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(19) **United States**(12) **Patent Application Publication**
Cha(10) **Pub. No.: US 2015/0167654 A1**(43) **Pub. Date: Jun. 18, 2015**(54) **VARIABLE CAPACITY COMPRESSOR**(71) Applicant: **Hyundai Motor Company**, Seoul (KR)(72) Inventor: **Yong Woong Cha**, Yongin-si (KR)(73) Assignee: **Hyundai Motor Company**, Seoul (KR)(21) Appl. No.: **14/304,657**(22) Filed: **Jun. 13, 2014**(30) **Foreign Application Priority Data**

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Publication Classification(51) **Int. Cl.****F04B 27/18** (2006.01)**F04B 35/01** (2006.01)**F25B 31/02** (2006.01)**F04B 27/10** (2006.01)(52) **U.S. Cl.**CPC **F04B 27/18** (2013.01); **F04B 27/1072**(2013.01); **F04B 35/01** (2013.01); **F25B****31/023** (2013.01)(57) **ABSTRACT**

A variable capacity compressor may include a drive shaft, a rotating plate connected to the drive shaft and rotatably disposed in a housing, a swash plate hingedly coupled to the rotating plate and rotated together with the rotating plate, pistons connected to an outer circumferential side edge of the swash plate and selectively inserted into compression chambers in the housing and reciprocating in the compression chambers when the swash plate is rotated, a rotating shaft hingedly connected to a center portion of the swash plate and rotated together with the swash plate, a connecting rod connected with the rotating shaft to move the rotating shaft in an axial direction to adjust a slope of the swash plate, and a drive motor connected to the connecting rod and moves the connecting rod in the axial direction of the rotating shaft.

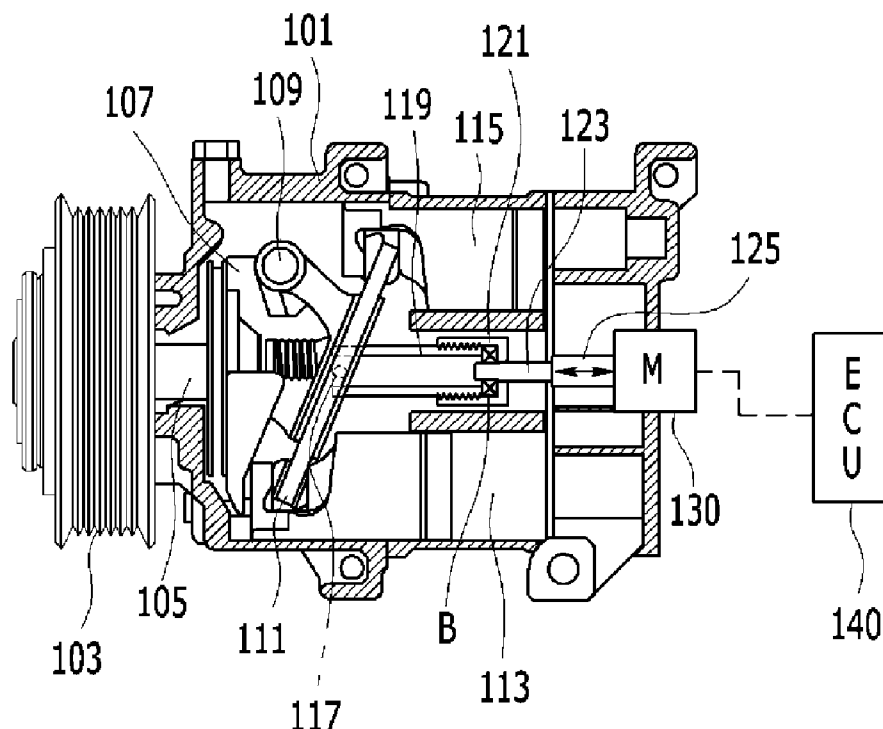
100

FIG. 1

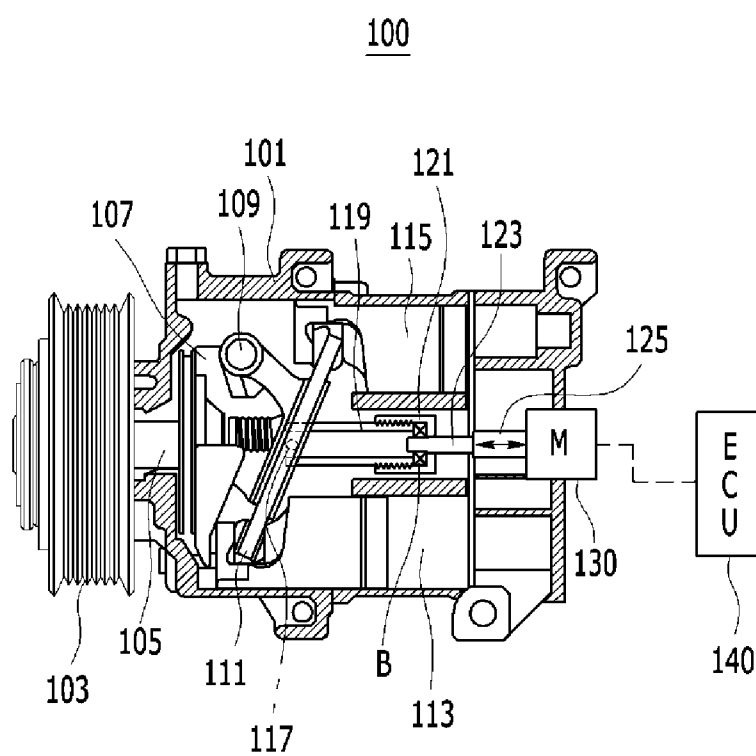


FIG. 2

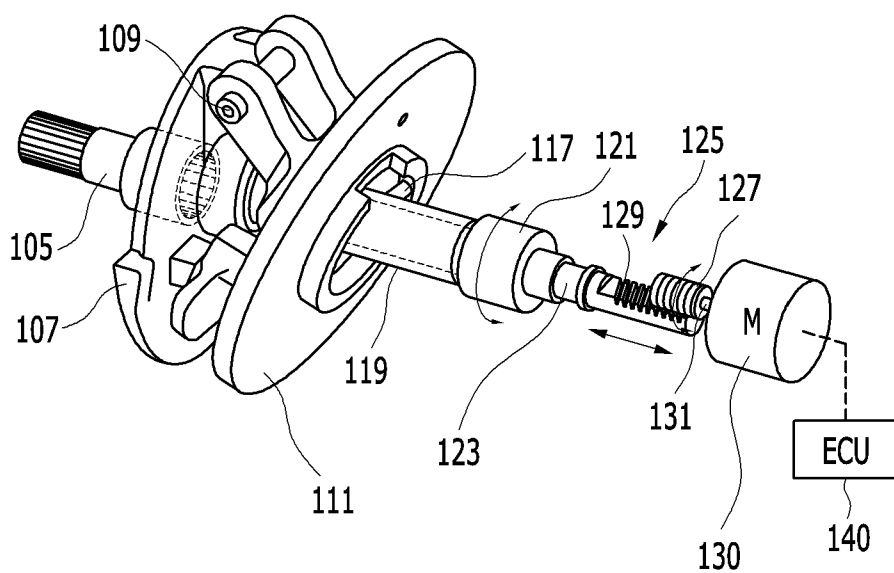


FIG. 3

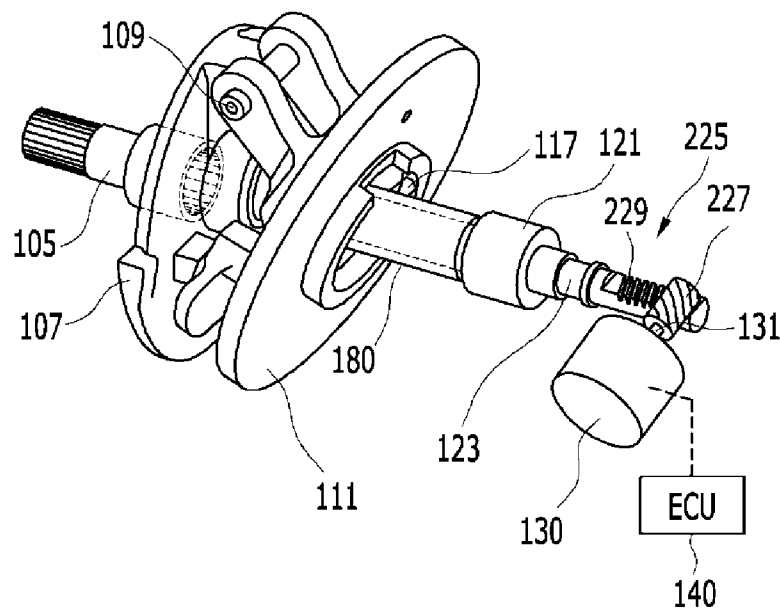
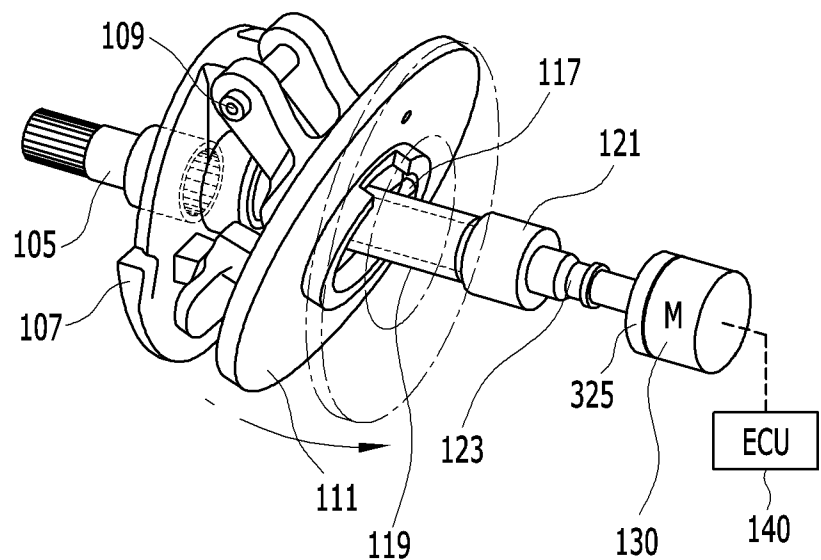


FIG. 4



VARIABLE CAPACITY COMPRESSOR

CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application claims priority of Korean Patent Application Number 10-2013-0155849 filed on Dec. 13, 2013, the entire contents of which application are incorporated herein for all purposes by this reference.

BACKGROUND OF INVENTION

[0002] 1. Field of Invention

[0003] The present invention relates to a variable capacity compressor, and more particularly, to a variable capacity compressor which accurately adjusts a slope of a swash plate to which a piston, which compresses a refrigerant, is connected, thereby actively controlling a discharge rate and a flow rate in real time by adjusting a reciprocating movement distance of the piston.

[0004] 2. Description of Related Art

[0005] In general, a compressor, which compresses a refrigerant, is applied to an air conditioning system of a vehicle, and recently, a variable capacity compressor in which an intake amount and a discharge amount are automatically adjusted by a control valve and a swash plate installed in the compressor is used.

[0006] The variable capacity compressor may variably control a discharge amount of a refrigerant in accordance with variation in cooling loads within the entire range in which an air conditioner is operated, and thus a frequent on/off control of the compressor is not necessary. Accordingly, it is possible to secure uniformity of a cooling temperature by reducing variation in temperature of air discharged to an interior room, which occurs when the compressor is turned on and off.

[0007] When a lower end portion of the swash plate is pushed toward the right side such that an inclination angle is reduced, a reciprocating movement distance of a piston connected to the swash plate is decreased such that a stroke is reduced, and as a result, a discharge amount of the refrigerant is also reduced.

[0008] In contrast, when the inclination angle of the swash plate is increased, an operation stroke of the piston is increased, and thus an amount of the refrigerant discharged from the compressor is also increased.

[0009] However, according to the variable capacity compressor in the related art, because pressure of the refrigerant is varied depending on an exterior environment, there is a problem in that even though control voltage are identically applied, slope positions of the swash plate are different from each other such that capacity for pumping the refrigerant by an operation of the piston is varied, and as a result, torque of the compressor cannot be accurately recognized.

[0010] In addition, there are also problems in that it is difficult to calculate torque, which is required to operate the compressor, to perform a precise control, and to optimize fuel consumption efficiency, and as a result, fuel efficiency deteriorates.

[0011] The information disclosed in this Background section is only for enhancement of understanding of the general background of the invention and should not be taken as an acknowledgement or any form of suggestion that this information forms the prior art already known to a person skilled in the art.

SUMMARY OF INVENTION

[0012] The present invention has been made in an effort to provide a variable capacity compressor which accurately and quickly controls a slope of a swash plate to which a piston, which compresses a refrigerant, is connected, such that a reciprocating movement distance of the piston may be accurately adjusted to be suitable for a required discharge rate and a required flow rate of the refrigerant, thereby improving fuel efficiency, power performance, and cooling performance.

[0013] Various aspects of the present invention provide a variable capacity compressor including: a drive shaft which is rotated by receiving drive power through a pulley mounted to one end portion thereof that protrudes to an outside of a housing, and has the other end portion that is inserted into the housing; a rotating plate which has a rotation center connected to the other end portion of the drive shaft, and is rotatably disposed in the housing; a swash plate which is hingedly coupled to the rotating plate and rotated together with the rotating plate; pistons which are connected to an outer circumferential side edge of the swash plate, and are selectively inserted into compression chambers provided in the housing and reciprocate in the compression chambers when the swash plate is rotated; a rotating shaft which is hingedly connected to a center portion of the swash plate through a hinge pin, and rotated together with the swash plate; a connecting rod which is connected with the rotating shaft to move the rotating shaft in an axial direction so that a slope of the swash plate is adjusted; and a drive motor which is connected to the connecting rod, and moves the connecting rod in the axial direction of the rotating shaft.

[0014] The rotating shaft may be formed in a hollow pipe shape, and disposed coaxially with a rotation center axis of the swash plate. The connecting rod may be disposed coaxially with a rotation center axis of the swash plate, may have one end portion that is inserted into the rotating shaft, and may be fixed in a rotation direction of the rotating shaft. The connecting rod may be mounted to the rotating shaft, and the one end portion thereof may be inserted into the rotating shaft through a bearing cap in which a bearing is interposed.

[0015] The drive motor may have a rotation shaft that is disposed to be substantially parallel to the connecting rod, and connected with the connecting rod through a gear means. The drive motor may have a rotation shaft that is disposed to be substantially perpendicular to the connecting rod, and connected with the connecting rod through a gear means. The gear means may include a drive gear which is mounted to the rotation shaft of the drive motor and a driven gear which is formed on the connecting rod to correspond to the drive gear and engages with the drive gear. The driven gear may be formed as a rack gear that is formed on one surface at the other end portion of the connecting rod in a length direction.

[0016] The drive motor may have a rotation shaft that is disposed coaxially with the connecting rod, and pushes or pulls the connecting rod to change the slope of the swash plate by movement of the rotating shaft in the axial direction. The drive motor may have a gear box that is embedded in the drive motor to convert rotation of the rotation shaft into the axial movement.

[0017] The drive motor may be controlled by an electronic control unit (ECU), which outputs a control signal to the drive motor, so that the slope of the swash plate is adjusted by adjusting a rotation amount of the drive motor. The ECU may operate the drive motor so that the slope of the swash plate is adjusted depending on a running state of a vehicle and

whether or not an air conditioner is operated, thereby variably controlling a compression capacity of the variable capacity compressor by variably controlling the pistons that compress a refrigerant.

[0018] According to the variable capacity compressor of the present invention, the slope of the swash plate to which the pistons, which compress a refrigerant, are connected is accurately and quickly controlled, and as a result, reciprocating movement distances of the pistons may be accurately controlled to be suitable for a required discharge rate and a required flow rate of the refrigerant.

[0019] In addition, the slope of the swash plate may be precisely controlled by operating the drive motor capable of adjusting a rotation speed and a rotation direction, such that torque required to operate the compressor is easily calculated, and an internal structure is simplified, and a precise control is possible in comparison with a manner in the related art in which a control valve using hydraulic pressure is applied, thereby improving cooling performance, and reducing manufacturing costs.

[0020] In addition, an inclination angle of the swash plate may be controlled so that the inclination angle is set to, for example, 0° in a case in which the air conditioner is not operated, and as a result, power consumption of the compressor is reduced such that power performance and fuel efficiency are improved, and a problem such as an initial operation delay may be resolved such that NVH performance may be improved.

[0021] The methods and apparatuses of the present invention have other features and advantages which will be apparent from or are set forth in more detail in the accompanying drawings, which are incorporated herein, and the following Detailed Description, which together serve to explain certain principles of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] FIG. 1 is a schematic cross-sectional configuration diagram of an exemplary variable capacity compressor according to the present invention.

[0023] FIG. 2 is a perspective view illustrating a main part of an exemplary variable capacity compressor according to the present invention.

[0024] FIG. 3 is a perspective view illustrating a main part of another exemplary variable capacity compressor according to the present invention.

[0025] FIG. 4 is a perspective view illustrating a main part of yet another exemplary variable capacity compressor according to the present invention.

DETAILED DESCRIPTION

[0026] Reference will now be made in detail to various embodiments of the present invention(s), examples of which are illustrated in the accompanying drawings and described below. While the invention(s) will be described in conjunction with exemplary embodiments, it will be understood that present description is not intended to limit the invention(s) to those exemplary embodiments. On the contrary, the invention(s) is/are intended to cover not only the exemplary embodiments, but also various alternatives, modifications, equivalents and other embodiments, which may be included within the spirit and scope of the invention as defined by the appended claims.

[0027] A part irrelevant to the description will be omitted to clearly describe the present invention, and the same or similar elements will be designated by the same reference numerals throughout the specification.

[0028] The size and thickness of each component illustrated in the drawings are arbitrarily shown for understanding and ease of description, but the present invention is not limited thereto. Thicknesses of several portions and regions are enlarged for clear expressions.

[0029] Further, throughout the specification and the claims, unless explicitly described to the contrary, the word “comprise” and variations such as “comprises” or “comprising” will be understood to imply the inclusion of stated elements but not the exclusion of any other elements.

[0030] In addition, “unit”, “means”, “part”, “member”, or the like, which is described in the specification, means a unit of a comprehensive configuration that performs at least one function or operation.

[0031] FIG. 1 is a schematic cross-sectional configuration diagram of a variable capacity compressor according to various embodiments of the present invention, and FIG. 2 is a perspective view illustrating a main part of the variable capacity compressor according to various embodiments of the present invention.

[0032] Referring to the drawings, a variable capacity compressor 100 according to various embodiments of the present invention accurately and quickly controls a slope of a swash plate 111 to which a piston 115, which compresses a refrigerant, is connected, such that a reciprocating movement distance of the piston 115 may be accurately adjusted to be suitable for a required discharge rate and a required flow rate of the refrigerant, thereby improving fuel efficiency, power performance, and cooling performance.

[0033] To this end, as illustrated in FIGS. 1 and 2, the variable capacity compressor 100 according to various embodiments of the present invention includes a housing 101, a pulley 103, a drive shaft 105, a rotating plate 107, the swash plate 111, the piston 115, a rotating shaft 119, a connecting rod 123, and a drive motor 130.

[0034] First, the pulley 103 is disposed outside the housing 101, and receives torque from a rotational power source such as an engine or a motor. The drive shaft 105 has one end portion, which protrudes from the housing 101 to the outside and is mounted to the pulley 103, is rotated by receiving drive power through the pulley 103, and has the other end portion that is inserted into the housing 101.

[0035] In various embodiments such as those illustrated in FIGS. 1 and 2, the rotating plate 107 has a rotation center, which is connected to one side at the other end portion of the drive shaft 105, is rotatably disposed in the housing 101, and is rotated about a rotation center axis by the drive shaft 105. The swash plate 111 is hingedly coupled to the rotating plate 107 such as through a swash plate hinge 109, which is provided at an edge of the rotating plate 107, and is rotated together with the rotating plate 107.

[0036] Further, the pistons 115 are provided to correspond to compression chambers 113, which are formed in the housing 101 in a length direction, and the plurality of pistons 115 is connected to an outer circumferential side edge of the swash plate 111 at positions that are spaced apart from the rotation center axis at predetermined distances.

[0037] When the swash plate 111 is rotated, the pistons 115 are selectively inserted into the compression chambers 113,

and reciprocate in the compression chambers 113, thereby compressing a working fluid including a refrigerant in the compression chambers 113.

[0038] In various embodiments such as those illustrated in FIGS. 1 and 2, the rotating shaft 119 is hingedly connected to a center of the swash plate 111 such as through a hinge pin 117, and rotated together with the swash plate 111. The rotating shaft 119 may be formed in a hollow pipe shape, and may be disposed on the rotation center axis of the swash plate 111.

[0039] The connecting rod 123 is connected to the rotating shaft 119 so as to adjust a slope of the swash plate 111 by moving the rotating shaft 119 in an axial direction. Here, the connecting rod 123 is disposed on the rotation center axis of the swash plate 111, has one end portion, which is inserted into the rotating shaft 119 that is formed in a hollow shape, and is fixed in a rotation direction of the rotating shaft 119.

[0040] The connecting rod 123 is mounted to the rotating shaft 119, and the one end portion, which is inserted into the rotating shaft 119 such as through a bearing cap 121 in which a bearing B is interposed, may be connected to the connecting rod 123. That is, the connecting rod 123 is mounted to the rotating shaft 119 using the bearing B, and thus is prevented from being rotated together with the rotating shaft 119.

[0041] Accordingly, the rotating shaft 119 is rotated based on the connecting rod 123, and when the connecting rod 123 reciprocates in the axial direction, the rotating shaft 119 is moved together with the connecting rod 123 so as to change the slope of the swash plate 111.

[0042] In various embodiments such as those illustrated in FIGS. 1 and 2, the drive motor 130 is connected to the connecting rod 123 through a gear means 125, and allows the connecting rod 123 to reciprocate in the axial direction of the rotating shaft 119. Here, detailed configuration and operation of the gear means 125 will be described below.

[0043] Meanwhile, the drive motor 130 may be controlled by an ECU 140, which outputs a control signal to the drive motor 130, so that the slope of the swash plate 111 may be adjusted by adjusting a rotation amount of the drive motor 130. That is, when the ECU 140 operates the drive motor 130, the gear means 125 converts rotational motion of the drive motor 130 into rectilinear motion, thereby allowing the connecting rod 123, which is connected with the drive motor 130, to be moved forward or rearward in the axial direction.

[0044] Then, when the connecting rod 123 is moved forward or rearward in the axial direction, the rotating shaft 119 adjusts the slope of the swash plate 111 while being moved forward or rearward by the connecting rod 123.

[0045] The ECU 140 operates the drive motor 130 so that the slope of the swash plate 111 is adjusted depending on a running state of a vehicle and whether or not an air conditioner is operated, thereby variably controlling a compression capacity by which the piston 115 compresses a refrigerant.

[0046] In addition, the ECU 140 accurately determines a distance at which the connecting rod 123 is moved forward or rearward by controlling a rotation speed of the drive motor 130, thereby more precisely controlling the slope of the swash plate 111.

[0047] Further, the ECU 140 may select torque data, which are required to operate the variable capacity compressor 100, using the slope of the swash plate 111 which is precisely controlled, and may easily calculate operation torque of the variable capacity compressor 100 using the selected required torque data.

[0048] Meanwhile, in the present exemplary embodiment, as illustrated in FIG. 2, the drive motor 130 may have a rotation shaft 131 that is disposed to be parallel or substantially parallel to the connecting rod 123 and connected with the connecting rod 123 through the gear means 125. Here, the gear means 125 includes a drive gear 127 which is mounted to the rotation shaft 131 of the drive motor 130, and a driven gear 129 which is formed on the connecting rod 123 so as to correspond to the drive gear 127, and engages with the drive gear 127.

[0049] The driven gear 129 may be formed as a rack gear that is formed on one surface at the other end portion of the connecting rod 123 in the length direction. That is, the gear means 125 transmits torque of the drive motor 130 to the connecting rod 123 through the driven gear 129 that engages with the drive gear 127, thereby converting torque of the drive motor 130 into the rectilinear motion of the connecting rod 123.

[0050] FIG. 3 is a perspective view illustrating a main part of a variable capacity compressor according to various other embodiments of the present invention. Meanwhile, in the description of various other embodiments of the present invention, like reference numerals refer to constituent elements identical or similar to those of the aforementioned embodiments.

[0051] Referring to FIG. 3, in a variable capacity compressor 100 according to various other embodiments of the present invention, a rotation shaft 131 of a drive motor 130 is disposed to be perpendicular or substantially perpendicular to a connecting rod 123, and connected with the connecting rod 123 through a gear means 225.

[0052] Here, the gear means 225 includes a drive gear 227 which is mounted to the rotation shaft 131 of the drive motor 130, and a driven gear 229 which is formed as a rack gear that is formed on one surface at the other end portion of the connecting rod 123 in a length direction so as to correspond to the drive gear 227, and engages with the drive gear 227.

[0053] Like the embodiments illustrated in FIGS. 1 and 2, the gear means 225, which is configured as described above, transmits torque of the drive motor 130 to the connecting rod 123 through the driven gear 229 that engages with the drive gear 227, thereby converting torque of the drive motor 130 into rectilinear motion of the connecting rod 123.

[0054] That is, the variable capacity compressor 100 according to another exemplary embodiment of the present invention is different from that of the aforementioned exemplary embodiment in that the rotation shaft 131 of the drive motor 130 is disposed to be perpendicular or substantially perpendicular to the connecting rod 123.

[0055] FIG. 4 is a perspective view illustrating a main part of a variable capacity compressor according to yet various other embodiments of the present invention. Meanwhile, in the description of yet various other embodiments of the present invention, like reference numerals refer to constituent elements identical or similar to those of the aforementioned embodiments.

[0056] Referring to FIG. 4, in a variable capacity compressor 100 according to yet various other embodiments of the present invention, a rotation shaft of a drive motor 130 is disposed coaxially with a connecting rod 123, and a slope of a swash plate 111 is changed using reciprocating movement of a rotating shaft 119 by pushing or pulling the connecting rod 123.

[0057] Here, a gear box 325, which converts rotation of the rotation shaft into the reciprocating movement, may be embedded in the drive motor 130. That is, unlike the aforementioned embodiments, the variable capacity compressor 100 according to yet various other embodiments of the present invention may have a structure in which the gear box 325, which corresponds to the gear means 125 and 225, is integrally embedded in the drive motor 130, rotational motion of the drive motor 130 is directly converted into rectilinear motion using the gear box 325, and the rectilinear motion is transferred to the connecting rod 123.

[0058] Therefore, according to the variable capacity compressor 100 according to various embodiments of the present invention, the slope of the swash plate 111 to which the pistons 115, which compress a refrigerant, are connected is accurately and quickly controlled, and as a result, reciprocating movement distances of the pistons 115 may be accurately controlled to be suitable for a required discharge rate and a required flow rate of the refrigerant.

[0059] In addition, the slope of the swash plate 111 may be precisely controlled by operating the drive motor 130 capable of adjusting a rotation speed and a rotation direction, such that torque required to operate the compressor 100 is easily calculated, and an internal structure is simplified, and a precise control is possible in comparison with a manner in the related art in which a control valve using hydraulic pressure is applied, thereby improving cooling performance, and reducing manufacturing costs.

[0060] In addition, an inclination angle of the swash plate 111 may be controlled so that the inclination angle is set to, for example, 0° in a case in which the air conditioner is not operated, and as a result, power consumption of the compressor 100 is reduced such that power performance and fuel efficiency are improved, and a problem such as an initial operation delay may be resolved such that NVH performance may be improved.

[0061] For convenience in explanation and accurate definition in the appended claims, the terms “upper” or “lower”, “forward” or “rearward”, and etc. are used to describe features of the exemplary embodiments with reference to the positions of such features as displayed in the figures.

[0062] The foregoing descriptions of specific exemplary embodiments of the present invention have been presented for purposes of illustration and description. They are not intended to be exhaustive or to limit the invention to the precise forms disclosed, and obviously many modifications and variations are possible in light of the above teachings. The exemplary embodiments were chosen and described in order to explain certain principles of the invention and their practical application, to thereby enable others skilled in the art to make and utilize various exemplary embodiments of the present invention, as well as various alternatives and modifications thereof. It is intended that the scope of the invention be defined by the Claims appended hereto and their equivalents.

What is claimed is:

1. A variable capacity compressor comprising:

a drive shaft which is rotated by receiving drive power through a pulley mounted to one end portion thereof that protrudes to an outside of a housing, and has the other end portion that is inserted into the housing;

a rotating plate which has a rotation center connected to the other end portion of the drive shaft, and is rotatably disposed in the housing;

a swash plate which is hingedly coupled to the rotating plate and rotated together with the rotating plate;

pistons which are connected to an outer circumferential side edge of the swash plate, and are selectively inserted into compression chambers provided in the housing and reciprocate in the compression chambers when the swash plate is rotated;

a rotating shaft which is hingedly connected to a center portion of the swash plate through a hinge pin, and rotated together with the swash plate;

a connecting rod which is connected with the rotating shaft to move the rotating shaft in an axial direction so that a slope of the swash plate is adjusted; and

a drive motor which is connected to the connecting rod, and moves the connecting rod in the axial direction of the rotating shaft.

2. The variable capacity compressor of claim 1, wherein: the rotating shaft is formed in a hollow pipe shape, and disposed coaxially with a rotation center axis of the swash plate.

3. The variable capacity compressor of claim 1, wherein: the connecting rod is disposed coaxially with a rotation center axis of the swash plate, has one end portion that is inserted into the rotating shaft, and is fixed in a rotation direction of the rotating shaft.

4. The variable capacity compressor of claim 3, wherein: the connecting rod is mounted to the rotating shaft, and the one end portion thereof is inserted into the rotating shaft through a bearing cap in which a bearing is interposed.

5. The variable capacity compressor of claim 1, wherein: the drive motor has a rotation shaft that is disposed to be substantially parallel to the connecting rod, and connected with the connecting rod through a gear means.

6. The variable capacity compressor of claim 1, wherein: the drive motor has a rotation shaft that is disposed to be substantially perpendicular to the connecting rod, and connected with the connecting rod through a gear means.

7. The variable capacity compressor of claim 5, wherein the gear means includes:

a drive gear which is mounted to the rotation shaft of the drive motor; and

a driven gear which is formed on the connecting rod to correspond to the drive gear, and engages with the drive gear.

8. The variable capacity compressor of claim 7, wherein: the driven gear is formed as a rack gear that is formed on one surface at the other end portion of the connecting rod in a length direction.

9. The variable capacity compressor of claim 1, wherein: the drive motor has a rotation shaft that is disposed coaxially with the connecting rod, and pushes or pulls the connecting rod to change the slope of the swash plate by movement of the rotating shaft in the axial direction.

10. The variable capacity compressor of claim 9, wherein: the drive motor has a gear box that is embedded in the drive motor to convert rotation of the rotation shaft into the axial movement.

11. The variable capacity compressor of claim 1, wherein: the drive motor is controlled by an electronic control unit (ECU), which outputs a control signal to the drive motor, so that the slope of the swash plate is adjusted by adjusting a rotation amount of the drive motor.

12. The variable capacity compressor of claim **11**, wherein: the ECU operates the drive motor so that the slope of the swash plate is adjusted depending on a running state of a vehicle and whether or not an air conditioner is operated, thereby variably controlling a compression capacity of the variable capacity compressor by variably controlling the pistons that compress a refrigerant.

13. The variable capacity compressor of claim **6**, wherein the gear means includes:

a drive gear which is mounted to the rotation shaft of the drive motor; and

a driven gear which is formed on the connecting rod to correspond to the drive gear, and engages with the drive gear.

14. The variable capacity compressor of claim **13**, wherein: the driven gear is a rack gear that is formed on one surface at the other end portion of the connecting rod in a length direction.

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