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(71) Applicant: **Kabushiki Kaisha Toyota Jidoshokki**
Kariya-shi, Aichi 448-8671 (JP)

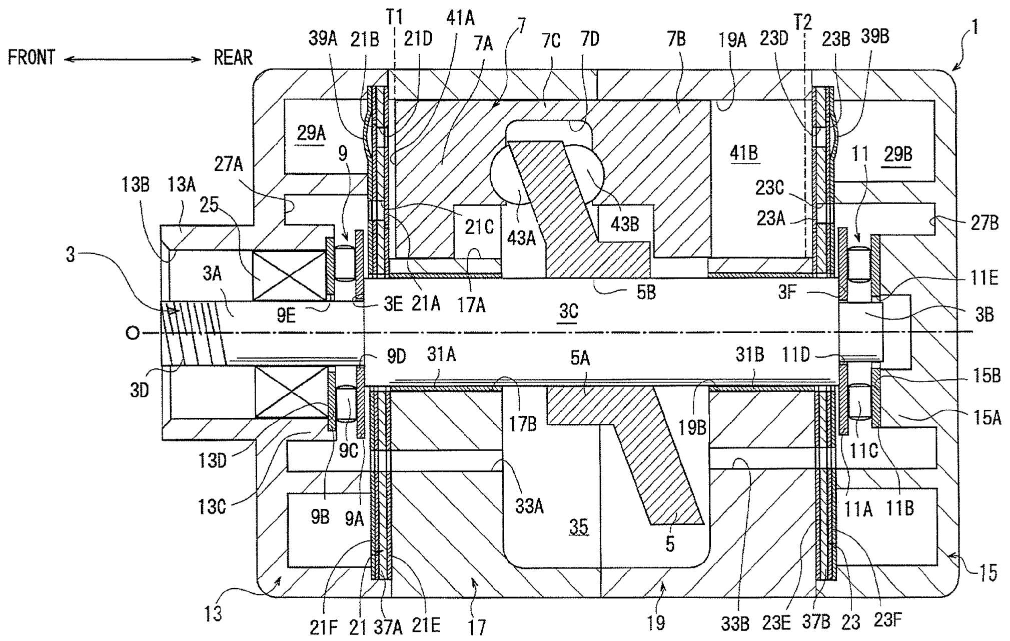
(72) Inventors:
- **Nakamori, Masashi**
  Kariya-shi, Aichi 448-8671 (JP)
- **Kobayashi, Toshiyuki**
  Kariya-shi, Aichi 448-8671 (JP)
- **Banno, Nobutoshi**
  Kariya-shi, Aichi 448-8671 (JP)

(74) Representative: **TBK**
Bavariaring 4-6
80336 München (DE)

(54) **Swash plate compressor**

(57) A swash plate type compressor includes a drive shaft, a swash plate, a piston, a cylinder block, a housing, a cylinder bore, a compression chamber, suction and discharge chambers and first and second thrust bearings. The cylinder bore is formed in the cylinder block and receiving therein the piston engaged with the swash plate mounted on the drive shaft. The compression chamber is defined in the cylinder bore by the piston so as to be communicable with the suction and the discharge chambers formed in the housing. The first and the second thrust bearings are disposed on opposite sides of the swash plate. The drive shaft extends through the cylinder block and supported in a thrust direction by the first and the second thrust bearings, and either one of the first and the second thrust bearings is disposed outside the cylinder block and between the housing and the drive shaft.

FIG. 1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a swash plate compressor.

[0002] Japanese Patent Application Publication No. 7-197883 discloses a swash plate compressor. The swash plate compressor includes first and second cylinder blocks, front and rear housings, a drive shaft, a swash plate and a plurality of pistons.

[0003] A plurality of first cylinder bores is formed in the first cylinder block around the axis of the drive shaft at a predetermined angular interval.
Secound cylinder bores of the same number as the first cylinder bores is formed in the second cylinder block around the axis of the drive shaft at positions corresponding to the respective cylinder bores in the first cylinder block. A crank chamber is formed between the first and the second cylinder blocks. Each first cylinder bore is in communication with its corresponding second cylinder bore through the crank chamber. Each pair of the first and the second cylinder bores forms a cylinder bore. The cylinder bore includes the first cylinder bore formed on the front side of the cylinder block and the second cylinder bore formed on the rear side of the cylinder block.

[0004] Each piston includes a first piston head reciprocable in the first cylinder bore and a second piston head reciprocable in the second cylinder bore. The first piston head is inserted in the first cylinder bore and a first compression chamber is defined by the first piston head in the first cylinder bore. The second piston head is inserted in the second cylinder bore and a second compression chamber is defined by the second piston head in the second cylinder bore. Each piston is engaged with the swash plate through a pair of shoes and reciprocates in its corresponding cylinder bore with the rotation of the swash plate.

[0005] The front housing is connected to the front end of the first cylinder block. A first valve unit is held between the front housing and the first cylinder block. A first suction chamber and a first discharge chamber are formed between the front housing and the first valve unit. The first suction chamber and the first discharge chamber are communicable with the first compression chamber, respectively.

[0006] The rear housing is connected to the rear end of the second cylinder block. A second valve unit is held between the rear housing and the second cylinder block. A second suction chamber and a second discharge chamber are formed between the rear housing and the second valve unit so as to be communicable with the second compression chamber, respectively.

[0007] A drive shaft is disposed extending through the front housing and the first and the second cylinder blocks. The swash plate is mounted on the drive shaft for rotation therewith in the crank chamber.

[0008] In the swash plate compressor, a first thrust bearing is disposed between the first cylinder block and the swash plate and a second thrust bearing is disposed between the second cylinder block and the swash plate. The first and the second thrust bearings are located on the opposite sides of the swash plate in the crank chamber. The drive shaft extending through the front housing and the first and the second cylinder blocks is supported in thrust direction by the first and the second thrust bearings. According to the compressor, the thrust force derived from the suction reaction force and applied to the piston during its suction stroke and the compression reaction force applied to the piston during its compression stroke are received by the first and the second thrust bearings.

[0009] For improving the ease of mounting the above compressor in a vehicle, the compressor is required to improve the degree of freedom in design, such as lightening of weight while maintaining the desired displacement capacity of the compressor. Meanwhile, the fixed displacement swash plate compressor is required to ensure the specific strength by employing bearings of a predetermined size, such as the first and the second thrust bearings.

[0010] In the above conventional double-headed swash plate compressor, the first and the second thrust bearings are located in the crank chamber between the front and the rear heads of the respective pistons, that is inside of the pistons, so that the axial length of the pistons tends to be increased. In such a case, it is difficult for the swash plate compressor to reduce its weight and size. Therefore, the increased the size of the swash plate compressor is inevitable due to the presence of the bearings between the front and the rear heads of the respective pistons.

[0011] The swash plate compressor having a drive shaft with a large axial length has a problem in that the strength of the drive shaft against torsion may be reduced. The thickness of the compressor housing needs to be increased in order to ensure the strength of the drive shaft, which further increases the size and weight of the swash plate compressor. Thus, the swash plate compressor is difficult to reduce its weight and size.

[0012] In the swash plate type compressor wherein the pistons are located radially outward of the first and the second thrust bearings, shortening the axial length of the piston while maintaining the volume of the cylinder bores causes the housing to be increased in radial direction. In this case, the swash plate compressor is difficult to reduce its weight and size. Reducing the volume of the cylinder bores causes the swash plate compressor to fail to maintain the displacement capacity.

[0013] The present invention is directed to providing a swash plate compressor that ensures high degree of freedom in design to achieve reduction in its weight while maintaining the desired displacement capacity and the strength of the swash plate compressor for the displacement capacity.

SUMMARY OF THE INVENTION

[0014] In accordance with the present invention, a swash plate type compressor includes a drive shaft, a swash plate, a piston, a cylinder block, a housing, a cylinder bore, a compression chamber, suction and discharge chambers and first and second thrust bearings. The swash plate is mounted on the drive shaft for rotation with the drive shaft. The piston is engaged with the swash plate. The cylinder block accommodates the swash plate. The housing is connected to the cylinder block. The cylinder bore is formed in the cylinder block and receives the piston in the cylinder bore. The compression chamber is defined in the cylinder bore by the piston. The suction chamber is formed in the housing so as to be communicable with the compression chamber. The discharge chamber is formed in the housing so as to be communicable with the compression chamber. The first thrust bearing and a second thrust bearing are disposed on opposite sides of the swash plate. The drive shaft extends through the cylinder block and supported in a thrust direction by the first thrust bearing and the second thrust bearing, and at least either one of the first thrust bearing and the second thrust bearing is disposed outside the cylinder block and between the housing and the drive shaft.

[0015] 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

[0016] 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 drawings in which:

Fig. 1 is a longitudinal sectional view showing a fixed displacement double-headed piston type swash plate compressor according to a preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0017] The following will describe a preferred embodiment with reference to Fig. 1. The fixed displacement type double-headed piston type swash plate compressor (hereinafter referred to simply as "compressor") shown in Fig. 1 is designed to be mounted on a vehicle and forms a part of the refrigerant circuit for use in a vehicle air conditioner.

[0018] Referring to Fig. 1, the compressor includes a housing 1, a first cylinder block 17, a second cylinder block 19, a drive shaft 3, a swash plate 5, a plurality of pistons 7 and first and second thrust bearings 9, 11. The first and the second cylinder blocks 17, 19 correspond to a cylinder block of the present invention.

[0019] The first cylinder block 17 has formed therein a plurality of first cylinder bores 17A on the front side thereof and a first shaft hole 17B through which the drive shaft 3 is inserted. The first cylinder bores 17A are formed around and parallel to the first shaft hole 17B at an equiangular spaced interval. A first slide bearing 31A is disposed in the first shaft hole 17B. A first suction passage 33A is formed extending through the first cylinder block 17 in the axial direction of the drive shaft 3. A first retainer (not shown) is formed in the first cylinder block 17 to limit the lift of a first suction reed valve 24A which will be described later.

[0020] The second cylinder block 19 is disposed rearward of the first cylinder block 17. The second cylinder block 19 has formed therein the same number second cylinder bores 19A as the first cylinder bores 17A and a second shaft hole 19B through which the drive shaft 3 is inserted. The second cylinder bores 19A are formed around and parallel to the second shaft hole 19B at an equiangular interval. A second slide bearing 31 B is mounted on the second shaft hole 19B. A second suction passage 33B is formed extending through the second cylinder block 19 in the axial direction of the drive shaft 3. A second retainer (not shown) is formed in the second cylinder block 19 to limit the lift of a second suction reed valve 23A which will be described later. The cylinder bore includes a first cylinder bore formed on the front side of the cylinder block and a second cylinder bore formed on the rear side of the cylinder block.

[0021] The housing 1 includes a front housing 13 and a rear housing 15.

[0022] The front housing 13 is formed with a boss 13A extending forward. The boss 13A has formed therein a shaft hole 13B. A shaft seal device 25 is disposed in the shaft hole 13B to seal between the drive shaft 3 and the front housing 13.

[0023] A first suction chamber 27A and a first discharge chamber 29A are formed annularly in the front housing 13. The first suction chamber 27A is formed radially inward of the first discharge chamber 29A.

[0024] The front housing 13 has a first support portion 13C extending in the first suction chamber 27A. The first support portion 13C has at the distal end thereof a recessed annular first pressure receiving seat 13D.

[0025] The second suction chamber 27B and the second discharge chamber 29B are formed annularly in the rear housing 15. The second suction chamber 27B is formed radially inward of the second discharge chamber 29B. The first and the second suction chambers 27A, 27B cooperate to serve as a suction chamber of the present invention.

[0026] The rear housing 15 includes a second support portion 15A extending in the second suction chamber 27B. The second support portion 15A has at the distal end thereof a recessed annular second pressure receiving seat 15B.

[0027] The front housing 13 and the rear housing 15 are fastened together by a plurality of bolts (not shown) so as to hold therebetween the first and the second cylinder blocks 17, 19. The front housing 13 is fixed to the front end of the first cylinder block 17. The front housing 13 and the first cylinder block 17 are connected to each other with a first valve unit 21 held therebetween. The rear housing 15 is connected to the rear end of the second cylinder block 19. The rear housing 15 and the second cylinder block 19 are connected to each other with a second valve unit 23 held therebetween.

[0028] With the front housing 13, the first and the second cylinder blocks 17, 19 and the rear housing 15 connected together, a crank chamber 35 is formed between the first and the second cylinder blocks 17, 19. The first and the second cylinder blocks 17, 19 accommodate therein the swash plate 5. The crank chamber 35 is in communication with the first suction chamber 27A through the first suction passage 33A and with the second suction chamber 27B through the second suction passage 33B.

[0029] The first valve unit 21 includes a first valve plate 37A, a first suction valve plate 21 E, a first discharge valve plate 21 F and a first retainer plate 39A.

[0030] First suction ports 21C and first discharge ports 21 D of the same number as the first cylinder bore 17A are formed through the first valve plate 37A. The first suction valve plate 21 E is formed with a plurality of the first suction reed valves 21A. The first suction reed valve 21A is configured to open and close the first suction port 21C. A plurality of first discharge reed valves 21 B is formed through the first discharge valve plate 21 F. The first discharge reed valve 21 B is configured to open and close the first discharge port 21 D. The first retainer plate 39A limits the lift of the first discharge reed valves 21 B.

[0031] The second valve unit 23 includes a second valve plate 37B, a second suction valve plate 23E, a second discharge valve plate 23F and a second retainer plate 39B.

[0032] Second suction ports 23C and second discharge ports 23D of the same number as the second cylinder bore 19A are formed through the second valve plate 37B. The second suction valve plate 23E is formed with a plurality of second suction reed valves 23A. The second suction reed valve 23A is configured to open and close the second suction port 23C. The second discharge valve plate 23F is formed with a plurality of second discharge reed valves 23B. The second discharge reed valve 23B is configured to open and close the second discharge port 23D. The second retainer plate 39B limits the lift of the second discharge reed valves 23B.

[0033] The drive shaft 3 includes a first shaft portion 3A forming a front part of the drive shaft 3, a second shaft portion 3B forming a rear part of the drive shaft 3 and a third shaft portion 3C between the first and the second shaft portions 3A, 3B. A thread 3D is formed on the front end of the first shaft portion 3A. A pulley (not shown) and an electromagnetic clutch (not shown) are connected to the thread 3D.

[0034] The first shaft portion 3A has the same diameter as the second shaft portion 3B. The third shaft portion 3C has a larger diameter than the first and the second shaft portions 3A, 3B. An annular third pressure receiving seat 3E is formed between the first shaft portion 3A and the third shaft portion 3C, or at the front end of the third shaft portion 3C. An annular fourth pressure receiving seat 3F is formed between the second shaft portion 3B and the third shaft portion 3C, or at the rear end of the third shaft portion 3C.

[0035] The drive shaft 3 extends through the front housing 13, the first and the second cylinder blocks 17, 19 and in the rear housing 15. The drive shaft 3 is inserted through the first and the second shaft holes 17B, 19B which are formed in the first and the second cylinder blocks 17, 19, respectively. The front end of the first shaft portion 3A is positioned in the shaft hole 13B and the rear end of the first shaft portion 3A and the third pressure receiving seat 3E are positioned in the first suction chamber 27A. The second shaft portion 3B and the fourth pressure receiving seat 3F are positioned in the second suction chamber 27B. The third shaft portion 3C is rotatably supported by the first and the second slide bearings 31A, 31 B. The drive shaft 3 is driven to rotate on the rotation axis O by the power transmitted through the pulley and the electromagnetic clutch.

[0036] The swash plate 5 has an annular shape. The swash plate 5 includes a boss 5A formed at the center thereof. A hole 5B is formed through the boss 5A. The third shaft portion 3C of the drive shaft 3 is press-fitted through the hole 5B, thus the swash plate 5 being connected to the drive shaft 3. Thus, the swash plate 5 is rotatable in the crank chamber 35 with the rotation of the drive shaft 3.

[0037] The piston 7 includes a first piston head 7A, a second piston head 7B and a intermediate portion 7C connecting the first and the second piston heads 7A, 7B. The first piston head 7A and the second piston head 7B are formed on the front side and the rear side of the piston 7, respectively. The first cylinder bore 17A receives therein the first piston head 7A of the piston 7 for reciprocation therein and the first piston head 7A defines a first compression chamber 41A in the first cylinder bore 17A. The first compression chamber 41A is formed between the first cylinder bore 17A and the first piston head 7A. The first compression chamber 41A is communicable with the first suction chamber 27A through the first suction port 21C and with the first discharge chamber 29A through the first discharge port 21 D.

[0038] The second piston head 7B is formed rearward of the intermediate portion 7C. The second cylinder bore 19A receives therein the second piston head 7B for reciprocation therein. The second piston head 7B defines a second compression chamber 41 B in the second cylinder bore 19A. the second compression chamber 41 B is formed between the second cylinder bore 19A and the second piston head 7B. The second compression chamber 41 B is communicable with the second suction chamber 27B through the second suction port 23C and with the second discharge chamber 29B through the second discharge port 23D.

[0039] A recess 7D is formed in the intermediate portion 7C of the piston 7 at the center thereof. A pair of semi-spherical shoes 43A, 43B is disposed in the recess 7D. The piston 7 is engaged with the swash plate 5 through the shoes 43A, 43B.

[0040] In this compressor, the pistons 7 reciprocate in the first and the second cylinder bores 17A, 19A in accordance with the tilt angle of the swash plate 5 relative to a hypothetical orthogonal plane orthogonal to the rotation axis O. The rotation of the swash plate 5 is converted into reciprocating motion of the piston 7 in its associated first and second cylinder bores 17A, 19A in the manner that is well known in the art. The top dead center of the first piston head 7A in the first compression chamber 41A is indicated by T1 in Fig. 1 and will be referred to as the first top dead center. The top dead center of the second piston head 7B in the second compression chamber 41 B is indicated by T2 and will be referred to as the second top dead center.

[0041] The first thrust bearing 9 is a roller thrust bearing including first and second races 9A, 9B, a roller 9C held between the first and the second races 9A, 9B and a first cage (not shown). A hole 9D is formed through the center of the first race 9A. A hole 9E is formed through the center of the second race 9B.

[0042] The first thrust bearing 9 is disposed in the front housing 13 at a position adjacent to the drive shaft 3. Specifically, the first thrust bearing 9 is disposed in the first suction chamber 27A at a position between the first pressure receiving seats 13D of the front housing 13 and the third pressure receiving seat 3E of the third shaft portion 3C of the drive shaft 3. Thus, the first thrust bearing 9 is located forward of the top dead center T1 of the first piston head 7A and outside the first cylinder block 17. More specifically, the first thrust bearing 9 is disposed with the first race 9A thereof in contact on the inner peripheral side thereof in contact on the inner peripheral side thereof with the third pressure receiving seat 3E and with the second race 9B thereof in contact with the first pressure receiving seat 13D on the outer peripheral side thereof and with the shaft seal device 25. The first race 9A is in contact in an area on the inner peripheral side thereof with the third pressure receiving seat 3E, so that the inner peripheral part of the first race 9A is elastically deformable toward the second race 9B by a thrust force applied to the first race 9A. The first race 9A of the first thrust bearing 9 serves as the cushion of the present invention.

[0043] The second thrust bearing 11 is a roller thrust bearing including first and second races 11A, 11 B, a roller 11C held between the first and the second race 11A, 11 B and a second cage (not shown). A hole 11 D is formed through the center of the first race 11A. A hole 11 E is formed through the center of the second race 11 B.

[0044] The second thrust bearing 11 is disposed in the rear housing 15 adjacent to the drive shaft 3. Specifically, the second thrust bearing 11 is disposed in the second suction chamber 27B between the second pressure receiving seat 15B of the rear housing 15 and the fourth pressure receiving seat 3F of the third shaft portion 3C of the drive shaft 3. Thus, the second thrust bearing 11 is located rearward of the top dead center T2 of the second piston head 7B and outside the second cylinder block 19. More specifically, the second thrust bearing 11 is disposed with the first race 11A thereof in contact with the fourth pressure receiving seat 3F on the inner peripheral side thereof and also with the second race 11 B thereof in contact with the second pressure receiving seat 15B. The first race 11A is in contact in an area on the inner peripheral side thereof with the fourth pressure receiving seat 3F, so that the inner peripheral part of the second race 11 B is elastically deformable toward the second race 11 B by a thrust force applied to the first race 11A. The first race 11A of the second thrust bearing 11 also serves as the cushion of the present invention. Thus, at least one of the first and the second thrust bearings serve as the cushion with the housing 1 and the drive shaft 3 for receiving thrust force by deforming themselves.

[0045] The first and the second thrust bearings 9, 11 which are disposed in the first suction chamber 27A and the second suction chamber 27B, respectively, are located on the opposite sides of the swash plate 5 in the front and the rear housings 13, 15, respectively. The size of the first and the second thrust bearings 9, 11 may be determined appropriately according to the thrust force applied to the pistons 7.

[0046] The first and the second discharge chambers 29A, 29B form a single discharge chamber (not shown) which is connected to a condenser. The condenser is connected to an evaporator through an expansion valve. The evaporator is connected to the crank chamber 35. The crank chamber 35 is in communication with the first and the second suction chambers 27A, 27B through the first and the second suction passages 33A, 33B, respectively. The compressor, the condenser, the expansion valve and the evaporator cooperate to form a refrigerant circuit. The condenser, the expansion valve and the evaporator are not shown in the drawing.

[0047] As the drive shaft 3 of the above-described compressor is driven to rotate by a vehicle engine or a motor through the pulley and the electromagnetic clutch, the pistons 7 are reciprocated in the first and the second cylinder bores 17A, 19A for a stroke length that is determined by the inclination angle of the swash plate 5. Accordingly, refrigerant in the first and the second suction chambers 27A, 27B is flowed into the first and the second compression chambers 41A, 41 B for compression therein and the refrigerant compressed in the first and the second compression chambers 41 A, 41 B is forced out thereof into the first and the second discharge chambers 29A, 29B. The thrust force derived from the suction reaction force of the pistons 7 during their suction stroke and also from the compression reaction force of the pistons 7 during their compression stroke are received by the first and the second thrust bearings 9, 11.

[0048] The first and the second thrust bearings 9, 11 are disposed in the first and the second suction chambers 27A, 27B on the opposite outer sides of the first and the second cylinder blocks 17, 19 in the front and the rear housings 13, 15, respectively. The first thrust bearing 9 is positioned outside the first cylinder block 17 and on the front side of the compressor. The second thrust bearing 11 is positioned outside the second cylinder block 19 and on the rear side of the compressor. Thus the first and the second thrust bearings 9, 11 are positioned outside the cylinder block and between the housing 1 and the drive shaft 3. Therefore, the first and the second thrust bearings 9, 11 are positioned on opposite outer sides of the crank chamber 35. The first and the second thrust bearings 9, 11 are positioned outside the crank chamber 35, respectively. In other words, the first and the second thrust bearings 9, 11 are positioned outside the pistons 7.

[0049] The use of the first and the second thrust bearings 9, 11 having any size that is large enough to ensure the strength will not increase of the axial length of the piston 7 due to an increase of the axial length of the intermediate portion 7C may be prevented. Thus, the axial length of the first and the second cylinder blocks 17, 19 may be reduced.

[0050] The compressor of the preferred embodiment may ease restrictions on the shape of the pistons 7 and the drive shaft 3. Because no thrust bearing is provided in contact with the boss 5A of the swash plate 5, the boss 5A may be downsized.

[0051] Because the piston 7 may reduce its axial length, the crank chamber 35 may be downsized and, therefore, the compressor may be made smaller in size. Accordingly, the compressor may ensure high strength against torsion.

[0052] In designing the compressor so as to reduce its size, the first and the second cylinder bores 17A, 19A need not be reduced in volume. In this double-headed swash plate compressor, wherein refrigerant gas is compressed in both the first and the second compression chambers 41A, 41 B, the displacement capacity of the compressor will not be influenced so much by the downsizing of the compressor.

[0053] The compressor according to the preferred embodiment may ensure high degree of freedom in design that permits reduction in its weight while maintaining the desired displacement of the compressor and the strength of the compressor required for that displacement.

[0054] The first races 9A, 11A of the first and the second thrust bearings 9, 11 are elastically deformable which allows the first and the second thrust bearings 9, 11 to receive thrust force generated in the compressor, with the result that the durability of the first and the second thrust bearings 9, 11 is increased. Therefore, the durability of the compressor may be increased and vibration and noise development of the compressor during the operation may be prevented.

[0055] The first suction chamber 27A is formed on the inner peripheral side of the front housing 13 and the first discharge chamber 29A is formed on the outer peripheral side of the front housing 13. Similarly, the second suction chamber 27B is formed on the inner peripheral side of the rear housing 15 and the second discharge chamber 29B is formed on the outer peripheral side of the rear housing 15. The first thrust bearing 9 is disposed in the first suction chamber 27A and the second thrust bearing 11 is disposed in the second suction chamber 27B.

[0056] In this compressor, the first thrust bearing 9 faces the first suction chamber 27A and the drive shaft 3 is supported at the rear end of the first shaft portion 3A thereof by the first thrust bearing 9 in the first suction chamber 27A. The second thrust bearing 11 faces the second suction chamber 27B and the drive shaft 3 is supported at the second shaft portion 3B thereof by the second thrust bearing 11 in the second suction chamber 27B.

[0057] In this compressor of the preferred embodiment, lubricating oil contained in the refrigerant flowing in the first and the second suction chambers 27A, 27B lubricate not only the drive shaft 3 but also the first and the second thrust bearings 9, 11, thus permitting the drive shaft 3 to rotate smoothly. The drive shaft 3 is protected against wear and the durability of the compressor is improved. Refrigerant in the suction chamber has a relatively low temperature. Thus, any frictional heat generated in the first and the second thrust bearings 9, 11, is cooled by refrigerant.

[0058] The present preferred embodiments is to be considered as illustrative and not restrictive, and the invention is not to be limited to the details given herein but it may be modified in various ways as exemplified below.

[0059] In the first and the second thrust bearings 9, 11, not only the first races 9A, 11A but also the second races 9B, 11 B may be formed so as to be elastically deformable.

[0060] Only either one of the first and the second thrust bearings 9, 11 may be formed so as to be elastically deformable. Alternatively, neither of the first nor the second thrust bearings 9, 11 may be formed elastically deformable.

[0061] The compressor may be constructed such that the inclination angle of the swash plate 5 is changeable so that the displacement of the compressor per rotation of the drive shaft 3 is variable. Also in this case, the first and the second thrust bearings 9, 11 are positioned outside the crank chamber 35, so that it is easy to ensure a space necessary for a mechanism for changing the inclination angle of the swash plate 5 if the crank chamber 35 is formed smaller.

[0062] The first thrust bearing 9 may be disposed within the crank chamber 35, or inside the first cylinder block 17. In this case, the first thrust bearing 9 should preferably be disposed forward of the top dead center T1 of the first piston head 7A in the first cylinder block 17.

[0063] Alternatively, the second thrust bearing 11 may be disposed within the crank chamber 35, or inside the second cylinder block 19. In this case, the second thrust bearing 11 should preferably be disposed rearward of the top dead center T2 of the second piston head 7B in the second cylinder block 19.

[0064] The first and the second thrust bearings 9, 11 are disposed in the first and the second suction chambers 27A, 27B, respectively. Alternatively, the first and the second thrust bearings 9, 11 may be disposed to be communicable with the first and the second suction chambers 27A, 27B, respectively. Thus, the first and the second thrust bearings 9, 11 face the first and the second suction chambers 27A, 27B, respectively. In this case, the first and the second thrust bearings 9, 11 are communicable with the first and the second suction chambers 27A, 27B, respectively, through an exclusive communication passage or a clearance formed between the housing 1 and the drive shaft 3.

[0065] A radial rolling bearing may be used instead of the first and the second slide bearings 31A, 31 B.

[0066] The present invention is applicable also to a single-headed piston type swash plate compressor. Also in this case, the compressor may be of either fixed displacement type or variable displacement type.

[0067] A swash plate type compressor includes a drive shaft, a swash plate, a piston, a cylinder block, a housing, a cylinder bore, a compression chamber, suction and discharge chambers and first and second thrust bearings. The cylinder bore is formed in the cylinder block and receiving therein the piston engaged with the swash plate mounted on the drive shaft. The compression chamber is defined in the cylinder bore by the piston so as to be communicable with the suction and the discharge chambers formed in the housing. The first and the second thrust bearings are disposed on opposite sides of the swash plate. The drive shaft extends through the cylinder block and supported in a thrust direction by the first and the second thrust bearings, and either one of the first and the second thrust bearings is disposed outside the cylinder block and between the housing and the drive shaft.

Claims

1. A swash plate type compressor comprising:

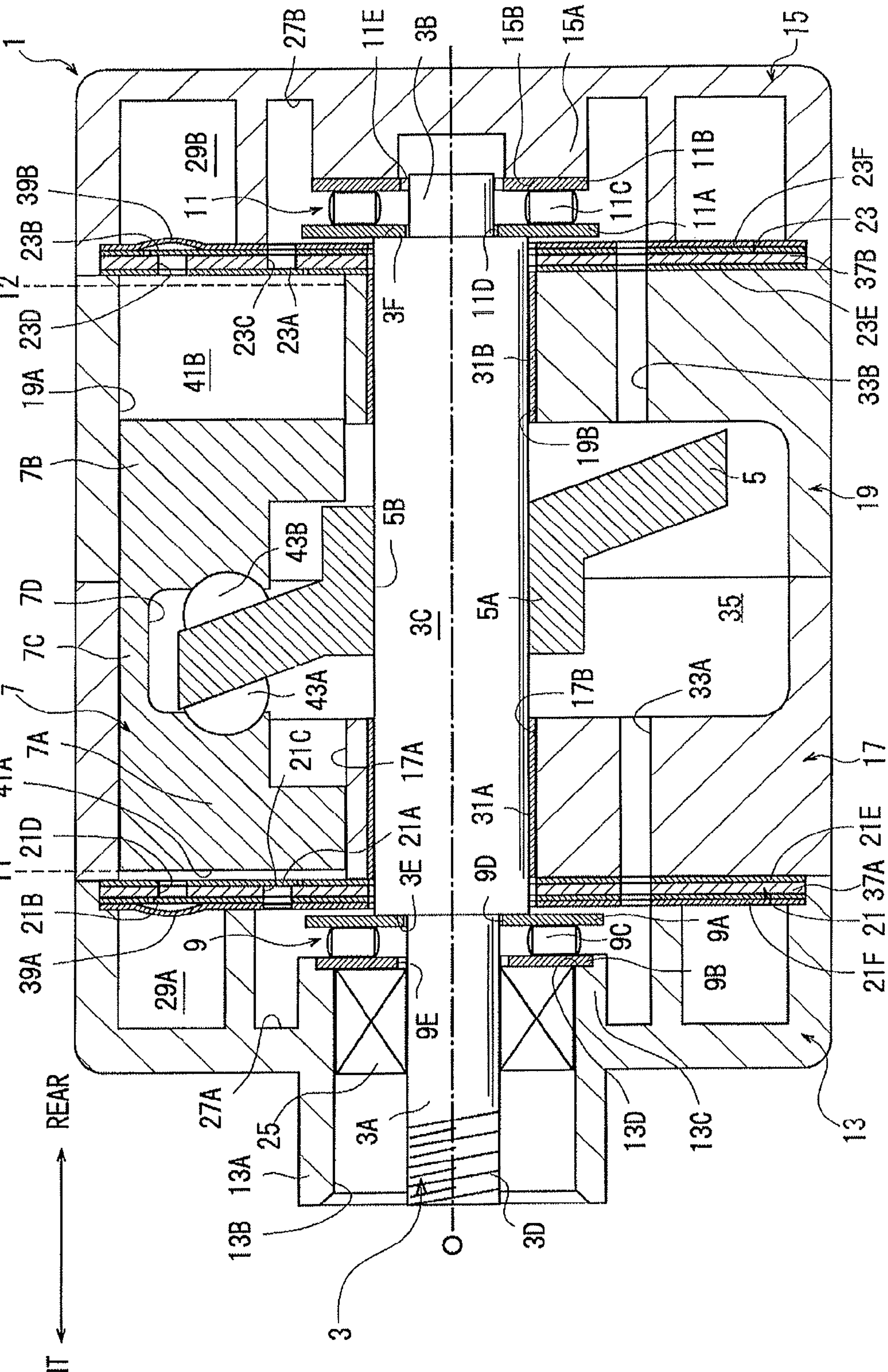
a drive shaft (3);
a swash plate (5) mounted on the drive shaft (3) for rotation with the drive shaft (3);
a piston (7) engaged with the swash plate (5);
a cylinder block (17, 19) accommodating the swash plate (5);
a housing (1) connected to the cylinder block (17, 19);
a cylinder bore (17A, 19A) formed in the cylinder block (17, 19) and receiving the piston (7) in the cylinder bore (17A, 19A);
a compression chamber (41A, 41 B) defined in the cylinder bore (17A, 19A) by the piston (7);
a suction chamber (27A, 27B) formed in the housing (1) so as to be communicable with the compression chamber (41A, 41 B);
a discharge chamber (29A, 29B) formed in the housing (1) so as to be communicable with the compression chamber (41A, 41 B); and
a first thrust bearing (9) and a second thrust bearing (11) disposed on opposite sides of the swash plate (5),
characterized in that the drive shaft (3) extends through the cylinder block (17, 19) and supported in a thrust direction by the first thrust bearing (9) and the second thrust bearing (11), and at least either one of the first thrust bearing (9) and the second thrust bearing (11) is disposed outside the cylinder block (17, 19) and between the housing (1) and the drive shaft (3).

2. The swash plate type compressor according to claim 1, **characterized in that** the housing (1) includes a front housing (13) connected to the front end of the cylinder block (17, 19) and a rear housing (15) connected to the rear end of the cylinder block (17, 19), the cylinder bore (17A, 19A) includes the first cylinder bore (17A) formed on the front side of the cylinder block (17, 19) and the second cylinder bore (19A) formed on the rear side of the cylinder block (17, 19), the piston (7) includes a first piston head (7A) reciprocable in the first cylinder bore (17A) and a second piston head (7B) reciprocable in the second cylinder bore (19A), the first thrust bearing (9) is disposed between the front housing (13) and the drive shaft (3) and the second thrust bearing (11) is disposed between the rear housing (15) and the drive shaft (3).

3. The swash plate type compressor according to claim 1 or 2, **characterized in that** at least one of the first thrust bearing (9) and the second thrust bearing (11), serves as a cushion with the housing (1) and the drive shaft (3) for receiving thrust force by deforming the first thrust bearing (9) and the second thrust bearing (11).

4. The swash plate type compressor according to any one of claims 1 through 3, **characterized in that** at least one of the first thrust bearing (9) and the second thrust bearing (11) faces the suction chamber (27A, 27B).

FIG. 1


1
27B
11E
3B
15B
15A
15
29B
11
11C
11B
11A
23F
23B
39B
23
37B
T2
23D
23C
23A
3F
11D
23E
19A
41B
31B
33B
7B
19B
5
19
5B
43B
7D
3C
5A
35
7C
43A
17B
33A
7
41A
7A
21C
17A
17
21D
21A
31A
21E
T1
3E
9D
37A
21B
21
39A
9
9C
9A
29A
9B
21F
9E
27A
25
13D
13C
13
REAR
3A
13A
13B
O
3D
3
FRONT

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EUROPEAN SEARCH REPORT

Application Number
EP 14 15 4785

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