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(54) Displacement control valve for use in a variable displacement compressor

(57) A valve for controlling a displacement volume of a compressor having a suction chamber, a discharge chamber, and a crank chamber, has a communication passage communicating between the crank chamber and the discharge chamber and a valve member projecting in the communication passage for controlling an opening degree of the communication passage, the valve member directly receiving a gas pressure of the crank chamber at its projecting end. The valve has a first driving member sensing a difference between the gas pressure between the crank chamber and the suction chamber to drive the valve member to opening of the communication passage, and a second driving member sensing a pressure difference between gas pressures of the discharge chamber and the crank chamber to drive the valve member to closing of the communication passage. In order to cancel the crank chamber gas pressure directly applied onto the valve member, the valve has a pressure room communicating with the communication passage for being introduced with the pressure of the crank chamber. The valve member has an opposite end projecting in the pressure room. The second driving member has a sensing rod which has an end subjected to the discharge chamber gas pressure and an opposite end exposed in the pressure room. The sensing rod pushes the valve member by a force corresponding to a pressure difference between the crank chamber and the discharge chamber.

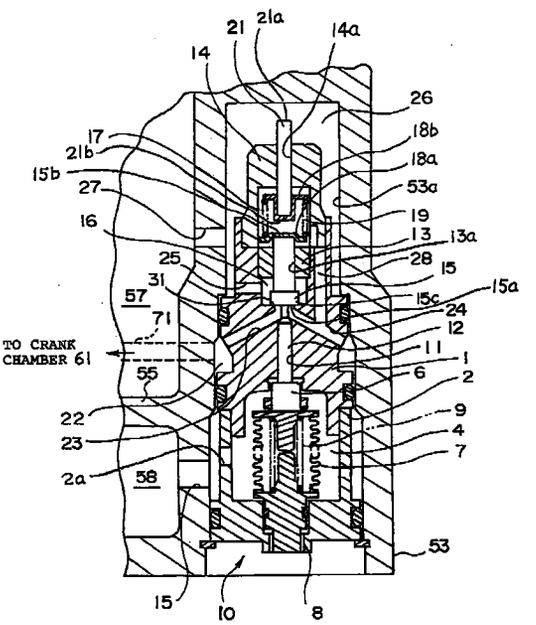

FIG. 5

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Description

Background of the Invention:

[0001] The present invention relates to a displacement control valve for use in a variable displacement compressor which is included in, for example, a vehicle air conditioner.

[0002] As such a variable displacement compressor, there has been a type having a piston. In the manner known in the art, the compressor of the type comprises a crank chamber, a suction chamber, and a discharge chamber. The piston has a piston stroke controlled in response to the pressure in the crank chamber. Therefore, the compressor has a displacement which is variable and determined in accordance with the piston stroke.

[0003] For making the displacement variable, a displacement control valve is fit to the variable displacement compressor to adjust amount of pressure of the crank chamber. Various displacement control valves have been known in the art.

[0004] Among them, the existing displacement control valve known to the inventor comprises a valve casing defining a communication passage and a valve member located in the communication passage. The communication passage communicates the discharge chamber with the crank chamber to conduct gas from the discharge chamber to crank chamber and, on the other hand, the valve member is movable in a predetermined direction under control of other components in response to gas pressures of the suction chamber, the discharge chamber and the crank chamber. As moving in the direction, the valve member adjusts opening degree of the communication passage so that the amount of gas introduced into the crank chamber from the discharge chamber is determined.

[0005] Such displacement control valve has a characteristic of controlling a gas pressure of the suction chamber in dependent on its structure. It is desirable that the characteristic is selected to be the most suitable one under the condition where the compressor is included in a target vehicle. In this event, what characteristic is the most suitable one depends upon a target vehicle in which the compressor is included. Therefore, the displacement control valve should be modified in its structure in order to correspond to a target vehicle. The drastic modification may be required for some cases, depending on the target vehicle.

[0006] However, the drastic modification is undesirable in design, cost, and so on. Therefore, it is desirable that the displacement control valve with small modification can give the above characteristic corresponding to a target vehicle.

Summary of the Invention:

[0007] This invention provides a displacement control valve for use in a variable displacement compressor having a discharge chamber, a suction chamber, and a crank chamber.

[0008] According to one aspect of the present invention, the displacement control valve comprises a valve casing, a valve member, a pressure applying system and a moving system.

[0009] The valve casing defines a communication passage which communicates the discharge chamber with the crank chamber to conduct gas from the discharge chamber to the crank chamber.

[0010] The valve member is held in the valve casing. The valve member projects in the communication passage and is movable in a predetermined direction to adjust a substantial opening degree of the communication passage. Such valve member has first and second surface opposite to each other in the predetermined direction, wherein the first surface is arranged to receive gas pressure of the crank chamber through the communication passage.

[0011] The pressure applying system is arranged and adapted to apply with the gas pressure of the crank chamber to the second surface. Thus, the pressure applying system can cancel the gas pressure of the crank chamber acting onto the first surface so that movement of the valve member itself is independent from the gas pressure of the crank chamber.

[0012] The moving system is arranged and adapted to move the valve member in the predetermined direction. In detail, the moving system comprises first and second driving member. The first driving member is adapted to drive the valve member in a first sense of the predetermined direction by applying to the first surface of the valve member a first force in response to gas pressure of the discharge chamber and the crank chamber. On the other hand, the second driving member is adapted to drive the valve member in a second sense opposite to the first sense by applying to the second surface of the valve member a second force in response to gas pressure of the discharge chamber and the crank chamber.

[0013] With this structure, the valve member does not move due to gas pressure received by itself, because the pressure applying system is arranged in the displacement control valve. But, the valve member does move in dependent upon the first and second force applied by the first and second driving member. That is, if either the first or the second driving member are modified, the adjustment of the above pressure controlling characteristic is achieved.

Brief Description of the Drawings:

[0014]

Fig. 1 is a longitudinal sectional view showing the overall structure of a variable displacement compressor;
Fig. 2 shows a longitudinal sectional view of an existing displacement control valve having a ball valve;
Fig. 3 is a graph for use in describing a relationship between pressures of the suction chamber and the discharge chamber in a displacement control valve shown in Fig. 2;
Fig. 4 is a graph for use in describing a problem in a displacement control valve mechanism shown in Fig 2;
Fig. 5 is a longitudinal sectional view showing a displacement control valve according to the preferred embodiment of the present invention;
Fig. 6 is a graph for use in describing of a relationship between pressures of the suction chamber and the discharge chamber in a displacement control valve shown in Fig. 5.

Description of the Preferred Embodiments:

[0015] Prior to description of embodiments of this invention, descriptions of the overall structure of a variable displacement compressor known to the inventor and an existing displacement control valve having a problem in its structural modification will be introduced.

[0016] Referring to Fig. 1, the illustrated compressor 50 comprises a cylinder block 51, a front housing 52 arranged on one side of the cylinder block 51, and a rear housing 53 arranged on the opposite side of the cylinder block 51. Herein, a valve plate 54 is interposed between the cylinder block 51 and the rear housing 53. The cylinder block 51 and the front housing 52 have through holes communicated with each other at the center thereof, which together form one through hole. A main shaft 62 is inserted into this through hole and rotatably supported by the front housing 52 and the cylinder block 51.

[0017] The front housing 52 defines a crank chamber 61 in cooperation with the cylinder block 51. In the crank chamber 61, a rotor 65 is mounted on the main shaft 62. A swash plate 60 is coupled to the rotor 65 via a hinge mechanism including a guide pin 66. The main shaft 62 passes through the swash plate 60 such that the swash plate 60 abuts on the main shaft 62 at the inside thereof so as to rotate together with the main shaft 62. An inclination of the swash plate 60 relative to the main shaft 62 can be changed by means of the hinge mechanism. A wobble plate 63 is slidablely mounted on the swash plate 60 via bearings 67.

[0018] In the cylinder block 51, a plurality of cylinders 51a are arranged at regular angular intervals so as to surround the main shaft 62. A plurality of piston rods 69 are coupled to the wobble plate 63 through ball connection. Furthermore, each of piston rods 69 is coupled through ball connection to corresponding one of pistons 68 disposed in the respective cylinders 51a.

[0019] In the rear housing 53, a discharge chamber 57 and a suction chamber 58 are formed by inner, outer and bottom walls 55, 56 and 118 of the rear housing 53, and the valve plate 54. The bottom walls 118 also defines an accommodating room 53a adapted to accommodate a displacement control valve 100 (or 10). Herein, the accommodating room 53a itself communicates with the discharge chamber 57 and the suction chamber 58 via through holes, and also does with the crank chamber 61 via a communication passage 71.

[0020] Referring to Fig. 2, an existing displacement control valve 100 comprises a valve casing 101 and a cap member 102 arranged on one side of the valve casing 101 and covering it. The one side of the valve casing 101 caves in to form a room 104 together with the cap member 102, where a bellows 112 is disposed. And also, the other side of the valve casing 101 caves in to define a valve cavity 103.

[0021] Such displacement control valve 100 is accommodated in the accommodating room 53a with a part of the valve casing 101 exposed in a space 117. Herein, the space 117 is applied with gas pressure of the discharge chamber 57 through a hole 116, and thereby, the valve cavity 103 is also applied with gas pressure of the discharge chamber 57.

[0022] In the valve casing 101, a through hole 105 is formed between the room 104 and the valve cavity 103, and extends in an up-to-down direction in the figure. The valve casing further has another through hole 106 extending in a direction perpendicular to the up-to-down direction, the through hole 106 communicating the hole 105 with a surrounding area 109 of the valve casing 101. Herein, the hole 106 and a part of the hole 105 comprise a part of the communication passage 71.

[0023] In the valve cavity 103, a ball valve 107 is arranged on the communication passage 71 and downwardly biased by a spiral spring 108. The valve 107 receives a downward force in Fig. 2, which is due to bias of the spiral spring 108 and gas pressure of the discharge chamber 57. The downward force serves to move the ball valve 107 in downward sense where the communication passage 71 will be closed, and therefore, such downward force will be referred to as the closing force F_V hereinafter.

[0024] In the room 104, the bellows 102 is mounted on an adjusting screw 113, and is connected to a rod 114 via a

supporting member 111. Herein, the room 104 is communicated with the suction chamber 58 via the through hole 115 so that the bellows 112 can sense gas pressure of the suction chamber 58 and expands/contracts itself in response to the gas pressure of the suction chamber 58.

[0025] In the bellows 112, an internal spring 112a is placed and makes a force corresponding to the gas pressure of the suction chamber 58, together with the bellows 112. The force is transferred to the ball valve 107 by the rod 114. Besides, the ball valve 107 receives gas pressure of the crank chamber 61 on a sealing area of the ball valve 107, which seals the communication passage 71. The pressure of the crank chamber 61 and the transferred force comprises an upward force serving to move the ball valve 107 in an upward sense where the communication passage 71 is opened, and therefore, such upward force will be called the opening force F_b hereinafter.

[0026] Practically, movement of the ball valve 107 depends on a difference between the opening force F_b and the closing force F_v. Herein, the closing and opening force F_v and F_b are represented by Equations (1) and (2), respectively.

$$F_v=(P_d-P_c)*S_v+f_v \tag{1}$$

$$F_b=f_b-\{(S_b-S_r)*P_s+S_r*P_c\} \tag{2},$$

where

P_d : gas pressure of the discharge chamber 57,
P_c : gas pressure of the crank chamber 61,
P_s : gas pressure of the suction chamber 58,
S_v : area of the ball valve 107 sealing the communication passage 71,
S_b : effective area of the bellows 102,
S_r : cross section of the rod 114,
f_v : force by the spiral spring 108, and
f_b : force by the bellows 112 and the internal spring 112a.

[0027] When $F_v < F_b$, the ball valve 107 opens the communication passage 71. Thus, opening condition is obtained as Inequality (3) from the Equation (1) and (2).

$$(P_d-P_c)*S_v+f_v<f_b-\{(S_b-S_r)*P_s+S_r*P_c\} \tag{3}$$

[0028] Provide that $P_c=P_s+\alpha$, then the Inequality (3) can be modified into Inequality (4).

$$(S_b-S_v)*P_s<-P_d*S_v+f_b-f_v+(S_v-S_r)*\alpha \quad \therefore P_s<\frac{-S_v}{(S_b-S_v)}*P_d+\frac{f_b-f_v+(S_v-S_r)*\alpha}{(S_b-S_v)} \tag{4}$$

[0029] This Inequality (4) represents a characteristic of controlling gas pressure in the suction chamber 58, which belongs to the displacement control valve 100. As a graph of the characteristic depicted in Fig. 3, gas pressure of the suction chamber 58 varies, depending upon gas pressure of the discharge chamber 57.

[0030] Consider adjustment of the characteristic to a target vehicle in which the compressor is included. In this event, the modification of the valve 100 requires changes in its structure.

[0031] In the valve 100, when the adjusting screw 113 is turned, a bottom level of the internal spring 112a is determined so that the force f_b can be adjusted to f_{b1}, f_{b2}, and f_{b3}, as shown in Fig. 4. That is, the adjusting screw 113 can change an intercept of the characteristic in the figure.

[0032] On the other hand, there is a method of changing an inclination of the characteristic in the figure to optimize the characteristic. To this end, it is necessary to change the sealing area S_v of the ball valve 107 and/or the effective area S_b of the bellows 112, in the above valve structure.

[0033] With the change of the effective area of the bellows 112, the displacement control valve should be modified drastically in its structure. Such drastic modification gives a harmful influence on its design, and therefore is undesirable. On the other hand, as the sealing area of the ball valve 107 is changed, the amount of gas introduced from the discharge chamber 57 into the crank chamber 61 is also changed so that a starting characteristic of gas pressure in the crank chamber 61 fluctuates. Such fluctuation makes the characteristic of controlling gas pressure in the suction chamber 58 unstable.

[0034] On the contrary to the existing mechanism, a displacement control valve according to one aspect of the present invention can easily change the characteristic of controlling gas pressure in the suction chamber 58 with no change of the sealing area of the valve member and the effective area of the bellows.

[0035] Referring to Fig. 5, a displacement control valve 10 according to an embodiment of this invention is for use in a variable displacement compressor having a discharge chamber 57, a suction chamber 58, and a crank chamber 61. The illustrated valve 10 is arranged within the accommodating room 53a of the rear housing 53, and comprises a main portion 1, a first cap member 2 and a second cap member 14 which are assembled into a valve casing (1, 2, 14).

[0036] In the accommodating room 53a, a space 26 is communicated with the discharge chamber 57 via a through hole 27 to be introduced gas pressure of the discharge chamber 57 thereinto. In the space 26, the second cap member 14 and a part of the main portion 1 are exposed to be applied with gas pressure of the chamber 57. On the other hand, the first cap member 2 is applied with gas pressure of the suction chamber 58 via a through hole 15.

[0037] The main portion 1 of the valve casing has opposite sides of the longitude direction thereof, each of which caves in. One side of the main portion 1 defines a sensing room 4 together with the first cap member 2, where a bellows 7 is disposed. Herein, the first cap member 2 has a through hole 2a between the sensing room 4 and a periphery of the first cap member 2 so that the sensing room 4 is applied with gas pressure of the suction chamber 58. The other side of main portion 1 defines a valve cavity 16 together with a valve guide 13, and furthermore, does a pressure room 17 together with the second cap member 14. Herein, the illustrated valve guide 13 has a co-axial shape and has a through hole 13a extending in a longitude direction of the valve casing. Between the valve cavity 16 and the sensing room 4, a through hole 11 is also formed.

[0038] Besides, the main portion 1 has the hollow surrounding thereof so that the hollow of the main portion 1 defines a room 22 together with the accommodating room 53a when the displacement control valve 10 is arranged within the accommodating room 53a.

[0039] Moreover, the main part 1 of the valve casing has a through hole 25 formed between the space 26 and the valve cavity 16, and through holes 23, 24 formed between a part of the through hole 11 and the room 22. The through holes 27, 25, 23 and 24, a part of the through hole 11, parts of the rooms 26 and 22, and the valve cavity 16 comprise a communication passage 71. That is, the main portion 1 of the valve casing defines a communication passage 71 which is to communicate the discharge chamber 57 with the crank chamber 61 and which the valve cavity 16 is included within (or arranged on the way of). Such communication passage 71 serves to conduct gas from the discharge chamber 57 to the crank chamber 61 in cooperation with a valve member 15, that will be mentioned in detail, later.

[0040] The valve member 15 has a shape extending in a longitude direction of the valve casing, and has first and second surface 15a and 15b opposite to each other in the direction. Such valve member 15 is placed on the through hole 11 in the valve cavity 16, and is partially and movably held in the through hole 13a of the valve guide 13. Under the circumstances, the valve member 15 is slidable in the longitude direction, depending upon forces which are applied on the first and the second surfaces 15a and 15b of the valve member 15.

[0041] In detail, the valve member 15 has a part 15c of large cross section in a plane perpendicular to the longitude direction, while the valve cavity 16 has a valve seat 31 facing the first surface 15a of the valve member 15 on the through hole 11. Thus, the communication passage 71 is closed when the valve member 15 rests on the valve seat 31 and, on the other hand, the communication passage 71 is opened when the valve member 15 is apart from the valve seat 31. That is, the valve member 15 can adjust a substantial opening degree of the communication passage 71, by the movement thereof. Such movement of the valve member 15 is mentioned in detail below.

[0042] The main portion 1 of the valve casing further defines an additional communication passage 28, such as a through hole, formed between the through hole 24 and the pressure room 17. Herein, the valve member 15 receives, on the first surface 15a thereof, gas pressure of the crank chamber 61 through the communication passage 71. The additional communication passage 28 serves to also apply with the gas pressure of the crank chamber 61 to the second surface 15b. Herein, the first surface 15a has a first area which receives the gas pressure of the chamber 61 thereon when the valve member 15 rests on the valve seat 31, while the second surface 15b has a second area which is subjected to the gas pressure of the chamber 61 when the valve member 15 rests on the valve seat 31. Besides, the first and second areas are equal to each other. Furthermore, the part 15c of the valve member 15 has a constant cross section so as not to be given the influence of the gas pressure of the discharge chamber 57. Thus, the gas pressure of the crank chamber 61 acting onto the first surface 15a is canceled with that applied to the second surface 15b. Therefore, the movement of the valve member 15 itself is independent from the gas pressure of the crank chamber 61.

[0043] The bellows 7 is placed within the sensing room 4, as mentioned above. More in detail, the bellows 7 is mounted on an adjusting screw 8 in the sensing room 4, and is connected to a rod 12 via a supporting member 6. Since the sensing room 4 is communicated with the suction chamber 58, the bellows 7 can sense gas pressure of the chamber 58 to expand/contract in response to the gas pressure of the chamber 58.

[0044] In the bellows 7, an internal spring 9 is placed and makes a force corresponding to gas pressure of the suction chamber 58, together with the bellows 7. The force is transmitted via the rod 12 onto the first surface 15a of the valve member 15. Herein, the influence of gas pressure of the chamber 61 onto the first surface 15a of the valve member 15, is prevented by the additional communication passage 28, as described above. Therefore, only the transmitted force by the rod 12 substantially operates upon the fist surface to move or drive the valve member 15. That is, the transmitted force is the opening force F_b of the valve mechanism 10 and, in this connection, the supporting member 6, the bellows

7, the internal spring 9, and the rod 12 together serve as a driving member for driving the valve member 15 to opening of the communication passage 71.

[0045] The second cap member 14 has a through hole 14a formed between the space 26 and the pressure room 17 and sliderably holds a sensing rod 21 in the through hole 14a thereof. The sensing rod 21 extends along the longitude direction of the valve casing, and has first and second pressure sensing areas 21a and 21b. The first sensing area 21a projects over the space 26 and receives the gas pressure of the discharge chamber 57, while the second pressure sensing area 21b is arranged within the pressure room 17 and receives the gas pressure of the crank chamber 61. As the results, the sensing rod 21 serves to produce a force corresponding to difference between the gas pressure of the discharge chamber 57 and the gas pressure of the crank chamber 61. Herein, the produced force is determined in dependent on cross section of the sensing rod 21 in a plane perpendicular to the longitude direction of the valve casing. That is, the first and the second pressure sensing area 21a and 21b of the sensing rod 21 are equal to each other in this embodiment.

[0046] The produced force is transmitted via a transmission member into the second surface 15b of the valve member 15. Herein, the transmission member does only transmit the produced force under the circumstances the produced force is downward force, besides, the valve member 15 itself does not depend upon the influence of the gas pressure. Therefore, the produced force is the closing force F_v and, in this connection, the sensing rod 21, the spring 19, and the spring guides 18a, 18b together serve a driving member for driving the valve member 15 to closing of the communication passage 71.

[0047] The illustrated transmission member comprises an elastic member, such as a spring 19, and guide members, such as spring guides 18a, 18b. Such transmission member is disposed between the sensing rod 21 and the second surface 15b of the valve member 15, namely, is arranged within the pressure room 17. Herein, the sensing rod 21, the spring 19, and the valve member 15 are arranged on an axis extending in the longitude direction of the valve casing in this embodiment.

[0048] As understood from the above description, the closing and opening force F_v and F_b are represented by Equations (5) and (6), respectively.

$$F_v=(P_d-P_c)*S_k \tag{5}$$

$$F_b=f_b-\{(S_b-S_r)*P_s+S_r*P_c\} \tag{6}$$

where

P_d : gas pressure of the discharge chamber 57,
P_c : gas pressure of the crank chamber 61,
P_s : gas pressure of the suction chamber 58,
S_k : cross section of the sensing rod 21,
S_b : effective area of the bellows 7,
S_x : cross section of the rod 12, and
f_b : force by the bellows 7 and the internal spring 9.

[0049] When $F_v < F_b$, the valve member 15 opens the communication passage 71. Thus, opening condition is obtained as Inequality (7) from the Equation (5) and (6).

$$(P_d-P_c)*S_k<f_b-\{(S_b-S_r)*P_s+S_r*P_c\} \tag{7}$$

[0050] Provide that $P_c=P_s+\alpha$, then the Inequality (7) can be modified into Inequality (8).

$$(P_d-P_s-\alpha)*S_k<f_b-\{S_b-S_r)*P_s+S_r*(P_s+\alpha)\} \therefore P_s<\frac{-S_k}{(S_b-S_k)}*P_d+\frac{f_b+(S_k-S_r)*\alpha}{(S_b-S_k)} \tag{8}$$

[0051] This Inequality (8) represents a characteristic of controlling gas pressure in the suction chamber 58, which belongs to the displacement control valve 10. Such as a graph of the characteristic depicted in Fig. 6, according to this embodiment, the change ratio of the gas pressure of the suction chamber 58 to the gas pressure of the discharge chamber 57 can be varied with no change the sealing area S_v of the valve member 15 and/or the effective area S_b of the bellows 7.

[0052] Furthermore, if $S_r=S_k$, then Inequality (9) is obtained.

$$P_s < \frac{-S_k}{S_b - S_k} * P_d + \frac{f_b}{S_b - S_k} \quad (9)$$

[0053] As understood from this Inequality (9), a term of α is removed from the Inequality (8). That is, the Inequality (9) has no influence of the gas pressure of the crank chamber 61. It shows that accuracy of controlling gas pressure of the suction chamber 58 becomes high when the rod 12 and the sensing rod 21 equal to each other in their cross section, namely, their areas receiving gas pressure.

[0054] Furthermore, the characteristic depicted in Fig. 6 has a flat part. The flat part of the characteristic shows that, when the pressure of the discharge chamber 57 becomes lower than a certain value which produces upward force of the sensing rod 21, the characteristic is subjected to no influence of the pressure of the discharge chamber 57, because elastic force of the spring 19 is larger than the force due to the sensing rod 21, and thereby, the spring guide 18b has contact with the second cap member 14 to stop the extension of the spring 19.

Claims

1. A displacement control valve (10) for use in a variable displacement compressor (50) having a discharge chamber (57), a suction chamber (58), and a crank chamber (61),

   said valve (10) comprising a valve casing (1, 2, 14) defining a communication passage (71) for communicating said discharge chamber (57) with said crank chamber (61) to conduct gas from said discharge chamber (57) to said crank chamber (61), a valve member (15) held in said valve casing (1, 2, 14), said valve member (15) projecting in said communication passage (71) and being movable in a predetermined direction for adjusting a substantial opening degree of said communication passage (71), and moving means (6, 7, 8, 9, 12, 18a, 18b, 19, 21) for moving said valve member (15) in said predetermined direction,
   characterized in that:
   said valve member has first and second surface (15a, 15b) opposite to each other in said predetermined direction, said first surface (15a) being arranged to receive gas pressure of said crank chamber (61) through said communication passage (71);
   said valve (10) further comprises pressure applying means (28) for applying with said gas pressure of said crank chamber (61) to said second surface (15b) to thereby cancel said gas pressure of said crank chamber (61) acting onto said first surface (15a) so that movement of said valve member (15) is independent from said gas pressure of said crank chamber (61).

2. The displacement control valve as claimed in claim 1,
   wherein said moving means comprises first driving means (6, 7, 8, 9, 12) for driving said valve member (15) in a first sense of said predetermined direction by applying to said first surface (15a) of said valve member (15) a first force in response to gas pressure of said discharge chamber (57) and said crank chamber (61), and second driving means (18a, 18b, 19, 21) for driving said valve member (15) in a second sense opposite to said first sense by applying to said second surface (15b) of the valve member (15) a second force in response to gas pressure of said discharge chamber (57) and said crank chamber (61).

3. The displacement control valve as claimed in claim 1 or 2, wherein:

   said communication passage (71) has a valve seat (31) facing said valve member (15) in said predetermined direction, said communication passage (71) is closed when said valve member (15) rests on said valve seat (31), and said communication passage (71) is opened when said valve member (15) is apart from said valve seat (31);
   said first surface (15a) has a first area which receives said gas pressure of said crank chamber (61) thereon when said valve member (15) rests on said valve seat (31); and
   said second surface (15b) has a second area which is subjected to said gas pressure of said crank chamber (61) when said valve member (15) rests on said valve seat (31), said second area being substantially equal to said first area.

4. The displacement control valve as claimed in one of claims 1 to 3, wherein said pressure applying means (28) comprises an additional communication passage (28) adapted to apply with said gas pressure of said crank chamber to said second surface of said valve member,

said additional communication passage (28) preferably being formed in said valve casing (1, 2, 14) and/or connected to said communication passage (71).

5. The displacement control valve as claimed in one of claims 2 to 4, wherein said second driving means comprises:

pressure sensing means (21) having first and second pressure sensing areas (21a, 21b), said first sensing area (21a) receiving said gas pressure of said discharge chamber (57) and said second pressure sensing area (21b) receiving said gas pressure of said crank chamber (61) so that said pressure sensing means (21) produces said second force corresponding to difference between said gas pressure of said discharge chamber (57) and said gas pressure of said crank chamber (61); and
transmission means (18a, 18b, 19) disposed between said pressure sensing means (21) and said second surface (15b) of said valve member (15), for transmitting said second force from said pressure sensing means (21) onto said second surface (15b) of said valve member (15).

6. The displacement control valve as claimed in claim 5, wherein said pressure sensing means (21) comprises a sensing rod (21) having opposite ends (21a, 21b) which serve as said first and second pressure sensing area.

7. The displacement control valve as claimed in claim 6, wherein said valve casing (1, 2, 14) comprises:

an exposed portion (14, 13, 1) exposed to said gas pressure of said discharge chamber (57);
a pressure room (17) formed within said valve casing (1, 2, 14) and connected to said communication passage (71) by said additional communication passage (28);
a first hole (14a) formed in said exposed portion (14, 13, 1) and extending in said predetermined direction from said pressure room (17) to outside of said valve casing (1, 2, 14), said sensing rod (21) being slidablely held in said first hole (14a); and
a second hole (13a) extending in said predetermined direction between said pressure room (17) and said communication passage (71), said valve member (15) partially and slidablely held in said second hole (13a).

8. The displacement control valve as claimed in claim 6 or 7,
wherein said sensing rod (21) extends along said predetermined direction and said second force is determined by a cross section of said sensing rod (21) in a plane perpendicular to said predetermined direction.

9. The displacement control valve as claimed in claim 9, wherein said transmission means (18a, 18b, 19) comprises an elastic member (19) and is arranged within said pressure room (17),

said sensing rod (21), said elastic member (19) and said valve member (15) preferably being arranged on an axis extending in said predetermined direction.

10. A valve (10) for controlling a displacement volume of a compressor (50) having a suction chamber (58), a discharge chamber (57), and a crank chamber (61),

said valve (10) having a valve casing (1, 2, 14) formed with a communication passage (71) communicating between the crank chamber (61) and the discharge chamber (57) and a valve member (15) projecting in the communication passage (71) for controlling an opening degree of the communication passage (71), said valve member (15) directly receiving a gas pressure of the crank chamber (61) at its projecting end, wherein:
said valve (10) further has a first driving member sensing a difference between the gas pressure between the crank chamber (61) and the suction chamber (58) to drive the valve member (15) to opening of the communication passage (71), and a second driving member sensing a pressure difference between gas pressures of the discharge chamber (57) and the crank chamber (61) to drive the valve member (15) to closing of the communication passage (71);
said valve casing (1, 2, 14) has a pressure room (17) communicating with the communication passage (71) for being introduced with the pressure of the crank chamber (61);
said valve member (15) has an opposite end projecting in the pressure room (17);
said second driving member has a sensing rod (21) which has an end subjected to the discharge chamber gas pressure and an opposite end exposed in the pressure room (17);
said sensing rod (21) pushes the valve member (15) by a force corresponding to a pressure difference between the crank chamber (61) and the discharge chamber (57).

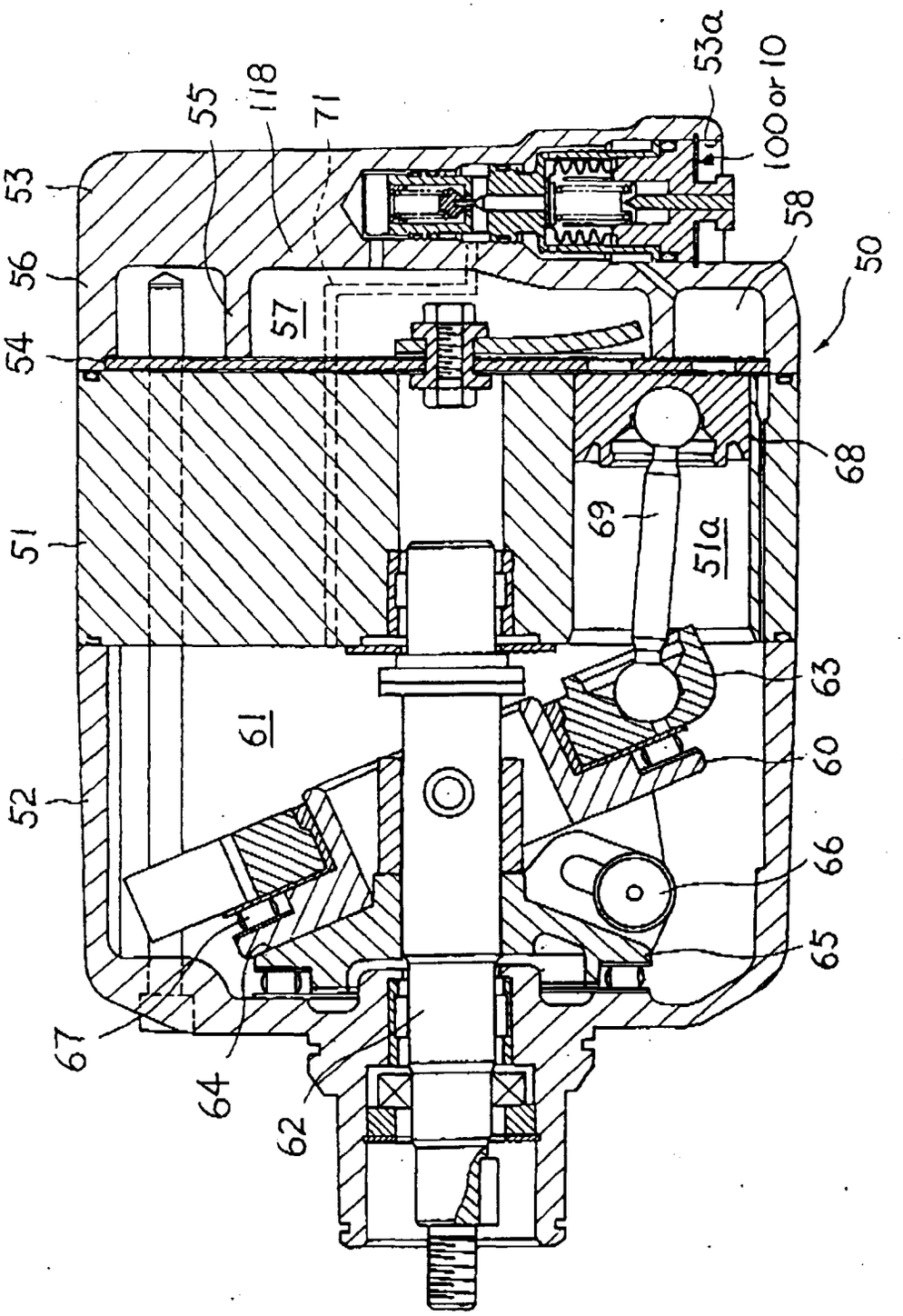
53
56
54
51
52
55
118
71
53a
100 or 10
58
50
57
68
69
51a
63
60
66
65
61
67
64
62

FIG. 1

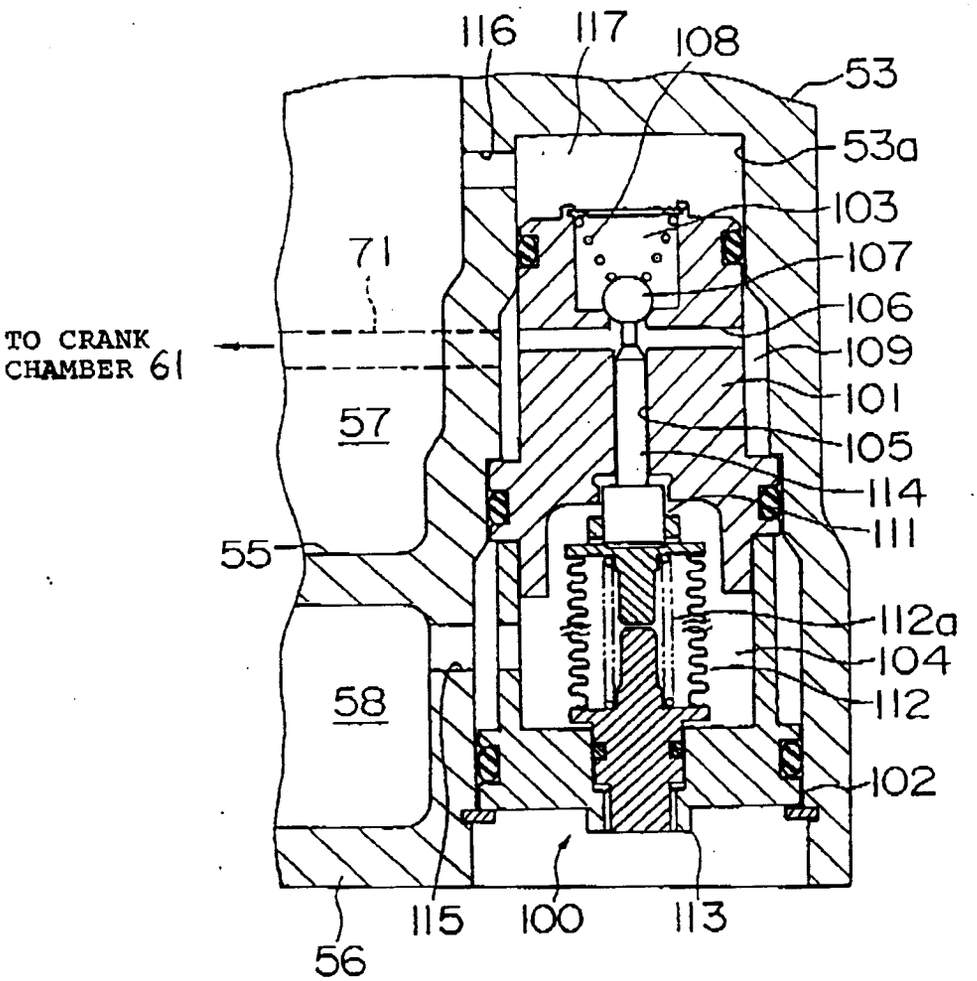
116
117
108
53
53a
103
71
107
106
TO CRANK CHAMBER 61
109
57
101
105
114
55
111
112a
104
58
112
102
115
100
113
56

FIG. 2

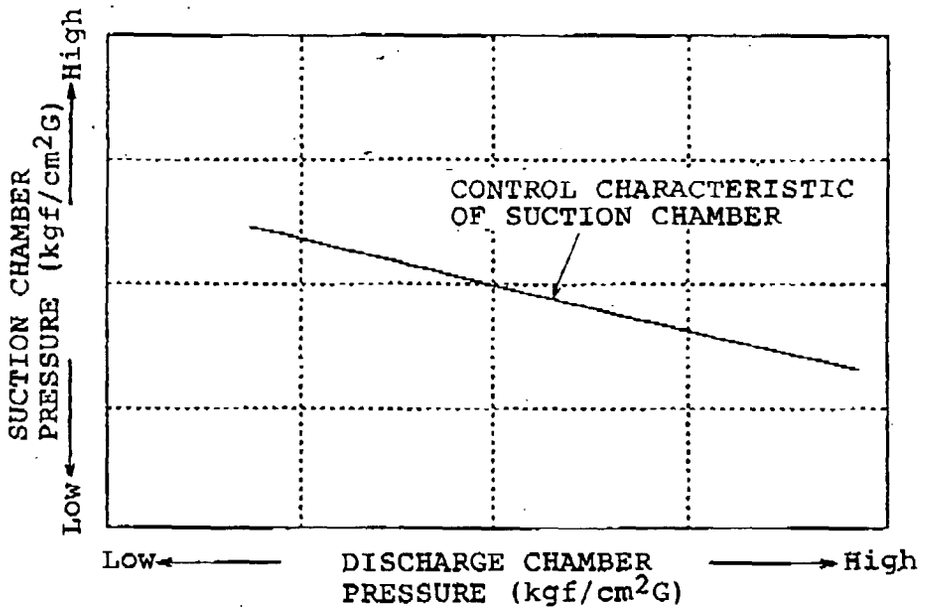
SUCTION CHAMBER PRESSURE (kgf/cm2G)
High
Low
CONTROL CHARACTERISTIC OF SUCTION CHAMBER
Low
DISCHARGE CHAMBER PRESSURE (kgf/cm2G)
High

FIG. 3

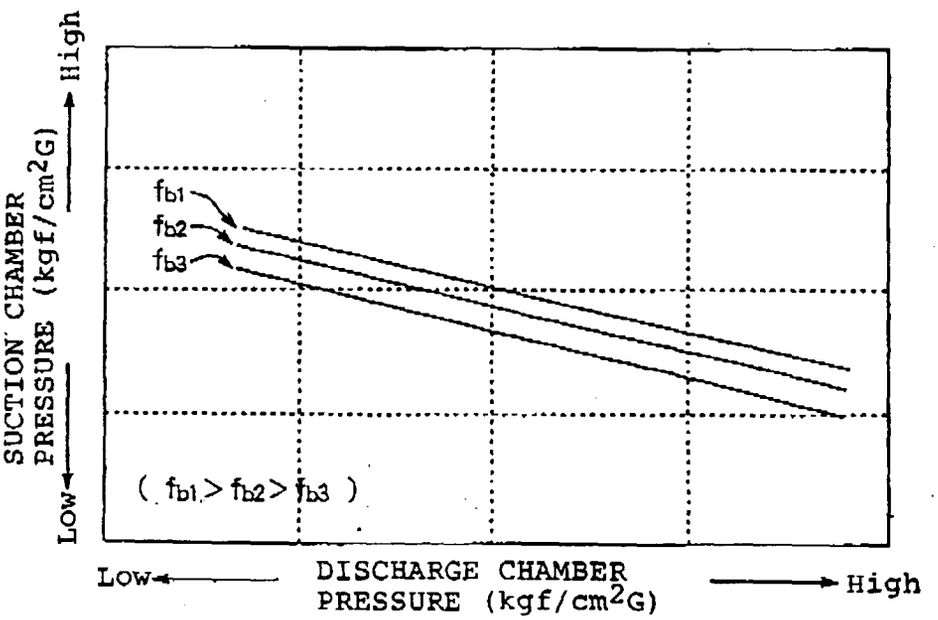
SUCTION CHAMBER PRESSURE (kgf/cm2G)
High
Low
fb1
fb2
fb3
(fb1 > fb2 > fb3)
Low
DISCHARGE CHAMBER PRESSURE (kgf/cm2G)
High

FIG. 4

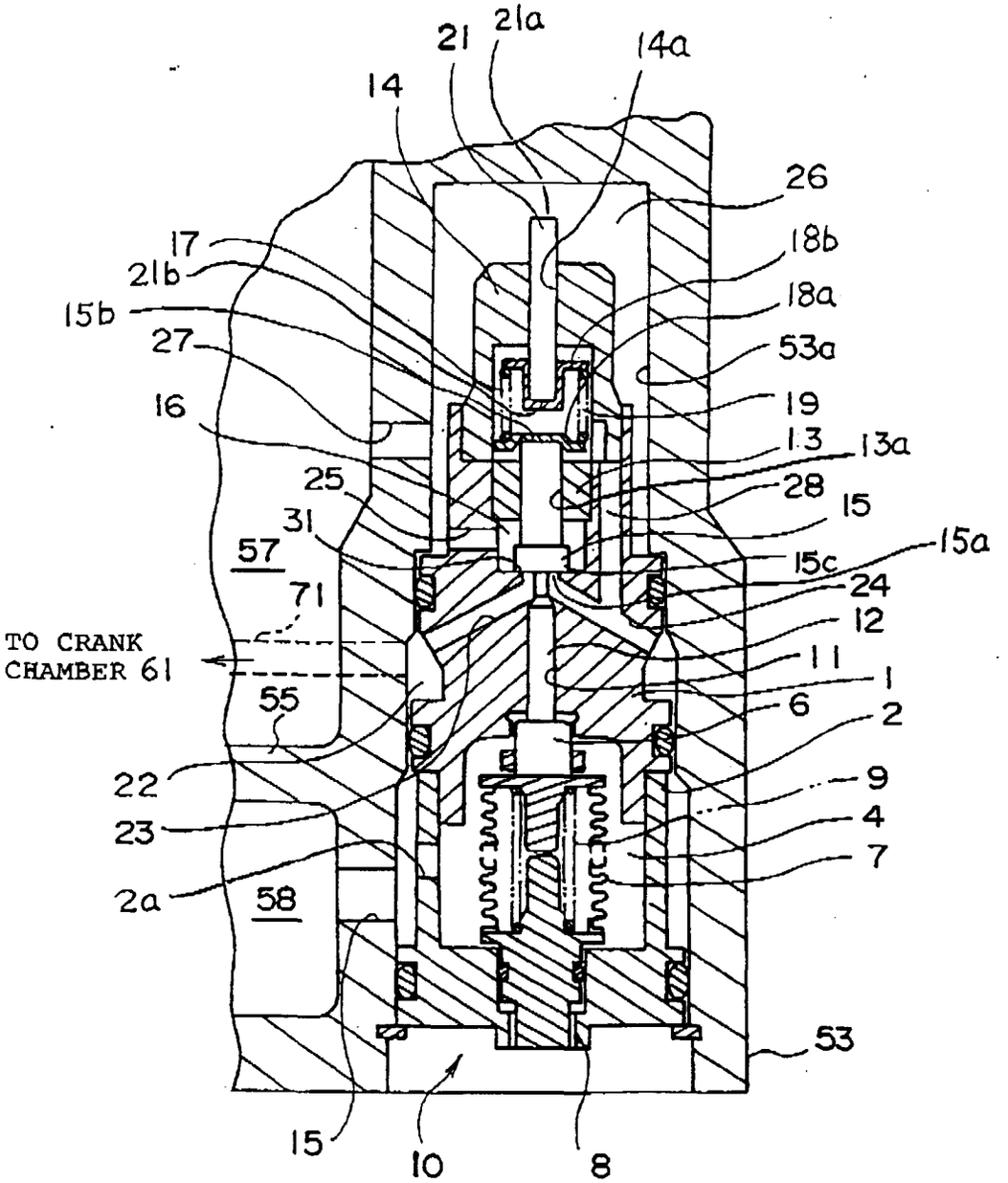
21
21a
14a
14
26
17
18b
21b
18a
15b
53a
27
19
16
13
13a
25
28
15
31
15a
57
15c
24
71
12
TO CRANK
CHAMBER 61
11
1
55
6
2
22
9
23
4
7
2a
58
53
15
10
8

FIG. 5

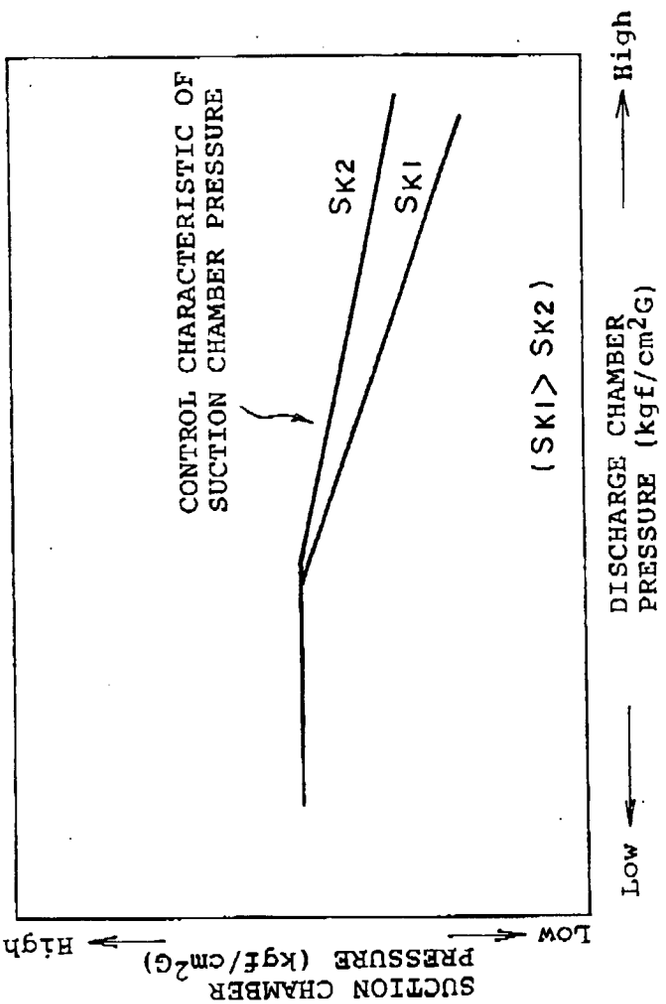
CONTROL CHARACTERISTIC OF
SUCTION CHAMBER PRESSURE
SK2
SK1
(SK1> SK2)
Low
High
DISCHARGE CHAMBER
PRESSURE (kgf/cm2G)
SUCTION CHAMBER
PRESSURE (kgf/cm2G)
High
Low

FIG. 6