Compressor with Oil Level Controlling Means

A compressor having oil level controlling means. The compressor comprises a casing having an oil storage portion at a bottom portion thereof, a compression unit installed inside the casing and configured to intake and compress working fluid, a driving unit mechanically connected to the compression unit and actuating the same, an oil level detecting means installed inside the casing and configured to detect an oil level of the oil storage portion, and a controller configured to control an operating speed of the compression unit based on the detected oil level of the oil storage portion, wherein the controller adjusts an acceleration of the operating speed of the compression unit to maintain the oil level of the oil storage portion within a desired range when the oil level exceeds the desired range while changing the operating speed.

FIG. 1

[Diagram of compressor with oil level detecting means and controller]
Description

[0001] This specification relates to a compressor having an oil level controlling means, and particularly, to a compressor capable of controlling a level of lubricant oil stored in a casing.

[0002] Generally, a compressor used in a refrigerator, an air conditioner, etc. has a configuration that a compression part for sucking and compressing a refrigerant is installed below a casing, and a motor part is installed above the compression part. The compression part and the motor part are connected to one shaft. Under this configuration, the shaft is rotated by a driving force generated through the motor part. By the rotation of the shaft, the compression part coupled to the shaft is driven to perform a compression operation.

[0003] In order to smoothly rotate the compression part, oil has to be supplied to bearing, a rolling piston, etc. of the compression part. Generally, the oil is stored at a lower part of a casing, and is pumped by an oil feeder installed at a lower end of the shaft to be supplied to the compression part. The oil serves not only to perform a lubrication operation, but also to cool the motor part. Therefore, for an enhanced lifespan and efficiency, it is very important to control a proper amount of oil to be stably supplied to the compressor.

[0004] The conventional compressor is configured to be driven at a constant speed in a normal driving mode. Accordingly, a proper amount of oil can be supplied to the compressor only if a proper amount of oil is supplied into a casing, in a condition that the compressor is not mechanically damaged or mal-operated. For an efficient driving, a compressor capable of having an increased or decreased operating speed is being widely used. As a representative example of the compressor, there is provided a compressor having a BrushLess Direct Current (BLDC) motor.

[0005] In case of this BLDC motor, an acceleration is irregularly increased and decreased during an operation. This irregular increment or decrement may influence on a level of oil stored at a lower portion of a casing. This may temporarily lower an oil level according to changes of the operating speed even in a state that the casing is supplied with a proper amount of oil therein. As a result, oil may not be smoothly supplied into the compression part. This may lower the efficiency and shorten the lifespan of the compressor.

[0006] Therefore, an aspect of the detailed description is to provide a compressor capable of controlling an oil level to maintain a proper level while increasing or decreasing an acceleration.

[0007] To achieve these and other advantages and in accordance with the purpose of this specification, as embodied and broadly described herein, there is provided a compressor including a casing having an oil storage portion at a bottom portion thereof, a compression unit installed inside the casing and configured to intake and compress working fluid, a driving unit mechanically connected to the compression unit and actuating the same, an oil level detecting means installed inside the casing and configured to detect an oil level of the oil storage portion, and a controller configured to control an operating speed of the compression unit based on the detected oil level of the oil storage portion, wherein the controller adjusts an acceleration of the operating speed of the compression unit to maintain the oil level of the oil storage portion within a desired range when the oil level exceeds the desired range while changing the operating speed.

[0008] After researching changes of an oil level when increasing or decreasing the operating speed, the present inventors observed that the oil level is changed due to a difference between an oil supply amount and an oil collection amount. More concretely, at the time of acceleration, an oil discharge amount from the compressor is larger than an oil returning amount from a system connected to the compressor. As a result, an oil level becomes low. On the other hand, at the time of decreasing an acceleration, the oil discharge amount from the compressor is smaller than the oil returning amount from the system connected to the compressor. As a result, an oil level becomes high.

[0009] The present disclosure has been derived from this research result. The oil level detecting means configured to detect an oil level may be disposed in the compressor. Through this oil level detecting means, changes of an oil level may be detected. The controller may control the oil level to be in a normal range by changing a rotation speed of a shaft when the oil level changes while increasing or decreasing the operating speed.

[0010] For instance, when it has been detected that the oil level became low at an acceleration section, the controller may control the operating speed of the compressor such that the oil level becomes high, by decreasing the operating speed or by performing a constant speed driving for a predetermined time. Here, the controller may decrease an acceleration of the operating speed when the oil level becomes low or reaches a level below a predetermined level. More concretely, if it has been detected that the oil level became low in an acceleration mode with a speed of about 4Hz per second, the acceleration may be lowered into about 2Hz per second. In some cases, the acceleration of the operating speed may be stopped, and an operating speed corresponding to a time point when lowering of the oil level was detected may be maintained for a predetermined time.

[0011] The time for constantly maintaining the operating speed may be differently set according to a place where the compressor is installed. For instance, in a case that the compressor is installed at a polar region or a cold region, the time for constantly maintaining the operating speed may be set to be much longer than in a case that the compressor is installed at a warm region. The time for constantly maintaining the operating speed may not be determined in advance, but accelerating may be restarted when it is detected, by the oil level detecting means, that the oil level restored a normal range.
[0012] However, when the oil level may not be controlled through mere changes of the operating speed in some cases where the compressor is damaged or an absolute amount of oil is deficient, etc. If the oil level has restored a normal range despite the aforementioned controls, the compression being operated may be stopped.

[0013] The compression unit may include a cylinder providing a compression chamber, a rolling piston eccentrically installed in the cylinder, a shaft including an oil feeder at a lower portion thereof and engaged with the rolling piston, and upper and lower bearings disposed on upper and lower sides of the cylinder, respectively.

[0014] The controller may be configured to decrease an acceleration of the operating speed when the oil level is lower than an uppermost portion of the oil feeder while increasing the operating speed. More concretely, oil supply may not be smoothly performed if an operation is continuously performed in a state that the oil feeder is not sufficiently soaked in oil. In this case, the acceleration of the operation speed may be decreased such that the oil level is higher than an uppermost portion of the oil feeder, i.e., such that the oil feeder is completely soaked in oil.

[0015] The controller may control the operating speed of the compression unit to maintain a constant speed when the oil level is lower than a lowermost portion of the oil feeder while accelerating the operating speed. When the oil level has restored a level more than the lowermost portion of the oil feeder, the controller may control accelerating the operating speed of the compression unit to be re-started.

[0016] Alternatively, when the oil level is lower than the lowermost portion of the oil feeder while accelerating the operating speed, the controller may stop the acceleration of the operating speed, and may control the operating speed to maintain a constant speed for a predetermined time.

[0017] The oil level detecting means may be installed to extend between an interface of the upper bearing and the cylinder and the lowermost portion of the oil feeder, and may be configured to continuously check changes of the oil level.

[0018] A plurality of oil level detecting means may be disposed between an interface of the upper bearing and the cylinder and the lowermost portion of the oil feeder, and may be configured to check whether the oil level has reached each installation point.

[0019] The plurality of oil level detecting means may be installed at a height of a lower surface of the rolling piston, an uppermost portion of the oil feeder and a lowermost portion of the oil feeder, respectively.

[0020] The oil level detecting means may include a plurality of heating wires disposed on an inner surface of the oil storage portion, a power supply unit configured to provide an alternating current to the heating wires, and a signal processor configured to process signals from the heating wires. When the alternating current is applied to the heating wires, amplitudes of temperature changes may become different according to a thermal property of a working fluid near the heating wires. The signal processor may detect amplitudes of temperature changes thus to detect an oil level. Here, the signal processor may detect an amplitude of temperature changes of the heating wires by a 3ω method.

[0021] To achieve these and other advantages and in accordance with the purpose of this specification, as embodied and broadly described herein, there is also provided an operating method of a compressor including accelerating an operating speed of a compressor, detecting an oil level inside the compressor while accelerating the operating speed, and decreasing the acceleration of the operating speed when the detected oil level is lower than a predetermined first level.

[0022] The first level may be set as a level lower than an allowable minimized value of an oil level inside the compressor.

[0023] The method may further include stopping the acceleration of the operating speed and constantly maintaining the operating speed for a predetermined time when the detected oil level is lower than a predetermined second level.

[0024] The second level may be set as a level equal to an allowable minimized value of an oil level inside the compressor.

[0025] The method may further include stopping the acceleration of the operating speed and constantly maintaining the operating speed when the oil level is lower than the predetermined second level, and restarting the acceleration of the operating speed when the oil level has restored a level more than the second level.

[0026] The compressor may include a cylinder providing a compression chamber, a rolling piston eccentrically installed in the cylinder, a shaft including an oil feeder at a lower portion thereof and engaged with the rolling piston, and upper and lower bearings disposed on upper and lower sides of the cylinder, respectively, wherein the first level is determined to correspond to a height of an uppermost portion of the oil feeder.

[0027] The second level may be determined to correspond to a height of a lowermost portion of the oil feeder.

[0028] The operating speed maintained as a constant speed may be a speed corresponding to a time point when it has been detected that the oil level is lower than the second level.

[0029] The present disclosure may be advantageous as follows.

[0030] The oil level may be controlled within a predetermined range even while changing the operating speed of the compressor. This may enhance the reliability and the lifespan of the compressor.

[0031] Further scope of applicability of the present application will become more 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 disclosure, are given by way of illustration only, since various
changes and modifications within the spirit and scope of the disclosure will become apparent to those skilled in the art from the detailed description.

[0032] The accompanying drawings, which are included to provide a further understanding of the disclosure and are incorporated in and constitute a part of this specification, illustrate exemplary embodiments and together with the description serve to explain the principles of the disclosure. In the drawings:

FIG. 1 is a sectional view of a compressor according to a first embodiment of the present disclosure;
FIG. 2 is an enlarged sectional view of a lower part of a casing of FIG. 1;
FIGS. 3A and 3B are enlarged front views of a level sensor of FIG. 1;
FIG. 4 is a block diagram schematically showing a configuration of a controller of FIG. 1; and
FIG. 5 is a flowchart showing procedures for operating the compressor of FIG. 1.

[0033] Description will now be given in detail of the exemplary embodiments, with reference to the accompanying drawings. For the sake of brief description with reference to the drawings, the same or equivalent components will be provided with the same reference numbers, and description thereof will not be repeated.

[0034] Hereinafter, a compressor according to the present disclosure will be explained in more details with reference to the attached drawings.

[0035] FIG. 1 is a sectional view of a compressor according to a first embodiment of the present disclosure. The compressor of FIG. 1 is a rotary compressor, and largely includes a casing 110 and an accumulator 120 disposed at one side of the casing 110. The accumulator 120 vaporizes a liquid included in a mixture of a refrigerant and oil, discharged from the compressor and returning to the compressor after circulating a device connected to the compressor, e.g., a refrigeration, an air conditioner, etc. The accumulator 120 is communicably connected with an upper suction pipe 112 and a lower suction pipe 114 installed at one side of the casing 110, respectively. In some cases, the accumulator 120 may not be provided. A discharge pipe 112 is installed above the casing 110, through which a compressed refrigerant is discharged to outside.

[0036] The upper suction pipe 112 and the lower suction pipe 114 are communicably connected with an upper cylinder 130 and a lower cylinder 132 disposed below the casing 110, respectively. That is, the compressor is implemented as a ‘two-stage’ type having two cylinders. However, the compressor of the present disclosure is not limited to the ‘two-stage’ type having two cylinders. An upper bearing 130a is installed above the upper cylinder 130, and a lower bearing 132a is installed below the lower cylinder 132. An intermediate plate 130b is installed between the upper cylinder 130 and the lower cylinder 132.

[0037] Under this structure, the upper cylinder 130, the upper bearing 130a and the intermediate plate 130b form an upper compression chamber, and the lower cylinder 132, the lower bearing 132a and the intermediate plate 130b form a lower compression chamber. An upper rolling piston 134 and a lower rolling piston 136 are installed in the upper compression chamber and the lower compression chamber, respectively. As the upper rolling piston 134 and the lower rolling piston 136 are eccentrically rotated, a refrigerant is sucked into the upper and lower compression chambers, compressed and discharged therefrom.

[0038] The upper rolling piston 134 and the lower rolling piston 136 are eccentrically installed on a shaft 140. The shaft 140 is disposed in a longitudinal direction of the casing 110, and an oil path 142 is penetratingly formed in the shaft 140. An oil groove 144 is formed below the shaft 140. Under this configuration, when the shaft 140 is rotated, oil stored at a lower portion of the casing 110 is transferred to an upper side of the casing along the oil path 142 and the oil groove 144.

[0039] A rotor 150 is installed above the shaft 140, and a stator 160 is fixedly installed in the casing 110 toward outside of the rotor 150. The rotor and the stator constitute a motor for rotating the shaft 140. The motor is configured to have a variable rotation speed by a controller (not shown), e.g., an inverter.

[0040] FIG. 2 is an enlarged sectional view of a lower portion of the casing 110 FIG. 1. Referring to FIG. 2, the lower portion of the casing 110 serves as a space for storing oil therein. When the compressor is operated, a level of the oil stored at a lower portion of the casing level is changed. This change of an oil level may be categorized into an absolute change due to oil loss or oil leakage, and a temporary change due to a change of an operating speed of the compressor. This oil level has to be maintained properly while the compressor is operated, such that the compressor is normally operated.

[0041] In FIG. 2, the level ‘a’ indicates an oil level before the compressor is operated. Here, the ‘a’ corresponds to a height of an interface between the upper cylinder and the upper bearing. The levels ‘b’ and ‘d’ correspond to a highest oil level and a lowest oil level where the compressor can be normally operated. More concretely, the ‘b’ corresponds to an interface between the intermediate plate and the upper cylinder, and the ‘d’ corresponds to a height of a lowermost portion of an oil feeder. That is, when the oil level is lower than the level ‘d’, oil supply by the oil feeder is not performed. Accordingly, the oil level has to be always more than the level ‘d’ while the compressor is operated.

[0042] The level ‘c’ is optional, which corresponds to an oil level for determining whether a user has taken a mistake or not. More concretely, the level ‘c’ corresponds to a height of an upper end of the oil feeder. When the oil level is more than the level ‘c’, the oil feeder is completely soaked in oil.

[0043] The level ‘c’ will be explained in more details. When a customer purchases a compressor, the customer
writes a contract to maintain an oil level as a level more than the level 'c' during an operation of the compressor. Then, when repairing the compressor, an engineer checks whether the customer has maintained an oil level as a level less than the level 'c'. According to a result of the check, the compressor is repaired for free or with charges.

Here, the positions of the lines may be arbitrarily set.

As a detecting means for checking an oil level, the compressor is provided with a level sensor 170. The level sensor 170 is installed on a lower inner wall surface of the casing 110. As shown in FIG. 3A, a plurality of level sensors may be disposed in parallel in a height direction of the casing. As shown in FIG. 3B, one level sensor may be extendingly installed between the highest oil level and the lowest oil level.

In FIG. 3A, a plurality of level sensors are disposed to be consistent with the levels 'a' to 'd', respectively. In FIG. 3B, an upper end of the level sensor is positioned to be higher than the level 'a', and a lower end thereof is positioned to be lower than the level 'c'. Each sensor is fabricated by processing a metallic thin film by etching, etc. Here, any sensor rather than the aforementioned sensors may be used.

Each level sensor is a thermal sensor using a heating wire. The level sensor detects whether a fluid such as oil has contacted thereto by detecting a change of a heat transfer property of heat generated by conducting a fluid near a heating wire. Through this detection, an oil level is measured.

The level sensor includes a thin film type heating wire fabricated by etching, and the thermal sensor measures temperature changes by applying a direct current (DC) or an alternating current (AC). In case of applying a direct current, the heating wire is heated to measure an equilibrium temperature of the sensor. In case of applying an alternating current, the heating wire is heated to measure amplitudes of temperature changes.

In case of a direct current, measurement procedures are relatively simple. However, it takes a long time for the level sensor to reach an equilibrium temperature. Accordingly, a reaction speed may be slow, and measurement errors may occur due to influences from an external temperature. On the other hand, in case of an alternating current, the level sensor reaches an equilibrium temperature very instantaneously. Accordingly, a reaction speed may be fast, and influences from an external temperature may be removed.

Therefore, the level sensor 170 performs a temperature measurement by applying an alternating current. Here, a three-omega method is used. The three-omega method is to measure a thermal property (thermal conductivity, volumetric thermal capacity) of a solid or liquid material by using a thin film type heating wire. As the thin film type sensor is used, a depth of thermal penetration is shallow. Accordingly, the sensor may reach a quasi-equilibrium temperature rapidly, and influences from external movements or vibrations may be reduced. Furthermore, the thin film type sensor has a structure that an area with respect to a volume is large and a heat accumulator is small. Accordingly, the thin film type sensor is sensitive to a change of an external medium, and has a rapid reaction speed. Furthermore, the thin film type sensor can be miniaturized, and is advantageous for massive productions using MEMS techniques.

Thin film heating wires 170a of the level sensors 170 shown in FIGS. 3A and 3B are connected to four electrodes (not shown) for supplying alternating currents and reading voltage signals. Accordingly, if a current having an angular frequency of $\omega$ is applied to the thin film heating wires 170a through the electrodes, a temperature and a resistance having an angular frequency of $2\omega$ are changed. The changed resistance having an angular frequency of $2\omega$ is multiplied with the current having an angular frequency of $\omega$, thereby being represented as a voltage signal having an angular frequency of $3\omega$. The resistance changes of the thin film heating wires implement a function of a temperature. Accordingly, temperature changes of the thin film heating wires may be measured from the voltage signal having an angular frequency of $3\omega$.

Amplitudes of the temperature changes of the thin film heating wires are determined by thermal properties of oil and the thin film, lengths and widths of the thin film heating wires, and heating frequencies. Here, the thermal property of the thin film, the length, the width, and the heating frequency are preset values. Accordingly, the amplitudes of the temperature changes of the thin film heating wires are determined by a thermal property of a material contacting the thermal film heating wires. In the preferred embodiment, a material contacting the thin film heating wires is oil or air. The thermal property of the thin film heating wires is very different from that of a material contacting the thin film heating wires. Accordingly, whether oil has contacted the thin film heating wires or not may be determined through the amplitudes of the temperature changes.

The level sensor of the present disclosure is not limited to a specific type, but may include any type of sensors capable of detecting an oil level by contacting oil. FIG. 4 shows a configuration of a controller for controlling the compressor of the present disclosure. The controller 200 includes a signal input unit 202 connected to the level sensor 170, and a micro computer 204 serving as a signal processor for processing a signal inputted from the signals input unit 202. A power supply unit 172 configured to supply an alternating current to the thin film heating wires 170a is connected to the level sensor 170.

The controller 200 includes a memory 206 configured to store therein each kind of information required to operate the controller, and information on an oil level measured by the level sensor 170.

The controller 200 is electrically connected to an inverter 210, and the inverter 210 is electrically connected to the aforementioned motor consisting of the sta-
tor and the rotor. The inverter 210 controls a rotation speed of the motor by commands from the controller 200.

[0057] The preferred embodiment will be explained with reference to FIG. 5.

[0058] FIG. 5 shows a method for controlling an operating speed of the compressor for changes. Firstly, in step of changing an operating speed (S01), an oil level (height: h) is continuously detected through the level sensor 170 (S02).

[0059] This detected level (h) is stored in the memory 206 (S03), which may be utilized as information through which a usage history of the compressor, etc. are checked later. In some cases, S03 may be omitted. S03 may not be necessarily performed in the aforementioned order, but may be performed before or after any step to be later explained.

[0060] After S03, the level (h) detected through the micro computer 204 is compared with the level 'c' (S04). More concretely, in S04, it is checked whether the detected oil level is within a normal range. Actually, a level of initially-introduced oil is not increased during an operation. Accordingly, in S04, it is checked whether the substantially-detected level (h) is lower than the level 'c'.

[0061] If it has been checked in S04 that the detected level (h) is higher than the level 'c', the current process returns to S05 to maintain a formal operation. On the other hand, if it has been checked in S04 that the detected level (h) is lower than the level 'c', the current step undergoes S06.

[0062] In S06, the oil level (h) is compared with the levels 'd' and 'c'. If it has been checked in S04 that the detected level (h) is lower than the level 'c', an acceleration is high and thus oil forcibly transferred in the previous step does not return to inside of the system. Accordingly, the acceleration has to be lowered to temporarily increase a supply amount to the system. On the other hand, if it has been checked in S04 that the detected level (h) is lower than the level 'd', an oil collection amount has to be increased more rapidly, and the acceleration has to be stopped.

[0063] In S06, it is checked whether the detected level (h) is higher than the lowest level 'c'. If the detected level (h) is higher than the lowest level 'd', oil supply can be performed to some degrees. Accordingly, the current process returns to S07 to decrease the acceleration, and then returns to S02 to repeat the aforementioned procedures.

[0064] If it is checked in S06 that the detected level (h) is lower than the lowest level 'd', the acceleration has to be stopped and a constant speed has to be maintained. Here, a time to maintain an operating speed of the compressor is differently set according to an installation place of the compressor. For instance, in case of a cold region such as a polar region, an oil viscosity is relatively high. Accordingly, a returning speed becomes also slow.

[0065] In S08, it is checked whether an installation place of the compressor corresponds to a cold region. According to a check result in S08, S09 or S10 is performed to stop acceleration of the compressor and to perform a constant speed operation for a predetermined time. Here, an operating speed in the constant speed operation mode is set as an operating speed corresponding to a time point when S06 is performed, i.e., the level (h) is lower than the ‘d’. Alternatively, the constant speed operation may be performed at a much lower operating speed according to a difference between the detected level (h) and the ‘d’.

[0066] Since an oil collection amount from the system is larger than an oil supply amount to the system, an oil level may be increased. Accordingly, if the compressor can start to be operated in a state that a sufficient amount of oil has been supplied thereinto, an oil level can be within a normal range through the steps. However, an oil supply amount may not be sufficient, or oil loss may occur due to damages of a device, oil leakage, etc. For prevention of these problems, the present disclosure may further include detecting an oil level again after S09 or S10, and stopping the operation of the compressor when the oil level is not within a normal range.

[0067] In some cases, an oil level may be detected at an initial stage of the operation. More concretely, when the compressor starts to be operated, an oil level may be detected. Then, if it has been detected that the oil level is lower than a minimized height, the controller may control the compressor not to be operated.

[0068] The foregoing embodiments and advantages are merely exemplary and are not to be construed as limiting the present disclosure. The present teachings can be readily applied to other types of apparatuses. This description is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art. The features, structures, methods, and other characteristics of the exemplary embodiments described herein may be combined in various ways to obtain additional and/or alternative exemplary embodiments.

Claims

1. . A compression device, comprising:

   a casing;
   a compressor in the casing;
   a driver to drive the compressor;
   a detector to detect a level of oil in an oil storage area; and
   a controller to control an operating speed of the compressor based on the detected oil level, wherein, during a speed-change operation, the controller controls acceleration of the compressor to maintain the oil level within a predetermined range when the oil level is detected to be outside the predetermined range.

2. . The device of claims 1, wherein the controller de-
creases acceleration of the compressor when a de-
crease in the oil level is detected during the speed-
change operation.

3.

. The device of claim 1, wherein the controller de-
creases acceleration of the compressor when the oil
level is detected to be below the predetermined
range during the speed-change operation.

4.

. The device of claim 1, wherein the controller stops
acceleration of the compressor at a substantially
constant speed for a predetermined time when the
oil level is detected to be below the predetermined
range during the speed-change operation.

5.

. The device of any of claims 1 to 4, wherein the
compressor comprises:

   a cylinder with a compression chamber;
   a rolling piston eccentrically coupled to the cy-
   linder;
   a shaft including an oil feeder coupled to the
   rolling piston; and
   upper and lower bearings adjacent upper and
   lower sides of the cylinder, respectively.

6.

. The device of claim 5, wherein the controller de-
creases acceleration of the compressor when the oil
level is detected to be lower than a lower surface of
the rolling piston during the speed-change operation.

7.

. The device of claim 5, wherein the controller stops
acceleration of the compressor and maintains the
operating speed of the compressor at a substantially
constant speed for a predetermined time when the
oil level is detected to be lower than a lowermost
portion of the oil feeder during the speed-change op-
eration.

8.

. The device of claim 5, wherein the oil level detector
is between an interface of the upper bearing and
cylinder, and a lower portion of the oil feeder.

9.

. The device of any of claims 5 to 8, wherein a plurality
of oil level detectors are between an interface of the
upper bearing and cylinder and a lower portion of the
feeder.

10.

. The device of claim 9, wherein the plurality of oil
level detectors are located at a height substantially
coincident with a lower surface of the rolling piston,
an upper portion of the oil feeder, and a lower portion
of the oil feeder, respectively.

11.

. The device of any of claims 1 to 10, wherein the oil
level detector includes:

   a plurality of heating wires;
   a power supply to provide current to the heating
   wires; and
   a signal processor to process signals from the
   heating wires to determine the oil level in the oil
   storage area.

12.

. A method of controlling a compressor, comprising:

   performing an speed-change operation for the
   compressor;
   detecting an oil level during the speed-change
   operation; and
   changing acceleration of the compressor when
   the detected oil level is lower than a predeter-
   mined first level.

13.

. The method of claim 12, further comprising:

   stopping acceleration of the compressor and
   maintaining the compressor at a substantially
   constant operating speed for a predetermined
time when the detected oil level is lower than a
   predetermined second level.

14.

. The method of claim 12, wherein the compressor
comprises:

   a cylinder with a compression chamber;
   a rolling piston eccentrically located in the cy-
   linder;
   a shaft including an oil feeder at a lower portion
   thereof and engaged with the rolling piston; and
   upper and lower bearings on upper and lower
   sides of the cylinder, respectively, wherein the
   first predetermined level corresponds to a height
   of a upper portion of the oil feeder.

15.

. The method of claim 13, wherein the compressor
comprises:

   a cylinder with a compression chamber;
   a rolling piston eccentrically located in the cy-
   linder;
   a shaft including an oil feeder at a lower portion
   thereof and engaged with the rolling piston; and
   upper and lower bearings on upper and lower
   sides of the cylinder, respectively, wherein the
   second predetermined level corresponds to a
   height of a lower portion of the oil feeder.
FIG. 4

POWER SUPPLY UNIT

LEVEL SENSOR

SIGNAL INPUT UNIT

MOTOR INVERTER MICRO COMPUTER MEMORY