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(54) **CONTROL VALVE FOR VARIABLE DISPLACEMENT COMPRESSOR**

(57) A control valve for a variable capacity compressor is provided with a ball valve element 37 to open or shut communication passages (32, 34, 33) for communicating a suction port of a compressor to a crank chamber. The ball valve element 37 is energized to move in a valve shutting direction by a spring force of a compression coil spring 44. The control valve for a variable capacity compressor is provided with a bellows device 40, which drives the ball valve element 37 to move in a valve opening direction being affected by a suction pressure of the compressor. The ball valve element 37 is directly connected to the bellows device 40 with utilizing the ball valve element 37 as an automatic centripetal ball. A valve housing 31 is provided with a hollow tube 49 for introducing a delivery pressure, which is joined to the ball valve element 37 at an end thereof and directly exerts the delivery pressure of the compressor on the ball valve element 37 to move in a valve opening direction. A compression coil spring 50 energizes the ball valve element 37 to move in a valve opening direction through the hollow tube 49 for introducing the delivery pressure.

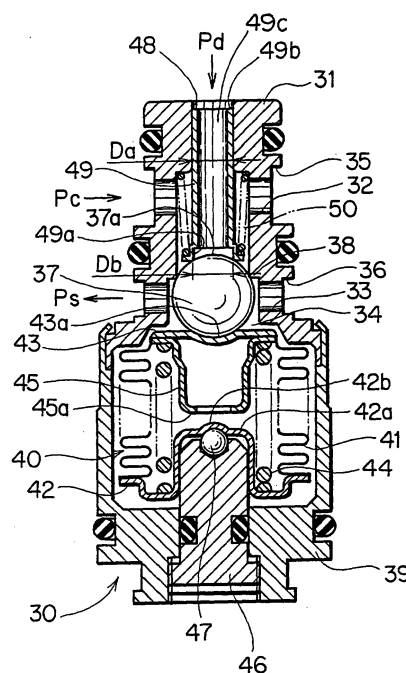


FIG. 2

Description

[TECHNICAL FIELD]

[0001] The present invention relates to a control valve for a variable capacity compressor and, more specifically, to a capacity control valve for a swash plate-type variable capacity compressor, which is used in an on-vehicle air conditioner and the like.

[BACKGROUND ART]

[0002] As a capacity control valve for a swash plate-type variable capacity compressor, capacity control valves described in Japanese Patent Publication No. H3-53474, Japanese Utility Model Publication No. H6-17010 and Japanese Patent Application Laid-Open No. H8-177735 have been known so far.

[0003] In a variable capacity compressor, in which a delivery capacity is decreased in response to a pressure increase in a crank chamber of a compressor with a built-in swash plate and is increased in response to a pressure decrease in a crank chamber, the capacity control valve basically opens or shuts a communication passage, which communicates a suction port of the compressor to the crank chamber, with using a valve element, which is driven by a balance between a valve opening force by a pressure responding device for responding a suction pressure of the compressor and a spring force by a valve shutting spring, so that the capacity control valve controls the suction pressure of the compressor, which is supplied to the crank chamber, the delivery pressure of the compressor is set so as to act to open the valve, and an operating point of opening or shutting of the valve element is displaced in response to the delivery pressure, thereby carrying out a capacity control in relation to a load of the air outside (delivery pressure).

[0004] Each conventional capacity control valve described above achieves its intended objective, though not quite satisfactorily. However, when the number of parts and the number of man-hour required for the assembly increase and when the capacity control valve is directly installed in a compressor housing, a structure of passages for applying the suction pressure and delivery pressure to respective portions of the capacity control valve becomes complicated and a degree of freedom for disposing the capacity control valve in the compressor housing is limited, therefore the conventional capacity control valve is not satisfactory in these respects.

[0005] As the pressure responding device, a diaphragm device and a bellows device are known, a driving force by which is needed to act as an axial force with respect to the valve element, otherwise the displacement of the valve element is often accompanied by an occurrence of a pinch and the smoothness in a displacement of opening or shutting of the valve element deteriorates. Consequently, the conventional capacity con-

trol valve needs to have a spring or an automatic centripetal ball between the valve element and the pressure responding device, causing an increase in the number of parts and the number of man-hour required for the assembly.

[DISCLOSURE OF INVENTION]

[0006] It is therefore an objective of the present invention to solve the above problem and to provide a control valve for a variable capacity compressor, in which a special automatic centripetal ball and the like are not needed, the structure is simple, the number of parts and the number of man-hour required for the assembly are not increased, the valve is built in the compressor housing without complicating the structure of the passages, and a degree of freedom for disposing the capacity control valve in the compressor housing is sufficient.

[0007] In order to attain the above objective, a control valve for a variable capacity compressor as described in claim 1 comprises: a valve housing having communication passages for communicating a suction port of the compressor to a crank chamber; a ball valve element provided in the valve housing to open or shut the communication passages; a spring for energizing the ball valve element to move in a valve shutting direction; a pressure responding device, which is directly connected to the ball valve element by using the ball valve element as an automatic centripetal ball and receives a suction pressure of the compressor so as to drive the ball valve element to move in a valve opening direction; and a hollow tube for introducing a delivery pressure, which is slidably engaged with the valve housing and joined to the ball valve element at one end thereof, and has an inlet for introducing the delivery pressure of the compressor at an opposite end thereof, and exerts the delivery pressure of the compressor on the back of the ball valve element to move the ball valve element in a valve opening direction through an inner passage.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0008]

Figure 1 is a sectional view illustrating an embodiment of a variable capacity compressor, in which a control valve according to the present invention is installed;

Figure 2 is a sectional view illustrating a first embodiment of a control valve for a variable capacity compressor according to the present invention;

Figure 3 is a graph illustrating a delivery pressure versus suction pressure characteristic of the control valve for a variable capacity compressor according to the first embodiment;

Figure 4 is a sectional view illustrating a second embodiment of a control valve for a variable capacity compressor according to the present invention; and

Figure 5 is a sectional view illustrating a third embodiment of a control valve for a variable capacity compressor according to the present invention.

[BEST MODE FOR CARRING OUT THE INVENTION]

(Constitution of a control valve for a variable capacity compressor according to a first preferred embodiment of the present invention)

[0009] A constitution of a control valve for a variable capacity compressor according to a first embodiment of the present invention will be explained with reference to Figs. 1 to 3.

[0010] As shown in Fig. 1, a swash plate-type variable capacity compressor 1 comprises a crank chamber 3 surrounded by a compressor housing 2 and a plurality of cylinder chambers 4 communicating with the crank chamber 3 at each one of stroke ends. A piston 5 slidably engages with each cylinder chamber 4 in an axial direction and one end of a piston rod 6 is connected to a respective piston 5 at the crank chamber 3 side thereof.

[0011] The compressor housing 2 slidably holds a drive shaft 7 which is connected to an engine (not shown in the figure) by a drive belt (not shown in the figure) running around a pulley 8 and driven by the engine.

[0012] In the crank chamber 3, the drive shaft 7 is connected to a wobble plate 9 (swash plate) with a variable fitting angle therebetween by a known linkage mechanism (not shown in the figure) in a relation of torque transmission, and the piston rod 6 engages with a plate surface of the wobble plate 9 at the cylinder chamber 4 side thereof in an axial force-transmissible manner.

[0013] The wobble plate 9 is rotationally driven in an inclined condition thereof by the drive shaft 7, each piston 5 of the respective cylinder chamber 4 does a reciprocating motion with a stroke in response to an inclined angle of the wobble plate 9, and the inclined angle is automatically adjusted in response to a differential pressure between a crank chamber pressure P_c and a suction pressure P_s of each cylinder chamber 4 (i.e. compressor suction pressure).

[0014] The inclined angle of the wobble plate 9 decreases in response to an increase in the crank chamber pressure P_c so that the stroke of the piston 5 decreases, thereby the compressor 1 decreases the delivery capacity, on the other hand, the inclined angle of the wobble plate 9 increases in response to a decrease in the crank chamber pressure P_c so that the stroke of the piston 5 increases, thereby the compressor 1 increases the delivery capacity, and the compressor 1 is in its full load operation when the crank chamber pressure P_c becomes substantially equal to the suction pressure P_s .

[0015] In each cylinder chamber 4, there are formed a suction port 14 and delivery port 15 having a one-way suction valve 12 and a one-way delivery valve 13, respectively, the suction port 14 is communicated to a suc-

tion connecting port 17 through a suction passage 16 while the delivery port 15 is communicated to an delivery connecting port 19 through a delivery passage 18, and a circulating passages for a refrigerating cycle including an evaporator 20, an expansion valve 21 and a condenser 22 are connected to the suction connecting port 17 and the delivery connecting port 19.

[0016] In the compressor housing 2 there is formed a closed-end insertion hole 23 for inserting a control valve 30, into which the control valve 30 according to the present invention is inserted and fixed therein.

[0017] The control valve 30 has a cylindrical valve housing 31 to be inserted into the insertion hole 23.

[0018] As shown in Fig. 2, in the valve housing 31 there are formed a crank chamber-side passage 32 and a suction port-side passage 33 each extending radially to penetrate through the middle of the valve housing 31 and a valve chamber 34 situated between the passage 32 and the passage 33 in the valve housing 31. On the outer circumference of the valve housing 31, there are formed annular circumferential grooves 35 and 36 for the passages 32 and 33, respectively.

[0019] In the valve chamber 34 there is disposed a ball valve element 37, which selectively takes seat on a valve seat 38, thereby carrying out the communicating or shutting between the passages 32 and 33.

[0020] At one end (bottom end) of the valve housing 31, a bellows insertion case 39 is connected with a caulking.

[0021] In the bellows insertion case 39 there is disposed a bellows device 40 having a closed structure as a pressure responding device. The bellows device 40 consists of a bellows body 41 integrally having an end plate 43 at one end thereof and another end plate 42 for shutting an opposite end of the bellows body 41. The inside of the bellows body is vacuum. Between the end plates 42 and 43, a compression coil spring 44 (corresponding to a spring in claims) is formed, by which the bellows device 40 is energized to move in its extension direction (valve closing direction). At the end plate 43 side in the bellows body 41 there is formed a patch member 45. A stopper surface 45a of the patch member 45 abuts on a stopper surface 42a of the end plate 42, thereby a maximum amount of the constriction of the bellows device 40 is regulated.

[0022] An adjusting screw member 46 engages with the bellows insertion case 39 and holds one end of the bellows device 40 by a spherical joint structure, consisting of a ball 47 disposed at an axial center of the adjusting screw member 46 and a spherical hollow 42b formed at an axial center (bellows center) of the stopper surface 42a of the end plate 42. That is, the bellows device 40 is connected to the bellows insertion case 39 at a sphere in the spherical joint structure through the adjusting screw member 46.

[0023] The bellows device 40 is directly connected to the ball valve element 37 in a spherical joint manner at a spherical hollow 43a, which is formed at an axial cent-

er (bellows center) of the end plate 43, so that the expansion and contraction of the bellows device 40 is transmitted to the ball valve element 37 as an axial force.

[0024] The bellows insertion case 39 communicates with the suction port-side passage 33 and the bellows device 40 expands or contracts in response to a differential pressure between the suction pressure introduced into the bellows insertion case 39 from the suction port-side passage 33 and an inner pressure in the bellows.

[0025] An opposite end (upper end) of the valve housing 31, there is formed an engaging hole 48 penetrating through the center of the valve housing 31 in the axial direction. The hollow tube 49 for introducing the delivery pressure engages with the engaging hole 48 slidably in the axial direction. The hollow tube 49 is joined to the ball valve element 37 at one end (lower end) thereof by welding and the like. The opposite end (upper end) of the hollow tube 49 is situated in the engaging hole 48, forming an inlet 49b of the delivery pressure Pd of the compressor 1. The diameter of the hollow tube 49 is made wider at a junction (lower end) with the ball valve element 37. The outer diameter Da of the hollow tube 49 is set equal to an effective diameter Db of a pressure receiving surface 37a, the pressure of which is applied from the hollow tube 49 to the ball valve element 37.

[0026] Between the widened portion 49a of the hollow tube 49 and the valve housing 31, there is provided a compression coil spring 50 (corresponding to energizing means for energizing the ball valve element) which energizes the ball valve element 37 to move the valve opening direction.

[0027] A spring load of the compression coil spring 50 is set so that neither the ball valve element 37 nor the bellows device 40 vibrate due to the vibration of the compressor 1 during the operation thereof when the ball valve element 37 is in its open mode.

[0028] As shown in Fig. 1, the control valve 30 with the constitution described above is fixed in the insertion hole 23 for inserting a control valve 30 in the compressor housing 2, the crank chamber-side passage 32 and the annular circumferential groove 35 communicate with the crank chamber 3 through a crank chamber pressure passage 24, while the suction port-side passage 33 and the annular circumferential groove 36 communicate with the suction port 14 through a suction pressure passage 25, and the engaging hole 48 communicates with the delivery port 15 through a delivery pressure passage 26.

[0029] The crank chamber pressure passage 24, the suction pressure passage 25 and the delivery pressure passage 26 are pressure passages formed in the interior of the compressor housing 2.

[0030] In the following, an action of the control valve 30 with the constitution described above will be explained.

[0031] The suction pressure Ps of the compressor 1 reaches the annular circumferential groove 36 and the suction port-side passage 33 from the suction port 14

through the suction pressure passage 25, then further reaches the bellows insertion case 39 and then, is applied to the bellows device 40. Thereby, the bellows device 40 expands or contracts in response to a differential pressure between the suction pressure Ps of the compressor 1 and the inner pressure in the bellows, and contracts against the spring force of the compression coil spring 44 as the suction pressure Ps increases. The ball valve element 37 opens the valve by the contraction of the bellows device 40 due to the increase of the suction pressure Ps, because the delivery pressure Pd of the compressor 1, which is introduced by the hollow tube 49 for introducing the delivery pressure, acts on the pressure receiving surface 37a and because the ball valve element 37 is energized to move in the valve opening direction by a spring force of the compression coil spring 50.

[0032] Supposing that the delivery pressure Pd, which acts on the pressure receiving surface 37a as a compensation pressure, is constant, the ball valve element 37 is driven by a balance between a valve opening force by the suction pressure Ps, which acts on the bellows device 40, and a valve shutting force by the spring force of the compression coil spring 44.

[0033] When the suction pressure Ps is equal to or lower than a control valve set pressure (standard set pressure Pss), which is determined by a set load of the compression coil spring 44, the ball valve element 37 is displaced in the valve shutting direction by the spring force of the compression coil spring 44 and takes a seat on the valve seat 38 so as to shut the valve. Thereby, the supply of the suction pressure into the crank chamber 3 is halted, the crank chamber pressure Pc increases, and the compressor 1 becomes in a condition of an unloaded operation thereof.

[0034] To the contrary, when the suction pressure Ps is equal to or higher than the control valve set pressure (standard set pressure Pss), the ball valve element 37 is displaced in the valve opening direction against the spring force of the compression coil spring 44 and becomes away from the valve seat 38 so as to open the valve. Thereby, the suction pressure is applied to the crank chamber 3, the crank chamber pressure Pc becomes the same as the suction pressure Ps, and the compressor 1 becomes in a condition of a fully loaded operation thereof.

[0035] As described above, if the delivery pressure Pd, which acts on the pressure receiving surface 37a as a compensation pressure, is supposed to be constant, that is, when a high pressure compensation is not carried out, the compressor 1 is in a capacity control operation, in which the suction pressure Ps is constant and equal to Pss as shown by a dotted line in Fig. 3.

[0036] The delivery pressure Pd of the compressor 1, which is introduced into the hollow tube 49 for introducing the delivery pressure as the compensation pressure, directly acts on the pressure receiving surface 37a of the ball valve element 37 and a valve opening force Ah

• Pd is applied on the ball valve element 37, wherein an effective area of the pressure receiving surface 37a is Ah.

[0037] The delivery pressure Pd of the compressor 1 is also applied to an end surface at the inlet 49b side of the hollow tube 49, which is sliderably engaged with the engaging hole 48. Since the outer diameter Da of the hollow tube 49 is set equal to the effective diameter Db of the pressure receiving surface 37a of the ball valve element 37, the delivery pressure Pd of the compressor 1, which acts on the end surface of the hollow tube 49, is canceled out.

[0038] Since the valve opening force $Ah \cdot Pd$, which correlates with the delivery pressure Pd, is applied to the ball valve element 37, if the standard set pressure Pss is set up in a balanced state at a standard delivery pressure Pds, the suction pressure Ps required for opening the valve increases due to the decrease in the delivery pressure Pd (i.e. delivery pressure $Pd \leq \text{standard delivery pressure Pds}$), while the suction pressure Ps required for opening the valve decreases due to the increase in the delivery pressure Pd (i.e. delivery pressure $Pd \geq \text{standard delivery pressure Pds}$).

[0039] That is, when the delivery pressure Pd decreases down to Pd', the valve opening force decreases by $Ah \cdot (Pd - Pd')$ and according to a ratio of the valve opening force to the effective area Ad of the bellows device 40, a pressure characteristic, in which the valve opening pressure increases according to an equation of $Ah \cdot (Pd - Pd')/Ad$ is obtained.

[0040] The situation is expressed by the following equation and an objective high pressure influence characteristic is obtained by selecting an effective diameter of the hollow tube 49, which determines the effective area Ah of the pressure receiving surface 37a.

$$Ps = Pss - Ah \cdot (Pd - Pds)/Ad$$

[0041] Thereby, as shown by a full line in Fig. 3, a control characteristic, in which the suction pressure Ps decreases in proportion to an increase in the delivery pressure Pd, is obtained and the control characteristic of the capacity control compressor can be adjusted by the delivery pressure Pd, which correlates with a system load characteristic.

[0042] That is, in a refrigerant circulation system, an evaporation load is in a proportional relationship with a condensation load, the evaporation load is proportional to an amount of a refrigerant circulation, and a pressure loss in an evaporator is proportional to the amount of a refrigerant circulation, thereby the capacity control of the capacity control compressor can be attained for realizing an effective energy saving system.

[0043] Since the ball valve element 37 is directly connected to the bellows device 40 and the ball valve element 37 acts as an automatic centripetal ball of a spherical joint between the valve element and the pressure

responding device, no particular automatic centripetal ball and the like is not necessary and the driving force by the bellows device 40 excellently acts on the ball valve element 37 as an axial force.

(Constitution of a control valve for a variable capacity compressor according to a second preferred embodiment of the present invention)

[0044] A constitution of a control valve for a variable capacity compressor according to a second embodiment of the present invention will be explained with reference to Fig. 4.

[0045] Figure 4 is a sectional view illustrating the second embodiment of a control valve for a variable capacity compressor according to the present invention. In Fig. 4, parts or members corresponding to those in Fig. 2 have the same abbreviation numerals and the explanation thereof are omitted.

[0046] In the second embodiment, a guide cylinder 52 is inserted into a hole 51 corresponding to the engaging hole (48) in the first embodiment and fixed therein, and the hollow tube 49 for introducing a delivery pressure slidably engages with an outer circumference of the guide cylinder 52.

[0047] In the second embodiment, the delivery pressure Pd of the compressor 1, which is introduced into the hollow tube 49 for introducing the delivery pressure as the compensation pressure, also directly acts on the pressure receiving surface 37a of the ball valve element 37, the same function and effect similar to the first embodiment can be obtained, and the control valve characteristic during an actual operation can be set to have a correlation with the delivery pressure Pd.

[0048] In the second embodiment, the delivery pressure Pd of the compressor 1 does not act on the widened portion 49a (end surface) of the hollow tube 49, therefore the effective diameter of the hollow tube 49 is not required to be set equal to the outer diameter of the hollow tube 49.

[0049] In the second embodiment, since the ball valve element 37 also is directly connected to the bellows device 40 and the ball valve element 37 acts as an automatic centripetal ball of a spherical joint between the valve element and the pressure responding device, no particular automatic centripetal ball and the like is not necessary and the driving force by the bellows device 40 excellently acts on the ball valve element 37 as an axial force.

[0050] In both first and second embodiments described above, the pressure responding device is the bellows device 40 having a closed structure. The pressure responding device is not limited to the bellows device 40, instead may be a diaphragm device and the like. A control valve for a variable capacity compressor according to a third embodiment, in which a diaphragm device is used as the pressure responding device, will be explained below.

(Constitution of a control valve for a variable capacity compressor according to a third preferred embodiment of the present invention)

[0051] A constitution of a control valve for a variable capacity compressor according to a third embodiment of the present invention will be explained with reference to Fig. 5.

[0052] Figure 5 is a sectional view illustrating the third embodiment of a control valve for a variable capacity compressor according to the present invention. In Fig. 5, parts or members corresponding to those in Fig. 2 have the same abbreviation numerals and the explanation thereof are omitted.

[0053] The diaphragm device 60 comprises: a dish-shaped upper lid 61 connected to a lower end of the valve housing 31 with a caulking; a dish-shaped lower lid 63 to the upper lid 61 sandwiching a diaphragm 62; a cylindrical spring box 64 connected to the lower lid 63 with a caulking; and an adjust screw 65 screwed to the spring box 64.

[0054] The diaphragm 62 forms a diaphragm chamber 66 at the valve housing side thereof and a closed chamber 67 at the spring box side thereof, and is connected to a holder 68 of the ball valve element 37 at the diaphragm chamber 66 side thereof.

[0055] At the closed chamber 67 side of the diaphragm 62, there are provided in turn a patch 69, a ball 70 and a spring receiving member 71, wherein a compression coil spring 72 for energizing the ball valve element 37 to move in a valve closing direction (upward) through the diaphragm 62 is provided between the spring receiving member 71 and the adjust screw 65.

[0056] The diaphragm chamber 66 communicates with the valve chamber 34 and receives the suction pressure P_s , which is introduced into the valve chamber 34.

[0057] In the third embodiment, the hollow tube 49 and the like is constituted similarly to the first embodiment, therefore the similar function and effect with those in the first embodiment can be obtained.

[0058] In the third embodiment, since the ball valve element 37 is directly connected to the diaphragm device 60 through the holder 68 and the ball valve element 37 acts as an automatic centripetal ball of a spherical joint between the valve element and the pressure responding device, no particular automatic centripetal ball and the like is not necessary and the driving force by the diaphragm device 60 excellently acts on the ball valve element 37 as an axial force.

[0059] In each embodiment described above, an end (lower end) of the hollow tube 49 is joined to the ball valve element 37 by welding and the like. Instead, the end (lower end) of the hollow tube 49 may be pressed on the ball valve element 37 by using an energizing force of the compression coil spring 50.

[INDUSTRIAL APPLICABILITY]

[0060] As clear from the first to third embodiments described above, according to the control valve for a variable capacity compressor of the present invention, the delivery pressure of the compressor directly acts on the ball valve element by the hollow tube for introducing a delivery pressure and a high pressure influence characteristic (delivery pressure influence characteristic) in response to the delivery pressure which correlates with a system load characteristic is set up. In this case, an effective diameter of the hollow tube is set up so as to obtain an optional high pressure influence characteristic, a degree of freedom of which can be set sufficient by selecting the effective diameter of the hollow tube.

[0061] Further, the delivery pressure of the compressor directly acts on the ball valve element by the hollow tube for introducing a delivery pressure, therefore the number of parts and the number of man-hour required for the assembly are decreased compared to the conventional art, and when the control valve is directly mounted into the compressor housing, the control valve can be built in the compressor housing without complicating the structure of the passages for introducing the suction pressure or the delivery pressure to each portion of the capacity control valve, and a degree of freedom for disposing the capacity control valve in the compressor housing is sufficient.

[0062] Since the ball valve element is directly connected to the pressure responding device and the ball valve element acts as an automatic centripetal ball of a spherical joint between the valve element and the pressure responding device, no particular automatic centripetal ball and the like is not necessary and the driving force by the pressure responding device excellently acts on the ball valve element as an axial force, thereby the number of parts and the number of man-hour required for the assembly can be decreased.

[0063] Furthermore, according to the control valve for a variable capacity compressor of the present invention, the delivery pressure of the compressor is also applied to an end surface at the inlet side of the hollow tube for introducing a delivery pressure, which is sliderably engaged with the engaging hole. Since the outer diameter of the hollow tube is set equal to the effective diameter of the pressure receiving surface of the ball valve element, the delivery pressure of the compressor, which acts on the end surface at the inlet side of the delivery pressure of the hollow tube, is canceled out, thereby an objective high pressure influence characteristic can be obtained.

[0064] Furthermore, according to the control valve for a variable capacity compressor of the present invention, the delivery pressure of the compressor does not act on the end surface of the hollow tube for introducing a delivery pressure, therefore the effective diameter of the hollow tube is not required to be set equal to the outer diameter of the hollow tube and an objective high pres-

sure influence characteristic can be obtained.

[0065] Furthermore, according to the control valve for a variable capacity compressor of the present invention, by the energizing force of the energizing means for energizing the ball valve element to move in a valve opening direction through the hollow tube for introducing the delivery pressure, a vibration resistance of the ball valve element and the pressure responding device is improved, and a silent and stable capacity control action can be attained.

sor as claimed in any one of claims 1 to 3, further comprising energizing means for energizing the ball valve element to move in a valve opening direction through the hollow tube for introducing the delivery pressure.

Claims

1. A control valve for a variable capacity compressor comprising:
 - a valve housing having communication passages for communicating a suction port of the compressor to a crank chamber;
 - a ball valve element provided in the valve housing to open or shut the communication passages;
 - a spring for energizing the ball valve element to move in a valve shutting direction;
 - a pressure responding device, which is directly connected to the ball valve element by using the ball valve element as an automatic centripetal ball and receives a suction pressure of the compressor so as to drive the ball valve element to move in a valve opening direction; and
 - a hollow tube for introducing a delivery pressure, which is slidably engaged with the valve housing and joined to the ball valve element at one end thereof, and has an inlet for introducing the delivery pressure of the compressor at an opposite end thereof, and exerts the delivery pressure of the compressor on the back of the ball valve element to move the ball valve element in a valve opening direction through an inner passage.
2. The control valve for a variable capacity compressor according to claim 1, wherein the hollow tube for introducing the delivery pressure is slidably engaged with an engaging hole formed on the valve housing and an outer diameter of the hollow tube is equal to an effective diameter of a pressure receiving surface exerting the delivery pressure of the compressor on the ball valve element.
3. The control valve for a variable capacity compressor according to claim 1, wherein the hollow tube for introducing the delivery pressure is slidably engaged with an outer circumference of a guide cylinder fixed to the valve housing.
4. The control valve for a variable capacity compres-

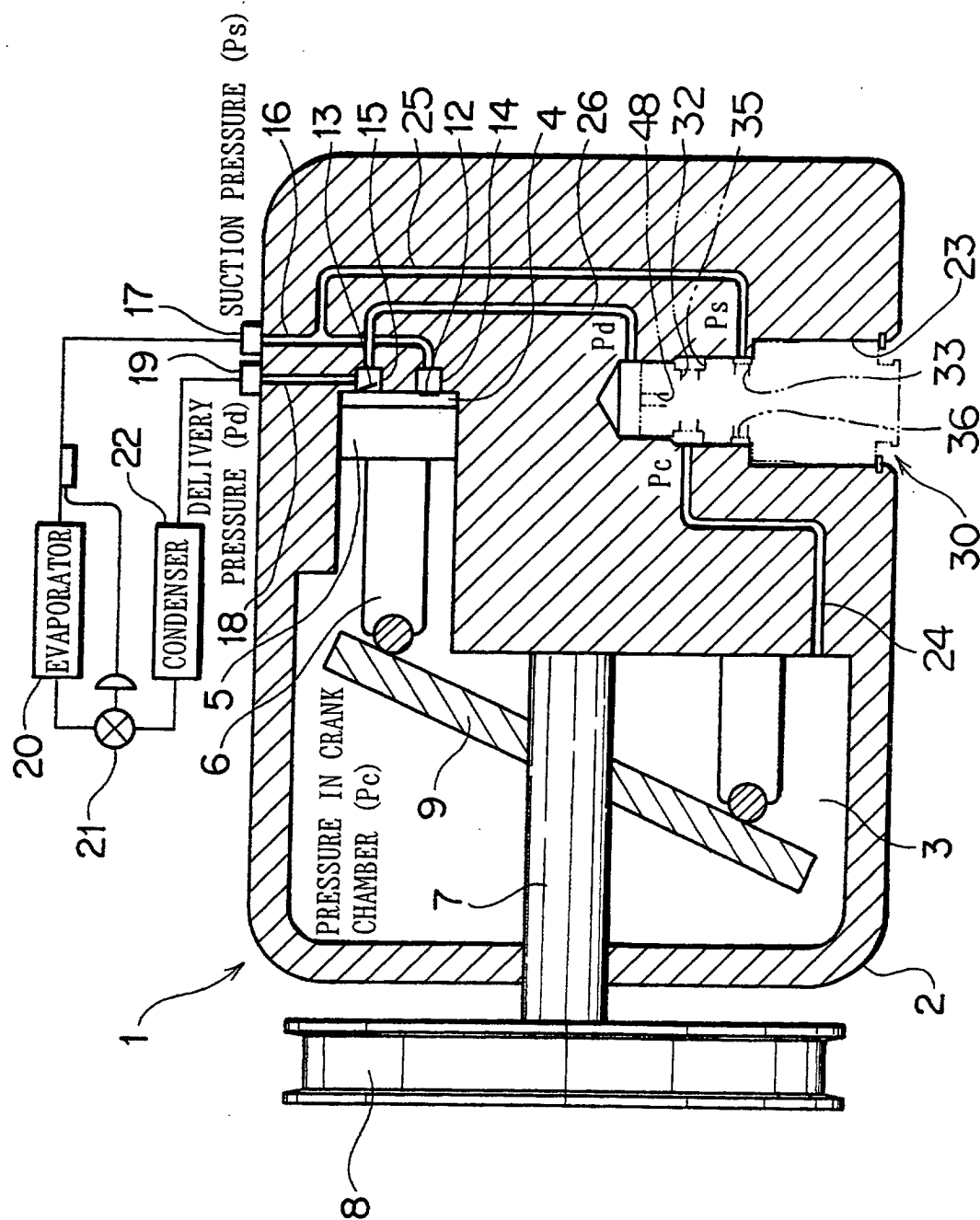


FIG. 1

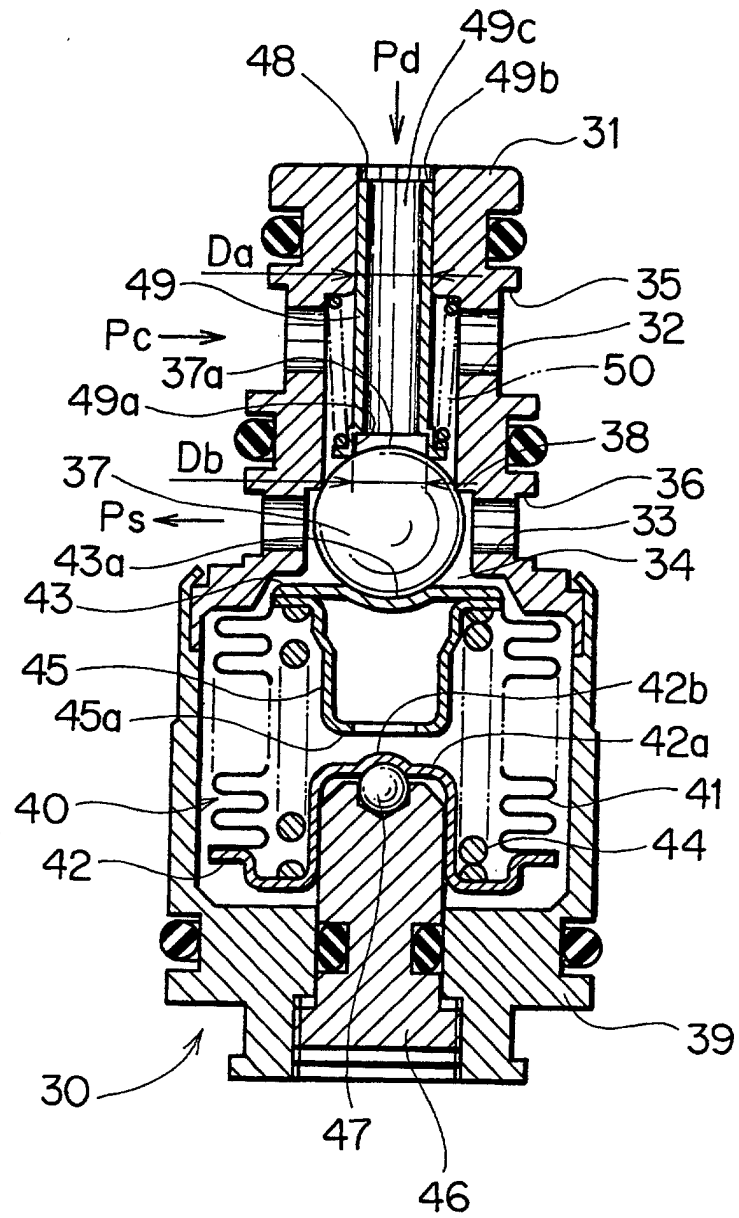


FIG. 2

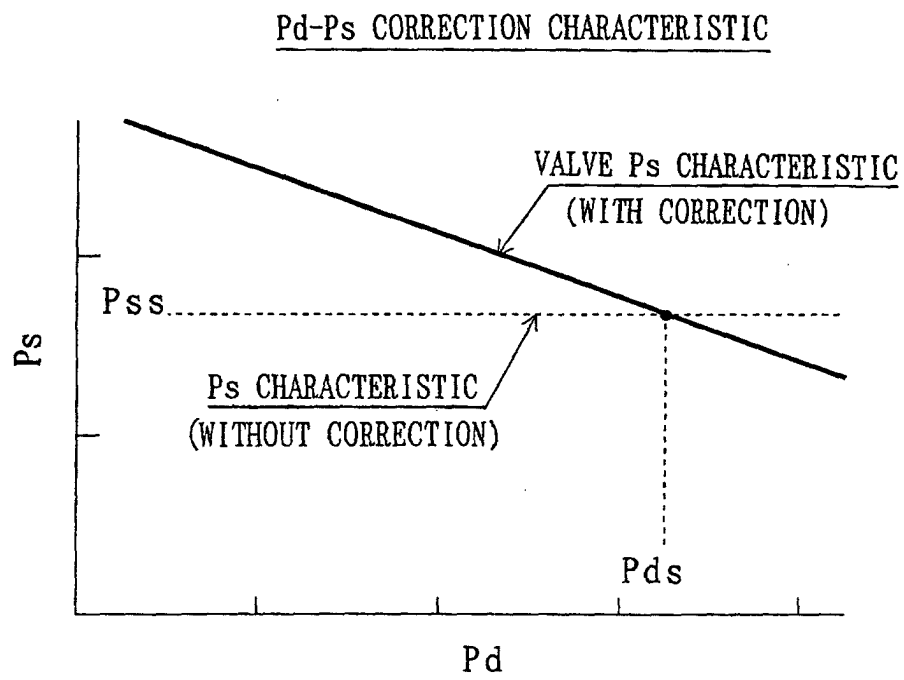


FIG. 3

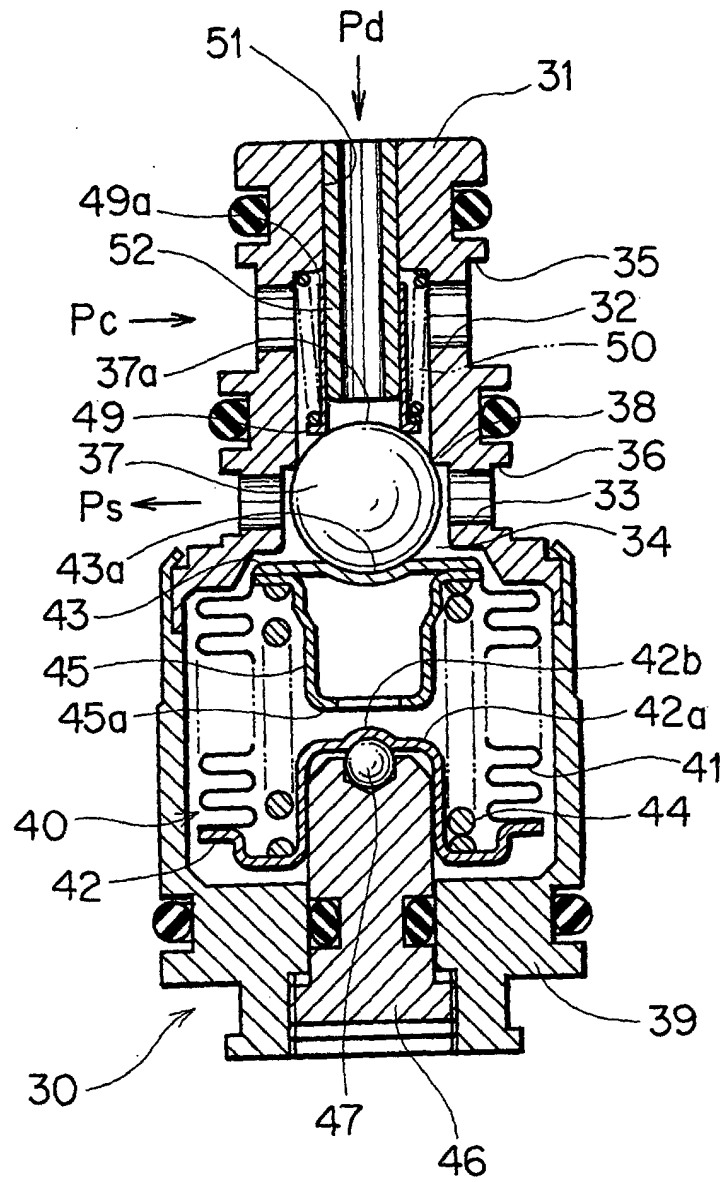


FIG. 4

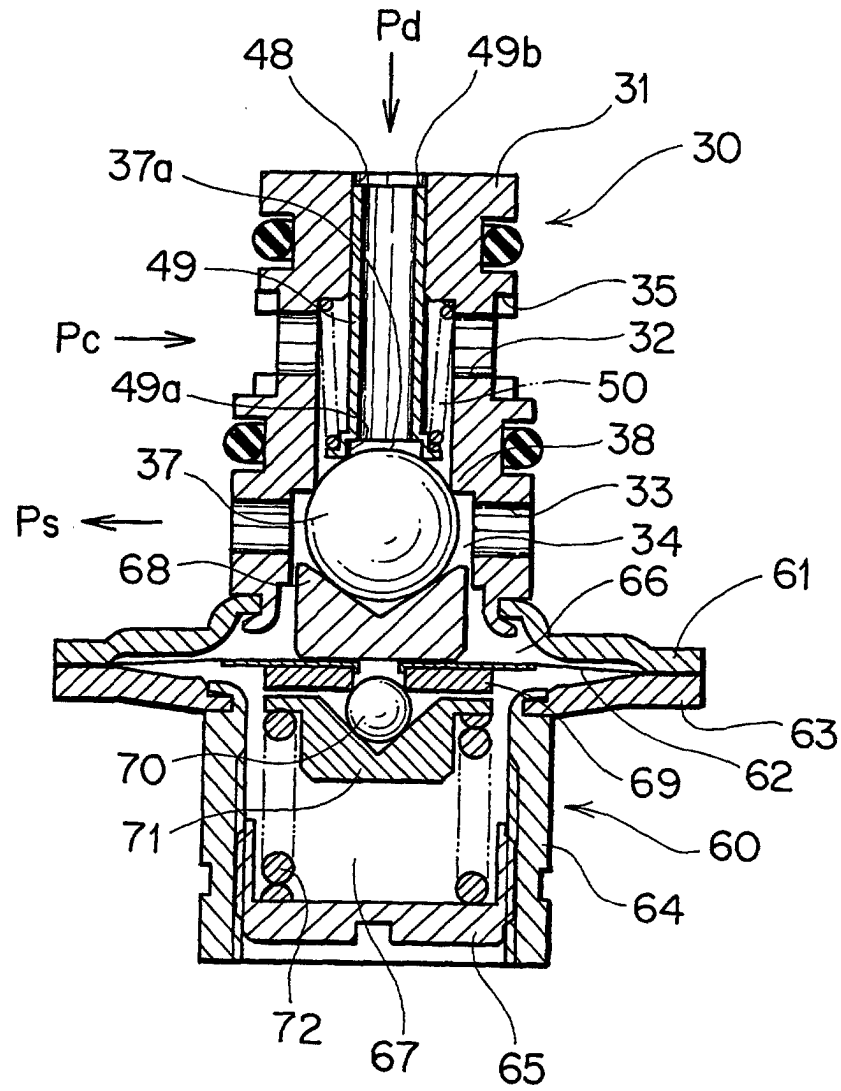


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP00/04300

A. CLASSIFICATION OF SUBJECT MATTER Int.Cl. ⁷ F04B27/14		
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 F04B27/14~27/22 F04C49/00, 361		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Toroku Jitsuyo Shinan Koho 1994-2000 Kokai Jitsuyo Shinan Koho 1971-2000 Jitsuyo Shinan Toroku Koho 1996-2000		
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.
A	JP, 6-200875, A (Toyoda Automatic Loom Works, Ltd.), 19 July, 1994 (19.07.94), Full text (Family: none)	1-4
☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
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