(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 1 775 470 A1**

(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 158(3) EPC

(43) Date of publication:
18.04.2007 Bulletin 2007/16

(21) Application number: **05758283.5**

(22) Date of filing: **11.07.2005**

(51) Int Cl.:
F04B 27/18 *(2006.01)*

(86) International application number:
PCT/JP2005/012760

(87) International publication number:
WO 2006/006560 (19.01.2006 Gazette 2006/03)

(84) Designated Contracting States:
DE FR

(30) Priority: **13.07.2004 JP 2004026550**

(71) Applicant: **Sanden Corporation**
Isesaki-shi,
Gunma 372-8502 (JP)

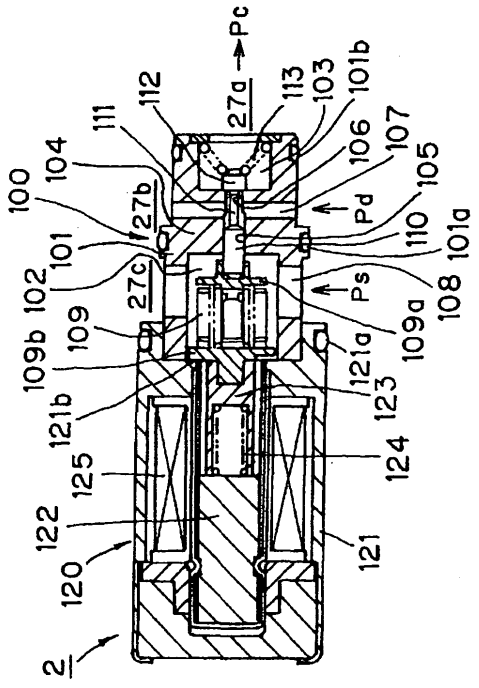
(72) Inventor: **TAGUCHI, Yukihiko,**
Sanden Corporation
Isesaki-shi, Gunma 372-8502 (JP)

(74) Representative: **Hofer, Dorothea et al**
Prüfer & Partner GbR
Patentanwälte
Sohnckestrasse 12
81479 München (DE)

(54) CAPACITY CONTROL VALVE FOR CLUTCHLESS VARIABLE DISPLACEMENT SWASH PLATE-TYPE COMPRESSOR

(57) A displacement control valve of a clutchless variable displacement inclined plate-type compressor for controlling the discharge displacement of the compressor by opening and closing a communication path between a discharge chamber and a crank chamber. The displacement control valve has a valve hole (106) formed in the communication path and always communicating with the discharge chamber, an inside control valve (100) for opening and closing the valve hole (106) by a valve body (112) operated in response to expansion and contraction of a pressure sensing member (109) for sensing a suction pressure, and an operation switching device (120) connected to the inside control valve for switching the inside control valve between an operating condition where the valve body opens and closes the valve hole in response to the expansion and contraction of the pressure sensing member and a non-operating condition where the valve body opens the valve hole independently of the expansion and contraction of the pressure sensing member. In this displacement control valve, because a discharge pressure Pd acts on both the valve body (112) and a pressure sensing rod (110), the force of the discharge pressure Pd for urging the valve body (112) in a valve opening direction is (Sr-Sv)Pd. The displacement control valve can be made smaller than conventional displacement control valves because (Sr-Sv) is very small.

FIG. 2A



EP 1 775 470 A1

(Cont. next page)

FIG. 2B

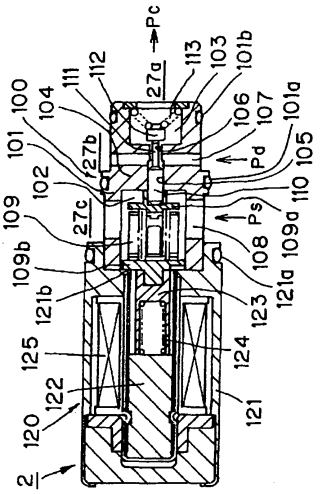


FIG. 2C

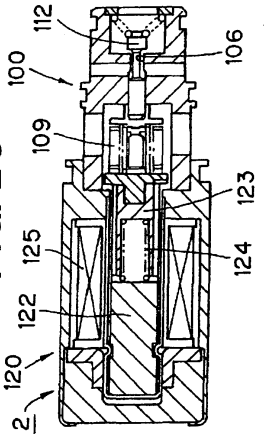
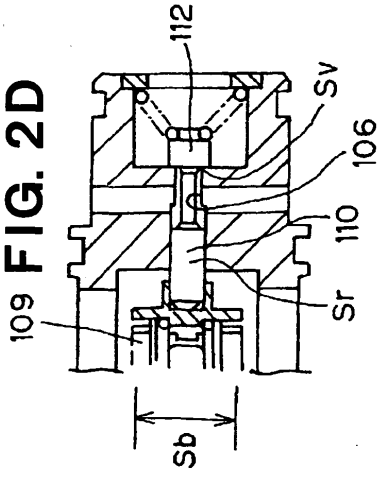


FIG. 2D



Description

Technical Field of the Invention

[0001] The present invention relates to a displacement control valve of a clutchless variable displacement inclined plate-type compressor which is connected directly to a drive source without using a clutch.

Background Art of the Invention

[0002] Patent Document 1 discloses a displacement control valve of a clutchless variable displacement inclined plate-type compressor for controlling a discharge displacement of the compressor by opening and closing a valve hole formed in a communication path between a discharge chamber and a crank chamber of the compressor, the displacement control valve including the valve hole always communicating with the crank chamber, an inside control valve for opening and closing the valve hole by a valve body operated in response to expansion and contraction of a pressure sensing member for sensing a suction pressure, and an electromagnetic solenoid connected to the inside control valve for switching the inside control valve between an operating condition where the valve body opens and closes the valve hole in response to the expansion and contraction of the pressure sensing member and a non-operating condition where the valve body opens the valve hole independently of the expansion and contraction of the pressure sensing member, and the displacement control valve controls the discharge displacement so that a suction pressure and a discharge pressure have a predetermined correlation. This Patent Document 1 describes that the displacement control property is expressed by the following equation in a region of $Pd>Pd_0$.

$$Ps = P_0 - (Pd - Pc)\, S_1/S_2$$

Where,

- Pd: discharge pressure
- Pc: crank chamber pressure
- Ps: suction chamber
- P_0: equivalent internal pressure of bellows
- S_1: cross-sectional area of valve hole
- S_2: effective cross-sectional area of bellows

Patent Document 1: JP-A-7-127566

Disclosure of the Invention

Problems to be solved by the Invention

[0003] However, there are the following problems in the displacement control valve disclosed in the above-described Patent Document 1.
Because the discharge pressure Pd urges the valve body in a direction of valve closing, in order to forcibly open the valve body by degaussing of the electromagnetic solenoid, it is necessary to set the force of a releasing spring of the electromagnetic solenoid at a value of $(Pd-Ps)S_1$ or more. In order to forcibly open the valve body in a region with a high discharge pressure Pd, it is necessary to use a releasing spring with a great spring force, and it is necessary to generate a great electromagnetic force for exciting the electromagnetic solenoid and attracting a movable core against the spring force of the releasing spring, and whereby, the electromagnetic solenoid becomes large.

[0004] Accordingly, paying attention to the above-described problems, an object of the present invention is to provide a displacement control valve of a clutchless variable displacement inclined plate-type compressor, which can be made smaller than the displacement control valve disclosed in Patent Document 1.

Means for solving the Problems

[0005] To achieve the above-described object, a displacement control valve of a clutchless variable displacement inclined plate-type compressor according to the present invention is provided as a displacement control valve for controlling a discharge displacement of the compressor by opening and closing a communication path between a discharge

chamber and a crank chamber of the compressor. The displacement control valve comprises a valve hole formed in the communication path and always communicating with the discharge chamber, an inside control valve for opening and closing the valve hole by a valve body operated in response to expansion and contraction of a pressure sensing member for sensing a suction pressure, and an operation switching device connected to the inside control valve for switching the inside control valve between an operating condition where the valve body opens and closes the valve hole in response to the expansion and contraction of the pressure sensing member and a non-operating condition where the valve body opens the valve hole independently of the expansion and contraction of the pressure sensing member.

[0006] In the present invention, because the valve hole is always communicated with the discharge chamber, the force for urging the valve body in a valve opening direction by a discharge pressure Pd can be decreased as compared with that in the displacement control valve disclosed in the aforementioned Patent Document 1, and the switching device for forcibly opening the valve body may be made smaller.

[0007] In such a displacement control valve according to the present invention, a structure is preferably employed wherein the above-described operation switching device has an electromagnetic solenoid, when the electromagnetic solenoid is excited, the inside control valve becomes the operating condition, and when the electromagnetic solenoid is degaussed, the inside control valve becomes the non-operating condition. In such a structure, because the variable displacement inclined plate-type compressor can be switched to between a displacement control condition and a minimum displacement condition by exciting/degaussing the electromagnetic solenoid, the control unit for the variable displacement inclined plate-type compressor may be simplified.

[0008] Further, in the displacement control valve according to the present invention, it is preferred that the electromagnetic solenoid includes a movable core connected to the inside control valve and a positioning member for positioning the inside control valve at an operating position when the electromagnetic solenoid is excited. By providing such a positioning member, it becomes possible to position the inside control valve at an operating position by exciting the electromagnetic solenoid, and the switching of the variable displacement inclined plate-type compressor to its operating condition becomes possible by the excitation of the electromagnetic solenoid.

[0009] Further, in the displacement control valve according to the present invention, it is preferred that the positioning member is formed by one end of the pressure sensing member and an end surface of a case of the electromagnetic solenoid. By forming the positioning member with one end of the pressure sensing member and the case of the electromagnetic solenoid, it is not necessary to dispose a particular positioning member separately, and the structure of the displacement control valve may be simplified.

[0010] Further, in the displacement control valve according to the present invention, it is preferred that the electromagnetic solenoid includes a releasing spring for urging a movable core in a direction apart from a fixed core, and when the electromagnetic solenoid is degaussed, the inside control valve becomes the non-operating condition by the releasing spring. Because the releasing spring of the electromagnetic solenoid can turn the inside control valve into the non-operating condition, it is not necessary to provide a spring separately for turning the inside control valve into the non-operating condition, and the structure of the displacement control valve may be simplified.

[0011] Further, in a preferred embodiment of the present invention, the inside control valve includes a pressure sensing rod which is slidably inserted into a hole formed in a valve housing and communicating with the valve hole and which is connected to the valve body, and a cross-sectional area of the pressure sensing rod is set greater than a cross-sectional area of the valve hole. In such a structure, because a control property is realized wherein the suction pressure decreases when the discharge pressure increases, the discharge displacement increases in a high thermal-load region with a high discharge pressure. Therefore, a cooler comprising a variable displacement inclined plate-type compressor with this displacement control valve does not deteriorate in cooling performance even in a high thermal-load region with a high discharge pressure.

[0012] Alternatively, in another preferred embodiment of the present invention, the inside control valve includes a pressure sensing rod which is slidably inserted into a hole formed in a valve housing and communicating with the valve hole and which is connected to the valve body, and a cross-sectional area of the pressure sensing rod is set smaller than a cross-sectional area of the valve hole. In such a structure, because a control property is realized wherein the suction pressure increases when the discharge pressure increases, the discharge displacement decreases in a region of a high discharge pressure. As a result, occurrence of a condition, in which the compressor operates at an excessive load, may be prevented.

Effect according to the Invention

[0013] In the displacement control valve of a clutchless variable displacement inclined plate-type compressor according to the present invention, because the valve hole is always communicated with the discharge chamber, the force for urging the valve body in a valve opening direction by a discharge pressure can be decreased as compared with that in the displacement control valve disclosed in the aforementioned Patent Document 1, and the switching device for forcibly opening the valve body may be made smaller than that in the displacement control valve of Patent Document 1. Therefore,

the displacement control valve of a clutchless variable displacement inclined plate-type compressor according to the present invention can be made smaller than the displacement control valve of Patent Document 1.

Brief explanation of the drawings

[0014]

[Fig. 1] Fig. 1 is a vertical sectional view of a clutchless variable displacement inclined plate-type compressor having a displacement control valve according to an embodiment of the present invention.

[Fig. 2] Figs. 2A and 2B are sectional views of the displacement control valve according to the embodiment of the present invention, showing operations of an inside control valve when an electromagnetic solenoid is excited, Fig. 2C is a sectional view of the displacement control valve, showing an operation of the inside control valve when the electromagnetic solenoid is degaussed, and Fig. 2D is an enlarged, partial sectional view of the inside control valve.

[Fig. 3] Figs. 3A and 3B are graphs showing the control property of the displacement control valve according to the embodiment of the present invention, Fig. 3A shows a control property in a case of Sr>Sv, and Fig. 3B shows a control property in a case of Sr<Sv.

Explanation of symbols

[0015]

1: clutchless variable displacement inclined plate-type compressor
2: displacement control valve
17: crank chamber
21: suction chamber
22: discharge chamber
26: concave portion
100: inside control valve
101: valve housing
102: pressure sensing chamber
103: valve chamber
106: valve hole
109: bellows assembly
110: pressure sensing rod
112: valve body
120: electromagnetic solenoid

The Best mode for carrying out the Invention

[0016] Hereinafter, desirable embodiments of a displacement control valve of a clutchless variable displacement inclined plate-type compressor according to the present invention will be explained referring to figures.
Figs. 1 and 2 depict a variable displacement inclined plate-type compressor having a displacement control valve according to an embodiment of the present invention. As depicted in Fig. 1, a variable displacement inclined plate-type compressor 1 has a main shaft 10, a rotor 11 fixed to main shaft 10, and an inclined plate 12 supported by main shaft 10 at a condition capable of changing its inclination angle. Inclined plate 12 is connected to rotor 11 via a link mechanism 13 allowing the change of the inclination angle of inclined plate 12, and rotates synchronously with rotor 11 and main shaft 10. Piston 15 is engaged with inclined plate 12 via a pair of shoes 14 sliding on the periphery of inclined plate 12. Piston 15 is inserted into a cylinder bore 16a formed in a cylinder block 16. A plurality of pistons 15 are disposed around main shaft 10 at an interval with each other in the circumferential direction.
[0017] A crank chamber 17 containing main shaft 10, rotor 11 and inclined plate 12 is formed by cylinder block 16 and a dish-like front housing 18. Main shaft 10 extends to outside through front housing 18. A shaft seal member 19 is disposed for sealing the through portion of main shaft 10 in front housing 18. A pulley 20 is fixed at a tip portion of main shaft 10. In a case where variable displacement inclined plate-type compressor 1 is a compressor used for a refrigeration cycle of an air conditioning system for vehicles, pulley 20 is connected, for example, to an engine of a vehicle (not shown) via a belt (not shown).
[0018] A cylinder head 23 forming a suction chamber 21 and a discharge chamber 22 is disposed at a position on a

side of cylinder block 16 opposite to the side of front housing 18. Suction chamber 21 is connected to an evaporator (not shown), which is provided in an external circuit, for example, a refrigeration cycle of an air conditioning system for vehicles, via a suction port (not shown). Discharge chamber 22 is connected to a condenser (not shown), which is provided in an external circuit, for example, a refrigeration cycle of an air conditioning system for vehicles, via a discharge port (not shown).

[0019] A valve plate 24 formed with suction hole 21 a and discharge hole 22a communicating with cylinder bore 16a is provided between cylinder block 16 and cylinder head 23. A discharge valve and a suction valve (not shown) are attached to the valve plate 24. Crank chamber 17 and suction chamber 21 are communicated with each other via an orifice hole 24a formed on valve plate 24.

[0020] Front housing 18, cylinder block 16, valve plate 24 and cylinder head 23 are integrally fastened by a plurality of through bolts 25 disposed at intervals along the circumference with a center of main shaft 10.

[0021] A displacement control valve 2 for controlling the discharge displacement of variable displacement inclined plate-type compressor 1 is fitted into and fixed in a concave portion 26 which is formed in cylinder head 23 at a position adjacent to discharge chamber 22. As shown in Figs. 1 and 2, displacement control valve 2 has an inside control valve 100 and an electromagnetic solenoid 120.

[0022] Inside control valve 100 has a cylindrical valve housing 101. Three closed spaces 27a, 27b and 27c are defined around valve housing 101 by two O-rings 101a and 101b tightly fitted onto the periphery of valve housing 101 and one O-ring 121a tightly fitted onto the periphery of a case 121 of electromagnetic solenoid 120.

[0023] In valve housing 101, a lateral partition wall 104 is formed for dividing the inside space of valve housing 101 into a pressure sensing chamber 102 on one end side and a valve chamber 103 on the other end side. On lateral partition wall 104, a rod insertion hole 105 communicating with pressure sensing chamber 102 and a valve hole 106 communicating with valve chamber 103 are formed. Rod insertion hole 105 and valve hole 106 are disposed on the same axis and communicated with each other. A communication hole 107 extending in the radial direction through lateral partition wall 104 is formed in lateral partition wall 104 passing through the communicating portion between rod insertion hole 105 and valve hole 106.

[0024] Pressure sensing chamber 102 communicates with suction chamber 21 via a communication hole 108 formed on the circumferential wall of valve housing 101, closed space 27c and a communication path 23a formed in cylinder head 23. Communication hole 107 communicates with discharge chamber 22 via closed space 27b and a communication path 23b formed in cylinder head 23. Valve hole 106 communicating with communication hole 107 always communicates with discharge chamber 22. Valve chamber 103 communicates with crank chamber 17 via closed space 27a, a communication path 23c formed in cylinder head 23 and communication path 16b formed in cylinder block 16.

[0025] A bellows assembly 109 functioning a pressure sensing member, in which a spring is disposed at a vacuum inside condition, is disposed in pressure sensing chamber 102. One end of a pressure sensing rod 110 is connected to one end 109a of bellows assembly 109, and the other end of pressure sensing rod 110 is slidably inserted into rod insertion hole 105. A small-diameter rod 111 extending from the other end of pressure sensing rod 110 is inserted into valve hole 106 at a movable condition with a gap. A spring 113 for urging a valve body 112 in a direction approaching valve hole 106 is disposed in valve chamber 103. Inside control valve 100 is formed by a series of structures from valve housing 101 to spring 113.

[0026] The end portion of pressure sensing chamber 102 side of valve housing 101 of inside control valve 100 is press fitted into one end of case 121 of electromagnetic solenoid 120. As aforementioned, O-ring 121a for forming closed space 27c is fitted onto the periphery of the one end portion of case 121.

[0027] Electromagnetic solenoid 120 has a fixed core 122 disposed in case 121, a movable core 123 disposed facing its one end to one end of fixed core 122, a releasing spring 124 for urging movable core 123 in a direction apart from the fixed core, and an electromagnetic coil 125 surrounding fixed core 122 and movable core 123. The space for containing movable core 123 is communicated with pressure sensing chamber 102, and is in a condition of the same pressure as that in pressure sensing chamber 102. The other end 109a of bellows assembly 109 is connected to the other end of movable core 123. The other end 109a is disposed so as to be able to engage with an end surface inner edge 121a near the above-described one end of case 121 of electromagnetic solenoid 120.

[0028] Next, the operation of displacement control valve 2 will be explained.

In a case where clutchless variable displacement inclined plate-type compressor 1 is operated at a displacement control condition, as shown in Figs. 2A and 2B, movable core 123 is moved toward fixed core 122 against the urging force of releasing spring 124 by exciting electromagnetic coil 125, and bellows assembly 109, ultimately, inside control valve 100, is positioned at its operating position by bringing the other end 109b of bellows assembly 109 into contact with end surface inner edge 121b of case 121 of electromagnetic solenoid 120. Inside control valve 100 becomes its operating condition, in which valve body 112 opens and closes valve hole 106, in response to the expansion and contraction of bellows assembly 109 which is a pressure sensing member4.

[0029] When inside control valve 100 is in the operating condition, if the suction pressure is lower than a set value, as shown in Fig. 2B, bellows assembly 109 expands, and valve body 112 connected to bellows assembly 109 via

pressure sensing rod 110 and small-diameter rod 111 opens valve hole 106 in response to the expansion of bellows assembly 109. High-pressure refrigerant gas is supplied from discharge chamber 22 to crank chamber 17 through communication hole 23b, communication hole 107, valve hole 106, valve chamber 103, closed space 27a, communication path 23c and communication path 16b. The crank chamber pressure increases, the inclination angle of the inclined plate decreases, the discharge displacement of variable displacement inclined plate-type compressor 1 decreases, and the suction pressure gradually increases.

[0030] If the suction pressure exceed the set value, as shown in Fig. 2A, bellows assembly 109 contracts, and valve body 112 connected to bellows assembly 109 via pressure sensing rod 110 and small-diameter rod 111 closes valve hole 106 in response to the contraction of bellows assembly 109. By this, the supply of high-pressure refrigerant gas from discharge chamber 22 to crank chamber 17 is stopped. Since orifice path 24a has an area enough to exhaust blow-by gas, which leaks from cylinder bore 16a to crank chamber 17 when piston 15 compresses refrigerant gas in cylinder bore 16a, into suction chamber 21, the crank chamber pressure gradually decreases. When the crank chamber pressure decreases, the inclination angle of the inclined plate increases, the discharge displacement of variable displacement inclined plate-type compressor 1 increases, and the suction pressure gradually decreases.

[0031] Thus, by the operation of inside control valve 100, the opening/closing of valve hole 106 is repeated so that the suction pressure becomes the set value, and the discharge displacement of variable displacement inclined plate-type compressor 1 is variably controlled.

[0032] When electromagnetic coil 125 is degaussed, as shown in Fig. 2C, the other end 109b of bellows assembly 109 moves away from end surface inner edge 121b of case 120 of electromagnetic solenoid 120 by receiving the urging force of releasing spring 124, bellows assembly 109 is positioned at the non-operating position, and inside control valve 100 is positioned at its non-operating position. By this, inside control valve 100 is kept at the non-operating condition, where valve body 112 opens valve hole 106, independently from the expansion and contraction of bellows assembly 109 which is a pressure sensing member. The lifting amount of valve body 112 is regulated by the contact of the end 109a of bellows assembly 109 with lateral partition wall 104. In this state, high-pressure refrigerant gas is supplied from discharge chamber 22 to crank chamber 17, the crank chamber pressure increases, the inclination angle of the inclined plate decreases down to the minimum inclination angle, the discharge displacement of variable displacement inclined plate-type compressor 1 is decreased down to the minimum displacement, and it is maintained at the minimum displacement. Because the discharge displacement of variable displacement inclined plate-type compressor 1 can be minimized by the degaussing of electromagnetic coil 125, displacement control valve 2 can be used for a clutchless variable displacement inclined plate-type compressor directly connected to an external drive source without using a clutch.

[0033] The control property of displacement control valve 2 is represented by the following equation (1).

$$Ps=-(Sr-Sv)Pd/\{Sb-(Sr-Sv)\}+(f+\alpha Sv-F)/\{Sb-(Sr-Sv)\} \quad (1)$$

Where,

- Pd: discharge pressure
- α: pressure difference between crank chamber and suction chamber
- F: urging force of bellows assembly incorporating a spring
- f: urging force of spring 113
- Sb: effective cross-sectional area of bellows assembly 109
- Sv: cross-sectional area of valve hole 106
- Sr: cross-sectional area of pressure sensing rod 110

[0034] In displacement control valve 2, because discharge pressure Pd acts on both valve body 112 and pressure sensing rod 110, the force of discharge pressure Pd for urging valve body 112 in the valve closing direction is (Sr-Sv) Pd. Because (Sr-Sv) is very small, the (Sr-Sv)Pd is much smaller than PdSv in the aforementioned Patent Document 1. Therefore, displacement control valve 2 can be made smaller that the displacement control valve of Patent Document 1.

[0035] In the displacement control valve of the aforementioned Patent Document 1, because the gradient of the correlation line of Ps relative to Pd is $-S_1/S_2$, the gradient cannot be changed unless a cross-sectional area S_1 of a valve hole or an effective cross-sectional area S_2 of a bellows, which are base specifications of a displacement control valve, is changed. Namely, the property of the displacement control cannot be easily changed. On the other hand, in displacement control valve 2, because the gradient of the correlation line of Ps relative to Pd is -(Sr-Sv)/ {Sb-(Sr-Sv)}, if the sectional area Sr of the pressure sensing rod is changed, even if the cross-sectional area Sv of the valve hole and the effective cross-sectional area Sb of the bellows assembly, which are base specifications of displacement control valve 2, are not changed, the gradient can be changed. Therefore, the property of the displacement control can be easily

changed.

[0036] Further, in the displacement control valve of the aforementioned Patent Document 1, if it is tried to make the displacement control valve smaller without changing the gradient of the correlation line of Ps relative to Pd, ultimately, without changing the property of the displacement control, it is necessary to make S_1 and S_2 smaller simultaneously. If a cross-sectional area S_1 of a valve hole is made smaller, the velocity of high-pressure refrigerant gas, flowing into a crank chamber through a valve hole after a valve body is forcibly opened, decreases, the time required for changing the displacement of the inclined plate-type compressor to the minimum displacement increases, and the property of the displacement control deteriorates. Therefore, it is difficult to make it smaller. On the other hand, in displacement control valve 2, because the gradient of the correlation line of Ps relative to Pd is -(Sr-Sv)/ {Sb-(Sr-Sv)}, the effective cross-sectional area Sb of the bellows can be made smaller by changing the cross-sectional area Sr of pressure sensing rod 110 without changing the cross-sectional area Sv of valve hole 106. Therefore, it is easy to make it smaller.

[0037] Because displacement control valve 2 can switch clutchless variable displacement inclined plate-type compressor 1 between a displacement control condition and a minimum displacement condition by excitation/degaussing of electromagnetic solenoid 120, by using this displacement control valve 2, the control unit for variable displacement inclined plate-type compressor 1 may be simplified.

[0038] Further, in displacement control valve 2, because provided is the positioning member formed by the other end 109b of bellows assembly 109 and the end surface inner edge 121b of case 121 of electromagnetic solenoid 120, it is possible to position inside control valve 100 at its operating position by the excitation of electromagnetic solenoid 120, and it is possible to switch variable displacement inclined plate-type compressor 1 to the displacement control condition by the excitation of electromagnetic solenoid 120. In displacement control valve 2, because the positioning member is formed by the other end 109b of bellows assembly 109 and the end surface inner edge 121b of case 121 of electromagnetic solenoid 120, it is not necessary to provide a particular positioning member separately, and the valve structure is simplified.

[0039] Further, in displacement control valve 2, because releasing spring 124 of electromagnetic solenoid 120 turns inside control valve 100 to the non-operating condition, it is not necessary to provide a spring for turning inside control valve 100 to the non-operating condition separately, and the valve structure is simplified.

[0040] In displacement control valve 2, when the cross-sectional area Sr of pressure sensing rod 110 is set greater than the cross-sectional area Sv of the valve hole. as shown in Fig. 3A, because the control property is realized wherein the suction pressure Ps decreases when the discharge pressure Pd increases, the discharge displacement of variable displacement inclined plate-type compressor 1 increases in a high thermal-load region with a high discharge pressure. Therefore, a cooler comprising variable displacement inclined plate-type compressor 1 with displacement control valve 2 does not deteriorate in cooling performance even in a high thermal-load region with a high discharge pressure.

[0041] On the other hand, when the cross-sectional area Sr of pressure sensing rod 110 is set smaller than the cross-sectional area Sv of the valve hole. as shown in Fig. 3B, because the control property is realized wherein the suction pressure Ps increases when the discharge pressure Pd increases, the discharge displacement of variable displacement inclined plate-type compressor 1 decreases in a region of a high discharge pressure. As a result, occurrence of a condition, in which variable displacement inclined plate-type compressor 1 operates at an excessive load and it may be damaged, may be prevented.

[0042] In the above-described embodiment, although the positioning member is formed by the other end 109b of bellows assembly 109 and the end surface inner edge 121 b of case 121 of electromagnetic solenoid 120, the positioning member may be formed by the attractive portions of movable core 123 and fixed core 122. Moreover, an adjusting member for adjusting the urging force of spring 113 from outside may be provided.

Industrial Applications of the Invention

[0043] The present invention can be applied broadly for displacement control valves of clutchless variable displacement inclined plate-type compressors. In particular, it is suitable as a displacement control valve for a compressor provided in a refrigeration cycle of an air conditioning system for vehicles.

Claims

1. A displacement control valve of a clutchless variable displacement inclined plate-type compressor for controlling a discharge displacement of said compressor by opening and closing a communication path between a discharge chamber and a crank chamber of said compressor, said displacement control valve comprising:

   a valve hole formed in said communication path and always communicating with said discharge chamber;
   an inside control valve for opening and closing said valve hole by a valve body operated in response to expansion and contraction of a pressure sensing member for sensing a suction pressure; and

an operation switching device connected to said inside control valve for switching said inside control valve between an operating condition where said valve body opens and closes said valve hole in response to said expansion and contraction of said pressure sensing member and a non-operating condition where said valve body opens said valve hole independently of said expansion and contraction of said pressure sensing member.

2. The displacement control valve of a clutchless variable displacement inclined plate-type compressor according to claim 1, wherein said operation switching device has an electromagnetic solenoid, when said electromagnetic solenoid is excited, said inside control valve becomes said operating condition, and when said electromagnetic solenoid is degaussed, said inside control valve becomes said non-operating condition.

3. The displacement control valve of a clutchless variable displacement inclined plate-type compressor according to claim 2, wherein said electromagnetic solenoid includes a movable core connected to said inside control valve and a positioning member for positioning said inside control valve at an operating position when said electromagnetic solenoid is excited.

4. The displacement control valve of a clutchless variable displacement inclined plate-type compressor according to claim 3, wherein said positioning member is formed by one end of said pressure sensing member and an end surface of a case of said electromagnetic solenoid.

5. The displacement control valve of a clutchless variable displacement inclined plate-type compressor according to any of claims 2 to 4, wherein said electromagnetic solenoid includes a releasing spring for urging a movable core in a direction apart from a fixed core, and when said electromagnetic solenoid is degaussed, said inside control valve becomes said non-operating condition by said releasing spring.

6. The displacement control valve of a clutchless variable displacement inclined plate-type compressor according to any of claims 1 to 5, wherein said inside control valve includes a pressure sensing rod which is slidably inserted into a hole formed in a valve housing and communicating with said valve hole and which is connected to said valve body, and a cross-sectional area of said pressure sensing rod is set greater than a cross-sectional area of said valve hole.

7. The displacement control valve of a clutchless variable displacement inclined plate-type compressor according to any of claims 1 to 5, wherein said inside control valve includes a pressure sensing rod which is slidably inserted into a hole formed in a valve housing and communicating with said valve hole and which is connected to said valve body, and a cross-sectional area of said pressure sensing rod is set smaller than a cross-sectional area of said valve hole.

FIG. 1

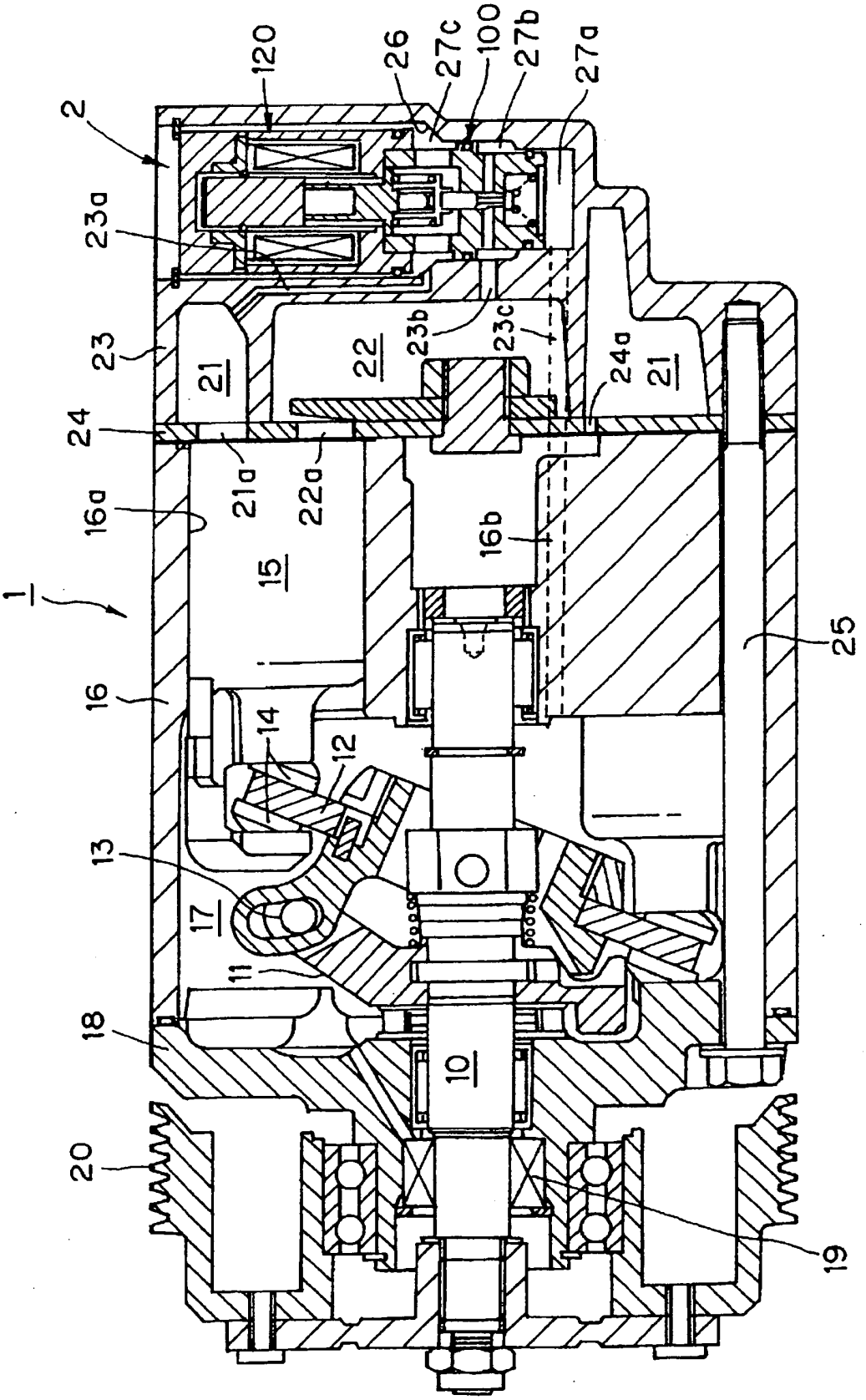

120
26
27c
100
27b
27a
2
23a
23
21
22
23b
23c
24a
21
24
21a
22a
16a
16b
1
15
25
16
14
12
13
17
11
18
10
20
19

FIG. 2A

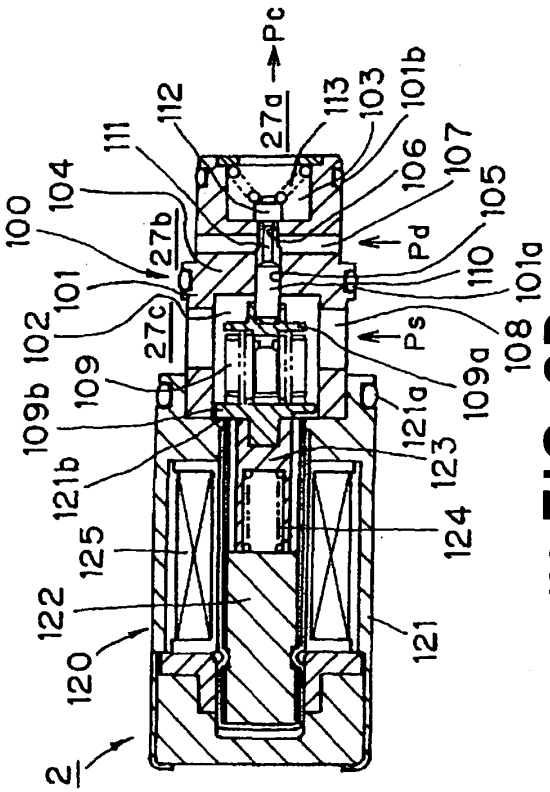


FIG. 2B

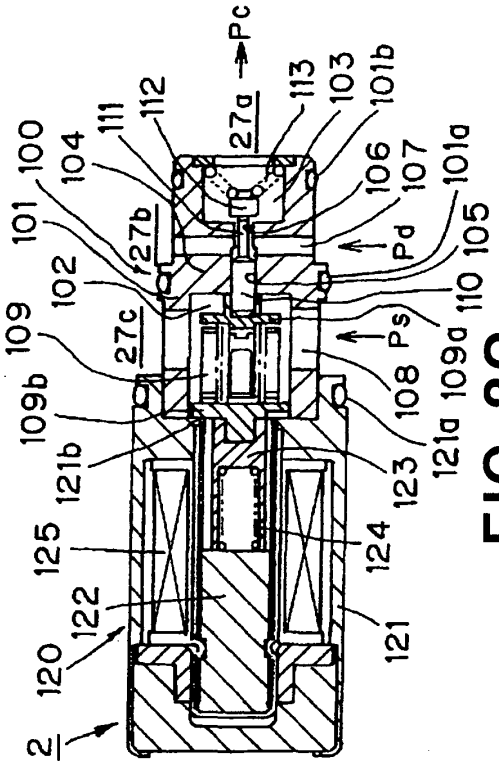


FIG. 2C

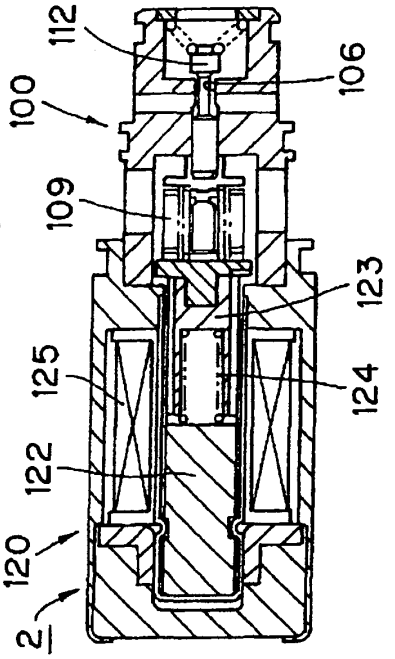


FIG. 2D

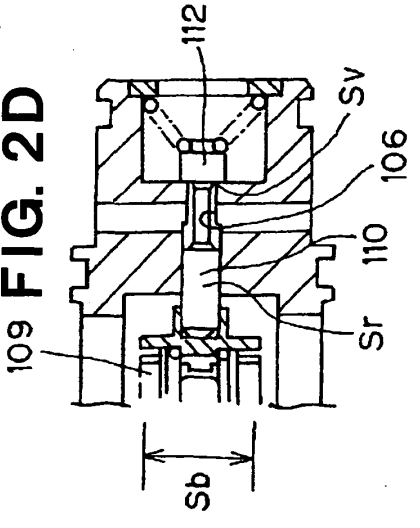


FIG. 3B

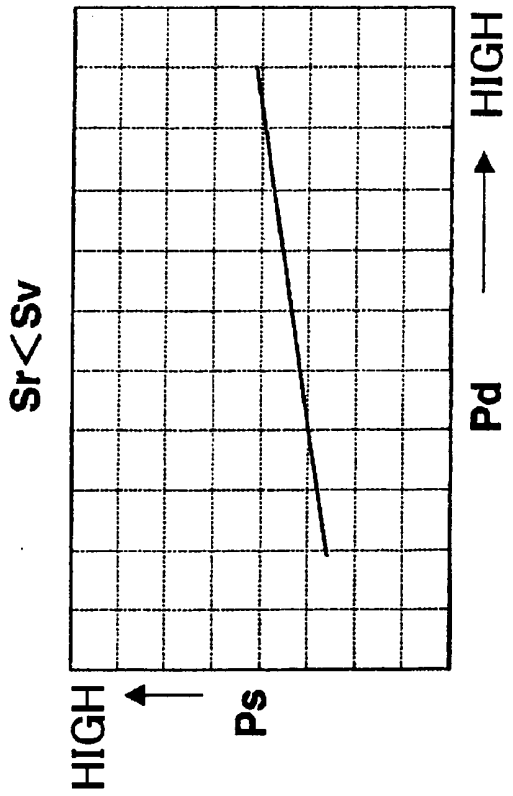
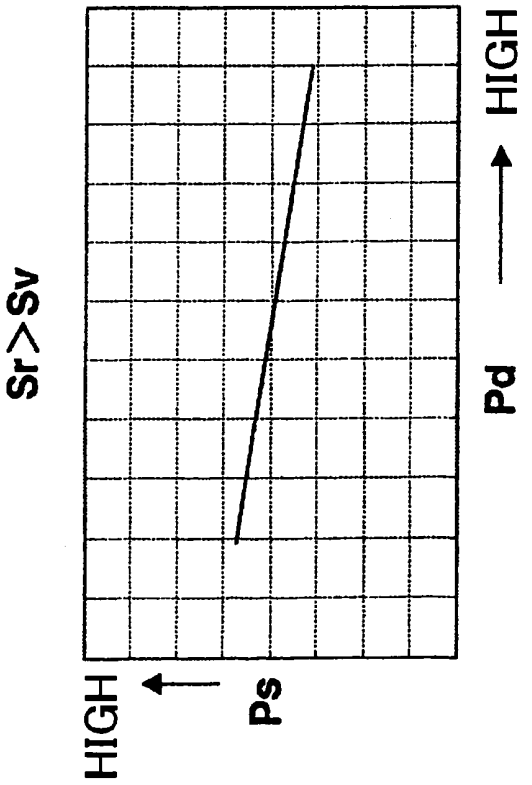


FIG. 3A



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/012760

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] F04B27/18

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] 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 1996-2005
Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005

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 2002-303263 A (Kabushiki Kaisha Fuji Koki), 18 October, 2002 (18.10.02), Par. Nos. [0025] to [0029]; Figs. 3 to 6 (Family: none)	1-2,5 3-4,7 6
Y A	JP 7-127566 A (Toyoda Automatic Loom Works, Ltd.), 16 May, 1995 (16.05.95), Full text; Figs. 1 to 10 & DE 4439512 A1	3-4,7 6
Y	JP 10-205444 A (Toyoda Automatic Loom Works, Ltd.), 04 August, 1998 (04.08.98), Par. No. [0066]; Fig. 5 & EP 854288 B1 & US 6200105 B1	7

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27 September, 2005 (27.09.05)	11 October, 2005 (11.10.05)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/012760

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	JP 2004-278511 A (TGK Co., Ltd.), 07 October, 2004 (07.10.04), Par. No. [0061]; Fig. 12 & EP 1413752 A1 & US 2004/0086391 A1	1-2,5,7
P,X	JP 2005-61253 A (TGK Co., Ltd.), 10 March, 2005 (10.03.05), Par. No. [0020]; Fig. 2 (Family: none)	1-2,5,7

Form PCT/ISA/210 (continuation of second sheet) (January 2004)

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 7127566 A **[0002]**