SUMMARY

[0028]

The present disclosure has been made in consideration of the above conventional problems and provides a motor driving device that stably starts up even while load torque fluctuations are large. Moreover, the present disclosure provides a motor driving device capable of reliably detecting the position signal of the brushless DC motor even in the driving state in which high torque driving is required and a large motor current flows at starting and so on, and capable of realizing high torque driving performance including starting performance for the brushless DC motor, and in addition, provides a compressor driving device capable of stably starting a compressor. Furthermore, the present disclosure provides a refrigerator equipped with such a motor driving device as described above, and provides a refrigerator including a compressor driven by such a motor driving device as described above.

[0029]

According to the present disclosure, there is provided a motor driving device comprising: a brushless DC motor that drives a load that fluctuates during one rotation; a driver that applies a voltage to the brushless DC motor and drives the brushless DC motor; and a speed accelerator configured to determine the voltage to be applied by the driver so as to accelerate the brushless DC motor such that a speed change rate of a speed within one rotation from start of the brushless DC motor with respect to a speed at next one rotation remains within a predetermined value or less. With such a configuration, the speed change of the brushless DC motor due to the load fluctuation is

decreased, an occurrence of the vibration is suppressed, and the motor driving device can be

started. Hence, even in a state in which the load torque fluctuations are large, the brushless DC motor can be started stably.

[0030]

Moreover, in the motor driving device according to the example of the exemplary embodiments of the present disclosure, the speed accelerator may be configured to accelerate the brushless DC motor such that a speed change rate of a speed within one rotation from the start of the brushless DC motor with respect to the speed of the next one rotation remains within a predetermined value or less under a condition where a change of the load during one rotation is maximized. With such a configuration, the motor driving device is capable of being started under the condition where it is most difficult to make the start-up of the load driven by the brushless DC motor, and can be stably started under all the required conditions.

[0031]

Moreover, the motor driving device according to the example of the exemplary embodiments of the present disclosure may include a position detector that detects a magnetic pole position of the brushless DC motor. In this case, in the motor driving device, in a state of performing positioning of flowing a current to a specific phase of the brushless DC motor before the start of the motor driving device, and flowing a current to a phase advanced by 90 degrees or more from the phase positioned after the lapse of a predetermined time, the driver is configured to acquire the position information of the position detector, and to start to drive the motor driving device. With such a configuration, driving is performed according to the magnetic pole position of the brushless DC motor, and therefore, even when the load fluctuates during one rotation and the speed greatly changes, the motor driving device can be stably driven.

[0032]

According to the present disclosure, there is provided a driving device of a compressor, wherein the motor driving device according to an example of the exemplary embodiments of the present disclosure is used. By being driven by the motor driving device, the compressor can be stably started.

[0033]

According to the present disclosure, there is provided a refrigerator comprising a compressor for which the motor driving device according to an example of the exemplary embodiments of the present disclosure is used, wherein the compressor is configured to be started in a state in which a pressure difference remains between a suction side and discharge side of the compressor. This configuration allows the motor driving device to start even in a state in which there is the pressure difference between the suction side and discharge side of the compressor, thereby making it possible to reduce an energy loss in a refrigeration cycle without raising a temperature of the evaporator with a simple system configuration at low cost.

[0034]

Moreover, the refrigerator according to the example of the exemplary embodiments of the present disclosure may be configured such that the pressure difference between the suction side and discharge side of the compressor is larger than at least 0.05 MPa. This configuration can reduce the energy loss in the refrigeration cycle while reducing the progress of deterioration due to the increase in vibration and maintaining the reliability of the compressor.

[0035]

According to the present disclosure, there is provided a motor driving device comprising: a rectifying/smoothing circuit composed of a rectifier that rectifies an AC voltage

and a smoother made of a capacitor that converts an output voltage of the rectifier into a stable DC voltage; a brushless DC motor composed of a rotor having a permanent magnet and a stator having a three-phase winding; and an inverter having six switching elements connected to one another in a three-phase bridge configuration, the inverter receiving the output of the rectifying/smoothing circuit and supplying power to the three-phase winding; a position detector that detects a rotational position of the rotor; a speed detector that detects a speed of the brushless DC motor based on a signal from the position detector; an energized phase determiner that determines an energized phase of the stator winding based on the detected rotational position and driving speed of the rotor; and an error detector that detects an error between the speed detected by the speed detector and a target speed; a PWM controller that adjusts an output voltage of the inverter by PWM control by ON chopping or OFF chopping of any one of the switching elements of the inverter such that the speed of the brushless DC motor becomes the target speed; and a drive waveform generator that generates a drive waveform of the inverter; wherein the motor driving device is configured to select the one of the switching elements, the switching element performing the chopping by PWM control, such that a current for charging the capacitor of the smoother flows from the winding, to which supply of power is interrupted, when the energized winding of the brushless DC motor is switched. With such a configuration, when the winding of the brushless DC motor is switched, the energy stored in the winding to which the supply of power is interrupted returns as regenerative energy to the power source side, whereby, the current of the winding to which the supply of power is interrupted can be reduced to zero in a short time. In this way, a zero-cross position (that is, a position

signal of the brushless DC motor) of the induced voltage as the position information can be reliably detected from the terminal of the brushless DC motor.

[0036]

According to the present disclosure, there is provided a driving device of a compressor, wherein the driving device is composed of the motor driving device according to an example of the exemplary embodiments of the present disclosure. When the compressor is stopped due to a power failure or the like, the compressor driven by the motor driving device can be promptly restarted even in a state in which large starting torque is required due to the pressure difference between the suction side and discharge side of the compressor. In this way, a stopping period of the compressor can be shortened, and the compressor can be stably started.

[0037]

According to the present disclosure, there is provided a refrigerator provided with the driving device of the compressor according to an example of the exemplary embodiments of the present disclosure, the refrigerator comprising: a condenser that condenses the high-temperature and high-pressure gas refrigerant compressed by the compressor; a decompressor that decreases the pressure of the liquid refrigerant liquefied by the condenser; and an evaporator that evaporates the liquid refrigerant whose pressure is decreased by the decompressor; a refrigerant flow rate adjuster that shuts off a refrigerant flow path between the condenser and the evaporator, wherein, while the compressor is

being stopped, the refrigerant flow path between the condenser and the evaporator is shut off by the refrigerant flow rate adjuster.

[0038]

With such a configuration, an increase in temperature of the condenser

due to inflow of the high-temperature refrigerant to the condenser side while the compressor is being stopped can be prevented. In this way, the energy loss of the refrigeration cycle at the time when the compressor is restarted can be reduced.

[0039]

Moreover, the refrigerator according to the example of the exemplary embodiments of the present disclosure may be configured such that, when the compressor is started from the stopped state, a pressure difference equal to or larger than a predetermined value is added between the suction-side pressure and discharge-side pressure of the compressor.

[0040]

With such a configuration, even when the compressor is restarted, the compressor can be started from substantially the same pressure state as while the compressor is being driven. Therefore, soon after the compressor is started, the pressure between the suction side and discharge side of the compressor can return to the stable pressure state during the operation of the compressor. Hence, the loss of the refrigeration cycle until the compressor returns to the stable pressure state after being started can be reduced to a large extent.

[0041]

According to the present disclosure, there is provided a refrigerator comprising the motor driving device or the driving device of the compressor according to an example of the exemplary embodiments of the present disclosure.

Furthermore, the refrigerator according to the example of the exemplary embodiments of the present disclosure may include a compressor driven by the above-described motor driving device. With such a configuration, even if the compressor is controlled