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(54) **VARIABLE-CAPACITY COMPRESSOR**

(57) To provide a variable-capacity compressor capable of improving starting performance of the compressor and eliminating the risk of the compressor becoming uncontrollable due to contamination or the like in a refrigerant. An opening passage 50 allowing the control pressure chamber 4 to communicate with a suction chamber 33 is provided separately from a bleed passage, a valve housing chamber 51 is formed on the opening passage, and the opening passage 50 is formed by including an upstream-side opening passage 50a allowing the control pressure chamber 4 to communicate with the valve housing chamber 51 and a downstream-side opening passage 50b allowing the valve housing chamber 51 to communicate with the suction chamber 33. In the valve housing chamber 51, a valve body 52 housed so as to open/close the downstream-side opening passage 50b and a biasing means (spring 53) biasing the valve body 52 in an opening direction are provided, and the valve housing chamber 51 is connected to the downstream side of a pressure control valve 42 provided on a supply passage 40 allowing a discharge chamber 34 to communicate with the control pressure chamber 4 through a pressure introduction passage 54. A check valve (first check valve 60) allowing only a flow from the upstream side to the downstream side may be provided on the

downstream side of a place where the pressure introduction passage 54 branches on the supply passage 40.

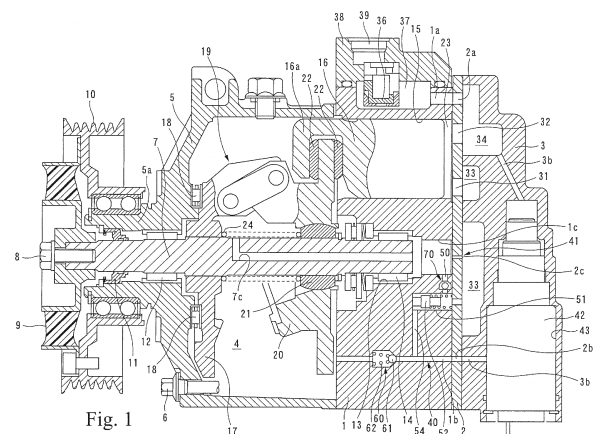


Fig. 1

Description

Technical Field

[0001] The present invention relates to a variable-capacity compressor capable of varying a discharge capacity by adjusting a pressure in a control pressure chamber, and particularly relates to a variable-capacity compressor including a supply passage allowing a discharge chamber to communicate with the control pressure chamber and a bleed passage allowing the control pressure chamber to communicate with a suction chamber, in which an opening degree of the supply passage is adjusted by a control valve provided on the supply passage to thereby adjust the pressure in the control pressure chamber.

Background Art

[0002] The variable-capacity compressor adopts a mechanism in which a tilt angle of the swash plate is changed and piston stroke amounts are adjusted by adjusting the pressure of the control pressure chamber to thereby vary the discharge capacity. As such compressor, a structure is known, in which the discharge chamber is allowed to communicate with the control pressure chamber through the supply passage, the control pressure chamber is allowed to constantly communicate with the suction chamber through the bleed passage, the opening degree of the supply passage is adjusted by the control valve provided on the supply passage and a refrigerant amount flowing into the control pressure chamber is adjusted to thereby control the pressure in the control pressure chamber.

[0003] In the above structure, when the supply passage is blocked by the control valve, a high-pressure gas is not introduced from the discharge chamber to the control pressure chamber and the control pressure chamber constantly communicates with the suction chamber through the bleed chamber, therefore, the pressure in the control pressure chamber is reduced to approximately the same value as a pressure in the suction chamber, and the compressor is operated at the maximum capacity. When the supply passage is opened by the control valve, the high-pressure gas is introduced from the discharge chamber to the control pressure chamber and a refrigerant gas flows out from the control pressure chamber to the suction chamber through the bleed passage, however, the pressure in the control pressure chamber is increased, therefore, the discharge capacity of the compressor is controlled by adjusting the opening degree of the supply passage by the control valve.

[0004] Incidentally, when the compressor is suspended for a long time without being operated, the pressure in a refrigerating cycle is balanced as well as a refrigerant in the refrigerating cycle becomes liquid at a portion of the lowest temperature in the refrigerating cycle. The compressor has the highest heat capacity in elements

forming the refrigerating cycle and is not easily heated following variation of outdoor temperature, therefore, the phenomenon in which the refrigerant in the refrigerating cycle becomes liquid inside the compressor occurs.

When the refrigerant becomes liquid inside the compressor, a liquid refrigerant is accumulated also in the control pressure chamber.

[0005] When the compressor is started from the state where the pressure is balanced, the pressure in the suction chamber is reduced by operation of the compressor, and a refrigerant in the control pressure chamber is discharged to the suction chamber through the bleed passage in accordance with the reduction of the pressure. However, when the liquid refrigerant is accumulated in the control pressure chamber, the inside of the control pressure chamber is in the balanced state in which both a gas-phase refrigerant and a liquid-phase refrigerant exist, therefore, the pressure in the control pressure chamber is maintained in a saturated pressure even when the refrigerant in the control pressure chamber is discharged to the suction chamber through the bleed passage. Accordingly, there has been known an inconvenience that the pressure in the control pressure chamber is not reduced until all the liquid refrigerant is vaporized and is discharged from the bleed passage and it is difficult to perform control of the discharge capacity (to increase the discharge capacity).

[0006] In order to solve the above problems, a structure shown in Fig. 6 is known (refer to Patent Literature 1). In the structure, a first control valve 104 that adjusts the opening degree of a supply passage is provided on the supply passage 103 connecting between a discharge chamber 101 and a control pressure chamber 102, and a second control valve 107 is provided on a bleed passage 106 connecting between the control pressure chamber 102 and a suction chamber 105. The second control valve 107 is configured by including a spool holding concave portion 108 formed in a housing, a spool 109 housed in the spool holding concave portion 108 so as to move, a back pressure chamber 110 demarcated and formed behind the spool 109 in the spool holding concave portion 108, a biasing spring 112 that biases the spool 109 in a direction away from a valve forming body 111. The spool holding concave portion 108 is adjacent to the suction chamber 105, and leakage in the spool holding concave portion 108 from the back pressure chamber 110 to the suction chamber 105 is suppressed to be small by a clearance between an inner wall of the spool holding concave portion 108 and the spool 109. On a downstream of the first control valve 104 on the supply passage 103, a fixed throttle 113 is provided, wherein an intermediate region K between the first control valve 104 and the fixed throttle 113 is connected to the back pressure chamber 110 through a branch passage 114.

[0007] According to the above structure, the first control valve 104 makes a supply passage 28 in a fully closed state and the communicating state between the discharge chamber 101 and the control pressure chamber

102 is cut off at the time of starting when a difference between a pressure P_d in the discharge chamber 101 and a pressure P_s in the suction chamber 105 is small. Then, a pressure P_k in the intermediate region K in the supply passage 103 on the downstream side of the first control valve 104, namely, the pressure in the back pressure chamber 110 is maintained to be approximately the same as a pressure P_c in the control pressure chamber 102, and the spool 109 makes the bleed passage 106 in a fully opened state by a spring force of the biasing spring 112.

[0008] As a result, even when the liquid refrigerant is accumulated in the control pressure chamber 102, the pressure in the control pressure chamber 102 can be reduced earlier by releasing the pressure to the suction chamber 105 through the bleed passage with a large opening degree (a period of time until all the liquid refrigerant accumulated in the control pressure chamber 102 is vaporized and discharged to the suction chamber 105 is shortened), therefore, it is possible to avoid an inconvenience that a period of time until discharge capacity can be controlled is increased. Therefore, the pressure P_c in the control pressure chamber 102 is smoothly reduced by fully closing the first control valve 104 and a tilt angle of the swash plate is smoothly increased, thereby increasing the discharge capacity.

[0009] When the difference between the pressure P_d in the discharge chamber 101 and the pressure P_s in the suction chamber 105 is increased after all the liquid refrigerant accumulated in the control pressure chamber 102 is evaporated and discharged to the suction chamber 105, the fully closed state of the first control valve 104 is released and the supply passage 103 is opened, then, the pressure in the intermediate region K (pressure in the back pressure chamber 110) is increased to be higher than the pressure P_c in the control pressure chamber 102. Then, the spool 109 moves against the biasing spring 112 and abuts on the valve forming body 111, and the bleed passage 106 is in a state of being largely throttled by a communicating groove 109a formed at a tip end portion of the spool 109. Accordingly, a refrigerant amount introduced out of the control pressure chamber 102 to the suction chamber 105 through the bleed passage 106 is largely reduced and the pressure P_c in the control pressure chamber 102 is increased and the tilt angle of the swash plate is reduced, as a result, the discharge capacity is reduced.

Citation List

Patent Literature

[0010] Patent Literature 1: JP-A-2002-021721

Summary of Invention

Technical Problem

[0011] In the above related-art structure, a bleed amount from the control pressure chamber 102 to the suction chamber 105 is adjusted by the spool 109 housed inside the spool holding concave portion 108 so as to slide, and the pressure in the intermediate region K between the first control valve 104 of the supply passage 103 and the fixed throttle 113 is allowed to act as a back pressure acting on the spool 109, therefore, it is necessary to strictly perform management of the clearance between the inner wall of the spool holding concave portion 108 and the spool 109 for reducing a leakage amount of the refrigerant from the intermediate region K (back pressure chamber 110) to the suction chamber 105 adjacent to the spool holding concave portion 108, which causes an inconvenience that the costs are increased.

[0012] Furthermore, when the clearance between the inner wall of the spool holding concave portion 108 and the spool 109 is set to a minute value, the leakage of the back pressure can be effectively suppressed, however, there may occur an inconvenience that contamination and so on are easily stuck into a sliding surface between the inner wall of the spool holding concave portion 108 and the spool 109, which may hinder movement of the spool 109 and may interfere with pressure control in the control pressure chamber 102.

[0013] The present invention has been made in view of the above circumstances and a main object thereof is to provide a variable-capacity compressor capable of increasing starting performance of the compressor and eliminating a risk of the compressor becoming uncontrollable due to contamination or the like in the refrigerant.

Solution to Problem

[0014] In order to solve the above problems, a variable-capacity compressor according to the present invention has a compression chamber compressing working fluid, a suction chamber housing the working fluid compressed in the compression chamber, a discharge chamber housing the working fluid compressed in the compression chamber and discharged, a control pressure chamber through which a drive shaft penetrates, housing a swash plate rotating with rotation of the drive shaft, a supply passage allowing the discharge chamber to communicate with the control pressure chamber, a bleed passage constantly allowing the control pressure chamber to communicate with the suction chamber, and a control valve adjusting an opening degree of the supply passage, in which a discharge capacity is varied by adjusting a pressure in the control pressure chamber, which includes an opening passage allowing the control pressure chamber to communicate with the suction chamber, a valve housing chamber formed on the opening passage, in which the opening passage is formed by including an upstream-

side opening passage allowing the control pressure chamber to communicate with the valve housing chamber, and a downstream-side opening passage provided so as to open to one end of the housing chamber in an axial direction and allowing the valve housing chamber to communicate with the suction chamber, a valve body housed in the valve housing chamber and opening/closing an opening of the downstream-side opening passage by an end surface on one end side in the axial direction, a biasing means for biasing the valve body in an opening direction of the downstream-side opening passage and a pressure introduction passage branching from a downstream side of the control valve of the supply passage and communicating with a region in the valve housing chamber, which is on the opposite side of the downstream-side opening passage with respect to the valve body housed in the valve housing chamber.

[0015] Here, one end of the housing chamber in the axial direction indicates one terminal end of the housing chamber when an operation direction of the valve body is the axial direction, and an end surface on one end side of the valve body in the axial direction indicates an end surface of one end portion in the operation direction of the valve body.

[0016] As described above, in the state where the compressor is suspended for a long time and the pressure in the refrigerating cycle is balanced, a liquid refrigerant is accumulated in the control pressure chamber. In this state, the control valve allows the supply passage to be in the fully opened state, however, the valve body housed in the valve housing chamber is biased by the biasing means to make the downstream-side opening passage in the opened state as pressures acting before and after the valve body is balanced.

[0017] When the compressor is started from the above state, the pressure in the suction chamber begins to reduce to be lower than the pressure in the control pressure chamber with operation at the minimum capacity in the beginning of starting the compressor. On the other hand, the supply passage is closed by the control valve, therefore, the pressure is not introduced to the control pressure chamber and the housing chamber. The evaporated refrigerant in the control pressure chamber is discharged to the suction chamber through the bleed passage, which flows into the valve housing chamber through the upstream-side opening passage and is discharged from the valve housing chamber to the suction chamber through the downstream-side opening passage.

[0018] Accordingly, the refrigerant in the control pressure chamber can be immediately released to the suction chamber through two systems of the bleed passage and the opening passage, and a period of time until all the liquid refrigerant accumulated in the control pressure chamber is evaporated and discharged to the suction chamber can be shortened.

[0019] After that, when the pressure in the control pressure chamber is reduced and the discharge capacity of the compressor is increased, the pressure in the dis-

charge chamber is increased, the closed state in the supply passage by the control valve is released and the opening degree of the supply passage is increased. Then, when a force acting on the valve body by a difference between a pressure introduced to the valve housing chamber from the supply passage through the pressure introduction passage and a pressure in the suction chamber (force biasing the valve body in a direction of blocking the downstream-side opening passage) is higher than the biasing force of the biasing means, the valve body moves in a direction of closing the downstream-side opening passage to thereby close the opening of the downstream-side opening passage by the end surface on one end side of the valve body in the axial direction.

[0020] As the opening of the downstream-side opening passage is closed by the end surface on one end of the valve body in the axial direction, the refrigerant flowing into the valve housing chamber through the pressure introduction passage does not flow into the suction chamber regardless of a clearance between the valve body and the valve housing chamber. Moreover, the pressure introduction passage is a passage branching from the downstream of the control valve in the supply passage, therefore, even when the refrigerant flowing into the valve housing chamber through the pressure introduction passage flows back to the control pressure chamber through the upstream-side opening passage, sum totals of a refrigerant amount flowing into the control pressure chamber via the supply passage and a refrigerant amount flowing into the control pressure chamber via the opening passage are approximately the same, which is not an obstacle for the control of discharge capacity.

[0021] Additionally, as the pressure introduction passage branches from the downstream side of the control valve in the supply passage and is connected to a region in the valve housing chamber, which is on the opposite side of the downstream-side opening passage with respect to the valve body housed in the valve housing chamber, therefore, a pressure with less pulsation on the downstream side of the control valve can be given in a direction of blocking the downstream opening passage by the valve body, and the valve body inside the valve housing chamber can be positively operated as compared with a structure where the valve body inside the valve housing chamber is opened and closed based on a pressure in the discharge chamber with many pulsations.

[0022] As described above, the opening of the downstream-side opening passage allowing the valve housing chamber to communicate with the suction chamber is opened/closed by the end surface on one end in the axial direction of the valve body housed in the valve housing chamber, therefore, it is not necessary to form the valve body housed in the valve housing chamber by the spool valve, and it is also not necessary to strictly manage a clearance between the valve body and the valve housing chamber.

[0023] As the use of the spool valve is avoided, there

is no risk of the valve body becoming uncontrollable due to contamination or the like in the refrigerant (movement of the valve body is not easily affected by contamination or the like) .

[0024] In the above structure, a boosting means may be provided on the downstream side of the place where the pressure introduction passage branches on the supply passage.

[0025] When the boosting means is provided, the pressure on the upstream side of the boosting means can be set to be higher than the pressure in the control pressure chamber, therefore, it is possible to give a higher pressure to the valve body housed in the valve housing chamber, and more stable operation can be obtained.

[0026] Moreover, a first check valve allowing only a flow from the upstream side to the downstream side of the supply passage is used as the boosting means, thereby adjusting a pressure difference before and after the check valve to a prescribed value by a spring force of the check valve regardless of the amount of the refrigerant flowing through the supply passage.

[0027] Furthermore, it is preferable that the valve body is formed by including a large-diameter portion moving along an inner peripheral surface of the valve housing chamber and a small diameter portion formed to have a smaller diameter than a diameter of the large diameter portion and opening/closing the downstream-side opening passage, and that a portion where the pressure introduction passage is connected to the valve housing chamber is positioned in a region on the opposite side of the downstream-side opening passage with respect to the large diameter portion in a state where the valve body is the most distant from the downstream-side opening passage.

[0028] In such structure, a pressure of the refrigerant introduced into the valve housing chamber through the pressure introduction passage can be reduced at the time of passing through a clearance between a peripheral surface of the large diameter portion and an inner wall of the valve housing chamber, and a strong pressing force can be given to the small diameter portion of the valve body by a pressure acting on the large diameter portion.

[0029] It is also preferable that a portion where the upstream-side opening passage is connected to the valve housing chamber is positioned closer to the downstream-side opening passage side than the large-diameter portion is in a state where the valve body is the closest to the downstream-side opening passage.

[0030] In the above structure, the pressure of the refrigerant in the control pressure chamber flowing into the valve housing chamber through the opening passage can be positively given to the downstream side of the large diameter portion (the end surface on the side where the small diameter portion is provided), and the opening passage is not blocked by the peripheral surface of the large diameter portion, therefore, it is possible to avoid increase of a passage resistance in the opening passage regardless of the position of the valve body.

[0031] It is also preferable that a second check valve allowing only a flow of fluid from the control pressure chamber to the valve housing chamber is provided on the upstream-side opening passage.

[0032] As described above, even when the refrigerant flowing from the pressure introduction passage to the valve housing chamber flows back to the control pressure chamber through the upstream-side opening passage, sum totals of the refrigerant amount flowing into the control pressure chamber via the supply passage and the refrigerant amount flowing into the control pressure chamber via the opening passage are approximately the same, which is not an obstacle for the control of discharge capacity, however, when the refrigerant amount flowing into the control pressure chamber through the upstream-side opening passage is increased, the refrigerant amount flowing into the control pressure chamber through the supply passage is reduced. The refrigerant flowing into the control pressure chamber through the supply passage contains oil, and lubrication to sliding components inside the control pressure chamber by the oil is expected. If the refrigerant flowing into the control pressure chamber through the supply passage is reduced, there is a risk that lubrication to sliding components will be insufficient.

[0033] In view of the above, when the second check valve allowing only the flow of fluid from the control pressure chamber to the valve housing chamber is provided on the upstream-side opening passage, thereby completely cutting off the backflow of the refrigerant from the valve housing chamber to the control pressure chamber and preventing the flow of the refrigerant to the control pressure chamber via the opening passage. Accordingly, it is possible to secure lubrication to the sliding components inside the control pressure chamber by preventing reduction of the refrigerant amount flowing into the control pressure chamber through the supply passage.

Advantageous Effects of Invention

[0034] As described above, in the variable-capacity compressor according to the present invention in which the pressure in the control pressure chamber is adjusted through the supply passage allowing the discharge chamber to communicate with the control pressure chamber to adjust the opening degree by the control valve and the bleed passage allowing the control pressure chamber to communicate with the suction chamber, the valve housing chamber connecting to the upstream-side opening passage communicating with the control pressure chamber and the downstream-side opening passage communicating with the suction chamber is provided, and the valve body opening/closing the downstream-side opening passage and biased in the direction of opening the downstream-side opening passage by the biasing means is housed in the valve housing chamber. Moreover, the pressure introduction passage communicating with the portion on the downstream side of the

control valve in the supply passage is connected to the valve housing chamber, thereby making the pressure introduced to the valve housing chamber to act on the valve body in the direction of blocking the downstream-side opening passage. Furthermore, the check valve allowing only the flow of fluid from the control pressure chamber to the valve housing chamber is provided on the upstream-side opening passage. At the time of starting the compressor when the pressures before and after the valve body (the pressure on the downstream side of the control valve in the supply passage and the pressure in the suction chamber) are approximately equivalent, the valve body housed inside the valve housing chamber maintains the opened state of the downstream-side opening passage by the biasing means, therefore, the vaporized refrigerant in the control pressure chamber can be smoothly discharged to the suction chamber through the bleed passage and the opening passage, which can increase starting performance of the compressor.

[0035] When the pressure in the discharge chamber is increased, the control valve is opened and the high-pressure refrigerant is supplied to the valve housing chamber from the supply passage through the pressure introduction passage, and a difference between the pressure introduced into the valve housing chamber and the pressure in the suction chamber exceeds a biasing force of the biasing means, the valve body moves in the direction of blocking the downstream-side opening passage to block the opening of the downstream-side opening passage by the end surface on one end of the valve body in the axial direction. As the opening of the downstream-side opening passage is closed by the end surface on one end of the valve body in the axial direction, the refrigerant flowing into the valve housing chamber through the pressure introduction passage does not flow into the suction chamber regardless of the clearance between the valve body and the valve housing chamber, and an inconvenience that an internal circulating refrigerant is increased and performance is reduced can be eliminated.

[0036] As the valve body for opening/closing the opening passages is opened/closed based on the pressure on the downstream side of the control valve as described above, the valve body inside the valve housing chamber can be positively operated as compared with a case where the valve body inside the valve housing chamber is opened/closed based on the pressure in the discharge chamber with many pulsations in the compressor.

[0037] Additionally, it is not necessary to use the spool valve for the valve body, therefore, it is possible to eliminate the risk of the valve body becoming uncontrollable due to contamination or the like in the refrigerant.

Brief Description of Drawings

[0038]

[Fig. 1] Fig. 1 is a cross-sectional view showing a

compressor according to the present invention, which is a view showing a state of a beginning of starting the compressor.

[Fig. 2] Fig. 2 is a cross-sectional view showing the compressor according to the present invention, which is a view showing a state at the time of full stroke.

[Fig. 3] Fig. 3 is a cross-sectional view showing the compressor according to the present invention, which is a view showing a state at the time of controlling a discharge capacity in an intermediate stroke.

[Fig. 4] Fig. 4 shows structure diagrams of an opened-state adjustment mechanism for adjusting the opened state in opening passages, in which (a) is a view showing a state of beginning of starting the compressor and (b) is a view showing a state during operation of the compressor.

[Fig. 5] Fig. 5 is a comparison table in which opened/closed states of respective valves and strokes of pistons are summarized according to operation states.

[Fig. 6] Fig. 6 is a view showing a structure proposed in related art for a variable-capacity compressor.

Description of Embodiments

[0039] Hereinafter, an embodiment of the present invention will be explained with reference to attached drawings.

[0040] In Fig. 1 to Fig. 3, a clutchless-type variable-capacity compressor that is belt-driven by a power source such as an engine. The variable-capacity compressor includes a cylinder block 1, a rear head 3 assembled to a rear side (right side in the drawing) of the cylinder block 1 through a valve plate 2 and a front head 5 assembled so as to block a front side (left side in the drawing) of the cylinder block 1 to demarcate a control pressure chamber 4, and these front head 5, the cylinder block 1, the valve plate 2 and the rear head 3 are fastened in an axial direction by a fastening bolt 6 to form a housing of the compressor.

[0041] A drive shaft 7 one end of which protrudes from the front head 5 penetrates the control pressure chamber (also referred to as a crank chamber) 4 demarcated by the front head 5 and the cylinder block 1. A drive pulley 10 fitted onto a boss portion 5a of the front head 5 so as to rotate freely through a relay member 9 attached in the axial direction by a bolt 8 is connected to a portion of the drive shaft 7 which protrudes from the front head 5, thereby transmitting rotational power from an engine of a vehicle through a not-shown drive belt. One end side of the drive shaft 7 is sealed with good airtightness between the drive shaft 7 and the front head 5 through a sealing member 11 provided between the drive shaft 7 and the front head 5 and supported by a radial bearing 12 so as to rotate freely. The other end of the drive shaft 7 is supported by a radial bearing 14 housed in a housing hole

13 formed at approximately the center of the cylinder block 1 so as to rotate freely.

[0042] In the cylinder block 1, the housing hole 13 in which the radial bearing 14 is housed and plural cylinder bores 15 arranged at equal intervals on a circumference around the housing hole 13 are formed, and single-head pistons 16 are inserted into respective cylinder bores 15 so as to reciprocate.

[0043] A thrust flange 17 rotating together with the drive shaft 7 is provided securely to the drive shaft 7 in the control pressure chamber 4. The thrust flange 17 is supported so as to rotate freely with respect to an inner surface of the front head 5 through a thrust bearing 18, and a swash plate 20 is connected to thrust flange 17 through a link member 19.

[0044] The swash plate 20 is provided so as to move in a tilting manner around a hinge ball 21 provided on the drive shaft 7 so as to slide, rotating together in synchronization with rotation of the thrust flange 17 through the link member 19. Then, engaging portions 16a of the single-head pistons 16 are captively held to a peripheral edge portion of the swash plate 20 through pairs of shoes 22.

[0045] Therefore, when the drive shaft 7 rotates, the swash plate 20 is rotated together, and the rotary motion of the swash plate 20 is converted into a reciprocating straight motion of the single-head pistons 16 through the shoes 22, which changes capacities of compression chambers 23 formed between the single-head pistons 16 and the valve plate 2 in the cylinder bores 15.

[0046] In the valve plate 2, suction holes 31 and discharge holes 32 are formed so as to correspond to respective cylinder bores 15. In the rear head 3, a suction chamber 33 housing a working fluid to be compressed in the compression chambers 23 and a discharge chamber 34 housing the working fluid compressed and discharged in the compression chambers 23 are demarcated. The suction chamber 33 is formed in the central portion of the rear head 3, communicating with a not-shown suction port connected to an exit side of an evaporator and is capable of communicating with the compression chambers 23 through the suction holes 31 opened and closed by not-shown suction valves. The discharge chamber 34 is formed in a periphery of the suction chamber 33 which is capable of communicating with the compression chambers 23 through the discharge holes 32 opened and closed by not-shown discharge valves and communicating with a discharge space 37 formed in a peripheral wall portion of the cylinder block 1 through passages 2a and 1a formed in the valve plate 2 and the cylinder block 1. The discharge space 37 is demarcated by the cylinder block 1 and a cover 38 attached to the cylinder block 1. A discharge port 39 communicating with an inlet side of a condenser is formed in the cover 38, and a discharge check valve 36 for preventing backflow of a refrigerant from the condenser into the discharge space 37 is provided.

[0047] A discharge capacity of the compressor is de-

termined by strokes of the pistons 16, and the strokes are determined by a tilt angle of the swash plate 20 with respect to a surface perpendicular to the drive shaft 7. The tilt angle of the swash plate 20 is balanced at an angle in which a sum total of a moment derived from a differential pressure between pressures of the compression chambers 23 (pressures inside the cylinder bores) acting on respective pistons 16 and a pressure in the control pressure chamber 4, a moment derived from an inertia force of the swash plate or the pistons and a moment derived from a biasing force of a destroke spring 24 that biases the hinge ball 21 becomes "0 (zero)". Accordingly, the piston strokes are determined and the discharge capacity is determined.

[0048] That is, when the pressure in the control pressure chamber 4 is reduced, the differential pressure between the compression chambers 23 and the control pressure chamber 4 is increased, therefore, the moment acts on in a direction in which the tilt angle of the swash plate 20 is increased. Therefore, when the tilt angle of the swash plate 20 is increased as shown in Fig. 2, the hinge ball 21 moves to the thrust flange side against the biasing force from the destroke spring 24, and the stroke amounts of the pistons 16 are increased to thereby increase the discharge capacity.

[0049] On the other hand, when the pressure in the control pressure chamber 4 is increased and the differential pressure between compression chambers 23 and the control pressure chamber 4 is reduced, the moment acts in a direction in which the tilt angle of the swash plate 20 is reduced. Therefore, when the tilt angle of the swash plate 20 is reduced as shown in Fig. 3, the hinge ball 21 moves in a direction away from the thrust flange 17 and the stroke amounts of the pistons 16 are reduced to thereby reduce the discharge capacity.

[0050] Then, in the present structure example, a supply passage 40 allowing the discharge chamber 34 to communicate with the control pressure chamber 4 is formed by passages 1b, 2b and 3b formed over the cylinder block 1, the valve plate 2 and the rear head 3, and a bleed passage 41 allowing the control pressure chamber 4 to communicate with the suction chamber 33 is formed through the housing hole 13 formed in the cylinder block 1, a passage 1c formed continuously from the housing hole 13, an orifice hole 2c formed in the valve plate 2 communication with the passage 1c, a passage 7c formed in the drive shaft 7, the clearance of the radial bearing 14 and the like.

[0051] On the supply passage 40, a pressure control valve 42 is provided, and a flow rate of a refrigerant flowing into the control pressure chamber 4 from the discharge chamber 34 through the supply passage 40 is adjusted by the pressure control valve 42 to thereby control the pressure in the control pressure chamber 4.

[0052] Here, the pressure control valve 42 is inserted into a mounting hole 43 formed in the rear head 3, which adjusts an opening degree of the supply passage 40 so that a suction pressure becomes a target value to thereby

control the pressure in the control pressure chamber as well as fully opens the supply passage 40 by stopping electrical conduction and minimizes the discharge capacity by increasing the pressure in the control pressure chamber 4. In the beginning of starting, the supply passage 40 is closed by maximizing the conductive amount (duty ratio is 100%), pressure supply to the control pressure chamber is stopped or other operations are performed.

[0053] Accordingly, when the electrical conduction to the pressure control valve 42 is stopped in the state where the compressor is driven to rotate, an internal circulation path is formed inside the compressor, in which the refrigerant discharged from the compression chambers 23 to the discharge chamber 34 is circulated from the discharge chamber 34 to the supply passage 40 (the pressure control valve 42 exists on the way), the control pressure chamber 4, the bleed passage 41, the suction chamber 33, the suction hole 31, the compression chamber 23, the discharge hole 32 and the discharge chamber 34 in this order. Sliding components inside the compressor is lubricated and cooled by a refrigerant gas circulating in the internal circulation path.

[0054] In the above compressor, an opening passage 50 allowing the control pressure chamber 4 to communicate with the suction chamber 33 is provided. One end of the opening passage 50 is connected to the passage 1c (portion on the upstream side of the orifice hole 2c of the bleed passage 41) allowing the housing hole 13 formed in the cylinder block 1 to communicate with the orifice hole 2c, the other end of which is connected to the suction chamber 33 through the valve plate 2.

[0055] In the present application of the invention, the control pressure chamber 4 includes not only a space housing the drive shaft and the swash plate but also a space where a pressure of the space housing the drive shaft and the swash plate is directly reflected, and the passage 1c allowing the housing hole 13 formed in the cylinder block 1 to communicate with the orifice hole 2c is also part of the control pressure chamber 4.

[0056] The opening passage 50 is provided with an opened-state adjustment mechanism for automatically adjusting the opened state of the passage also shown as Fig. 4.

[0057] The opened-state adjustment mechanism is formed by a valve housing chamber 51 formed on the opening passage 50, a valve body 52 provided inside the valve housing chamber 51 and a spring 53 pressing the valve body 52, having a structure in which a downstream-side opening passage 50b is opened and closed by the valve body 52 when a portion allowing the control pressure chamber 4 to communicate with the valve housing chamber 51 in the opening passage 50 is an upstream-side opening passage 50a and a portion allowing the valve housing chamber 51 in the opening passage 50 to communicate with the suction chamber 33 is the downstream-side opening passage 50b. Specifically, the valve housing chamber 51 is formed in a cylindrical shape, and

the downstream-side opening passage 50b opens at an end portion on one end side of the valve housing chamber 51 in the axial direction, and an opening 50b-1 of the downstream-side opening passage 50b is opened and closed by an end surface 52b-1 on one end side of the valve body 52 in the axial direction (an end surface of a later-described first small diameter portion 52b). The valve body 52 is biased in a direction of opening the downstream-side opening passage 50b by the spring 53 (biasing means). In the example, the valve housing chamber 51 is configured by blocking a cylindrical bottomed hole formed in the cylinder block 1 by the valve plate 2, and the downstream-side opening passage 50b is configured by a through hole having a diameter smaller than a diameter of the valve housing chamber 51 formed on the valve plate 2.

[0058] A pressure introduction passage 54 branching on the downstream side of the pressure control valve 42 of the supply passage 40 is connected to the valve housing chamber 51 (the valve housing chamber 51 communicates with the downstream side of the pressure control valve 42 of the supply passage 40 through the pressure introduction passage 54). In a case where the valve housing chamber 51 is formed in an approximately cylindrical shape and the downstream-side opening passage 50b is connected to one end portion of the valve housing chamber 51 in the axial direction, the pressure introduction passage 54 is connected close to an end portion on the opposite side of an end portion where the downstream-side opening passage 50b of the valve housing chamber 51 is connected, and the upstream-side opening passage 50a is connected to close to an end portion where the downstream-side opening passage 50b of the valve housing chamber 51 is connected.

[0059] The valve body 52 housed in the valve housing chamber 51 has a shape in which a suitable throttle is formed between a portion where the pressure introduction passage 54 opens in the valve housing chamber 51 and a portion where the upstream-side opening passage 50a opens in a state in which the downstream-side opening passage 50b is blocked.

[0060] Specifically, the valve body 52 is configured by including a large diameter portion 52a moving along an inner peripheral surface in a state where a prescribed clearance is secured between the valve body 52 and the inner peripheral surface of the valve housing chamber 51, the first small diameter portion 52b formed continuously from the large diameter portion 52a to have a smaller diameter than a diameter of the large diameter portion 52a and opening/closing the downstream-side opening passage 50b by an end surface thereof and a second small diameter portion 52c formed continuously from the large diameter portion 52a on the opposite side of the first diameter portion to have a smaller diameter than the diameter of the large diameter portion 52a.

[0061] In the valve housing chamber 51, a portion where the pressure introduction passage 54 is connected is a position where a pressure introduced through the

pressure introduction passage 54 acts on the valve body 52 in a direction of blocking the downstream-side opening passage 50b, which is a portion to be an opposite side of the downstream-side opening passage 50b (first small diameter portion 52b) with respect to the large diameter portion 52a in a state where the valve body 52 is positioned at the most distant position from the downstream-side opening passage 50b. In the example, the valve housing chamber 51 is configured so that the pressure introduction passage 54 is connected to an peripheral surface of the valve housing chamber 51 facing a peripheral surface of the second small diameter portion 52c of the valve body 52 in the state where the valve body 52 is positioned at the most distant position from the downstream-side opening passage 50b in the valve housing chamber 51.

[0062] Furthermore, a portion where the upstream-side opening passage 50a is connected in the valve housing chamber 51 is a region which is on the same side as the downstream-side opening passage 50b (the first small diameter portion 52b) with respect to the large diameter portion 52a in a state where the valve body 52 is closest to the downstream-side opening passage 50b (in the state where the valve body 52 blocks the downstream-side opening passage 50b). In the example, the valve housing chamber 51 is configured so that the upstream-side opening passage 50a is connected to an peripheral surface of the valve housing chamber 51 facing a peripheral surface of the first small diameter portion 52b of the valve body 52 in the state where the valve body 52 is positioned at the closest position to the downstream-side opening passage 50b in the valve housing chamber 51.

[0063] A first check valve 60 as a boosting means is provided on the downstream side of a place where the pressure introduction passage 54 branches in the supply passage 40. The first check valve 60 allows only a flow from the upstream side to the downstream side of the supply passage 40, housing a ball-shaped valve body 60b in a valve-body housing portion 60a provided on the supply passage 40 to allow the ball-shaped valve body 60b to be seated on a seating surface 60c provided on the upstream side of the valve body housing portion 60a from the downstream side and to bias the ball-shaped valve body 60b toward the seating surface 60c from the downstream side by a spring 60d so as to have a prescribed valve-opening pressure.

[0064] Furthermore, the upstream-side opening passage 50a is provided with a second check valve 70 allowing only a flow from the control pressure chamber 4 (the passage 1c formed in the cylinder block 1) to the valve housing chamber 51.

[0065] The second check valve 70 houses a ball-shaped valve body 70b in a valve-body housing portion 70a provided on the upstream-side opening passage 50a to allow the ball-shaped valve body 70b to be seated on a seating surface 70c provided on the control pressure chamber side of the valve body housing portion 70a from

the valve housing chamber side and to open/close the upstream-side opening passage 50 due to a pressure difference between the control pressure chamber 4 and the valve housing chamber 51.

[0066] In the above example, the example in which the ball-shaped valve bodies are used as the check valves (first check valve 60, second check valve 70) provided on the upstream-side opening passage 50a and the supply passage 40 is shown, however, the present invention is not limited to this .

[0067] In the above structure, the pressure Pd in the discharge chamber 34, the pressure Pc in the control pressure chamber 4 and the pressure Ps in the suction chamber 33 are approximately equivalent in a state where the compressor is stopped for a long period of time (while the engine is stopped), and the liquefied refrigerant stagnates in the control pressure chamber 4. As the pressure control valve 42 is in the fully opened state as the electrical conduction is stopped, the pressure (control valve downstream pressure PK) in the intermediate region K of the bleed passage 41 (region between the pressure control valve 42 and the first check valve 60 in the supply passage 41) is also approximately equivalent to the pressure Ps of the suction chamber 33. Under this state, the swash plate 20 is biased by the biasing force of the destroke spring 24 so that the tilt angle with respect to the surface perpendicular to the drive shaft 7 is the smallest. Also as shown in "at the time of engine stop" of Fig. 5, the first check valve 60 is in the closed state by the biasing force of the spring 60d, the valve body 52 is in the opened state by the biasing force of the spring 53, the second check valve 70 is in the opened state and the discharge check valve 36 is in the closed state.

[0068] When the engine of the vehicle is started from this state, rotation power of the engine is transmitted to the drive pulley 10 of the compressor through the drive belt even when the electrical conduction to the pressure control valve 42 is stopped, and when the drive shaft 7 of the compressor is rotated, the pistons 16 reciprocate inside the cylinder bores 15 at the minimum stroke. Accordingly, an amount of refrigerant to be circulated inside the compressor is discharged to the discharge chamber 34, however, the amount is not sufficient to push open the discharge check valve 36 provided in the discharge space 37, therefore, the refrigerant is not supplied to the external refrigerating cycle.

[0069] After that, when a switch of an air conditioner of the vehicle is turned on, electrical conduction to the pressure control valve 42 is started and the supply passage 40 is in the closed state (the pressure control valve 42 is in the closed state), the pressure is not supplied from the discharge chamber 34 to the control pressure chamber 4, and the pressure Pd in the display chamber 34 is accordingly increased. At this time, the pressure is not supplied to the control pressure chamber 4 from the discharge chamber 34 through the supply passage 40, however, the liquid refrigerant accumulated in the control pressure chamber 4 is continued to be vaporized, there-

fore, the pressure in the control pressure chamber 4 is not reduced and maintained.

[0070] Therefore, in the beginning of starting of the air conditioner and the compressor, the pressure in the intermediate region K (control valve downstream pressure P_k) between the pressure control valve 42 and the boosting means (the first check valve 60) of the supply passage 40 is approximately equivalent to the pressure P_s in the suction chamber 33, which is lower than the pressure P_c in the control pressure chamber 4. As a result, a difference between the pressure on the downstream side of the pressure control valve 42 (control valve downstream pressure P_s) and the pressure (P_s) of the suction chamber 33 is small, therefore, the valve 52 is maintained in a position where the downstream-side opening passage 50b is opened by the biasing force of the spring 53 as shown in "beginning of starting (when the liquid refrigerant stagnates) in Fig. 4(a) and Fig. 5. Moreover, the pressure P_c in the control pressure chamber 4 is increased to be higher than the control valve downstream pressure P_k , therefore, the first check valve 60 forming the boosting means is in the closed state (the ball-shaped valve body 60b abuts on the seating surface 60c provided on the supply passage 40), which prevents the refrigerant in the control pressure chamber 4 from flowing back to the valve housing chamber 51 through the pressure introduction passage 54.

[0071] The pressure P_c in the control pressure chamber 4 is higher than the pressure P_s in the suction chamber 33, therefore, the second check valve 70 is in the opened state (the ball-shaped valve body 70b is separated from seating surface 70c provided on the upstream-side opening passage 50a), the vaporized refrigerant in the control pressure chamber 4 flows to the valve housing chamber 51 through the upstream-side opening passage 50a and flows out to the suction chamber 33 from the valve housing chamber 51.

[0072] As described above, while the liquid refrigerant accumulated in the control pressure chamber 4 is vaporized, the vaporized refrigerant continues to flow out to the suction chamber 33 through the opening passage 50 in addition to the related-art bleed passage 41 flowing through the orifice hole 2c, therefore, the refrigerant in the control pressure chamber 4 can be immediately released to the suction chamber 33 through two systems of the bleed passage 41 and the opening passage 50, which reduces the pressure in the control pressure chamber 4 earlier (a period of time until all the liquid refrigerant accumulated in the control pressure chamber is evaporated and discharged to the suction chamber is shortened to thereby avoid an inconvenience that a period of time until discharge capacity control can be performed is extended), as a result, it is possible to increase the tilt angle of the swash plate 20 smoothly and to increase the discharge capacity (Fig. 2).

[0073] When all the liquid refrigerant accumulated in the control pressure chamber 4 is evaporated and discharged to the suction chamber 33 and the compressor

makes a transition to operation at the maximum capacity, the discharge check valve 36 is opened and the sufficient refrigerant is supplied to the external refrigerating cycle (refer to "at the time of operation at the maximum capacity" in Fig. 5), the temperature in the evaporator in the refrigerating cycle is gradually reduced, and the pressure P_s in the suction chamber 33 is reduced. Then, when a refrigerating ability in the evaporator reaches a sufficient value, the conduction amount of the pressure control valve 42 is adjusted and the supply passage 40 is opened (the pressure control valve 42 is opened), and a high-pressure gas in the discharge chamber 34 is supplied to the control pressure chamber 4 through the supply passage 40.

[0074] In this case, as the boosting means (first check valve 60) is provided in the downstream of the control valve of the supply passage 40, the control valve downstream pressure P_k can be smoothly increased by utilizing a passage resistance generated when the refrigerant passes through the boosting means, thereby giving a pressure higher than the pressure P_c in the control chamber 4 to the valve body 52 housed in the valve housing chamber 51. In the example, the boosting means is configured by the first check valve 60 having a prescribed valve-opening pressure as described above, thereby generating a prescribed pressure difference before and after the boosting means regardless of the amount of the refrigerant gas passing through the supply passage 40.

[0075] Then, when a difference between the control valve downstream pressure P_k introduced into the valve housing chamber 51 through the pressure introduction passage 54 and the pressure P_s in the suction chamber 33 is increased to be higher than a biasing force of the spring 53, the valve body 52 moves in a direction of blocking the downstream-side opening passage 50b against the spring force of the spring 53 and makes the downstream-side opening passage 50b in the closed state as shown in "at the time of an intermediate stroke (discharge capacity control operation)" in Fig. 4(b) and Fig. 5.

[0076] At the same time, the refrigerant flowing into the valve housing chamber 51 through the pressure introduction passage 54 passes through a clearance between an inner wall of the valve housing chamber 51 and the large diameter portion 52a of the valve 52 and flows into the control pressure chamber 4 through the upstream-side opening passage 50a, however, the second check valve 70 allowing only the flow of fluid from the control pressure chamber 4 to the valve housing chamber 51 is provided in the upstream-side opening passage 50a, therefore, the second check valve 70 is in the closed state and prevents the flow of the refrigerant to the control pressure chamber 4 through the upstream-side opening passage 50a.

[0077] Accordingly, the refrigerant in the control pressure chamber 4 is discharged to the suction chamber 33 only through the related-art bleed passage 41, and the high pressure gas is supplied to the control pressure chamber 4 through the supply passage 40 in a state

where the refrigerant amount introduced out of the control pressure chamber 4 to the suction chamber 33 is drastically reduced, therefore, the pressure P_c in the control pressure chamber 4 is smoothly increased and the tilt angle of the swash plate 20 is smoothly reduced to thereby reduce the discharge amount (Fig. 3).

[0078] Here, in the example, the pressure introduction passage 54 is connected to a portion of the valve housing chamber 51 on the opposite side of the downstream-side opening passage 50b (the first small diameter portion 52b) with respect to the large diameter portion 52a in the state where the valve body 52 is the most distant from the downstream-side opening passage 50b, therefore, a pressure of the refrigerant introduced into the valve housing chamber 51 through the pressure introduction passage 54 can be reduced when passing through a clearance between a peripheral surface of the large diameter portion 52a and the inner wall of the valve housing chamber 51, thereby generating a difference between a pressure acting on one end side of the valve body 52 in the axial direction and a pressure acting on the other end side in the axial direction and giving a pressing force in the direction of blocking the downstream-side opening passage 50b against the biasing force of the spring 53.

[0079] Moreover, the upstream-side opening passage 50a is connected to a portion to be closer to the downstream-side opening passage than the large diameter portion 52a is in the state where the valve body 52 is the closest to the downstream-side opening passage 50b (state where the downstream-side opening passage 50b is blocked by the valve body 52), therefore, the refrigerant pressure P_c in the control pressure chamber 4 flowing into the valve housing chamber 51 through the upstream-side opening passage 50a can be positively given to the downstream side in the large diameter portion (end surface on the side where the first small diameter portion 52b is provided), and the opening passage 50 is not blocked by the peripheral surface of the large diameter portion 52a, therefore, it is possible to avoid the increase in the passage resistance of the opening passage 50 regardless of the position of the valve body 52.

[0080] In a case where the time of the maximum capacity operation or the time of the discharge capacity control operation makes a transition to an idling state, the pressure control valve 42 is fully opened and the high-pressure refrigerant is supplied from the discharge chamber 34 to the control pressure chamber 4 through the supply passage 40 to thereby minimize piston strokes for minimizing the discharge capacity of the compressor as shown in "at the time of idling (clutchless off operation)" in Fig. 5. In such case, the high-pressure gas is supplied from the supply passage 40 to the valve housing chamber 51 through the pressure introduction passage 54, therefore, the valve body 52 is immediately closed, the pressure P_c in the control pressure chamber 4 is smoothly increased, the tilt angle of the swash plate 20 is smoothly reduced and the discharge capacity is reduced.

[0081] As described above, the valve body inside the

valve housing chamber 51 is controlled to be opened and closed based on the pressure on the downstream side (control valve downstream pressure P_k) of the pressure control valve 42 in the supply passage 40, therefore, the valve body inside the valve housing chamber can be positively operated as compared with a case where the valve body inside the valve housing chamber is controlled to be opened and closed based on a pressure in the discharge chamber 34 with many pulsations.

[0082] The flow of the refrigerant from the valve housing chamber 51 to the control pressure chamber 4 can be interrupted by the second check valve 70 in the case where the downstream-side opening passage 50b is in the closed state by the valve body 52 even when the valve body 52 does not have the structure like spool valve, therefore, the inconvenient that the amount of the refrigerant supplied to the control pressure chamber is reduced through the supply passage does not occur and lubrication for slicing components inside the control pressure chamber can be secured.

[0083] Furthermore, it is possible to avoid using the spool valve as the valve body 52 in the above structure, therefore, it is not necessary to strictly manage the clearance between the valve body 52 and the valve housing chamber 51, and contamination or the like in the refrigerant does not affect movement of the valve body.

[0084] When there is a request for maximizing the discharge capacity of the compressor after that, the conduction amount to the pressure control valve 42 is increased and the supply passage 40 is closed, then, the pressure is not supplied from the discharge chamber 34 to the control pressure chamber 4 through the pressure control valve 42. The pressure in the intermediate region K (control valve downstream pressure P_k) of the supply passage 40 is lower than the pressure P_c in the control pressure chamber 4, therefore, the ball-shaped valve body 60b in the first check valve 60 abuts on the seating surface 60c and the supply passage 40 is blocked. There are not pressure supply from the discharge chamber 34 and the backflow from the control pressure chamber 4 in the intermediate region K (a region between the downstream of the pressure control valve 42 and the upstream of the boosting means), therefore, the pressure in the intermediate region K (control valve downstream pressure P_k) is smoothly reduced and the pressure introduced to the valve housing chamber 51 through the pressure introduction passage 54 is also reduced. Accordingly, the valve body 52 moves to a position where the downstream-side opening passage 50b is opened by the spring force of the spring 53 as shown in Fig. 4(a). Moreover, as the pressure in the valve housing chamber 51 is lower than the pressure P_c in the control pressure chamber 4, the second check valve 70 is opened.

[0085] Accordingly, as the refrigerant in the control pressure chamber 4 flows to the suction chamber 33 through the upstream-side opening passage 50a, the valve housing chamber 51 and the downstream-side opening passage 50b, the pressure in the control pres-

sure chamber 4 is smoothly reduced and the discharge capacity becomes maximum.

[0086] It is sufficient that the portion of the pressure introduction passage 54 that opens to the valve housing chamber 51 has a structure in which the control valve downstream pressure P_k introduced to the valve housing chamber 51 acts on the valve body 52 in the direction of blocking the downstream-side opening passage 50b, therefore, the structure is not limited to the example shown in Fig. 4.

[0087] In the above example, the structure in which the first check valve 60 as the boosting means is provided on the downstream side of the place where the pressure introduction passage 54 of the supply passage 40 branches is shown, however, it is also preferable that the orifice hole substitutes for the boosting means as well as that the boosting means can be omitted.

Reference Signs List

[0088]

4	control pressure chamber
7	drive shaft
20	swash plate
23	compression chamber
33	suction chamber
34	discharge chamber
40	supply passage
41	bleed passage
42	pressure control valve
50	opening passage
50a	upstream-side opening passage
50b	downstream-side opening passage
51	valve housing chamber
52	valve body
52a	large diameter portion
52b	small diameter portion
53	spring (biasing means)
54	pressure introduction passage
60	first check valve
70	second check valve

Claims

1. A variable-capacity compressor including a compression chamber (23) compressing working fluid, a suction chamber (33) housing the working fluid to be compressed in the compression chamber (23), a discharge chamber (34) housing the working fluid compressed in the compression chamber (23) and discharged, a control pressure chamber (4) through which a drive shaft (7) penetrates, housing a swash plate (20) rotating with rotation of the drive shaft (7), a supply passage (40) allowing the discharge chamber (34) to communicate with the control pressure chamber (4), a bleed passage (41) constantly allow-

ing the control pressure chamber (4) to communicate with the suction chamber (33), and a control valve (42) adjusting an opening degree of the supply passage (40), in which a discharge capacity is changed by adjusting a pressure in the control pressure chamber (4),

characterized in that the compressor comprising:

an opening passage (50) allowing the control pressure chamber (4) to communicate with the suction chamber (33);
a valve housing chamber (51) formed on the opening passage (50),
wherein the opening passage (50) is formed by including an upstream-side opening passage (50a) allowing the control pressure chamber (4) to communicate with the valve housing chamber (51), and a downstream-side opening passage (50b) provided so as to open to one end of the housing chamber (51) in an axial direction and allowing the valve housing chamber (51) to communicate with the suction chamber (33);
wherein the compressor further comprises:

a valve body (52) housed in the valve housing chamber (51) and opening/closing an opening of the downstream-side opening passage (50b) by an end surface on one end side in the axial direction;

a biasing means (53) for biasing the valve body (52) in an opening direction of the downstream-side opening passage (50b);
and

a pressure introduction passage (54) branching from a downstream side of the control valve (42) of the supply passage (40) and communicating with a region in the valve housing chamber (51), which is on the opposite side of the downstream-side opening passage (50b) with respect to the valve body (52) housed in the valve housing chamber (51).

2. The variable-capacity compressor according to claim 1, further comprising:

a boosting means provided on the downstream side of the place where the pressure introduction passage (54) branches on the supply passage (40).

3. The variable-capacity compressor according to claim 2,
wherein the boosting means is formed by a first check valve (60) allowing only a flow from the upstream side to the downstream side of the supply passage (40).

4. The variable-capacity compressor according to any one of claims 1 to 3,
wherein the valve body (52) is formed by including a large-diameter portion (52a) moving along an inner peripheral surface of the valve housing chamber (51) and a small diameter portion (52b) formed to have a smaller diameter than a diameter of the large diameter portion (50a) and opening/closing the downstream-side opening passage (50b), and a portion where the pressure introduction passage (54) is connected to the valve housing chamber (51) is positioned in a region on the opposite side of the downstream-side opening passage (50b) with respect to the large diameter portion (52a) in a state where the valve body (52) is the most distant from the downstream-side opening passage (50b).
5. The variable-capacity compressor according to claim 4,
wherein a portion where the upstream-side opening passage (50a) is connected to the valve housing chamber (51) is positioned closer to the downstream-side opening passage side (50b) than the large-diameter portion (52a) is in a state where the valve body (52) is the closest to the downstream-side opening passage (50b).
6. The variable-capacity compressor according to any one of claims 1 to 5, further comprising:
a second check valve (70) provided on the upstream-side opening passage (50a) and allowing only a flow of fluid from the control pressure chamber to the valve housing chamber (51) .

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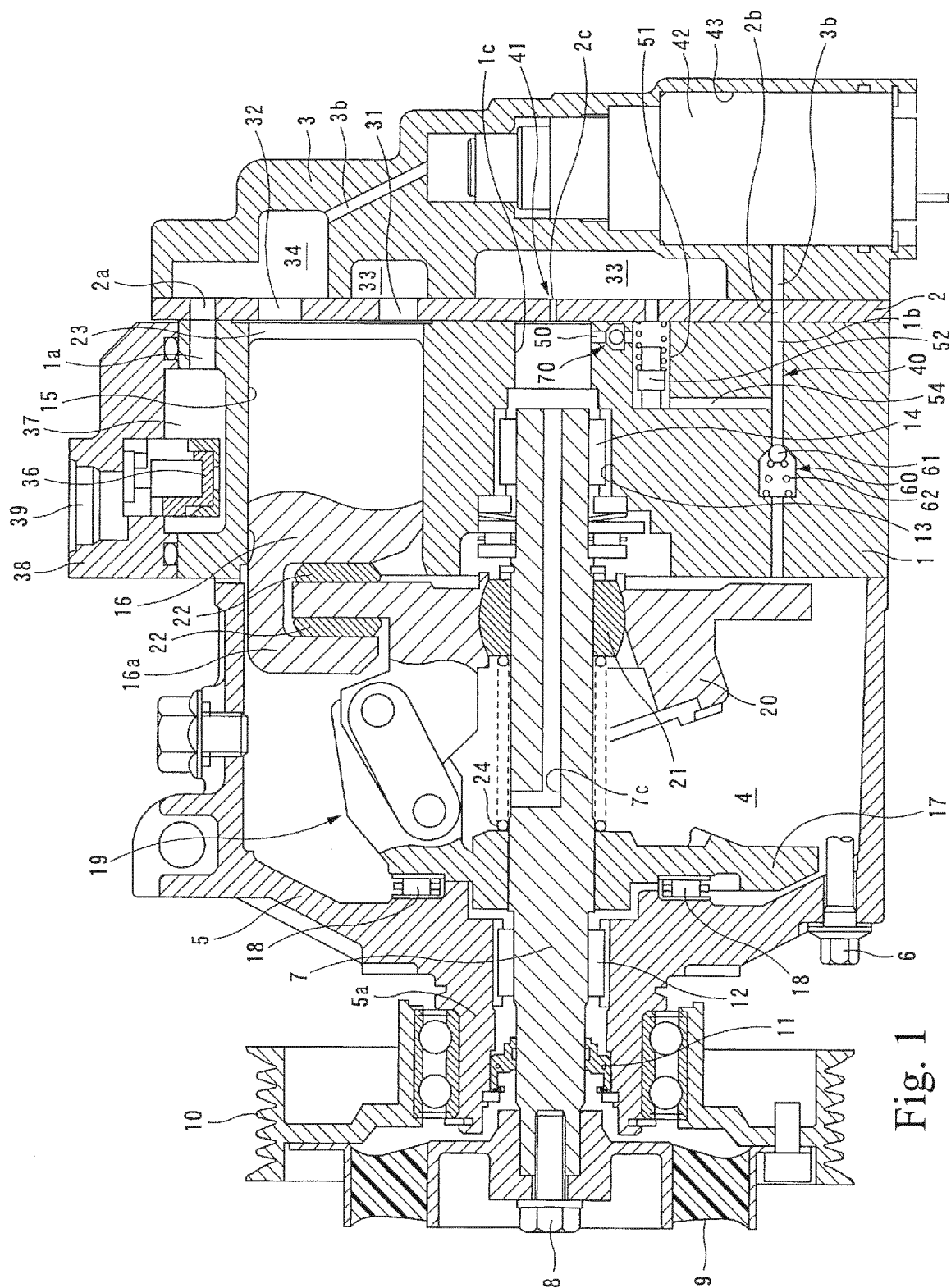


Fig. 1

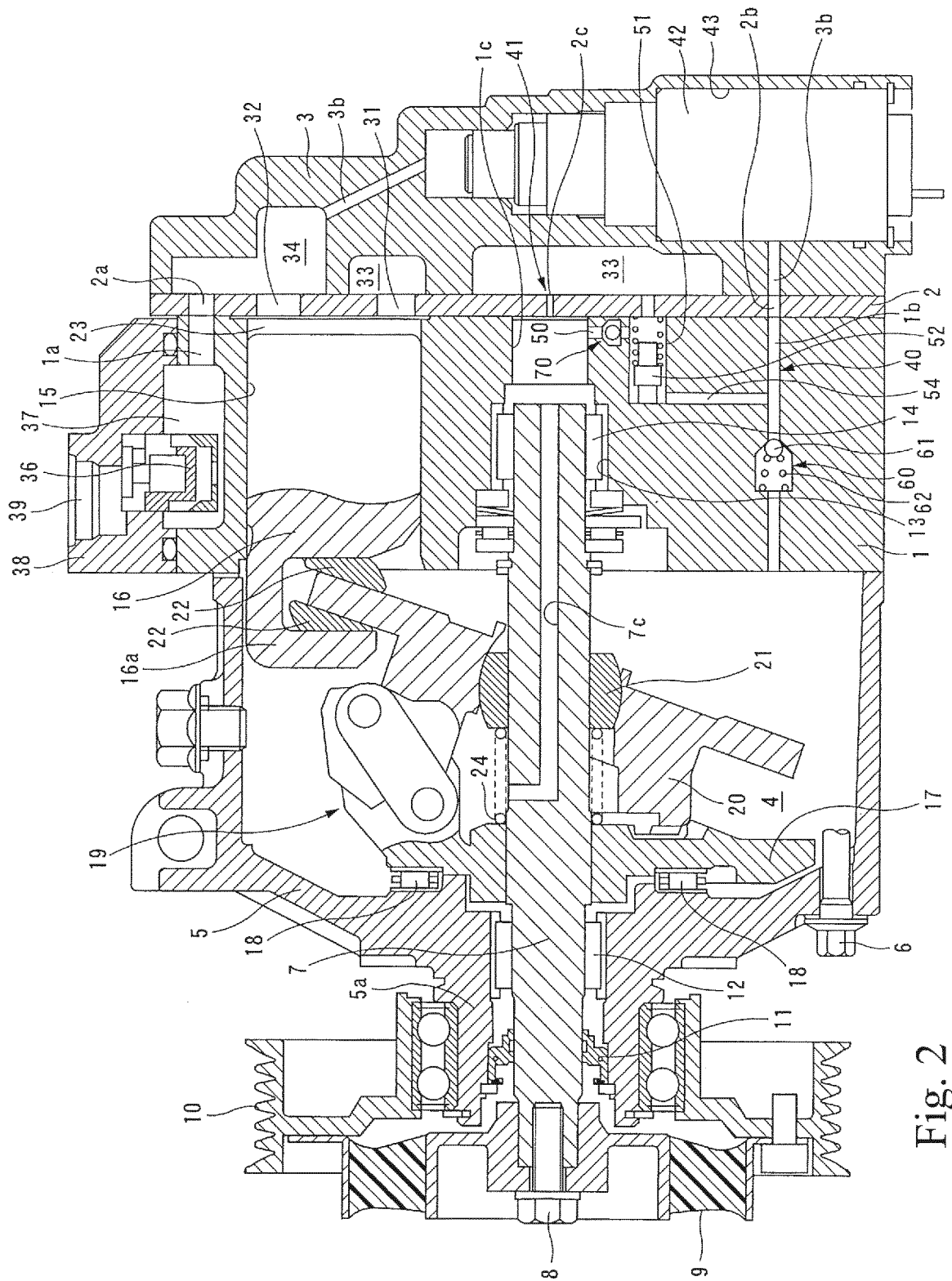


Fig. 2

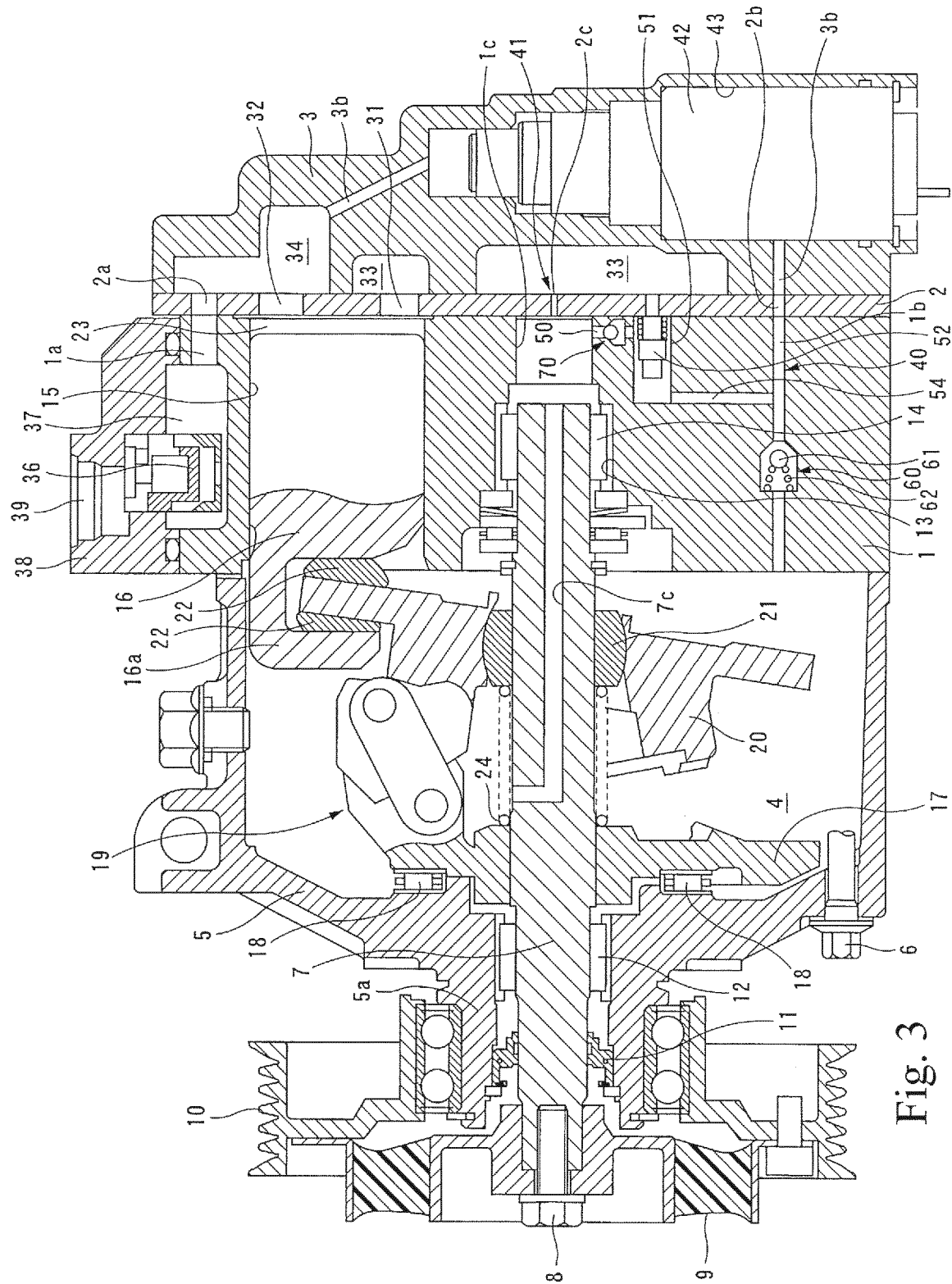


Fig. 3

state	pressure control valve	stroke (the swash plate angle)	first check valve	opening passage (valve body)	second check valve	discharge check valve
at the time of engine stop	full open	minimum	close	open	open	close
beginning of starting (when the liquid refrigerant stagnates)	close	minimum	close	open	open	close
at the time of operation at the maximum capacity	close	maximum	close	open	open	open
at the time of an intermediate stroke (discharge capacity control operation)	half open	middle (minimum~maximum)	open	close	close	open
at the time of idling (clutchless off operation)	full open	minimum	open	close	close	close

Fig. 5

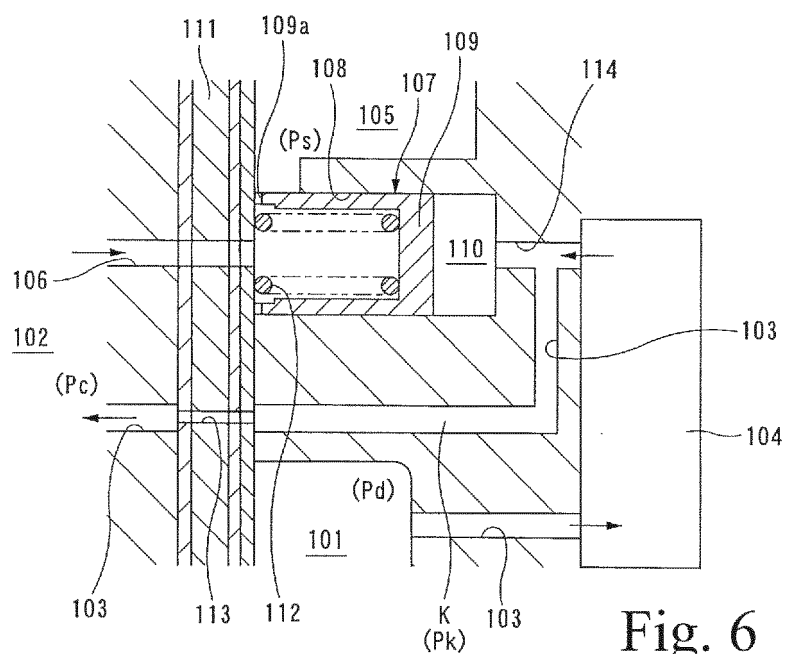


Fig. 6

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/059317

A. CLASSIFICATION OF SUBJECT MATTER

F04B27/18(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)

F04B27/18

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 1996-2016
 Kokai Jitsuyo Shinan Koho 1971-2016 Toroku Jitsuyo Shinan Koho 1994-2016

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 2005-307882 A (Toyota Industries Corp.), 04 November 2005 (04.11.2005), paragraphs [0025] to [0031], [0042] to [0043], [0053], [0068] to [0069]; fig. 1, 5 (Family: none)	1, 4-5 2-3 6
Y A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 5842/1986(Laid-open No. 119483/1987) (Nihon Radiator Co., Ltd.), 29 July 1987 (29.07.1987), specification, page 8, line 17 to page 9, line 14; page 13, line 7 to page 15, line 3; fig. 1 to 2 (Family: none)	2-3 1, 4-6

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

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 Date of the actual completion of the international search
 15 June 2016 (15.06.16)

 Date of mailing of the international search report
 28 June 2016 (28.06.16)

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 Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2016/059317

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 2012-215088 A (Toyota Industries Corp.), 08 November 2012 (08.11.2012), entire text; all drawings & US 2012/0247140 A1 & DE 102012204794 A1 & CN 102734116 A	1-6

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

REFERENCES CITED IN THE DESCRIPTION

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