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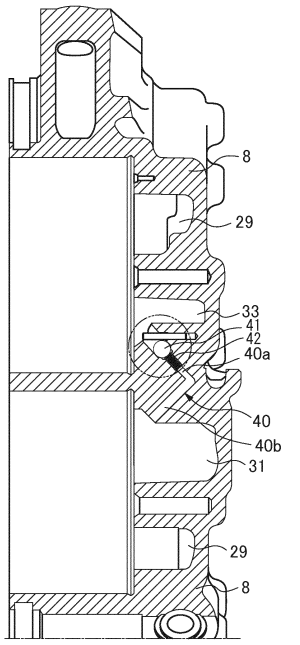
(54) COMPRESSOR

(57) To provide a compressor capable of suppressing the flowing out of lubrication oil in a compressor to the outside of the compressor due to the movement of a refrigerant in a refrigerating cycle caused by a change in temperature in a state where an operation of the compressor is stopped.

[Solution]

A compressor includes: a housing; a suction region (suction passage 31) and a discharge region (discharge passage 33) which are formed in the housing in a partitioned manner; a shaft which is pivotally supported in the inside of the housing; and a compression mechanism which sucks a refrigerant from the suction region and discharges the refrigerant to the discharge region due to a rotational motion of the shaft, wherein the compressor further includes: a bypass passage 40 which makes the suction region and the discharge region communicate with each other; a valve element 41 which is capable of closing the bypass passage 40 from a discharge region side; and a spring 42 which biases the valve element 41 toward the discharge region side (toward the valve opening direction).



cross section taken along line A-A

Fig. 3

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Description

TECHNICAL FIELD

[0001] The present invention relates to a compressor of a refrigerating cycle used in a vehicle-use air conditioner or the like, and more particularly to a compressor having a function of suppressing the flowing out of lubrication oil in the compressor to the outside of the compressor due to the movement of a refrigerant in the refrigerating cycle caused by a change in temperature when the compressor is stopped.

BACKGROUND ART

[0002] In a refrigerating cycle used in an automobile-use air conditioner, using a partition wall (fire wall) which partitions an engine room side and a cabin side from each other as a boundary, an evaporator is arranged in the cabin side, and a condenser, a compressor and the like are arranged in the engine room side. In such a refrigerating cycle, when a vehicle is warmed by sunbeams during daytime in a state where the operation of the compressor is stopped, as shown in Fig. 6, a temperature of an evaporator A arranged in the cabin side which is liable to be warmed by sunbeams is also elevated, while temperatures of a condenser B and a compressor C arranged in the inside of the engine room are not elevated to an extent that the temperature of the evaporator A is elevated. Further, the compressor C having a large thermal capacity is hardly warmed and hence, the compressor C is a place which exhibits the lowest temperature in the refrigerating cycle so that a refrigerant is condensed in the compressor. Accordingly, in the compressor, due to oil (lubrication oil) and liquefied refrigerant, a liquid whose amount exceeds an oil storage capacity stays.

[0003] On the other hand, when evening arrives and the vehicle is no more heated by sunbeams, a temperature of the condenser having a small thermal capacity is gradually lowered, and the following relationship is established among the respective temperatures of the evaporator, the compressor, and the condenser.

evaporator temperature > compressor temperature > condenser temperature

[0004] Due to such temperature difference, a pressure in the condenser becomes the lowest in the refrigerating cycle thus giving rise a phenomenon where a refrigerant which remains in the compressor and into which oil is dissolved is pushed out to a condenser side due to a pressure from the evaporator.

[0005] When such a phenomenon caused by a change in temperature happens repeatedly, oil held in the compressor is gradually conveyed to the outside of the compressor and, eventually, oil remaining in the compressor is depleted. Accordingly, when an air conditioner is operated again after a long period where the air conditioner is not used at all, there is fear that a seizure of the compressor arises due to lubrication failure.

[0006] To overcome such a drawback, conventionally, as described in the following PTL 1, there has been proposed the constitution where a low-pressure pipe which is connected to a suction port of a compressor in a refrigerating cycle and a high-pressure pipe which is connected to a discharge port of the compressor are connected to each other by a bypass pipe passage, a check valve which allows the flow of a refrigerant to the bypass pipe passage when a refrigerant pressure on a low-pressure pipe side(evaporator side) becomes higher than a refrigerant pressure on a high-pressure pipe side(condenser side) is mounted in the bypass pipe passage. Due to such a constitution, in a state where an operation of the compressor is stopped, when the refrigerant pressure on the low-pressure pipe side becomes higher than the refrigerant pressure on the high-pressure pipe side, the check valve is opened due to the pressure difference so that the refrigerant on the low-pressure pipe side is made to flow to the high-pressure pipe side through the bypass pipe passage thus almost preventing the refrigerant from flowing into the inside of the compressor whereby the flowing out of oil from the compressor is prevented.

CITATION LIST

PATENT LITERATURE

[0007] PTL 1: JP-A-7-218007

SUMMARY OF INVENTION

TECHNICAL PROBLEM

[0008] However, the check valve disclosed in the above-mentioned patent literature is configured such that a compression coil spring is arranged in a high-pressure pipe side of a valve element which constitutes a part of the check valve, and the valve element is biased in the closing direction by a biasing force of the compression coil spring. Due to such a constitution, unless a refrigerant pressure on a low-pressure pipe side (evaporator side) is increased by an amount corresponding to a spring force of the compression coil spring with respect to a refrigerant pressure on a high-pressure pipe side (condenser side), the bypass passage is not released. Accordingly, when a refrigerant pressure on the low-pressure pipe side (evaporator side) does not reach a pressure at which the valve element can be opened by pushing against the spring force of the compression coil spring although the refrigerant pressure on the low-pressure pipe side (evaporator side) is higher than the refrigerant pressure on the high-pressure pipe side (condenser side), a liquid refrigerant in the compressor is pushed out to the high-pressure pipe side (condenser side) together with oil due to the difference in pressure and hence, there still exists a possibility that oil in the compressor is depleted.

[0009] The present invention has been made in view

of such circumstances, and it is a primary object of the present invention to provide a compressor capable of effectively suppressing the flowing out of lubrication oil in a compressor to the outside of the compressor due to the movement of a refrigerant in a refrigerating cycle caused by a change in temperature in a state where an operation of the compressor is stopped.

SOLUTION TO PROBLEM

[0010] To achieve the above-mentioned object, a compressor according to the present invention includes: a housing; a suction region and a discharge region which are formed in the housing in a partitioned manner; a shaft which is pivotally supported in the inside of the housing; and a compression mechanism which sucks a refrigerant from the suction region and discharges the refrigerant to the discharge region due to a rotational motion of the shaft, wherein the compressor further includes: a bypass passage which makes the suction region and the discharge region communicate with each other; a valve element which is capable of closing the bypass passage from a discharge region side; and a spring which biases the valve element toward the discharge region side (toward the valve opening direction).

[0011] Due to the above-mentioned constitution, in a state where the operation of the compressor is stopped, when a refrigerant pressure in the discharge region (high-pressure pipe side) which is defined in the housing and a refrigerant pressure in the suction region (low-pressure pipe side) which is defined in the housing are balanced with each other, the bypass passage is always opened. Accordingly, even when the refrigerant pressure on the suction region side (low-pressure pipe side) becomes slightly higher than the refrigerant pressure on the discharge region side (high-pressure pipe side) due to a change in temperature, it is possible to promptly release the refrigerant pressure on the suction region side (low-pressure pipe side) to the discharge region side (high-pressure pipe side) through the bypass passage and hence, there is no possibility that oil remaining in the compressor is taken out to the high-pressure pipe side together with a liquid refrigerant.

[0012] It is preferable that, a valve port formed with a diameter smaller than an outer diameter of the valve element, and a valve accommodating hole formed on a discharge region side with respect to the valve port with a diameter larger than the outer diameter of the valve element are formed in the bypass passage directly or by way of a holder, and the valve element is accommodated in the valve accommodating hole in an axially movable manner.

[0013] Due to such a constriction, when the operation of the compressor is started, the valve element accommodated in the valve accommodating hole moves in the valve accommodating hole promptly so that the bypass passage is closed by the valve element. This state is maintained until the compressor is stopped again so that the pressure difference between the discharge region and the suction region is decreased to an extent that the valve element is movable toward a discharge region side (toward the valve opening direction) due to a spring force of the spring.

[0014] Assuming that, as shown in Fig. 7, a valve element A were positioned in anopen space of the discharge region, when the operation of the compressor is started, a refrigerant gas which tends to flow into the suction region from the discharge region through a bypass passage B would pass through a gap between the valve element A and a peripheral edge of an opening end of the bypass passage B instead of passing along side of the valve element A, and directly flows into the suction region. Accordingly, the valve element A does not close the bypass passage B thus giving rise to a drawback that a refrigerant gas is blown off into the suction region from the discharge region. However, by adopting the above-mentioned constitution, a refrigerant which tends to flow to a suction region side from a discharge region side passes along a side surface of the valve element held in the valve accommodating hole and, thereafter, flows out to the suction region through the valve port. Accordingly, the flow of the refrigerant works to push the valve element toward a valve port side against a spring force, and this force allows the valve element to promptly close the valve port. Once the valve element closes the valve port, a discharge pressure and a suction pressure act on a front side and a rear side of the valve element respectively, and a closed state is maintained against a spring force of the spring due to such pressure difference.

[0015] To acquire such an action more effectively, it is preferable that an area of a passage formed between an outer peripheral surface of the valve element and an inner peripheral surface of the valve accommodating hole is set smaller than an area of the valve port. Due to such a constitution, pressure drop in the bypass passage from the discharge region to the suction region is preferentially imparted to before and after a refrigerant passes along the valve element rather than to before and after a refrigerant passes through the valve port and hence, the pressure difference can be surely generated on an upstream side and a downstream side of the valve element whereby the valve element can be moved promptly.

[0016] Further, in the compressor where the housing is constituted of shell members formed by dividing the housing in two in the axial direction of the shaft, the discharge region and the suction region are defined in the respective shell members, and a discharge port which is communicated with the discharge region and a suction port which is communicated with the suction region are formed in either one of the shell members, it is desirable that the bypass passage is formed in the above-mentioned one shell member in which the discharge port and the suction port are formed so as to make the above-mentioned refrigerant which moves due to a change in temperature flow toward a high-pressure pipe side without passing the inside of the compressor as much as

possible whereby the flowing out of oil in the compressor is prevented.

[0017] The above-mentioned constitution may be realized such that the valve element is formed of a steel ball, the spring accommodated in the valve port is formed of a compression coil spring, and a valve seat face on which the valve element is seated is formed on a portion shifting to the valve accommodating hole from the valve port.

ADVANTAGEOUS EFFECTS OF INVENTION

[0018] As has been explained heretofore, according to the present invention, the suction region and the discharge region defined in the housing of the compressor are communicated with each other by forming the bypass passage, and the valve element which is capable of closing the bypass passage from a discharge region side and the spring which biases the valve element toward the discharge region side (toward the valve opening direction) are provided to the bypass passage. Due to such a constitution, even when a refrigerant pressure in the suction region, that is, on a low-pressure pipe side (evaporator side) is slightly increased also with respect to a refrigerant pressure in the discharge region, that is, on a high-pressure pipe side (condenser side), the refrigerant pressure on the suction region side (low-pressure pipe side) can be promptly released to the discharge region side (high-pressure pipe side) through the bypass passage whereby there is no fear that oil remaining in the compressor is taken out to the outside of the compressor together with a liquid refrigerant.

[0019] The valve port formed with a diameter smaller than an outer diameter of the valve element, and a valve accommodating hole formed on a discharge region side with respect to the valve port with a diameter larger than the outer diameter of the valve element are formed in the bypass passage directly or by way of a holder, the spring is held on the valve port, and the valve element is accommodated in the valve accommodating hole in an axially movable manner. Due to such a constitution, the valve element can be moved against a spring force of the spring by a refrigerant which tends to flow in the bypass passage along a side of the valve element immediately after the operation of the compressor is started and hence, the valve port can be promptly closed and the closed state can be maintained in a stable manner.

[0020] In this case, by setting the area of the passage formed between the outer peripheral surface of the valve element and the inner peripheral surface of the valve accommodating hole smaller than the area of the valve port, it is possible to make the valve element react more sensitively by a refrigerant which tends to flow the bypass passage immediately after the operation of the compressor is started and hence, the valve element can promptly and surely close the valve port.

[0021] Further, in the compressor where the housing is constituted of the shell members formed by dividing the housing in two in the axial direction of the shaft, the discharge region and the suction region are defined in the respective shell members, and the discharge port which is communicated with the discharge region and the suction port which is communicated with the suction region are formed in either one of the shell members, by forming the bypass passage in one shell member in which the discharge port and the suction port are formed, even when the bypass passage is formed in the compressor, a refrigerant passes only in the vicinity of the port without passing the inside of the compressor as much as possible and hence, it is possible to surely prevent oil from being taken out from the compressor.

BRIEF DESCRIPTION OF DRAWINGS

[0022]

[Fig. 1] Fig. 1(a) is a cross-sectional view showing an example of a compressor according to the present invention in which a bypass passage is formed, and Fig. 1(b) is a view of a rear-side shell member as viewed from an inner side in the axial direction.

[Fig. 2] Fig. 2(a) and Fig. 2(b) are conceptual views for explaining the flow of a refrigerant in the compressor according to the present invention, wherein Fig. 2(a) is a side cross-sectional view of the compressor, and Fig. 2(b) is a cross-sectional view taken along a line B-B in Fig. 2(a).

[Fig. 3] Fig. 3 is a cross-sectional view of the rear-side shell member, and is also a view taken along a line A-A in Fig. 1(b) (a view showing the compressor in cross section such that the bypass passage can be observed).

[Fig. 4] Fig. 4(a) and Fig. 4(b) are enlarged cross-sectional views showing a portion of the bypass passage where a valve element and a spring are provided, wherein Fig. 4(a) is the view showing a state where the valve element is away from a valve seat face, and Fig. 4(b) is a view showing a state where the valve element is seated on the valve seat face.

[Fig. 5] Fig. 5 is an enlarged cross-sectional view showing a portion of the bypass passage where the valve element and the spring are provided, and is also a view for explaining the flow of a refrigerant which flows through the bypass passage and the behavior of the valve element.

[Fig. 6] Fig. 6 is a view showing a graph which indicates changes in temperature in an evaporator, a condenser, and the compressor in a refrigerating cycle mounted on a vehicle, and a schematic view for explaining the flow of a refrigerant and the flow of oil in a state where the compressor is stopped.

[Fig. 7] Fig. 7 is a view for explaining the flow of the refrigerant and the behavior of the valve element when the valve element is positioned in an open space of a discharge region.

DESCRIPTION OF EMBODIMENTS

[0023] Hereinafter, an embodiment of the present invention is explained by reference to attached drawings.

[0024] In Fig. 1 and Fig. 2, a compressor 1 is a reciprocating-type compressor employed in a refrigerating cycle where a refrigerant is used as a working fluid. The compressor 1 includes: a front-side cylinder block 2; a rear-side cylinder block 4 which is assembled to the front-side cylinder block 2; a front-side shell member 6 which is assembled to a front side (a left side in the drawing) of the front-side cylinder block 2 with a valve plate 5 interposed therebetween; and a rear-side shell member 8 which is assembled to a rear side (a right side in the drawing) of the rear-side cylinder block 4 with a valve plate 7 interposed therebetween. The front-side shell member 6 and the rear-side shell member 8 respectively have opening end sides thereof extended so as to cover the cylinder blocks 2, 4 which are arranged close to the front-side shell member 6 and the rear-side shell member 8 respectively and are engaged with each other in the axial direction by fitting engagement. The front-side shell member 6, the valve plate 5, the front-side cylinder block 2, the rear-side cylinder block 4, the valve plate 7 and the rear-side shell member 8 are fastened to each other in the axial direction using fastening bolts 9. The front-side shell member 6 and the rear-side shell member 8 constitute a housing of the compressor which is divided in two in the axial direction.

[0025] In the inside of the front-side cylinder block 2 and the rear-side cylinder block 4, a swash plate accommodating chamber 10 is formed in a defined manner by assembling the front-side cylinder block 2 and the rear-side cylinder block 4 to each other. In the swash plate accommodating chamber 10, a shaft 12 is rotatably supported by shaft support holes 11 formed in the front-side cylinder block 2 and the rear-side cylinder block 4 respectively by way of radial bearings 19. One end of the shaft 12 projects from the front-side shell member 6, and a relay member 14 is fixed to the portion of the shaft 12 projecting from the front-side shell member 6 in a state where the relay member 14 is mounted in the axial direction using a bolt 13. A boss portion 6a which extends toward a front side so as to cover the shaft is integrally formed with the front-side shell member 6, and a pulley 16 which is connected to a drive source not shown in the drawing by way of a belt is rotatably fitted on the boss portion 6a by way of a bearing 15. The pulley 16 transmits rotational power to the shaft 12 by way of the relay member 14.

[0026] A plurality of cylinder bores 17 which are arranged parallel to the shaft support hole 11 and are arranged equidistantly on the circumference about the shaft 12 are formed in the respective cylinder blocks 2, 4. In the inside of each cylinder bore 17, a double-headed piston 18 having head portions on both ends thereof is inserted and is slidable in a reciprocating manner, and compression chambers 25 are defined between the double-headed piston 18 and the valve plates 5, 7 respectively.

[0027] A swash plate 20 which is accommodated in the swash plate accommodating chamber 10 and is rotated integrally with the shaft 12 is fixed to the shaft 12. The swash plate 20 is rotatably supported on the front-side cylinder block 2 and the rear-side cylinder block 4 by way of thrust bearings 21, and a peripheral edge portion of the swash plate 20 is sandwiched between a pair of semispherical shoes 22 which is engaged with an engaging recessed portion 23 formed on a center portion of the double-headed piston 18 such that a front side and a rear side of the peripheral portion is sandwiched by the semispherical shoes 22. Accordingly, when the shaft 12 is rotated so that the swash plate 20 is rotated in an oscillating manner, such an oscillating rotation motion is converted into a reciprocating motion of the double-headed piston 18 by way of the shoes 22 so that a capacity of the compression chamber 25 is changed.

[0028] In each of the respective valve plates 5, 7, a suction hole 26 which is opened or closed by a suction valve not shown in the drawing which is mounted on a cylinder-block-side end face of the valve plate 5, 7, and a discharge hole 27 which is opened or closed by a discharge valve not shown in the drawing which is mounted on a shell-member-side end face of the valve plate 5, 7 are formed corresponding to each cylinder bore 17. A suction chamber 28 for accommodating a refrigerant to be supplied to the compression chamber 25 and a discharge chamber 29 for accommodating a refrigerant to be discharged from the compression chamber 25 are defined in the front-side shell member 6 and the rear-side shell member 8 respectively.

[0029] The suction chambers 28 formed in the respective shell members 6, 8 are connected with the swash plate accommodating chamber 10 through low-pressure passages 30, and the swash plate accommodating chamber 10 is communicated with a suction port 32 which is formed in the rear-side shell member 8 and is connected to an external cycle through a suction passage 31 connected to the swash plate accommodating chamber 10.

[0030] The discharge chambers 29 formed in the respective shell members 6, 8 are communicated with a discharge port 34 formed in the rear-side shell member 8 through a discharge passage 33, and the discharge chambers 29 are connected to the external cycle through the discharge port 34.

[0031] Accordingly, during a suction stroke where a volume of the compression chamber 25 is increased along with the reciprocating movement of the double-headed piston 18, a refrigerant which is introduced into the suction chamber 28 from the suction port 32 through the suction passage 31, the swash plate accommodating chamber 10, and the low-pressure passage 30 is sucked into the compression chamber 25 through the suction hole 26. On the other hand, during a compression stroke where the volume of the compression chamber 25 is de-

creased, a refrigerant which is compressed in the compression chamber 25 is discharged into the discharge chamber 29 through the discharge hole 27, is introduced to the discharge port 34 formed in the rear-side shell member 8 from the discharge chamber 29 through the discharge passage 33, and is pumped out to the external cycle from the discharge port 34.

[0032] As shown also in Fig. 3, in the rear-side shell member 8, a bypass passage 40 is formed through which an area in the vicinity of the suction port 32 of the suction passage 31 which forms a suction region and an area in the vicinity of the discharge port 34 of the discharge passage 33 which forms a discharge region are communicated with each other. The bypass passage 40 is constituted such that a passage forming hole 40a is formed in the rear-side shell member 8 from an inner face of the discharge passage 33, a passage forming hole 40b is formed in the rear-side shell member 8 from an inner surface of the suction passage 31, and distal end portions of the respective passage forming holes 40a, 40b are communicated with each other. A valve element 41 and a spring 42 are accommodated in the passage forming hole 40a which is formed in the rear-side shell member 8 from the discharge passage 33.

[0033] To be more specific, as shown in Fig. 4, a valve port 43 which is formed with a diameter smaller than an outer diameter of the valve element 41 and a valve accommodating hole 44 which is formed on a discharge region side (a discharge passage 33 side) with respect to the valve port 43 with a diameter larger than the outer diameter of the valve element 41 are directly formed in the passage forming hole 40a of the bypass passage 40 formed from the discharge passage 33 along the axial direction of the passage forming hole 40a of the bypass passage 40, and a valve seat face 45 on which the valve element 41 is seated is formed on a portion shifting to the valve port 43 from the valve accommodating hole 44 in a tapered shape such that a diameter of the valve seat face 45 is gradually decreased.

[0034] In this example, the valve element 41 is formed of a steel ball, and the spring 42 is formed of a compression coil spring. The spring 42 is accommodated in and held by the valve port 43, the valve element 41 is accommodated in and held by the valve accommodating hole 44, and the valve element 41 is always biased toward a discharge region side (a discharge passage 33 side) by the spring 42. A stopper member mounting hole 46 which opens at an inner peripheral face of the valve accommodating hole 44 and extends in the direction different from the axial direction of the valve accommodating hole 44 is formed in the vicinity of an opening end of the valve accommodating hole 44 which opens at the discharge passage 33. A stopper member 47 which is press-fitted in the stopper member mounting hole 46 is fixed in a projecting manner such that the stopper member 47 traverses the valve accommodating hole 44. Accordingly, the valve element 41 is held in the inside of the valve accommodating hole 44 in a state where the valve element 41 is movable along the axial direction while a moving range of the valve element 41 is restricted by the stopper member 47.

[0035] An area of a passage between an outer peripheral surface of the valve element 41 and an inner peripheral surface of the valve accommodating hole 44 (a value obtained by subtracting a cross-sectional area of the valve element 41 from a cross-sectional area of the valve accommodating hole 44 on a plane perpendicular to an axis of the valve accommodating hole 44) is set smaller than a cross-sectional area of the valve port 43.

[0036] In the above-mentioned constitution, in a state where the operation of the compressor 1 is stopped, when a refrigerant pressure in the compressor on a high-pressure pipe side and a refrigerant pressure in the compressor on a low-pressure pipe side are approximately balanced with each other, there exists substantially no pressure difference between front and rear sides of the valve element 41 in the bypass passage 40 which is formed between the discharge region and the suction region, and the valve element 41 is in a state where the valve element 41 is away from the valve seat face 45 by being pushed toward a discharge region side by a spring force of the spring 42 (a state shown in Fig. 4(a)).

[0037] In this state, when a temperature of a refrigerating cycle apparatus is increased due to the influence of sunbeams and, thereafter, the vehicle is no more heated by sunbeams so that the relationship of evaporator temperature > compressor temperature > condenser temperature is established among a temperature of the evaporator, a temperature of the compressor and a temperature of the condenser, a refrigerant tends to flow toward a high-pressure pipe side from a low-pressure pipe side through the compressor 1 due to a pressure from the evaporator. However, the valve element 41 of the bypass passage 40 is in a state where the valve element 41 is away from the valve seat face 45 and hence, an area of the suction region in the vicinity of the suction port 32 and an area of the discharge region in the vicinity of the discharge port 34 are communicated with each other through the bypass passage 40. Accordingly, a refrigerant on the low-pressure pipe side can be made to flow promptly toward the high-pressure pipe side through the bypass passage 40 without passing through the inside of the compressor. Accordingly, there is no possibility that a refrigerant which flows from the low-pressure pipe side takes out oil in the compressor to the outside of the compressor thus preventing oil in the inside of the compressor from being depleted.

[0038] On the other hand, immediately after the operation of the compressor is started, a refrigerant which is compressed by the piston and is discharged into the discharge region is discharged to the outside of the compressor and some of the refrigerant tends to flow in the suction region through the bypass passage. In this case, as shown in Fig. 5, the refrigerant which tends to flow in a suction region side from a discharge region side passes along the side of the valve element 41 which is accom-

modated in the valve accommodating hole 44 and, thereafter, tends to flow out to the suction region through the valve port 43. However, the area of the passage between the valve element 41 and the valve accommodating hole 44 is set smaller than the cross-sectional area of the valve port 43 and hence, a pressure of the refrigerant is largely dropped at the place whereby the pressure difference is surely generated between an upstream side and a downstream side of the valve element 41. Accordingly, the refrigerant pushes the valve element 41 toward a valve port 43 side against a spring force of the spring 42 so that the valve element 41 is promptly seated on the valve seat face 45 due to such a force and closes the valve port 43. Once the valve element 41 closes the valve port 43, a discharge pressure and a suction pressure act on front and rear sides of the valve element 41 respectively so that a closed state is maintained in a stable manner against a spring force of the spring 42 due to such pressure difference.

[0039] This state is maintained until the compressor 1 is stopped again so that the pressure difference between the discharge region side and the suction region side is sufficiently decreased and the valve element 41 starts to move toward the discharge region side (toward the valve opening direction) due to the spring force of the spring 42.

[0040] Particularly, in the above-mentioned constitution, the area of the passage between the outer peripheral surface of the valve element 41 and the inner peripheral surface of the valve accommodating hole 44 is set smaller than the area of the valve port 43 and hence, immediately after the operation of the compressor 1 is started, the pressure difference is surely generated between the front and rear sides of the valve element 41 due to the refrigerant which tends to flow in the bypass passage 40 along the side of the valve element 41 and hence, the valve element can be moved promptly thus surely closing the valve port 43.

[0041] In the above-mentioned constitution, the constitution where the valve port 43, the valve accommodating hole 44, and the valve seat face 45 are integrally formed on a middle portion of the bypass passage 40 by working an inner wall of the passage is taken as an example. However, it may be possible to adopt the structure where a cartridge is formed by accommodating the spring 42 and the valve element 41 in a holder in which the valve port 43, the valve accommodating hole 44 and the valve seat face 45 are formed, and the cartridge is mounted in a middle portion of the bypass passage 40.

[0042] Further, in the above-mentioned example, as the compressor, the reciprocating-type compressor which makes use of a double-headed piston is exemplified. However, the compressor is not limited to such a reciprocating-type compressor, and other piston-type compressors or compressors of other types may adopt the substantially same constitution.

REFERENCE SIGNS LIST

[0043]

1: compressor
6: front-side shell member
8: rear-side shell member
12: shaft
31: suction passage
32: suction port
33: discharge passage
34: discharge port
40: bypass passage
41: valve element
42: spring
43: valve port
44: valve accommodating hole
45: valve seat face

Claims

1. A compressor (1) comprising: a housing; a suction region (31) and a discharge region (33) which are formed in the housing in a partitioned manner; a shaft (12) which is pivotally supported in the inside of the housing; and a compression mechanism which sucks a refrigerant from the suction region (31) and discharges the refrigerant to the discharge region (33) due to a rotational motion of the shaft, **characterized in that** the compressor (1) further comprises:

   a bypass passage (40) which makes the suction region (31) and the discharge region (33) communicate with each other;
   a valve element (41) which is capable of closing the bypass passage (40) from a discharge region side; and
   a spring (42) which biases the valve element (41) toward the discharge region side.

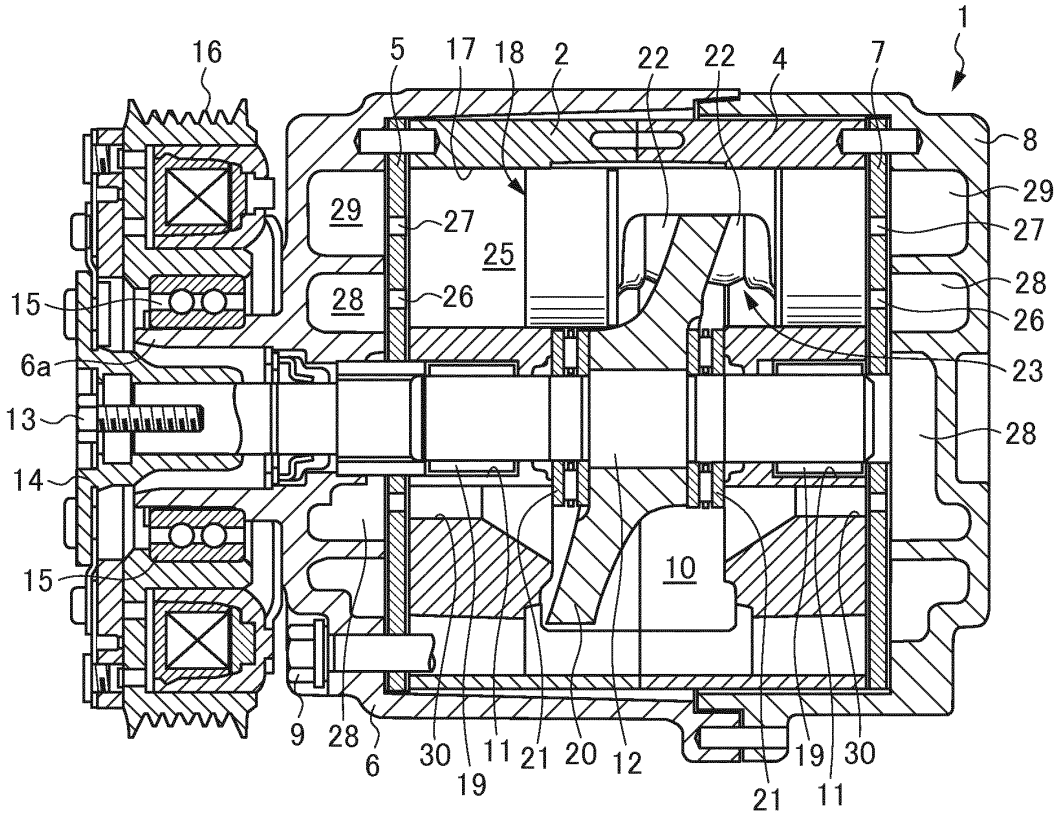
2. The compressor according to claim 1, **characterized in that**
   a valve port (43) formed with a diameter smaller than an outer diameter of the valve element (41), and a valve accommodating hole (44) formed on a discharge region side with respect to the valve port (43) with a diameter larger than the outer diameter of the valve element (41) are formed in the bypass passage (40), and the valve element (41) is accommodated in the valve accommodating hole (44) in an axially movable manner.

3. The compressor according to claim 2, **characterized in that** an area of a passage formed between an outer peripheral surface of the valve element (41) and an inner peripheral surface of the valve accommodating hole (44) is set smaller than an area of the

valve port (43).

4. The compressor according to any one of claims 1 to 3, **characterized in that** the housing is constituted of shell members (6, 8) formed by dividing the housing in two in the axial direction of the shaft (12), the discharge region (33) and the suction region (31) are defined in the respective shell members (6, 8), a discharge port (34) which is communicated with the discharge region (33) and a suction port (32) which is communicated with the suction region (31) are formed in either one of the shell members (6, 8), and the bypass passage (40) is formed in the one shell member in which the discharge port (34) and the suction port (32) are formed.

5. The compressor according to any one of claims 1 to 4, **characterized in that** the valve element (41) is formed of a steel ball, and a valve seat face (45) on which the valve element (41) is seated is formed on a portion shifting to the valve accommodating hole (44) from the valve port (43).


1
16
5
17
18
2
22
22
4
7
8
29
27
25
28
26
15
6a
13
14
15
10
9
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6
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19
11
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12
21
19
11
30
23
28

Fig. 1A

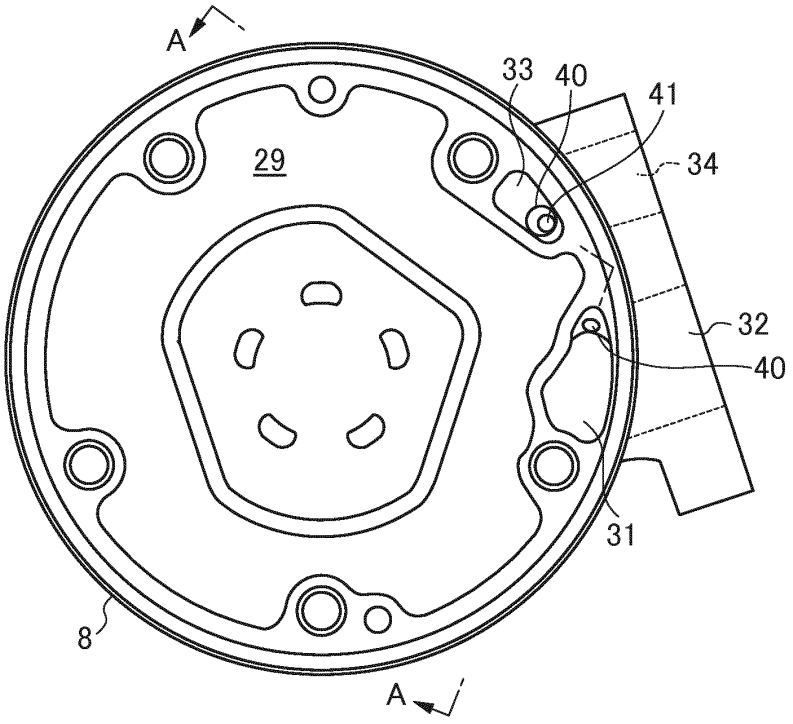

A
33
40
41
34
29
32
40
31
8
A

Fig. 1B

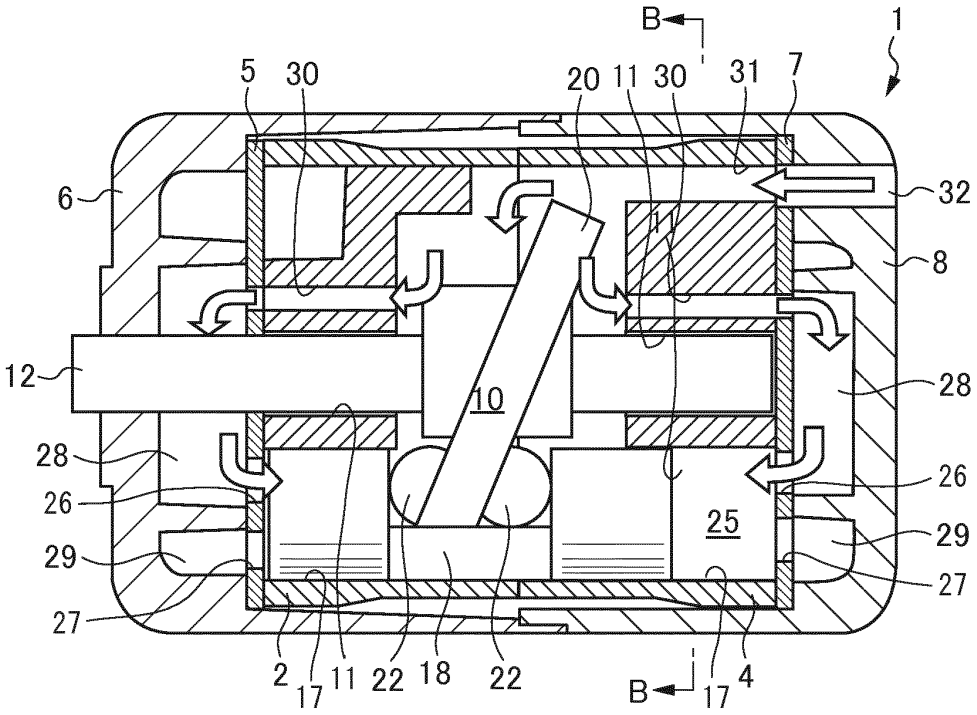
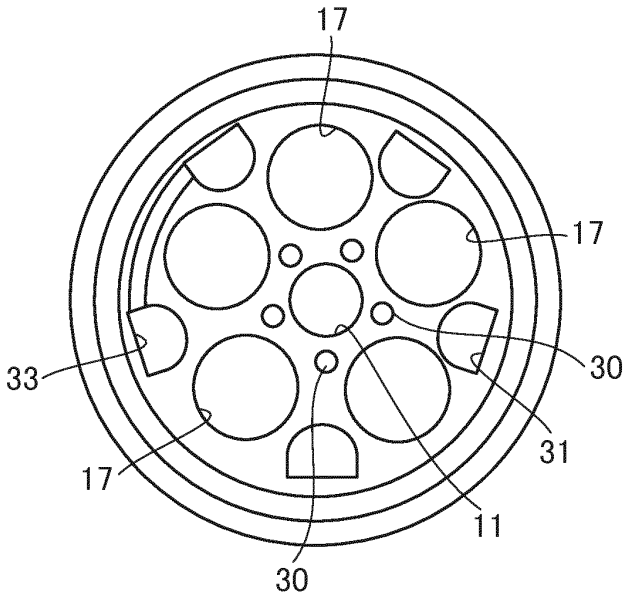
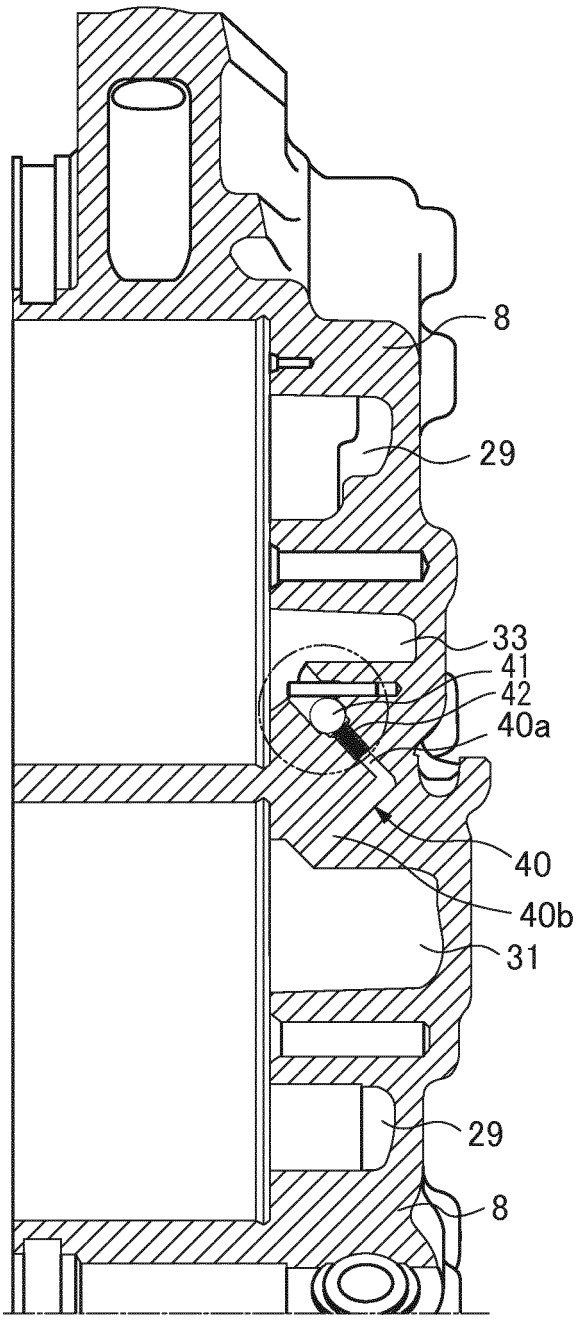


Fig. 2A



cross section taken along line B-B

Fig. 2B



cross section taken along line A-A

Fig. 3

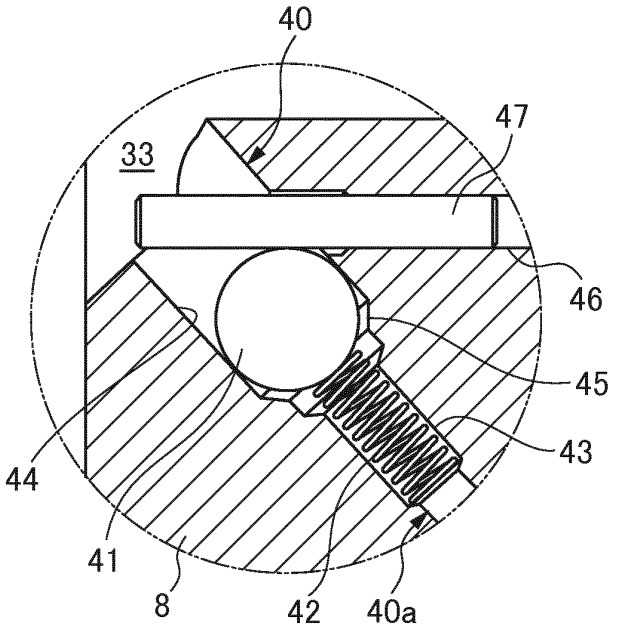


Fig. 4A

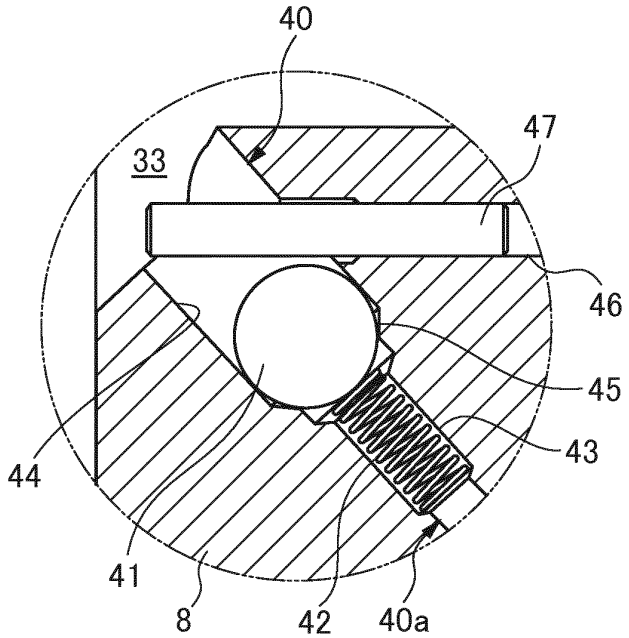


Fig. 4B

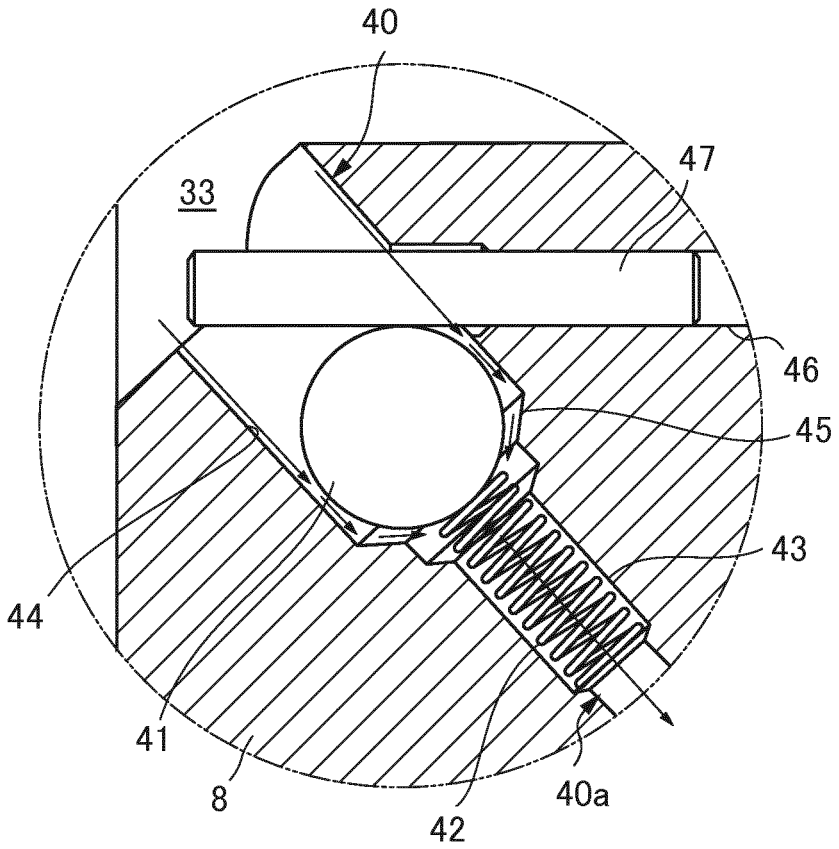


Fig. 5

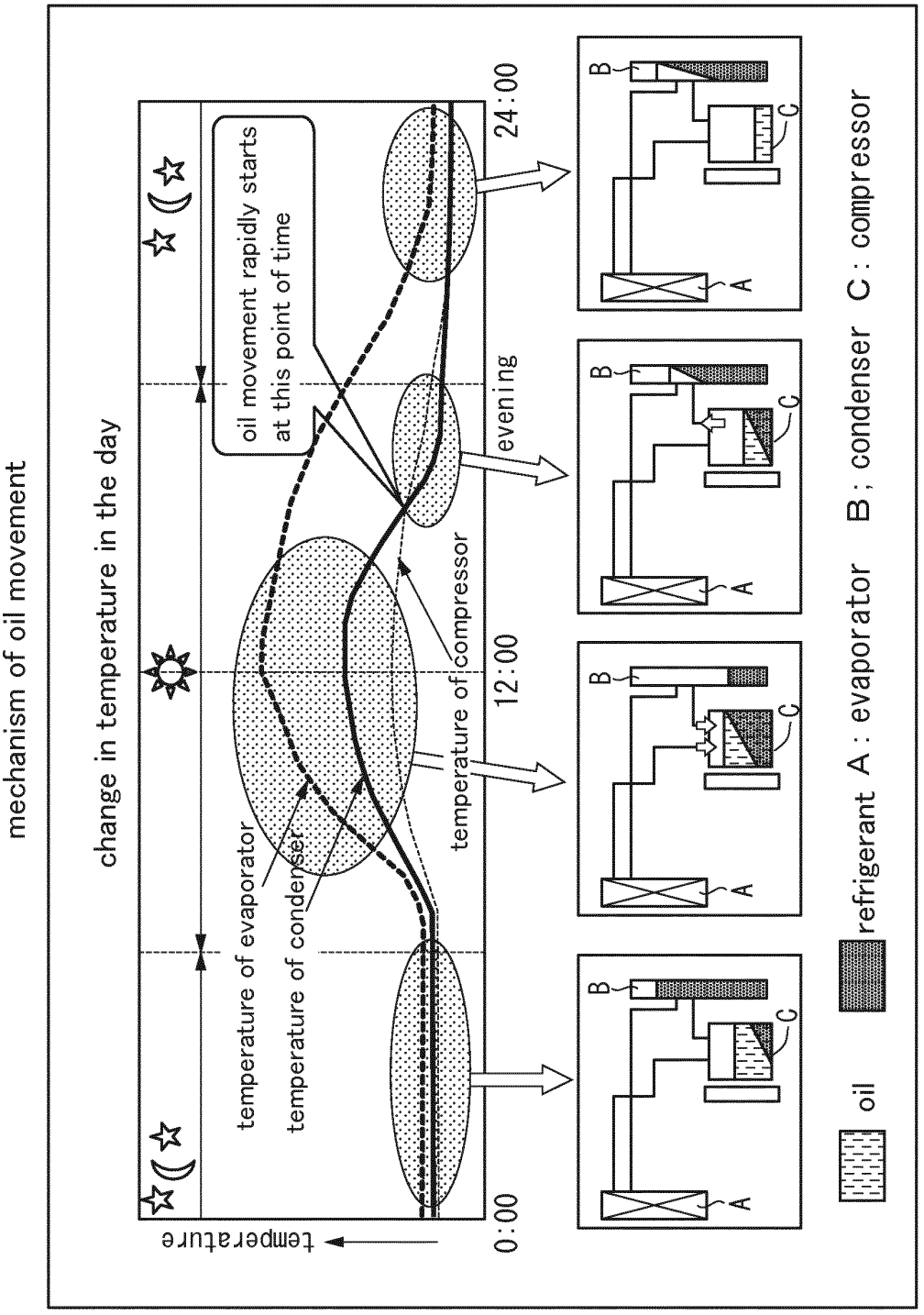

mechanism of oil movement
change in temperature in the day
temperature
0:00
12:00
24:00
evening
oil movement rapidly starts at this point of time
temperature of evaporator
temperature of condenser
temperature of compressor
A
B
C
oil
refrigerant
A : evaporator
B ; condenser
C : compressor

Fig. 6

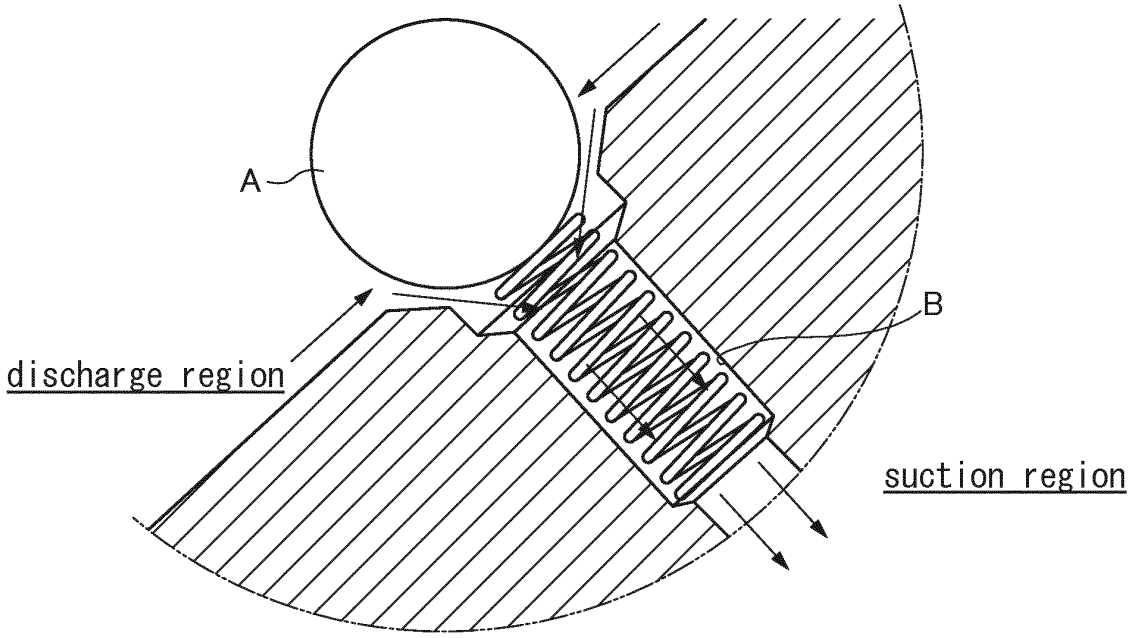


Fig. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/007999

A. CLASSIFICATION OF SUBJECT MATTER
F04B39/12(2006.01)i, *F04B39/10*(2006.01)i, *F04B49/10*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04B39/12, F04B39/10, F04B49/10

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2013
Kokai Jitsuyo Shinan Koho	1971-2013	Toroku Jitsuyo Shinan Koho	1994-2013

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.
Y A	JP 7-218007 A (Nippondenso Co., Ltd.), 18 August 1995 (18.08.1995), paragraphs [0025] to [0026]; fig. 3 (Family: none)	1-3,5 4
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 089304/1971(Laid-open No. 045202/1973) (Mitsubishi Heavy Industries, Ltd.), 13 June 1973 (13.06.1973), fig. 2 (Family: none)	1-3,5 4

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

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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"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	Date of mailing of the international search report
01 March, 2013 (01.03.13)	12 March, 2013 (12.03.13)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2012/007999

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 043474/1979(Laid-open No. 143462/1980) (Hitachi, Ltd.), 14 October 1980 (14.10.1980), fig. 3 (Family: none)	1-3,5 4
Y	JP 4-159485 A (Zexel Corp.), 02 June 1992 (02.06.1992), fig. 2 (Family: none)	5
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 089131/1982(Laid-open No. 191392/1983) (Tokyo Shibaura Electric Co., Ltd.), 19 December 1983 (19.12.1983), entire text; all drawings (Family: none)	1-5
A	JP 4-124479 A (Toyoda Automatic Loom Works, Ltd.), 24 April 1992 (24.04.1992), entire text; all drawings & US 5201189 A	1-5

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 7218007 A **[0007]**