

HERMETIC COMPRESSOR AND DEVICE USING THE SAME

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

[0001]

The present invention relates to a hermetic compressor and a device using it.

10 2. Description of the Related Art

[0002]

As a related hermetic compressor, a compressor shown in Japanese Patent Application Laid-Open No. Hei 7-224761 is known. The hermetic compressor is a reciprocating compressor having a piston and a crankshaft. A piston pin is used for connection between the piston and a connecting rod. A piston pin 59 is provided with an oil groove 3, arranged to be orthogonal to a sliding direction, in a position where compression load is not applied (paragraph 15 0018, Figs. 3 and 4). Further, the compressor has an oil hole 1 communicating the sliding part of a bearing 55 to pivotally support a crankshaft 54 with a cylinder bore 56.

[0003]

[Patent Document 1] Japanese Patent Application Laid-
25 open No. Hei 7-224761

[0004]

According to Japanese Patent Application Laid-Open No. Hei 7-224761, lubrication between the piston pin and the connecting rod is performed only with the oil groove 3
5 provided in the axial direction of the piston pin. There is a conceivable problem that the lubricant does not sufficiently spread over in the piston pin circumferential direction.

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SUMMARY OF THE INVENTION

[0005]

The present invention has been made in view of the above situation, and provides a hermetic compressor including: a sealed container containing lubricant; a
15 reciprocatable piston provided with a piston pin; a piston-pin axial-direction lubricant passage extending in an axial direction of the piston pin; and a piston-pin circumferential direction groove extending in a circumferential direction of the piston pin.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0006]

Fig. 1 is a longitudinal sectional view of a compressor according to an embodiment 1 of the present
25 invention;

Fig. 2 is a cross-sectional perspective view in the vicinity of a cylinder of the compressor according to the embodiment 1;

Fig. 3 is a cross-sectional view in the vicinity of
5 the cylinder of the compressor according to the embodiment 1;

Fig. 4 is a top view of a piston of the compressor according to the embodiment 1;

Fig. 5 is a perspective view of a piston pin
10 according to an embodiment 2 of the present invention;

Fig. 6 is a perspective view of the piston pin according to an embodiment 3 of the present invention;

Fig. 7 is a side view of the piston pin according to the embodiment 3; and

15 Fig. 8 is a perspective view of the piston pin according to an embodiment 4 of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS [0007]

20 Hereinbelow, preferred embodiments of the present invention will now be described in detail in accordance with the accompanying drawings. The same constituent elements will have the same reference numerals and the same explanation will not be repeated.

25 [0008]

The various constituent elements in the present invention are not necessarily independent elements. One constituent element may be formed with plural members, or plural constituent elements may be formed of one member.

5 Further, a constituent element may be a part of another constituent element. Further, a part of a constituent element and that of another constituent element may overlap.

Embodiment 1

10 [0009]

Fig. 1 is a longitudinal sectional view of a hermetic compressor 50 according to the present embodiment. Fig. 2 is a cross-sectional perspective view in the vicinity of a cylinder 1 of the hermetic compressor 50 according to the present embodiment. Fig. 3 is a cross-sectional view in the vicinity of the cylinder 1 of the hermetic compressor 50 according to the present embodiment, explaining a flow direction of lubricant. Fig. 4 is a top view of a piston 4 of the hermetic compressor 50 according to the present embodiment. In Fig. 3, a bold arrow indicates a direction in which the lubricant is supplied.

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In the hermetic compressor 50, an electric element 30, a compression element 20, and lubricant 35 are accommodated in a sealed container 3.

25 [0010]

[Electric Element 30]

The hermetic compressor 50 has the electric element 30 including a stator 5 and a rotor 6. The stator 5 and the rotor 6 are positioned below the cylinder 1, the piston 4, a connecting rod 2, and a piston pin 43.

5 [0011]

Winding is put around the stator 5. When an electric current is passed through the winding to drive the electric element 30, the rotor 6 starts rotating motion. The rotor 6 is connected to a crankshaft 7. When the rotor 6 rotates, 10 the crankshaft 7 performs rotating motion along with the rotor 6.

[0012]

[Compression Element 20]

The hermetic compressor 50 has a compression element 15 20 including the crankshaft 7, the connecting rod 2, the piston 4 and the piston pin 43, the cylinder 1 and a cylinder block 17.

[0013]

[Crankshaft 7]

20 A lower end of the crankshaft 7 is soaked in the lubricant 35 stored in a lower part of the sealed container 3. A crank pin 7a is provided in a position different from a rotary shaft of the crankshaft 7 (eccentric position from the rotary shaft) at an upper end of the crankshaft 7. 25 Accordingly, when the crankshaft 7 rotates, the crank pin

7a revolves around the rotary shaft of the crankshaft 7 (performs an eccentric motion). Further, the crankshaft 7 pumps up the lubricant 35 in accordance with the revolution of the crankshaft 7, to the crank pin 7a. As the
5 configuration to pump up the lubricant, various known configurations may be adopted. As an example, a columnar shaped hollow may be provided on the lubricant 35 side. When the crankshaft 7 rotates, the lubricant 35 in the hollow rotate-moves by friction against the crankshaft 7.
10 The centrifugal force caused by the rotating motion pumps up the lubricant 35. As another example, a spiral groove may be provided in the outer periphery of the crankshaft 7 or a stationary bearing opposite to the outer periphery of the crankshaft 7. Upon rotation of the crankshaft 7,
15 friction occurs between the shaft or the bearing wall surface and the lubricant 35 in the spiral groove due to speed difference. With this friction as a driving force, the lubricant in the spiral groove moves up along the spiral groove.
20 [0014]

The crank pin 7a has a pin bored part 7f which is a hollow and which is connected from the crankshaft 7. The lubricant elevated by the rotation of the crankshaft 7 enters the pin bored part 7f. The pin bored part 7f is
25 provided with a passage connected to an outer peripheral

surface of the crank pin 7a. A part of the lubricant is supplied between the crank pin 7a and a large end 2b to be described later, and other part of the lubricant is spouted from the upper end side of the crank pin 7a and is supplied
5 to a piston recess 4a to be described later or the like.

[0015]

[Connecting Rod 2]

The connecting rod 2 has the large end 2b and a small end 2c respectively having a hollow ring shape, and a bar
10 shaped arm 2d connecting these rings. The crank pin 7a of the crankshaft 7 is fitted in the large end 2b, with which the large end 2b and the crank pin 7a are connected. The piston pin 43 inserted in the piston 4 is fitted in the small end 2c, with which the small end 2c and the piston 4
15 are connected. The arm 2d connects the large end 2b to the small end 2c via an opening on the bottom dead side of the piston 4.

[0016]

In this manner, the crank pin 7a is positioned in the
20 ring of the large end 2b, and the piston pin 43 is positioned in the ring of the small end 2c. The crank pin 7a and the piston pin 43 respectively have an approximately cylindrical shape. These pins are slightly small in comparison with the inner peripheral diameters (inside
25 measurements) of the respective rings of the large end 2b

and the small end 2c. Accordingly, the crank pin 7a and the piston pin 43 are approximately fitted in the large end 2b and the small end 2c, and are relatively freely movable.

[0017]

5 A communicating hole 2a to connect the inner periphery of the large end 2b and the inner periphery of the small end 2c is provided in the arm 2d. In the communicating hole 2a, the lubricant is supplied between the outer peripheral surface of the crank pin 7a and the
10 large end 2b from a passage connecting the passage provided in the pin bored part 7f to the outer peripheral surface of the crank pin 7a. The lubricant is further provided through the communicating hole 2a to the small end 2c, thus lubricates a part between the small end 2c and the piston
15 pin 43.

[0018]

[Piston Pin 43 and Piston 4]

 The piston 4 having a cylindrical shape is provided slidably in the cylinder 1. Accordingly, the motion
20 direction of the piston 4 is limited within the cylindrical space provided in the cylinder 1. The connecting rod 2 performs sliding motion about the piston pin 43 in accordance with the revolution of the crank pin 7a. In this manner, the revolution motion of the crank pin 7a is
25 converted to the reciprocating motion of the piston 4 in

the cylinder 1. In the present embodiment, the reciprocating direction of the piston 4 is an approximate horizontal direction.

[0019]

5 The shape of the piston pin 43 is an approximate cylindrical shape having an axis in the vertical direction. The piston pin 43 has a piston-pin circumferential direction groove 43a as an oil groove in the circumferential direction and a piston-pin axial-direction
10 lubricant passage 43b as an oil groove in the axial direction. The piston-pin circumferential direction groove 43a is provided in a position opposite to the inner periphery of the small end 2c, and the piston-pin circumferential direction groove 43a intersects with the
15 piston-pin axial-direction lubricant passage 43b. In the present embodiment, the piston-pin circumferential direction groove 43a makes a circuit around the piston pin 43 in the peripheral direction. It is preferable for the sake of process when the groove is formed to make a circuit
20 in this manner. Further, the groove less than one circuit may be formed, or a spiral shape over one circuit may be formed.

[0020]

 The piston recess 4a lower (recessed) than the outer
25 peripheral surface of the piston 4 is provided in the upper

surface of the piston 4. The piston recess 4a is provided around a piston pin insertion hole 4b in which the piston pin 43 is inserted. A part or the entire piston recess 4a is exposed from the cylinder 1 while the piston 4 is at least positioned in the bottom dead. In the present embodiment, the piston recess 4a has an approximately rectangular shape, however, the shape is not particularly limited. A part of the lubricant fallen on the upper surface of the piston 4 is caught with the piston recess 4a, and flows in the piston-pin axial-direction lubricant passage 43b. An upper end of the piston-pin axial-direction lubricant passage 43b is observable in the top plan view of the piston 4. That is, the piston-pin axial-direction lubricant passage 43b is connected (communicated) to the upper surface of the piston 4.

[0021]

The lubricant passed through the communicating hole 2a is supplied to the inner periphery of the small end 2c. The lubricant is supplied to the piston-pin circumferential direction groove 43a and the piston-pin axial-direction lubricant passage 43b, but is mainly supplied to the piston-pin circumferential direction groove 43a. This lubricates a part between the piston pin 43 and the small end 2c. The lubricant is further guided with the piston-pin axial-direction lubricant passage 43b in the upward

direction and the downward direction, to lubricate a part between the piston pin 43 and the piston 4.

[0022]

Further, a part of the lubricant scattered around
5 from the upper end of the pin bored part 7f by the
centrifugal force is supplied to the piston recess 4a. The
piston recess 4a has a function as an oil reservoir. The
lubricant arrived at the piston recess 4a is passed through
the piston-pin axial-direction lubricant passage 43b, to
10 lubricate a part between the piston pin 43 and the piston 4.

[0023]

[Cylinder 1]

The cylinder 1 is a member including cylindrical
space in which the piston 4 slides. The cylinder 1 is
15 provided with a cylinder block 17 at one end, and is
provided with the piston 4 reciprocate-slidably at the
other end.

[0024]

A cylinder head 10 is provided with an intake hole
20 and a discharge hole (not shown). When the piston 4
reciprocates, it is possible to intake refrigerant into the
cylinder 1 and discharge the compressed refrigerant from
the cylinder 1 through these holes.

[0025]

25 [Lubricant Supply]

The lubricant passed through the communicating hole 2a flows toward the small end 2c, and arrives at the piston-pin circumferential direction groove 43a. Further, the part of the lubricant scattered from the upper end of the pin bored part 7f falls on the upper surfaces of the piston 4 and the cylinder 1. The part of the lubricant fallen on the upper surface of the cylinder 1 drops on the upper surface of the piston 4, and is collected in the piston recess 4a. Then the lubricant is guided with an upper groove 43b1, positioned on the upper side from the piston-pin circumferential direction groove 43a in the piston-pin axial-direction lubricant passage 43b communicating with the piston recess 4a, and flows downward.

[0026]

The lubrication between the small end 2c and the piston pin 43 is performed with both of the lubricant passed through the communicating hole 2a and the lubricant fallen on the upper surface of the piston 4 or the cylinder 1. At this time, as the piston-pin circumferential direction groove 43a is connected to the upper groove 43b1, the reciprocation of the lubricant between these grooves is facilitated.

Note that although it is possible to supply oil in the vicinity of the small end 2c with the piston-pin circumferential direction groove 43a, in the small end 2c,

the oil supply to a region away in the vertical direction is frequently insufficient. As in the case of the present embodiment, by providing the upper groove 43b1, it is possible to supply the oil to a region away from the piston-pin circumferential direction groove 43a in the upward direction, by using both of the lubricant passed through the communicating hole 2a and the lubricant fallen on the upper surface of the piston 4 or the cylinder 1. Accordingly the lubricity is improved.

10 [0027]

Further, in the present embodiment, the piston-pin circumferential direction groove 43a is connected to a lower groove 43b2 positioned lower from the piston-pin circumferential direction groove 43a in the piston-pin axial-direction lubricant passage 43b. Accordingly, both of the lubricant passed through the communicating hole 2a and the lubricant fallen on the upper surface of the piston 4 or the cylinder 1 are supplied to a lower surface of the piston 4. It is possible to improve the lubricity between the lower surface of the piston 4 and the cylinder 1.

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It is preferable that both of the upper groove 43b1 and the lower groove 43b2 are provided as in the case of the present embodiment, however, it may be configured such that only one of these grooves is provided.

25 [0028]

In the present embodiment, the upper groove 43b1 and the lower groove 43b2 have the same point in the piston-pin circumferential direction groove 43a as an origin. However, the grooves may have different points as origins. That is, in the present embodiment, the intersection between the piston-pin circumferential direction groove 43a and the piston-pin axial-direction lubricant passage 43b is formed as a point where the grooves extend in four directions. The point may be formed as a point where the grooves extend in three directions.

[0029]

Note that in the present embodiment, the piston-pin circumferential direction groove 43a is provided in the piston pin 43. However, the groove may be provided at the small end 2c. That is, the groove may be provided in any position as long as there is a gap between the small end 2c and the piston pin 43.

[0030]

The hermetic compressor 50 according to the present embodiment is applicable to various devices such as a refrigerator, an air conditioner, and a refrigerating cycle device.

Embodiment 2

[0031]

The configuration of the present embodiment is the same as that of the embodiment 1 except the following. Fig. 5 is a perspective view of the piston pin 43 according to the present embodiment. As in the case of the embodiment 1, the piston-pin circumferential direction groove 43a is formed in the piston pin 43. In place of or in addition to the piston-pin axial-direction lubricant passage 43b, a piston-pin axial-direction plane cut 43c is formed in the axial direction of the piston pin 43. The piston-pin axial-direction plane cut 43c is formed by cutting and processing a part of the circle of the piston pin 43 having an approximately round shape in the axial direction, as a chord. When this piston pin 43 is incorporated in the piston 4 shown in Fig. 4, an oil supply passage through which the lubricant is passed in the axial direction of the piston pin 43 is formed with a gap between the inner peripheral surface of the piston pin insertion hole 4b and the piston-pin axial-direction plane cut 43c. The oil supply passage has the same function and advantage as those of the piston-pin axial-direction lubricant passage 43b shown in the embodiment 1.

Embodiment 3

[0032]

The configuration of the present invention is the

same as that of the embodiment 1 or 2 except the following.
Fig. 6 is a perspective view of the piston pin 43 according
to the present embodiment. In the embodiment 1, an angle θ
formed with the piston-pin axial-direction lubricant

5 passage 43b and a horizontal surface is approximately 90° .

In the present embodiment, the angle θ is not 90° but an
acute or obtuse angle.

[0033]

Fig. 7 is a side view explaining the position of load
10 applied to the piston pin 43 upon driving of the hermetic
compressor 50. In Fig. 7, a broken line indicates an end
position of a region where the small end 2c and the piston
pin 43 overlap upon assembly. Since the connecting rod 2
is swingably fitted around the piston pin 43, the internal
15 diameter of the small end 2c is slightly larger than the
outer diameter of the piston pin 43. Accordingly, upon
driving of the hermetic compressor 50, the piston pin 43
and the small end 2c are in line contact with each other.
Fig. 7 shows an example of the line contact position at
20 this time as a piston pin load line 43d. The line contact
position is shifted in accordance with position of the
piston 4 or the connecting rod 2 or driving conditions for
the hermetic compressor 50. However, the piston pin load
line 43d is an approximately parallel to the axial
25 direction of the piston pin 43.

[0034]

In the present embodiment, the angle θ formed with the piston-pin axial-direction lubricant passage 43b and the horizontal surface is not 90° . As the piston-pin axial-direction lubricant passage 43b and the axial direction of the piston pin 43 are not parallel, it is possible to suppress approximate correspondence between the piston pin load line 43d and the piston-pin axial-direction lubricant passage 43b in whatever position the piston pin load line 43d is located. That is, it is possible to suppress line contact between the piston pin load line 43d and the piston-pin axial-direction lubricant passage 43b. When the piston-pin axial-direction lubricant passage 43b and the piston pin load line 43d become into correspondence and in line contact with each other, the oil film pressure is low in the groove part and it is not possible to hold the axis. Accordingly, there is a probability of degradation of sliding condition. However, in the present embodiment, it is possible to avoid the contact between the piston-pin axial-direction lubricant passage 43b and the piston pin load line 43d in parallel directions. In the present embodiment, it is possible to limit the contact between the piston-pin axial-direction lubricant passage 43b and the piston pin load line 43d to merely point contact or the like. Accordingly it is possible to reduce the degradation

of lubricity.

[0035]

Further, the relative motion between the small end 2c and the piston pin 43 is a sliding motion. Accordingly, during driving of the hermetic compressor 50, the piston pin load line 43d moves in a wide range in the outer peripheral surface of the piston pin 43. To improve the lubricity, it is preferable to provide plural piston-pin axial-direction lubricant passages 43b.

10 [0036]

As a value of the angle θ , it is preferable to use a value from 20° to 80° . Further, in consideration of assembly accuracy to be described later, it is preferable to use a value from 30° to 60° .

15 [0037]

Note that the angle formed with the piston-pin axial-direction lubricant passage 43b and the "horizontal surface" is described as the angle θ , in view of determination of the direction of the piston pin load line 43d. The piston pin load line 43d is determined by a force caused upon conversion of the revolution motion of the crank pin 7a with the connecting rod 2 into the reciprocating motion of the piston 4. The piston pin load line 43d is shifted to a certain degree in accordance with direction of the revolution axis of the crank pin 7a or

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angle of connection between the connecting rod 2 and the crank pin 7a or the piston pin 43. However, the direction of the revolution axis of the crank pin 7a, the swing shaft determined by the connection between the crank pin 7a and the large end 2b, and the connection between the piston pin 43 and the small end 2c, are generally designed such that they are parallel to each other in the vertical direction. In this case, as the piston pin load line 43d is orthogonal to the "horizontal surface", the angle θ is explained as an angle formed with the piston-pin axial-direction lubricant passage 43b and the "horizontal surface". That is, it is necessary to regard an angle shifted from the "horizontal surface" to a certain degree as the angle θ in accordance with assembly accuracy. Accordingly, it may be configured such that the value of the angle θ is set within the above range while the "horizontal surface" is maintained as a reference. Further, it may be configured such that the "horizontal surface" is replaced with a virtual plane orthogonal to the revolution axis of the crank pin 7a while the above range of the angle θ is maintained.

Embodiment 4

[0038]

The configuration of the present embodiment is the same as that of any of the embodiments 1 to 3 except the

following. Fig. 8 is a perspective view of the piston pin 43 according to the present embodiment. In the present embodiment, plural piston-pin axial-direction lubricant passages 43b are formed. Among them, one set (two
5 passages) or more passages intersect to form intersections. In the present embodiment, these intersections overlap the piston-pin circumferential direction groove 43a, however, they may not overlap the groove.

[0039]

10 When the relative motion (swing motion) between the small end 2c and the piston pin 43 is small, the flow direction of the lubricant in the piston-pin axial-direction lubricant passage 43b is ruled mainly by the gravity. As shown in Fig. 3, the lubricant flows downward.
15 On the other hand, when the relative motion (swing motion) between the small end 2c and the piston pin 43 is large, the lubricant driving force by wall surface friction is dominant. Then a flow of the lubricant gathering to the intersection of the piston-pin axial-direction lubricant
20 passage 43b and a flow of the lubricant away from the intersections are formed. At this time, at the intersection of the respective piston-pin axial-direction lubricant passages 43b, the lubricant flowing from the respective piston-pin axial-direction lubricant passages
25 43b inevitably collide against each other. Accordingly,

hydrodynamic dynamic pressure occurs, and high oil film pressure occurs. As the axis holding force is improved, the sliding condition is improved.

[0040]

5 Note that the "intersection" here is interpreted as a point where the piston-pin axial-direction lubricant passage 43b or the piston-pin circumferential direction groove 43a, or preferably the piston-pin axial-direction lubricant passage 43b, extends in at least three or four
10 directions. That is, the passage or groove may extend in an "X" shape as in the case of the present embodiment, or may extend in a "\(\lambda\)" shape.

REFERENCE SIGNS LIST

15 [0041]

1 ... cylinder, 2 ... connecting rod, 2a ... communicating hole, 2b ... large end, 2c ... small end, 2d ... arm, 3 ... sealed container, 4 ... piston, 4a ... piston recess, 4b ... piston pin insertion hole, 5 ...
20 stator, 6 ... rotor, 7 ... crankshaft, 7a ... crank pin, 7f ... pin bored part, 17 ... head cover, 20 ... compression element, 30 ... electric element, 35 ... lubricant, 43 ... piston pin, 43a ... piston-pin circumferential-direction groove, 43b ... piston-pin axial-
25 direction lubricant passage, 43c ... piston-pin axial-direction plane cut, 43d ... piston pin load line, and

50 ... hermetic compressor.

WHAT IS CLAIMED IS:

1. A hermetic compressor comprising:

a sealed container that contains lubricant;

5 a piston that is reciprocable and is provided with a piston pin;

a piston-pin axial-direction lubricant passage that extends in an axial direction of the piston pin; and

a piston-pin circumferential direction groove that
10 extends a circumferential direction of the piston pin,

a crankshaft that is rotatable and that pumps up the lubricant;

a crank pin that revolves around the rotary shaft of the crankshaft;

15 a connecting rod having a large end and a small end respectively fitted in the crank pin and the piston, and an arm to connect the large end to the small end; and

a communicating hole provided from the large end toward the small end,

20 wherein at least a part of a piston recess provided on an upper surface of the piston is exposed from a cylinder when the piston is positioned at the bottom dead,

wherein the piston-pin axial-direction lubricant passage communicates with the upper surface and a lower
25 surface of the piston, and is connected to the piston-pin

circumferential direction groove,

wherein the piston-pin axial-direction lubricant passage has an upper lubricant passage positioned on the upper side from the piston-pin circumferential direction groove and communicates with the upper surface of the piston and a lower lubricant passage positioned on the lower side from the piston-pin circumferential direction groove and communicates with the lower surface of the piston, and

wherein lubricant supply channels which supply the lubricant pumped up by the crank shaft to the lower surface of the piston include a first lubricant supply channel through which the lubricant flows in an order of the crank pin, the communicating hole, the piston-pin circumferential direction groove, the lower lubricant passage and the lower surface of the piston and a second lubricant supply channel through which the lubricant flows in an order of the crank pin, the piston recess provided on the upper surface of the piston, the upper lubricant passage, the lower lubricant passage and the lower surface of the piston.

2. The hermetic compressor according to claim 1, wherein the piston-pin axial-direction lubricant passage forms an acute angle or obtuse angle with respect to a horizontal surface.

3. The hermetic compressor according to any one of claims 1 and 2, further comprising two or more piston-pin axial-direction lubricant passages,

5 wherein at least two of the piston-pin axial-direction lubricant passages form an intersection.

4. A device having the hermetic compressor according to any one of claims 1 to 3.