

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention generally relates to a piston type refrigerant compressor and, more particularly, to a swash plate type compressor with a variable displacement mechanism suitable for use in an automotive air conditioning system.

2. Description of the Prior Art

A swash plate type refrigerant compressor with a variable displacement mechanism suitable for use in an automotive air conditioning system is disclosed in Japanese Utility Model Application Publication No. 63-93480 and document EP-A-0 259 760. Referring to Figure 1, an outer shell of the compressor is formed by front housing 1, front valve plate 9, cylinder block 3, rear valve plate 4, and rear housing 5, which are made of an aluminum alloy. Cylinder block 3 comprises front cylinder block 3a and rear cylinder block 3b which abut each other. Front housing 1 is mounted through front valve plate 9 on one side of cylinder block 3, and rear housing 5 is mounted through rear valve plate 4 on the other side of cylinder block 3. These shell components are coupled in a unit by a plurality of bolts 6.

A plurality of cylinders 7, arranged in parallel with each other, and chamber 8 are formed by front and rear cylinder blocks 3a and 3b within cylinder block 3. Further, first bearing 10 and second bearing 11 are disposed in cylinder block 3 and rear housing 5, respectively, to rotatably support drive shaft 12. Drive shaft 12 is arranged coaxially with the annular arrangement of cylinders 7. One end portion 13 of drive shaft 12 extends to the outside of front housing 1 through drive shaft sealing bearing 14 mounted on front housing 1. Exposed end portion 13 is connected to an electromagnetic clutch (not shown), so that the rotational torque of an automotive vehicle engine may be transmitted to drive shaft 12 through the electromagnetic clutch.

Piston 17 defines a front side working chamber 15 and a rear side working chamber 16 in cooperation with an inner surface of each cylinder 7 and is reciprocatingly inserted into each cylinder 7. Thus, each piston 17 may be slidably reciprocated by swash plate 18 disposed within crank chamber 8.

Swash plate 18 has a projection portion at its central region, and arm 19 is formed in the projection portion. Planar plate portion 20 is formed in drive shaft 12 at a position corresponding to arm 19 of swash plate 18. Swash plate 18 is obliquely

mounted on drive shaft 12 with planar plate portion 20 engaged with arm 19. Also, pin 21 is fixed to the projection portion of swash plate 18. Pin 21 is engaged through a collar with elongated hole 22 formed in planar plate portion 20 of drive shaft 12. In this configuration, swash plate 18 is shifted between a position in which the slant angle is large and a position in which the slant angle is small, while pin 21 of swash plate 18 slides within elongated hole 22. The capacity of the compressor is dependent upon the slant angle of swash plate 18. When the slant angle of swash plate 18 is increased, the stroke length of piston 17 in cylinder 7 is maximized, and the capacity of the compressor is decreased. The rotational force of drive shaft 12 is transmitted to swash plate 18 through the engagement between planar plate portion 20 and arm 19. Swash plate 18 is driven to rotate about the axis of drive shaft 12 together with drive shaft 12 and to move in the axial direction of drive shaft 12. Thus, swash plate 18 is swung between a rightwardly upward inclination and a rightwardly downward inclination.

The circumferential peripheral portion of swash plate 18 is connected to piston 17 through a pair of shoes 23. Swash plate 18 is inserted slidably into the space between the pair of shoes 23. Shoes 23 form a single spherical shape when in contact with swash plate 18 and rotatably mounted on recesses formed in piston 17 in a complementary manner. Accordingly, the swing motion concomitant with the rotation of swash plate 18 is transmitted to piston 17 through shoes 23, while the rotational motion component of swash plate 18 is released by shoes 23. Only the swing motion of swash plate 18 is converted into the reciprocating motion of piston 17 which is reciprocated within cylinder 7, so that the volume of front side working chamber 15 and rear side working chamber 16 are alternately increased and decreased.

Front housing 1 defines front suction chamber 24 and front discharge chamber 25. Drive shaft sealing bearing 14 is provided between front suction chamber 24, drive shaft 12, and front housing 1 to prevent the refrigerant, e.g., a mixture of refrigerant and lubricant, from leaking out. Front suction chamber 24 is in communication with crank chamber 8 through a hole formed in front valve plate 9 and front passage 26 formed in cylinder block 3. Further, front suction chamber 24 is in communication with front side working chamber 15 through front suction hole 27 formed in front valve plate 9. Also, front discharge chamber 25 is in communication with front side working chamber 15 through front discharge hole 28 formed in front valve plate 9.

Front suction valve 29 in the form of a sheet is provided on the surface of front valve plate 9 within

front side working chamber 15, so that front suction valve 29 is opened when piston 17 is rightwardly moved. Sheet-like discharge valve 30 is provided on the surface of front valve plate 9 within discharge chamber 25, so that discharge valve 30 is opened when piston 17 is leftwardly moved. Discharge valve 30 is converted by front valve retainer 31.

Rear housing 5 defines rear suction chamber 32 and rear discharge chamber 33. Rear suction chamber 32 is in communication with crank chamber 8 through a hole formed in rear valve plate 4 and rear passage 34 formed in cylinder block 3. Further, rear suction chamber 32 is in communication with rear side working chamber 16 through rear suction hole 35. Rear discharge chamber 33 is in communication with rear side working chamber 16 through rear discharge hole 36 formed in rear valve plate 4. Rear suction valve 37, rear discharge valve 38, and rear valve retainer 39 are mounted on rear valve plate 4 in a similar manner to that described for the corresponding front elements.

Switching valve 40 and control chamber 41 also are provided in rear housing 5. Slider 42 is rotatably mounted on drive shaft 12 to be slidable in the axial direction of drive shaft 12. Slider 42 is provided with spherical support portion 43 at one end thereof close to planar plate portion 20 of drive shaft 12. Spherical support portion 43 permits the central portion of swash plate 18 to rotate about the axis of drive shaft 12 and to move in the axial direction. Slider 42 has flange portion 44 which is connected to one end of spool 46 through second thrust bearing 45.

Spool 46 has annular piston portion 47 which is formed at the outer end of spool 46 and is inserted into rear suction chamber 32 to divide the chamber into rear suction chamber 32 and control chamber 41, and cylindrical portion 48 which extends coaxially with drive shaft 12 and slider 42 from piston portion 47 to the interior of cylinder block 3. Cylindrical portion 48 of spool 46 is slidably inserted into cylindrical portion 3d formed in rear cylinder block 3b. Thus, the motion of spool 46 in the axial direction is transmitted to slider 42 through second thrust bearing 45 and flange portion 44. First thrust bearing 49 is also provided on drive shaft 12 on the front side of planar plate portion 20 and is clamped between planar plate portion 20 of drive shaft 12 and retainer shoulder 3c provided in front cylinder block 3a to impart a thrust to drive shaft 12.

Referring to Figure 2a, piston 17 includes piston head 17b at each end. Piston 17 is formed such that the middle portion of piston 17, namely coupling portion 17c which is substantially semicircular in section and through which two piston heads 17b are coupled together, is operatively connected with both sides of the peripheral portion of

swash plate 18 through shoes 23. Supporting portion 17d which is formed inside of coupling portion 17c supports shoes 23.

The operation of the compressor will now be described. Referring to Figure 1, when the above-described electromagnetic clutch is engaged to transmit the drive torque from the automotive vehicle engine, drive shaft 12 begins to rotate within cylinder block 3. The rotation of drive shaft 12 is transmitted to arm 19 and swash plate 18 to rotate the latter. Because swash plate 18 is slanted relative to drive shaft 12, swash plate 18 is swung in accordance with the rotation of drive shaft 12, so that piston 17 is reciprocated within cylinder 7 in accordance with this swing motion.

When the discharge displacement of the compressor must be kept at a maximum level, switching valve 40 is switched over to place control chamber 41 in communication with rear discharge chamber 33. Then the pressure applied to the right side of piston portion 47 of spool 46 is higher than the pressure applied to the left side, so that spool 46 moves leftwardly. At the same time, the central position of swash plate 18 and slider 42 are moved leftwardly, so that the left end of slider 42 is brought into contact with planar plate portion 20 of drive shaft 12. By the leftward movement of swash plate 18, the projection portion of swash plate 18 having pin 21 is moved leftwardly relative to planar plate portion 20 of drive shaft 12, so that pin 21 is moved along elongated hole 22 of planar plate portion 20 toward the left upward end. In accordance with the left upward movement of pin 21, swash plate 18 is rotated about the center of spherical support portion 43 of slider 42 to create a large slant angle.

Further, piston 17 is reciprocated within cylinder 7. As piston 17 reciprocates, the refrigerant is alternately drawn into and compressed within front and rear side working chambers 15 and 16.

The refrigerant is introduced to the compressor from the refrigerant cycle through crank chamber 8 to front and rear suction chambers 24 and 32 and exits to the refrigerant cycle through front and rear discharge chambers 25 and 33. As described above, swash plate 18 is moved in the axial direction of drive shaft 12, so that the slant angle is changed and the central position is located substantially at the center in the longitudinal direction of cylinder 7. Therefore, as piston 17 reciprocates through a complete stroke, a loss of compression is avoided in front and rear side working chambers 15 and 16. The refrigerant compressed in the same manner is discharged from either of front and rear side working chambers 15 and 16. Accordingly, the flow refrigerant is generated in either of front and rear side working chamber 15 and 16, drive shaft sealing bearing 14 is in contact with that flow

refrigerant, and the heat generated due to the friction with drive shaft 12 is removed by the refrigerant.

When the discharge displacement of the compressor must be kept at a minimum level, the switching over of switching valve 40 places control chamber 41 in communication with rear suction chamber 32. When drive shaft 12 is rotated under this condition, swash plate 18 causes piston 17 to move rightwardly. As a result of the reactive force applied to piston 17, a force decreasing the inclination angle of swash plate 18 is applied to swash plate 18. Namely, the force rotating swash plate 18 in a counterclockwise direction is applied to swash plate 18 by piston 17.

The force applied to swash plate 18 is limited because pin 21 is slidably engaged with elongated hole 22, and a force pressing the central position of swash plate 18 to the right in the axial direction of drive shaft 12 is created. The force component is transmitted to spool 46 through slider 42. As described above, because the pressure difference is not generated between both sides of the piston portion 47 of spool 46, piston portion 47 moves rightwardly. Thus, the inclination angle of swash plate 18 is decreased and, at the same time, the central portion of swash plate 18 is moved toward rear side working chamber 16. The dead center position in rear side working chamber 16 is kept at substantially the same position as in the case of the above-described maximum displacement operation. Further, each piston 17 includes inner surface 300c formed on the inside thereof. A clearance of about 2 to 3 mm exists between radial end extremity 18a of swash plate 18 and each piston 17 because a swash plate compressor with variable displacement requires a relatively large clearance to vary the capacity of compression by changing the piston stroke.

Unfortunately, this relatively large clearance allows piston 17 to rotate within cylinder 7 and creates noise due to collisions between inner surface 300c of piston 17 and radial end extremity 18a of swash plate 18. Therefore, each piston 17 is provided with rotation prevention means 300 integrally formed on the center portion of piston 17 and extending radially therefrom. Referring to Figures 2a and 2b, rotation prevention means 300 includes first surface 300a formed on the upper surface thereof and second surface 300b formed on the radial end thereof. Rotation prevention means 300 is adapted to engage recess 310 formed in the wall of each cylinder 7. It will be seen that rotation prevention means 300 and recess 310 cooperate to prevent piston 7 from rotating about its own axis, thereby suppressing noise during operation of the compressor.

In this configuration, however, both the surface of recess 310 of cylinder block 3 and first surface 300a of rotation prevention means 300 are preferably formed as fine surfaces by machining in a finishing process in order to smoothly slide against each other. To cut and grind the surface of recess 310 of cylinder block 3 with a lathe and finishing tool consumes much time and energy because recess 310 is provided inside of cylinder block 3 which includes various projections impeding milling. Further, these above-described surfaces are relatively broad. As a result, this compressor has reduced productivity and a high manufacturing cost.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a piston type compressor and, more particularly, a variable displacement swash plate type compressor which can be easily and inexpensively manufactured.

It is a further object of the invention to provide a piston type compressor and, more particularly, a variable displacement swash plate type compressor which has a superior durability relating to a piston rotation prevention mechanism.

A piston type compressor according to the present invention, is defined in claim 1.

Further objects, features, and advantages of the present invention will be understood from the detailed description of the preferred embodiments of the present invention with reference to the appropriate figures.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a longitudinal cross-sectional view of a swash plate type refrigerant compressor with a variable displacement mechanism in accordance with the prior art.

Figure 2a is a perspective view of a piston in the compressor shown in Figure 1.

Figure 2b is a cross-sectional view taken along line 2b-2b in Figure 1.

Figure 3a is a perspective view showing a piston for use in a piston type compressor.

Figure 3b is a cross-sectional view taken along line 2b-2b in Figure 1.

Figure 4a is a perspective view showing another piston for use in a piston type compressor.

Figure 4b is a cross-sectional view taken along line 2b-2b in Figure 1.

Figure 5a is a perspective view showing a further piston for use in a piston type compressor.

Figure 5b is a cross-sectional view taken along line 2b-2b in Figure 1.

Figure 6a is a perspective view showing a piston for use in a piston type compressor in accordance with a first embodiment of the present invention.

Figure 6b is a cross-sectional view taken along line 2b-2b in Figure 1 in accordance with the first embodiment of the invention.

Figure 7a is a perspective view showing a piston for use in a piston type compressor in accordance with a second embodiment of the present invention.

Figure 7b is a cross-sectional view taken along line 2b-2b in Figure 1 in accordance with the second embodiment of the present invention.

Figure 8a is a perspective view showing a piston for use in a piston type compressor.

Figure 8b is a cross-sectional view taken along line 2b-2b in Figure 1.

Figure 9a is a schematic view showing two pistons moving in a reciprocated compressing motion, the rotation prevention means of which slide against each other in accordance with Figures 8a and 8b.

Figure 9b is a graph showing the distance changes between an axial end of one piston and an axial end of the other piston according to rotational angle changes of a swash plate in accordance with Figure 8a and 8b.

DETAILED DESCRIPTION OF THE DRAWINGS

The preferred embodiments of the present invention are similar to the compressor shown in Figure 1 except for the construction of the rotation prevention mechanism of the pistons within the cylinders. Therefore, similar parts are represented by the same reference numerals as in Figure 1, and detailed descriptions of similar parts will be omitted in order to simplify the following description of the preferred embodiments. Moreover, although the following description of the preferred embodiments will refer to a swash plate type compressor, the present invention is not limited to a swash plate type compressor.

Referring to Figures 3a and 3b, a piston 17 is depicted. Piston 17 includes piston head 17b at each end thereof. Piston 17 comprises coupling portion 17c which is located at the center of piston 17 between piston heads 17b. Coupling portion 17c is substantially semicircular in section and couples two piston heads 17b together. Further, coupling portion 17c is operatively connected with both sides of the peripheral portion of swash plate 18 through shoes 23. Supporting portion 17d which is formed inside of coupling portion 17c supports shoes 23. Each piston 17 is provided with projection 301 integrally formed on, and arching and extending radially from, the center of coupling por-

tion 17c of piston 17. Projection 301 includes radial end portions 301a having a tapered form. Bolts 6 are respectively arranged between each piston 17 through front housing 1, cylinder block 3, and rear housing 5, connecting them as one body and are in parallel with the longitudinal axis of drive shaft 12. Both radial end portions 301a of projection 301 are slidably abutted to peripheral surfaces 6a of bolts 6, so that projection 301 and bolts 6 cooperate to prevent piston 17 from rotating about its own axis.

Referring to Figures 4a and 4b, another piston 17 is depicted. Piston 17 may include projection 302 which is rectangular and convex in shape at the surface of piston 17 and extends outward rectangularly from center coupling portion 17c of piston 17. Projection 302 includes groove 302a which is substantially semicylindrical in shape, is parallel with piston 17, and is formed on the end surface of projection 302. The peripheral surface 6a of bolt 6 is slidably adapted to fit in groove 302a, so that projection 302 and bolt 6 cooperate to prevent piston 17 from rotating about its own axis.

Referring to Figures 5a and 5b, a further piston 17 is depicted. Piston 17 may include a pair of projections 303 which are wing shaped and extend from both sides of the center of coupling portion 17c of piston 17. Projections 303 include grooves 303a which are substantially semicylindrical in shape, are parallel with piston 17, and are formed on the end surfaces of projections 303. Peripheral surfaces 6a of bolts 6 are slidably adapted to fit in grooves 303a so that projections 303 and bolts 6 cooperate to prevent piston 17 from rotating about its own axis.

Referring to Figures 6a and 6b, piston 17 is depicted according to the first embodiment of the present invention. Piston 17 includes projection 304 which is rectangular and convex in shape at the surface of piston 17 and extends outward rectangularly from the center of coupling portion 17c of piston 17. Housing 3 is provided with ring member 50 which is shaped like a circular plate and is fixed to the inside of housing 3. Ring member 50 includes cutout portion 50a which is shaped like a rectangular notch and is cut out from the inner region of ring member 50. Outer peripheral surface 304a of projection 304 of piston 17 is slidably adapted to fit into peripheral surface 50d of cutout portion 50a of ring member 50, so that ring member 50 and projection 304 of piston 17 cooperate to prevent piston 17 from rotating about its own axis.

Referring to Figures 7a and 7b, piston 17 is depicted according to the second embodiment of the present invention. Each piston 17 may be provided with groove 305 which is rectangular and convex in shape at the surface of piston 17 and is formed on the surface of, and extends axially along, coupling portion 17c of piston 17. Ring

member 50 may include projections 50b which extend radially inward from ring member 50. Peripheral surfaces 50c of projections 50b of ring member 50 are slidably adapted to fit in groove 305 of piston 17, so that ring member 50 and groove 305 cooperate to prevent piston 17 from rotating about its own axis.

Referring to Figures 8a and 8b, another piston 17 is depicted. Each piston 17 is provided with projection 306 which is integrally formed on, and arches and extends radially from, the center of coupling portion 17c of piston 17. Projection 306 includes axial end surface 306a formed on the radial end thereof. Each axial end portion 306a of projection 306 abuts the adjacent axial end portion 306a, so that adjacent end portions slide against each other as the pistons 17 reciprocate.

The above-described surfaces of the rotation prevention means formed on piston 17, such as radial end portion 301a in Figures 3a and 3b, groove 302a in Figures 4a and 4b, groove 303a in Figures 5a and 5b, outer peripheral surface 304a in Figures 6a and 6b, groove 305 in Figures 7a and 7b, and axial end surface 306a in Figures 8a and 8b are machined, e.g., by milling or grinding during a finishing process, to have fine surfaces. The surface roughness (R_a) of these fine surfaces is less than about $1.6\mu\text{m}$ (ANSI B46.1-1978). Such fine surfaces improve the anti-seizure and wear resistance of the above-described rotation prevention means when sliding against peripheral surfaces 6a or bolts 6 as in Figures 3a through 5b, peripheral surfaces 50d of cutout portions 50a of ring member 50 as in Figures 6a and 6b, peripheral surfaces 50c of projections 50b of ring member 50 as in Figures 7a and 7b, and adjacent axial end surfaces 306a as in Figures 8a and 8b. Further, peripheral surfaces 6a of bolts 6, peripheral surfaces 50d of cutout portions 50a of ring member 50, and peripheral surfaces 50c of projections 50b of ring member 50 are formed have fine surfaces as described above. Moreover, these surfaces may be coated with a surface treatment, such as a PTFE plating, a chromate treatment, and a ceramic coating, after machining in a finishing process in order to provide sufficient slidability, wear resistance, and durability.

Therefore, in this invention, the area of the above-described slidably contacting surfaces which are machined to have fine surfaces is considerably less than that of the prior art because the various embodiments of the rotation prevention means of piston 17 are desired to partly slide on rotation prevention members fixed to the inside of cylinder block 3 or bolts 6. Further, it is not necessary to finish the inside surface of cylinder block 3 with a finishing tool because other members, such as ring member 50, are provided to slidably contact the

above-described rotation prevention means of piston 17 and to prevent piston 17 from rotating about its own axis.

Additionally, in relation to the piston as shown Figures 8a and 8b and referring to Figures 9a and 9b, the period during which axial end portion 306a of projection 306 smoothly slides on an adjacent axial end portion 306a' is less than the period during which contacting surfaces slide against each other in the first through fifth embodiments. This sliding period is shorter because piston 17 and adjacent piston 17' are reciprocated together and maintain a constant distance A between the axial end of piston 17 and the axial end of adjacent piston 17' until arriving at bottom dead center or top dead center and because axial end portion 306a and adjacent axial end portion 306a' only smoothly slide on each other immediately before and after arriving at bottom dead center or top dead center of piston 17 or adjacent piston 17' respectively. Accordingly, excessive wear of rotation prevention means such as axial end portions 306a and 306a' can be effectively reduced.

Claims

1. A piston type compressor comprising a compressor housing (1, 3, 5) enclosing a crank chamber, a suction chamber and a discharge chamber therein, said compressor housing including a cylinder block (3); a plurality of cylinders (7) formed in said cylinder block (3); a plurality of pistons (17) slidably disposed within each of said cylinders (7), each of said pistons having a corresponding axis; a drive shaft (12) rotatably supported in said cylinder block (3); a plate (18) tiltably connected to said drive shaft (12); a bearing (23) coupling said plate (18) to said pistons (17) so that said pistons (17) may be driven in a reciprocating motion within said cylinders (7) upon rotation of said plate (18); at least one working chamber (32, 33) defined by an end of each of said pistons (17) and an inner surface of each of said cylinders (7); a support portion (43) disposed coaxially with said drive shaft (12) and tiltably supporting a central portion of said plate (18); a tilt control device (46) driving said support portion (43) axially along said drive shaft (12) to move a central portion of said plate (18) axially along said drive shaft (12) to change the angle of tilt of said plate (18), said pistons (17) being adapted to be reciprocally moved in said cylinders (7) in accordance with a tilting motion of said plate (18); and a rotation prevention

member 50 may include projections 50b which extend radially inward from ring member 50. Peripheral surfaces 50c of projections 50b of ring member 50 are slidably adapted to fit in groove 305 of piston 17, so that ring member 50 and groove 305 cooperate to prevent piston 17 from rotating about its own axis.

Referring to Figures 8a and 8b, another piston 17 is depicted. Each piston 17 is provided with projection 306 which is integrally formed on, and arches and extends radially from, the center of coupling portion 17c of piston 17. Projection 306 includes axial end surface 306a formed on the radial end thereof. Each axial end portion 306a of projection 306 abuts the adjacent axial end portion 306a, so that adjacent end portions slide against each other as the pistons 17 reciprocate.

The above-described surfaces of the rotation prevention means formed on piston 17, such as radial end portion 301a in Figures 3a and 3b, groove 302a in Figures 4a and 4b, groove 303a in Figures 5a and 5b, outer peripheral surface 304a in Figures 6a and 6b, groove 305 in Figures 7a and 7b, and axial end surface 306a in Figures 8a and 8b are machined, e.g., by milling or grinding during a finishing process, to have fine surfaces. The surface roughness (R_a) of these fine surfaces is less than about $1.6\mu\text{m}$ (ANSI B46.1-1978). Such fine surfaces improve the anti-seizure and wear resistance of the above-described rotation prevention means when sliding against peripheral surfaces 6a or bolts 6 as in Figures 3a through 5b, peripheral surfaces 50d of cutout portions 50a of ring member 50 as in Figures 6a and 6b, peripheral surfaces 50c of projections 50b of ring member 50 as in Figures 7a and 7b, and adjacent axial end surfaces 306a as in Figures 8a and 8b. Further, peripheral surfaces 6a of bolts 6, peripheral surfaces 50d of cutout portions 50a of ring member 50, and peripheral surfaces 50c of projections 50b of ring member 50 are formed have fine surfaces as described above. Moreover, these surfaces may be coated with a surface treatment, such as a PTFE plating, a chromate treatment, and a ceramic coating, after machining in a finishing process in order to provide sufficient slidability, wear resistance, and durability.

Therefore, in this invention, the area of the above-described slidably contacting surfaces which are machined to have fine surfaces is considerably less than that of the prior art because the various embodiments of the rotation prevention means of piston 17 are desired to partly slide on rotation prevention members fixed to the inside of cylinder block 3 or bolts 6. Further, it is not necessary to finish the inside surface of cylinder block 3 with a finishing tool because other members, such as ring member 50, are provided to slidably contact the

above-described rotation prevention means of piston 17 and to prevent piston 17 from rotating about its own axis.

Additionally, in relation to the piston as shown Figures 8a and 8b and referring to Figures 9a and 9b, the period during which axial end portion 306a of projection 306 smoothly slides on an adjacent axial end portion 306a' is less than the period during which contacting surfaces slide against each other in the first through fifth embodiments. This sliding period is shorter because piston 17 and adjacent piston 17' are reciprocated together and maintain a constant distance A between the axial end of piston 17 and the axial end of adjacent piston 17' until arriving at bottom dead center or top dead center and because axial end portion 306a and adjacent axial end portion 306a' only smoothly slide on each other immediately before and after arriving at bottom dead center or top dead center of piston 17 or adjacent piston 17' respectively. Accordingly, excessive wear of rotation prevention means such as axial end portions 306a and 306a' can be effectively reduced.

Claims

1. A piston type compressor comprising a compressor housing (1, 3, 5) enclosing a crank chamber, a suction chamber and a discharge chamber therein, said compressor housing including a cylinder block (3); a plurality of cylinders (7) formed in said cylinder block (3); a plurality of pistons (17) slidably disposed within each of said cylinders (7), each of said pistons having a corresponding axis; a drive shaft (12) rotatably supported in said cylinder block (3); a plate (18) tiltably connected to said drive shaft (12); a bearing (23) coupling said plate (18) to said pistons (17) so that said pistons (17) may be driven in a reciprocating motion within said cylinders (7) upon rotation of said plate (18); at least one working chamber (32, 33) defined by an end of each of said pistons (17) and an inner surface of each of said cylinders (7); a support portion (43) disposed coaxially with said drive shaft (12) and tiltably supporting a central portion of said plate (18); a tilt control device (46) driving said support portion (43) axially along said drive shaft (12) to move a central portion of said plate (18) axially along said drive shaft (12) to change the angle of tilt of said plate (18), said pistons (17) being adapted to be reciprocally moved in said cylinders (7) in accordance with a tilting motion of said plate (18); and a rotation prevention



mechanism (300) preventing each of said pistons (17) from rotating about said corresponding axis, said rotation prevention mechanism (300) including a first rotation prevention device formed on a center of said piston (17) and a second rotation prevention device disposed within said compressor housing (1, 3, 5), said first rotation prevention device having at least one first sliding surface (304a, 50c) formed thereon, said first sliding surface being formed to be a fine surface, said second rotation prevention device having at least one second sliding surface (50d, 50b) formed on a peripheral surface thereof, said first sliding surface of said first rotation prevention device smoothly sliding on said second sliding surface of said second rotation prevention device so that said first rotation prevention device and said second rotation prevention device cooperate to prevent each of said piston (17) from rotating about said corresponding axis, characterized in that said second rotation prevention device comprises a ring member (50) fixed to the inside of said compressor housing (3, 5, 7), one of said rotation prevention devices comprising a projection (304)', 50b) engaging said other rotation prevention device.

2. The piston type compressor of claim 1, characterized in that said projection (304) is formed at said first rotation prevention device so as to extend from a center of said piston (17).
3. The piston type compressor of claim 1, characterized in that a projection (50b) corresponding to each cylinder is formed in said ring member (50).
4. The piston type compressor of claim 3, characterized in that said first rotation prevention device comprises a groove (50c) formed on a center of said piston (17).
5. The piston type compressor of one of claims 1 to 4, wherein said first sliding surface of said first rotation prevention device is formed to be a fine surface having a surface roughness which is less than about 1.6 μm .
6. The piston type compressor of any of claims 1 to 5, characterized in that said second sliding surface of said second rotation prevention device is formed to be a fine surface having a surface

roughness which is less than about 1.6 μm .

Patentansprüche

- 5 1. Kolbenkompressor mit
einem Kompressorgehäuse (1, 3, 5), das eine Kurbelkammer, eine Ansaugkammer und eine Auslaßkammer darin einschließt, wobei das Kompressorgehäuse einen Zylinderblock (3) enthält;
10 einer Mehrzahl von Zylindern (7), die in dem Zylinderblock (3) gebildet sind;
einer Mehrzahl von Kolben (17), die gleitend verschiebbar in jedem der Zylinder (7) vorgesehen sind, wobei jeder Kolben eine entsprechende Achse aufweist;
15 einer Antriebswelle (12), die drehbar in dem Zylinderblock (3) gelagert ist;
einer Scheibe (18), die neigbar mit der Antriebswelle (13) verbunden ist;
20 einem Lager (23), das die Scheibe (18) mit den Kolben (17) so verbindet, daß die Kolben (17) in einer Hin- und Herbewegung innerhalb der Zylinder (7) bei einer Rotation der Scheibe (18) angetrieben werden können;
25 mindestens einer Arbeitskammer (32, 33), die durch ein Ende eines jeden der Kolben (17) und einer inneren Oberfläche eines jeden der Zylinder (7) abgegrenzt ist;
einem Tragabschnitt (43), der koaxial zu der Antriebswelle (12) vorgesehen ist und neigbar einen Mittelabschnitt der Scheibe (18) trägt;
einer Neigungssteuereinrichtung (46), die den Tragabschnitt (43) axial entlang der Antriebswelle (12) antreibt zum Bewegen eines Mittelabschnittes der Scheibe (18) axial entlang der Antriebswelle (12) zum Ändern des Neigungswinkels der Scheibe (18), wobei die Kolben (17) dazu ausgelegt sind, daß sie in den Zylindern (7) gemäß einer Neigungsbewegung der Scheibe (18) hin- und herbewegt werden; und
einem Rotationsverhinderungsmechanismus (300), der jeden der Kolben (17) daran hindert, sich um die entsprechende Achse zu drehen, wobei der Rotationsverhinderungsmechanismus (300) eine erste Rotationsverhinderungseinrichtung, die an einer Mitte des Kolbens (17) gebildet ist, und eine zweite Rotationsverhinderungseinrichtung, die innerhalb des Kompressorgehäuses (1, 3, 5) vorgesehen ist, aufweist, die erste Rotationsverhinderungseinrichtung mindestens eine erste Gleitoberfläche (304a, 50c) darauf gebildet aufweist, die erste Gleitoberfläche als feine Oberfläche gebildet ist, die zweite Rotationsverhinderungseinrichtung mindestens eine zweite Gleitoberfläche (50d, 50b) auf einer Umfangsoberfläche davon gebildet aufweist, die erste Gleitoberfläche der



ersten Rotationsverhinderungseinrichtung glatt auf der zweiten Gleitoberfläche der zweiten Rotationsverhinderungseinrichtung so gleitet, daß die erste Rotationsverhinderungseinrichtung und die zweite Rotationsverhinderungseinrichtung zum Verhindern, daß sich jeder der Kolben (17) um die entsprechende Achse dreht, zusammenwirken; dadurch gekennzeichnet, daß die zweite Rotationsverhinderungseinrichtung ein Ringteil (50) aufweist, das an der Innenseite des Kompressorgehäuses (1, 3, 5) befestigt ist, wobei eine der Rotationsverhinderungseinrichtungen einen Vorsprung (304', 50b) aufweist, der in Eingriff mit der anderen Rotationsverhinderungseinrichtung steht.

2. Kolbenkompressor nach Anspruch 1, dadurch gekennzeichnet, daß der Vorsprung (304) an der ersten Rotationsverhinderungseinrichtung so gebildet ist, daß er sich von einer Mitte des Kolbens (17) erstreckt.
3. Kolbenkompressor nach Anspruch 1, dadurch gekennzeichnet, daß ein Vorsprung (50b) entsprechend für jeden Zylinder in dem Ringteil (50) gebildet ist.
4. Kolbenkompressor nach Anspruch 3, dadurch gekennzeichnet, daß die erste Rotationsverhinderungseinrichtung eine Rille (50c) aufweist, die an einer Mitte des Kolbens (17) gebildet ist.
5. Kolbenkompressor nach einem der Ansprüche 1 bis 4, bei dem die erste Gleitoberfläche der ersten Rotationsverhinderungseinrichtung so gebildet ist, daß sie eine feine Oberfläche ist, die eine Oberflächenrauheit aufweist, die kleiner als ungefähr $1,6\mu\text{m}$ ist.
6. Kolbenkompressor nach einem der Ansprüche 1 bis 5, dadurch gekennzeichnet, daß die zweite Gleitoberfläche der zweiten Rotationsverhinderungseinrichtung so gebildet ist, daß sie eine feine Oberfläche ist, die eine Oberflächenrauheit aufweist, die kleiner als ungefähr $1,6\mu\text{m}$ ist.

Revendications

1. Compresseur de type à pistons, comprenant : une enveloppe de compresseur (1, 3, 5) incluant un carter de moteur, une chambre d'as-

piration et une chambre d'échappement placés à l'intérieur, ladite enveloppe de boîtier comprenant un bloc-cylindres (3) ;

une pluralité de cylindres (7) formés dans ledit bloc-cylindres (3) ;

une pluralité de pistons (17) placés en coulissement à l'intérieur de chacun desdits cylindres (7), chacun desdits pistons ayant un axe correspondant ;

un arbre d'entraînement (12) supporté en rotation dans ledit bloc-cylindres (3) ;

un plateau (18) relié en oblique audit arbre d'entraînement (12) ;

un palier (23) accouplant ledit plateau (18) auxdits pistons (17) de manière que lesdits pistons (17) puissent être entraînés selon un mouvement alternatif à l'intérieur desdits cylindres (7) sous l'effet de la rotation dudit plateau (18) ;

au moins une chambre de travail (32, 33) délimitée par une extrémité de chacun desdits pistons (17) et une surface intérieure de chacun desdits cylindres (7) ;

une partie support (43) montée coaxiale avec ledit arbre d'entraînement (12) et supportant de manière inclinée une partie centrale dudit plateau (18) ;

un dispositif de commande d'inclinaison (46) entraînant ladite partie support (43) dans la direction axiale le long dudit arbre d'entraînement (12) pour déplacer une partie centrale dudit plateau (18) dans la direction axiale dudit arbre d'entraînement (12) afin de modifier l'angle d'inclinaison dudit plateau (18), lesdits pistons (17) étant prévus pour se déplacer dans les deux sens à l'intérieur desdits cylindres (7) en fonction d'un mouvement d'inclinaison dudit plateau (18) ; et un mécanisme (300) pour empêcher la rotation empêchant chacun desdits pistons (17) de tourner autour dudit axe correspondant, ledit mécanisme pour empêcher la rotation (300) comprenant un premier dispositif pour empêcher la rotation formé au centre dudit piston (17) et un second dispositif pour empêcher la rotation placé à l'intérieur de ladite enveloppe de compresseur (1, 3, 5), ledit premier dispositif pour empêcher la rotation comprenant au moins une première surface coulissante (304a, 50c) formée sur ce piston, ladite première surface coulissante étant usinée en forme de surface lisse, ledit second dispositif pour empêcher la rotation comportant au moins une seconde surface coulissante (50d, 50b) formée sur sa surface périphérique, ladite première surface coulissante dudit premier dispositif pour empêcher la rotation couissant régulièrement sur ladite seconde surface coulissante dudit second dispositif pour em-



pêcher la rotation de manière que ledit premier dispositif pour empêcher la rotation et ledit second dispositif pour empêcher la rotation coopèrent entre eux afin d'empêcher chacun desdits pistons (17) de tourner autour dudit axe correspondant, caractérisé en ce que

ledit second dispositif pour empêcher la rotation comprend un élément annulaire (50) fixé à l'intérieur de ladite enveloppe de compresseur (3, 5, 7), l'un desdits dispositifs pour empêcher la rotation comprenant une partie en saillie (304', 50b) venant en prise avec ledit autre dispositif pour empêcher la rotation.

2. Compresseur du type à pistons selon la revendication 1, caractérisé en ce que ladite partie en saillie (304) est formée sur ledit premier dispositif pour empêcher la rotation de manière à s'étendre à partir du centre dudit piston (17). 15
3. Compresseur du type à pistons selon la revendication 1, caractérisé en ce qu'une partie en saillie (50b) correspondant à chaque cylindre est formée dans ledit élément annulaire (50). 20
4. Compresseur du type à pistons selon la revendication 3, caractérisé en ce que ledit premier dispositif pour empêcher la rotation comprend une rainure (50c) formée au centre dudit piston (17). 25
5. Compresseur du type à pistons selon l'une quelconque des revendications 1 à 4, dans lequel ladite première surface coulissante dudit premier dispositif pour empêcher la rotation est usinée en une surface lisse dont la rugosité de surface est inférieure à environ 1,6 μm . 30
6. Compresseur du type à pistons selon l'une quelconque des revendications 1 à 5, caractérisé en ce que ladite seconde surface coulissante dudit second dispositif pour empêcher la rotation est usinée en une surface lisse dont la rugosité de surface est inférieure à environ 1,6 μm . 35

