compression mechanism 3 and is sucked into the compression chamber 34.

[0031] Since the intermediate-pressure refrigerant gas from which the lubricating oil 12 is separated can be sucked into the high-stage scroll compression mechanism 3 in this manner, the amount of the lubricating oil 12 sucked into the high-stage scroll compression mechanism 3 by being entrained in the intermediate-pressure refrigerant gas and discharged to the outside together with the high-pressure compressed gas can be reduced. This can reduce the oil circulation ratio (OCR) of the lubricating oil 12 circulated to the refrigerating cycle side, that is, the ratio of the mass flow rate of the lubricating oil to the total-mass flow rate (refrigerant flow rate + lubricating-oil flow rate), thereby enhancing system efficiency and eliminating the occurrence of a shortage of lubricating oil in the compressor.

Furthermore, part of the lower end of the bearing 30 is located lower than the oil separation plate 45. That is, since part of the lower end of the bearing 30 is inserted in a hole 45a formed at the inner periphery side of the oil separation plate 45, the entire length of the rotating shaft 7 can be decreased, thereby decreasing the heightwise dimension of the multistage compressor 1.

[0032] A second embodiment of a multistage compressor according to the present invention will be described with reference to Fig. 3. Fig. 3 is an enlarged vertical sectional view of a relevant part of the multistage compressor according to the second embodiment of the present invention.

A multistage compressor 51 according to this embodiment differs from that of the above-described first embodiment in that it further includes an oil separation plate (second oil separation plate) 52. Since the other components are the same as those of the first embodiment described above, descriptions of those components will be omitted here.

[0033] As shown in Fig. 3, the multistage compressor 51 according to this embodiment is provided with the oil separation plate 52 in addition to the oil separation plate 45. This oil separation plate 52 is constituted by a disc that is located higher than the upper end face of the rotor 6 and lower than the lower end of the bearing 30 and that is mounted to the rotating shaft 7. The outside diameter of this oil separation plate 52 is set at a size to keep a slight gap G3 from the inner peripheral surface of the balance weight 46, and the inside diameter of the oil separation plate 45 is set to the same diameter as that of the outer peripheral surface of the rotating shaft 7. This oil separation plate 52 is mounted such that its inner peripheral surface is in contact (close contact) with the outer peripheral surface of the rotating shaft 7.

[0034] With the multistage compressor 51 according to this embodiment, the intermediate-pressure refrigerant gas that has circulated in the gas passage hole 6A of the rotor 6 collides with the oil separation plates 52 and 45 rotating with the rotor 6, and the lubricating oil 12 is separated from the intermediate-pressure refrigerant gas due to the centrifugal separating action thereof. The lubricating oil 12 that has been centrifugally separated due to the centrifugal separating action of the oil separation plates 52 and 45 is guided to the outer periphery side of the stator-coil end 5A of the electric motor 4 through the gap therealong and is allowed to flow down to the bottom along the inner peripheral surface of the sealed housing 10. On the other hand, the intermediate-pressure refrigerant gas from which the lubricating oil 12 is separated is compressed in two stages in such a manner as to be allowed to flow through the gap G1 at the outer periphery side of the oil separation plate 45 (outside in the radial direction) into the space above the electric motor 4, from which the intermediate-pressure refrigerant gas is guided to the intake port of the high-stage scroll compression mechanism 3 and is sucked into the compression chamber 34.

[0035] Since the intermediate-pressure refrigerant gas from which the lubricating oil 12 is separated can be sucked into the high-stage scroll compression mechanism 3 in this manner, the amount of the lubricating oil 12 sucked into the high-stage scroll compression mechanism 3 by being entrained in the intermediate-pressure refrigerant gas and discharged to the outside together with the high-pressure compressed gas can be reduced. This can reduce the oil circulation ratio (OCR) of the lubricating oil 12 circulated to the refrigerating cycle side, that is, the ratio of the mass flow rate of the lubricating oil to the total-mass flow rate (refrigerant flow rate + lubricating-oil flow rate), thereby enhancing system efficiency and eliminating the occurrence of a shortage of lubricating oil in the compressor.

Furthermore, part of the lower end of the bearing 30 is located lower than the oil separation plate 45. That is, since part of the lower end of the bearing 30 is inserted in the hole 45a formed at the inner periphery side of the oil separation plate 45, the entire length of the rotating shaft 7 can be decreased, thereby decreasing the height-wise dimension of the multistage compressor 51.

Furthermore, since the oil separation plate 52 is mounted to the rotating shaft 7 that significantly fluctuates in torque, the inertia force of the rotating body can be increased to thereby decrease fluctuations in torque.

[0036] A third embodiment of a multistage compressor according to the present invention will be described with reference to Fig. 4. Fig. 4 is an enlarged vertical sectional view of a relevant part of the multistage compressor according to the third embodiment of the present invention. A multistage compressor 61 according to this embodiment differs from that of the above-described first embodiment in that a collision plate 62 is provided at the lower end of the bearing 30. Since the other components are the same as those of the first embodiment described above, descriptions of those components will be omitted here.

[0037] As shown in Fig. 4, the multistage compressor 61 according to this embodiment is provided with the collision plate 62 in addition to the oil separation plate 45. This collision plate 62 is constituted by a disc that is located higher than the lower end of the bearing 30 and lower than the oil separation plate 45 and that is mounted to the bearing 30. The outside diameter of this collision plate 62 is set at a size to keep a slight gap G4 from the inner peripheral surface of the balance weight 46, and the inside diameter of the collision plate 62 is set to the same diameter as that of the outer peripheral surface of the lower end of the bearing 30. This collision plate 62 is mounted such that its inner peripheral surface is in contact (close contact) with the outer peripheral surface of the lower end of the bearing 30.

In this embodiment, the collision plate 62 is mounted at the lowermost end of the bearing 30.

[0038] With the multistage compressor 61 according to this embodiment, the intermediate-pressure refrigerant gas that has circulated in the gas passage hole 6A of the rotor 6 collides with the collision plate 62 mounted to the lower end of the bearing 30, and thereafter collides with the oil separation plate 45 rotating with the rotor 6, and the lubricating oil 12 is separated from the intermediate-pressure refrigerant gas due to its centrifugal separating action. The lubricating oil 12 that has been centrifugally separated due to the centrifugal separating action of the oil separation plate 45 is guided to the outer periphery side of the stator-coil end 5A of the electric motor 4 through the gap therealong and is allowed to flow down to the bottom along the inner peripheral surface of the sealed housing 10. On the other hand, the intermediate-pressure refrigerant gas from which the lubricating oil 12 is separated is compressed in two stages in such a manner as to be allowed to flow through the gap G1 at the outer periphery side of the oil separation plate 45 (outside in the radial direction) into the space above the electric motor 4, from which the intermediate-pressure refrigerant gas is guided to the intake port of the high-stage scroll compression mechanism 3 and is sucked into the compression chamber 34.

[0039] Since the intermediate-pressure refrigerant gas from which the lubricating oil 12 is separated can be sucked into the high-stage scroll compression mechanism 3 in this manner, the amount of the lubricating oil 12 sucked into the high-stage scroll compression mechanism 3 by being entrained in the intermediate-pressure refrigerant gas and discharged to the outside together with the high-pressure compressed gas can be reduced. This can reduce the oil circulation ratio (OCR) of the lubricating oil 12 circulated to the refrigerating cycle side, that is, the ratio of the mass flow rate of the lubricating oil to the total-mass flow rate (refrigerant flow rate + lubricating-oil flow rate), thereby enhancing system efficiency and eliminating the occurrence of a shortage of lubricating oil in the compressor.

Furthermore, part of the lower end of the bearing 30 is located lower than the oil separation plate 45. That is, since part of the lower end of the bearing 30 is inserted in the hole 45a formed at the inner periphery side of the oil separation plate 45, the entire length of the rotating shaft 7 can be decreased, thereby decreasing the height-wise dimension of the multistage compressor 61.

[0040] The present invention is not limited to the embodiments described above, and various modification and changes can be made without departing from the technical spirit of the present invention.

For example, in the second embodiment shown in Fig. 3, the oil separation plate 45 is not an essential component; only the oil separation plate 52 may be provided instead of the oil separation plate 45.

{Reference Signs List}

[0041]

1	multistage compressor
2	low-stage compression mechanism (low-stage rotary compression mechanism)
3	high-stage compression mechanism scroll compression mechanism)
4	electric motor
7	rotating shaft
10	sealed housing
12	lubricating oil
30	bearing
45	oil separation plate (first oil separation plate)

51 multistage compressor
52 oil separation plate (second oil separation plate)
61 multistage compressor
62 collision plate

Claims

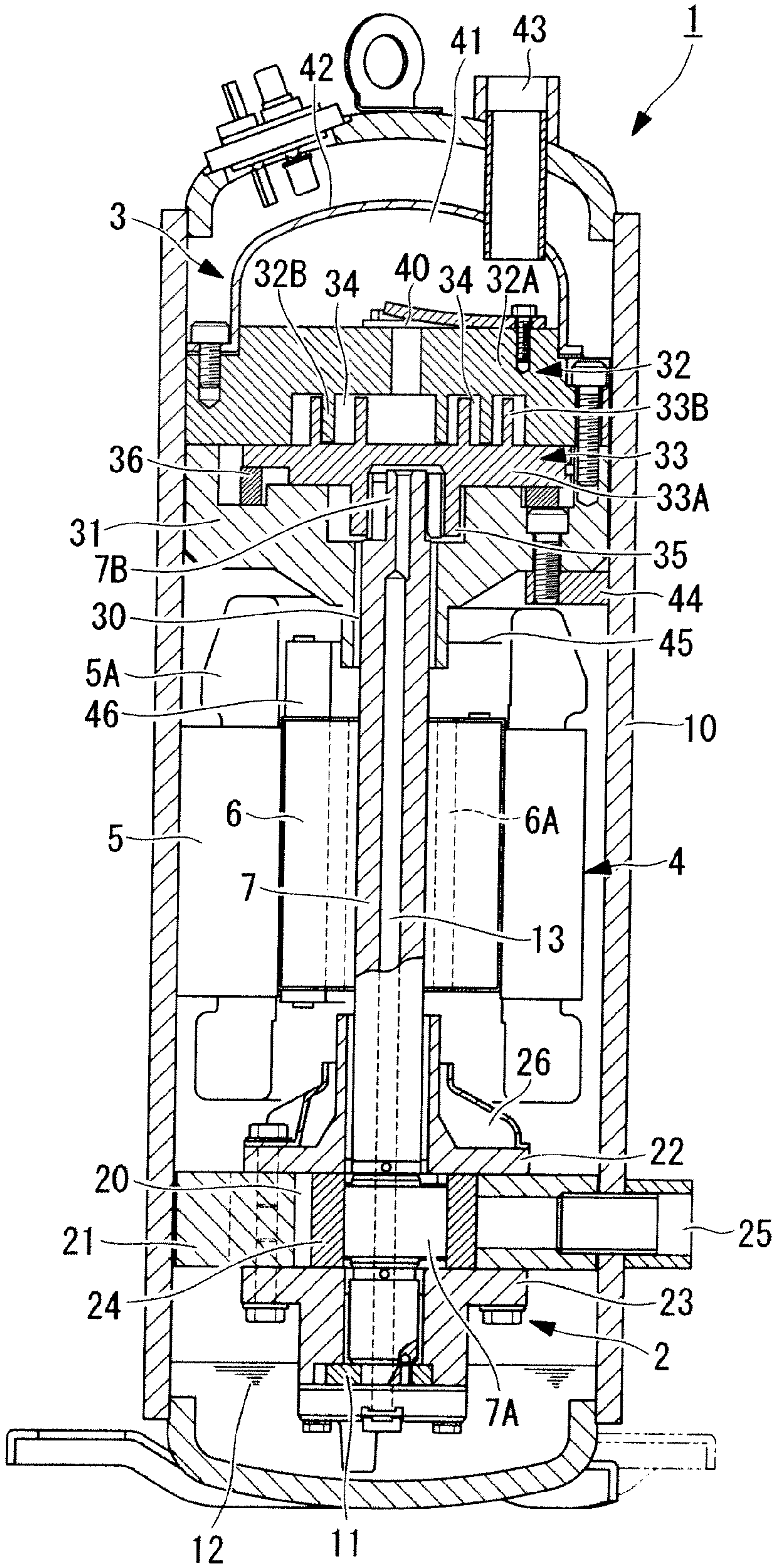
1. A multistage compressor in which an electric motor is mounted at substantially the center in a sealed housing, a low-stage compression mechanism and a high-stage compression mechanism which are driven by the electric motor via a rotating shaft are mounted below and above the electric motor, with the electric motor therebetween, and two-stage compression is performed by discharging intermediate-pressure refrigerant gas compressed by the low-stage compression mechanism into the sealed housing and then sucking the intermediate-pressure refrigerant gas into the high-stage compression mechanism, wherein
a first oil separation plate that centrifugally separates lubricating oil contained in the intermediate-pressure refrigerant gas that is to be sucked into the high-stage compression mechanism after circulating in the electric motor is provided so as to pass through a bearing that supports one end of the rotating shaft.

2. The multistage compressor according to Claim 1, wherein a second oil separation plate that centrifugally separates lubricating oil contained in the intermediate-pressure refrigerant gas that is to be sucked into the high-stage compression mechanism after circulating in the electric motor is provided at one end of the rotating shaft so as to pass through the rotating shaft.

3. The multistage compressor according to Claim 1, wherein a collision plate with which the intermediate-pressure refrigerant gas that is to be sucked into the high-stage compression mechanism after circulating in the electric motor collides is provided so as to pass through the bearing that supports one end of the rotating shaft.

4. A multistage compressor in which an electric motor is mounted at substantially the center in a sealed housing, a low-stage compression mechanism and a high-stage compression mechanism which are driven by the electric motor via a rotating shaft are mounted below and above the electric motor, with the electric motor therebetween, and two-stage compression is performed by discharging intermediate-pressure refrigerant gas compressed by the low-stage compression mechanism into the sealed housing and then sucking the intermediate-pressure refrigerant gas into the high-stage compression mechanism, wherein
an oil separation plate that centrifugally separates lubricating oil contained in the intermediate-pressure refrigerant gas that is to be sucked into the high-stage compression mechanism after circulating in the electric motor is provided at one end of the rotating shaft so as to pass through the rotating shaft.

FIG. 1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33B
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31
7B
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44
30
45
5A
46
10
6
6A
5
4
7
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22
20
25
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24
23
2
7A
12
11

FIG. 2

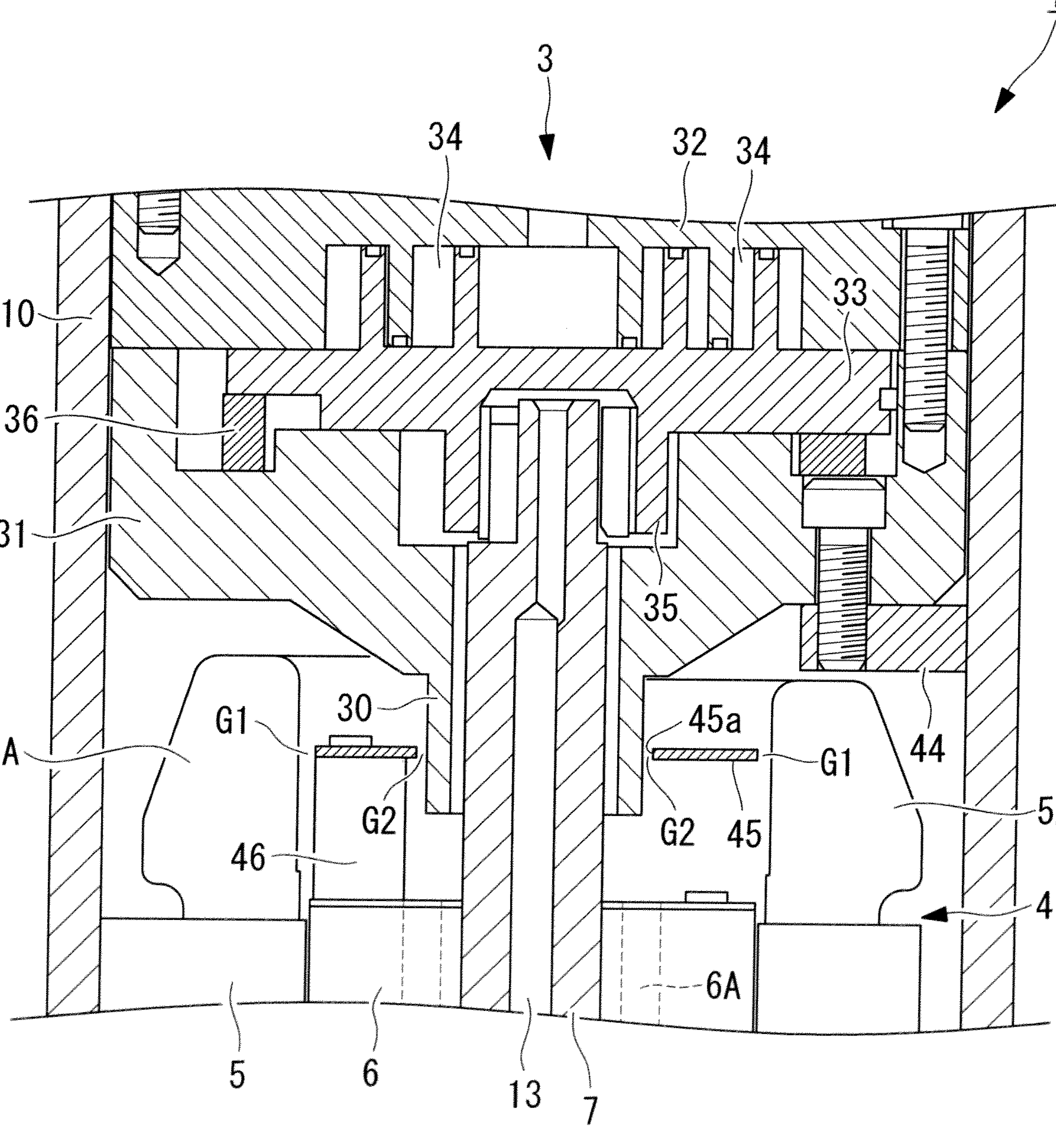
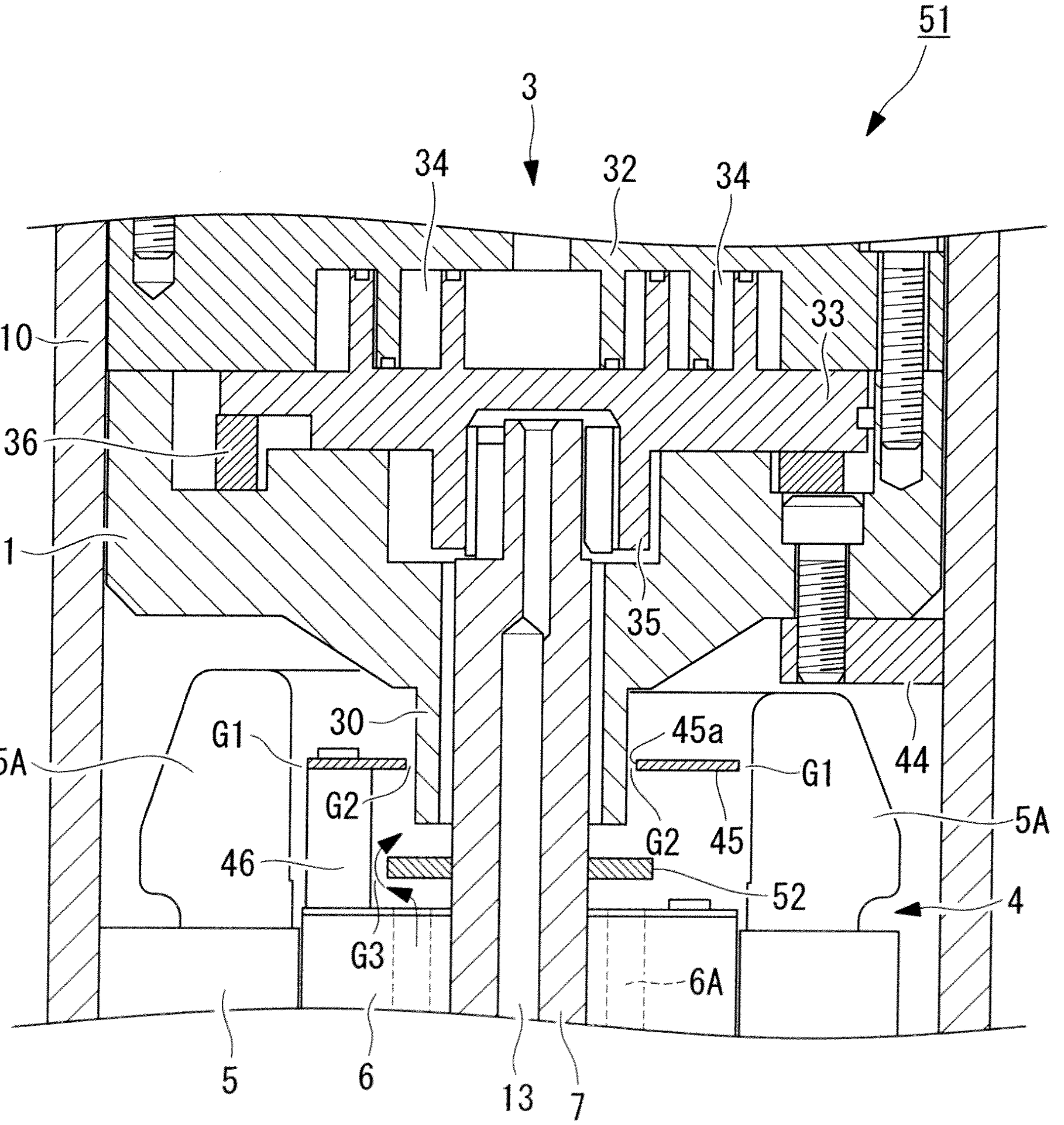


FIG. 3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G1
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G2
G1
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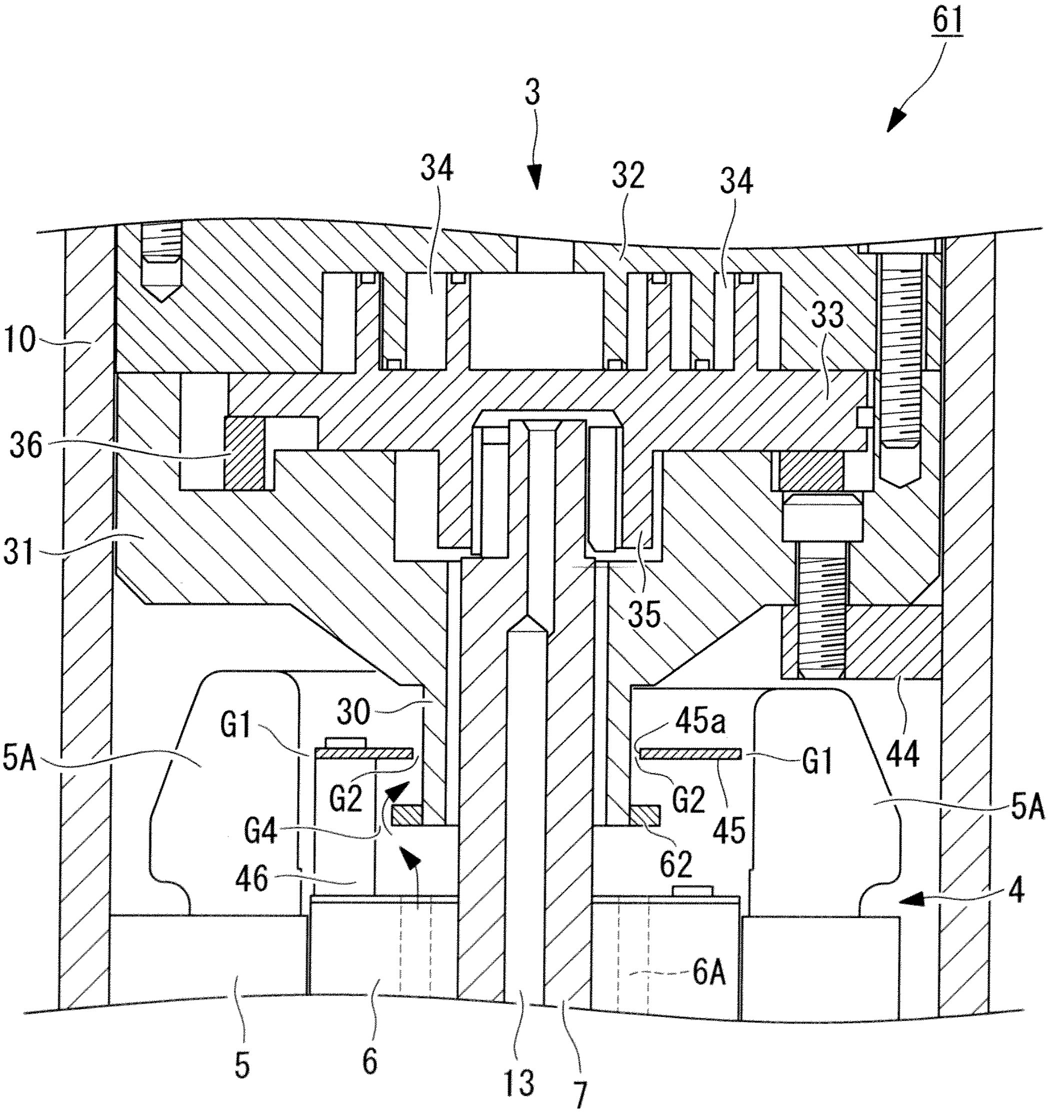
5A
G2
46
52
4
G3
6A
5
6
13
7

FIG. 4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G1
45a
5A
G1
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G2
G2
5A
G4
45
62
46
4
6A
5
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13
7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2009/068199

A. CLASSIFICATION OF SUBJECT MATTER
F04C23/00(2006.01)i, *F04B39/04*(2006.01)i, *F04C29/02*(2006.01)i

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

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
F04C23/00, F04B39/04, F04C29/02

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2010
Kokai Jitsuyo Shinan Koho	1971-2010	Toroku Jitsuyo Shinan Koho	1994-2010

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 2006-132377 A (Daikin Industries, Ltd.), 25 May 2006 (25.05.2006), entire text; all drawings (Family: none)	1-4
A	JP 11-107967 A (Sanyo Electric Co., Ltd.), 20 April 1999 (20.04.1999), entire text; all drawings (Family: none)	1-4

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

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Date of the actual completion of the international search 13 January, 2010 (13.01.10)	Date of mailing of the international search report 26 January, 2010 (26.01.10)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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Patent documents cited in the description

- JP HEI587074 B **[0004]**