



## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention

**[0001]** The present invention relates to a hermetic two-stage compressor and a compressor system including the same.

#### Description of Related Art

**[0002]** In the related art, a hermetic two-stage compressor which is, for example, used for refrigeration air conditioning and includes a low-stage side compression chamber and a high-stage side compression chamber which are sealed within a housing is known. An example of such a hermetic two-stage compressor is disclosed in Japanese Unexamined Patent Application, First Publication No. 2009-180107.

**[0003]** In the hermetic two-stage compressor of Japanese Unexamined Patent Application, First Publication No. 2009-180107, a rotary compressor is disposed as a low-stage side compression chamber, a scroll compressor is disposed as a high-stage side compression chamber, gas supplied into a housing is compressed by the rotary compressor, and then is further compressed by the scroll compressor, and is discharged from the housing. In a case where oil for lubrication of the low-stage side compression chamber and the high-stage side compression chamber is held within the housing, a hermetic two-stage compressor is operated within the housing. In order to avoid a decrease in operation efficiency of the hermetic two-stage compressor, it is important to hold a sufficient amount of oil within the housing.

### SUMMARY OF THE INVENTION

**[0004]** Here, some of oil within the housing is discharged to an outside of the housing together with compressed gas. A hermetic two-stage compressor is known in which an oil return pipe is provided so that oil discharged to the outside of the housing returns again to the inside of the housing. However, a sufficient amount of oil cannot be returned to the inside of the housing and an amount of oil within the housing may be insufficient due to a problem such as a long system pipe. Therefore, a holding amount of oil is increased within the housing by increasing an internal volume of the housing and thereby it is conceivable to solve such a problem of lack of the amount of oil.

**[0005]** However, in a case where for example, gas such as carbon dioxide is compressed, since the inside of the housing is in a very high pressure, it is necessary to improve pressure resistance performance of the housing. In this case, if the internal volume of the housing is increased for the purpose of solving the lack of the amount of oil within the housing, a thickness of the hous-

ing has to be increased accordingly. As a result, there is a problem that the hermetic two-stage compressor is increased in size and in weight, and the like.

**[0006]** Therefore, an object of the invention is to provide a hermetic two-stage compressor capable of increasing a holding amount of oil within a housing while avoiding an increase in size and in weight, and a compressor system including the same.

**[0007]** According to a first aspect of the present invention, there is provided a hermetic two-stage compressor including a housing that has an oil reservoir at the bottom of the housing on an inside thereof; a low-stage side compression chamber that compresses gas on the inside of the housing; a high-stage side compression chamber that is disposed above the low-stage side compression chamber and further compresses gas discharged from the low-stage side compression chamber on the inside of the housing; and an oil pot that is connected to the inside of the housing at a position of the oil reservoir and above the position of the oil reservoir, stores oil, and supplies oil to the inside of the housing.

**[0008]** In such a hermetic two-stage compressor, it is possible to always supply oil to the inside of the housing by providing the oil pot communicating with the inside of the housing. In addition, since the oil pot connected the inside of the housing above the oil reservoir, pressures on the inside of the housing and the inside of the oil pot can be equalized. Therefore, it is possible to keep a liquid surface position of oil within the oil pot and a liquid surface position of the oil reservoir of the housing at the same level. Therefore, it is possible to easily adjust an oil amount on the inside of the housing and to avoid the lack of the oil amount on the inside of the housing by adjusting the oil amount within the oil pot.

**[0009]** According to a second aspect of the invention, in the first aspect, the hermetic two-stage compressor may further include an oil dropping section that is provided in the oil pot, connects the oil pot and a position corresponding to the high-stage side compression chamber in the housing, and is capable of introducing oil from the high-stage side compression chamber into the oil pot.

**[0010]** It is possible to introduce oil used for lubrication in the high-stage side compression chamber into the oil pot by providing the oil dropping section at such a position. Therefore, it is possible to reduce the oil amount flowing out to the outside of the housing together with gas discharged from the housing and to further avoid the lack of the oil amount on the inside of the housing.

**[0011]** Furthermore, the oil dropping section is connected to the oil pot and can return oil to the inside of the housing via the oil pot. Therefore, as compared to a case where the oil dropping section is directly connected to the housing and directly returns oil from the oil dropping section to the inside of the housing, it is possible to suppress that oil returned to the inside of the housing is rolled up by the flow of gas on the inside of the housing when returning oil. Therefore, it is possible to avoid that rolled up oil passes through the high-stage side compression

chamber and is discharged to the outside of the housing. As a result, it is possible to reduce an oil circulation amount (OC%) within a system.

**[0012]** According to a third aspect of the invention, in the first or second aspect, the hermetic two-stage compressor may further include an oil separator that separates oil from gas discharged from the high-stage side compression chamber, and an oil return section that connects the oil separator and the oil pot, and is capable of introducing oil from the oil separator into the oil pot.

**[0013]** Oil flowing out to the outside together with gas compressed by the high-stage side compression chamber and discharged from the housing can be returned to the oil pot via the oil separator and the oil return section by providing such an oil return section. Therefore, it is possible to further avoid the lack of the oil amount on the inside of the housing.

**[0014]** Furthermore, the oil return section is connected to the oil pot and can return oil to the inside of the housing via the oil pot. Therefore, as compared to a case where the oil return section is directly connected to the housing and directly returns oil from the oil return section to the inside of the housing, it is possible to suppress that oil returned to the inside of the housing is rolled up by the flow of gas on the inside of the housing when returning oil. Therefore, it is possible to avoid that rolled up oil passes through the high-stage side compression chamber and is discharged to the outside of the housing. As a result, it is possible to reduce an oil circulation amount (OC%) within the system.

**[0015]** According to a fourth aspect of the invention, in the third aspect, the hermetic two-stage compressor may further include a gas heat exchanger that heats gas (injection gas) introduced into the housing by heat of the oil pot.

**[0016]** Gas, which is compressed by the high-stage side compression chamber, is discharged from the housing, and is introduced to the oil separator, is at a high temperature. Therefore, oil contained in gas is also at a high temperature. Thus, oil having a high temperature is introduced from the oil separator into the oil pot by the oil return section. Therefore, the oil pot can be heated.

**[0017]** Here, heat exchange is performed by the gas heat exchanger between the heated oil pot and gas (injection gas) which is directly introduced into the housing. Therefore, it is possible to inject gas into the housing in a state where gas is heated. Therefore, it is possible to suppress that a liquid refrigerant is injected due to the lack of heating and to improve reliability of the compressor.

**[0018]** According to a fifth aspect of the invention, in the third or fourth aspect, the hermetic two-stage compressor may further include an accumulator that separates a liquid phase from gas and supplies a gas phase to the low-stage side compression chamber, and an accumulator heat exchanger that heats the accumulator by heat of the oil pot.

**[0019]** Gas, which is compressed by the high-stage

side compression chamber, is discharged from the housing, and is introduced into the oil separator, is at a high temperature. Therefore, oil contained in gas is also at a high temperature. Thus, oil having a high temperature is introduced from the oil separator into the oil pot by the oil return section. Therefore, the oil pot can be heated.

**[0020]** Here, heat exchange is performed by the accumulator heat exchanger between the heated oil pot and the accumulator. Therefore, it is possible to heat gas in advance by the accumulator before supplying gas to the low-stage side compression chamber.

**[0021]** Thus, it is possible to suppress suction of the liquid refrigerant and to improve reliability of the compressor.

**[0022]** According to a sixth aspect of the hermetic two-stage compressor of the invention, in the fifth aspect, the accumulator may be disposed in the vicinity of the oil pot.

**[0023]** It is possible to share a bracket for attaching the oil pot to the housing and a bracket for attaching the accumulator to the housing by disposing the accumulator and the oil pot at such positions. Therefore, it is possible to simplify the manufacture of the hermetic two-stage compressor and to reduce the cost.

**[0024]** According to a seventh aspect of the invention, in any one of the first to sixth aspects, the hermetic two-stage compressor may further include a connection pipe that is provided in the oil pot and is connected to a position of the oil reservoir in the housing. An inside of the oil pot may be connected to the inside of the housing at the position of the oil reservoir. A sensor attachment section that is provided with a temperature sensor for measuring a temperature of oil may be provided on an outer peripheral surface of the connection pipe.

**[0025]** As described above, it is possible to dispose the temperature sensor on the outer peripheral surface of the connection pipe of which a thickness dimension is smaller than that of a wall surface of the housing by providing the sensor attachment section in the coordinate position. Therefore, it is possible to measure the temperature of oil of the oil reservoir by the temperature sensor by disposing the temperature sensor at a position closer to oil in the oil reservoir in the housing. Thus, it is possible to improve measurement accuracy of the temperature of the oil of the oil reservoir.

**[0026]** According to an eighth aspect of the invention, in any one of the first to seventh aspects, the hermetic two-stage compressor may further includes a liquid surface sensor that is provided in the oil pot and measures a height of a liquid surface of oil within the oil pot.

**[0027]** It is possible to indirectly measure the liquid surface position of the oil reservoir of the housing which is equal level to the liquid surface position within the oil pot by measuring the liquid surface position within the oil pot by such a liquid surface sensor. Thus, It is possible to easily adjust the oil amount on the inside of the housing so as not to be insufficient in the oil amount and to avoid the lack of the oil amount on the inside of the housing by adjusting the oil amount within the oil pot based on a

measurement result of the liquid surface sensor.

**[0028]** According to a ninth aspect of the present invention, there is provided a compressor system including the hermetic two-stage compressor according to any one of the aspects 1 to 8; and an oil equalizing pipe that connects between the oil pots in each hermetic two-stage compressor.

**[0029]** In such a compressor system, it is possible to always supply oil from the oil pot to the inside of the housing by providing the hermetic two-stage compressor and to easily adjust the oil amount on the inside of the housing by adjusting the oil amount within the oil pot. Therefore, it is possible to avoid the lack of the oil amount on the inside of the housing.

**[0030]** Furthermore, the oil equalizing pipes allow oil to be delivered between the oil pots in a plurality of hermetic two-stage compressors. Thus, it is possible to eliminate the lack of the oil amount on the inside of the housing in an entirety of the compressor system and to improve reliability of the compressor system.

**[0031]** Furthermore, the oil equalizing pipe is connected to the oil pot and can supply oil to the inside of the housing via the oil pot. Therefore, as compared to a case where the oil equalizing pipe is directly connected to the housing and oil is directly supplied from the oil equalizing pipe to the inside of the housing, it is possible to suppress that oil supplied to the inside of the housing is rolled up by the flow of gas on the inside of the housing when supplying oil. Therefore, it is possible to avoid that rolled up oil passes through the high-stage side compression chamber and is discharged to the outside of the housing. As a result, it is possible to reduce the oil circulation amount (OC%) within the system.

**[0032]** According to the hermetic two-stage compressor and the compressor system described above, it is possible to increase a holding amount of oil within the housing while avoiding an increase in size and in weight by providing the oil pot described above.

#### BRIEF DESCRIPTION OF THE DRAWINGS

##### **[0033]**

FIG. 1 is an entire schematic view illustrating a compressor system according to an embodiment of the invention.

FIG. 2 is a vertical sectional view illustrating a hermetic two-stage compressor of the compressor system according to the embodiment of the invention.

#### DETAILED DESCRIPTION OF THE INVENTION

**[0034]** Hereinafter, a compressor system 1 in an embodiment of the invention will be described.

**[0035]** As illustrated in FIG. 1, the compressor system 1 includes a plurality of hermetic two-stage compressors 2 (hereinafter, referred to as the two-stage compressor 2) and oil equalizing pipes 3 connecting the two-stage

compressors 2.

**[0036]** As illustrated in FIG. 2, each of the two-stage compressors 2 compresses a refrigerant R that is, for example, gas such as carbon dioxide. The two-stage compressor 2 includes a housing 11, a rotary compressor (low-stage side compression chamber) 12, a scroll compressor (high-stage side compression chamber) 13, an electric motor 14, and a rotation shaft 15 which are provided on an inside of the housing 11, and an accumulator 16 and an oil pot 17 which are provided on an outside of the housing 11.

**[0037]** The housing 11 includes a body section 23 having a cylindrical shape, and an upper lid section 22 and a lower lid section 24 which seal upper and lower openings of the body section 23. Thus, the housing 11 seals a space on the inside thereof.

**[0038]** The rotation shaft 15 is supported by an upper bearing 31 provided at an upper portion on the inside of the housing 11 and lower bearings 32A and 32B provided at a lower portion on the inside of the housing 11, and is rotatable with respect to the housing 11 around an axis X. A discharge cover 60, which is fixed to a fixed scroll 51 by a bolt 70, is provided at an upper portion of the scroll compressor 13 and an inside of the discharge cover 60 is sealed with respect to an internal space of the housing 11. Here, the internal space of the housing 11 is an intermediate pressure space MC and the internal space of the discharge cover 60 is a discharge space DC.

**[0039]** The electric motor 14 is disposed on an outer periphery side of the rotation shaft 15 within the intermediate pressure space MC in the housing 11 and rotates the rotation shaft 15 around the axis X. That is, the electric motor 14 has a rotor 38 that is fixed to an outer peripheral surface of the rotation shaft 15 and a stator 39 that is fixed to an inner peripheral surface of the body section 23 of the housing 11 to face an outer peripheral surface of the rotor 38 in a radial direction. The electric motor 14 is connected to power supply (not illustrated) and the rotation shaft 15 is rotated by power from the power supply.

**[0040]** The rotary compressor 12 is disposed at a position adjacent to the lower lid section 24 below the electric motor 14 on the inside of the housing 11. The rotary compressor 12 includes an eccentric shaft section 41 that is provided in the rotation shaft 15, a piston rotor 42 that is fixed to the eccentric shaft section 41 and is eccentrically rotated with respect to the axis X in accordance with the rotation of the rotation shaft 15, and a cylinder 44 in which a compression chamber C1 for accommodating the piston rotor 42 is formed on an inside thereof.

**[0041]** The cylinder 44 is formed with a suction hole 44a through which the refrigerant R is capable of flowing into the inside. The suction hole 44a is connected to a suction pipe 33 penetrating the body section 23 of the housing 11 and the refrigerant R is supplied from the outside of the housing 11 through the suction pipe 33. In addition, the cylinder 44 is formed with a discharge hole

(not illustrated) and the refrigerant R, which is compressed by the rotary compressor 12, is discharged from the discharge hole to the intermediate pressure space MC of the housing 11.

**[0042]** Here, the lower bearings 32A and 32B are disposed so as to pinch the rotary compressor 12 from above and below in the axis X, and is fixed to the cylinder 44 with a bolt 48.

**[0043]** Oil A is stored at a bottom portion of the housing 11 and an oil reservoir O1 is provided. A liquid surface of the oil reservoir O1 during initially sealing of the oil A is positioned above the rotary compressor 12. Therefore, the rotary compressor 12 is driven in the oil reservoir O1.

**[0044]** The scroll compressor 13 is disposed above the electric motor 14 on the inside of the housing 11. The scroll compressor 13 includes the fixed scroll 51 that is fixed to the upper bearing 31 and a turning scroll 57 that is disposed below the fixed scroll 51 to face the fixed scroll 51.

**[0045]** The fixed scroll 51 has an end plate 52 that is fixed to an upper surface of the upper bearing 31 and a fixed wrap 53 that protrudes below from the end plate 52. A discharge hole 52a vertically penetrating is formed at a center portion (vicinity of the axis X) of the end plate 52.

**[0046]** The turning scroll 57 has an end plate 58 that is disposed so as to be pinched by the upper bearing 31 and the end plate 52 of the fixed scroll 51 in a direction of the axis X, and is fixed to the rotation shaft 15, and a turning wrap 59 that protrudes above from the end plate 58.

**[0047]** The end plate 58 is fixed to an eccentric shaft section 56 provided at an upper end of the rotation shaft 15 and is eccentrically rotated with respect to the axis X in accordance with the rotation of the rotation shaft 15.

**[0048]** The turning wrap 59 is formed with a compression chamber C2 that compresses the refrigerant R between the fixed wrap 53 and the compression chamber C2 by meshing with the fixed wrap 53.

**[0049]** Here, the fixed scroll 51 is formed with a suction hole (not illustrated) for sucking the refrigerant R which is compressed by the rotary compressor 12 and is discharged within the intermediate pressure space MC of the housing 11 within the compression chamber C2. The refrigerant R, which is compressed by the compression chamber C2, is discharged from a discharge pipe 34 that penetrates the housing 11 and is opened to the discharge space DC to the outside of the housing 11 through the discharge hole 52a of the fixed scroll 51 and through the discharge space DC within the discharge cover 60.

**[0050]** The accumulator 16 is disposed on the outside of the housing 11 and is fixed to the outer peripheral surface of the body section 23 of the housing 11 via a bracket 37a. The accumulator 16 separates a liquid phase from the refrigerant R and supplies a gas phase of the refrigerant R to the rotary compressor 12 through the suction pipe 33.

**[0051]** The oil pot 17 is disposed on the outside of the

housing 11 and is fixed to the outer peripheral surface of the body section 23 of the housing 11 via a bracket 37b. The oil pot 17 includes a cylindrical pot body section 61, and a pot upper lid section 62 and a pot lower lid section 63 which seal upper and lower openings of the pot body section 61 and are provided to be mountable and demountable with respect to the body section 23. Therefore, the oil pot 17 is formed with an oil reservoir O2 for storing the oil A on the inside. The oil pot 17 may be provided with an oil supply source (not illustrated) for supplying the oil A from the outside of the compressor system 1.

**[0052]** In addition, the oil pot 17 is provided with a lower connection pipe 67 that connects a lower end portion of the pot lower lid section 63 and a lower end portion of the lower lid section 24 of the housing 11. The lower connection pipe 67 is opened in the oil reservoir O2 of the lower portion of the inside of the oil pot 17 and in the oil reservoir O1 of the inside of the housing 11, and is disposed below the liquid surfaces of the oil reservoirs O1 and O2.

**[0053]** In addition, a sensor attachment section 69 is provided on an outer peripheral surface of the lower connection pipe 67 so as to mountably and demountably attach a temperature sensor 81 for measuring a temperature. The sensor attachment section 69 may be provided in the lower connection pipe 67 close to the housing 11. The temperature sensor 81 measures a temperature on the outer peripheral surface of the lower connection pipe 67 and indirectly measures a temperature of the oil A of the oil reservoir O1 within the housing 11.

**[0054]** Furthermore, the oil pot 17 is provided with an upper connection pipe 68 that connects an upper end portion of the pot upper lid section 62 and the body section 23 of the housing 11. The upper connection pipe 68 is opened to an upper portion of the oil reservoir O2 on the inside of the oil pot 17 and the intermediate pressure space MC above the oil reservoir O1 on the inside of the housing 11.

**[0055]** Here, in the embodiment, the oil pot 17 is provided to be connected to an oil dropping pipe (oil dropping section) 72. The oil dropping pipe 72 connects the upper end portion of the oil pot 17 and a position corresponding to the scroll compressor 13 in the housing 11, and is capable of introducing the oil A from the scroll compressor 13 into the oil pot 17. Here, the upper bearing 31 is formed with a bearing flow path 31a that penetrates in the radial direction and is opened to the inside of the housing 11 at a position in which the turning scroll 57 is fixed to the eccentric shaft section 56 in the axis X direction. Furthermore, the housing 11 is formed with a dropping pipe opening 36 which allows the bearing flow path 31a to communicate with the outside of the housing 11. The oil dropping pipe 72 is inserted into the bearing flow path 31a and the dropping pipe opening 36 thereby being connected to the housing 11.

**[0056]** Furthermore, in the embodiment, the discharge pipe 34 is provided with an oil separator 71. The oil separator 71 separates the oil A from the refrigerant R dis-

charged from the discharge pipe 34.

**[0057]** The oil pot 17 is provided with an oil return pipe (oil return section) 73 that connects the oil separator 71 and the oil pot 17.

**[0058]** The oil return pipe 73 is capable of introducing the oil A separated by the oil separator 71 into the oil pot 17. The oil return pipe 73 is opened to the inside of the oil pot 17 above from the liquid surface of the oil reservoir 02 within the oil pot 17.

**[0059]** Furthermore, in the embodiment, the oil pot 17 is provided with a refrigerant heat exchanger (gas heat exchanger) 74 for heating a refrigerant R1 (injection refrigerant) blown into the housing 11 by heat of the oil pot 17. Here, the housing 11 is provided with a blowing pipe 35 provided so as to penetrate inside and outside.

**[0060]** For example, the refrigerant heat exchanger 74 circulates a fluid F between a wall surface of the oil pot 17 and a refrigerant supply source 75 connected to the blowing pipe 35 thereby heating the refrigerant R1 blowing from the oil pot 17 and the blowing pipe 35 to the scroll compressor 13.

**[0061]** Furthermore, in the embodiment, the oil pot 17 is provided with an accumulator heat exchanger 77 for heating the accumulator 16 by heat of the oil pot 17. The accumulator heat exchanger 77 circulates, for example, the fluid F between the wall surface of the oil pot 17 and the wall surface of the accumulator 16 thereby heating the accumulator 16.

**[0062]** Furthermore, in the embodiment, a liquid surface sensor 82, which is capable of measuring a height position of the liquid surface of the oil reservoir 02 within the oil pot 17, is provided on the wall surface of the oil pot 17. The liquid surface sensor 82 has a pair of measurement sections 82a and 82b which is provided to be separated from each other vertically on the wall surface of the oil pot 17. Therefore, the liquid surface sensor 82 issues a signal when the liquid surface position reaches the upper measurement section 82a and issues a signal when the liquid surface position is lower than the lower measurement section 82b. Therefore, it is possible to maintain the liquid surface position of the oil A between a pair of measurement sections 82a and 82b.

**[0063]** As illustrated in FIG. 1, the oil equalizing pipe 3 is connected to the wall surface of the oil pot 17 in each two-stage compressor 2 between a pair of measurement sections 82a and 82b in the liquid surface sensor 82, and is opened to the inside of the oil pot 17 at the position. The oil equalizing pipe 3 causes the oil pots 17 of adjacent two-stage compressors 2 to communicate with each other.

**[0064]** Here, an opening position of the oil equalizing pipe 3 may be positioned above from the liquid surface position of the oil reservoir 01 during initial sealing of the oil A into the oil pot 17.

**[0065]** The compressor system 1 of the embodiment described above is provided with the oil pot 17 communicating with the inside of the housing 11 of each two-stage compressor 2. Therefore, it is possible to always

supply the oil A to the inside of the housing 11. In addition, since the oil pot 17 connected to inside of the housing 11 above the oil reservoir 01, it is possible to maintain the liquid surface position of the oil reservoir 02 within the oil pot 17 and the lower surface portion of the oil reservoir 01 of the housing 11 at the same level. Therefore, It is possible to easily adjust the amount of the oil A on the inside of the housing 11 and to avoid the lack of the oil amount on the inside of the housing 11 by adjusting the amount of the oil A within the oil pot 17.

**[0066]** Therefore, it is not necessary to increase the size of the housing 11 in order to solve the lack of the oil amount by providing the oil pot 17 in the compressor system 1. Therefore, it is not necessary to increase a thickness of the housing 11 accordingly. Thus, it is possible to increase a holding amount of the oil A within the housing 11 while avoiding an increase in size and in weight of the two-stage compressor 2.

**[0067]** Furthermore, in the embodiment, the upper connection pipe 68 is opened to the intermediate pressure space MC in which the refrigerant R of an intermediate pressure after being compressed by the rotary compressor 12. Therefore, the oil A discharged from the rotary compressor 12 can effectively flow into the oil pot 17. Therefore, in a state where the amount of the oil A in the refrigerant R is reduced, when supplying the refrigerant R to the scroll compressor 13, it is possible to reduce the amount of the oil A in the refrigerant R discharged from the scroll compressor 13. As a result, it is possible to further increase the holding amount of the oil A within the housing 11.

**[0068]** In addition, it is possible to introduce the oil A used for lubrication in the scroll compressor 13 into the oil pot 17 by providing the oil dropping pipe 72 in the oil pot 17. Therefore, it is possible to reduce the oil A that flows out to the outside of the housing 11 together with the refrigerant R disposed from the housing 11 through the discharge pipe 34 and it is possible to further avoid the lack of the oil amount on the inside of the housing 11.

**[0069]** Furthermore, the oil dropping pipe 72 is connected to the oil pot 17 and can return the oil A from the oil dropping pipe 72 to the inside of the housing 11 via the oil pot 17. Therefore, as compared to a case where the oil dropping pipe 72 is directly attached to the housing 11 and the oil A is returned to the inside of the housing 11, it is possible to suppress rolled-up of the oil A returned to the inside of the housing 11 by the flow of the refrigerant R on the inside of the housing 11 when the oil A is returned to the inside of the housing 11. Therefore, it is possible to avoid that the rolled-up oil A passes through the scroll compressor 13 and is discharged to the outside of the housing 11. As a result, it is possible to reduce the oil circulation amount (OC%) within the system.

**[0070]** In addition, it is possible to return the oil A flowing out to the outside of the housing 11 via the oil separator 71 and the oil return pipe 73 together with the refrigerant R, which is compressed by the scroll compressor 13 and is discharged from the housing 11, to the oil

pot 17 by providing the oil return pipe 73 in the oil pot 17. Therefore, it is possible to further avoid the lack of the oil amount on the inside of the housing 11.

**[0071]** Furthermore, it is possible to return the oil A from the oil return pipe 73 to the inside of the housing 11 via the oil pot 17. Therefore, as compared to a case where the oil return pipe 73 is directly attached to the housing 11 and the oil A is returned to the inside of the housing 11, it is possible to suppress that the oil A, which is returned to the inside of the housing 11 by the flow of the refrigerant R on the inside of the housing 11, is rolled up when the oil A is returned from the oil pot 17 to the inside of the housing 11. Therefore, it is possible to reduce the oil circulation amount (OC%) within the system by reducing the amount of the oil A discharged from the housing 11 to the outside. Furthermore, since a thickness of the oil pot 17 is thinner than that of the housing 11, it is possible to easily install the oil return pipe 73. Therefore, it is possible to suppress the manufacturing cost.

**[0072]** In addition, the refrigerant R, which is compressed by the scroll compressor 13, is discharged from the housing 11, and is introduced into the oil separator 71, is at a high temperature. Therefore, the oil A contained in the refrigerant R is also at a high temperature. Therefore, it is possible to heat the oil pot 17 by introducing the oil A having a high temperature from the oil separator 71 to the oil pot 17 by the oil return pipe 73.

**[0073]** Therefore, it is possible to blow the refrigerant R1 into the housing 11 in a state where the refrigerant R1 is heated by performing heat exchange by, for example, the fluid F between the heated oil pot 17 and the refrigerant R1 (injection refrigerant) blown into the housing 11 by the refrigerant heat exchanger 74. Therefore, it is possible to suppress that the liquid refrigerant is injected by the lack of heating and it is possible to improve reliability of the two-stage compressor 2.

**[0074]** Furthermore, heat exchange is performed between the heated oil pot 17 and the accumulator 16, for example, by the fluid F by the accumulator heat exchanger 77. Therefore, it is possible to heat the refrigerant R in advance by the accumulator 16 before supplying the refrigerant R to the rotary compressor 12. Therefore, it is possible to suppress that the liquid refrigerant is sucked and it is possible to improve reliability of the two-stage compressor 2.

**[0075]** In addition, it is possible to install the temperature sensor 81 on the outer peripheral surface of the lower connection pipe 67 of which the thickness dimension is thinner than that of the wall surface of the housing 11 by providing the sensor attachment section 69 in the lower connection pipe 67. Therefore, it is possible to install the temperature sensor 81 at a position closer to the oil A of the oil reservoir O1 and to measure the temperature by the temperature sensor 81. Thus, it is possible to improve the measurement accuracy of the temperature of the oil A.

**[0076]** In addition, it is possible to indirectly measure the liquid surface position of the oil reservoir O1 of the

housing 11 which is the same level as the liquid surface position within the oil pot 17 by measuring the liquid surface position of the oil reservoir O2 within the oil pot 17 by the liquid surface sensor 82. Therefore, it is possible to easily adjust the amount of the oil A on the inside of the housing 11 and to avoid the lack of the oil amount on the inside of the housing 11 by adjusting the amount of the oil A within the oil pot 17 based on a measurement result of the liquid surface sensor 82.

**[0077]** In addition, the oil equalizing pipe 3 is capable of delivering the oil A between the oil pots 17 in the plurality of two-stage compressors 2. That is, when the amount of the oil A within the oil pot 17 of one two-stage compressor 2 and is increased until the liquid surface exceeds the position of the oil equalizing pipe 3, it is possible to introduce the oil A to the oil pot 17 in another two-stage compressor 2 connected to the oil equalizing pipe 3. Therefore, it is possible to avoid that the lack of the oil amount in the oil pot 17 of any one two-stage compressor 2 in the compressor system 1. As a result, it is possible to avoid that the lack of the oil amount occurs within the housing 11 of any one two-stage compressor 2. Therefore, it is possible to solve the lack of the oil amount on the inside of the housing 11 and to improve reliability of the compressor system 1 in the entirety of the compressor system 1.

**[0078]** Furthermore, since it is possible using the oil equalizing pipe 3 to supply the oil A to the inside of the housing 11 through the oil pot 17, as compared to a case where the oil equalizing pipe 3 is directly attached to the housing 11, it is possible to suppress that the oil A, which is returned to the inside of the housing 11 by the flow of the refrigerant R on the inside of the housing 11, is rolled up by the oil equalizing pipe 3 when the oil A is returned from the oil pot 17 to the inside of the housing 11. Therefore, it is possible to suppress that the rolled-up oil A passes through the scroll compressor 13 and is discharged to the outside of the housing 11. As a result, it is possible to reduce an oil circulation amount (OC%) within a system. Furthermore, since the thickness of the oil pot 17 is thinner than that of the housing 11, it is possible to easily install the oil equalizing pipe 3. Therefore, it is possible to suppress the manufacturing cost.

**[0079]** Although the embodiments of the invention is described in detail with reference to the drawings, each configuration in each embodiment and combinations thereof, and the like are merely examples and additions, omissions, replacements, and other changes of configurations may be made without departing from the spirit of the invention. In addition, the invention is not limited to the embodiments but is limited by the claims.

**[0080]** For example, the oil pot 17 may be disposed adjacent to the accumulator 16. Therefore, it is possible to share the bracket 37b for attaching the oil pot 17 to the housing 11 and the bracket 37a for attaching the accumulator 16 to the housing 11. Therefore, it is possible to simplify the manufacture of the two-stage compressor 2 and to reduce the cost.

**[0081]** Furthermore, the oil dropping pipe 72, the oil return pipe 73, the refrigerant heat exchanger 74, the accumulator heat exchanger 77, the sensor attachment section 69 of the temperature sensor 81, and the liquid surface sensor 82 are not necessarily provided.

**[0082]** In addition, the rotary compressor 12 is provided as the low-stage side compression chamber and the scroll compressor 13 is provided as the high-stage side compression chamber within the housing 11, but the invention is not limited thereto. For example, the scroll compressor 13 may be provided as the low-stage side compression chamber and the rotary compressor 12 may be used as the high-stage side compression chamber. In addition, the scroll compressor 13 may be provided on both the low-stage side and the high-stage side, or the rotary compressor 12 may be provided on both the low-stage side and the high-stage side. Furthermore, a compressor other than the scroll compressor 13 and the rotary compressor 12 may be provided.

**[0083]** While preferred embodiments of the invention have been described and illustrated above, it should be understood that these are exemplary of the invention and are not to be considered as limiting. Additions, omissions, substitutions, and other modifications can be made without departing from the scope of the present invention. Accordingly, the invention is not to be considered as being limited by the foregoing description, and is only limited by the scope of the appended claims.

#### EXPLANATION OF REFERENCES

#### **[0084]**

1	compressor system
2	hermetic two-stage compressor
3	oil equalizing pipe
11	housing
12	rotary compressor (low-stage side compression chamber)
13	scroll compressor (high-stage side compression chamber)
14	electric motor
15	rotation shaft
16	accumulator
17	oil pot
22	upper lid section
23	body section
24	lower lid section
31	upper bearing
31a	bearing flow path
32A, 32B	lower bearing
33	suction pipe
34	discharge pipe
35	blowing pipe
36	dropping pipe opening
37a	bracket
37b	bracket
38	rotor

39	stator
41	eccentric shaft section
42	piston rotor
44	cylinder
5	44a suction hole
48	bolt
51	fixed scroll
52	end plate
52a	discharge hole
10	53 fixed wrap
56	eccentric shaft section
57	turning scroll
58	end plate
59	turning wrap
15	60 discharge cover
61	pot body section
62	pot upper lid section
63	pot lower lid section
67	lower connection pipe
20	68 upper connection pipe
69	sensor attachment section
70	bolt
71	oil separator
72	oil dropping pipe (oil dropping section)
25	73 oil return pipe (oil return section)
74	refrigerant heat exchanger (gas heat exchanger)
75	refrigerant supply source
77	accumulator heat exchanger
30	81 temperature sensor
82	liquid surface sensor
82a, 82b	measurement section
C1	compression chamber
C2	compression chamber
35	MC intermediate pressure space
DC	discharge space
O1	oil reservoir
O2	oil reservoir
F	fluid
40	R refrigerant
R1	refrigerant
A	oil
X	axis

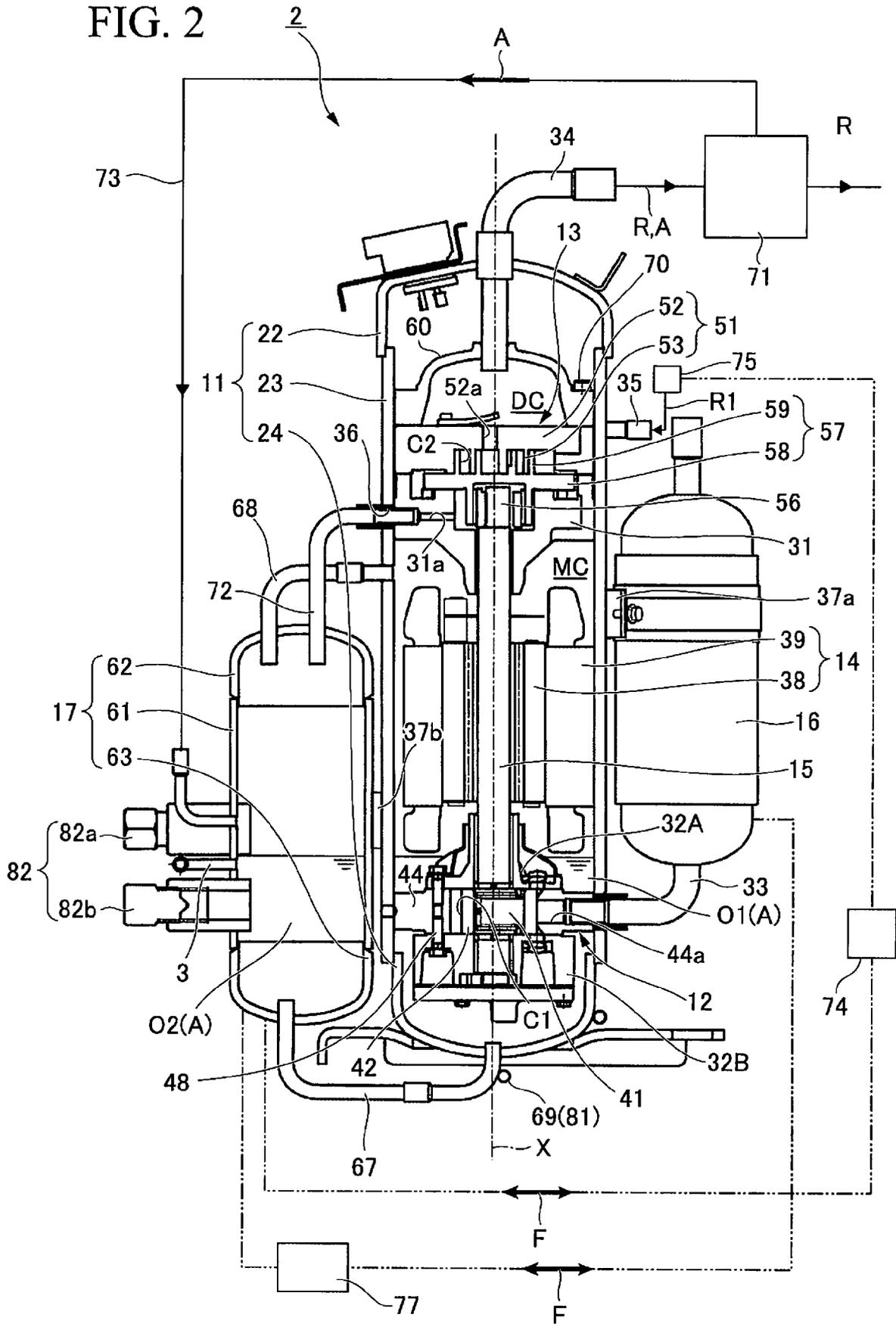
#### 45 **Claims**

1. A hermetic two-stage compressor (2) comprising:
  - 50 a housing (11) that has oil reservoir (O1) at the bottom of housing on an inside thereof;
  - a low-stage side compression chamber (12) that compresses gas on the inside of the housing;
  - a high-stage side compression chamber (13) that is disposed above the low-stage side compression chamber and further compresses gas discharged from the low-stage side compression chamber on the inside of the housing; and

- an oil pot (17) that is connected to the inside of the housing (11) at a position of the oil reservoir (O1) and above the position of the oil reservoir, stores oil, and supplies oil to the inside of the housing.
2. The hermetic two-stage compressor according to claim 1, further comprising:
- an oil dropping section (72) that is provided in the oil pot (17), connects the oil pot and a position corresponding to the high-stage side compression chamber (13) in the housing (11), and is capable of introducing oil from the high-stage side compression chamber (13) into the oil pot (17).
3. The hermetic two-stage compressor according to claim 1 or 2, further comprising:
- an oil separator (71) that separates oil from gas discharged from the high-stage side compression chamber (13), and  
an oil return section (73) that connects the oil separator (71) and the oil pot (17), and is capable of introducing oil from the oil separator into the oil pot.
4. The hermetic two-stage compressor according to claim 3, further comprising:
- a gas heat exchanger (74) that heats gas introduced into the housing by heat of the oil pot (17).
5. The hermetic two-stage compressor according to claim 3 or 4, further comprising:
- an accumulator (16) that separates a liquid phase from gas and supplies a gas phase to the low-stage side compression chamber (12), and  
an accumulator heat exchanger (77) that heats the accumulator by heat of the oil pot.
6. The hermetic two-stage compressor according to claim 5, wherein the accumulator (16) is disposed in the vicinity of the oil pot (17).
7. The hermetic two-stage compressor according to any one of claims 1 to 6, further comprising:
- a connection pipe (67) that is provided in the oil pot and is connected to a position of the oil reservoir (O1) in the housing (11), wherein an inside of the oil pot (17) is connected to inside of the housing (11) at the position of the oil reservoir (O1), and  
wherein a sensor attachment section (69) that is provided with a temperature sensor (81) for measuring a temperature of oil is provided on an outer peripheral surface of the connection pipe (67).
8. The hermetic two-stage compressor according to any one of claims 1 to 7, further comprising:
- a fluid level sensor (82) that is provided in the oil pot (17) and measures a height of a fluid level of oil within the oil pot.
9. A compressor system comprising:
- a plurality of hermetic two-stage compressors (2) according to any one of claims 1 to 8; and  
a pipe (3) that connects between the oil pots (17) in each hermetic two-stage compressor to equalize oil level of compressors.



FIG. 2





EUROPEAN SEARCH REPORT

Application Number  
EP 17 16 3713

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