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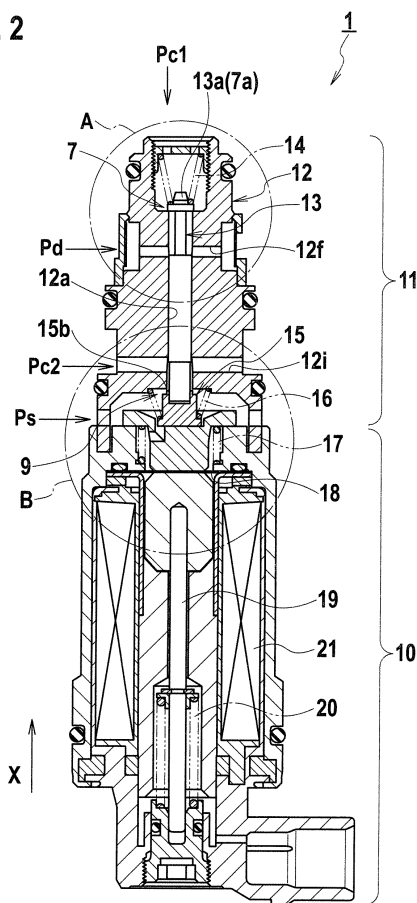
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(54) CONTROL VALVE FOR VARIABLE DISPLACEMENT COMPRESSOR

(57) A control valve is configured such that as a position of a high pressure-side valve body positioned by a solenoid is closer to one side, a degree of opening for communication of a high pressure valve portion is more widened and a pressure on the side of a discharge flow path acting on the high pressure-side valve body is weakened. Further, the control valve is configured such that as a position of a low pressure-side valve body positioned by the solenoid is closer to the other side, a degree of opening for communication of a low pressure valve portion is more widened. When the high pressure-side valve body and the low pressure-side valve body are integrally positioned on the one side by the solenoid and the low pressure-side valve body is positioned on the other side by the solenoid, the high pressure-side valve body and the low pressure-side valve body are separated from each other.

FIG. 2



Description

TECHNICAL FIELD

[0001] The present invention relates to a control valve for a variable displacement compressor.

BACKGROUND ART

[0002] As a conventional control valve for a variable displacement compressor used for a refrigeration cycle of an automotive air conditioning system, there has been known a control valve including a high pressure valve portion provided in an introducing-side communication passage which brings a discharge flow path and a control pressure chamber of the variable displacement compressor into communication with each other, and a low pressure valve portion provided in a discharging-side communication passage which brings an intake flow path and the control pressure chamber, in which a degree of opening for communication between the high pressure valve portion and the low pressure valve portion is variably controlled, thereby changing a pressure in the control pressure chamber to change an angle of a swash plate.

[0003] According to such a configuration, a case chamber (crank chamber) is used as the control pressure chamber in many cases. In such a case, if a control pressure (pressure in the control pressure chamber) is increased, the angle of the swash plate is reduced and the discharge capacity is reduced, and if the control pressure is reduced, the angle of the swash plate is increased and the discharge capacity is increased (patent document 1, for example).

[0004] In the control valve disclosed in the patent document 1, however, in a ball valve as the high pressure valve portion, a discharge pressure is applied in a direction closing a valve body. Therefore, when control is performed to reduce the angle of the swash plate to reduce the discharge capacity, there is concern that the high pressure valve portion is closed unintentionally by the discharge pressure, the control pressure is reduced, the angle of the swash plate is increased and the discharge capacity is increased.

[0005] In addition to the high pressure valve portion having the ball valve, there is also a conventional high pressure valve portion in which a valve body of the low pressure valve portion is integrally formed on a spool valve as the high pressure valve portion. In such a case, there is a problem that since a pressure leaks from a clearance generated between a sleeve and a spool in the high pressure valve portion, the actuation of the air conditioning system delays when the cooling operation is started.

[0006] Therefore, it is an object of the present invention to obtain a control valve for a variable displacement compressor capable of preventing a high pressure valve portion from being unintentionally closed by increase of a discharge pressure, capable of preventing an angle of a

swash plate from increasing, and capable of enhancing the actuating performance.

Patent document 1: International Publication WO2004/06578

DISCLOSURE OF INVENTION

[0007] According to the present invention, a control valve for a variable displacement compressor comprises a high pressure valve portion provided in an introducing-side communication passage which brings a discharge flow path and a control pressure chamber of the variable displacement compressor into communication with each other, and a low pressure valve portion provided in a discharging-side communication passage which brings an intake flow path and the control pressure chamber into communication with each other, in which degree of opening for communication of the high pressure valve portion and the low pressure valve portion are variably controlled, thereby varying a pressure in the control pressure chamber to change an angle of a swash plate, wherein the control valve further comprises a position control unit which controls advancing/retracting positions of a high pressure-side valve body of the high pressure valve portion and a low pressure-side valve body of the low pressure valve portion, as a position of the high pressure-side valve body positioned by the position control unit is closer to one side, a degree of opening for communication of the high pressure valve portion is more widened, a pressure on the side of a discharge flow path acting on the high pressure-side valve body is weakened, as a position of the low pressure-side valve body positioned by the position control unit is closer to the other side, a degree of opening for communication of the low pressure valve portion is more widened, and when the high pressure-side valve body and the low pressure-side valve body are integrally positioned on the one side by the position control unit and the low pressure-side valve body is positioned on the other side by the position control unit, the high pressure-side valve body and the low pressure-side valve body are separated from each other.

[0008] According to the present invention, when the high pressure-side valve body and the low pressure-side valve body are positioned on the one side by the position control unit, the low pressure valve portion is fully closed.

[0009] According to the present invention, there is provided an urging unit which urges, of the high pressure-side valve body and the low pressure-side valve body, only the low pressure-side valve body toward the other side.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

[Fig.1] Fig. 1 is a schematic diagram of apparatus configurations of a variable displacement compressor and a control valve according to an embodiment

of the present invention.

[Fig. 2] Fig. 2 is a vertical sectional view of the control valve for the variable displacement compressor according to the embodiment of the present invention, and shows that a high pressure valve portion is closed and a low pressure valve portion is opened.

[Fig. 3] Fig. 3 is an enlarged view of a portion A in Fig. 2.

[Fig. 4] Fig. 4 is an enlarged view of a portion B in Fig. 2.

[Fig. 5] Fig. 5 is a vertical sectional view of the control valve for the variable displacement compressor according to the embodiment of the present invention, and shows that the high pressure valve portion is opened and the low pressure valve portion is closed.

[Fig. 6] Fig. 6 is a graph showing a correlation between a position of a movable portion of the control valve for the variable displacement compressor and opening areas of the high pressure valve portion and the low pressure valve portion according to the embodiment of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0011] An embodiment of the present invention will be explained below in detail with reference to the accompanying drawings. Fig. 1 is a schematic diagram of apparatus configurations of a variable displacement compressor and a control valve according to the embodiment, Fig. 2 is a vertical sectional view of the control valve, and shows that a high pressure valve portion is closed and a low pressure valve portion is opened, Fig. 3 is an enlarged view of a portion A in Fig. 2, Fig. 4 is an enlarged view of a portion B in Fig. 2, Fig. 5 is a vertical sectional view of the control valve, and shows that the high pressure valve portion is opened and the low pressure valve portion is closed, and Fig. 6 is a graph showing a correlation between a position of a movable portion of the control valve and opening areas of the high pressure valve portion and the low pressure valve portion.

[0012] As shown in Fig. 1, a control valve 1 according to the present embodiment controls a control pressure P_c which changes an inclination angle of a swash plate 2a to change a discharge capacity of a variable displacement compressor 2, and the control valve 1 controls a pressure (control pressure) P_c in a case chamber 3 as a control pressure chamber for example. In this case, the lower the pressure P_c in the case chamber 3 is, the greater a pressure difference applied to a piston in the variable displacement compressor 2 becomes and the discharge capacity is increased. On the contrary, the higher the pressure in the case chamber 3 is, the lower the discharge capacity becomes.

[0013] The control pressure P_c is produced as an intermediate pressure between a pressure of refrigerant (discharge pressure) P_d in a discharge flow path 4 (e.g., discharge port) and a pressure of refrigerant (intake pressure) P_s in an intake flow path 5 (e.g., intake port). For

this purpose, the control valve 1 includes a high pressure valve portion 7 and a low pressure valve portion 9. The high pressure valve portion 7 is provided in an introducing-side communication passage 6 which brings the discharge flow path 4 and the case chamber 3 into communication with each other. The high pressure valve portion 7 variably controls a degree of opening for communication of the introducing-side communication passage 6. The low pressure valve portion 9 is provided in a discharging-side communication passage 8 which brings the intake flow path 5 and the case chamber 3 into communication with each other. The low pressure valve portion 9 variably controls a degree of opening for communication of the discharging-side communication passage 8. By adjusting these degrees of opening for communication, the control pressure P_c is produced. In the case of such a configuration, as the degree of opening for communication of the high pressure valve portion 7 is larger, the control pressure P_c becomes closer to the discharge pressure P_d and becomes higher, and as the degree of opening for communication of the low pressure valve portion 9 is larger, the control pressure P_c becomes closer to the intake pressure P_s and becomes lower. By controlling the degree of opening for communication of the high pressure valve portion 7 and the degree of opening for communication of the low pressure valve portion 9, it is possible to produce the control pressure P_c while suppressing the refrigerant from flowing out from the discharge flow path 4 toward the intake flow path 5 and while reducing the energy loss.

[0014] In the present embodiment, the flow path (including the introducing-side communication passage 6 and the discharging-side communication passage 8) of refrigerant used for producing the control pressure P_c is also used as a refrigerant circulating path in the case chamber 3, and the flow path is used for lubricating and cooling a sliding portion. For this reason, an opening 6a of the introducing-side communication passage 6 facing the case chamber 3 and an opening 8a of the discharging-side communication passage 8 facing the case chamber 3 are appropriately separated from each other, and a refrigerant path extending from the high pressure valve portion 7 to the low pressure valve portion 9 is long for some distance. Therefore, a pressure P_{c1} in the high pressure valve portion 7 on the side of the case chamber 3 is slightly higher than a pressure P_{c2} in the low pressure valve portion 9 on the side of the case chamber 3.

[0015] As shown in Fig. 2, the control valve 1 includes a solenoid 10 in which a solenoid as a position control unit is incorporated, and a valve portion 11 in which the high pressure valve portion 7 and the low pressure valve portion 9 are incorporated.

[0016] In the valve portion 11, a valve body (high pressure-side valve body 7a) of the high pressure valve portion 7 and a valve body (low pressure-side valve body 9a) of the low pressure valve portion 9 are positioned and abutted against each other in tandem in an advancing/retracting direction of a movable portion 10a of the

solenoid, and the valve bodies are pushed against the movable portion 10a by coil springs 14 and 16 as an urging unit. By making the advancing/retracting position of the movable portion 10a variable, positions of the high pressure-side valve body 7a and the low pressure-side valve body 9a are made variable, and the degree of opening for communication of the high pressure valve portion 7 and the low pressure valve portion 9 can be controlled. In the present embodiment, the low pressure-side valve body 9a is positioned on the side closer to the movable portion 10a, and the high pressure-side valve body 7a is positioned on the side further from the movable portion 10a. In the following description, the direction of the arrow X in Figs. 2 to 5 is called a leading end side, and the opposite direction is called a base end side for convenience sake. The movable portion 10a, the low pressure-side valve body 9a and the high pressure-side valve body 7a advance and retract along the X direction. The X direction extends along axial directions of a sleeve 12, a spool 13 and the movable portion 10a of the solenoid.

[0017] The valve portion 11 includes a substantially cylindrical sleeve 12 formed with a through hole 12a in its longitudinal direction. The through hole 12a has a circular cross section. The spool 13 is inserted into the through hole 12a with an appropriate clearance, and the spool 13 can advance and retract in the through hole 12a along its longitudinal direction.

[0018] The high pressure valve portion 7 is formed on the leading end side of the valve portion 11. A concrete configuration of the high pressure valve portion 7 will be explained with reference to Figs. 2 and 3.

[0019] A bottomed cylindrical recess 12b is formed on the leading end side of the through hole 12a of the sleeve 12. The recess 12b has a diameter greater than that of the through hole 12a. A side of an opening 12e of the recess 12b is closed with a lid 12d.

[0020] An umbrella-like poppet 13a is formed on a leading end of the spool 13. The poppet 13a projects slightly radially outward of the through hole 12a. The poppet 13a is accommodated in the recess 12b. In a state shown in Figs. 2 and 3, a bottom surface 13b of the poppet 13a and a bottom surface 12c of the recess 12b are abutted against each other. In the present embodiment, the poppet 13a corresponds to the high pressure-side valve body 7a of the high pressure valve portion 7, and the bottom surface 12c of the recess 12b corresponds to its sealing surface (sitting surface).

[0021] The coil spring 14 as an urging unit is interposed between the lid 12d and the poppet 13a. The poppet 13a is urged toward the base end side in the X direction, in the closing direction of the high pressure-side valve body 7a by the coil spring 14.

[0022] A lateral hole port 12f intersecting with the through hole 12a is formed in the sleeve 12 at a location separating away from the opening 12e on the leading end side of the through hole 12a toward the base end side in the X direction by a predetermined distance. A diameter-reduced portion 13c which is narrowed is

formed in the spool 13 from the bottom surface 13b of the poppet 13a to a location opposed to the lateral hole port 12f. The diameter-reduced portion 13c has a substantially constant circular cross section.

[0023] A side of the introducing-side communication passage 6 on the side of the case chamber 3 which is not shown in Fig. 2 or 3 is in communication with the recess 12b through a through hole 12g formed in the lid 12d, and a side of the introducing-side communication passage 6 on the side of the discharge flow path 4 is in communication with the lateral hole port 12f. A pressure in the recess 12b, i.e., a back pressure of the poppet 13a becomes a control pressure (P_{c1}), and a pressure in a gap 12h corresponding to the lateral hole port 12f and the diameter-reduced portion 13c of the spool 13 becomes the discharge pressure P_d .

[0024] The discharge pressure P_d is applied to an end surface of the diameter-reduced portion 13c of the spool 13 on the side of the leading end in the X direction toward the leading end side of the X direction, and the discharge pressure P_d is applied to an end surface of the diameter-reduced portion 13c of the spool 13 on the side of the base end in the X direction toward the leading end side in the X direction. Therefore, the discharge pressure P_d applied to the spool 13 is weakened (offset) in the axial direction of the spool 13.

[0025] In the configuration described above, if the spool 13 moves toward the leading end side in the X direction and the poppet 13a as the high pressure-side valve body 7a is separated away from the bottom surface 12c as the sitting surface, the high pressure valve portion 7 is opened and the introducing-side communication passage 6 is brought into communication. The degree of opening for communication of the high pressure valve portion 7 becomes larger in accordance with a distance of the poppet 13a separated away from the bottom surface 12c. A state where the spool 13 is located at the nearest position of the base end side in the X direction and the poppet 13a sits on the bottom surface 12c corresponds to a state where the high pressure valve portion 7 closes. In this state, the introducing-side communication passage 6 is shut. According to this configuration, the poppet 13a is pushed against the bottom surface 12c such that the poppet 13a conforms to the bottom surface 12c, thereby enhancing the sealing performance of the high pressure valve portion 7. The position of the poppet 13a in the X direction, i.e., the degree of opening for communication of the high pressure valve portion 7 is controlled by a solenoid as a later-described position control unit.

[0026] The low pressure valve portion 9 is formed on the valve portion 11 on the side of the base end. A concrete configuration of the low pressure valve portion 9 will be explained with reference to Figs. 2, 4, and 5.

[0027] Another lateral hole port 12i intersecting with the through hole 12a is formed in the sleeve 12 at a location separating away from the lateral hole port 12f by a predetermined distance toward the base end side in

the X direction. A diameter-reduced portion 13d which is narrowed from a location opposed to the lateral hole port 12i to an end on the base end side is formed on the spool 13. The diameter-reduced portion 13d has a substantially constant circular cross section.

[0028] A clearance between the through hole 12a and a section of the spool 13 (general portion 13e) existing between the lateral hole port 12f and the lateral hole port 12i is narrowed so that leakage of refrigerant between the lateral hole ports 12f and 12i is reduced.

[0029] A bottomed cylindrical recess 12j is formed in the sleeve 12 on the base end side from the through hole 12a. The recess 12j has a diameter greater than that of the through hole 12a. A leading end of a sidewall 12k of the recess 12j is press-fitted into a recess groove 10b formed in the leading end of the solenoid 10. With this configuration, the valve portion 11 and the solenoid 10 are coupled to each other.

[0030] A poppet 15 as the low pressure-side valve body 9a is positioned in the recess 12j. A substantially cylindrical recess 15a is formed in the poppet 15. The diameter-reduced portion 13d of the spool 13 is loosely inserted into the recess 15a.

[0031] An annular projection 15b is provided on the poppet 15 on the leading end side in the X direction. As shown in Fig. 5, in a state where the poppet 15 is located at the furthest position of the leading end side in the X direction, the projection 15b is inserted into the through hole 12a from its opening 12m on the base end side of the through hole 12a, and a top surface 15c around the projection 15b and a bottom surface 12n of the recess 12j abut against each other. As described above, in the present embodiment, the poppet 15 corresponds to the low pressure-side valve body 9a of the low pressure valve portion 9, and the bottom surface 12n of the recess 12j corresponds to its sealing surface (sitting surface).

[0032] A coil spring 16 as an urging unit is interposed between the bottom surface 12n and the poppet 15. The poppet 15 is urged toward the base end side in the X direction, in the opening direction of the low pressure-side valve body 9a by the coil spring 16.

[0033] A side of the discharging-side communication passage 8 (not shown in Figs. 2, 4, and 5) closer to the case chamber 3 is in communication with the lateral hole port 12i, and a side of the discharging-side communication passage 8 closer to the intake flow path 5 is in communication with the recess 12j through a through hole 12o formed in the sidewall 12k. With this configuration, a pressure in the recess 12j, i.e., a back pressure of the poppet 15 is the intake pressure P_s , and a pressure in the lateral hole port 12i is the control pressure (P_{c2}).

[0034] That is, in the present embodiment, if the spool 13 moves toward the base end side in the X direction and the poppet 15 as the low pressure-side valve body 9a separates from the bottom surface 12n as the sitting surface, the low pressure valve portion 9 opens and the discharging-side communication passage 8 is brought into communication. The degree of opening for commu-

nication of the low pressure valve portion 9 becomes larger in accordance with a distance of the poppet 15 separated away from the bottom surface 12n. A state where the spool 13 is located at the furthest position of the leading end side in the X direction and the poppet 15 sits on the bottom surface 12n corresponds to a state where the low pressure valve portion 9 is closed. In this state, the discharging-side communication passage 8 is blocked. According to this configuration, the poppet 15 is pushed against the bottom surface 12n such that the poppet 15 conforms to the bottom surface 12n, thereby enhancing the sealing performance of the low pressure valve portion 9. The position of the poppet 15 in the X direction, i.e., the degree of opening for communication of the low pressure valve portion 9 is controlled by a solenoid as a later-described position control unit.

[0035] The movable portion 10a of the solenoid 10 is positioned on the base end side of the poppet 15 as the low pressure-side valve body 9a.

[0036] In the present embodiment, the movable portion 10a has such a shape that a first member 10c located on the leading end side in the X direction and a second member 10d located on the base end side are arranged in the X direction and are integrally coupled to each other. A recess 10e is formed in the first member 10c. A leading end side of the recess 10e is widened in a conical shape and a base end of the recess 10e is of a cylindrical shape. The poppet 15 is loosely inserted into the recess 10e. At that time, a bottom surface 15d of the poppet 15 abuts against a bottom surface 10f of the recess 10e, and the poppet 15 is pushed against the first member 10c by the coil spring 16. An axial deviation between the poppet 15 and the movable portion 10a can be absorbed by a clearance between an inner wall of the recess 10e and an outer wall of the poppet 15.

[0037] A flange 10g is formed on a leading end of the first member 10c. The flange 10g is latched together with an opening edge of a recess 10i formed in leading end side of the casing 10h of the solenoid 10, thereby limiting the movement of the movable portion 10a toward the base end side.

[0038] A coil spring 17 as an urging unit is interposed between a back surface 10j of the flange 10g and a step 10k formed on a sidewall of the recess 10i. The movable portion 10a is urged toward the leading end side in the X direction by the coil spring 17.

[0039] The recess 10i is isolated by an annular plate-like diaphragm 18. A peripheral edge of the diaphragm 18 is attached to the casing 10h in a sealed manner, and a central portion of the diaphragm 18 is nipped between the first member 10c and the second member 10d in a sealed manner.

[0040] The recess 10i is in communication with the recess 12j through a passage 10m which penetrates front and back surfaces of the flange 10g. Therefore, a pressure in the recess 10i, i.e., a pressure acting on a surface (front surface) of the diaphragm 18 on the side of the leading end is the intake pressure P_s . A pressure acting

on a surface (back surface) of the diaphragm 18 on the side of the base end is the atmospheric pressure. Therefore, if the intake pressure P_s exceeds a predetermined value, the movable portion 10a is moved toward the base end side by a pressure difference acting on the diaphragm 18.

[0041] A shaft 19 is coupled to the movable portion 10a. The shaft 19 is urged toward the leading end side by a coil spring 20 as an urging unit positioned on the base end side.

[0042] In the above configuration, if a coil 21 is energized, a suction force acting toward the base end side is applied to the movable portion 10a (second member 10d). By adjusting the suction force by controlling current flowing to the coil 21, positions, in the X direction, of the movable portion 10a, the poppet 15 as the low pressure-side valve body 9a which abuts against the movable portion 10a, and the poppet 13a as the high pressure-side valve body 7a provided on the spool 13 which abuts against the poppet 15 are determined by balance between the suction force and the urging forces of the coil springs 14, 16, 17, and 20 as the urging unit.

[0043] If the movable portion 10a is moved toward the base end side by controlling the current supplied to the coil 21 or by increasing the intake pressure P_s acting on the diaphragm 18, the poppet 15 as the low pressure-side valve body 9a is also moved toward the base end side in association with the movable portion 10a by the spring force of the coil spring 16 as the urging unit, and the poppet 13a as the high pressure-side valve body 7a provided on the spool 13 is also moved toward the base end side in association with the movable portion 10a by the spring force of the coil spring 14 as the urging unit.

[0044] According to the present embodiment, however, since poppet 15 and the spool 13 provided with the poppet 13a are not coupled to each other and they can separate from each other, after the poppet 13a as the high pressure-side valve body 7a sits on the bottom surface 12c as the sitting surface, the poppet 15 separates from the spool 13 as shown in Fig. 2, and the degree of opening for communication of only the low pressure valve portion 9 becomes larger.

[0045] Fig. 6 shows the degree of opening for communications of the high pressure valve portion 7 and the low pressure valve portion 9 with respect to the position, in the X direction, of the movable portion 10a in the control valve 1 having the configuration described above. In Fig. 6, the lateral axis shows a position of the movable portion 10a in the X direction, the right side is the base end side, and the left side is the leading side. The vertical axis shows the degree of opening for communication (an area of opening).

[0046] The degree of opening for communication of the high pressure valve portion 7 is linearly varied depending upon the position of the movable portion 10a, i.e., the position of the poppet 13a. That is, in a state where the movable portion 10a is located at the furthest position of the leading end side (Fig. 5), the degree of

opening for communication of the high pressure valve portion 7 becomes the maximum, the degree of opening for communication of the high pressure valve portion 7 is linearly reduced as the position of the movable portion 10a is varied toward the base end side. When the poppet 13a as the high pressure-side valve body 7a abuts against the bottom surface 12c as the sitting surface, the high pressure valve portion 7 closes and its degree of opening for communication becomes 0. If the high pressure valve portion 7 closes, the supply of refrigerant into the case chamber 3 through the introducing-side communication passage 6 is stopped, but refrigerant can be supplied into the case chamber 3 due to leakage from the clearance between the piston and the cylinder.

[0047] The degree of opening for communication of the low pressure valve portion 9 is also varied in accordance with the position of the movable portion 10a, but the manner of variation of the degree of opening for communication differs depending upon the position of the movable portion 10a. That is, when the movable portion 10a is located at the furthest position of the leading end side direction, the poppet 15 as the low pressure-side valve body 9a abuts against the bottom surface 12n as the sitting surface and the low pressure valve portion 9 is closed.

[0048] If the position of the movable portion 10a is varied to the base end side, the poppet 15 separates from the bottom surface 12n. While the poppet 15 is not separated from the bottom surface 12n so much, the degree of opening for communication is varied linearly (region 1). Thereafter, even if the distance between the poppet 15 and the bottom surface 12n is increased, if the projection 15b is still inserted into the through hole 12a, the clearance between the projection 15b and the through hole 12a occupies the most of the degree of opening for communication of the low pressure valve portion 9, and this degree of opening for communication is equivalent to a fixed orifice. Therefore, in this section, the degree of opening for communication is varied substantially constantly (region 2). Thereafter, if the projection 15b is pulled out from the through hole 12a, the degree of opening for communication of the low pressure valve portion 9 is linearly increased in accordance with the distance between the poppet 15 and the bottom surface 12n (region 3). In this region 3, the poppet 15, i.e., the low pressure-side valve body 9a separates from the poppet 13a, i.e., the spool 13 having the high pressure-side valve body 7a (gap G). Therefore, the high pressure valve portion 7 is closed and the movement of the high pressure-side valve body 7a toward the base end side is limited, but irrespective of this, the degree of opening for communication of the low pressure valve portion 9 can swiftly be larger.

[0049] According to the present embodiment, as described above, the discharge pressure P_d acting to the poppet 13a as the high pressure-side valve body 7a acts on both the base end side and the leading end side of the spool 13 in the X direction and the discharge pressure

Pd is weakened. Therefore, unlike the conventional technique, it is possible to avoid a case where when the high pressure valve portion is opened, the high pressure valve portion is closed by the discharge flow path side pressure Pd acting on the high pressure-side valve body and a pressure in the case chamber is reduced. Thus, it is possible to avoid a case where in a state in which the angle of the swash plate 2a of the variable displacement compressor 2 is small, the degree of opening for communication of the high pressure valve portion 7 is reduced or closed, a pressure in the case chamber 3 is reduced and the angle of the swash plate 2a is increased.

[0050] That is, according to the present embodiment, it is possible to keep the angle of the swash plate 2a small and to reliably obtain a state where there is almost no discharge capacity. Therefore, this is suitably applied to a variable displacement compressor for a so-called clutch-less system. In this case, as compared with a system which stops rotation of a compressor using a clutch, there is a merit that the number of parts is reduced, the apparatus configuration can be simplified and its weight can be reduced.

[0051] According to the present embodiment, when the poppet 15 as the low pressure-side valve body 9a is positioned on the side of the base end by the solenoid 10 as the position control unit, the poppet 13a as the high pressure-side valve body 7a and the poppet 15 as the low pressure-side valve body 9a are separated from each other. Therefore, the degree of opening for communication of the low pressure valve portion 9 can be widened and the poppet 15 is not subjected to any constraints by the poppet 13a. Therefore, when the variable displacement compressor 2 is started, the degree of opening for communication of the low pressure valve portion 9 can be larger more swiftly, the control pressure Pc in the case chamber 3 can be reduced, the angle of the swash plate 2a can be increased, and a necessary discharge capacity can be secured more swiftly.

[0052] Further, since the high pressure-side valve body 7a and the low pressure-side valve body 9a can be separated from each other, even if a discharge pressure Pd acts on the high pressure-side valve body 7a toward the leading end side in the X direction, the movement of the low pressure-side valve body 9a toward the base end side in the X direction is not hindered.

[0053] According to the present embodiment, the low pressure valve portion 9 is fully closed when the poppet 13a as the high pressure-side valve body 7a and the poppet 15 as the low pressure-side valve body 9a are positioned on the side of the leading end by the solenoid 10 as the position control unit. Therefore, it becomes easy to keep the control pressure Pc in the case chamber 3 high, the leaking flow in the low pressure valve portion 9 can be reduced and the energy loss can be reduced correspondingly.

[0054] Since the low pressure valve portion 9 is configured such that it closes, the degree of opening for communication when the low pressure valve portion 9 is

closed is naturally small as compared with a case where the low pressure valve portion 9 is configured such that it does not close. However, according to the present embodiment, since the high pressure-side valve body 7a and the low pressure-side valve body 9a can be separated from each other, the degree of opening for communication of the low pressure valve portion 9 can be larger more swiftly as compared with a case where the high pressure-side valve body 7a and the low pressure-side valve body 9a are integrally formed as one piece, and a state where the low pressure valve portion 9 is closed, i.e., a state where the control pressure Pc in the case chamber 3 is high can be switched, more swiftly, to a state where the low pressure valve portion 9 is opened, i.e., a state where the control pressure Pc in the case chamber 3 is low, and the control response can be enhanced.

[0055] Furthermore, according to the present embodiment, the poppet 13a and the poppet 15 can be separated more swiftly by the coil spring 17 which does not urge the poppet 13a and which urges only the poppet 15 toward the base end side. Therefore, the degree of opening for communication of the low pressure valve portion 9 can be larger more swiftly, and the control response can be enhanced.

[0056] While a preferred embodiment of the present invention has been described above, the invention is not limited to the embodiment and can be variously modified. For example, the poppet valve can be changed to a ball valve or a needle valve. The direction of the suction force cause by the solenoid, the configuration to generate the suction force, the configuration of the valve portion, the configuration of the urging unit and the like are not limited to those of the embodiment.

INDUSTRIAL APPLICABILITY

[0057] The present invention can be utilized as a control valve for a variable displacement compressor.

Claims

1. A control valve for a variable displacement compressor comprising a high pressure valve portion provided in an introducing-side communication passage which brings a discharge flow path and a control pressure chamber of the variable displacement compressor into communication with each other, and a low pressure valve portion provided in a discharging-side communication passage which brings an intake flow path and the control pressure chamber into communication with each other, in which degree of opening for communication of the high pressure valve portion and the low pressure valve portion are variably controlled, thereby varying a pressure in the control pressure chamber to change an angle of a swash plate, wherein

the control valve further comprises a position control unit which controls advancing/retracting positions of a high pressure-side valve body of the high pressure valve portion and a low pressure-side valve body of the low pressure valve portion, 5
as a position of the high pressure-side valve body positioned by the position control unit is closer to one side, a degree of opening for communication of the high pressure valve portion is more widened, a pressure on the side of a discharge flow path acting on the high pressure-side valve body is weakened, 10
as a position of the low pressure-side valve body positioned by the position control unit is closer to the other side, a degree of opening for communication of the low pressure valve portion is more widened, 15
and
when the high pressure-side valve body and the low pressure-side valve body are integrally positioned on the one side by the position control unit and the low pressure-side valve body is positioned on the other side by the position control unit, the high pressure-side valve body and the low pressure-side valve body are separated from each other. 20

2. The control valve for a variable displacement compressor according to claim 1, wherein when the high pressure-side valve body and the low pressure-side valve body are positioned on the one side by the position control unit, the low pressure valve portion is fully closed. 25 30
3. The control valve for a variable displacement compressor according to claim 1, further comprising an urging unit which urges, of the high pressure-side valve body and the low pressure-side valve body, only the low pressure-side valve body toward the other side. 35 40

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FIG. 1

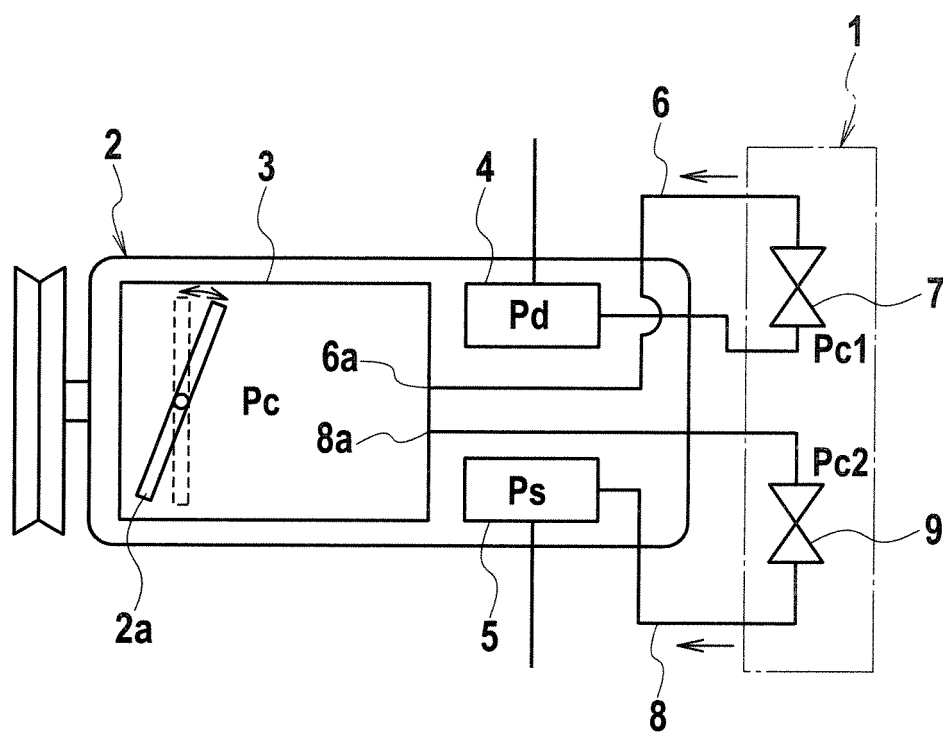


FIG. 2

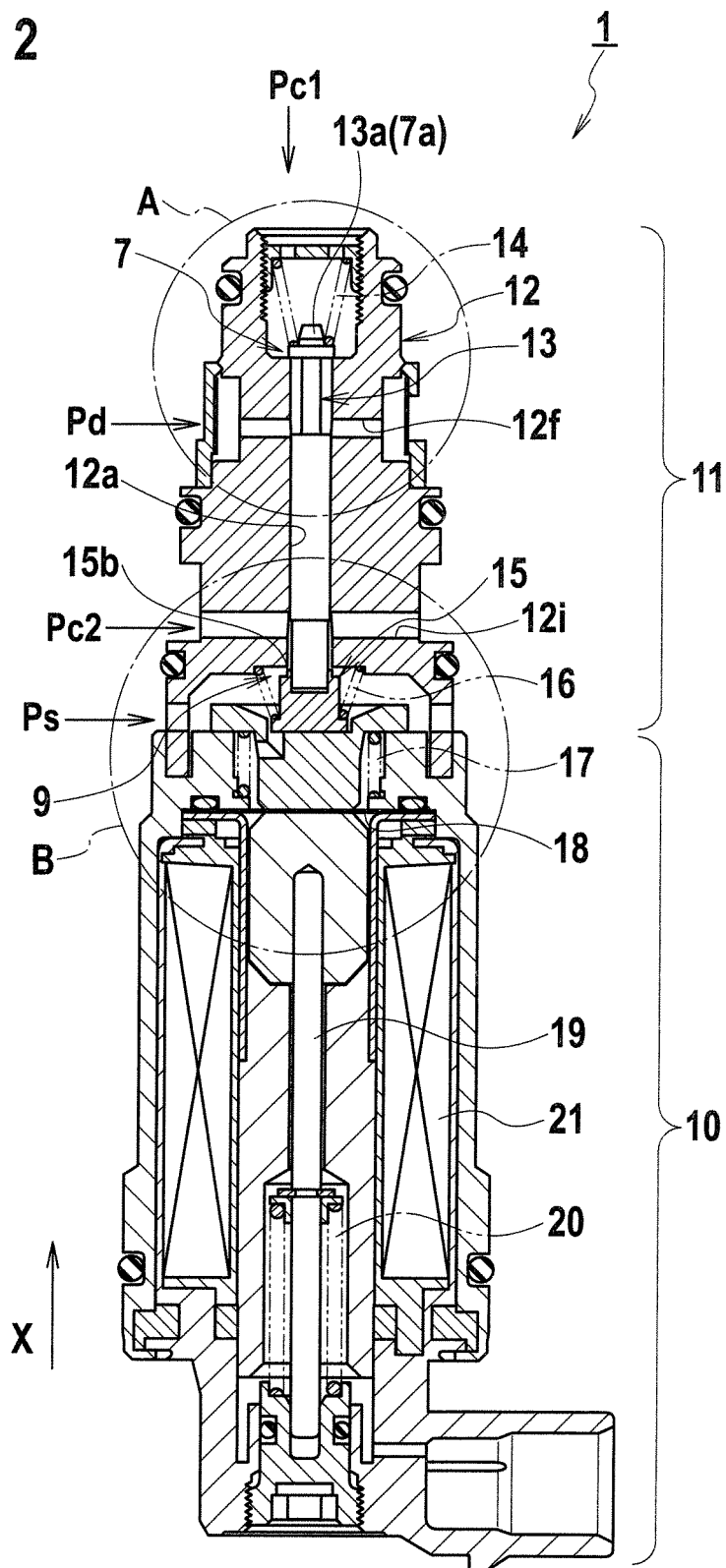


FIG. 3

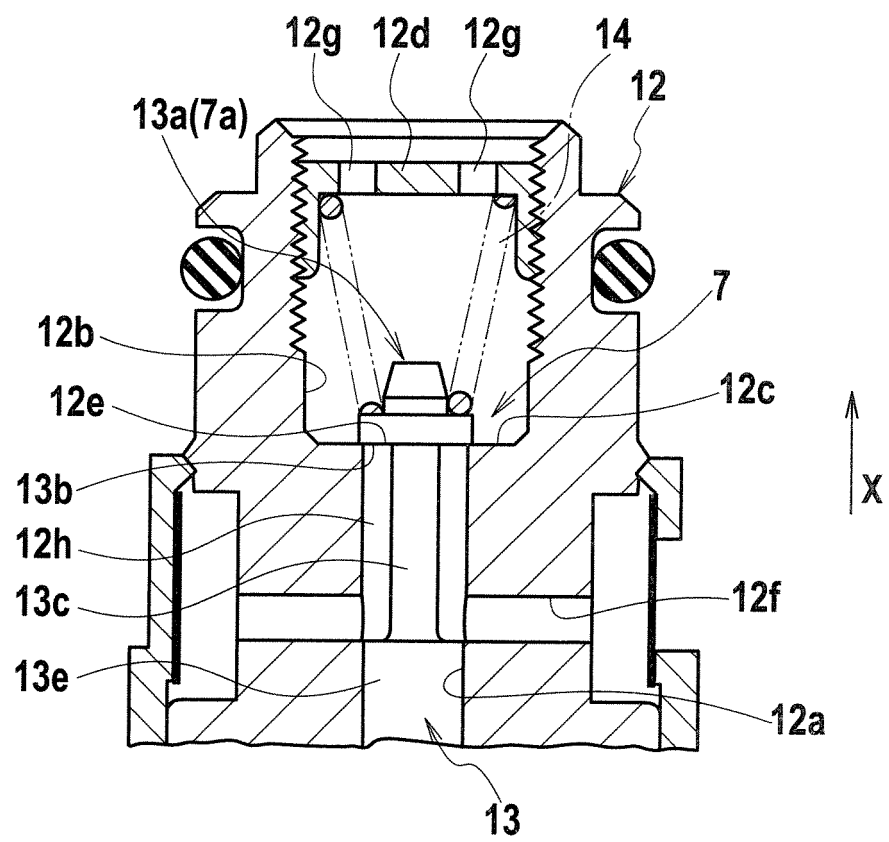


FIG. 4

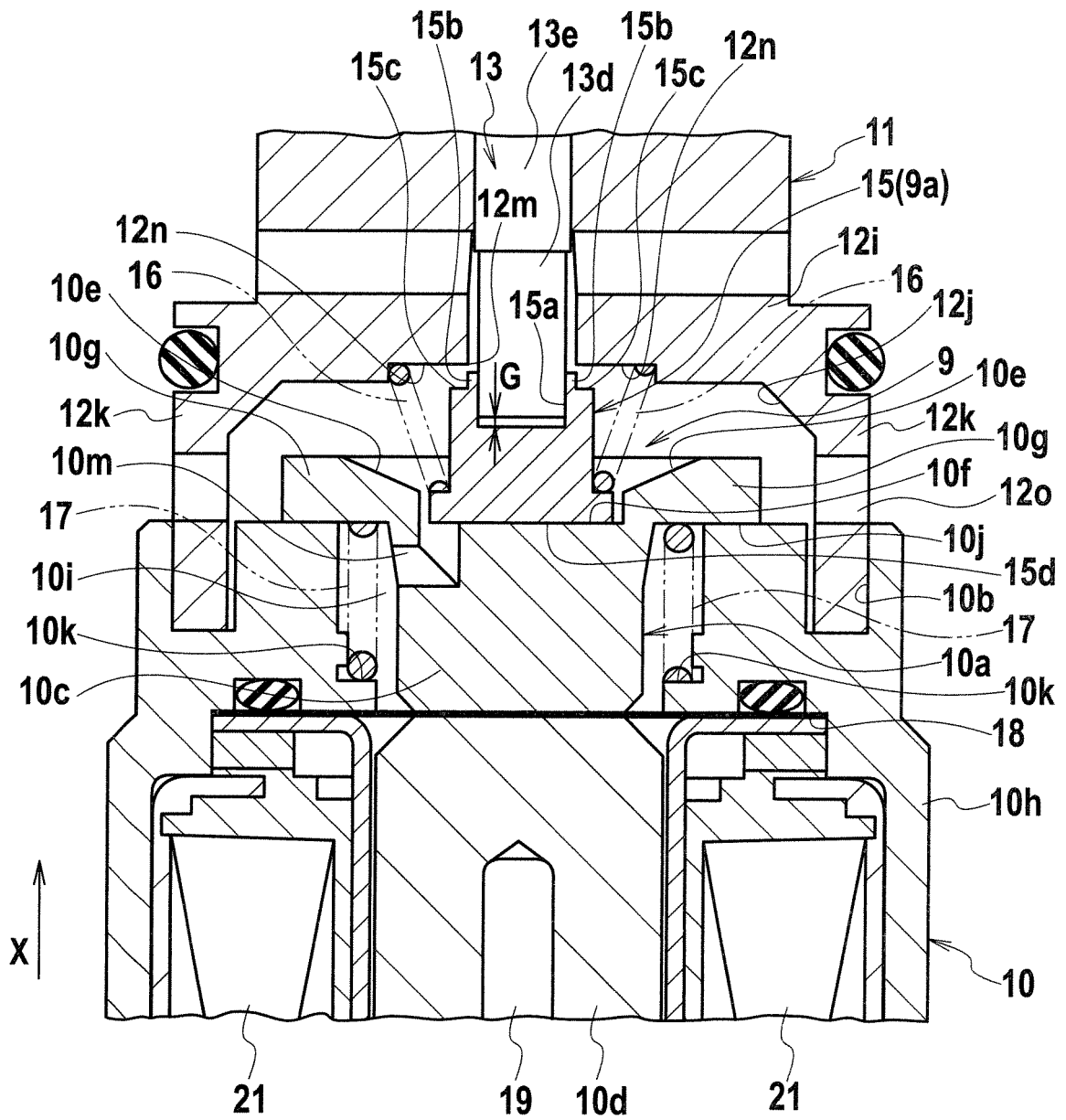


FIG. 5

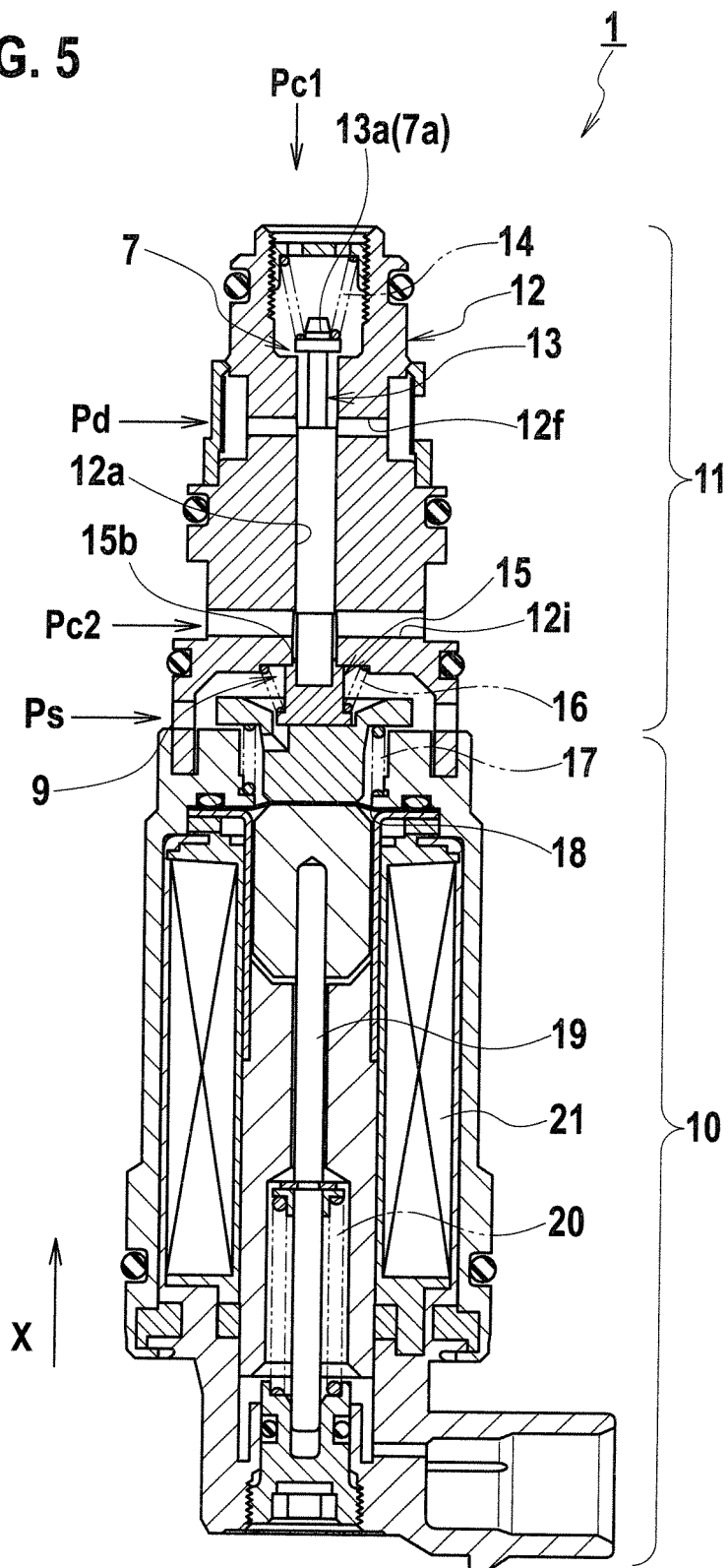
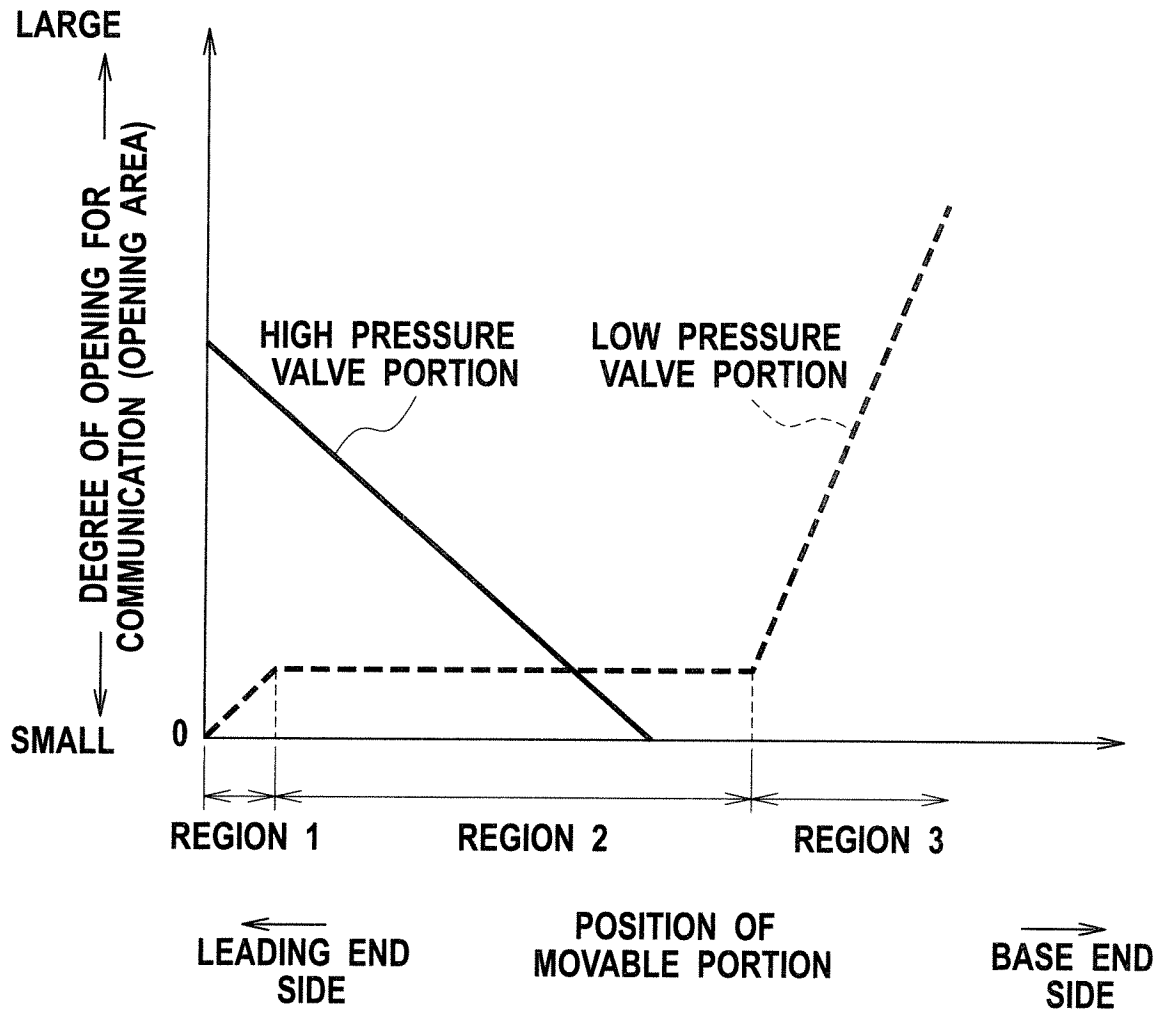


FIG. 6



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/073104

A. CLASSIFICATION OF SUBJECT MATTER

F04B27/14(2006.01)i, B60H1/32(2006.01)i, F04B49/00(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04B27/14, B60H1/32, F04B49/00

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 1996-2008

Kokai Jitsuyo Shinan Koho 1971-2008 Toroku Jitsuyo Shinan Koho 1994-2008

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	JP 2005-282414 A (Zexel Valeo Climate Control Corp.), 13 October, 2005 (13.10.05), Par. Nos. [0012] to [0020]; Figs. 1 to 2 (Family: none)	1-3
X A	WO 2004/065789 A1 (Zexel Valeo Climate Control Corp.), 05 August, 2004 (05.08.04), Page 5, line 3 to page 7, line 1; Figs. 1 to 3 & US 2005/0254961 A1 & EP 1589223 A1	1, 3 2
A	JP 2006-307828 A (TGK Co., Ltd.), 09 November, 2006 (09.11.06), Par. Nos. [0061] to [0063]; Figs. 7 to 9 & US 2006/0218953 A1 & EP 1707811 A2	1-3

☒ 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
16 January, 2008 (16.01.08)Date of mailing of the international search report
29 January, 2008 (29.01.08)Name and mailing address of the ISA/
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INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2007/073104

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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