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(54) **COMPRESSOR**

VERDICHTER

COMPRESSEUR

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Description

FIELD

[0001] The present disclosure relates to a compressor, and more particularly, to a variable speed compressor.

BACKGROUND

[0002] This section provides background information related to the present disclosure and is not necessarily prior art.

[0003] A centrifugal oil pump is widely used in a vertical compressor which has a vertical crankshaft. Such an oil pump may include an oil flinger disposed in an axially extending bore through a bottom end of the vertical crankshaft. Of course, this type of centrifugal oil pump may also have other various designs.

[0004] However, for this type of centrifugal oil pump, an oil flow rate through the oil pump is directly proportional to the square of the rotation speed of the crankshaft. Therefore, when the rotational speed of the crankshaft is relatively high, the oil pump delivers a relatively large amount of oil, but when the rotational speed of the crankshaft is relatively low, the oil pump delivers much less oil or even no oil.

[0005] In order to deliver sufficient oil at low speed, various improved designs may be made.

[0006] JP H04-27788 discloses an oil sump section collecting a lubricant, formed on the inner bottom section of a sealed case, and an oil feed passage guiding the lubricant fed from the oil sump section to various sliding portions of a compression system. The suction section of a oil feeding pump is dipped into the oil sump section, and a discharge section is communicated to the oil feed passage. The oil feeding pump is electrically connected to a power source separate from a motor section, and it is driven independently from the compression system. In a sealed compressor using the inverter control system, an invariably stable oil feed quantity can be fed to sliding portions of the compression system even at the extremely high or extremely low operating frequency.

SUMMARY

[0007] According to the invention there is provided a method of operating a compressor according to claim 1.

[0008] The following section provides a general summary of the disclosure, and is not a comprehensive disclosure of its full scope of all of its features.

[0009] The present disclosure provides an oil pump that can deliver sufficient amounts of oil at substantially the same oil flow rate at different rotation speeds of a crankshaft of the compressor. The compressor of the present disclosure can be manufactured relatively inexpensively and is highly reliable.

[0010] The present disclosure provides a compressor that may include a crankshaft, a lower bearing, an oil sump, and an oil pump. The crankshaft may include an upper part, a lower part, and an oil supply passage formed therethrough from the upper part to the lower part. The lower bearing may rotatably support the lower part of the crankshaft. The oil sump may be disposed proximate the lower part of the crankshaft. The oil pump may include an oil inlet, an oil outlet, an oil intake chamber and an oil discharging chamber. The oil inlet may be positioned below a level of oil in the oil sump and in fluid communication with the oil intake chamber. The oil discharging chamber may be in fluid communication with the oil supply passage at the lower part of the crankshaft through the oil outlet. The compressor may also include a pressure equilibrium tube which provides fluid communication between a space above the level of oil in the oil sump and the oil intake chamber. In some embodiments, the pressure equilibrium tube may be arranged outside of the oil pump and the crankshaft.

[0011] The compressor may also include a lower bearing assembly with an upper portion thereof forming the lower bearing and a lower portion thereof extendedly forming a case of the oil pump; an impeller assembly comprising an upper section for attaching to the lower part of the crankshaft so as to rotate together, a lower section for forming an impeller, and a middle section located between the upper section and the lower section, wherein the oil intake chamber is defined by the space between the outer circumference surface of the middle section of the impeller assembly and the inner circumference surface of the case, and the oil discharging chamber is defined by the space between the outer circumference surface of the impeller and the inner circumference surface of the case, when the impeller assembly is fitted into the case; and a pump cover fitted in the case and located below the impeller.

[0012] At least one guiding channel can be provided on one side of the impeller, that one side of the impeller being adjacent to the middle section of the impeller assembly; a static passage is provided on one side of the pump cover, that one side of the pump cover being adjacent to the impeller; an the impeller assembly has a central passage longitudinally formed therethrough, the upper end of the central passage defines the oil outlet and the lower end of the central passage adapts to be in fluid communication with the static passage; wherein, the oil intake chamber, the guiding channel, the oil discharging chamber, the static passage and the central passage sequentially define an oil flow path of the oil pump.

[0013] The interior wall of the lower bearing assembly from top to bottom may define a first circumference region for supporting the crankshaft, a second circumference region having a smaller diameter than that of the first circumference region, and a third circumference region having a larger diameter than that of the first circumference region; wherein the oil intake chamber is defined between the second circumference region and the outer circumference surface of the middle section of the impeller assembly, the oil inlet of the oil pump radially extends through the second circumference region from the exterior wall of the lower bearing assembly.

[0014] A venting hole may radially extend through the second circumference region from the exterior wall of the lower bearing assembly, and the pressure equilibrium tube is in fluid communication with the oil intake chamber via the venting hole.

[0015] The oil discharging chamber may be defined between the third circumference region and the outer circumference surface of the impeller.

[0016] The pressure equilibrium tube may be arranged inside of the oil pump and the crankshaft.

[0017] The compressor may further comprise: a lower bearing assembly with an upper portion thereof forming the lower bearing and a lower portion thereof extendedly forming a case of the oil pump; an impeller assembly comprising an upper section for attaching to the lower part of the crankshaft so as to rotate together, a lower section for forming an impeller, and a middle section located between the upper section and the lower section, wherein the oil intake chamber is formed by recessing the bottom of the impeller at central portion thereof, and the oil discharging chamber is defined by the space between the outer circumference surface of the impeller and the inner circumference surface of the case when the impeller assembly is fitted into the case; and a pump cover fitted in the case and located below the impeller, wherein the oil inlet is defined by a central opening in the pump cover.

[0018] At least one guiding channel can be provided on one side of the impeller, that one side of the impeller being adjacent to the pump cover; a static passage is defined by the space between the outer circumference surface of the middle section of the impeller assembly and the inner circumference surface of the case; and the oil outlet is formed by longitudinally extending through the upper section of the impeller assembly; wherein, the oil intake chamber, the guiding channel, the oil discharging chamber, the static passage and the oil outlet sequentially define an oil flow path of the oil pump.

[0019] The interior wall of the lower bearing assembly from top to bottom may define a first circumference region for supporting the crankshaft, a second circumference region having a smaller diameter than that of the first circumference region, a third circumference region having a larger diameter than that of the first circumference region, and a fourth circumference region having a larger diameter than that of the third circumference region; wherein the static passage is defined between the second and third circumference regions and the outer circumference surface of the middle section of the impeller assembly, and the oil discharging chamber is defined between the fourth circumference region and the outer circumference surface of the impeller.

[0020] The impeller assembly may have a central passage longitudinally formed therethrough for being in fluid communication with the oil intake chamber, and a lower end of the pressure equilibrium tube is inserted into the central passage.

[0021] The oil outlet, which is formed in the upper section of the impeller assembly and in fluid communication with the oil supply passage, can be positioned outside of the central passage in the radial direction of the impeller assembly.

[0022] A venting hole may be formed at the lower part of the crankshaft, an opening of the venting hole on the exterior wall of the crankshaft is above the level of oil in the oil sump, and an upper end of the pressure equilibrium tube is inserted into a portion of the venting hole through the oil supply passage.

[0023] The diameter of the impeller of the oil pump may be larger than that of the crankshaft such that sufficient oil is supplied to the oil supply passage when the rotation speed of the crankshaft is low.

[0024] The oil pump may be a centrifugal pump, an axial flow pump, a positive displacement pump or any other suitable pump.

[0025] The lower bearing may be located below the level of oil in the oil sump.

[0026] The compressor may further comprise a debris filter which is arranged around the outer circumference of the oil pump.

[0027] The compressor may further comprise a retainer ring which is used to hold the pump cover within the case.

[0028] In another form, the present disclosure provides a method of operating a compressor. The method may include rotating a crankshaft of the compressor at a first rotational speed and rotating the crankshaft at a second rotational speed. Oil may be supplied through an oil supply passage extending between first and second ends of the crankshaft at a flow rate while the crankshaft is rotating at the first rotational speed. Oil may be supplied through the oil supply passage at substantially the same flow rate while the crankshaft is rotating at the second rotational speed.

[0029] In another form, the present disclosure provides a compressor that may include a compression mechanism, a crankshaft, an annular case, and an impeller. The crankshaft may drive the compression mechanism and may include a first end coupled to the compression mechanism, a second end opposite the first end, and an oil passageway extending between the first and second ends. The annular case may receive the second end of the crankshaft and may include an interior cavity and a radially extending aperture in communication with the interior cavity. The interior cavity may be in communication with the lubricant passageway. The radially extending aperture may control communication of fluid from a lubricant sump to the interior cavity. The impeller may be at least partially disposed within the interior cavity of the annular case and may be coupled to the second end of the crankshaft for rotation with the crankshaft. The impeller may communicate lubricant from the interior cavity of the annular case to the lubricant passageway of the crankshaft. The impeller may include an axially extending aperture communicating lubricant from the interior cavity to the lubricant passageway. The impeller may include a plurality of apertures circumferentially spaced apart from each other and radially spaced apart from the axially extending aperture. The plurality of apertures may provide communication between the axially extending aperture and the radially extending aperture in the casing.

[0030] The compressor constructed according to the principles of the present disclosure may provide for oil to be fed to the oil pump via the oil inlet so as to ensure that the oil can be delivered with the same oil flow rate at different rotation speeds of the crankshaft. That is, the oil flow rate is not significantly affected by the rotation speed of the crankshaft.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031]

Figure 1 is a cross-sectional view of a compressor according to the principles of the present disclosure;

Figure 2 is a partial exploded perspective view of a crankshaft and an oil pump of the compressor of Figure 1;

Figure 3 is a cross-sectional view showing an impeller and a crankshaft of the oil pump according to the principles of the present disclosure;

Figure 4 is a cross-sectional view showing a pump cover and a lower bearing of the oil pump of the compressor according to the principles of the present disclosure;

Figure 5 is a cross-sectional view showing a portionof the lower bearing having an oil inlet and a venting hole according to the principles of the present disclosure;

Figure 6 is a partial cross-sectional view of the oil pump of the compressor according to the principles of the present disclosure;

Figure 7 is another partial cross-sectional view of the compressor;

Figure 8 is a graph showing a relationship between an oil flow rate of the oil pump and the rotational speed of the crankshaft;

Figure 9 is a partial cross-sectional view of an oil pump according to another embodiment of the present disclosure; and

Figure 10 is a perspective view of an impeller assembly of the oil pump of Figure 9.

DETAILED DESCRIPTION

[0032] As shown in Figures 1 and 2, a compressor 100 according to the principles of the present disclosure is provided and may include an oil pump 500. The compressor 100 may include a housing 110, a compression mechanism 115, a crankshaft 120 vertically arranged within the housing 110 and having an upper end part 124 and a lower end part 126, a lower bearing 140 disposed within the housing 110 and pivotably supporting the lower end part 126 of the crankshaft 120, and an oil sump 180 disposed within the housing 110 and located at the vicinity of the lower end part 126 of the crankshaft 120. The crankshaft 120 has an oil supply passage 127 provided to penetrate through the upper end part 124 and the lower end part 126. The upper end part 124 of the crankshaft 120 may be coupled to the compression mechanism 115 for driving the compression mechanism 115.

[0033] As shown in Figure 2, the compressor 100 comprises a lower bearing assembly 510, a pressure equilibrium tube 520, an impeller assembly 530, a pump cover 550, a retainer ring 570 and a debris filter 590.

[0034] An upper portion of the lower bearing assembly 510 forms the lower bearing 140 for supporting the lower end part 126 of the crankshaft 120, and a lower portion thereof extends so as to form a case 515 of the oil pump 500. As shown in Figure 6, an interior wall of the lower bearing assembly 510 successively comprises, from top to bottom, a first inner circumference region 5102 for supporting the crankshaft 120, a second inner circumference region 5104 having a smaller inner diameter than that of the first inner circumference region, and a third inner circumference region 5106 having a larger inner diameter than that of the first inner circumference region.

[0035] The impeller assembly 530 comprises an upper section 531 for connecting with the lower end part 126 of the crankshaft 120 so as to rotate therewith, a lower section for forming an impeller 535, and a middle section 533 located between the upper section and the lower section.

[0036] An oil intake chamber 5305 is formed between the second inner circumference region 5104 and an outer circumference surface of the middle section 533 of the impeller assembly 530, and an oil discharging chamber 5308 is formed between the third inner circumference region 5106 and an outer circumference surface of the impeller 535.

[0037] Moreover, an oil inlet 507 of the pump 500 is formed to radially penetrate through the second inner circumference region 5104 from an exterior wall of the lower bearing assembly 510. Also, a venting hole 508 is formed to radially penetrate through the second inner circumference region 5104 from the exterior wall of the lower bearing assembly 510. As a non-limiting example, the oil inlet 507 and the venting hole 508 are disposed symmetrically.

[0038] With reference to Figures 1, 2 and 6, the pressure equilibrium tube 520 may be generally L-shaped. One end of the pressure equilibrium tube 520 (i.e. an end of a transverse portion of the L-shape) is inserted into the venting hole 508 so as to be in fluid communication with the oil intake chamber 5305, and the other end (i.e. an end of a vertical portion of the L-shape) extends up to be above the level of oil 1808 in the oil sump 180 so as to be in fluid communication with a space above the level of oil 1808 in the oil sump 180.

[0039] With reference to Figures 2-6, four guiding channels 5356 are provided on one side surface of the impeller 535 adjacent to the middle section 533 of the impeller assembly 530. A static passage 5506 is provided on one side surface of the pump cover 550 adjacent to the impeller 535. A central passage 5306 is provided in the impeller assembly 530 so as to longitudinally penetrate therethrough. An upper end of the central passage 5306 forms an oil outlet 509. A lower end of the central passage 5306 is in fluid communication with the static passage 5506. As such, the oil inlet 507, the oil intake chamber 5305, the guiding channel 5356, the oil discharging chamber 5308, the static passage 5506, the central passage 5306 and the oil outlet 509 are sequentially connected so as to form an oil flow path of the oil pump 500. In addition, the oil outlet 509 of the oil pump is connected at the lower end part 126 of the crankshaft 120 to the oil supply passage 127 for supplying the oil to the upper end part 124.

[0040] As a non-limiting example, the diameter of the impeller 535 of the oil pump 500 may be larger than that of the crankshaft 120 such that sufficient oil is supplied to the oil supply passage 127 when the rotation speed of the crankshaft 120 is low.

[0041] In the oil pump 500, the impeller assembly 530 and the crankshaft 120 rotate together, and the other components remain stationary. Two ears 5315 provided at the upper section 531 of the impeller assembly 530 are engaged with grooves (not numbered) provided at an inner wall of the lower end part 126 of the crankshaft 120 so as to ensure that the impeller assembly 530 and the crankshaft 120 rotate together, as shown in Figure 3. Two ears 5505 of the pump cover 550 are inserted into notches (not indicated) of the case 515 of the lower bearing assembly 510 so as to prevent the pump cover 550 from rotation, as shown in Figure 4. A through hole 5109, which matches the upper section 531 of the impeller assembly 530 in profile and shape and through which the upper section 531 of the impeller assembly 530 passes during assembly, is provided in the lower bearing assembly 510. Generally, the impeller assembly 530 sits on the pump cover 550 due to its gravity, as shown in Figure 6. The retainer ring 570 is used to hold the pump cover 550 within the lower bearing assembly 510 (more precisely within the case 515 of the lower bearing assembly 510), as shown in Figure 6. The debris filter 590 arranged around an outer circumference of the oil pump prevents debris or the like from getting into the oil pump 500.

[0042] The pressure equilibrium tube 520 may function to ensure that the pressure in the oil intake chamber 5305 is the same as the gas pressure above the level of oil 1808 in the oil sump 180. The pressure equilibrium tube 520 may also assist in removing the excessive refrigerant gas which gets inside the oil pump.

[0043] In Figure 6, the solid arrows show the movement of oil flow, and the dotted arrows show the flow of the refrigerant gas.

[0044] With reference to Figure 6, in operation, when the crankshaft 120 is rotating, the oil at position 2 is captured by the impeller 535, and the oil flows outward by centrifugal force to position 3. Thus, the oil droplets pick up the kinetic energy and/or build up the pressure (as the oil droplets move from position 2 to position 3). Then, the oil droplets are forced into the static passage 5506 in the pump cover 550 (i.e., the oil droplets are force from position 3 to position 4). Next, the oil flows through the static passage 5506 of the pump cover 550 (from position 4 to position 5). Next, the oil flows through the central passage 5306 of the impeller assembly 530 (from position 5 to position 6) and into the oil supply passage 127 in the crankshaft 120(position 7). In the particular embodiment illustrated in Figure 6, the diameter of the impeller 535 is slightly smaller than that of the crankshaft 120. In some embodiments, the diameter of the impeller 535 may be larger than or equal to that of the crankshaft 120 such that the oil droplets can pick up sufficient energy (speed and pressure) to move to the top of the crankshaft 120 even when the rotational speed of the crankshaft 120 is relatively low.

[0045] As shown in Figure 6, when the oil flows from position 2to position3, due to the pressure equilibrium tube 520, the oil intake chamber 5305 (position2) will be full of gas and the pressure therein will be equal to the gas pressure above the level of oil 1808 in the oil sump 180 (i.e., at position 8 shown in Figure 7). The pressure equilibrium tube 520 ensures that the gas pressure above the oil sump 180 will not influence the flow velocity of the oil in the oil inlet 507. Under the action of gravity, the oil in the oil sump 180 continually flows into the oil intake chamber 5305 (i.e., from position 1 to position 2). The flow velocity is dependent on the height difference H between the level of oil 1808 and the oil inlet 507 (here, the effect of oil viscosity is neglected). Normally, the height difference H just varies within a narrow range. In other words, when the compressor runs steadily, the height difference H is basically constant, and thus the flow velocity may be regarded as constant.

[0046] The precondition for delivering at the same oil flow rate at different rotation speeds of the crankshaft 120 is to make the diameter of the impeller 535 large enough so as to ensure that the oil pump 500 can pump sufficient oil to the top of the crankshaft 120 at low speed. The oil flow rate can, therefore, be determined by selecting a size of the oil inlet 507 to just meet the lubrication requirement at different rotational speeds of the crankshaft 120.

[0047] For example, the size of the oil inlet 507 and diameter of the impeller 535 can be selected such that when the crankshaft 120 is rotating at a relatively low speed, the oil pump 500 is just able to pump the oil to the top of the oil supply passage 127 of the crankshaft 120. When the crankshaft 120 is rotating at a relatively high speed, the oil pump 500 cannot pump more oil than at low speed since no more oil is able to flow through the oil inlet 507 and into the oil intake chamber 5305 than when the crankshaft 120 is rotating at a lower speed.

Thus, the rotational speed of the crankshaft 120 may have little or no influence on the oil flow rate through the oil supply passage 127.

[0048] As shown in Figure 8, experimental data obtained during operation of the oil pump 500 shows the relationship between the oil flow rate of the oil pump 500 and the rotational speed of the crankshaft 120. The particular oil pump that was the subject of the experimental data of Figure 8 has an impeller having a diameter of about forty millimeters, an oil outlet having a diameter of about seven millimeters, the height difference H is about forty millimeters, and the oil type selected is 46BWMO. As shown in Figure 8, the oil flow rate remains substantially constant when the crankshaft rotates at any rotational speed above about 1800 revolutions per minute (RPM).

[0049] While the test was only conducted up to a speed of 3900 RPM, theoretically, a rotational speed above 3900 RPM can also result in nearly the same oil flow rate, as shown by a dashed line in the graph of Figure 8. In some embodiments, when the rotational speed of the crankshaft 120 is below 1800 RPM, the oil pump 500 may not be able to pump all of the oil in the chamber to the top of the crankshaft. Under such circumstances, the oil flow rate may be directly proportional to the square of the rotational speed of the crankshaft.

[0050] Therefore, in designing the oil pump 500 of the present disclosure, first, the minimum oil flow rate required at both low and high rotation speeds of the crankshaft may be calculated. Next, the oil inlet size may be determined based on the height difference H and the expected flow rate. Then, other features of the oil pump are determined. The oil pump thus obtained can deliver the oil at the same oil flow rate at different rotation speeds of the crankshaft.

[0051] With reference to Figures 9 and 10, an oil pump 500' according to another embodiment of the principles of the present disclosure is provided. The oil sump 500' may be mounted at a lower end 126' of a crankshaft 120'. The compressor may include a lower bearing assembly 510', a pressure equilibrium tube 520', an impeller assembly 530', a pump cover 550', a retainer ring 570' and a debris filter 590'.

[0052] Similar to the oil pump 500 described above, an upper portion of the lower bearing assembly 510' forms a lower bearing for supporting the lower end part 126' of the crankshaft 120', and a lower portion thereof extends so as to form a case of the oil pump 500'. An interior wall of the lower bearing assembly 510' successively comprises, from top to bottom, a first inner circumference region 5102' for supporting the crankshaft 120', a second inner circumference region 5104' having a smaller inner diameter than that of the first inner circumference region, a third inner circumference region 5106' having a larger inner diameter than that of the first inner circumference region and a fourth inner circumference region 5108' having a larger inner diameter than that of the third inner circumference region.

[0053] Similar to the impeller assembly 530 described above, the impeller assembly 530' comprises an upper section 531' for connecting with the lower end part 126' of the crankshaft 120' so as to rotate therewith, a lower section for forming an impeller 535', and a middle section 533' located between the upper section and the lower section.

[0054] An oil inlet 507' of the oil pump 500' may extend through a central portion of the pump cover 550', as shown in Figure 9. An oil intake chamber 5305' is formed in a bottom surface of the impeller 535' adjacent the pump cover 550'. That is, the oil intake chamber 5305' may be formed by recessing a bottom surface of the impeller 535' upward at the central portion thereof. A plurality of guiding channels 5356' may be disposed in a bottom surface of the impeller 535', may extend radially and may be arranged equidistantly in a circumstantial direction, as shown in Figure 10. These guiding channels 5356' may be in fluid communication with the oil intake chamber 5305'. Also, a central passage 5306' may be provided in the impeller assembly 530' so as to longitudinally penetrate therethrough. A lower end of the central passage 5306' is in fluid communication with the oil intake chamber 5305'. A lower end of the pressure equilibrium tube 520' may be inserted into the central passage 5306'. A middle section of the pressure equilibrium tube 520' may pass through an oil supply passage 127' at the lower end part 126' of the crankshaft 120'. An upper end of the pressure equilibrium tube 520' may be coupled with a vertical portion of a venting hole 508' which is formed at the lower end part 126' of the crankshaft 120'. An opening of the venting hole 508' on an exterior wall of the crankshaft 120' is above the level of oil in the oil sump. Thereby, a space above the level of oil in the oil sump is in communication with the oil intake chamber 5305' through the pressure equilibrium tube 520', as shown by a dotted arrow in Figure 9.

[0055] Moreover, an oil discharging chamber 5308' is formed between the fourth inner circumference region 5108' and an outer circumference surface of the impeller 535'. A static passage 5506' is formed between the second and third inner circumference regions 5104', 5106' and an outer circumference surface of the middle section 533' of the impeller assembly 530'. Also, an oil outlet 509' is formed at both sides of the central passage 5306' so as to penetrate through the upper section 531' of the impeller assembly 530'. As such, after the assembly is completed, the oil inlet 507', the oil intake chamber 5305', the guiding channel 5356', the oil discharging chamber 5308', the static passage 5506' and the oil outlet 509' are sequentially connected so as to form an oil flow path of the oil pump 500', as shown by a solid arrow in Figure 9. Further, the oil outlet 509' of the oil pump 500' is, at the lower end part 126' of the crankshaft 120', in fluid communication with the oil supply passage 127' for supplying the oil to an upper end part of the crankshaft 120'.

[0056] In this exemplary embodiment, when the oil flows along the oil flow path in Figure 9 (i.e., along the path of the solid arrow), the oil intake chamber 5305' may contain a quantity of gas and the pressure therein may be equal to the gas pressure above the level of oil in the oil sump due to the pressure equilibrium tube 520'. The pressure equilibrium tube 520' ensures that the gas pressure above the oil sump will not influence the flow velocity of the oil in the oil inlet 507'. The oil in the oil sump continually flows into the oil intake chamber 5305'. The flow velocity is dependent on the height difference between the level of oil and the oil inlet 507' (here, the effect of oil viscosity is neglected). Normally, the height difference just varies within a narrow range. In other words, when the compressor runs steadily, the height difference is basically constant, and thus the flow velocity may be regarded as constant.

[0057] It will be appreciated that, like the oil pump 500, the oil pump 500' is able to provide a substantially constant oil flow rate through the oil supply passage 127' at a variety of rotational speeds of the crankshaft 120'.

[0058] It will be appreciated that the principles of the present disclosure are not limited to the specific exemplary structure described and illustrated herein. For example, in some embodiments, the central passage 5306' and the venting hole 508' may not be provided, and instead, one end of the pressure equilibrium tube may enter the oil intake chamber 5305' via the oil inlet 507' and the other end of the pressure equilibrium tube may extend above the level of oil in the oil sump.

Claims

1. A method of operating a compressor (100) comprising:

rotating a crankshaft (120, 120') of the compressor at a first rotational speed;
rotating said crankshaft at a second rotational speed;
supplying oil through an oil supply passage (127, 127') extending between first and second ends of said crankshaft at a flow rate while said crankshaft is rotating at said first rotational speed by rotating an impeller (530, 530') of an oil pump (500, 500') at said first rotational speed while said crankshaft is rotating at said first rotational speed;and
supplying oil through said oil supply passage at substantially the same flow rate while said crankshaft is rotating at said second rotational speed by rotating said impeller at said second rotational speed while said crankshaft is rotating at said second rotational speed.

2. The method of claim 1, wherein said first rotational speed and said second rotational speed are between 1800 and 3900 revolutions per minute.

3. The method of claim 2 wherein said first rotational speed is two times greater than said second rotational speed.

4. The method of claim 1, further comprising communicating a gas between a chamber (5305) of said oil pump and a space above an oil level of an oil sump (180) of the compressor.

Patentansprüche

1. Verfahren des Betreibens eines Kompressors (100), umfassend:

Drehen einer Kurbelwelle (120, 120') des Kompressors mit einer ersten Drehgeschwindigkeit;
Drehen der Kurbewelle mit einer zweiten Drehgeschwindigkeit;
Zuführen von Öl durch einen Ölzuführkanal (127, 127'), der sich zwischen ersten und zweiten Enden der Kurbelwelle erstreckt, mit einer Strömungsgeschwindigkeit, während sich die Kurbelwelle mit der ersten Drehgeschwindigkeit dreht, durch Drehen eines Laufrads (530, 530') einer Ölpumpe (500, 500') mit der ersten Drehgeschwindigkeit, während sich die Kurbelwelle mit der ersten Drehgeschwindigkeit dreht; und
Zuführen von Öl durch den Ölzuführkanal mit einer im Wesentlichen gleichen Strömungsgeschwindigkeit, während sich die Kurbelwelle mit der zweiten Drehgeschwindigkeit dreht, durch Drehen des Laufrads mit der zweiten Drehgeschwindigkeit, während sich die Kurbelwelle mit der zweiten Drehgeschwindigkeit dreht.

2. Verfahren nach Anspruch 1, wobei die erste Drehgeschwindigkeit und die zweite Drehgeschwindigkeit zwischen etwa 1800 und 3900 Umdrehungen pro Minute sind.

3. Verfahren nach Anspruch 2, wobei die erste Drehgeschwindigkeit um das Zweifache größer als die zweite Drehgeschwindigkeit ist.

4. Verfahren nach Anspruch 1, ferner umfassend ein Kommunizieren eines Gases zwischen einer Kammer (5305) der Ölpumpe und einem Raum über einem Ölstand einer Ölwanne (180) des Kompressors.

Revendications

1. Procédé d'exploitation d'un compresseur (100) comprenant :

la rotation d'un vilebrequin (120, 120') du compresseur à une première vitesse de rotation ;

la rotation dudit vilebrequin à une deuxième vitesse de rotation ;
l'alimentation en pétrole par un passage d'alimentation en pétrole (127, 127') s'étendant entre des première et deuxième extrémités dudit vilebrequin selon un débit tandis que ledit vilebrequin tourne à ladite première vitesse de rotation en faisant tourner une turbine (530, 530') d'une pompe à huile (500, 500') à ladite première vitesse de rotation tandis que ledit vilebrequin tourne à ladite première vitesse de rotation ; et
l'alimentation en pétrole par ledit passage d'alimentation en pétrole selon sensiblement le même débit tandis que ledit vilebrequin tourne à ladite deuxième vitesse de rotation en faisant tourner ladite turbine à ladite deuxième vitesse de rotation tandis que ledit vilebrequin tourne à ladite deuxième vitesse de rotation.

2. Procédé selon la revendication 1, dans lequel ladite première vitesse de rotation et ladite deuxième vitesse de rotation sont situées entre 1800 et 3900 tours par minute.

3. Procédé selon la revendication 2, dans lequel ladite première vitesse de rotation est deux fois plus élevée que ladite deuxième vitesse de rotation.

4. Procédé selon la revendication 1, comprenant en outre la circulation d'un gaz entre une chambre (5305) de ladite pompe à huile et un espace au-dessus d'un niveau d'huile d'un carter d'huile (180) du compresseur.

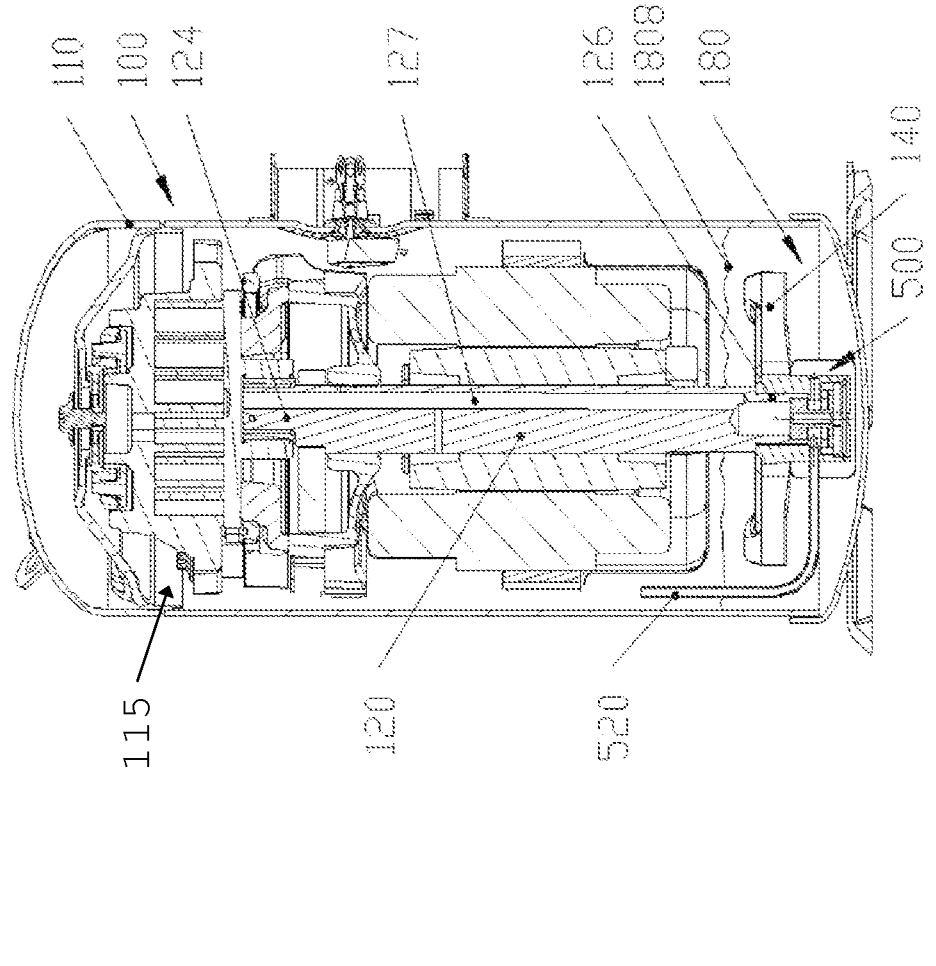

Figure 1

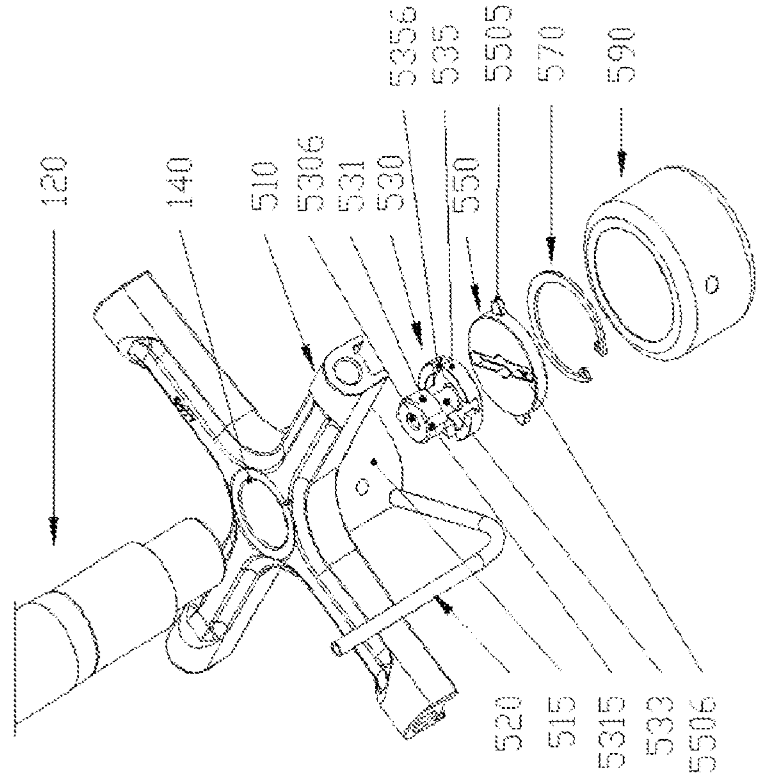

Figure 2

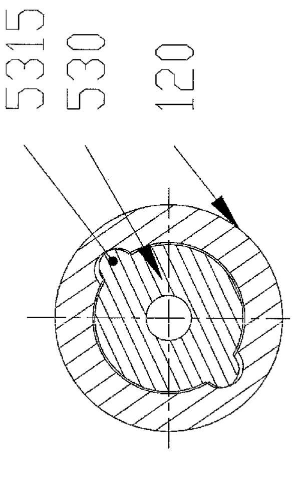

Figure 3

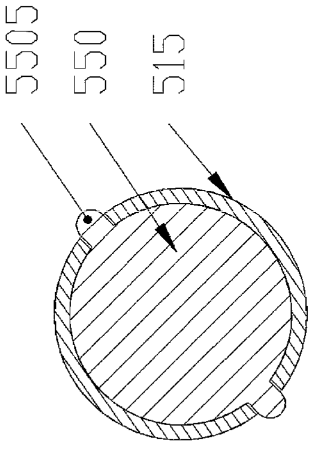

Figure 4

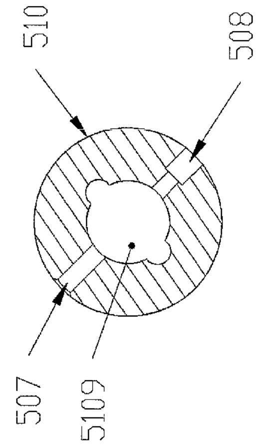

Figure 5

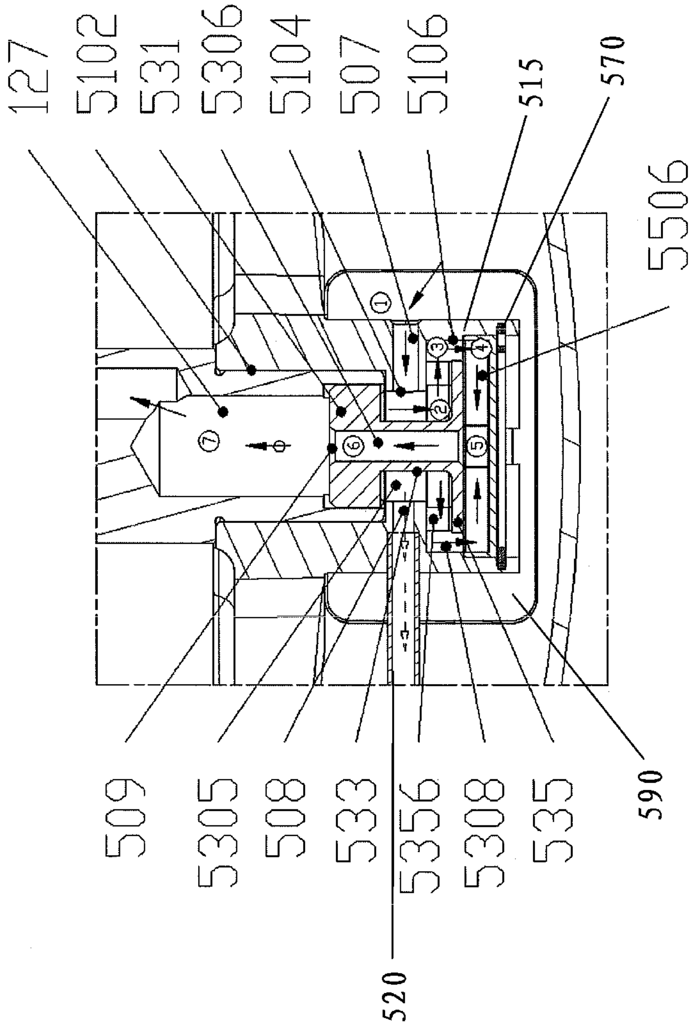

Figure 6

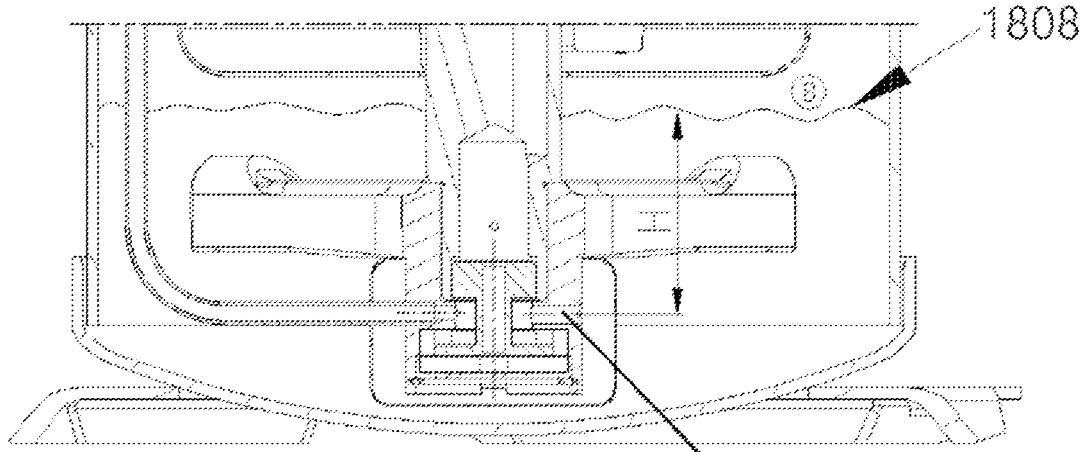

Figure 7

Test Results:

Main Shaft Speed(RPM)	3900	3600	3300	3000	2700	2400	2220	2100	1800	1680	1500	1200
Flow Rate(ml/sec)	10.7	10.9	10.9	10.9	11.1	10.8	10.7	10.7	10.6	9.3	6.7	1.0

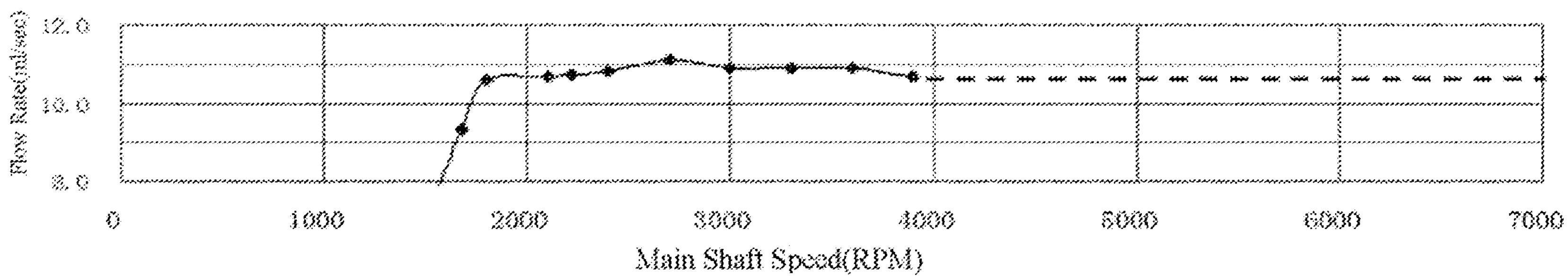

Figure 8

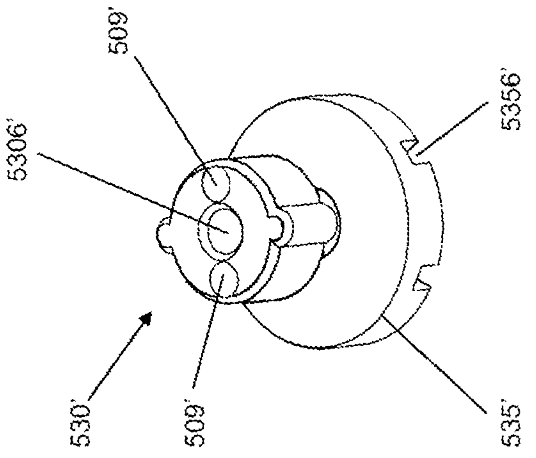

Figure 10

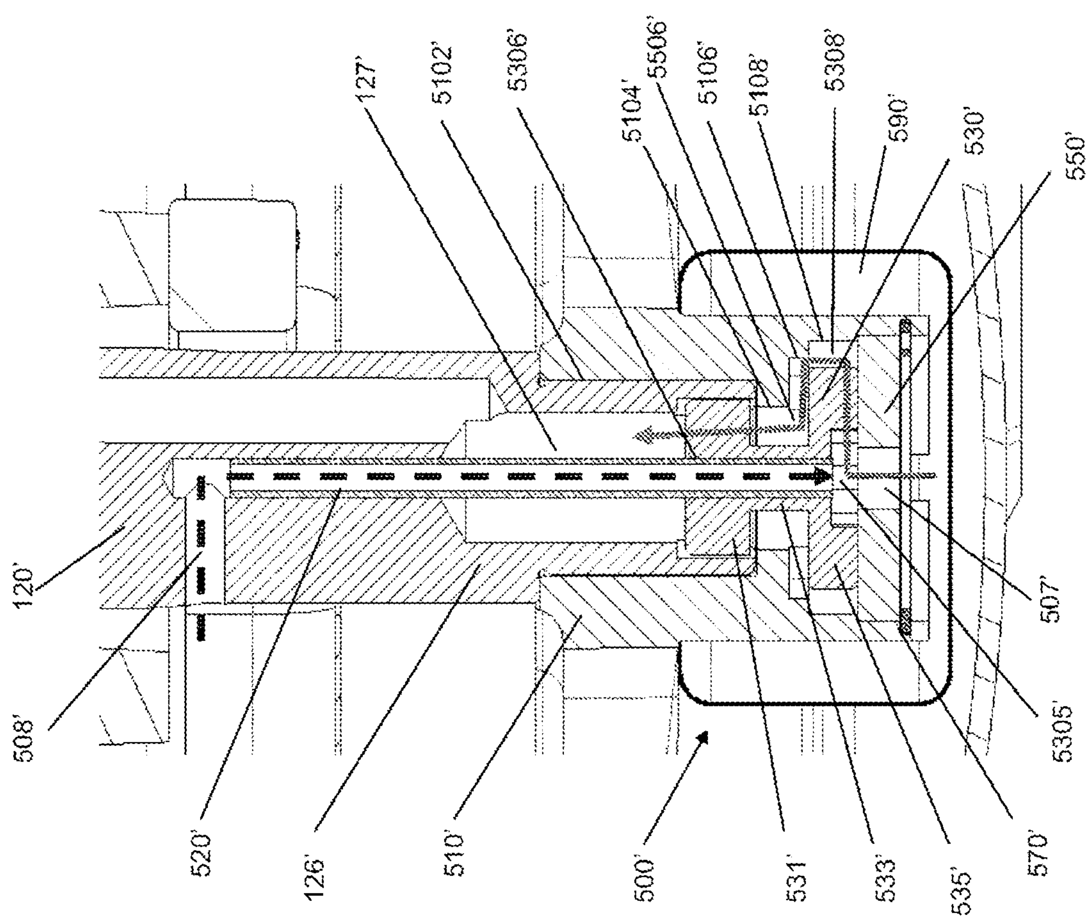

Figure 9

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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