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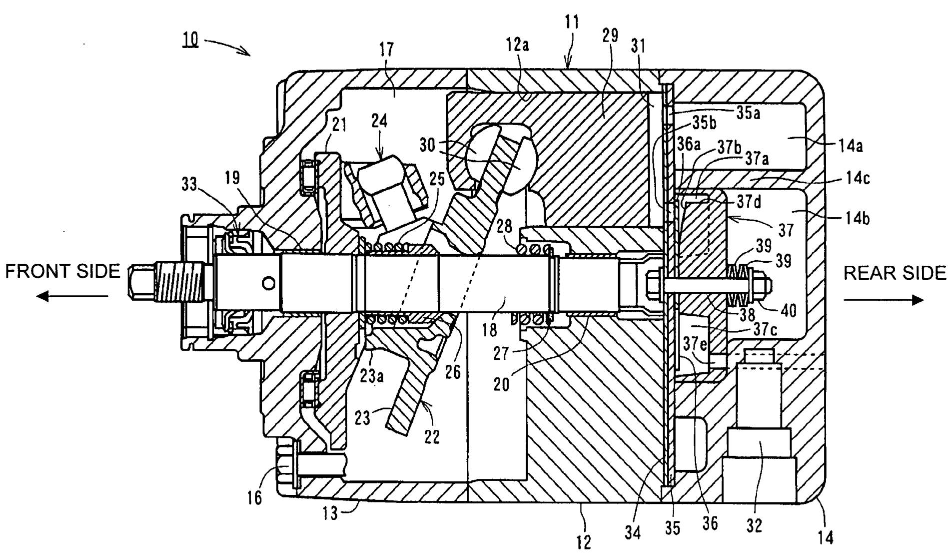
(54) **Compressor**

(57) A compressor includes a suction chamber, a working chamber, a discharge chamber, a discharge valve and a thermal insulating member. A low-pressure compressible fluid resides in the suction chamber. The low-pressure compressible fluid in the suction chamber is introduced into the working chamber and is compressed to a predetermined pressure. The compressed compressible fluid in the working chamber is discharged into the discharge chamber. The discharge valve is interposed between the working chamber and the discharge chamber. The thermal insulating member is disposed in the discharge chamber. The thermal insulating member has an opening restricting portion for restricting the maximum opening degree of the discharge valve.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a compressor which introduces a low-pressure compressible fluid for compression and discharges a compressed compressible fluid.

[0002] A swash plate type compressor is generally known as a compressor for use in a vehicle air conditioning apparatus. A compressor of this type is disclosed in Japanese Unexamined Patent Publication No. 5-164042. The compressor includes a cylinder block which forms therein a cylindrical working chamber (or compression chamber) in which a piston is received for compressing a compressible fluid such as refrigerant gas. The compressor also includes a housing which covers the working chamber of the cylinder block and a valve port plate which is interposed between the housing and the cylinder block. The valve port plate has a suction port through which a low-pressure compressible fluid is introduced from a suction chamber formed in the housing into the working chamber. The valve port plate has also a discharge port through which a compressible fluid compressed by the piston is discharged into a discharge chamber formed in the housing.

[0003] The compressor has also a discharge valve plate (or discharge plate) interposed between the valve port plate and the housing and made of a metal. The discharge valve plate has a plurality of discharge valves which is integrally formed with the discharge valve plate. When a compressed compressible fluid with high pressure is discharged through the discharge port, the discharge valve may be deformed in excess of the elastic limit of the discharge valve plate. Therefore, the compressor has a retainer which is formed on the side opposite to the discharge port with respect to the discharge valve for restricting the maximum opening degree of the discharge valve so that the opening degree is within the elastic limit of the discharge valve plate.

[0004] Meanwhile, the temperature of the compressed compressible fluid discharged from the working chamber into the discharge chamber is increased by the compression in the working chamber. Part of the heat of the compressed compressible fluid is transferred to the compressible fluid in the suction chamber thereby causing the compressible fluid before compression to be expanded. Consequently, the amount of gas substantially introduced into the working chamber is reduced and, therefore, the compression efficiency of the compressor is reduced. To prevent such heat transfer, this compressor has a partition which is formed in the housing so as to define the discharge chamber and the suction chamber, and an annular groove is formed in the partition which serves as a thermal insulating member for preventing the heat transfer of the compressible fluid in the discharge chamber to the suction chamber.

[0005] A compressor which prevents the heat transfer of the compressed compressible fluid in the discharge chamber to the suction chamber in a similar manner is disclosed in Japanese Unexamined Patent Publication No. 2004-11531. Further, another compressor which uses rubber or resin serving as thermal insulating means is disclosed in Japanese Unexamined Patent Publication No. 2002-235667.

[0006] However, these prior art compressors merely adds thermal insulating means for preventing the heat transfer of the compressible fluid in the discharge chamber to the suction chamber thereby achieving a thermal insulating effect. To merely provide additional thermal insulating means causes problems such as increased number of parts, enlargement of the compressor, and reduced design freedom due to increased installation space.

SUMMARY OF THE INVENTION

[0007] The present invention is directed to a compressor having a thermal insulating member which prevents the heat transfer of compressible fluid in a discharge chamber to a suction chamber while serving as a retainer, thereby enabling reduction of the number of parts, simplification of the compressor, or reduction of the size of the compressor while maintaining the compression efficiency of the compressor.

[0008] The present invention provides the following feature. A compressor includes a suction chamber, a working chamber, a discharge chamber, a discharge valve and a thermal insulating member. A low-pressure compressible fluid resides in the suction chamber. The low-pressure compressible fluid in the suction chamber is introduced into the working chamber and is compressed to a predetermined pressure. The compressed compressible fluid in the working chamber is discharged into the discharge chamber. The discharge valve is interposed between the working chamber and the discharge chamber. The thermal insulating member is disposed in the discharge chamber. The thermal insulating member has an opening restricting portion for restricting the maximum opening degree of the discharge valve.

[0009] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The features of the present invention that are believed to be novel are set forth with particularity in the appended claims. The invention, together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments, together with the accompanying drawing, in which:

FIG. 1 is a longitudinal sectional view showing a compressor according to a first preferred embodiment of the present invention;

FIG. 2 is an explanation drawing explaining a thermal insulating member of the compressor according to the first preferred embodiment of the present invention;

FIG. 3 is a longitudinal sectional view showing a compressor according to a second preferred embodiment of the present invention;

FIG. 4 is an explanation drawing explaining a thermal insulating member of the compressor according to the second preferred embodiment of the present invention;

FIG. 5 is a partially enlarged longitudinal sectional view showing a compressor according to a third preferred embodiment of the present invention; and

FIG. 6 is a partially enlarged longitudinal sectional view showing a compressor according to a fourth preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0011] The following will describe a compressor according to a first preferred embodiment of the present invention with reference to FIGS. 1 and 2. It is noted that the left side of the compressor in FIG. 1 is the front side and the opposite right side thereof is the rear side. The compressor according to the first preferred embodiment is a variable displacement type compressor which uses carbon dioxide as a compressible fluid.

[0012] FIG. 1 shows a compressor 10 of the first embodiment. Referring to FIG. 1, the compressor 10 includes a compressor housing 11 which forms the outer shell of the compressor 10. The compressor housing 11 includes a cylinder block 12 in which a plurality of cylinder bores 12a is formed, a front housing 13 which is joined to the front end of the cylinder block 12 and a rear housing 14 which is joined to the rear end of the cylinder block 12. In the first preferred embodiment, the front housing 13, the cylinder block 12 and the rear housing 14 of the compressor housing 11 are made of aluminum-based metal to reduce the compressor weight. A plurality of through bolts 16 (only one shown in FIG. 1) extends through the front housing 13, the cylinder block 12 and the rear housing 14 and tightens those components together in the axial direction thereof, thereby integrally fixing those components to form the compressor housing 11.

[0013] The front housing 13 and the cylinder block 12 cooperate to define a crank chamber 17 whose rear side is closed by the cylinder block 12. A rotatable drive shaft 18 extends through the crank chamber 17 at the center thereof. The drive shaft 18 is supported at the front portion thereof by a radial bearing 19 which is disposed in the front housing 13 and at the rear portion thereof by a radial bearing 20 which is disposed in the cylinder block 12. A shaft seal mechanism 33 is provided on the front side of the radial bearing 19 in sliding contact with the outer peripheral surface of the drive shaft 18. The shaft seal mechanism 33 includes a lip seal member and a holder which holds the lip seal member, thereby preventing compressible fluid in the crank chamber 17 from leaking through a gap between the front housing 13 and the drive shaft 18.

[0014] A lug plate 21 is fixed to the drive shaft 18 in the crank chamber 17 for rotation therewith. A swash plate 23 which forms a displacement changing mechanism 22 is supported by the drive shaft 18 at the rear side of the lug plate 21 so as to slide along and incline with respect to the axis of the drive shaft 18. A hinge mechanism 24 is interposed between the swash plate 23 and the lug plate 21, and the swash plate 23 is connected to the lug plate 21 and the drive shaft 18 through the hinge mechanism 24 for synchronous rotation therewith and inclination with respect thereto.

[0015] A coil spring 25 is provided around the drive shaft 18 between the lug plate 21 and the swash plate 23, and a tubular body 26 is slidably fitted on the drive shaft 18 and urged rearward by the coil spring 25. Thus, the swash plate 23 is constantly pushed rearward by the coil spring 25 through the tubular body 26 in such a way the swash plate 23 is urged in the direction which reduces inclination angle of the swash plate 23. It is noted that the inclination angle of the swash plate 23 is an angle between a plane perpendicular to the axial direction of the drive shaft 18 and a plane of the swash plate 23. A stopper 23a protrudes from the front side of the swash plate 23, and as shown in FIG. 1, the contact of the stopper 23a with the lug plate 21 restricts the position of the maximum inclination of the swash plate 23. A retaining ring 27 is installed on the drive shaft 18 on the rear side of the swash plate 23, and a coil spring 28 is provided around the drive shaft 18 on the front side of the retaining ring 27. The contact of the swash plate 23 with the coil spring 28 restricts the position of the minimum inclination of the swash plate 23. A single-headed piston 29 is received in each cylinder bore 12a of the cylinder block 12 for reciprocation therein, and a neck portion of each piston 29 engages with the periphery of the swash plate 23 through a corresponding pair of shoes 30.

[0016] A displacement control valve 32 is provided in the rear housing 14 which is operable to adjust the stroke of the piston 29 or the displacement of the compressor 10 by changing the angle of inclination of the swash plate 23.

[0017] The rear housing 14, a valve port plate 35 and a suction valve plate 34 which are interposed between the rear housing 14 and the cylinder block 12, a discharge valve plate 36 and a thermal insulating member

37 will now be described. The rear housing 14 which is joined to the rear end of the cylinder block 12 has a suction chamber 14a formed in the rear housing 14 and a discharge chamber 14b in which the thermal insulating member 37, which will be described in detail later, is provided. The valve port plate 35 forms a working chamber 31 in each cylinder bore 12a with the corresponding piston 29. The valve port plate 35 has a suction port 35a which is in communication with the suction chamber 14a in the rear housing 14 and a discharge port 35b which is in communication with the discharge chamber 14b in the rear housing 14. The discharge port 35b serves as a valve port. The suction valve plate 34 is a plate which has suction valves (not shown) interposed between the working chambers 31 and the suction ports 35a, while the discharge valve plate 36 is a plate which has reed type discharge valves 36a interposed between the discharge ports 35b and the discharge chambers 14b. The thermal insulating member 37 is disposed in the discharge chamber 14b of the rear housing 14 and has a discharge space 37a formed in the thermal insulating member 37. The thermal insulating member 37 is provided to prevent the heat transfer of the compressible fluid in the discharge space 37a to the suction chamber 14a. In addition, the thermal insulating member 37 has an opening restricting portion 37b for restricting the maximum opening degree of the discharge valve 36a.

[0018] To describe more in detail with reference to FIG. 1, while the front end of the rear housing 14 and the rear end of the cylinder block 12 are joined to each other, the valve plates 34, 36 are disposed between the rear housing 14 and the cylinder block 12 with the valve port plate 35 interposed therebetween. That is, the suction valve plate 34 is located on the front side of the valve port plate 35 and the discharge valve plate 36 is located on the opposite rear side thereof. The thermal insulating member 37 is disposed on the side of the rear housing 14 with respect to the discharge valve plate 36. In the first preferred embodiment, the suction valve plate 34, the valve port plate 35, the discharge valve plate 36 and the thermal insulating member 37 are arranged in this order from the front side, and a bolt 38 extends through the valve plates 34, 36, the valve port plate 35 and the thermal insulating member 37. A nut 40 is screwed on the bolt 38 for fastening the valve plates 34, 36, the valve port plate 35 and the thermal insulating member 37 by way of two disc springs 39. Thus, the thermal insulting member 37 is constantly urged against the discharge valve plate 36 by the resilient force of the disc springs 39. Although in the first preferred embodiment the disc springs 39 are used as the urging member for providing urging force to the thermal insulating member 37, members other than the disc springs 39 may be used, such as resilient member made of rubber-based material or resilient sealing member.

[0019] The suction chamber 14a is formed in radially outer region of the rear housing 14 in communication with the cylinder bore 12a via the suction port 35a formed through the valve port plate 35. On the other hand, the discharge chamber 14b, in which the thermal insulating member 37 is provided, is formed in radially inner region of the rear housing 14. The discharge chamber 14b and the suction chamber 14a are separated sealingly from each other by a partition 14c. The discharge space 37a is formed in the thermal insulating member 37 so as to face the discharge valve plate 36.

[0020] The discharge valve plate 36 is made of a thin metal sheet which has the reed type discharge valve 36a for opening and closing the discharge port 35b formed through the valve port plate 35. As shown in FIG. 2, the discharge valve 36a corresponds to each of the discharge ports 35b which is correspond to the cylinder bore 12a, and a proximal end 361 of the discharge valve 36a which is located on the center of the rear housing 14 is fixed between the valve port plate 35 and the thermal insulating member 37 by being pressed by the thermal insulating member 37 which is urged frontward by the disc springs 39. The discharge valve 36a is flexible as the chain line shown in FIG. 2, and the maximum opening degree of the discharge valve 36a is restricted by contact thereof with the opening restricting portion 37b of the thermal insulating member 37.

[0021] The thermal insulating member 37 of the first preferred embodiment will now be described in detail. FIG. 2 shows a front view of the thermal insulating member 37 as seen from the discharge valve plate 36 (drawing on the left). FIG. 2 also shows a longitudinal-sectional view of the thermal insulating member 37 drawing on the right). The valve port plate 35 and the discharge valve plate 36 are illustrated by solid and chain lines. The thermal insulating member 37 has a substantially disk-like shape. The thermal insulating member 37 also has a plurality of recesses 37c arranged circumferentially in facing to the discharge valve plate 36 and each having substantially a sector shape. The recesses 37c are formed in the thermal insulating member 37 adjacent to the periphery of the thermal insulating member 37. The opening restricting portion 37b is formed between any two adjacent recesses 37c and a communication groove 37d is formed adjacent to the outer periphery of the recesses 37c for communication between the recesses 37c. In the first preferred embodiment, these recesses 37c and the communication grooves 37d form the discharge space 37a.

[0022] The opening restricting portion 37b has a curved surface as shown in the cross section of FIGS. 1 and 2, so that no harmful force is applied to the discharge valve 36a when the discharge valve 36a is fully opened in contact with the opening restricting portion 37b. As shown in FIG. 2, one of the recesses 37c of the thermal insulating member 37 has an outlet 37e which is in communication with a discharge piping (broken line shown in FIG. 1) connected to an external refrigerant circuit. The outlet 37e is formed on the one recess 37c. The thermal insulating member 37 prevents the heat transfer of the compressible fluid in the discharge space

37a to the rear housing 14 including the suction chamber 14a, because the thermal insulating member 37 is made of resin material which has a smaller heat transfer coefficient than the rear housing 14 which is made of aluminum-based metal in the present embodiment. In the first preferred embodiment, PPS (polyphenylene sulfide) resin is used as the resin material.

[0023] In the first preferred embodiment, a contacted portion 371 formed in the thermal insulating member 37 is contacted with the proximal end 361 of the discharge valve 36a, that is, the contacted portion 371 is pressed against the proximal end 361. This contacted portion 371 is defined by a circular region of the thermal insulating member 37, as shown by latticed hatching in FIG. 2, which ranges from the center thereof to the opening restricting portion 37b. The discharge valve plate 36 is kept in tight contact with the thermal insulating member 37 at the contacted portion 371 thereof, so that irregular movement of the discharge valve 36a relative to the valve port plate 35 is prevented when the discharge valve 36a is opened and closed.

[0024] The operation of the compressor 10 of the first preferred embodiment will now be described. As the drive shaft 18 is rotated and the swash plate 23 is driven to rotate accordingly, each piston 29 is reciprocated through the shoes 30. When the piston 29 moves from its top dead center to its bottom dead center, the compressible fluid in the suction chamber 14a is drawn into the working chamber 31 in the cylinder bore 12a through the suction valve. Then, when the piston 29 moves from the bottom dead center to the top dead center, the compressible fluid in the working chamber 31 is compressed to a predetermined pressure, and then discharged into the discharge space 37a through the discharge valve 36a. Although the compressible fluid in the discharge space 37a is then high in temperature and pressure, the heat transfer of the compressible fluid in the discharge space 37a to the suction chamber 14a is prevented by the thermal insulating member 37, thereby preventing temperature rise of the low-pressure compressible fluid in the suction chamber 14a. During the operation of the compressor 10, the discharge valve 36a is not opened or bent in excess of its elastic limit by the contact with the opening restricting portion 37b of the thermal insulating member 37. The compressible fluid discharged into the discharge space 37a of the thermal insulating member 37 is discharged from the outlet 37e to the discharge piping through the communication groove 37d, which is in communication with the adjacent recesses 37c.

[0025] The compressor 10 of the first preferred embodiment has the following advantageous effects.

(1) The thermal insulating member 37 not only prevents the heat transfer of the compressible fluid in the discharge space 37a to the rear housing 14 including the suction chamber 14a but also serves as a retainer. Therefore, the number of parts of the compressor 10 is reduced as compared to that of a prior art compressor. In addition, the space for installation is reduced as compared to the case in which the retainer and the thermal insulating member are separately installed, thus enabling the compressor 10 to be simplified and reduce its size. Further, the freedom of designing the interior of the rear housing 14 is enhanced. Further, the reduced number of parts enables reduction of manufacturing cost and simplification of assembling operation.

(2) Because the opening restricting portion 37b of the thermal insulating member 37 has an arched surface in cross section, the discharge valve 36a of the discharge valve plate 36 is opened along the arched surface in its maximum opening degree. Thus, the discharge valve 36a is not opened in excess of its elastic limit and the valve 36a is not susceptible to excessive deformation or breakage.

(3) In the above-described embodiment wherein the thermal insulating member 37 is urged against the discharge valve plate 36 by the disc springs 39 serving as the urging member, the discharge valve plate 36 is firmly pressed against the thermal insulating member 37 and the valve port plate 35. Therefore, the pressed contact of the discharge valve plate 36 with both of the valve port plate 35 and the thermal insulating member 37 is maintained when the discharge valve 36a is fully opened, thereby stabilizing the opening and closing operation of the discharge valve 36a.

(4) The thermal insulating member 37 is pressed against the discharge valve plate 36 thereby maintaining fluid tightness of the discharge space 37a. Also, since the thermal insulating member 37 is pressed against the discharge valve plate 36, the surface of the thermal insulating member 37 with which the discharge valve plate 36 is contacted does not require highly accurate machining, thereby facilitating the machining of the thermal insulating member 37. This is particularly effective when the thermal insulating member 37 is made of resin material.

(5) Using a resin as the material for the thermal insulating member 37, it is easier to set the heat transfer coefficient of the thermal insulating member 37 lower than that of the housing 11 made of metal and forming the outer shell of the compressor and to make the opening restricting portion 37b as compared with the conventional practice according to which the thermal insulating member and the opening restricting portion are formed separately. Thus, the manufacture of the compressor 10 is simplified.

(6) In a case where carbon dioxide is employed as

the compressible fluid which is used under a relatively high pressure as compared to another compressible fluid, the carbon dioxide generates a greater amount of heat in the discharge space 37a. As the temperature of the carbon dioxide in the discharge space 37a rises, the prevention effect of the heat transfer of the compressible fluid to the suction chamber 14a by the thermal insulating member 37 becomes more remarkable.

(7) The prevention effect of the thermal insulating member 37 is improved by increasing the thickness thereof. If the thermal insulating member 37 is formed with a sufficiently large thickness, the prevention effect of the heat transfer of the compressible fluid in the discharge space 37a to the suction chamber 14a is further improved, thereby enhancing the compression efficiency of the compressor 10.

(8) As the number of cylinder bores 12a in the cylinder block 12 of the compressor 10 is increased, the diameter of the cylinder bores and the size of the discharge valves 36a are reduced. However, in the above-described embodiment of the invention wherein the thermal insulating member 37 is formed integrally with the opening restricting portion 37b, the maximum opening degree of the discharge valves 36a can be restricted easily in a compressor having an increased number of cylinder bores.

[0026] A compressor 50 according to a second preferred embodiment of the present invention will now be described with reference to FIGS. 3 and 4. As shown in FIG. 3, the compressor 50 according to the second preferred embodiment is different from the compressor 10 according to the first preferred embodiment in that a discharge chamber 54b is formed in radially outer region of a rear housing 54 and that a suction chamber 54a is formed in radially inner region thereof. For convenience of explanation, the drawings for the second embodiment use like reference numerals or symbols to denote like parts or elements of the first embodiment. Explanation of those parts which are common to the first and second embodiments is omitted, and the explanation of the first embodiment is incorporated in the second preferred embodiment. Therefore, the following description will deal with mainly the differences from the first preferred embodiment.

[0027] As shown in FIGS. 3 and 4, the cylinder block 12 is joined at the rear end thereof to the front end of the rear housing 54 with a suction valve plate 53, a discharge valve plate 56 and a valve port plate 55 interposed therebetween. The suction valve plate 53 is located on the front side of the valve port plate 55 and the discharge valve plate 56 is located on the opposite rear side thereof. In the radially outer region of the rear housing 54, the discharge chamber 54b is annularly formed. An annular thermal insulating member 57 which forms a discharge space 57a is disposed in the discharge chamber 54b. In the radially inner region of the rear housing 54, a suction chamber 54a is formed. The valve port plate 55 has a suction port 55a corresponding to the suction chamber 54a and a discharge port 55b that serves as a valve port through the valve port plate 55. The discharge port 55b corresponds to the discharge space 57a formed by the thermal insulating member 57. The suction valve plate 53 which forms a suction valve is interposed between the suction port 55a of the valve port plate 55 and the working chamber 31. The discharge valve plate 56 formed annularly and having a discharge valve 56a is interposed between the discharge port 55b of the valve port plate 55 and the discharge space 57a. The discharge valve 56a of the discharge valve plate 56 extends from an annular proximal end 561 of the discharge valve plate 56 toward the center of the discharge valve plate 56. The discharge valve 56a is formed at a position corresponding to the discharge port 55b.

[0028] The thermal insulating member 57 will now be described in detail. As shown in FIG. 4, the thermal insulating member 57 of the second preferred embodiment is made in the form of a gear and has a through hole 57e formed in the central region of the thermal insulating member 57. FIG. 4 shows a front view of the thermal insulating member 57 which is seen from the discharge valve plate 56 (drawing on the left). FIG. 4 also shows a longitudinal-sectional view of the thermal insulating member 57 (drawing on the right). The valve port plate 55 and the discharge valve plate 56 are illustrated by solid line and chain line. A communication groove 57c is formed in the outer peripheral portion of the thermal insulating member 57 along the outline of the gear-like shape thereof. In the present embodiment, the communication groove 57c substantially corresponds to the discharge space 57a. An opening restricting portion 57b of a bell-like shape is formed so as to be surrounded on three sides thereof by the communication groove 57c. The discharge valve 56a is formed so as to face the opening restricting portion 57b. Because the opening restricting portion 57b has an arched surface in cross section, the discharge valve 56a is opened along the arched surface in its maximum opening position. Thus, the discharge valve 56a is not opened in excess of its elastic limit and the discharge valve 56a is not susceptible to excess deformation or break.

[0029] In FIGS. 3 and 4, the rear housing 54 also serves as an urging member to urge the thermal insulating member 57 toward the discharge valve plate 56 through the bolts 16, thereby pressing the thermal insulating member 57 against the discharge valve plate 56. Thus, the proximal end 561 of the discharge valve 56a is held securely by the thermal insulating member 57 and the valve port plate 55. Therefore, the discharge valve plate 56 makes steady opening and closing motion without irregular motion when the discharge valve

56a is in its maximum opening degree. One of the communication grooves 57c of the thermal insulating member 57 has an outlet 57d which is in communication with a discharge piping (not shown). The outlet 57d is formed on the one communication groove 57c. The compressible fluid in the communication groove 57c that serves as the discharge space 57a is discharged to the discharge piping through the outlet 57d. As in the first preferred embodiment, a portion of the thermal insulating member 57 which is contacted with the proximal end 561 of the discharge valve 56a, that is, a contacted portion 571 is formed in the thermal insulating member 57. In the present preferred embodiment, the contacted portion 571 is shown by latticed regions in FIG. 4.

[0030] According to the compressor 50 of the present preferred embodiment, when the piston 29 moves from its bottom dead center to its top dead center, the compressible fluid in the working chamber 31 is compressed to a predetermined pressure and then discharged into the discharge space 57a through the discharge valve 56a. Although the compressible fluid in the discharge space 57a is then high in temperature and pressure, the heat transfer of the compressible fluid to the rear housing 54 including the suction chamber 54a is prevented by the thermal insulating member 57, thereby preventing temperature rise of the low-pressure compressible fluid in the suction chamber 54a. During the operation of the compressor 50, the discharge valve 56a is not opened or bent in excess of its elastic limit by the contact with the opening restricting portion 57b of the thermal insulating member 57. The compressible fluid discharged into the discharge space 57a of the thermal insulating member 57 is discharged from the outlet 57d to the discharge piping.

[0031] As is apparent to those skilled in the art, though the compressor 50 of the second embodiment differs from the compressor 10 of the first embodiment in that the suction chamber 54a is formed in radially inner region while the discharge space 57a is formed in radially outer region of the rear housing 54, the compressor 50 having the thermal insulating member 57 offers substantially the same effects as the compressor 10.

[0032] A compressor 60 according to a third preferred embodiment of the present invention will now be described with reference to FIG. 5. For convenience of explanation, the drawing for the third embodiment uses like reference numerals or symbols to denote like parts or elements of the first embodiment. Explanation of those parts which are common to the first and third embodiments is omitted, and the explanation of the first embodiment is incorporated in the third preferred embodiment. Therefore, the following description will deal with mainly the differences from the first preferred embodiment. Accordingly, FIG. 5 shows only those parts of the compressor 60 which are relevant to the third embodiment. The compressor 60 according to the third preferred embodiment has a suction chamber 64a which is formed in the radially outer region of a rear housing 64 and a discharge chamber 64b having a thermal insulating member 67 disposed therein is formed in the radially inner region of the rear housing 64. The suction chamber 64a and the discharge chamber 64b are separated from each other by a partition 64c. The cylinder block 12 is joined at the rear end thereof to the front end of the rear housing 64. Between the cylinder block 12 and the rear housing 64, a suction valve plate 63 which forms a suction valve, a valve port plate 65 which forms a discharge port 65b serving as a valve port and a discharge valve plate 66 which forms a discharge valve 66a are provided. The suction valve plate 63 is located on the front side of the valve port plate 65 and the discharge valve plate 66 is located on the rear side thereof. In the present preferred embodiment, a bolt 68 extends through the center of the valve port plate 65 and the valve plates 63, 66, and a nut 69 is screwed on the bolt 68 thereby fastening the valve plates 63, 66 to the valve port plate 65.

[0033] Meanwhile, the thermal insulating member 67, which is disposed in the discharge chamber 64b of the rear housing 64, has a discharge space 67a, an opening restricting portion 67b, a recess 67c, a communication groove 67d and an outlet 67e, as in the case of the first embodiment. In the present preferred embodiment, a thermal insulating groove 67f is further formed in the thermal insulating member 67 on the radially outer side of the communication groove 67d. The thermal insulating groove 67f serves an air space in the thermal insulating member 67 for thermal insulation, and the thermal insulating effect of the air space further enhances the prevention effect of the heat transfer of the compressible fluid in the discharge space 67a to the rear housing 64 including the suction chamber 64a. That is, it can be said that the air space which serves as thermal insulating means having a heat transfer coefficient that is smaller than that of the thermal insulating member 67 is provided in the thermal insulating member 67. Thus, while the present preferred embodiment employs the thermal insulating groove 67f as the air space, a material whose heat transfer coefficient is smaller than that of the thermal insulating member 67 is suitably selected.

[0034] In the present preferred embodiment wherein the rear housing 64 is fastened to the cylinder block 12 by axial force of the through bolts 16 and presses the thermal insulating member 67 against the valve port plate 65, the through bolts 16 substantially serves as the urging member. The thermal insulating member 67 has a recess 67g which is opened on the front side of thermal insulating member 67. The recess 67g is formed in the central region of the thermal insulating member 67, and accommodates therein the bolt 68 and the nut 69. In the present embodiment, the air space serving as the thermal insulating means whose heat transfer coefficient is smaller than that of the thermal insulating member 67 is provided in the thermal insulating member 67, thereby further enhancing the prevention effect of the heat transfer of the compressible fluid in the discharge space 67a to the suction chamber 64a.

[0035] A compressor 70 according to a fourth preferred embodiment of the present invention will now be described with reference to FIG. 6. For convenience of explanation, the drawing for the fourth embodiment uses like reference numerals or symbols to denote like parts or elements of the first embodiment. Explanation of those parts which are common to the first and fourth embodiments is omitted, and the explanation of the first embodiment is incorporated in the fourth preferred embodiment. Therefore, the following description will deal with mainly the differences from the first preferred embodiment. Accordingly, FIG. 6 shows only those parts of the compressor 70 which are relevant to the fourth embodiment. The compressor 70 according to the fourth preferred embodiment has a suction chamber 74a which is formed in the radially outer region of a rear housing 74 and a discharge chamber 74b accommodating a thermal insulating member 77 disposed therein is formed in the radially inner region of the rear housing 74. The suction chamber 74a and the discharge chamber 74b are separated from each other by a partition 74c. The cylinder block 12 is joined at the rear end thereof to the front end of the rear housing 74. A suction valve plate 73 which forms a suction valve, a valve port plate 75 which forms a discharge port 75b serving as a valve port, a discharge valve plate 76 which forms a discharge valve 76a and a plate 78 for pressing against the discharge valve plate 76 are provided in this order between the cylinder block 12 and the rear housing 74.

[0036] In the present preferred embodiment, a bolt 79 extends through the center of the valve port plate 75, the valve plates 73, 76 and the plate 78. A nut 80 is screwed on the bolt 79 thereby fastening the discharge valve plate 76 to the valve port plate 75. A disc spring 81, through which the bolt 79 extends, is interposed between the plate 78 and the nut 80. The disc spring 81 urges the plate 78 against the discharge valve plate 76, and serves as the urging means.

[0037] Meanwhile, the thermal insulating member 77, which is disposed in the discharge chamber 74b of the rear housing 74, has a discharge space 77a, an opening restricting portion 77b, a recess 77c, a communication groove 77d and an outlet 77e, as in the case of the first embodiment. While the thermal insulating member 77 according to the present preferred embodiment is pressed against the plate 78, the thermal insulating member 77 does not directly press against a proximal end 761 of the discharge valve 76a of the discharge valve plate 76. That is, the proximal end 761 of the discharge valve 76a is mainly pressed by the plate 78 which receives elastic force of the disc spring 81, and a part of the thermal insulating member 77 is merely contacted with the plate 78. Therefore, the contact between the thermal insulating member 77 and the plate 78 may be in such condition that fluid tightness of the discharge space 77a is accomplished by providing an adhesive or sealing member between the thermal insulating member 77 and the plate 78. Thus, the contacted portions 371, 571 which have been explained with reference to the first and second preferred embodiments do not exist in the thermal insulating member 77 of the fourth preferred embodiment.

[0038] In the present preferred embodiment, the opening restricting portion 77b of the thermal insulating member 77 has an arched surface, with which part of the discharge valve 36a is contacted, in cross section. Although the area of the opening restricting portion 77b with which the discharge valve 76a is contacted is smaller than that of the opening restricting portion 37b of the first preferred embodiment due to the thickness of the plate 78 interposed between the discharge valve plate 76 and the thermal insulating member 77, the opening restricting portion 77b of the thermal insulating member 77 performs the function of restricting the maximum opening degree of the discharge valve 76a substantially in the same manner as the opening restricting portion 37b. According to the compressor 70 of the present preferred embodiment, while the thermal insulating member 77 prevents the heat transfer of the compressible fluid in the discharge space 77a to the rear housing 74 including the suction chamber 74a, the thermal insulating member 77 restricts the maximum opening degree of the discharge valve 76a. In addition, since the thermal insulating member 77 does not need to be directly pressed against the discharge valve plate 76, the degree of freedom of selecting material of the thermal insulating member 77, for example, its strength is improved.

[0039] While the foregoing descriptions for the first through fourth embodiments has dealt with the swash plate type compressor provided with pistons, the present invention is also applicable to a scroll type compressor. Although not shown, the scroll type compressor generally includes a working chamber which is formed by a fixed scroll and a movable scroll, a suction chamber from which a low-pressure fluid is introduced into the working chamber, a discharge chamber into which a high-pressure fluid compressed in the working chamber is discharged, a discharge valve interposed between the working chamber and the discharge chamber and a retainer which restricts the maximum opening degree of the discharge valve. By providing a thermal insulating member in which a discharge space and an opening restricting portion for restricting the opening degree of the discharge valve are formed in the discharge chamber of the scroll type compressor, the thermal insulating member can perform the function of preventing the heat transfer from the discharge space to a housing including the suction chamber and also retaining the discharge valve opening.

[0040] The present invention is not limited to the above-mentioned first through fourth embodiments, but may be modified within the scope of the appended claims, as exemplified below.

[0041] While the first through fourth embodiments have been described by way of an example of variable displacement swash plate type compressor, the present invention is applicable to a fixed displacement swash plate type compressor. At least if the compressor is constructed such that its suction chamber and discharge chamber are located relatively adjacent to each other and that a compressible fluid is discharged into the discharge chamber through a discharge valve, the present invention is applicable to the fixed displacement swash plate type compressor. Thus, types of compressor to which the present invention is applicable are not limited.

[0042] While the thermal insulating member according to the first through fourth embodiments is made of a resin material, the thermal insulating member may be made of any material whose heat transfer coefficient is smaller than that of a housing made of a metal such as aluminum-based or ferrous metal. Any other metals or inorganic materials whose heat transfer coefficient is small may be used.

[0043] In each of the first through fourth embodiments, because the thermal insulating member which serves also as a retainer has a discharge space therein, the discharge space prevents the heat transfer of the compressible fluid in the discharge chamber to the suction chamber, thereby improving the performance of the compressor. However, the suction chamber may be formed by another thermal insulating member. In this case, the heat transfer of the compressible fluid in the discharge chamber to the suction chamber is further prevented by the thermal insulating member of the suction chamber side and the thermal insulating member forming the discharge space, thereby improving the compression efficiency of the compressor. Thus, the performance of the compressor is further enhanced.

[0044] In each of the first through fourth embodiments, carbon dioxide which is compressed to a high pressure is employed as the compressible fluid. In the present invention, however, chlorofluorocarbon or Freon gas which is compressed to a pressure that is lower than that of carbon dioxide may be employed as the compressible fluid. Thus, kinds of compressible fluid to which the present invention is applicable are not limited.

[0045] Therefore, the present examples and embodiments are to be considered as illustrative and not restrictive and the invention is not to be limited to the details given herein but may be modified.

Claims

1. A compressor includes a suction chamber in which a low-pressure compressible fluid resides, a working chamber into which the low-pressure compressible fluid in the suction chamber is introduced and in which the compressible fluid is compressed to a predetermined pressure, a discharge chamber into which the compressed compressible fluid in the working chamber is discharged, and a discharge valve interposed between the working chamber and the discharge chamber, **characterized in that** a thermal insulating member is disposed in the discharge chamber, and **in that** the thermal insulating member has an opening restricting portion for restricting the maximum opening degree of the discharge valve.

2. The compressor according to claim 1, further comprising an urging member for pressing the thermal insulating member against the discharge valve.

3. The compressor according to claim 1 or 2, wherein heat transfer coefficient of the thermal insulating member is smaller than that of a housing which forms an outer shell of the compressor.

4. The compressor according to claim 2, wherein the urging member is a spring.

5. The compressor according to claim 2, wherein the urging member is a housing which forms an outer shell of the compressor.

6. The compressor according to any one of claims 1 through 3, further comprising a plate for pressing the discharge valve to a valve port plate.

7. The compressor according to any one of claims 1 through 5, wherein the thermal insulating member has a contacted portion which is contacted with a proximal end of the discharge valve.

8. The compressor according to any one of claims 1 through 7, wherein the thermal insulating member has a substantially disk-like shape.

9. The compressor according to any one of claims 1 through 7, wherein the thermal insulating member has an annular shape.

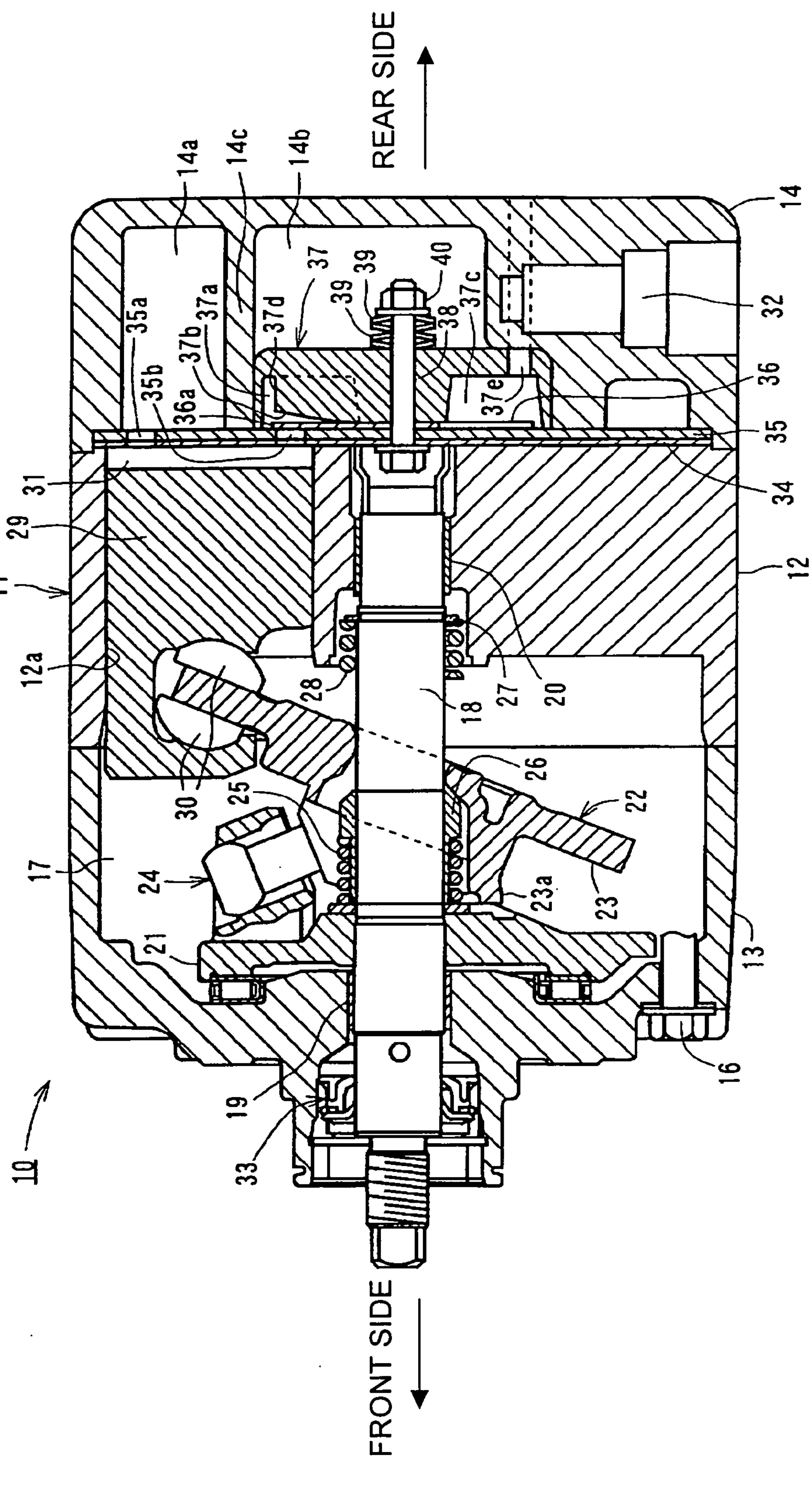
10. The compressor according to claim 9, wherein the thermal insulating member has a gear-like shape.

11. The compressor according to any one of claims 1 through 10, wherein the thermal insulating member is made of a resin material.

12. The compressor according to any one of claims 1 through 11, wherein the opening restricting portion has an arched surface in cross section.

13. The compressor according to any one of claims 1 through 12, wherein the compressible fluid is a carbon dioxide.

FIG. 1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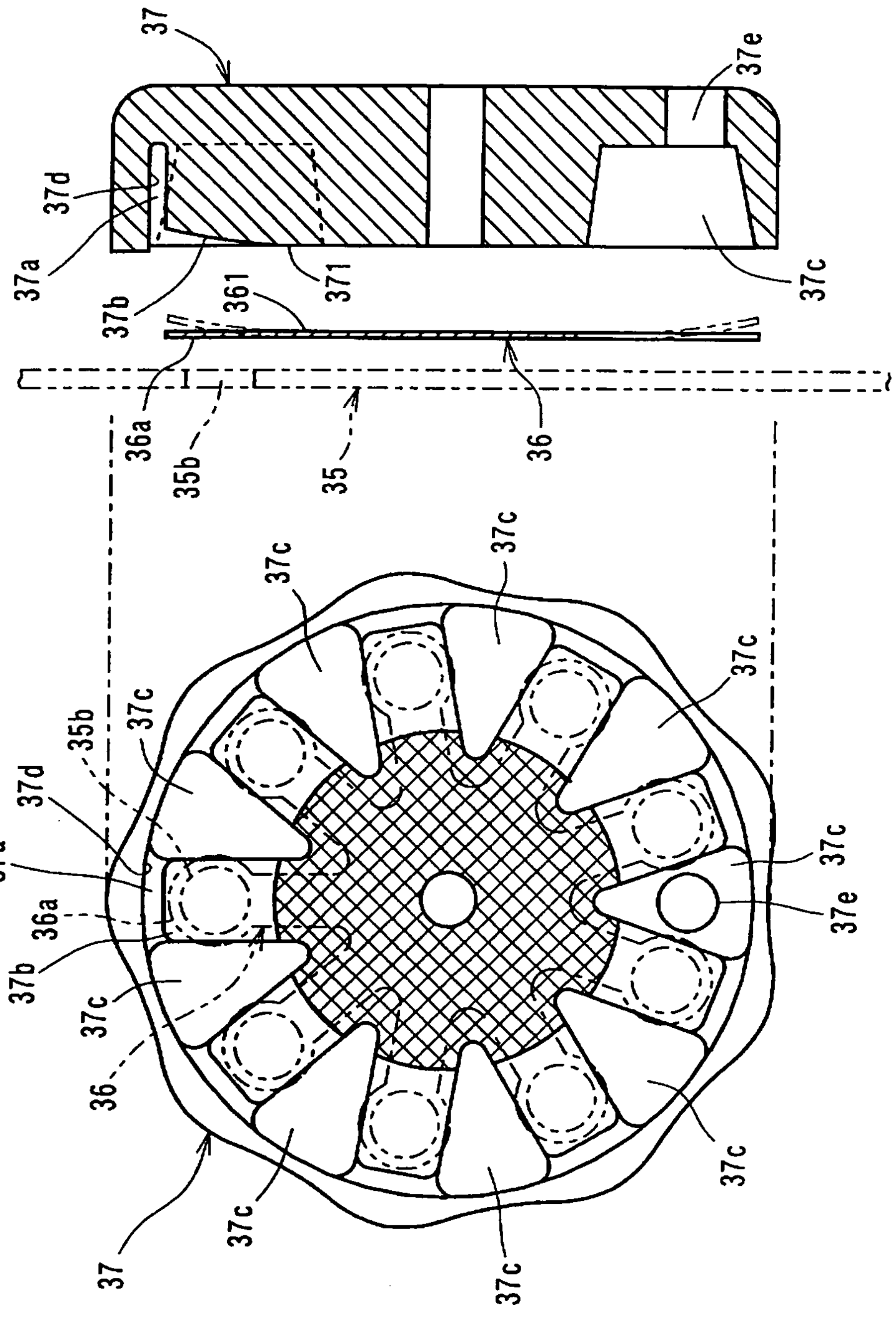

FIG. 2

FIG. 3

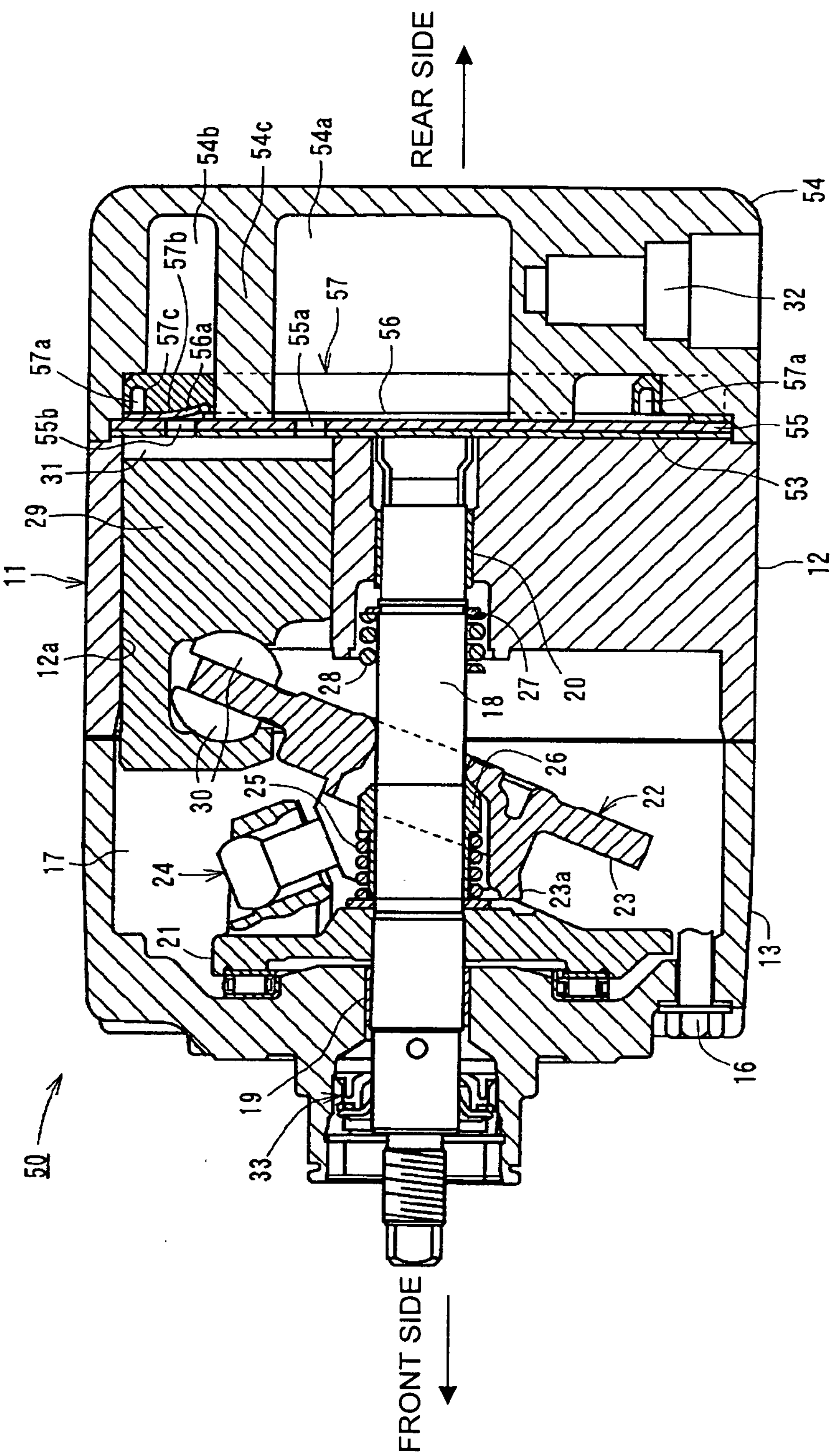
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FIG. 4

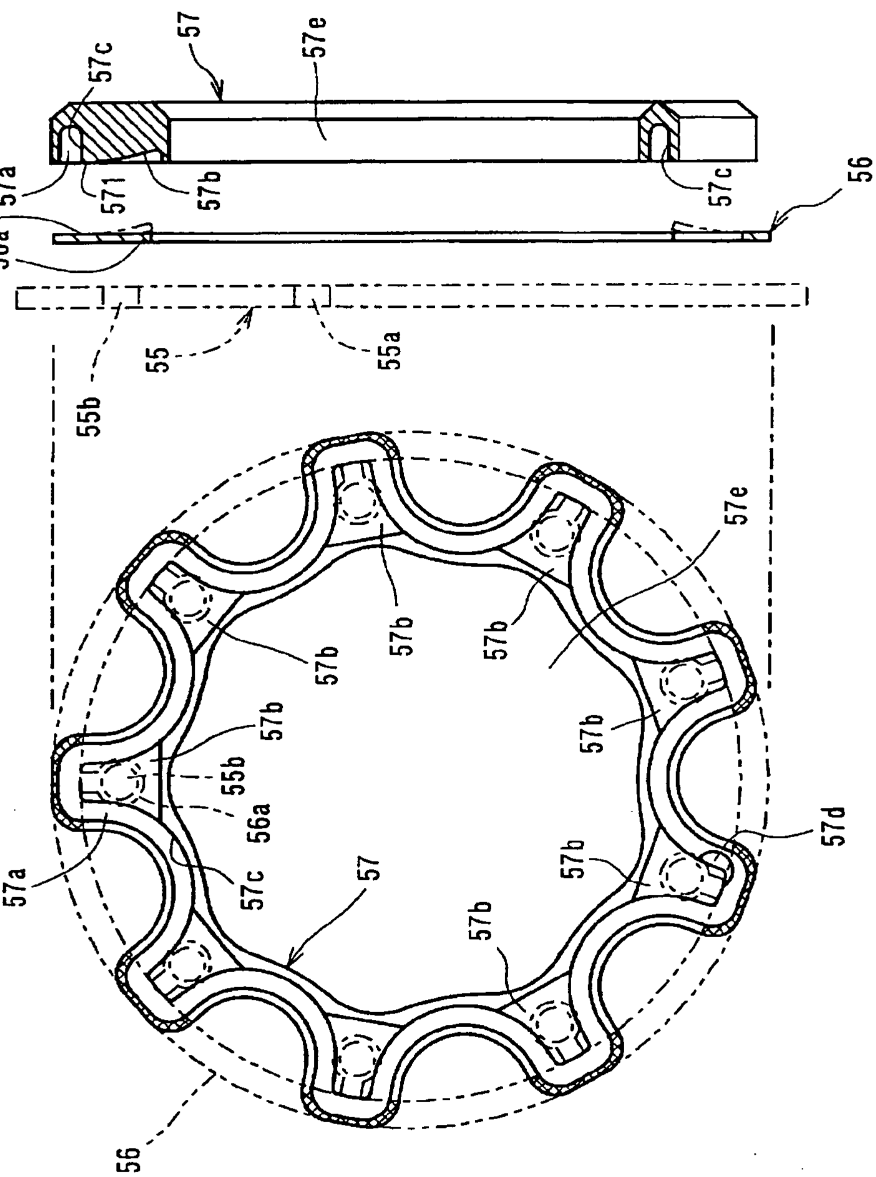
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FIG. 5

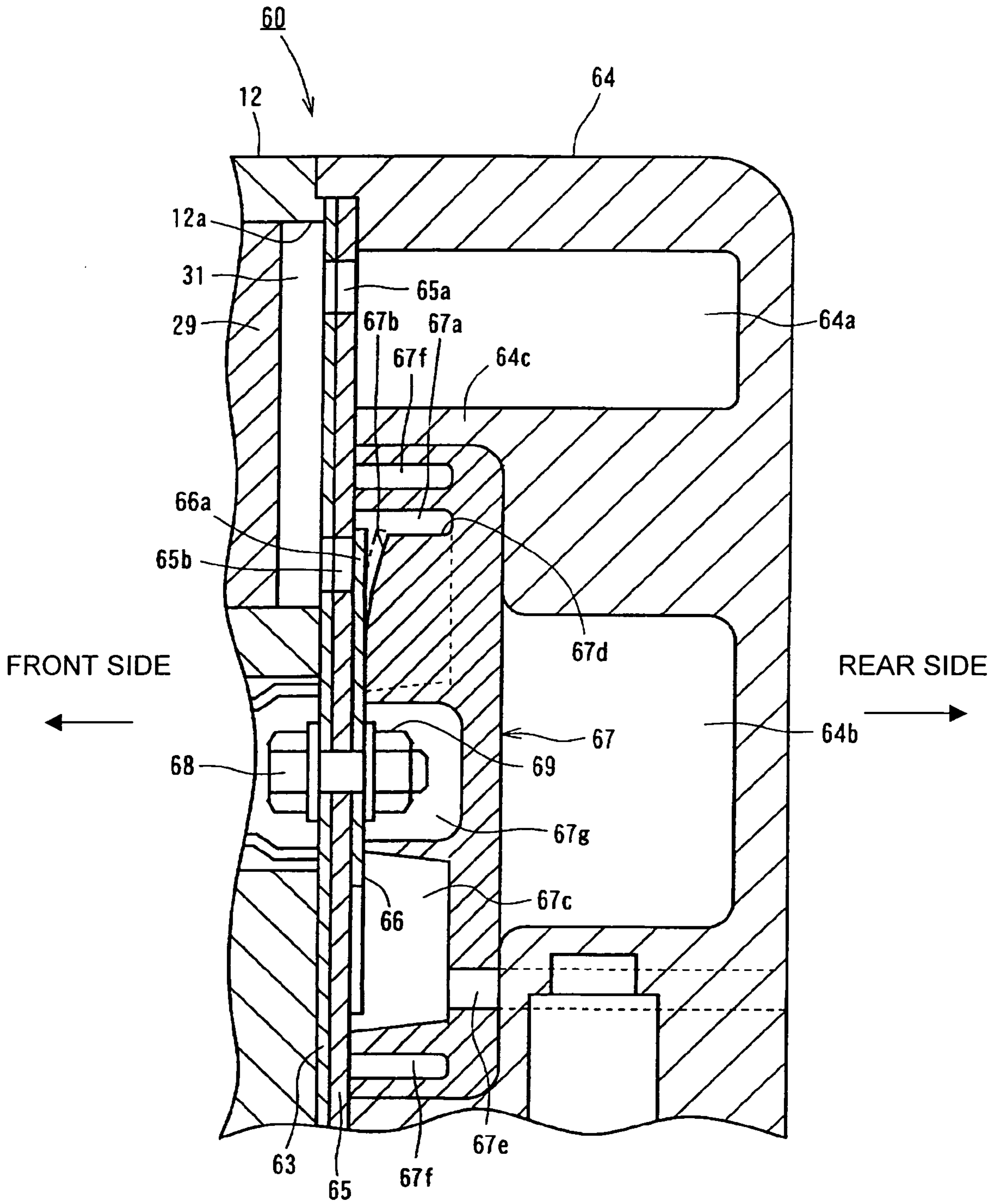
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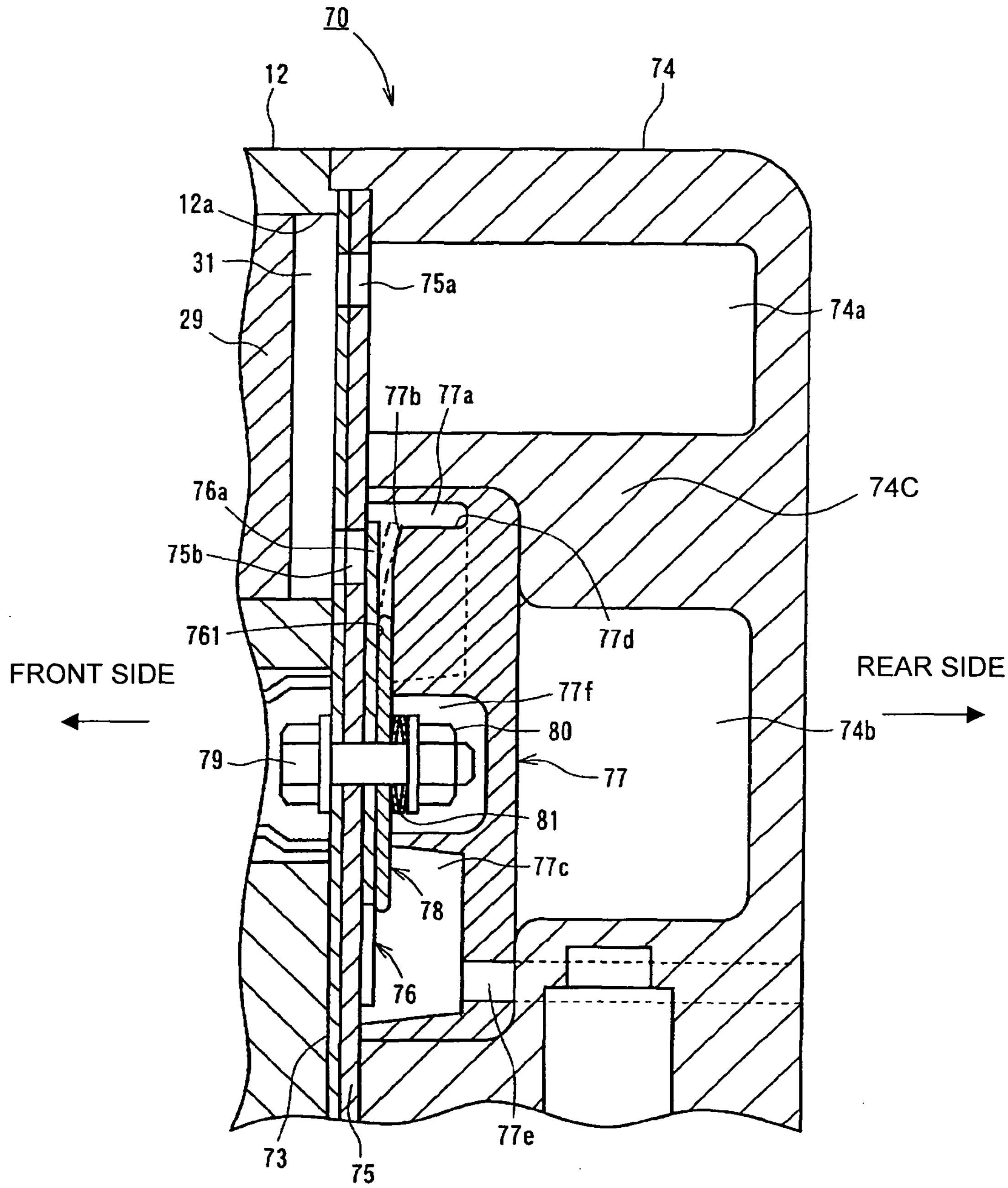
FIG. 6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