



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**16.04.2008 Bulletin 2008/16**

(51) Int Cl.:  
**F04C 29/02 (2006.01) F04C 23/00 (2006.01)**

(21) Application number: **07019353.7**

(22) Date of filing: **02.10.2007**

(84) Designated Contracting States:  
**AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IS IT LI LT LU LV MC MT NL PL PT RO SE SI SK TR**  
Designated Extension States:  
**AL BA HR MK RS**

(72) Inventor: **Higashiyama, Akiyoshi**  
**Isesaki-shi**  
**Gunma 372-8502 (JP)**

(30) Priority: **04.10.2006 JP 2006272851**

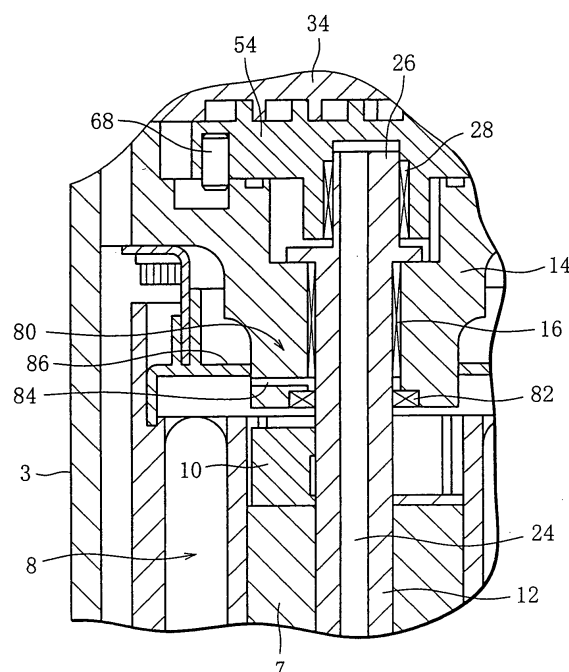
(74) Representative: **Feldmeier, Jürgen et al**  
**Prüfer & Partner GbR**  
**Patentanwälte**  
**Sohnckestrasse 12**  
**81479 München (DE)**

(71) Applicant: **Sanden Corporation**  
**Isesaki-shi,**  
**Gunma 372-8502 (JP)**

(54) **Sealed electric compressor**

(57) A sealed electric compressor includes a compression unit (30) and an electric motor (6) disposed inside a sealed housing (2), a reservoir chamber (23) located at the bottom of the housing (2) and holding a lubricant to be supplied to bearings (28, 16) rotatably supporting a drive shaft (12) of the motor (6), and a return path (80) for deflecting the lubricant supplied to lubricate the bearings (28, 16), away from a rotor (7) of the motor (6), and directing it to the reservoir chamber (23). The return path (80) includes a seal ring (82) between a main support (14) with a bearing (16) and the drive shaft (12) to stop the lubricant supplied to lubricate the bearings (28, 16) from flowing down the outer cylindrical face of the drive shaft (12) toward the rotor (7), and a discharge hole (84) formed in the main support (14) to discharge the lubricant stopped by the seal ring (82) from the outer cylindrical face of the main support (14) toward a stator (8) of the motor (6).

FIG. 2



## Description

### BACKGROUND OF THE INVENTION

#### Field of the Invention

**[0001]** This invention relates to a sealed electric compressor, and more specifically, a sealed electric compressor having a reservoir chamber for a lubricant and a supply passage for conveying the lubricant from the reservoir chamber to sliding contact surfaces, bearings, etc. provided within the compressor.

#### Description of the Related Art

**[0002]** The compressor of this type is provided in a refrigeration system or a hot-water supply system and used to compress an operating fluid, or a refrigerant of such system. The compressor includes a refrigerant compression unit and an electric motor for driving the compression unit, and the unit and the motor include sliding contact surfaces, bearings, etc. A lubricant is supplied to these sliding contact surfaces, bearings, etc. to prevent seizure of the sliding contact surfaces, bearings, etc., thereby protecting the compressor from damage.

**[0003]** More specifically, the compressor further includes a reservoir chamber provided at the bottom of a sealed housing to hold the lubricant, and a supply passage extending from the reservoir chamber to the sliding contact surfaces, bearings, etc. to convey the lubricant to them. The lubricant supplied to the sliding contact surfaces, bearings, etc. is then returned to the reservoir chamber.

**[0004]** In the above-described compressor, the refrigerant is taken into the sealed housing and then drawn into the compression unit, and the refrigerant is mixed with the lubricant. Thus, the lubricant is utilized not only to prevent the above-mentioned seizure, but also to create a seal between the sliding contact surfaces within the compression unit.

**[0005]** Thus, when the lubricant supplied to the sliding contact surfaces, bearings, etc. contacts the refrigerant within the sealed housing, some of the lubricant mixes with the refrigerant, and the lubricant mixed with the refrigerant is discharged from the compressor with the refrigerant.

**[0006]** Thus, as the compressor is driven longer, the lubricant held in the reservoir chamber decreases, so that the amount of the lubricant supplied from the reservoir chamber to the sliding contact surfaces, bearings, etc. decreases. In order to prevent a shortage of the lubricant held in the reservoir chamber, a sealed electric compressor disclosed in Japanese Unexamined Patent Publication No. Hei 10-47269 includes a return pipe for collecting the lubricant supplied to the sliding contact surfaces, bearings, etc. and returning the lubricant to the reservoir chamber.

**[0007]** The above-mentioned return pipe, however, ex-

tends outside the electric motor within the sealed housing, so that the sealed housing has an increased size, which results in an increased weight of the sealed housing, and therefore of the compressor as a whole.

**[0008]** Considering that the above-mentioned compressor is intended to be used also in the household hot-water supply system, an increase in size and weight of the compressor should be avoided.

**[0009]** The primary object of the present invention is to provide a sealed electric compressor which can prevent a shortage of the lubricant in the reservoir chamber with a simple structure, and which allows a reduction in size and weight.

### SUMMARY OF THE INVENTION

**[0010]** In order to achieve this object, a sealed electric compressor according to the present invention comprises a sealed housing having a reservoir chamber holding a lubricant at a bottom thereof; a compression unit for performing a process of drawing in, compressing and discharging an operating fluid, disposed inside the sealed housing, in an upper area thereof; an electric motor for driving the compression unit, disposed inside the sealed housing, between the compression unit and the reservoir chamber, the electric motor including a drive shaft connected with the compression unit by an upper bearing, a rotor fitted on the drive shaft, and a stator surrounding the rotor and having a plurality of armature windings; a support member disposed between the compression unit and the electric motor and including a lower bearing for supporting the drive shaft rotatably; and a supply device for supplying the lubricant from the reservoir chamber to the upper and lower bearings, the supply device including a supply passage extending in the drive shaft to convey the lubricant supplied from the reservoir chamber to the upper and lower bearings, and is characterized in that the compressor further includes a return path for deflecting the lubricant flowing down the outer cylindrical face of the drive shaft toward the rotor after used to lubricate the upper and lower bearings, away from the rotor into the stator so that the lubricant returns to the reservoir chamber passing through the stator.

**[0011]** In the above-described sealed electric compressor, the return path is provided such that the lubricant returns to the reservoir chamber passing through the stator. Thus, the provision of the return path does not require an increase in outer diameter of the compressor, so that the compressor can have a reduced size and weight.

**[0012]** Further, since the return path directs the lubricant such that the lubricant returns to the reservoir chamber, away from the rotor of the electric motor, the rotation of the rotor does not hinder the return of the lubricant to the reservoir chamber. This ensures that the reservoir chamber always holds the lubricant, and prevents a shortage of the lubricant in the reservoir chamber. Consequently, the supply device can supply the lubricant to the upper and lower bearings stably and sufficiently, so

that the compressor is reliably protected from damage caused by seizure of these bearings.

**[0013]** Specifically, the return path can be provided to include a seal ring fitted into the support member, under the lower bearing, to surround the outer cylindrical face of the drive shaft and prevent the lubricant from flowing down, and a discharge hole formed in the support member to be located above the seal ring and have an inner open end facing the outer cylindrical face of the drive shaft and an outer open end located at the outer cylindrical face of the support member. Such seal ring and discharge hole reliably stops the lubricant flowing down the outer cylindrical face of the drive shaft toward the rotor.

**[0014]** Further, the seal ring and discharge hole does not result in an increase in structural complexity of the compressor nor a great increase in compressor production costs.

**[0015]** Preferably, the discharge hole should extend in the support member, radially of the drive shaft, and at the position at which the outer open end of the discharge hole is provided, the support member should be equal or slightly greater in outer diameter than the rotor. In this case, since the outer end of the discharge hole is located on or outside an imaginary cylinder of diameter approximately equal to the outer diameter of the rotor, the lubricant discharged from the outer end of the discharge hole falls into the stator, away from the rotor.

**[0016]** The return path can be provided to further include a discharge pipe running through the stator, where the discharge pipe has an end connected with the outer end of the discharge hole and an opposite end located inside the reservoir chamber. Specifically, the discharge pipe can be provided to extend in one of the spaces between the armature windings within the stator.

**[0017]** The above-described discharge pipe brings the lubricant discharged from the outer end of the discharge hole, back to the reservoir chamber reliably, thereby increasing the ratio of the lubricant returned to the reservoir chamber.

**[0018]** Specifically, the compressor can be a compressor that compresses, as the operating fluid, a refrigerant in a refrigeration circuit, and the refrigerant can include carbon dioxide. In this case, desirably, the sealed housing should include a refrigerant intake chamber into which the refrigerant is taken before drawn into the compression unit, and the electric motor should be disposed in the refrigerant intake chamber.

**[0019]** As mentioned above, in the compressor according to the present invention, the ratio of the lubricant returned to the reservoir chamber is increased, or in other words, the amount of the lubricant mixing with the refrigerant in the refrigerant intake chamber is reduced. Thus, in the case where the refrigerant is delivered from the refrigerant intake chamber through the compression unit to the refrigeration circuit, the amount of the lubricant contained in the refrigerant circulating in the refrigeration circuit, or in other words, the oil circulation ratio is re-

duced. This leads to an improvement of efficiency of heat exchangers disposed in the refrigeration circuit, and energy saving in the refrigeration circuit.

**[0020]** Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirits and scope of the invention will become apparent to those skilled in the art from this detailed description.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0021]** The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus, are not limitative of the present invention, and wherein:

FIG. 1 is a vertical cross-sectional view showing a first embodiment of sealed electric compressor according to the present invention,

FIG. 2 is a diagram showing part of FIG. 1 on an enlarged scale, and

FIG. 3 is a vertical cross-sectional view showing a second embodiment of sealed electric compressor according to the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0022]** A sealed electric compressor 1 shown in FIG. 1 is incorporated in a refrigeration circuit for a refrigerating air-conditioning device, a heat-pump type hot-water supply machine or the like. The refrigeration circuit includes a circulation path along which CO<sub>2</sub> refrigerant (hereinafter referred to simply as "refrigerant"), which is an operating fluid, circulates. The compressor 1 draws in the refrigerant from the circulation path, compresses the drawn-in refrigerant and discharges it to the circulation path.

**[0023]** The compressor 1 includes a vertically-disposed sealed housing 2, and the sealed housing 2 has a hollow cylinder 3, and an upper cover 4 and a lower cover 5 which air-tightly close the cylinder 3 at the top and bottom, respectively. The covers 4, 5 each have a U-like cross-sectional shape.

**[0024]** An electric motor 6 is disposed inside the cylinder 3. The electric motor 6 has a hollow drive shaft 12. The drive shaft is disposed on the axis of the cylinder 3. The upper end of the drive shaft 12 is fitted to a main support 14 by means of a bearing 16. The main support 14 is fixed to the inner surface of the cylinder 3. The lower end of the drive shaft 12 is fitted to a sub-support 18 by means of a bearing 20. Similarly to the main support 14, the sub-support 20 is fixed to the inner surface of the

cylinder 3.

**[0025]** A rotor 7 is mounted on the drive shaft 12. The rotor 7 is located between the main support 14 and the sub-support 18, and includes a plurality of permanent magnets. A stator 8 is disposed outside the rotor 7. The stator 8 is fixed to the inner surface of the cylinder 3 by press-fitting. The stator 8 has a plurality of armature windings 9 which cooperate with the permanent magnets of the rotor 7. Thus, when power is supplied to the armature windings 9, the rotating magnetic field generated by the armature windings 9 causes the rotor 7 to rotate with the drive shaft 12.

**[0026]** Further, a compression unit 30 is disposed inside the cylinder 3. The compression unit 30 is located above the electric motor 6, on top of the main support 13. The compression unit 30 performs a process of drawing in the refrigerant, compressing the drawn-in refrigerant and discharging the compressed refrigerant.

**[0027]** More specifically, the compression unit 30 includes a movable scroll 52 and a fixed scroll 32. The movable scroll 52 includes an end plate 54 and a movable-side spiral lap formed integrally with the end plate 54. The movable-side spiral lap projects toward the fixed scroll 32.

**[0028]** Meanwhile, the fixed scroll 32 includes an end plate 34 and a fixed-side spiral lap formed integrally with the end plate 34. The fixed-side spiral lap projects toward the movable scroll 52. The movable-side and fixed-side spiral laps engage with each other so that a compression chamber is defined between the movable-side and fixed-side spiral laps.

**[0029]** The end plate 34 of the fixed scroll 32 is fixed to the main support 14 so that the interior of the sealed housing 2 is air-tightly divided into a refrigerant intake chamber 59, in which the electric motor 6 is located, and a discharge chamber 60. The refrigerant intake chamber 59 is connected with the above-mentioned refrigerant circulation path by an intake pipe 70. The intake pipe 70 is joined to the cylinder 3 to convey the refrigerant from the circulation path into the refrigerant intake chamber 59. It is to be noted that the refrigerant conveyed into the refrigerant intake chamber 59 is supplied from an evaporator disposed in the refrigeration circuit, and low in temperature.

**[0030]** More specifically, the refrigerant intake chamber 59 includes an intake groove 59a formed in the outer cylindrical face of the end plate 34, a plurality of axial grooves 59b formed in the outer cylindrical face of the main support 14 and a plurality of axial grooves 59c formed in the outer cylindrical face of the stator 8. The intake pipe 70 is connected with the intake groove 59a, and the intake groove 59a can be brought into communication with the above-mentioned compression chamber. Further, the intake groove 59 communicates with one of the axial grooves 59b, so that the refrigerant conveyed to the intake groove 59a is distributed all over the refrigerant intake chamber 59 by the axial grooves 59b, 59c. As mentioned above, the refrigerant conveyed into

the refrigerant intake chamber 59 is low in temperature. Thus, the electric motor 6 is cooled by the refrigerant satisfactorily, and overheating of the electric motor 6 is prevented.

**[0031]** In the discharge chamber 60, a discharge valve 62 is provided. The discharge valve 62 is attached to the fixed scroll 32, more specifically to the end face of the end plate 34 facing the discharge chamber 60. The end plate 34 has a discharge hole (not shown) in the center. The discharge hole can be brought into communication with the compression chamber, and is opened and closed by the discharge valve 62.

**[0032]** The discharge valve 62 is covered with a valve cover 64, and the valve cover 64 is also attached to the above-mentioned end face of the end plate 34. The valve cover 64 reduces the propagation of hitting sounds produced when the discharge valve 62 is opened and collides with a valve retainer. Further, a discharge pipe 72, which is connected with the refrigerant circulation path, is joined to the discharge chamber 60.

**[0033]** The end plate 54 of the movable scroll 52 has a boss 66 provided in the center of the end face facing the electric motor 6. An eccentric shaft 26 is rotatably fitted to the boss by means of a bearing 28. The eccentric shaft 26 integrally extends from the upper end of the drive shaft 12, and is eccentric relative to the axis of the drive shaft 12. Thus, when the electric motor 6 is driven, the drive shaft 12 causes the movable scroll 52 to rotate.

**[0034]** Further, the end plate 54 is supported on the main support 14 with its cylindrical face in sliding contact with the main support 14, and the movable scroll 52 and the main support 14 are connected by a rotation prevention mechanism. The rotation prevention mechanism includes a plurality of circular grooves 67 formed in the main support 14 and a plurality of pins 68 which project from the end plate 54 of the movable scroll 52 into the corresponding circular grooves 67, and prevents the movable scroll 52 from rotating on its axis. Thus, when the electric motor 6 is driven, the movable scroll 52 revolves relative to the fixed scroll 32 while prevented from rotating on its axis.

**[0035]** The revolution of the movable scroll 32 produces the compression chamber outside the spiral laps, where as the movable scroll revolves, the compression chamber decreases in volume and approaches the center of the spiral laps, and therefore the above-mentioned discharge hole. By such motion of the compression chamber, the process including the steps of drawing the refrigerant from the intake groove 59a into the compression chamber, compressing the drawn-in refrigerant, and discharging the compressed refrigerant into the discharge chamber 60 through the discharge valve 62 opened is performed. The high-pressure refrigerant discharged into the discharge chamber 60 is delivered to the refrigerant circulation path through the discharge pipe 72.

**[0036]** Further, a counterweight 10 for balancing the movable scroll 32 is mounted on the drive shaft 12. The

counterweight 10 is located between the rotor 7 of the electric motor 6 and the main support 14. More specifically, as clear from FIG. 2, the counterweight 10 is disposed within the stator 8 of the electric motor 6, and has an outer diameter approximately equal to the outer diameter of the rotor and slightly smaller than the outer diameter of the lower end of the main support 14. Preferably, the lower end of the main support 14 should have an outer diameter somewhat greater than the outer diameter of the rotor 7.

**[0037]** The bottom of the sealed housing 2 forms a reservoir chamber 23. The reservoir chamber 23 holds a lubricant. The drive shaft 12 has a lower end portion projecting from the sub-support 18 into the reservoir chamber 23. An oil pump 22 is mounted on this lower end portion, so that the oil pump 22 is driven by the drive shaft 12 with the compression unit 30.

**[0038]** An intake tube 22a extends from the oil pump 22 into the reservoir chamber 23. The lower end of the intake tube 22a is located adjacent to the bottom of the reservoir chamber 23 and therefore in the lubricant. The oil pump 22 has a discharge hole connected with the internal passage of the hollow drive shaft 12. Thus, when the oil pump 22 is driven, the oil pump 22 draws in the lubricant from the reservoir chamber 23 through the intake tube 22a and forces the drawn-in lubricant into the internal passage of the drive shaft 12 through the discharge hole.

**[0039]** Thus, the internal passage of the drive shaft 12 forms a lubricant supply passage 24, and the lubricant supply passage 24 has an extension which extends in the above-mentioned eccentric shaft 26 up to the upper end of the eccentric shaft 26. Thus, the lubricant forced into the supply passage 24 by the oil pump 22 spurts out from the upper end of the eccentric shaft 26. The spurted lubricant flows down the outer cylindrical faces of the eccentric shaft 26 and the drive shaft 12, thereby being supplied to the bearings 28, 16 to lubricate the bearings 28, 16. Due to the rotation of the drive shaft 12, part of the lubricant flowing down the outer cylindrical face of the drive shaft 12 flies off the outer cylindrical face of the drive shaft 12 around, and the flying-off lubricant is supplied to the sliding contact surfaces of the movable scroll 32 and the main support 14, the sliding contact surfaces of the spiral laps within the compression unit 30, the sliding contact surfaces of the end plates 34, 54, etc. to lubricate those sliding contact surfaces.

**[0040]** In the first embodiment of compressor, there is provided a deflection path 80 for deflecting the lubricant supplied to lubricate the bearings 28, 16, away from the outer cylindrical face of the drive shaft 12. More specifically, as shown in FIG. 2, the deflection path 80 includes an oil seal ring 82. The oil seal ring 82 is fitted in the lower part of the main support 14, just under the bearing 16, to surround the outer cylindrical face of the drive shaft 12. Thus, the outer cylindrical face of the drive shaft 12 is in liquid-tight sliding contact with the inner cylindrical face of the oil seal ring 82. The oil seal ring 82 functions as a

barrier for stopping the lubricant from flowing further down the outer cylindrical face of the drive shaft 12 after passing the bearing 16.

**[0041]** The deflection path 80 further includes an oil discharge hole 84. The oil discharge hole 84 is formed in the main support 14. The oil discharge hole 84 extends radially of the drive shaft 12, and has an inner open end which faces the outer cylindrical face of the drive shaft 12, between the bearing 16 and the oil seal ring 82, and an outer open end located at the outer cylindrical face of the lower part of the main support 14.

**[0042]** The oil discharge hole 84 conveys the lubricant stopped by the oil seal ring 82 to discharge it from the outer cylindrical face of the lower part of the main support 14. Since the lower end of the main support 14 is approximately equal or slightly greater in outer diameter than the rotor 7, the lubricant discharged from the outer cylindrical face of the main support 14 is directed toward the stator 8 of the electric motor 6, not toward the rotor 7 nor the counter weight 10.

**[0043]** Further, in the first embodiment, since the counter weight 10 is disposed within the stator 8, the rotation of the counter weight 10 and the rotor 7 does not cause a strong rotating flow of the refrigerant, around the lower part of the main support 14. Thus, the phenomenon that the lubricant discharged from the main support 14 is caused to fly off by the rotating flow of the refrigerant is reduced, and the lubricant is directed toward the stator 8 satisfactorily.

**[0044]** The lubricant directed to the stator 8 then flows down through spaces within the stator 8, specifically, spaces between the armature windings 9 within the stator 8, onto the sub-support 18. As shown in FIG. 1, a plurality of discharge holes 19 are formed in the sub-support 18, so that the lubricant falling on the sub-support 18 returns to the reservoir chamber 23 through the discharge holes 19, without staying on the sub-support 18.

**[0045]** This ensures that the reservoir chamber 23 always holds the minimum lubricant required, and prevents a shortage of the lubricant in the reservoir chamber 23. Thus, stable supply of the lubricant to the above-mentioned bearings 28, 16 and sliding contact surfaces is ensured, so that the compressor is reliably protected from damage caused by seizure of the bearings 28, 16 and sliding contact surfaces and enjoys an improved reliability of operation.

**[0046]** As clear from the above description, since the lubricant return path from the oil discharge hole 84 to the reservoir chamber 23 is provided within the electric motor 6, the provision of the return path does not result in an increase in outer diameter of the sealed housing 2. This allows the compressor to have a reduced size and weight. Further, the provision of the above-described oil seal ring 82 and oil discharge hole 82 does not result in a significant increase in compressor production costs.

**[0047]** Further, when the flying-off of the lubricant is reduced as mentioned above, mist of the lubricant floating in the refrigerant intake chamber 59 is reduced ac-

cordingly. This results in a great reduction in the amount of the lubricant mixing with the refrigerant, and therefore a reduction in the amount of the lubricant discharged from the compression unit 30 with the refrigerant to outside the compressor 1, namely, the amount of the lubricant delivered to the circulation path.

**[0048]** Thus, the first embodiment of compressor 1 enables a reduction in the amount of the lubricant contained in the refrigerant circulating along the circulation path, or in other words, a reduction in OCR (Oil Circulation Ratio). The reduction in OCR leads to an improvement of efficiency of heat exchangers disposed in the refrigeration circuit, and contributes much to energy saving in the refrigeration circuit.

**[0049]** In order to further reduce the OCR, the first embodiment of compressor can further include a mist cover 88. As shown in FIG. 1, the mist cover 88 is attached to the lower part of the main support 14, immediately above the outer end of the oil discharge hole 84. More specifically, the mist cover 88 extends radially outward from the lower part of the main support 14 and has a disklike shape covering the outer end of the discharge hole 84 and the armature windings 9. Such mist cover 88 prevents the refrigerant containing the mist of the lubricant from flowing directly toward the compression unit 30.

**[0050]** FIG. 3 shows a second embodiment of sealed electric compressor. In the explanation of the second embodiment of compressor, the members and portions having the same functions as those of the first embodiment of compressor are assigned the same reference signs, and the description of those members and portions is omitted.

**[0051]** The deflection path 80 in the second embodiment includes an oil discharge tube 86 in addition to the oil seal ring 82 and the oil discharge hole 84. The oil discharge tube 86 is connected with the outer end of the oil discharge hole 84. More specifically, the oil discharge tube 86 extends radially outward from the main support 14, then bends downward and passes through the stator 8 axially. The oil discharge tube 86 further passes through one of the discharge holes 19 of the sub-support 20, and its lower open end is located inside the reservoir chamber 23. More specifically, the oil discharge tube 86 extends through one of the spaces between the armature windings 9 within the stator 8.

**[0052]** In the second embodiment, the lubricant discharged from the oil discharge hole 84 is brought back into the reservoir chamber 23 by the oil discharge tube 86. This enables quick return of the lubricant into the reservoir chamber 23 and increases the reliability of preventing a shortage of the lubricant in the reservoir chamber 23. Further, the oil discharge tube 86 is useful in preventing the lubricant discharged from the oil discharge hole 84 from splashing, thereby further reducing the OCR.

**[0053]** The present invention is not limited to the above-described embodiments but can be modified in various ways.

**[0054]** For example, although the first and second embodiments of compressor include a scroll-type compression unit, the compressor according to the present invention can include another type of compression unit which similarly performs the process of drawing in, compressing and discharging the refrigerant, in place of the scroll-type unit.

## 10 Claims

### 1. A sealed electric compressor, comprising:

a sealed housing (2) including a reservoir chamber (23) holding a lubricant at a bottom thereof; a compression unit (30) for performing a process of drawing in, compressing and discharging an operating fluid, disposed inside said sealed housing (2), in an upper area thereof; an electric motor (6) for driving said compression unit (30), disposed inside said sealed housing (2), between said compression unit (30) and the reservoir chamber (23), said electric motor (6) including a drive shaft (12) connected with said compression unit (30) by an upper bearing (28), a rotor (7) mounted on the drive shaft (12), and a stator (8) surrounding the rotor (7) and having a plurality of armature windings (9); a supporter member (14) disposed between said compression unit (30) and said electric motor (6) and including a lower bearing (16) for rotatably supporting the drive shaft (12); and a supply device for supplying the lubricant from the reservoir chamber (23) to the upper and lower bearings (28, 16), said supply device including a supply passage (24) extending in the drive shaft (12) to convey the lubricant supplied from the reservoir chamber (23) to the upper and lower bearings (28, 16), **characterized in that** the compressor further includes a return path (80) for deflecting the lubricant flowing down the outer cylindrical face of the drive shaft (12) toward the rotor (7) after used to lubricate the upper and lower bearings (28, 16), away from the rotor (7) into the stator (8) so that the lubricant returns to the reservoir chamber (23) passing through the stator (8).

### 2. The compressor according to claim 1, **characterized in that**

the return path (80) includes a seal ring (82) fitted to the support member (14), under the lower bearing (16), to surround the outer cylindrical face of the drive shaft (12) and prevent the lubricant from flowing down, and a discharge hole (84) formed in the support member (14) to be located above the seal ring (82) and have an

inner open end facing the outer cylindrical face of the drive shaft (12) and an outer open end located at the outer circumferential face of the support member (14).

3. The compressor according to claim 2, **characterized in that**

the discharge hole (84) extends in the support member (14), radially of the drive shaft (12), and at the position at which the outer open end of the discharge hole (84) is provided, the support member (14) is equal or slightly greater in outer diameter than rotor (7).

4. The compressor according to any one of claims 1 to 3, **characterized in that**

said compression unit (30) includes a fixed scroll (52) and a movable scroll (32), and the compressor further includes a counterweight (10) for balancing the movable scroll (32), the counter weight (10) being mounted on the drive shaft (12), between the support member (14) and the rotor (7), to be located within the stator (8).

5. The compressor according to one of claims 2 to 4, **characterized in that**

the compressor further includes a cover member (88) attached to the support member (14), the cover member (88) being located above the outer end of the discharge hole (84) and extending radially outward from the outer cylindrical face of the support member (14).

6. The compressor according to one of claims 2 to 5, **characterized in that**

the return path (80) further includes a discharge pipe (86) running through the stator (8), the discharge pipe (86) having one end connected with the outer end of the discharge hole (84) and the other end located inside the reservoir chamber (23).

7. The compressor according to claim 6, **characterized in that**

the discharge pipe (86) extends in one of the spaces between the armature windings (9) within the stator (8).

8. The compressor according to one of claims 2 to 7, **characterized in that**

the compressor compresses, as the operating

fluid, a refrigerant in a refrigeration circuit, and the refrigerant includes carbon dioxide.

9. The compressor according to claim 8, **characterized in that**

said sealed housing (2) includes a refrigerant intake chamber (59) into which the refrigerant is taken before drawn into said compression unit (30), and said electric motor (6) is disposed in the refrigerant intake chamber (59).

FIG. 1

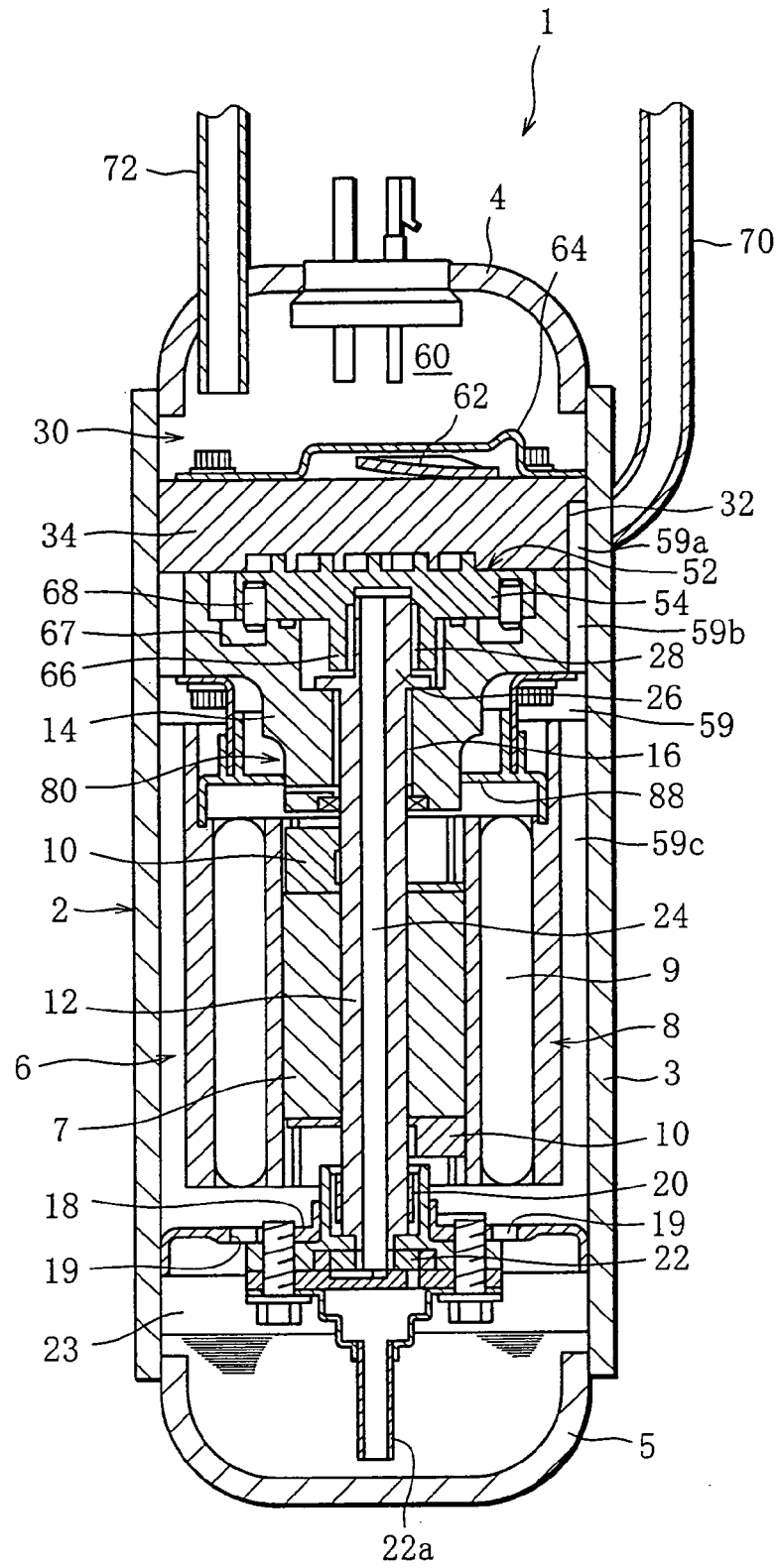


FIG. 2

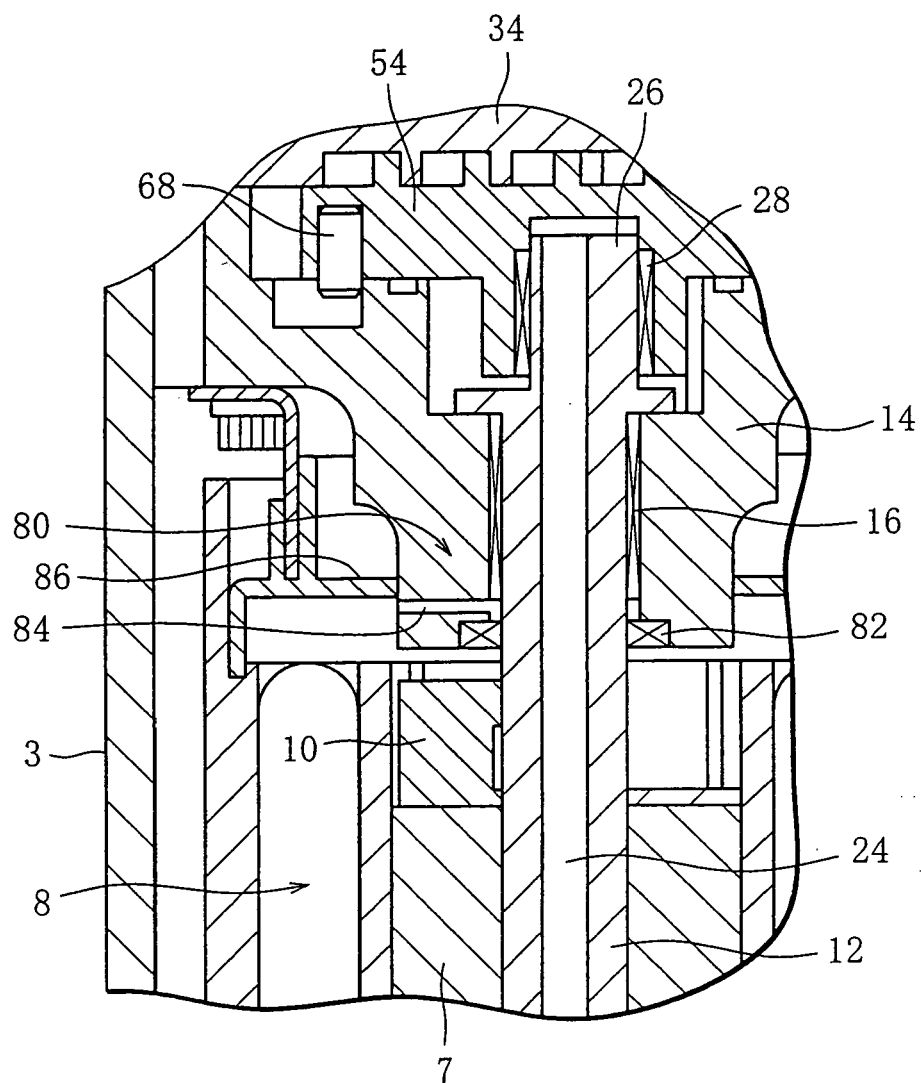
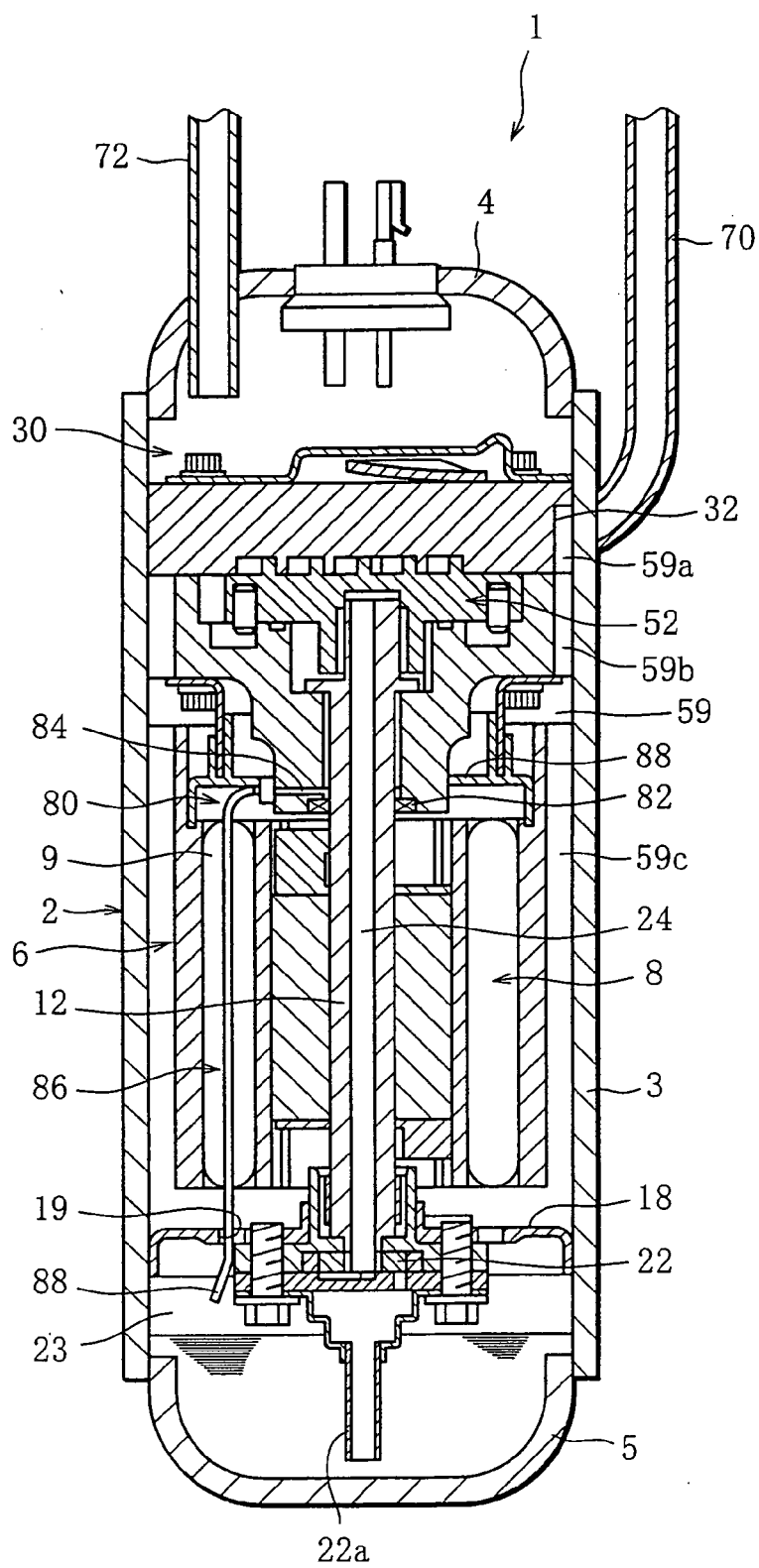


FIG. 3





European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number  
EP 07 01 9353

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                           |                                                     |                                         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------|-----------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Citation of document with indication, where appropriate, of relevant passages                                             | Relevant to claim                                   | CLASSIFICATION OF THE APPLICATION (IPC) |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | EP 0 924 430 A (MITSUBISHI HEAVY IND LTD [JP]) 23 June 1999 (1999-06-23)                                                  | 1,4,8,9                                             | INV.<br>F04C29/02<br>F04C23/00          |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | * column 6, line 28 - line 33; figure 1 *<br>-----                                                                        | 2,3,5                                               |                                         |
| X                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 6 386 840 B1 (WILLIAMS JOHN R [US] ET AL) 14 May 2002 (2002-05-14)<br>* column 2, line 43 - line 51; figures 1A,1B,4 * | 1,4,6-9                                             |                                         |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | JP 06 010864 A (MITSUBISHI ELECTRIC CORP) 21 January 1994 (1994-01-21)<br>* abstract *                                    | 2,3                                                 |                                         |
| Y                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | US 4 762 471 A (ASANUMA HAJIME [JP] ET AL) 9 August 1988 (1988-08-09)<br>* abstract; figures 1,3-6 *                      | 5                                                   |                                         |
| A,D                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | JP 10 047269 A (MITSUBISHI ELECTRIC CORP) 17 February 1998 (1998-02-17)<br>* abstract *                                   | 1-9                                                 |                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                           |                                                     | TECHNICAL FIELDS SEARCHED (IPC)         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                           |                                                     | F04C                                    |
| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                           |                                                     |                                         |
| Place of search<br>Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                           | Date of completion of the search<br>29 January 2008 | Examiner<br>Descoubes, Pierre           |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons<br/>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                           |                                                     |                                         |

1  
EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 07 01 9353

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

29-01-2008

| Patent document<br>cited in search report |    | Publication<br>date | Patent family<br>member(s) | Publication<br>date |
|-------------------------------------------|----|---------------------|----------------------------|---------------------|
| EP 0924430                                | A  | 23-06-1999          | CN 1222652 A               | 14-07-1999          |
|                                           |    |                     | JP 2984640 B2              | 29-11-1999          |
|                                           |    |                     | JP 11182477 A              | 06-07-1999          |
|                                           |    |                     | US 6106254 A               | 22-08-2000          |
| US 6386840                                | B1 | 14-05-2002          | BE 1014909 A5              | 01-06-2004          |
|                                           |    |                     | GB 2358889 A               | 08-08-2001          |
| JP 6010864                                | A  | 21-01-1994          | JP 2820179 B2              | 05-11-1998          |
| US 4762471                                | A  | 09-08-1988          | CN 85108114 A              | 27-08-1986          |
|                                           |    |                     | JP 6004070 Y2              | 02-02-1994          |
|                                           |    |                     | JP 61082090 U              | 30-05-1986          |
|                                           |    |                     | KR 870004163 Y1            | 26-12-1987          |
| JP 10047269                               | A  | 17-02-1998          | NONE                       |                     |

**REFERENCES CITED IN THE DESCRIPTION**

*This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.*

**Patent documents cited in the description**

- JP 10047269 A [0006]