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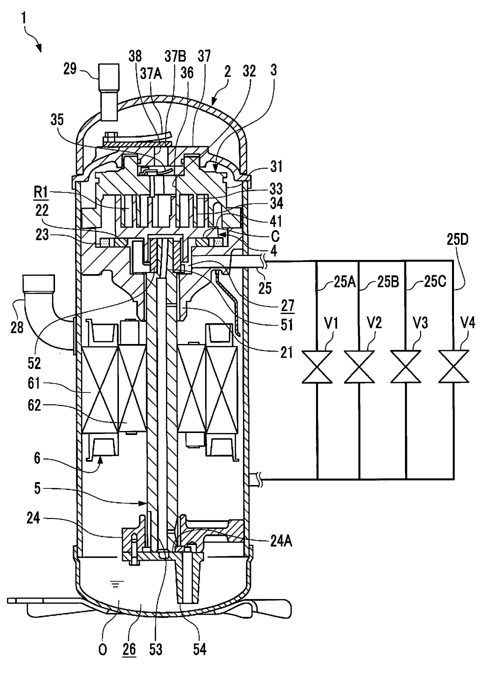
(54) **COMPRESSOR**

(57) Provided is a compressor with which the operating conditions can be controlled during operation of the compressor and suitable compressor performance in response to the operating conditions can be exhibited, with no prior restrictions on the operating conditions. This compressor, which compresses a refrigerant by transmitted driving force, is characterized by being equipped with a moving element moved by driving force, a support element supporting the moving element, and a detection means provided accompanying the moving element, said detection means detecting a change in the state in the vicinity of the detection means.

FIG. 1



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Description

Technical Field

[0001] The present invention relates to a compressor which includes a mechanism for reducing a mechanical loss during an operation.

Background Art

[0002] In the related art, a compressor such as a scroll compressor or a rotary compressor is used in a refrigerating cycle. For example, a scroll compressor disclosed in PTL 1 includes a fixed scroll which is fixed to an inside of a casing and an orbiting scroll which meshes with the fixed scroll and of which a drive shaft is connected to a rear surface side of the scroll compressor. In the scroll compressor, if the drive shaft rotates, the orbiting scroll orbits. In addition, during the orbiting, a fluid is sucked into a compression chamber formed between the two scrolls, and the fluid in the compression chamber is compressed.

[0003] In addition, in the scroll compressor, during a compression operation, a pressure of a back pressure space formed between the orbiting scroll and a housing on a rear surface side of the orbiting scroll increases, and thus, the orbiting scroll is pressed to the fixed scroll, a sliding loss of thrust bearing decreases, and it is possible to improve efficiency of the compression.

Citation List

Patent Literature

[0004] [PTL 1] Japanese Unexamined Patent Application Publication No. 5-187369

Summary of Invention

Technical Problem

[0005] However, in a scroll compressor, a state of an orbiting scroll depends on an operating condition. In addition, it is difficult to ascertain the state of the orbiting scroll with respect to the operating condition.

[0006] Therefore, in order to secure ability of the orbiting scroll capable of performing a required function during a given period under a given condition, that is, in order to secure reliability performance thereof, the operating condition of the scroll compressor is restricted. Accordingly, higher ability can be exerted if the operating condition is not restricted. But, the ability cannot be sufficiently exerted due to the restriction of the operating condition.

[0007] Therefore, an object of the present invention is to provide a compressor capable of exerting an appropriate compressor capacity according to an operating condition by controlling the operating condition during an operation of the compressor without restricting the operating condition in advance.

Solution to Problem

[0008] According to an aspect of the present invention, there is provided a compressor which compresses a refrigerant by a transmitted driving force, including: a movement element which is moved by a driving force; a support element which supports the movement element; and detection means which is provided in association with the movement element, in which the detection means detects a change in a state around the detection means.

[0009] Preferably, the detection means of the present invention is a sensor having a thickness of 10 μm or less.

[0010] Preferably, the detection means of the present invention is provided on a sliding surface of the support element with respect to the movement element.

[0011] Preferably, the detection means of the present invention is provided in the movement element.

[0012] Preferably, the change in the state around the detection means is at least one of a change in a pressure of a lubricating oil, a change in a temperature of the lubricating oil, and a change in capacitance.

[0013] Preferably, the compressor of the present invention is a scroll compressor which includes a fixed scroll, an orbiting scroll which revolves and orbits with respect to the fixed scroll, a thrust bearing which supports the orbiting scroll in a revolvable manner, and a back pressure chamber into which the lubricating oil flows.

[0014] Preferably, in a case where the compressor of the present invention is a scroll compressor, the detection means is provided on a sliding surface of the thrust bearing, which is connected to the back pressure chamber, with respect to the orbiting scroll.

[0015] In this case, preferably, the detection means is provided inside an accommodation chamber recessed from the sliding surface of the thrust bearing.

[0016] Moreover, preferably, the detection means has a measurement region which measures a pressure of the lubricating oil between the thrust bearing and the orbiting scroll, and the measurement region is provided inside a disposition region of the thrust bearing.

[0017] Preferably, in the compressor of the present invention, a pressure of the lubricating oil inside the back pressure chamber is adjusted by a detection value of the detection means.

[0018] In the case where the compressor of the present invention is the scroll compressor, the detection means can detect a change in a state between a key of an Oldham ring which restricts a rotation of the orbiting scroll and a key groove into which the key is inserted.

[0019] Moreover, the detection means can detect a change in a state of a compression chamber between a tooth surface of a wrap of the fixed scroll, the fixed scroll, and the orbiting scroll.

[0020] Preferably, the compressor of the present invention is a rotary compressor which includes a cylinder, a piston rotor which slides inside the cylinder, an upper bearing which is disposed on upper-side end surfaces of the cylinder and the piston rotor, a lower bearing which is disposed on lower-side end surfaces of the cylinder and the piston rotor, a compression chamber which is formed by the cylinder, the piston rotor, the upper bearing, and the lower bearing, a blade which partitions the compression chamber, and a blade groove into which the blade is inserted.

[0021] In a case where the compressor of the present invention is the rotary compressor, the detection means can detect a change in a state between the blade and the blade groove.

Advantageous Effects of Invention

[0022] According to the present invention, by measuring a physical quantity at a predetermined place when the compressor is operated, an appropriate compressor capacity can be exerted according to an operating condition by controlling a operating condition by a detection result without restricting the operating condition in advance.

Brief Description of Drawings

[0023]

Fig. 1 is a sectional view schematically showing the entire view of a scroll compressor of a first embodiment.

Fig. 2 is a partially enlarged view of Fig. 1.

Fig. 3 is a plan view of a characteristic portion of the scroll compressor of the first embodiment.

Fig. 4A is a plan view of the characteristic portion of the scroll compressor of the first embodiment, Fig. 4B is a sectional view taken along line b-b of Fig. 4A, and Fig. 4C is a partially enlarged view of Fig. 4A.

Fig. 5A is a graph showing a relationship between a sensor output of a thin film sensor and a pressure of a lubricating oil inside a back pressure chamber and Fig. 5B is a graph (Stribeck curve) showing a relationship between a frictional coefficient between an orbiting scroll and a thrust bearing and a bearing characteristic number of the orbiting scroll.

Fig. 6A is a sectional view schematically showing the entire view of a rotary compressor of another embodiment and Fig. 6B is a sectional view taken along line b-b of Fig. 4A.

Description of Embodiments

[0024] In a compressor of the present invention, a physical quantity at a predetermined place is measured when the compressor is operated, and the compressor is operated under an appropriate condition based on a measurement result.

[0025] Hereinafter, in the compressor of the present invention, first to fifth embodiments will be described.

[0026] In the first to fourth embodiments, the compressor of the present invention is applied to a scroll compressor 1, and in the fifth embodiment, the compressor of the present invention is applied to a rotary compressor 8.

[0027] First, configurations and operations common to the first to fourth embodiments described later will be described with reference to Fig. 1.

[0028] As shown in Fig. 1, the scroll compressor 1 of the present embodiment includes a fixed scroll 3, an orbiting scroll 4 which is a movement element revolved and orbited with respect to the fixed scroll 3, a motor 6 which drives the orbiting scroll 4, a rotary shaft 5 which transmits the power of the motor 6 to the orbiting scroll 4, and a housing 2 which accommodates the above-described components.

[0029] The orbiting scroll 4 is supported by a thrust bearing 22 which is a support element such that the orbiting scroll 4 can be revolved and orbited. However, a rotation of the orbiting scroll 4 is restricted by an Oldham ring 23.

[0030] The rotary shaft 5 is rotatably supported by an upper bearing 21 and a lower bearing 24 fixed to the housing 2.

[0031] As shown in Fig. 1, the housing 2 includes a storage region 26 which stores a lubricating oil O in a bottom portion of the housing 2. The lubricating oil O is pumped through an oil supply path 53 inside the rotary shaft 5 by a pump 54 provided on a lower end of the rotary shaft 5, and is supplied to locations at which the upper bearing 21, the lower bearing 24, a bearing 52 provided in an eccentric pin 51 of the rotary shaft 5, the orbiting scroll 4, the Oldham ring 23, and the thrust bearing 22 and other parts slide on each other. The supplied lubricating oil O is returned to the storage region 26 through a circulation passage 25.

[0032] A suction pipe 28 and a discharge pipe 29 provided in the housing 2 is connected to a refrigerant circuit of a refrigerator (not shown) or an air conditioner (not shown).

[0033] In the scroll compressor 1, if a drive current is supplied to a stator 61 of the motor 6 by a power supply (not shown), a rotor 62 of the motor 6 rotates, and a driving force is output to the rotary shaft 5.

[0034] If the rotary shaft 5 rotates, the driving force is transmitted to the orbiting scroll 4 via the eccentric pin 51 eccentrically provided in one direction (eccentric direction) radially outward from a center axis of the rotary shaft 5 on an upper end of the rotary shaft 5, and the orbiting scroll 4 is revolved and orbited with respect to the fixed scroll 3 fixed to the housing 2.

[0035] A refrigerant which has flowed into the housing 2 from the suction pipe 28 is sucked to between the orbiting scroll 4 and the fixed scroll 3 by the orbiting of the orbiting scroll 4. In addition, a volume of a compression chamber R1 between the orbiting scroll 4 and the fixed scroll 3 is decreased by the orbiting of the orbiting scroll

4, and thus, the refrigerant in the compression chamber R1 is compressed. A thrust load generated by a pressure of the compressed refrigerant is born by the upper bearing 21 supporting an end plate 41 of the orbiting scroll 4 via the thrust bearing 22.

[0036] The compressed refrigerant is discharged to the refrigerant circuit through the discharge pipe 29 via a discharge port 32 of the fixed scroll 3 and a discharge port 38 of a discharge cover 37. A reed valve 36 attached to an end plate 31 of the fixed scroll 3 via a retainer 35 is provided in the discharge port 32, and a reed valve 37B attached to the discharge cover 37 via a retainer 37A is provided in the discharge port 38 of the discharge cover 37. If the pressure of the compressed refrigerant reaches a predetermined value, the refrigerant which pushes and opens the reed valves 36 and 37B is discharged to the refrigerant circuit.

[First Embodiment]

[0037] The scroll compressor 1 of the first embodiment includes a pressure adjustment mechanism which adjusts a pressure of the lubricating oil O inside a back pressure chamber 27.

[0038] In the scroll compressor 1, the orbiting scroll 4 is pressed to the fixed scroll 3 side by the pressure of the lubricating oil O inside the back pressure chamber 27.

[0039] As shown in Figs. 2 and 3, the pressure adjustment mechanism includes the back pressure chamber 27, an accommodation chamber 22B which is formed on a surface of the thrust bearing 22 facing the orbiting scroll 4, a thin film sensor 7 which is provided inside the accommodation chamber 22B, and a control valve V which is provided in a circulation passage 25.

[0040] In the pressure adjustment mechanism, the pressure of the lubricating oil O supplied into the back pressure chamber 27 is measured by the thin film sensor 7, and opening and closing of the control valve V of the circulation passage 25 are adjusted by a measurement result such that the pressure of the back pressure chamber 27 reaches a predetermined pressure.

[0041] Hereinafter, each configuration of the pressure adjustment mechanism will be described.

[Back Pressure Chamber 27]

[0042] As shown in Fig. 2, the back pressure chamber 27 is partitioned by the orbiting scroll 4, the upper bearing 21, and the thrust bearing 22 and is a space inside the thrust bearing 22. The back pressure chamber 27 is formed in an annular shape.

[Circulation Passage 25]

[0043] The lubricating oil O supplied into the back pressure chamber 27 from the storage region 26 is returned to the storage region 26 of the housing 2 from the back pressure chamber 27 through the circulation passage 25.

[0044] As shown in Fig. 1, the circulation passage 25 is connected to the storage region 26 in which the lubricating oil O of the housing 2 is stored. The circulation passage 25 includes the control valve V which controls a circulation flow rate of the lubricating oil O. In the present embodiment, the control valve V is used as a generic name for control valves V1, V2, V3, and V4.

[0045] In the present embodiment, an electromagnetic valve whose flow path is opened or closed according to an instruction can be exemplified as the control valve V.

[0046] An amount of the lubricating oil O inside the back pressure chamber 27 is controlled by the control valve V as follows.

[0047] In the scroll compressor 1, the lubricating oil O is supplied to the back pressure chamber 27 during the operation of the scroll compressor 1. If the control valve V is closed, the lubricating oil O, which is no longer inside the back pressure chamber 27, is introduced to a thrust surface 22A side of the thrust bearing 22 and enters a gap C between the thrust bearing 22 and the orbiting scroll 4.

[0048] Meanwhile, if the control valve V is opened in a state where the lubricating oil O enters the gap C, the lubricating oil O flows from the gap C toward the circulation passage 25.

[0049] The circulation passage 25 of the present embodiment branches into four passages 25A, 25B, 25C, and 25D in the middle of the circulation passage 25, and the control valves V1, V2, V3, and V4 are respectively provided in the passages 25A to 25D. In the circulation passage 25, it is possible to adjust the amount of the lubricating oil O returned from the back pressure chamber 27 to the storage region 26 can be adjusted according to the number of the control valves V1 to V4 which are opened and closed.

[0050] In addition, it is possible to adjust the amount of the lubricating oil O returned from the back pressure chamber 27 to the storage region 26 using a flow rate adjustment valve instated of the plurality of control valves V1 to V4.

[Accommodation Chamber 22B]

[0051] As shown in Fig. 3, the thrust bearing 22 includes the accommodation chamber 22B which is recessed backward from the thrust surface 22A coming into contact with the orbiting scroll 4.

[0052] The accommodation chamber 22B is provided such that a measurement region 74 which is a detection unit of the thin film sensor 7 described later does not come into contact with the orbiting scroll 4.

[0053] As shown in Fig. 2, the accommodation chamber 22B is connected to the back pressure chamber 27 via the gap C between the thrust bearing 22 and the orbiting scroll 4.

[0054] As shown in Figs. 4A and 4C, the accommodation chamber 22B is formed of a linear groove which is provided on the thrust surface 22A and extends in a radial direction.

[0055] As shown in Figs. 4B and 4C, a depth D of the accommodation chamber 22B is deeper than a thickness T of the measurement region 74 of the thin film sensor 7 which is provided inside the accommodation chamber 22B.

[Thin Film Sensor 7]

[0056] The thin film sensor 7 detects a change in the pressure of the lubricating oil O inside the back pressure chamber 27 as a change in an electric resistance value.

[0057] As shown in Fig. 4A, the thin film sensor 7 includes a linear portion which extends radially inward from an outer peripheral edge 22D of the thrust surface 22A, a curved portion which is connected to the linear portion, and a linear portion which is connected to the curved portion and extends the outer peripheral edge 22D of the thrust surface 22A. That is, the thin film sensor 7 is formed in an approximately U shape on the thrust surface 22A. The thin film sensor 7 is connected to a terminal (not shown) at the peripheral edge 22D of the thrust surface 22A.

[0058] A detection signal from the thin film sensor 7 is input to a control unit (not shown) via lead wires connected to the respective terminals.

[0059] As shown in Fig. 4B, the thin film sensor 7 has a three-layer structure in which an insulating layer 72, a sensor layer 71, and a protective layer 73 are laminated in order from the thrust bearing 22 side.

[0060] The sensor layer 71 has a characteristic that the electric resistance value is changed if the pressure of the lubricating oil O inside the back pressure chamber 27 is changed. The insulating layer 72 electrically insulates a portion between the thrust bearing 22 and the sensor layer 71. The protective layer 73 protects the sensor layer 71 such that the sensor layer 71 is not damaged by foreign matters such as metal powder entering the accommodation chamber 22B.

[0061] A thickness of the sensor layer 71 is 1 μm or less, preferably, the entire thickness T of the thin film sensor 7 including the insulating layer 72 and the protective layer 73 is selected from a range of 10 μm or less, more preferably is approximately 5 μm or less, and particularly preferably is approximately 3 μm or less.

[0062] The sensor layer 71 is formed of a material having a characteristic that the electric resistance value is changed according to the change in the pressure. For example, Manganin (registered trademark) which is a Cu-Mn-Ni based alloy can be used. Typically, the Manganin has a chemical composition of 84% of Cu, 12% of Mn, and 4% of Ni in mass%.

[0063] The insulating layer 72 is formed of a material having electric insulation properties. For example, silicon oxide (SiO_2), aluminum oxide (Al_2O_3), or the like can be used.

[0064] For example, DLC (Diamond-Like Carbon), PTFE (Poly Tetra Fluoro Ethylene), silicon oxide, aluminum oxide, or the like can be used for the protective layer 73.

[0065] As shown in Fig. 4C, the thin film sensor 7 has the measurement region 74 which is used as a detection unit which measures the pressure of the lubricating oil O inside the back pressure chamber 27. The measurement region 74 is set to a width which is so small that the electric resistance value of the other regions 79 can be ignored, as compared with the electric resistance value of the measurement region 74.

[0066] Accordingly, an electric resistance value between terminals provided on both ends of the thin film sensor 7 is substantially the same as the electric resistance value of the measurement region 74. In addition, the change in the pressure by the lubricating oil O acting on the measurement region 74 of the thin film sensor 7 inside the accommodation chamber 22B is detected as a change in an electric resistance between the terminals.

[0067] The width of the measurement region 74 is narrow, and thus, sensitivity of the measurement region 74 with respect to the change in the electric resistance is higher than those of the other regions 79.

[0068] For example, a width W of the measurement region 74 can be 20 to 30 μm.

[0069] In addition, the entire thin film sensor 7 including the measurement region 74 is a three-layer structure including the insulating layer 72, the sensor layer 71, and the protective layer 73.

[0070] As shown in Fig. 3, in the thin film sensor 7, the measurement region 74 is provided in a disposition region 22C of the thrust surface 22A of the thrust bearing 22.

[0071] As shown in Fig. 4A, in the thrust surface 22A, there is a concern that an annular region 22E radially inside the outer peripheral edge 22D strongly abuts against the end plate 41 of the orbiting scroll 4 which revolves and orbits. In addition, there is a concern that an annular region 22G radially outside an inner peripheral edge 22F strongly abuts against the end plate 41 if the end plate 41 of the orbiting scroll 4 is deformed.

[0072] As shown in Fig. 4A, the disposition region 22C is an annular region except for the regions 22E and 22G in the thrust surface 22A of the thrust bearing 22. A width of each of the regions 22E and 22G is approximately 1 mm.

[0073] The measurement region 74 is provided in the disposition region 22C which has a weaker abutment against the end plate 41 compared to the regions 22E and 22G, the thin film sensor 7 can stably measure the pressure of the lubricating oil O inside the back pressure chamber 27.

[0074] As shown in Fig. 5A, the thrust bearing 22 is in contact with the orbiting scroll 4, and thus, in a boundary lubrication state I where the lubricating oil O is insufficient or does not exist in the gap C between the thrust surface 22A of the thrust bearing 22 and the end plate 41 of the orbiting scroll 4, an oil pressure measured by the thin film sensor 7 is low.

[0075] However, in a mixed lubrication state II in which the lubricating oil O enters the gap C between the thrust surface 22A of the thrust bearing 22 and the end plate 41 of the orbiting scroll 4 and an oil film is formed in the gap C by the lubricating oil O, the oil pressure measured by the thin film sensor 7 gradually increases.

[0076] If the amount of the lubricating oil O which enters the gap C between the thrust surface 22A of the thrust bearing 22 and the end plate 41 of the orbiting scroll 4 increases, the measured oil pressure further increases. Moreover, in a fluid lubrication state III where the thrust bearing 22 and the orbiting scroll 4 do not come into contact with each other and is completely separated from each other, the oil pressure measured by the thin film sensor 7 is higher than that in the mixed lubrication state II.

[0077] In addition, as shown in Fig. 5B, a dynamic frictional coefficient between the thrust surface 22A of the thrust bearing 22 and the end plate 41 of the orbiting scroll 4 decreases if the state is transferred from the boundary lubrication state I to the mixed lubrication state II. However, the dynamic frictional coefficient increases if the state is transferred from the mixed lubrication state II to the fluid lubrication state III.

[0078] That is, during the operation of the scroll compressor 1, it is preferable that the gap C between the thrust surface 22A of the thrust bearing 22 and the end plate 41 of the orbiting scroll 4 is in the mixed lubrication state II.

[Operation of Pressure Adjustment Mechanism]

[0079] During the operation of the scroll compressor 1, an operation of the pressure adjustment mechanism for adjusting the pressure of the lubricating oil O inside the back pressure chamber 27 will be described with reference to Fig. 1.

[0080] In the pressure adjustment mechanism, the gap C between the thrust surface 22A and the end plate 41 maintains the mixed lubrication state II in which an oil film is formed by the lubricating oil O. Accordingly, the pressure adjustment mechanism changes the number of the control valves V to be closed for each threshold value.

[0081] In addition, during the operation of the scroll compressor 1, the lubricating oil O is supplied to the back pressure chamber 27. Moreover, in the scroll compressor 1, four threshold values such as threshold values P1, P2, P3, and P4 are set in order to control opening and closing of the control valve V (V1 to V4). The threshold values P1, P2, P3, and P4 are set to determine the number of the control valves V1 to V4 to be opened and closed by the oil pressure measured by the thin film sensor 7. Moreover, in the present embodiment, the threshold value P2 is larger than the threshold value P1, the threshold value P3 is larger than the threshold value P2, and the threshold value P4 is larger than the threshold value P3.

[0082] When the pressure of the lubricating oil O inside the back pressure chamber 27 measured by the thin film sensor 7 is in a range of the threshold values P1, P2, and P3, the gap C between the thrust surface 22A and the end plate 41 is in the mixed lubrication state II in which the oil film is formed by the lubricating oil O. By increasing the number of the control valves V opened as the pressure reaches the threshold value P3 from the threshold value P1, the state is not transferred from the state II to the fluid lubrication state III in which much lubricating oil O enters the gap C and the thrust bearing 22 and the orbiting scroll 4 are separated from each other without coming into contact with each other.

[0083] If the measured oil pressure reaches the threshold value P4, the gap C between the thrust surface 22A and the end plate 41 is in the state III. Accordingly, all the control valves V1 to V4 are opened such that the gap C between the thrust surface 22A and the end plate 41 is transferred from the state III to the state II.

[0084] Moreover, if the pressure of the lubricating oil O inside the back pressure chamber 27 measured by the thin film sensor 7 does not reach the threshold value P1, the gap C between the thrust surface 22A of the thrust bearing 22 and the end plate 41 of the orbiting scroll 4 is in the boundary lubrication state I in which the lubricating oil O is insufficient or does not exist. Therefore, all the control valves V1 to V4 are closed. Accordingly, the amount of the lubricating oil O inside the back pressure chamber 27 increases, and thus, the state can be transferred to the mixed lubrication state II in which the oil film is formed between the thrust surface 22A and the end plate 41 by the lubricating oil O.

[Effect of Scroll Compressor 1]

[0085] Hereinafter, effects exerted by the scroll compressor 1 will be described.

[0086] The scroll compressor 1 includes the pressure adjustment mechanism which adjusts the pressure of the back pressure chamber 27 to a desired pressure by controlling opening and closing of the control valve V (V1 to V4) of the circulation passage 25 based on the pressure of the lubricating oil O inside the back pressure chamber 27 measured by the thin film sensor 7 which is the detection means.

[0087] Accordingly, in the scroll compressor 1, it is possible to appropriately control the pressure of the lubricating oil O inside the back pressure chamber 27 while lubricating a location at which the orbiting scroll 4, the thrust bearing 22, or the like and other parts slide on each other, and thus, an appropriate compressor capacity can be exerted according to the operating condition.

[0088] Hereinafter, with comparison with the pressure of the lubricating oil O inside the back pressure chamber 27 is set in advance so as to be within a predetermined defined value, descriptions will be given.

[0089] The pressure of the lubricating oil O inside the back pressure chamber 27 required to obtain a desired compressor capacity during the operation of the scroll compressor 1 is changed by influences of a thrust load of the orbiting scroll 4 changed by the operating condition, wedge effects of the lubricating oil on a sliding surface, or the like. Accordingly, it is difficult to calculate the appropriate pressure of the lubricating oil O inside the back pressure chamber 27 during the operation of the scroll compressor 1.

[0090] Therefore, even when the pressure of the lubricating oil O inside the back pressure chamber 27 is within the predetermined defined value, the pressure of the lubricating oil O inside the back pressure chamber 27 may not be the value required to obtain a desired compressor capacity due to the operating condition of the scroll compressor 1.

[0091] Meanwhile, in the scroll compressor 1, the change in the state around the thin film sensor 7, that is, the change in the pressure of the lubricating oil O inside the back pressure chamber 27 during the operation is detected, the pressure can be appropriately controlled, and thus, an appropriate compressor capacity can be exerted according to the operating condition.

[0092] Next, in the scroll compressor 1, the thin film sensor 7 is provided in the accommodation chamber 22B provided on the thrust surface 22A coming into contact with the orbiting scroll 4, and a portion between the thin film sensor 7 and the orbiting scroll 4 is filled with the lubricating oil O. Accordingly, the thin film sensor 7 can detect the pressure of the lubricating oil O inside the back pressure chamber 27 without coming into contact with the orbiting scroll 4.

[0093] Moreover, in the thin film sensor 7, the measurement region 74 is disposed within the range of the disposition region 22C having a relatively weak abutment, and thus, it is possible to stably measure the pressure of the lubricating oil O inside the back pressure chamber 27.

[0094] In addition, in the scroll compressor 1, it is sufficient for the thin film sensor 7 to be provided in association with the orbiting scroll 4 which is a movement element. That is, the thin film sensor 7 can be provided in the orbiting scroll 4. However, the thin film sensor 7 is provided in the stationary thrust bearing 22, and thus, compared to a case where the thin film sensor 7 is provided in the orbiting scroll 4 which performs the orbiting movement, a terminal of the thin film sensor 7 can be easily wired.

[Second Embodiment]

[0095] Next, a second embodiment of the present invention will be described with reference to Figs. 1 and 2.

[0096] Moreover, in the second embodiment, the same reference numerals as those of the first embodiment are assigned to components similar to those of the first embodiment, and descriptions thereof are omitted.

[0097] The scroll compressor 1 of the second embodiment suggests that the thin film sensor 7 for measuring the pressure or the temperature of the lubricating oil O between a key and a key groove is provided in the key groove of the upper bearing 21 on which the key of the Oldham ring 23 (not shown) slides.

[0098] As the thin film sensor which detects the temperature, a thermocouple which can measure a temperature by a thermoelectromotive force or a resistance temperature sensor in which a resistance value is changed by a temperature so as to measure the temperature, for example, a platinum thin film temperature sensor can be used.

[0099] In the second embodiment, the thin film sensor is provided in an accommodation chamber which is formed in the key groove similarly to the accommodation chamber 22B of the first embodiment. This also applies to the third and subsequent embodiments.

[0100] In the scroll compressor 1 during the operation thereof, if the pressure or temperature of the lubricating oil O between the key of the Oldham ring 23 and the key groove of the upper bearing 21 increases and the lubricating oil O inside the key groove decreases, an abrasion amount between the upper bearing 21 and the Oldham ring 23 increases.

[0101] Accordingly, in the scroll compressor 1 of the second embodiment, if a predetermined pressure or temperature is measured by the thin film sensor, the amount of the lubricating oil O to be supplied to a portion between the key and the key groove is increased by temporarily increasing a rotating speed of the orbiting scroll 4.

[0102] Accordingly, it is possible to prevent the abrasion amount between the upper bearing 21 and the Oldham ring 23 from increasing.

[Third Embodiment]

[0103] Next, a third embodiment of the present invention will be described with reference to Figs. 1 and 2.

[0104] Moreover, in the third embodiment, the same reference numerals as those of the first embodiment are assigned to components similar to those of the first embodiment, and descriptions thereof are omitted.

[0105] In the scroll compressor 1 of the third embodiment, the thin film sensor 7 can be provided on a tooth surface 34 of a wrap 33 of the fixed scroll 3. Although not shown, the thin film sensor 7 is provided inside an accommodation chamber formed on the tooth surface 34. In the third embodiment, the thin film sensor 7 is provided so as to detect occurrence of so-called liquid compression inside the compression chamber R1 in advance.

[0106] Even when the thin film sensor 7 is provided on the tooth surface 34, the thin film sensor 7 is extremely thin, and thus, it is possible to minimize a dead volume which a factor of lowering compression efficiency of the refrigerant.

[0107] In the scroll compressor 1, if a liquid refrigerant is sucked and liquid compression is generated, the pressure inside the compression chamber R1 significantly increases. Therefore, in the scroll compressor 1, if the thin film sensor 7 measures a pressure having a predetermined value at which the liquid compression may be generated, the rotating speed of the orbiting scroll 4 decreases.

[0108] Accordingly, the liquid compression is avoided, and thus, it is possible to the pressure inside the compression chamber R1 from abnormally increasing.

[Fourth Embodiment]

[0109] Next, a fourth embodiment of the present invention will be described with reference to Fig. 1.

[0110] Moreover, in the fourth embodiment, the same reference numerals as those of the first embodiment are assigned to components similar to those of the first embodiment, and descriptions thereof are omitted.

[0111] In the scroll compressor 1 of the fourth embodiment, the thin film sensor 7 which measures a pressure of the lubricating oil O between the upper bearing 21 and the rotary shaft 5, the thin film sensor which measures a temperature between the upper bearing 21 and the rotary shaft 5, or a sensor which measures capacitance between the upper bearing 21 and the rotary shaft 5 is provided in a portion of the upper bearing 21 facing the rotary shaft 5.

[0112] Moreover, as the sensor to measure the pressure of the lubricating oil O and measure the temperature of the lubricating oil O, the above-described sensors can be used.

[0113] In the scroll compressor 1, if the temperature or a load between the upper bearing 21 and the rotary shaft 5 abnormally increases, there is a concern that a so-called lock state in which the scroll compressor 1 is not operated may occur.

[0114] Accordingly, in the scroll compressor 1 of the fourth embodiment, the thin film sensor detects that the temperature between the upper bearing 21 and the rotary shaft 5 or the load obtained from the pressure of the lubricating oil O is a predetermined value or more. Then, the load between the upper bearing 21 and the rotary shaft 5 is decreased or the operation of the scroll compressor 1 is stopped by decreasing the rotating speed of the rotary shaft 5.

[0115] Accordingly, it is possible to prevent the scroll compressor 1 from entering the lock state.

[0116] Moreover, if a dilution rate of the lubricating oil O by the refrigerant is calculated from a relationship between temperature and the pressure measured by the thin film sensor or the capacitance and the dilution rate is a predetermined value or more, an operation of decreasing the load between the upper bearing 21 and the rotary shaft 5 can be performed by decreasing the rotating speed of the rotary shaft 5 or the pressure of the lubricating oil O until the dilution rate decreases.

[0117] The dilution rate from the relationship between the temperature and the pressure is calculated from a relationship expression previously obtained according to a type of the compressed refrigerant or the used lubricating oil O. In addition, the dilution rate from the capacitance is calculated by a correlation between the capacitance and the dilution rate obtained in advance.

[0118] Next, an example in which a thin film sensor for detecting a radial gap between the upper bearing 21 and the rotary shaft 5 is provided will be described. In addition, here, it should be noted that the gap means not only a presence or absence of a gap but also a dimension of the gap. This is also applied to a fifth embodiment described next.

[0119] As this thin film sensor, the above-described sensor for measuring the capacitance can be used.

[0120] In the fourth embodiment, a capacitance sensor is provided on the upper bearing 21 so as to measure the capacitance between the upper bearing 21 and the rotary shaft 5. If a gap between the capacitance sensor and the rotary shaft 5 is changed, the capacitance generated between the capacitance sensor and the rotary shaft 5 is changed, and thus, it is possible to detect the gap between the upper bearing 21 and the rotary shaft 5 from the measured capacitance.

[0121] Meanwhile, an outer peripheral surface of the rotary shaft 5 strongly abuts against the upper bearing 21 a position which is deviated by a predetermined angle in a rotation direction of the rotary shaft 5 in an eccentric direction of the provided eccentric pin 51. Although this position varies depending on an element such as a centrifugal force generated by the orbiting of the orbiting scroll 4, typically, the position is a position deviated by 90°. Accordingly, if the scroll compressor 1 is continuously used, abrasion of the strongly abutting portion of the rotary shaft 5 preferentially increases, and thus, a radial gap between the strongly abutting portion of the rotary shaft 5 and the upper bearing 21 increases.

[0122] Accordingly, in the scroll compressor 1 of the fourth embodiment, if the capacitance sensor provided in the upper bearing 21 detects that the radial gap between the upper bearing 21 and the rotary shaft 5 increases to be a predetermined value or more, the operation is stopped. In the scroll compressor 1, an error signal for informing that the operation has been stopped can be output according to the stopping of the operation.

[Fifth Embodiment]

[0123] Next, a fifth embodiment of the present invention will be described with reference to Fig. 6.

[0124] Moreover, the fifth embodiment relates to the rotary compressor 8. As shown in Fig. 6A, the rotary compressor 8 includes a cylinder 83, a piston rotor 82 which slides inside the cylinder 83, a motor 89 which drives the piston rotor 82, a rotary shaft 87 which transmits power of the motor 89 to the piston rotor 82, and a housing 81 which accommodates the above-described components.

[0125] An upper bearing 84 is disposed on upper-side end surfaces of the cylinder 83 and the piston rotor 82, and a lower bearing 85 is disposed on lower-side end surfaces thereof.

[0126] The piston rotor 82 is inserted into an eccentric shaft portion 87A of the rotary shaft 87 along a center axis of the housing 81 and is fixed to the eccentric shaft portion 87A. The rotary shaft 87 is rotatably supported by the upper bearing 84 and the lower bearing 85.

[0127] As shown in Fig. 6B, a compression chamber R2 is formed by the cylinder 83, the piston rotor 82, the upper bearing 84, and the lower bearing 85.

[0128] The cylinder 83 includes a blade groove 83B which is connected to the compression chamber R2 and into which a blade 86 is inserted and an accommodation groove 83D which is connected to the blade groove 83B and in which a coil spring 83C is accommodated.

[0129] The cylinder 83 penetrates in a radial direction by the blade groove 83B and the accommodation groove 83D.

[0130] The compression chamber R2 is partitioned by the plate-shaped blade 86 which is formed to have a height similar to an axial dimension of the piston rotor 82.

[0131] The blade 86 is inserted into the blade groove 83B and is circumferentially supported. In addition, a distal end of the blade 86 is always pressed to an outer peripheral surface of the piston rotor 82 by a pressing force generated by the coil spring 83C disposed inside the accommodation groove 83D and a pressure generated by a high-pressure portion. The blade 86 protrudes or retracts with respect to the compression chamber R2 inside the cylinder 83 according to a rotation angle of the piston rotor 82.

[0132] The refrigerant sucked into the cylinder 83 from a suction port 83A is compressed by being pushed by the piston rotor 82 in the cylinder 83. The compressed refrigerant is discharged from a discharge port 84A formed in the upper bearing 84.

[0133] A reed valve (not shown) is provided in the discharge port 84A. If the pressure of the compressed refrigerant reaches a predetermined value, the reed valve is pushed and opened, and thus, the refrigerant is discharged to the outside of the cylinder 83. The discharged refrigerant is supplied to a system side such as a refrigerator (not shown) or an air conditioner (not shown) connected to the rotary compressor 8.

[0134] In the rotary compressor 8 of the fifth embodiment, the thin film sensor 7 which measures a circumferential contact pressure between the blade 86 and the blade groove 83B is provided in the blade 86 or the blade groove 83B. In addition, in Figs. 6A and 6B, the thin film sensor 7 is not shown. Alternatively, the rotary compressor 8 includes a thin film sensor which detects a circumferential gap between the blade 86 and the blade groove 83B. This thin film sensor is not shown.

[0135] First, an example in which the thin film sensor 7 is provided will be described.

[0136] In the rotary compressor 8 during the operation thereof, if the contact pressure between the blade 86 and the blade groove 83B increases, there is a concern that a so-called lock state in which the rotary compressor 8 is not operated may occur.

[0137] Accordingly, in the rotary compressor 8 of the fifth embodiment, the thin film sensor 7 detects that the contact pressure between the blade 86 and the blade groove 83B is a predetermined value or more. Then, a rotating speed of the piston rotor 82 is limited so as to decrease a sliding speed between the blade 86 and the blade groove 83B or change an opening degree of an expansion valve on the system side. In this way, in the rotary compressor 8, a differential pressure between the compression chamber R2 on the suction port 83A side and the compression chamber R2 on the discharge port 84A side separated by the blade 86 is decreased so as to decrease a load between the blade 86 and the blade groove 83B. Alternatively, the operation of the rotary compressor 8 may be stopped.

[0138] As described above, it is possible to prevent the rotary compressor 8 from entering the lock state.

[0139] Next, an example in which the thin film sensor which detects the circumferential gap between the blade 86 and the blade groove 83B is provided will be described.

[0140] As the thin film sensor which detects the gap, the above-described capacitance sensor can be used.

[0141] In the fifth embodiment, the capacitance sensor is provided in the blade 86 or the blade groove 83B in order to measure the capacitance between the blade 86 and the blade groove 83B. The gap between the blade 86 and the blade groove 83B is detected from the measured capacitance.

[0142] In the rotary compressor 8, if the blade 86 and the blade groove 83B wear, the circumferential gap between the blade 86 and the blade groove 83B gradually increases.

[0143] Accordingly, in the rotary compressor 8 of the fifth embodiment, the capacitance sensor provided in the blade 86 or the blade groove 83B detects that the circumferential gap between the blade 86 and the blade groove 83B increase to reach the predetermined value or more. Then, the rotating speed of the piston rotor 82 is limited so as to decrease the sliding speed between the blade 86 and the blade groove 83B or change the opening degree of the expansion valve on the system side. In this way, in the rotary compressor 8, a differential pressure between the compression chamber R2 on the suction port 83A side and the compression chamber R2 on the discharge port 84A side separated by the blade 86 is decreased so as to decrease a load between the blade 86 and the blade groove 83B.

[0144] In addition, if the circumferential gap between the blade 86 and the blade groove 83B reaches the predetermined value or more, in addition to stopping the operation of the above-described rotary compressor 8 and reducing the load, an error signal may be output to the outside.

[0145] Hereinbefore, preferred embodiments of the present invention are described. However, in addition to this, the configurations described in the above embodiments can be selected or appropriately changed to other configurations within a scope which does not depart from the gist of the present invention.

[0146] For example, in the scroll compressor 1 of the present embodiment, the example in which the thin film sensor 7 is formed in an approximately U shape is described. However, the present invention is not limited to this, and the thin film sensor 7 may be formed in any shape.

[0147] Moreover, in the scroll compressor 1 of the present embodiment, the example in which the thin film sensor 7 has a three-layer structure including the insulating layer 72, the sensor layer 71, and the protective layer 73 is described. However, the present invention is not limited to this. The thin film sensor 7 may have any layer structure as long as it has at least the sensor layer 71.

[0148] Moreover, in the first embodiment, the signal of the thin film sensor 7 may be used to determine an error. For example, if the thin film sensor 7 outputs a signal having an abnormal value, an error signal indicating that the thrust surface 22A of the thrust bearing 22 may be damaged may be output to the outside.

[0149] In addition, in the fourth embodiment, the example in which the thin film sensor 7 is provided in the upper bearing 21 of the scroll compressor 1 is described. However, the thin film sensor 7 may be provided in other journal bearings, for example, the lower bearing 24 of the scroll compressor 1, the upper bearing 84 and the lower bearing 85 of the rotary compressor 8, or the like.

[0150] Moreover, in the first to fifth embodiments, the thin film sensor is used. However, the present invention is not limited to this.

[0151] For example, a wire formed of a thin film may be provided on the surface of the reed valve 36 so as to detect the damage of the reed valve 36 such that the wire is cut off and an electric connection is cut off if damage such as defect or crack occurs in the reed valve 36 of the scroll compressor 1.

[0152] When the damage of the reed valve 36 is detected, an error signal may be output to the outside, and the operation of the scroll compressor 1 may be stopped such that a reverse rotation is not generated in the orbiting scroll 4.

[0153] Moreover, similarly, the wire formed of a thin film can be applied to a reed valve (not shown) of the rotary compressor 8.

[0154] Moreover, the type of the compressor to which the present invention is applied is not limited to the scroll compressor or the rotary compressor, and can be widely applied to a screw compressor, a reciprocating compressor, or the like.

[0155] Moreover, as the portion of the compressor to which the present invention is applied, in addition to the above-described portions, there are the retainer 35 of the fixed scroll 3, the retainer 37A of the discharge cover 37, and the shaft thrust surface 24A of the lower bearing 24 of the scroll compressor 1, the shaft thrust surface 85A of the lower bearing 85 of the rotary compressor 8, or the like.

Reference Signs List

[0156]

1:	scroll compressor
2:	housing
21:	upper bearing
22:	thrust bearing
22A:	thrust surface
22B:	accommodation chamber
22C:	disposition region
22D:	peripheral edge
22E:	region
22F:	peripheral edge
22G:	region
23:	Oldham ring
24:	lower bearing
24A:	shaft thrust surface
25:	circulation passage
26:	storage region
27:	back pressure chamber
28:	suction pipe
29:	discharge pipe
3:	fixed scroll
31:	end plate
32:	discharge port
33:	wrap
34:	tooth surface
35:	retainer
36:	reed valve
37:	discharge cover
37A:	retainer
37B:	reed valve
38:	discharge port
4:	orbiting scroll
41:	end plate
5:	rotary shaft
51:	eccentric pin
52:	bearing
53:	oil supply path
54:	pump
6:	motor
61:	stator
62:	rotor
7:	thin film sensor
71:	sensor layer
72:	insulating layer
73:	protective layer
74:	measurement region
8:	rotary compressor
81:	housing
82:	piston rotor
83:	cylinder
83A:	suction port
83B:	blade groove
83C:	coil spring
84:	upper bearing
84A:	discharge port

85:	lower bearing
85A:	shaft thrust surface
86:	blade
87:	rotary shaft
89:	motor
C:	gap
O:	lubricating oil
V1, V2, V3, V4:	control valve

Claims

1. A compressor which compresses a refrigerant by a transmitted driving force, comprising:

a movement element which is moved by a driving force;
a support element which supports the movement element; and
detection means which is provided in association with the movement element,
wherein the detection means detects a change in a state around the detection means.

2. The compressor according to claim 1,
wherein the detection means is a sensor having a thickness of 10 μm or less.

3. The compressor according to claim 1 or 2,
wherein the detection means is provided on a sliding surface of the support element with respect to the movement element.

4. The compressor according to claim 1 or 2,
wherein the detection means is provided in the movement element.

5. The compressor according to any one of claims 1 to 4,
wherein the change in the state around the detection means is at least one of a change in a pressure of a lubricating oil, a change in a temperature of the lubricating oil, and a change in capacitance.

6. The compressor according to any one of claims 1 to 5,
wherein the compressor is a scroll compressor which includes
a fixed scroll,
an orbiting scroll which revolves and orbits with respect to the fixed scroll,
a thrust bearing which supports the orbiting scroll in a revolvable manner, and
a back pressure chamber into which the lubricating oil flows.

7. The compressor according to claim 6,
wherein the detection means is provided on a sliding surface of the thrust bearing, which is connected to the back pressure chamber, with respect to the orbiting scroll.

8. The compressor according to claim 7,
wherein the detection means is provided inside an accommodation chamber recessed from the sliding surface of the thrust bearing.

9. The compressor according to claim 8,
wherein the detection means has a measurement region which measures a pressure of the lubricating oil between the thrust bearing and the orbiting scroll, and
wherein the measurement region is provided inside a disposition region of the thrust bearing.

10. The compressor according to any one of claims 6 to 9,
wherein a pressure of the lubricating oil inside the back pressure chamber is adjusted by a detection value of the detection means.

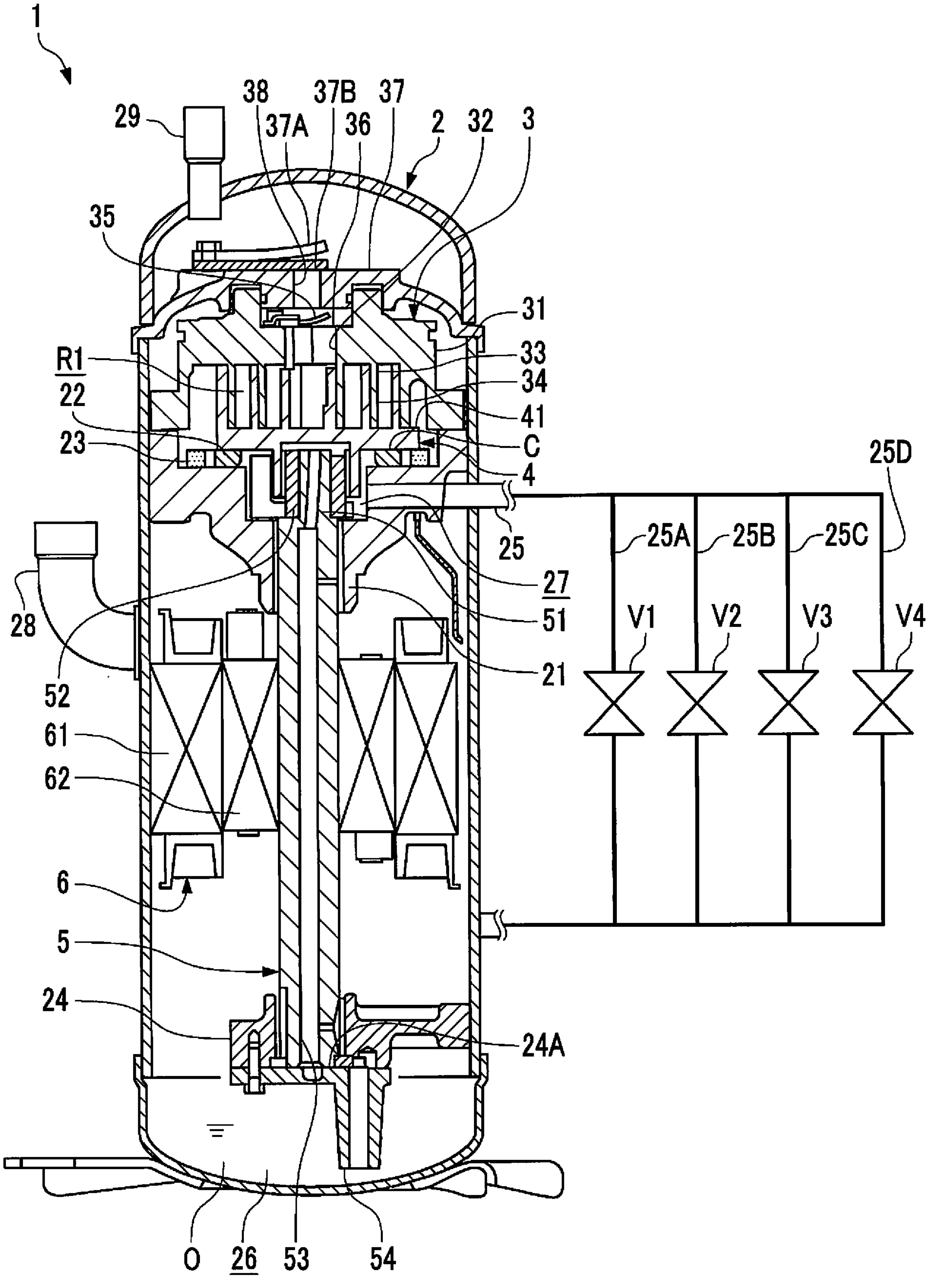
11. The compressor according to claim 6,
wherein the detection means detects a change in a state between a key of an Oldham ring which restricts a rotation of the orbiting scroll and a key groove into which the key is inserted.

12. The compressor according to claim 6,
wherein the detection means detects a change in a state of a compression chamber between a tooth surface of a wrap of the fixed scroll, the fixed scroll, and the orbiting scroll.

13. The compressor according to any one of claims 1 to 5,
wherein the compressor is a rotary compressor which includes
a cylinder,
a piston rotor which slides inside the cylinder,
an upper bearing which is disposed on upper-side end surfaces of the cylinder and the piston rotor,
a lower bearing which is disposed on lower-side end surfaces of the cylinder and the piston rotor,
a compression chamber which is formed by the cylinder, the piston rotor, the upper bearing, and the lower bearing,
a blade which partitions the compression chamber, and
a blade groove into which the blade is inserted.

14. The compressor according to claim 13,
wherein the detection means detects a change in a state between the blade and the blade groove.

FIG. 1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29
38
37A
37B
36
37
2
32
3
35
31
R1
22
33
34
41
C
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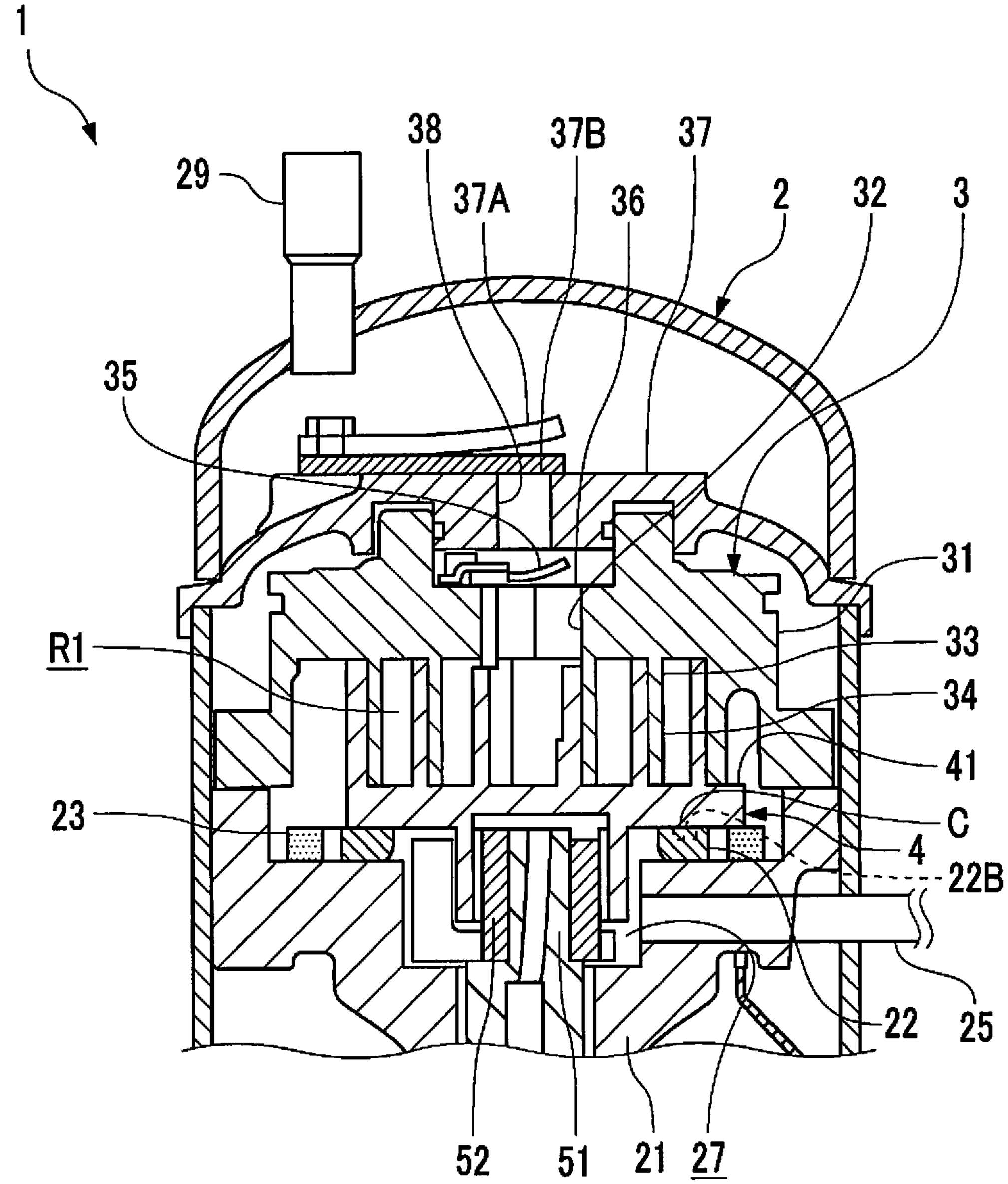
4
25D
25
25A
25B
25C
27
28
51
V1
V2
V3
V4
21
52
61
62
6
5
24
24A
O
26
53
54

FIG. 2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37B
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37A
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23
C
4
22B
22
25
52
51
21
27

FIG. 3

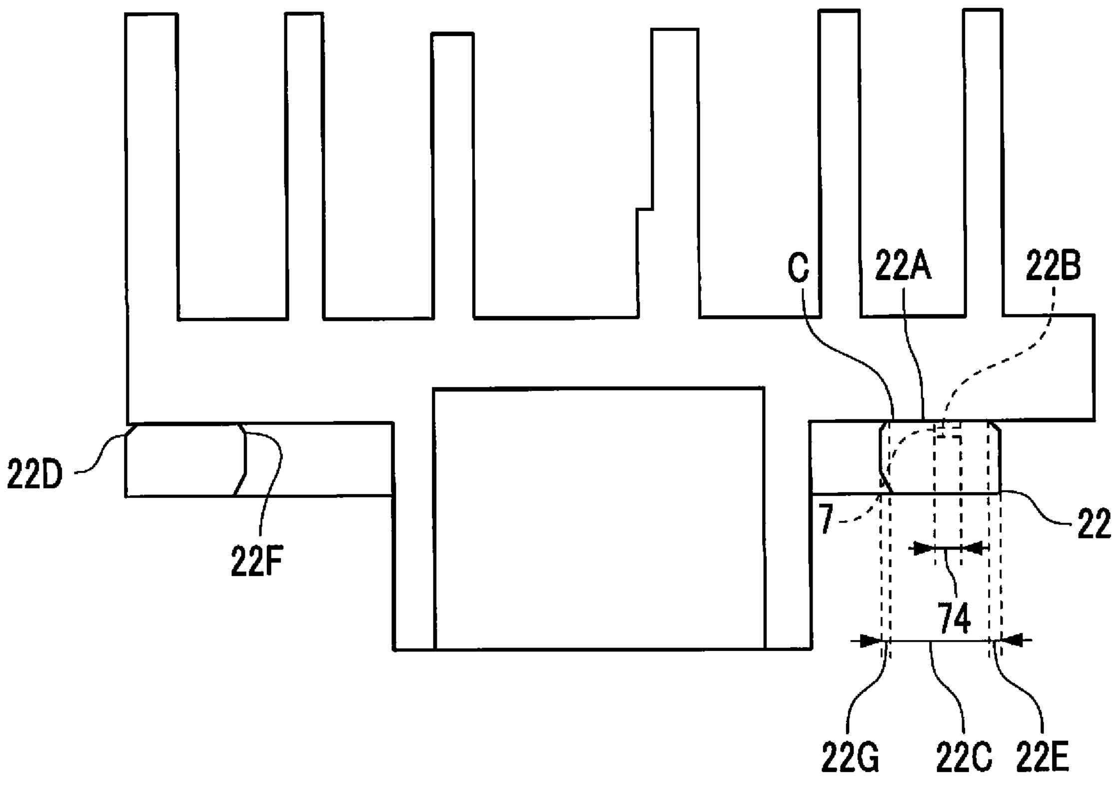


FIG. 4A

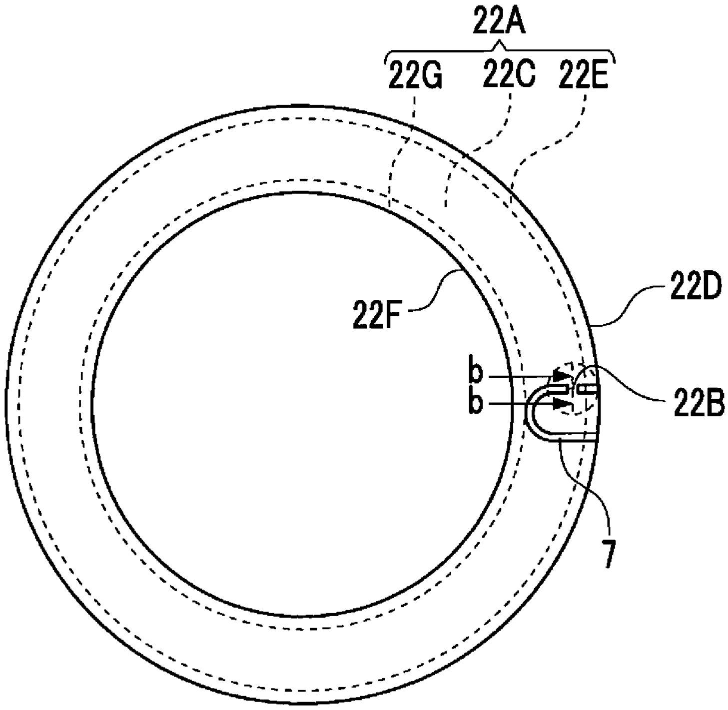


FIG. 4B

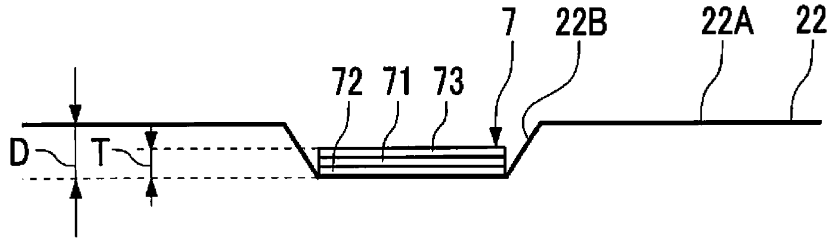


FIG. 4C

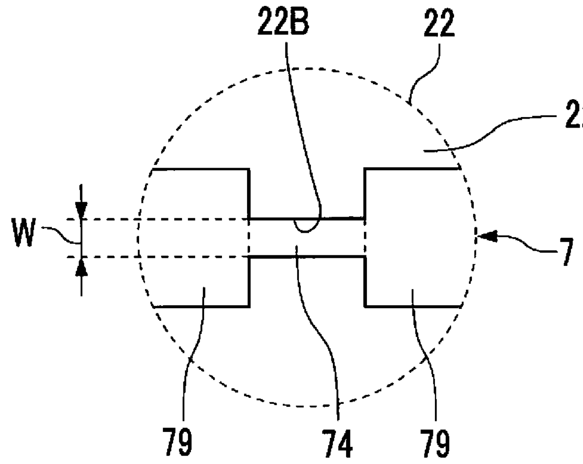


FIG. 5A

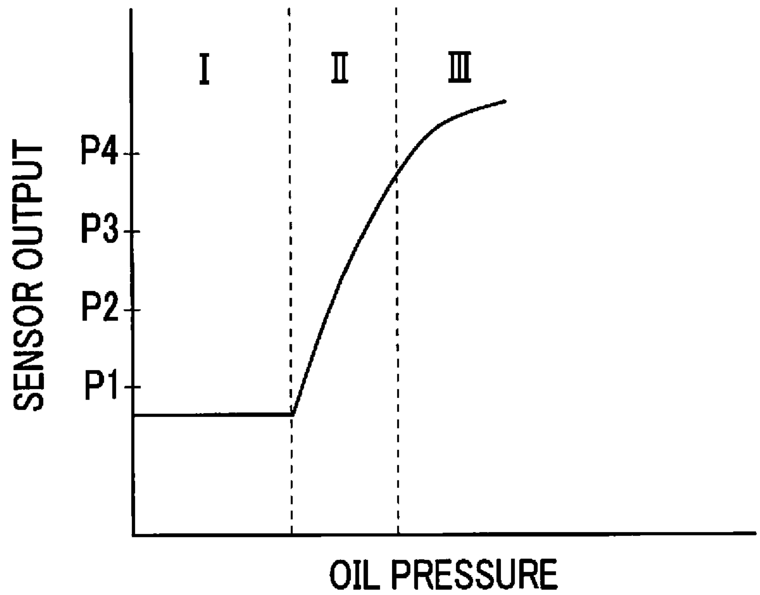

I
II
III
SENSOR OUTPUT
P4
P3
P2
P1
OIL PRESSURE

FIG. 5B

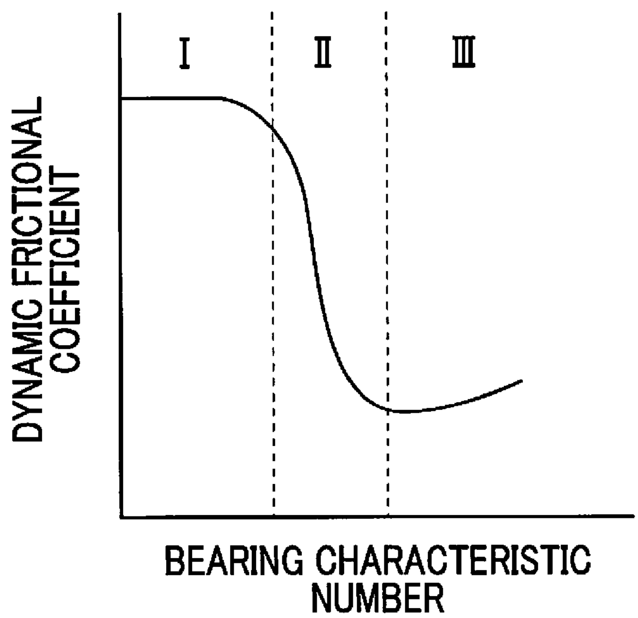
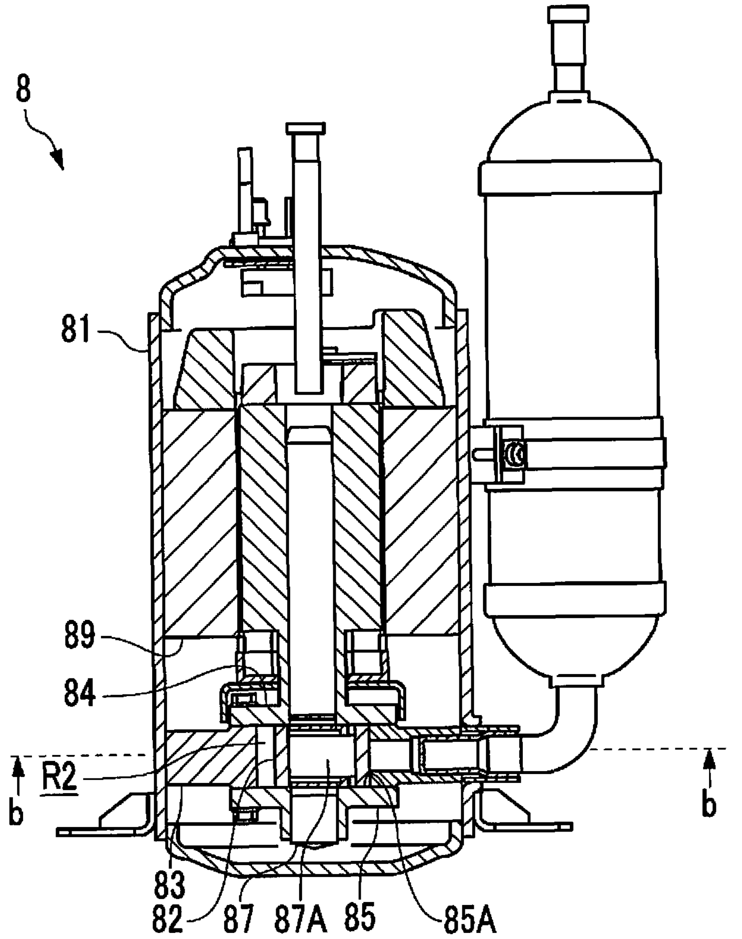

I
II
III
DYNAMIC FRICTIONAL COEFFICIENT
BEARING CHARACTERISTIC NUMBER

FIG. 6A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R2
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b
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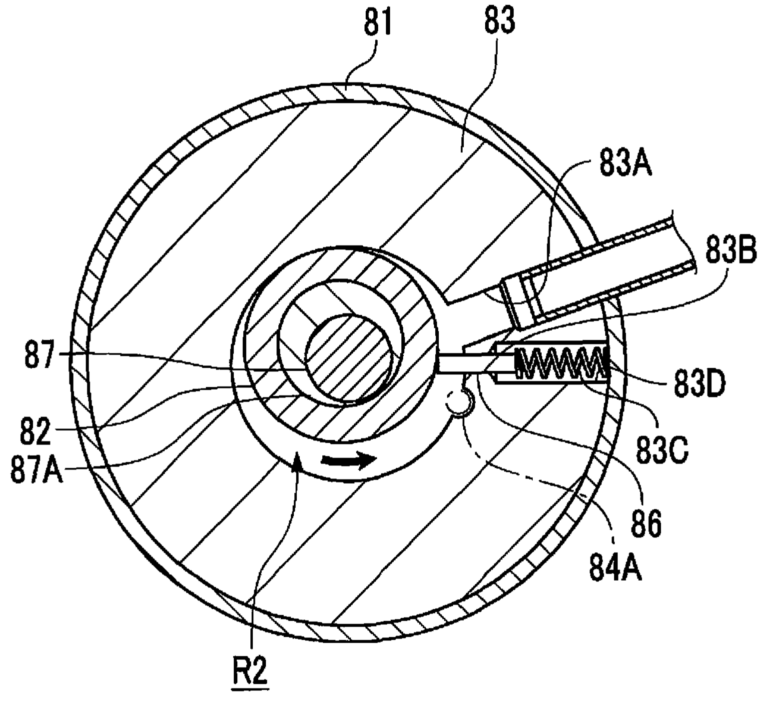
87
87A
85
85A

FIG. 6B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83A
83B
87
83D
82
83C
87A
86
84A
R2

INTERNATIONAL SEARCH REPORT

International application No. PCT/JP2017/044982

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F04C28/28(2006.01)i, F04C18/02(2006.01)i, F04C29/00(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)
Int.Cl. F04C28/28, F04C18/02, F04C29/00

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

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2018
Registered utility model specifications of Japan	1996-2018
Published registered utility model applications of Japan	1994-2018

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.
X Y A	JP 62-178791 A (MATSUSHITA ELECTRIC INDUSTRIAL CO., LTD.) 05 August 1987, page 2, lower left column, line 8 to page 6, lower right column, line 2, fig. 1-6 (Family: none)	1, 4-6, 10, 12 2-8, 10-14 9
X Y A	JP 2001-99070 A (HITACHI, LTD.) 10 April 2001, paragraphs [0014]-[0039], fig. 1-7 (Family: none)	1-3, 6-8, 11 2-8, 10-14 9
Y	JP 2017-31810 A (TOSHIBA CARRIER CORPORATION) 09 February 2017, paragraph [0029], fig. 1, 2 & CN 106401960 A	13-14

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

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search 06.03.2018	Date of mailing of the international search report 13.03.2018
Name and mailing address of the ISA/ Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

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Patent documents cited in the description

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