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(54) **Piston compressor**

(57) A piston compressor in which carbon dioxide is used as a refrigerant is provided. The compressor includes a cylinder block, reciprocating pistons, a valve plate, a housing member, and sealing members. The cylinder block has an end face and a plurality of cylinder bores. The pistons are housed in the individual cylinder bores. The valve plate has a plurality of discharge ports. The housing member is fixed to the end face of the cylinder block with the valve plate in between. The housing member has a partition wall. The housing member and

the valve plate define a suction chamber and a discharge chamber. The discharge chamber is connected to the cylinder bores through the corresponding discharge ports. The suction chamber and the discharge chamber are partitioned by the partition wall. The sealing members each are interposed between the valve plate and the cylinder block, and between the valve plate and the housing. A value of a ratio of the thickness of the valve plate relative to a diameter of each cylinder bore is between 0.13 and 0.4, inclusive.

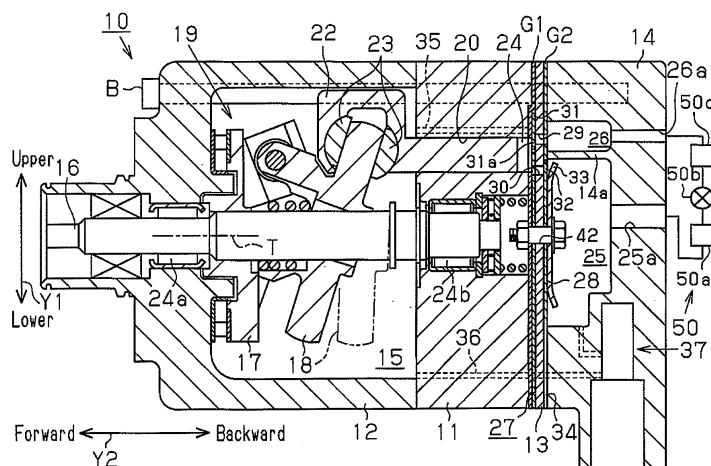


Fig.1

Description

[0001] The present invention relates to a piston compressor in which sealing members are interposed between a valve plate and a cylinder block, and between a valve plate and a housing member.

[0002] In general, in a piston compressor configuring a refrigeration circuit of a vehicle air conditioner device, an entire housing includes: a cylinder block; a front housing member fixed on a front end face of the cylinder block; and a rear housing member fixed onto a rear end face of the cylinder block with a valve plate in between. In addition, the entire housing is integrated by tightening and fixing the front housing member, the cylinder block, the valve plate, and the rear housing member to one another by means of a plurality of through bolts. In the cylinder block, a plurality of cylinder bores are arranged around a shaft, and a piston is housed so as to be able to reciprocate in each cylinder bore. Moreover, in each cylinder bore, a compression chamber, whose volume is changed by a reciprocal movement of the piston, is defined. Compression of a refrigerant gas is carried out within the compression chamber.

[0003] A partition wall is formed in the rear housing member to define a discharge chamber and a suction chamber between the valve plate and the rear housing member. The valve plate has discharge ports and suction ports. The discharge ports each connect one of the cylinder bores with the discharge chamber. The suction ports each connect one of the cylinder bores with the suction chamber. The partition wall is arranged at positions that correspond to cylinder bores so as to enable each chamber to communicate with the cylinder bores, while at the same time, preventing communication between the discharge chamber and the suction chamber.

[0004] In the piston compressor, gaskets that serve as sealing members are interposed between a rear end face of the cylinder block and a front face of the valve plate. The gaskets inhibit leakage of the refrigerant from between a valve plate and a member adjacent to the valve plate.

[0005] In recent years, from the viewpoint of environmental issues, as the refrigerant used in the refrigeration circuit, carbon dioxide has been preferred to chlorofluorocarbon. In circumstances in which carbon dioxide is used, a discharge pressure is at a much higher level than a suction pressure, and then, in contrast to cases in which chlorofluorocarbon is used, the difference in pressure between the discharge chamber and the suction chamber increases. Thus, in cases in which carbon dioxide is used, in the piston compressor, the inhibition of the leakage of the refrigerant from a discharge chamber to a suction chamber by means of the gasket is required to be highly effectively.

[0006] On the other hand, in the piston compressor, in order for the valve plate to bear a compression reaction force of the compression chamber, a predetermined degree of rigidity is required. Moreover, it has been dis-

closed in the Prior Art section of Japanese Laid-Open Patent Publication No. 9-4563 that, by increasing the thickness of the valve plate, the degree of rigidity of the valve plate can be reinforced in such a way that, even if the valve plate is subjected to a compression reaction force, the valve plate is not easily deformed. A diameter of a cylinder bore of a general piston compressor which uses chlorofluorocarbon as a refrigerant is about 30mm. A thickness of a valve plate of the general compressor is about 2mm.

[0007] A graph of FIG. 4 illustrates the thickness of a valve plate on the horizontal axis and an extent of the leakage of a refrigerant from the discharge chamber to the suction chamber in the piston compressor (or dead volume) on the vertical axis. The performance of the piston compressor is expressed in accordance with a balance between the extent of the leakage of the refrigerant and the dead volume from the discharge chamber to the suction chamber. The dead volume depends on the size of a volume of a discharge port, i.e., a volume in a region in which the gas is not compressed. In the graph of FIG. 4, as the value on the vertical axis approaches zero, the extent of the leakage of the refrigerant is reduced, and the dead volume is reduced. This demonstrates that the performance of the piston compressor is enhanced. On the other hand, in the graph of FIG. 4, as a value on the vertical axis moves away from zero, the extent of the leakage of the refrigerant increases, and the dead volume increases. This demonstrates that the performance of the piston compressor is diminished.

[0008] In the graph of FIG. 4, a curve K1 is a curve that represents an extent of the leakage of a refrigerant in the piston compressor in a case where carbon dioxide is used as a refrigerant in the refrigeration circuit; and a curve K2 is a curve that represents an extent of the leakage of a refrigerant in the piston compressor in a case where chlorofluorocarbon is used as a refrigerant. As can be evidenced by curve K1 and curve K2 in FIG. 4, in a case where valve plates of an identical thickness are used, a larger extent of the leakage of the refrigerant occurs in cases where carbon dioxide is used as the refrigerant. It is demonstrated that in the case of both of the refrigerants, as the thickness of a valve plate increases, the extent of the leakage of the refrigerant decreases, and the performance of the piston compressors is enhanced.

[0009] A straight line M is a straight line that represents the size of a dead volume. As demonstrated by the straight line M, as the thickness of the valve plate increases, a route length of the discharge port increases. In this manner, the volume of the discharge port increases, and the dead volume increases. In other words, in the graph of FIG. 4, it is demonstrated that, as the thickness of a valve plate increases, the volume efficiency of the piston compressor diminishes, and the performance of the piston compressor is diminished.

[0010] As described above, in a case where carbon dioxide is used as a refrigerant, it is essential that the leakage of the refrigerant from the discharge chamber to

the suction chamber be effectively inhibited. Thus, consideration has been given to intensifying a tightening force by means of the through bolts, thereby enhancing a sealing force while increasing a pressure contacting force of the gasket relative to the cylinder block, the valve plate, and the rear housing member. When the pressure contacting force is intensified, the rear housing member is brought into close pressure contact with the gasket and the valve plate. At this time, regions of the valve plate compressed by the partition wall of the rear housing member may be deformed into the cylinder bores. If the valve plate is deformed, a pressure contacting state of the cylinder block and the valve plate relative to the gasket is degraded at a peripheral edge of each cylinder bore, whose edge supports the valve plate. As a result, the degree of sealing force between the cylinder block and the valve plate is reduced, and such a situation is not desirable.

[0011] Therefore, as described in Japanese Laid-Open Patent Publication No. 9-4563, consideration has been given to increasing the thickness of a valve plate, and then, enhancing the level of rigidity of the valve plate, thereby preventing deformation of the valve plate that results from an increase in the compression force, and enhancing the sealing force created by the gasket. However, as demonstrated by the straight line M of FIG. 4, increasing the thickness of the valve plate results in an increase in dead volume and thus reduces the volume efficiency of the compressor.

[0012] It is an objective of the present invention to provide a piston compressor that is capable of preventing a reduction in volume efficiency while inhibiting leakage of the refrigerant.

[0013] In accordance with one aspect of the present invention, a piston compressor in which carbon dioxide is used as a refrigerant is provided. The compressor includes a cylinder block, reciprocating pistons, a valve plate, a housing member, and sealing members. The cylinder block has an end face and a plurality of cylinder bores. The pistons are housed in the individual cylinder bores. The valve plate has a plurality of discharge ports. The housing member is fixed to the end face of the cylinder block with the valve plate in between. The housing member has a partition wall. The housing member and the valve plate define a suction chamber and a discharge chamber. The discharge chamber is connected to the cylinder bores through the corresponding discharge ports. The suction chamber and the discharge chamber are partitioned by the partition wall. The sealing members each are interposed between the valve plate and the cylinder block, and between the valve plate and the housing. A value of a ratio of the thickness of the valve plate relative to a diameter of each cylinder bore is between 0.13 and 0.4, inclusive.

[0014] Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings that illustrate by way of example the principles of the inven-

tion.

[0015] The invention, together with the objects and the advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments, together with the accompanying drawings in which:

FIG. 1 is a longitudinal cross-sectional view illustrating a piston compressor according to an embodiment;

FIG. 2 is a partially enlarged cross-sectional view illustrating the vicinity of a valve plate and a cylinder bore;

FIG. 3 is a graph depicting a relationship between the performance of the piston compressor and the value of a ratio in thickness of a valve plate relative to a diameter of a cylinder bore; and

FIG. 4 is a graph depicting a relationship between the performance of the piston compressor and the thickness of the valve plate.

[0016] The present invention will now be described with reference to FIG. 1 to FIG. 3 and to an embodiment of a piston compressor for use in a refrigeration circuit in which carbon dioxide is used as a refrigerant. In the following description, with respect to the "upward" and "downward" directions of the piston compressor, the direction of arrow Y1 appearing in FIG. 1 is defined as a vertical direction, and the "frontward" and "rearward" directions of the piston compressor are each defined as a direction of arrow Y2.

[0017] As illustrated in FIG. 1, an entire housing of a piston compressor 10 includes: a cylinder block 11; a front housing member 12 fixed to a front end of the cylinder block 11; and a rear housing member 14 fixed to a rear end of the cylinder block 11 by way of a valve plate 13. As illustrated in FIG. 2, a first gasket G1 that serves as a sealing member is interposed between a rear end face of the cylinder block 11 and a front face of the valve plate 13. The first gasket G1 inhibits the leakage of the refrigerant between the cylinder block 11 and the valve plate 13. In addition, a second gasket G2 that also serves as a sealing member is interposed between a rear face of the valve plate 13 and a front end face of a rear housing member 14. The second gasket G2 inhibits the leakage of the refrigerant between the valve plate 13 and the rear housing member 14. As illustrated in FIG. 1, a front housing member 12, the cylinder block 11, the first gasket G1, the valve plate 13, the second gasket G2, and the rear housing member 14 are fastened to one another by means of a plurality of through bolts (only one through bolt B is shown in FIG. 1).

[0018] In the entire housing, a crank chamber 15 is defined between the cylinder block 11 and the front housing member 12. In addition, a drive shaft 16 is rotatably supported in the cylinder block 11 and the front housing member 12 by way of radial bearings 24a and 24b. The drive shaft 16 is coupled to an engine (not shown) that

serves as a running drive source of a vehicle through a clutchless type power transmission mechanism (not shown), which constantly transmits power. Therefore, while the engine is in operation, the drive shaft 16 receives the power from the engine, and is constantly rotated.

[0019] In the crank chamber 15, a rotor 17 is integrally and rotatably fixed to the drive shaft 16. A disk-shaped swash plate 18 is housed in the crank chamber 15. The drive shaft 16 is inserted through a center part of the swash plate 18, and the swash plate 18 is supported to be integrally rotatable with and slidably inclinable on the drive shaft 16. In detail, a hinge mechanism 19 is interposed between the rotor 17 and the swash plate 18. The swash plate 18 is rotatable synchronously with the drive shaft 16 and the rotor 17 by hinge coupling by way of the hinge mechanism 19, and by the support of the drive shaft 16. In addition, this swash plate 18 is inclinable relative to the drive shaft 16 together with a slide movement in an axial direction (in a center axis T direction) of the drive shaft 16.

[0020] In the cylinder block 11, around the center axis T of the drive shaft 16, a plurality of cylinder bores 20 are disposed at equal angular intervals. Each cylinder bore 20 is formed in a circular hole shape in a cross section as viewed relative to the center axis T of the drive shaft 16, and extended through the inside of the cylinder block 11 in lengthwise directions. The diameter of each cylinder bore 20 is defined as L (refer to FIG. 2). A single-head piston 22 is housed movably in a lengthwise direction in each cylinder bore 20. The lengthwise openings of the cylinder bore 20 are closed by means of a front face of the valve plate 13 and a rear end of the corresponding piston 22. In each cylinder bore 20, a compression chamber 24, whose volume changes according to the movement of the piston 22 in a lengthwise direction, is defined. In this embodiment, a thickness of the valve plate 13 is 3.75mm. A diameter of the cylinder bore 20 is 15mm.

[0021] Each of such pistons 22 is engaged with an outer periphery of the swash plate 18 by way of a pair of shoes 23. Therefore, when the swash plate 18 is rotated by means of the rotation of the drive shaft 16, the swash plate 18 is wobbled in the center axis T direction of the drive shaft 16. By the wobble movement of the swash plate 18, the piston 22 linearly reciprocates in the lengthwise direction.

[0022] A partition wall 14a is formed in the rear housing member 14. The partition wall 14a is formed in a cylindrical shape, and is opened toward the valve plate 13. A front end face of the partition wall 14a is brought into contact with the second gasket G2 at a position that is opposed to each cylinder bore 20. Then, at the rear housing member 14, a discharge chamber 25 is defined between an inside region of the partition wall 14a and the valve plate 13. In addition, in the rear housing member 14, along the entire periphery that is further outside than the partition wall 14a, a suction chamber 26 is defined so as to surround the entire periphery of the discharge

chamber 25.

[0023] At the rear housing member 14, an outlet 25a that communicates with the discharge chamber 25 is formed, and an inlet 26a that communicates with the suction chamber 26 is formed. The outlet 25a and the inlet 26a are connected to each other by means of an external refrigerant circuit 50. In other words, a high-pressure refrigerant discharged into the discharge chamber 25 is guided to the external refrigerant circuit 50 through the outlet 25a. The guided refrigerant is cooled by means of a condenser 50a. The cooled gas is depressurized by means of an expansion valve 50b, and the depressurized refrigerant is then sent to an evaporator 50c, and evaporated. The condenser 50a, the expansion valve 50b, and the evaporator 50c configure the external circuit 50. Then, the evaporated refrigerant from the evaporator 50c is drawn into the suction chamber 26 by way of the inlet 26a. The piston compressor 10 according to the present embodiment configures a refrigeration circuit together with the external refrigerant circuit 50.

[0024] As shown in FIG. 2, a valve plate 13 has suction ports 29 and discharge ports 30 at positions opposed to each cylinder bore 20. Each suction port 29 extends in a lengthwise direction in a position of the valve plate 13 that is radially outside of the partition wall 14a. Each discharge port 30 extends in a lengthwise direction in a position of the valve plate 13 that is radially inside of the partition wall 14a. In addition, the first gasket G1 is interposed between the rear end face of the cylinder block 11 and the front face of the valve plate 13, and a suction valve plate 31 is interposed between a rear face of the first gasket G1 and the front face of the valve plate 13. The suction valve plate 31 has suction valves 31a for opening and closing the suction ports 29 at positions corresponding to the suction ports 29.

[0025] The second gasket G2 is interposed between the front end face of the rear housing member 14 and the rear face of the valve plate 13. An outer periphery of the second gasket G2 is sandwiched between the outer periphery of the front end face of the rear housing member 14 and the outer periphery of the rear face of the valve plate 13. The inner periphery of the second gasket G2 is sandwiched between the front end face of a partition wall 14a of the rear housing member 14 and the inner periphery of the rear face of the valve plate 13. In addition, a discharge valve plate 28 formed integrally with the second gasket G2 is interposed between the inner periphery of the front end face of the rear housing member 14 and the inner periphery of the rear face of the valve plate 13. The discharge valve plate 28 has discharge valves 32 for opening and closing the discharge ports 30 at positions corresponding to the discharge ports 30. Each discharge valve 32 is restrained regarding an opening degree of the discharge valve 32 by a retainer 33 fixed to the valve plate 13.

[0026] As shown in FIG. 1, a bleed passage 35, a supply passage 36 and a control valve 37 are provided within the entire housing of the piston compressor 10. The bleed

passage 35 connects the crank chamber 15 and the suction chamber 26 to one another. The supply passage 36 connects the discharge chamber 25 and the crank chamber 15 to one another. A known control valve 37 made up of a solenoid valve is arranged on the supply passage 36.

[0027] By means of the movement of each piston 22 from a top dead center to a bottom dead center with the rotation of the drive shaft 16, the refrigerant of the suction chamber 26 passes through the suction port 29, pushes and opens the suction valve 31a, and is drawn into a compression chamber 24 (suction stroke). Further, the refrigerant drawn into the compression chamber 24 is compressed up to a predetermined level of pressure by means of the movement of the piston 22 from the bottom dead center to the top dead center. Further, the compressed refrigerant passes through the discharge port 30, pushes and opens the discharge valve 32, and is discharged into the discharge chamber 25 (discharge stroke).

[0028] A balance between the amount of the compressed refrigerant entering the crank chamber 15 by way of the supply passage 36 and the amount of the refrigerant exiting the crank chamber 15 by way of the bleed passage 35 is controlled by adjusting a degree of opening of the control valve 37, and then, an internal pressure of the crank chamber 15 is determined. In accordance with changing in the internal pressure of the crank chamber 15, a pressure difference between the internal pressure of the crank chamber 15 and the internal pressure of the compression chamber 24 by means of the piston 22 can be varied. In this manner, an inclination angle of a swash plate 18 can be varied. As a result of the stroke of the pistons 22 being varied, the displacement of the piston compressor 10 is varied.

[0029] An explanation will next be given about the thickness D of the valve plate 13, and then advantages that can be secured by setting the thickness D of the valve plate 13.

[0030] As illustrated in FIG. 2, a thickness of the valve plate 13 in a lengthwise direction is defined as D. A value of the ratio of the thickness D of the valve plate 13 relative to a diameter L of the cylinder bore 20, i.e., D/L , is set within a range of 0.13 to 0.4. The value of the ratio denotes a value obtained by dividing the thickness D of the valve plate 13 by the diameter L of the cylinder bore 20. It is preferable that the value of the ratio be set within a range of 0.2 to 0.35, and it is particularly preferable that the value of the ratio be set within a range of 0.24 to 0.26. In the present embodiment, the value of the ratio is set to 0.25. A thickness of the valve plate used in a piston compressor, in which chlorofluorocarbon is used as a refrigerant of a refrigeration circuit, is less than thickness D of the valve plate 13 according to the present embodiment.

[0031] The graph of FIG. 3 illustrates the value of the ratio (D/L) on the horizontal axis and illustrates a performance of the piston compressor 10 on the vertical axis.

The horizontal axis in the graph of FIG. 3 demonstrates that, when the value of the ratio approaches zero, the thickness D of the valve plate 13 is reduced, and that, as the value moves away from zero in a case that the diameter L is constant, the thickness D of the valve plate 13 increases. In the vertical axis of the graph of FIG. 3, the performance of the piston compressor 10 is represented by the balance between the extent of the leakage of the refrigerant from the discharge chamber 25 to the suction chamber 26 of the piston compressor 10 and the size of the dead volume. In the graph of FIG. 3, when the value on the vertical axis approaches zero, the extent of refrigerant leakage increases and the dead volume increases. This indicates that the performance of the piston compressor 10 is diminished. On the other hand, if the value on the vertical axis moves away from zero, the extent of refrigerant leakage is reduced and the dead volume is reduced. This indicates that the performance of the piston compressor 10 is enhanced.

[0032] Furthermore, in the graph of FIG. 3, a curve C illustrates a relationship between the performance of the piston compressor 10 and the value of the above described ratio (D/L) in a case where carbon dioxide is used as the refrigerant. Further, on the vertical axis in the graph of FIG. 3, a point indicating the minimum performance required for the piston compressor 10 is defined as a point P. As shown in the graph of FIG. 3, the value of the ratio at a time when the performance is equal or higher than that at point P on the curve C is within the range of the values of the ratios in the piston compressor 10. In the piston compressor 10 according to the present embodiment, the range of the value of the ratio for indicating a minimally required performance is from 0.13 to 0.4.

[0033] When the value of the ratio is smaller than 0.13, i.e., when the thickness D of the valve plate 13 is reduced, the degree of rigidity of the valve plate 13 is reduced. As a result, in the piston compressor 10 in which carbon dioxide is used as the refrigerant, when the compression chamber 24 is subjected to a compression reaction force, the valve plate 13 is easily deformed. Such a situation is undesirable. Further, in order to inhibit the leakage of the refrigerant from the discharge chamber 25 to the suction chamber 26 of the piston compressor 10, when urging forces of the cylinder block 11 and the rear housing member 14 relative to the valve plate 13 is intensified by increasing a tightening axial force with the through bolt B, the valve plate 13 can be easily deformed. Such a situation is undesirable.

[0034] On the other hand, if the value of the ratio exceeds 0.4, i.e., when the thickness D of the valve plate 13 increases, the degree of rigidity of the valve plate 13 increases. However, the length of a passage of the discharge port 30 increases and the volume of the discharge port 30 increases. As a result, in the piston compressor 10, the volume, the degree of the volume efficiency diminishes. Such a situation is undesirable. As illustrated by the curve C of FIG. 3, by setting the value of the ratio within the range of 0.2 to 0.35, increases in a dead volume

is inhibited, and by inhibiting the degree of the leakage of the refrigerant, the performance of the piston compressor 10 is significantly enhanced. Moreover, if the value of the ratio is 0.25, the performance of the piston compressor 10 is maximized.

[0035] In contrast to a case in which chlorofluorocarbon is used as a refrigerant, in the case in which carbon dioxide is used as a refrigerant, the pressure at the discharge chamber 25 of the piston compressor 10 becomes much higher than that at the suction chamber 26. In consequence, a difference in pressure between both of these chambers 25 and 26 increases. Thus, in order to inhibit the leakage of the refrigerant from the discharge chamber 25 to the suction chamber 26 in the piston compressor 10, the tightening axial force with the through bolts B is set at a higher level than that of the piston compressor in which chlorofluorocarbon refrigerant is used.

[0036] However, in the valve plate 13 according to the present embodiment, the thickness D is formed so as to be greater than that of chlorofluorocarbon refrigerant piston compressor, and the degree of rigidity is enhanced. Thus, even if the tightening axial force by means of the through bolts B is high and the compression force of the cylinder block 11 and the rear housing member 14 relative to the valve plate 13 is high, deformation of the valve plate 13 is prevented. In the valve plate 13, a region in which a urging force caused by the front end face of the partition wall 14a acts through the second gasket G2 is a position opposite to the cylinder bore 20. Moreover, the urging force acting on the valve plate 13 is received on the peripheral edge of each cylinder bore 20 at the rear end face of the cylinder block 11. By taking into consideration the diameter L of each cylinder bore 20, the thickness D of the valve plate 13 is set.

[0037] In other words, the thickness D of the valve plate 13 is set such that the value of the ratio (D/L) relative to the diameter L of each cylinder bore 20 is within a range of 0.13 to 0.4. In consequence, as the diameter L of the cylinder bore 20 increases, the thickness D of the valve plate 13 increases and as the diameter L of the cylinder bore 20 decreases, the thickness D of the valve plate 13 also decreases. Therefore, for example, even when the diameter L of the cylinder bore 20 is too large, it is still possible to prevent the occurrence of a failure in which the valve plate 13 is easily deformed into the cylinder bore 20 as a result of urging force.

[0038] Even when the tightening axial force is intensified, deformation of the valve plate 13 is prevented. Thus, deformation of the first gasket G1 and the second gasket G2 that come into pressure contact with the valve plate 13 is also prevented. Therefore, the pressure contacting state of the valve plate 13 and the cylinder block 11 relative to the first gasket G1 is maintained, and the pressure contacting state of the valve plate 13 and the rear housing member 14 relative to the second gasket G2 is maintained. As a result, refrigerant is inhibited from leaking between the cylinder block 11 and the valve plate 13

by the first gasket G1. By the second gasket G2, refrigerant is inhibited from leaking from the discharge chamber 25 to the suction chamber 26 between the rear housing member 14 and the valve plate 13.

[0039] In addition, as the thickness D of the valve plate 13 increases, the length of passage of the discharge port 30 increases, the dead volume increases, and the degree of volume efficiency of the piston compressor 10 diminishes. However, with respect to the thickness D of the valve plate 13, not only does the thickness D simply increase but also the value of the ratio is set relative to the diameter L of the cylinder bore 20. Therefore, the thickness D of the valve plate 13 is prevented from becoming excessive, thereby preventing and the length of the discharge port 30, i.e., the dead volume from becoming greater than necessity.

[0040] According to the embodiment described above, the following advantages are obtained.

[0041] In the piston compressor 10 in which carbon dioxide is used as a refrigerant, the thickness D of the valve plate 13 is greater than that of the valve plate in a piston compressor in which chlorofluorocarbon is used as a refrigerant, and the degree of rigidity of the valve plate 13 is enhanced. At this time, instead of merely increasing the thickness D of the valve plate 13, the value of the ratio of the thickness D of the valve plate 13 relative to the diameter L of each cylinder bore 20 is set within the range of 0.13 to 0.4. Thus, in the piston compressor 10, because it is possible to highly effectively inhibit leakage of the refrigerant, the tightening axial force of the through bolts B that passes through the entire housing is intensified. Even if the partition wall 14a is strongly urged to the valve plate 13, the valve plate 13 that is subjected to the urging force is still prevented from being deformed into the cylinder bores 20. As a result, deformation of the valve plate 13, and of the first and second gaskets G1 and G2, is prevented, thereby making it possible to effectively inhibit leakage of the refrigerant from the discharge chamber 25 to the suction chamber 26.

[0042] Furthermore, if the thickness D is increased in order to enhance the degree of rigidity of the valve plate 13, the dead volume increases. However, the value of the ratio of the thickness D of the valve plate 13 relative to the diameter L of each cylinder bore 20 is set within the range of 0.13 to 0.4, and thus an upper limit of thickness D of the valve plate 13 is set. Therefore, an excessive increase in the dead volume is prevented. As a result, in the present embodiment, the degree of rigidity of the valve plate 13 is enhanced, thus making it possible to prevent a diminution in the volume efficiency caused by an increase in the dead volume, while preventing leakage of the refrigerant.

[0043] The present embodiment that has been described above may be changed as follows.

[0044] In a double-head piston compressor, the thickness D of a valve plates 13 arranged between the cylinder block 11 and a front housing member, and the thickness D of a valve plates 13 between the cylinder block 11 and

a rear housing member, may be set as in the illustrated embodiment.

[0045] In a piston compressor 10 in which a rotary valve is used as a refrigerant suction mechanism in stead of the suction port 29 and the suction valve 31a, the thickness D of the valve plate 13 that configures part of the suction mechanism may be set as in the illustrated embodiment.

[0046] 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 within the scope and equivalence of the claims appended.

[0047] A piston compressor in which carbon dioxide is used as a refrigerant is provided. The compressor includes a cylinder block, reciprocating pistons, a valve plate, a housing member, and sealing members. The cylinder block has an end face and a plurality of cylinder bores. The pistons are housed in the individual cylinder bores. The valve plate has a plurality of discharge ports. The housing member is fixed to the end face of the cylinder block with the valve plate in between. The housing member has a partition wall. The housing member and the valve plate define a suction chamber and a discharge chamber. The discharge chamber is connected to the cylinder bores through the corresponding discharge ports. The suction chamber and the discharge chamber are partitioned by the partition wall. The sealing members each are interposed between the valve plate and the cylinder block, and between the valve plate and the housing. A value of a ratio of the thickness of the valve plate relative to a diameter of each cylinder bore is between 0.13 and 0.4, inclusive.

Claims

1. A piston compressor (10) in which carbon dioxide is used as a refrigerant, the compressor (10) comprising:

a cylinder block (11) having an end face and a plurality of cylinder bores (20);
 reciprocating pistons (22) housed in the individual cylinder bores (20);
 a valve plate (13) having a plurality of discharge ports (30);
 a housing member (14) fixed to the end face of the cylinder block (11) with the valve plate (13) in between, the housing member (14) having a partition wall (14a), the housing member (14) and the valve plate (13) defining a suction chamber (26) and a discharge chamber (25) which is connected to the cylinder bores (20) through the corresponding discharge ports (30), and the suction chamber (26) and the discharge chamber (25) being partitioned by the partition wall (14a); and

sealing members each interposed between the valve plate (13) and the cylinder block (11), and between the valve plate (13) and the housing member (14), **characterized in that** a value of a ratio of the thickness of the valve plate (13) relative to a diameter of each cylinder bore (20) is between 0.13 and 0.4, inclusive.

2. The piston compressor (10) according to claim 1, **characterized in that** the value of the ratio is between 0.2 and 0.35, inclusive.
3. The piston compressor (10) according to claim 1 or 2, **characterized in that** the sealing members are gaskets (G1, G2).

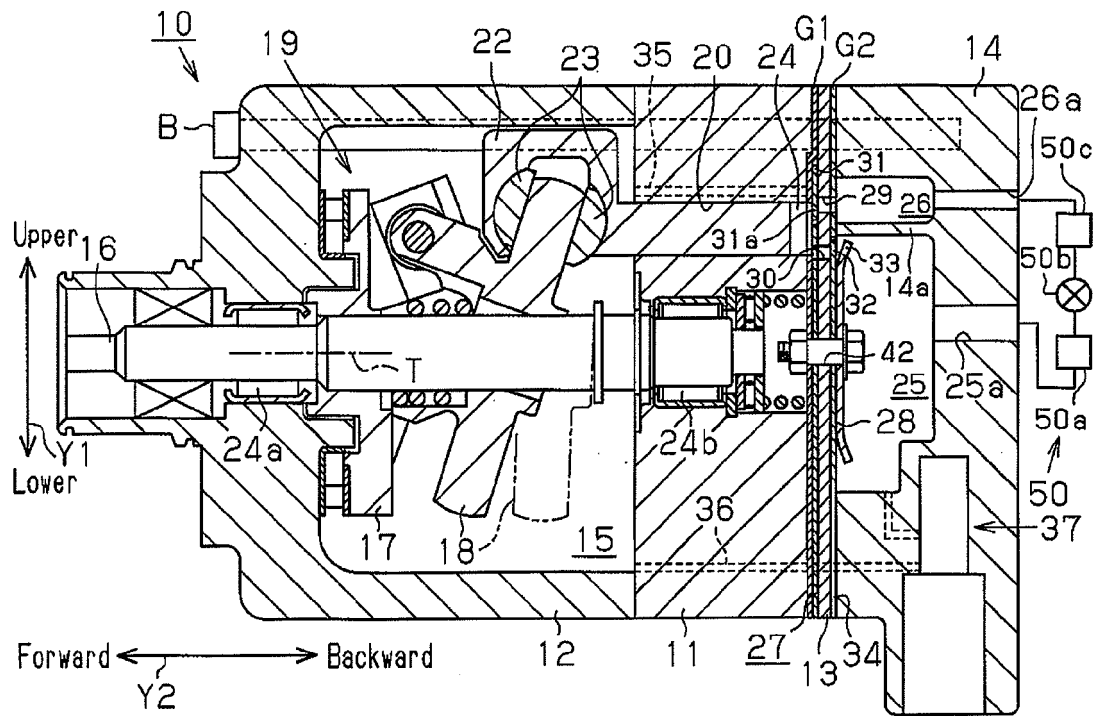


Fig.1

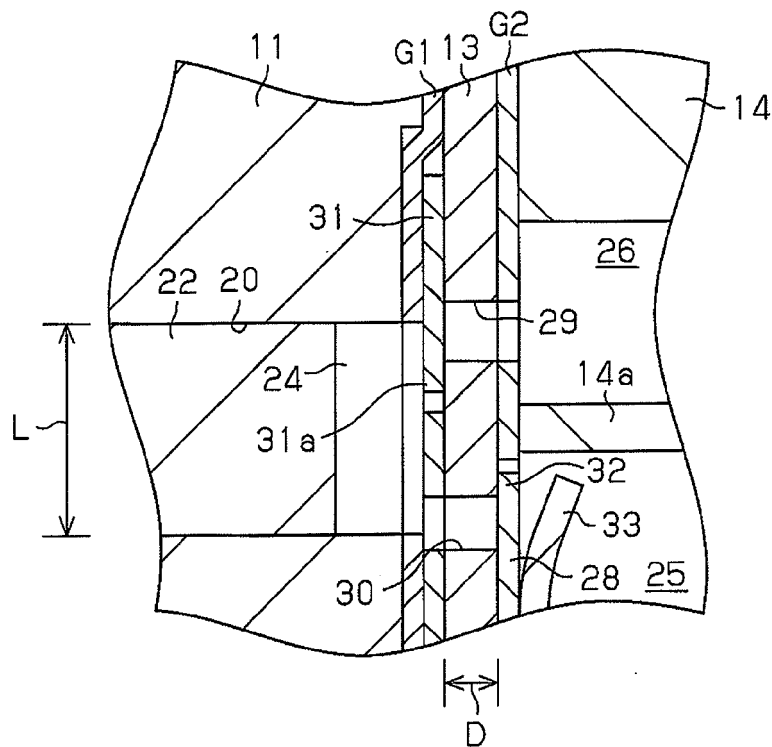


Fig.2

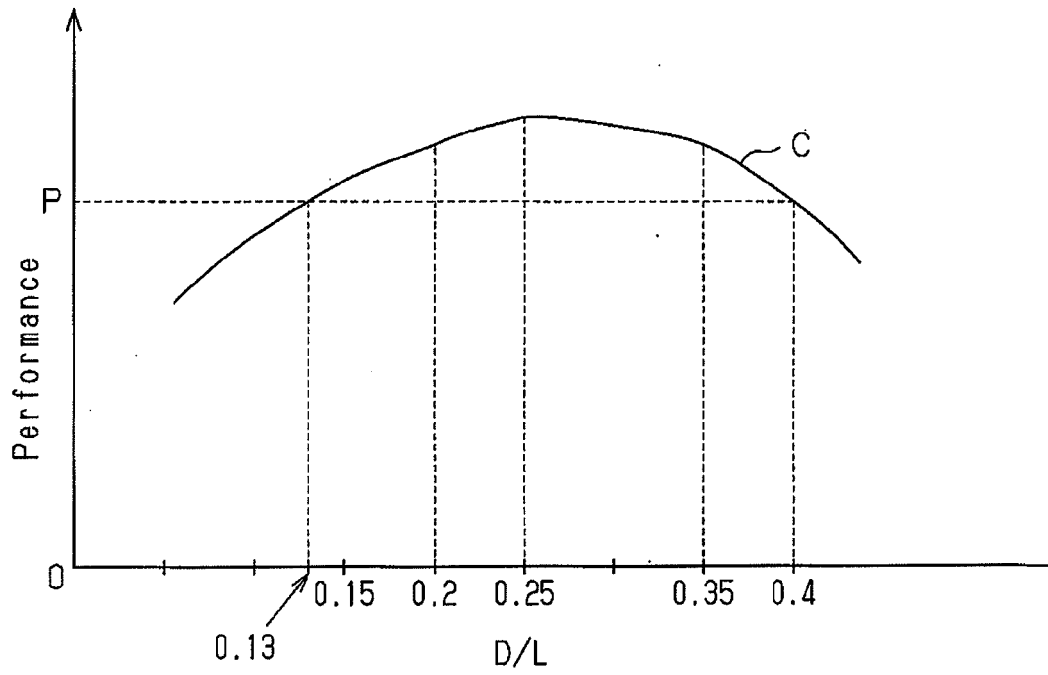


Fig.3

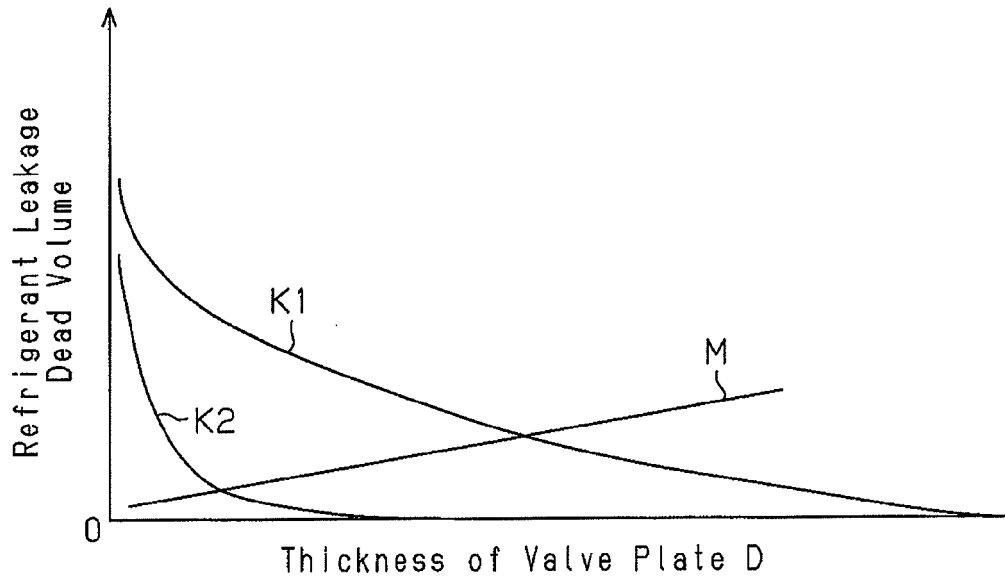


Fig.4



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Application Number
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