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(72) Inventors:
• **YAKUSHIJI, Shunsuke**
Tokyo 108-8215 (JP)
• **OGAWA, Makoto**
Tokyo 108-8215 (JP)

(74) Representative: **Intès, Didier Gérard André et al**
Cabinet Beau de Loménie
158 rue de l'Université
75340 Paris Cedex 07 (FR)

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(71) Applicant: **Mitsubishi Heavy Industries, Ltd.**
Tokyo 108-8215 (JP)

(54) **COMPRESSOR**

(57) A compressor is provided that is capable of reducing a bending amount of a drive shaft to reduce noise generated by vibration caused by a bending eigenvalue. The compressor is provided with: a compression mechanism; a motor that includes a rotor (13) formed by a plurality of steel plates stacked on top of each other, and a stator (12) provided around an outer circumferential portion of the rotor (13); and a drive shaft (14) that connects the motor and the compression mechanism. A first balance weight (35) is provided on the surface of the rotor located remote from the compression mechanism in the axial direction of the drive shaft (14), and of the stacked steel plates, a steel plate (13A) adjacent to the first balance weight (35) protrudes toward the stator (12) located remote from the first balance weight (35) in the radial direction of the rotor (13) with respect to the axis of the drive shaft (14).

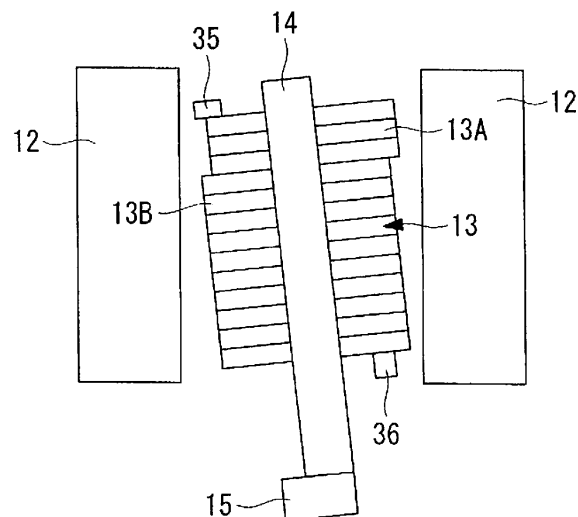


FIG. 3

Description

Technical Field

[0001] The present invention relates to a compressor that is applied to an air conditioner and the like, and that includes a rotary-type compression portion and a motor.

Background Art

[0002] A compression portion of a compressor used in an air conditioner is driven by an electromagnetic motor. The electromagnetic motor is constituted of a rotor and a stator, and the rotor and the compression portion are connected to each other via a drive shaft (a shaft). The rotor of the motor rotates, which rotates the compression portion.

[0003] One end of the drive shaft adjacent to the compression portion is fixed, and the other end of the drive shaft adjacent to the rotor is a free end. Further, for a rotary-type compressor, the drive shaft is provided with a crank pin (an eccentric pin) adjacent to the compression portion, and the crank pin is fitted into a roller of the compression portion. As a result, the center of gravity of the roller of the compression portion is eccentrically positioned with respect to an axis of the drive shaft, and is not positioned on the axis of the drive shaft. Therefore, in order to keep balance with a centrifugal force generated by the rotation of the roller, a balance weight is provided as a weight, on the upper surface or the lower surface of the rotor.

[0004] In Patent Document 1 described below, a technology is disclosed in which the center of a drive shaft is displaced, with respect to the center of a rotor of a motor, toward a first balance weight provided on the upper surface of the rotor, in order to suppress a centrifugal whirling of the rotor to reduce vibration and noise from the rotor. Further, in Patent Document 2, a technology is disclosed in which, in order to reduce vibration and noise during operation, a drive shaft is provided with a first section to which a rotor is mounted and a second section located adjacent to a cylinder chamber, and the central axis of the first section is displaced, with respect to the central axis of the second section, toward the opposite side to a side on which a balance weight is provided.

Citation List

Patent Document

[0005]

Patent Document 1: Japanese Unexamined Patent Application Publication No. 2006-200527A

Patent Document 2: Japanese Unexamined Patent Application Publication No. 2009-74464A

Summary of Invention

Technical Problems

[0006] During the operation of a compressor, noise is generated by vibration caused by a bending eigenvalue of a drive shaft. This noise based on resonance is larger than noise caused by other vibrations generated in the drive shaft. Given the structure of the compressor, the drive shaft is not easily prevented from resonating at the eigenvalue. However, even when the resonance has occurred, reducing a bending amount of the drive shaft can suppress the vibration and reduce the noise.

[0007] In light of the foregoing, an object of the present invention is to provide a compressor capable of reducing a bending amount of a drive shaft to reduce noise generated by vibration caused by a bending eigenvalue.

Solution to Problem

[0008] A compressor according to a first aspect of the present invention includes: a compression portion; a motor portion including a rotor formed by a plurality of metal plates stacked on top of each other, and a stator provided around an outer circumferential portion of the rotor; and a drive shaft connecting the motor portion and the compression portion. The rotor includes a weight portion on a surface thereof on one side in an axial direction of the drive shaft. Of the stacked metal plates, the metal plate located adjacent to the weight portion protrudes toward the stator located remote from weight portion in a radial direction of the rotor with respect to an axis of the drive shaft.

[0009] With this configuration, the stacked metal plate constituting a part of the rotor protrudes toward the stator located remote from the weight portion in the radial direction of the rotor. Therefore, when the rotor of the motor rotates, a magnetic attraction force generated adjacent to the stator is larger in a section from which the metal plates protrude than a magnetic attraction force in a section from which the metal plates do not protrude. As a result, even when a centrifugal force acts due to the weight portion at the time of rotation, since the magnetic attraction force is generated in a direction that alleviates bending of the drive shaft, the bending of the drive shaft can be alleviated, in comparison to a case in which the rotor does not have the section in which the metal plate protrudes. Note that the surface on which the weight portion is provided on the one side in the axial direction of the drive shaft is a surface on the opposite side to a surface located adjacent to the compression portion, for example.

[0010] In the first aspect of the present invention, of the stacked metal plates, the metal plate located adjacent to the weight portion may be stacked so as to be displaced toward the stator located remote from the weight portion in the radial direction of the rotor with respect to the axis of the drive shaft.

[0011] With this configuration, the stacked metal plate constituting a part of the rotor is stacked in a displaced manner so as to protrude toward the stator located remote from the weight portion. Therefore, when the rotor of the motor rotates, the magnetic attraction force generated adjacent to the stator is larger in a section where the metal plate is stacked so as to protrude than a magnetic attraction force in a section where the metal plate is not stacked so as to protrude.

[0012] In the first aspect of the present invention, of the stacked metal plates, the metal plate located adjacent to the weight portion may have a metal coating applied thereto so as to protrude toward the stator located remote from the weight portion in the radial direction of the rotor with respect to the axis of the drive shaft.

[0013] With this configuration, the stacked metal plate constituting a part of the rotor has the metal coating applied thereto so as to protrude toward the stator located remote from the weight portion. Therefore, when the rotor of the motor rotates, the magnetic attraction force generated adjacent to the stator is larger in a section to which the metal coating is applied than a magnetic attraction force in a section from which the metal plate does not protrude.

[0014] In the first aspect of the present invention, a weight of a section of the metal plate located adjacent to the weight portion with respect to the axis of the drive shaft may be reduced, taking into account a weight of a section of the metal plate that protrudes in the radial direction of the rotor.

[0015] With this configuration, even when the stacked metal plate protrudes toward the opposite side to the weight portion with respect to the axis of the drive shaft, a centrifugal force that acts on the compression portion and a centrifugal force that acts on the rotor can be balanced against each other.

[0016] In the first aspect of the present invention, a second weight portion may be provided on a surface of the rotor on the other side opposite to the one side in the axial direction of the drive shaft. Of the stacked metal plates, the metal plate located adjacent to the second weight portion protrudes toward the stator located remote from the second weight portion in the radial direction of the rotor with respect to the axis of the drive shaft.

[0017] With this configuration, the metal plate located adjacent to the second weight portion protrudes toward the stator located remote from the second weight portion in the radial direction of the rotor, and in addition to the above-described metal plate located adjacent to the weight portion, the magnetic attraction force generated adjacent to the stator becomes larger than a magnetic attraction force in a section from which the metal plate does not protrude. As a result, the bending of the drive shaft can be further alleviated than a case in which the rotor does not have the section from which the metal plate protrudes.

[0018] A compressor according to a second aspect of the present invention includes: a compression portion; a

motor portion including a rotor formed by a plurality of metal plates stacked on top of each other, and a stator provided around an outer circumferential portion of the rotor; and a drive shaft connecting the motor portion and the compression portion. The rotor includes a weight portion on a surface thereof located remote from the compression portion in an axial direction of the drive shaft and includes a plurality of permanent magnets therein. The permanent magnets provided remote from the compression portion in the axial direction of the drive shaft are arranged such that a magnetic force increases in a direction toward the stator located remote from the weight portion in a radial direction of the rotor with respect to an axis of the drive shaft.

[0019] With this configuration, the magnetic force of the permanent magnets increases toward the stator located remote from the weight portion in the radial direction of the rotor. Therefore, when the rotor of the motor rotates, the magnetic attraction force generated adjacent to the stator is larger in a section where the magnetic force of the permanent magnets increases than a magnetic attraction force in the other section. As a result, even when the centrifugal force acts due to the weight portion at the time of rotation, because the increased magnetic attraction force is generated in the direction that alleviates the bending of the drive shaft, the bending of the drive shaft can be alleviated, in comparison to a case in which the rotor does not have the section where the magnetic force of the permanent magnets increases.

[0020] In the second aspect of the present invention, the permanent magnets provided remote from the compression portion in the axial direction of the drive shaft may be arranged so as to be shifted toward the stator in the radial direction of the rotor, in comparison to the other permanent magnets, or have a larger magnetic force than a magnetic force of the other permanent magnets.

[0021] With this configuration, the permanent magnets are arranged so as to be shifted toward the stator located remote from the weight portion in the radial direction of the rotor, in comparison to the other permanent magnets. Therefore, when the rotor of the motor rotates, the magnetic attraction force generated adjacent to the stator is larger in a section where the permanent magnets are arranged so to be shifted than a magnetic attraction force in a section where the permanent magnets are not shifted. In other words, because the magnetic force of the permanent magnets toward the stator located remote from the weight portion in the radial direction of the rotor is larger than a magnetic force of the other permanent magnets, when the rotor of the motor rotates, the magnetic attraction force generated adjacent to the stator is larger in a section where the magnetic force of the permanent magnets is larger than a magnetic attraction force in the other section, than in the other section.

Advantageous Effects of Invention

[0022] According to the present invention, the bending

amount of the drive shaft can be reduced, and the noise generated by the vibration caused by the bending eigenvalue can thus be reduced.

Brief Description of Drawings

[0023]

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

FIG. 2 is a horizontal cross-sectional view of a compression mechanism of the compressor according to the first embodiment of the present invention.

FIG. 3 is a schematic vertical cross-sectional view of a rotor and a motor of the compressor according to the first embodiment of the present invention.

FIG. 4 is a plan view of the rotor of the compressor according to the first embodiment of the present invention.

FIG. 5 is a schematic vertical cross-sectional view of a first modified example of the rotor and the motor of the compressor according to the first embodiment of the present invention.

FIG. 6 is a plan view of the first modified example of the rotor of the compressor according to the first embodiment of the present invention.

FIG. 7 is a schematic vertical cross-sectional view of a second modified example of the rotor and the motor of the compressor according to the first embodiment of the present invention.

FIG. 8 is a plan view of the second modified example of the rotor of the compressor according to the first embodiment of the present invention.

FIG. 9 is a schematic vertical cross-sectional view of a third modified example of the rotor and the motor of the compressor according to the first embodiment of the present invention.

FIG. 10 is a plan view of the third modified example of the rotor of the compressor according to the first embodiment of the present invention.

FIG. 11 is a horizontal cross-sectional view of a rotor and a motor of a compressor according to a second embodiment of the present invention.

Description of Embodiments

First Embodiment

[0024] A compressor 1 according to a first embodiment of the present invention will be described below with reference to the drawings. As illustrated in FIG. 1, the multi-cylinder rotary-type compressor 1 according to the present embodiment is provided with a cylindrical sealed container 2 whose upper and lower portions are respectively sealed by an upper cover 3 and a lower cover 4. A motor 5 is provided in the upper part of the interior of the sealed container 2, and a compression mechanism (a

rotary compression mechanism) 6 to be driven by the motor 5 is provided in the lower part of the sealed container 2.

[0025] A mounting leg 7 is provided on the outer circumference of the lower portion of the sealed container 2. Further, a discharge pipe 8 that penetrates through the upper cover 3 is provided in the upper portion of the sealed container 2. The discharge pipe 8 discharges a high-pressure refrigerant gas compressed by the multi-cylinder rotary compressor 1 toward a refrigeration cycle. Furthermore, an accumulator 9 is mounted on an outer circumferential portion of the sealed container 2. The accumulator 9 separates a liquid portion, such as oil and liquid refrigerant, contained in a low-pressure refrigerant gas returned from the refrigerating cycle side, and causes only a gas portion to be taken in by the compressor mechanism 6 via intake pipes 10 and 11.

[0026] The motor 5 is provided with a stator 12 and a rotor 13. The stator 12 is fixedly installed on the inner circumferential surface of the sealed container 2 by press fitting and the like. The rotor 13 is connected to and integrally provided with a drive shaft 14. This configuration allows a rotational driving force of the rotor 13 to be transmitted to the compression mechanism 6 via the drive shaft 14. Further, in the lower part of the drive shaft 14, a first eccentric pin 15 and a second eccentric pin 16 are provided so as to respectively correspond to a first roller 24 and a second roller 25 of the rotary-type compression mechanism 6 described below.

[0027] In the present embodiment, the rotary-type compression mechanism 6 is of a two-cylinder type, and a first cylinder chamber 17 and a second cylinder chamber 18 are respectively formed in first and second compression mechanisms 6A and 6B of the compression mechanism 6. The compression mechanism 6 is further provided with a first cylinder main body 19, a second cylinder main body 20, a partition plate (a separator plate) 21, an upper bearing 22, a lower bearing 23, and the like.

[0028] The first cylinder main body 19 and the second cylinder main body 20 are fixedly installed inside the sealed container 2 so as to respectively correspond to the first eccentric pin 15 and the second eccentric pin 16 of the drive shaft 14. The partition plate 21 is interposed between the first cylinder main body 19 and the second cylinder main body 20, defining the first cylinder chamber 17 and the second cylinder chamber 18. The upper bearing 22 is provided on the upper surface of the first cylinder main body 19, defining the first cylinder chamber 17 and supporting the drive shaft 14. The lower bearing 23 is provided on the lower surface of the second cylinder main body 20, defining the second cylinder chamber 18 and supporting the drive shaft 14.

[0029] The first and second compression mechanisms 6A and 6B are respectively provided with the first roller 24 and the second roller 25 and with blades 28 and 29.

[0030] The first roller 24 and the second roller 25 are respectively rotatably fitted with the first eccentric pin 15 and the second eccentric pin 16, and rotate inside the

first cylinder chamber 17 and the second cylinder chamber 18. The first eccentric pin 15 and the second eccentric pin 16 are connected to the drive shaft 14 and rotate integrally with the drive shaft 14. The center of gravity of the second roller 25 fitted with the second eccentric pin 16 is positioned, with respect to an axis of the drive shaft 14, remote from the center of gravity of the first roller 24 fitted with the first eccentric pin 15.

[0031] As illustrated in FIG. 2, the blades 28 and 29 are slidably fitted into blade grooves 26 and 27 provided in the first cylinder main body 19 and the second cylinder main body 20, and partition the interior of the first cylinder chamber 17 and the second cylinder chamber 18, respectively, into an intake chamber side and a discharge chamber side.

[0032] The low-pressure refrigerant gas is taken into the first cylinder chamber 17 and the second cylinder chamber 18 of the first and second compression mechanisms 6A and 6B, from the intake pipes 10 and 11 via intake ports 30 and 31.

[0033] The refrigerant gas taken into the first cylinder chamber 17 and the second cylinder chamber 18 is compressed by the rotation of the first roller 24 and the second roller 25, and then discharged into discharge chambers 32 and 33 via discharge ports and discharge valves (not illustrated). The refrigerant gas discharged into the discharge chambers 32 and 33 is discharged into the sealed container 2, and then delivered to the refrigeration cycle via the discharge pipe 8.

[0034] The first cylinder main body 19, the second cylinder main body 20, the partition plate 21, the upper bearing 22, and the lower bearing 23, which constitute the compressor mechanism 6, are integrally tightened and fixed by bolts. Further, a bottom portion of the interior of the sealed container 2 is filled with refrigeration oil 34, such as PAG oil or POE oil. The refrigeration oil 34 can be supplied to lubrication parts inside the compressor mechanism 6 via oil supply holes and the like provided in the drive shaft 14. An appropriate amount of an extreme-pressure agent suitable for each type of oil is added to the refrigeration oil 34. Note that, because an oil supply mechanism for the compression mechanism 6 has a typical configuration, a detailed description thereof is omitted herein.

[0035] A first balance weight 35 is provided on the upper surface of the rotor 13, which is one side of the drive shaft 14 in the axial direction thereof and is a surface located remote from the compression mechanism 6. Further, the center of gravity of the first balance weight 35 is positioned, with respect to the axis of the drive shaft 14, remote from the center of gravity of the first roller 24. A second balance weight 36 is provided on the lower surface of the rotor 13, which is the other side of the drive shaft 14 in the axial direction thereof and is a surface located adjacent to the compression mechanism 6. Further, the center of gravity of the second balance weight 36 is positioned, with respect to the axis of the drive shaft 14, remote from the center of gravity of the second roller

25.

[0036] As a result of the first balance weight 35 and the second balance weight 36 being provided on the upper surface and the lower surface of the rotor 13, a centrifugal force that acts on the first balance weight 35 and the second balance weight 36 can be balanced against a centrifugal force that is generated by the rotation of the first roller 24 and the second roller 25 and acts on the first roller 24 and the second roller 25.

[0037] The rotor 13 is formed by a plurality of steel plates insulated from each other and stacked on top of each other in the axial direction of the drive shaft 14. The steel plate is an example of a magnetic metal plate, and may be another magnetic metal plate. The steel plates stacked on top of each other suppress generation of an eddy current. Conventionally, the steel plates are arranged such that the outer surface of the rotor 13 is on the same plane. Therefore, conventionally, a gap (also referred to as an air gap) formed between the stator 12 and the rotor 13 is constant in the circumferential direction. The size of the air gap ranges, for example, from a hundred and several ten μm to several hundred μm in a manner that depends on the size of the motor 5 and the like.

[0038] Meanwhile, with respect to the air gap according to the present embodiment, when the rotation of the rotor 13 is stopped, on the upper side of the rotor 13, namely, on one side of the drive shaft 14 in the axial direction thereof remote from the compression mechanism 6, an air gap on a side on which the first balance weight 35 is installed is different from that on the opposite side to the side on which the first balance weight 35 is installed with respect to the drive shaft 14. The air gap on the opposite side, with respect to the drive shaft 14, to the side on which the first balance weight 35 is installed is narrower than that on the side on which the first balance weight 35 is installed.

[0039] For example, as illustrated in FIGS. 3 and 4, steel plates 13A, which are stacked on the upper side of the rotor 13, are arranged in a displaced manner so as to protrude further toward the stator 12 located remote from the side on which the first balance weight 35 is installed, than other steel plates 13B. Here, the planar shape of the steel plate 13A and the planar shape of the steel plate 13B are identical to each other. A displacement amount of the steel plates 13A is approximately one tenth of the air gap, for example. Note that FIG. 3 schematically illustrates a state in which the rotor 13 centrifugally whirls with an end adjacent to the compression mechanism 6 as a fixed end (the same state is illustrated below in FIGS. 5, 7, and 9).

[0040] The number of the steel plates 13A arranged in the displaced manner depends, for example, on a magnetic attraction force to be increased, and is the number of steel plates accounting for a range from several % to a little over 10% on the upper side of the rotor 13. Note that the minimum number of the steel plates 13A is assumed to be one, and the maximum number of the steel

plates 13A is assumed to be in a range from half to two-thirds of the total number of the steel plates. Note that, in FIG. 3, a case is illustrated in which, as a displacement amount of the steel plate 13A, the same value is applied to all of the steel plates 13A arranged in the displaced manner. The displacement amount of the steel plate 13A is not limited to this example. The displacement amount may be increased in a stepwise or continuous manner toward the upper side of the rotor 13, and is not limited to the illustrated example in the drawing.

[0041] As a result of the steel plates 13A stacked on the upper side of the rotor 13 being arranged in the displaced manner, when the rotation of the rotor 13 is stopped, the air gap on the opposite side, with respect to the drive shaft 14, to the side on which the first balance weight 35 is installed is narrower than that on the side on which the first balance weight 35 is installed. As a result, because the steel plates 13A of the rotor 13 protrude toward the opposite side to the first balance weight 35, when the rotor 13 of the motor 5 rotates, a larger magnetic attraction force is generated adjacent to the stator 12 over the protrusion section than over other sections. Specifically, even when the centrifugal force acts due to the first balance weight 35, as a result of the steel plates 13A being arranged in the displaced manner as described above, the magnetic attraction force is generated in a direction that alleviates the bending of the drive shaft 14, namely, in the opposite direction to the first balance weight 35 with respect to the axis of the drive shaft 14, and the bending of the drive shaft 14 can thus be alleviated.

[0042] As a result, even when the drive shaft 14 resonates at an eigenvalue, compared with a case in which the steel plate is not arranged in the displaced manner, the bending amount of the drive shaft 14 can be reduced, and noise generated by vibration caused by a bending eigenvalue can thus be reduced.

[0043] Taking into account the protrusion section of the steel plates 13A, the weight of a section of the steel plate 13 of the rotor 13 located adjacent to the first balance weight 35 with respect to the axis of the drive shaft 14 may be reduced. In FIGS. 5 and 6, an example is illustrated in which the formation of a through-hole 40 in each of the steel plates 13A reduces the weight of the steel plates 13A.

[0044] When the steel plates 13A are arranged in the displaced manner, the magnetic attraction force can be increased. However, compared with a case in which the steel plates 13A are not displaced, a balance with the centrifugal force acting on the first roller 24 and the second roller 25 may worsen. Note that, because the weight of the protrusion section is smaller than that of the first balance weight 35, a degree by which the balance worsens is estimated not to be significantly large.

[0045] As illustrated in FIGS. 5 and 6, the formation of the through-hole 40 enables the centrifugal force acting on the upper part of the rotor 13 to be balanced against the centrifugal force generated by the rotation of the first

roller 24 and the second roller 25 and acting on the first roller 24 and the second roller 25.

[0046] Note that, in FIGS. 5 and 6, although a case is illustrated in which the through-hole 40 is provided in all of the steel plates 13A protruding toward the stator 12 located remote from the first balance weight 35, the present invention is not limited to this example. Specifically, the through-hole 40 may be provided in some of the steel plates 13A. Further, instead of providing the through-hole 40 in the steel plates 13A, the weight of the first balance weight 35 itself may be reduced, taking into account the protrusion section of the steel plates 13A.

[0047] Although the compressor according to the first embodiment of the present invention is described above, the present invention is not limited to the configuration of the above-described embodiment.

[0048] For example, in the above-described embodiment, although the air gap on the upper side of the rotor 13 is narrowed in order to reduce the bending generated by the centrifugal force of the first balance weight 35, the present invention is not limited to this example.

[0049] For example, as illustrated in FIGS. 7 and 8, a steel plate 13C stacked on the lower side of the rotor 13 may be arranged in a displaced manner so as to protrude further toward the stator 12 located remote from the side on which the second balance weight 36 is installed, than the other steel plates 13B located in the intermediate section of the rotor 13. As a result, when the rotation of the rotor 13 is stopped, on the lower side of the rotor 13, namely, on the other side in the axial direction of the drive shaft 14, that is, on the side adjacent to the compression mechanism 6, the air gap on the side remote from the side on which the second balance weight 36 is installed, with respect to the drive shaft 14, is narrower than that on the side on which the second balance weight 36 is installed.

[0050] As a result, because the steel plate 13C of the rotor 13 protrudes toward the side remote from the second balance weight 36, when the rotor 13 of the motor 5 rotates, a larger magnetic attraction force is generated adjacent to the stator 12 over the protrusion section than over the other sections. Specifically, even when the centrifugal force acts due to the second balance weight 36, and the bending of the drive shaft 14 occurs, as a result of the steel plate 13C being arranged in the displaced manner as described above, the magnetic attraction force is generated in the direction that alleviates the bending of the drive shaft 14, namely, in the radial direction opposite to the second balance weight 36 with respect to the axis of the drive shaft 14, and the bending of the drive shaft 14 can thus be alleviated.

[0051] As described above, arranging the steel plate 13C of the rotor 13 in the displaced manner allows, when the drive shaft 14 resonates at the eigenvalue, the bending amount of the drive shaft 14 to be reduced, and allows, when the steel plate 13C and the steel plates 13A of the rotor 13 are displaced at the same time, the noise generated by the vibration caused by the bending eigenvalue

to be further reduced. Note that, when the bending amount of the drive shaft 14 is larger on the lower side of the rotor 13, only the steel plate 13C of the rotor 13 may be arranged so as to be displaced.

[0052] Further, although, in the above-described embodiment, the steel plates 13A stacked on the upper side of the rotor 13 are arranged in the displaced manner so as to protrude further toward the opposite side to the side where the first balance weight 35 is installed than the other steel plates, the present invention is not limited to this example. Specifically, it is sufficient that, when the rotation of the rotor 13 is stopped, the air gap on the opposite side to the side where the first balance weight 35 is installed, with respect to the drive shaft 14, is caused to be narrower than that on the side where the first balance weight 35 is installed. For example, as illustrated in FIGS. 9 and 10, a protrusion section 41 may be provided on an outer circumferential portion of the steel plate 13A by separately applying a coating thereto. In this case, the protrusion section 41 is formed by a silver paste or the like. Alternatively, the protrusion section 41 may be formed by changing the planar shape of the steel plate 13A itself to be different from that of the steel plate 13B in the other section.

[0053] Of the stacked steel plates 13A, the protrusion section 41 is formed on the opposite side to the side where the first balance weight 35 is installed with respect to the drive shaft 14. As a result, when the rotation of the rotor 13 is stopped, the air gap on the opposite side to the side where the first balance weight 35 is installed, with respect to the drive shaft 14, is narrower than that on the side where the first balance weight 35 is installed. As a result, because the protrusion section 41 of the steel plates 13A of the rotor 13 protrudes toward a side remote from the first balance weight 35, when the rotor 13 of the motor 5 rotates, a larger magnetic attraction force is generated adjacent to the stator 12 over the protrusion section 41 than over the other sections. Specifically, even when the centrifugal force acts due to the first balance weight 35, and the bending of the drive shaft 14 occurs, as a result of the protrusion section 41 being formed as described above, the magnetic attraction force is generated in the direction that alleviates the bending of the drive shaft 14, namely, in the direction toward the stator 12 located remote from the first balance weight 35 with respect to the axis of the drive shaft 14, and the bending of the drive shaft 14 can thus be alleviated.

[0054] As a result, even when the drive shaft 14 resonates at the eigenvalue, the bending amount of the drive shaft 14 can be reduced, and the noise generated by the vibration caused by the bending eigenvalue can thus be reduced.

Second Embodiment

[0055] Next, a compressor according to a second embodiment of the present invention will be described. In the compressor according to the present embodiment,

the rotor 13 is different from the rotor 13 of the compressor according to the above-described first embodiment, and therefore the rotor 13 according to the present embodiment will be described below. Because the structural members other than the rotor 13 are the same as those of the first embodiment, a detailed description thereof will be omitted.

[0056] The rotor 13 is formed by a plurality of steel plates insulated from each other and stacked on top of each other in the axial direction of the drive shaft 14. The steel plates stacked on top of each other suppress generation of an eddy current. Each of the steel plates according to the present embodiment is arranged such that the outer surface of the rotor 13 is on the same plane. Therefore, the gap (air gap) formed between the stator 12 and the rotor 13 is constant in the circumferential direction.

[0057] Permanent magnets 42 and 50 are embedded in the rotor 13. Note that, although an arrangement example of the permanent magnets 42 and 50 is illustrated in FIG. 11, the size, locations, orientations, and the like of the permanent magnets arranged in the rotor 13 are not limited to the arrangement example illustrated in FIG. 11.

[0058] The permanent magnets 42 and 50 are arranged inside openings formed in the steel plates. In a steel plate 13D stacked on the upper side of the rotor 13, the permanent magnets 42 are arranged so as to be displaced further toward the stator 12 located on the opposite side to the side where the first balance weight 35 is installed than the permanent magnets 50 provided in another steel plate 13E. Here, the planar shape of the steel plate 13D and the planar shape of the steel plate 13E are identical to each other.

[0059] Specifically, the plurality of permanent magnets 50 provided in a section other than the upper side of the rotor 13 are provided point-symmetrically with each other centered around the axis of the drive shaft 14, in the same manner as permanent magnets arranged in a conventional rotor. Meanwhile, as described above, the plurality of permanent magnets 42 provided on the upper side of the rotor 13 are arranged so as to be displaced toward the opposite side to the side where the first balance weight 35 is installed, so that the center of the point-symmetry of the permanent magnets 42 is also displaced toward the opposite side to the side where the first balance weight 35 is installed with respect to the axis of the drive shaft 14.

[0060] As a result, when the rotor 13 of the motor 5 rotates, a larger magnetic attraction force is generated adjacent to the stator 12 in the upper side of the rotor 13 than in the other sections of the rotor 13. Specifically, even when the centrifugal force acts due to the first balance weight 35, and the bending of the drive shaft 14 occurs, as a result of the permanent magnets 42 being arranged in the displaced manner as described above, the magnetic attraction force is generated in the direction that alleviates the bending of the drive shaft 14, namely,

in the radial direction opposite to the first balance weight 35 with respect to the axis of the drive shaft 14, and the bending of the drive shaft 14 can thus be alleviated.

[0061] As a result, even when the drive shaft 14 resonates at the eigenvalue, the bending amount of the drive shaft 14 can be reduced, and the noise generated by the vibration caused by the bending eigenvalue can thus be reduced.

[0062] With respect to the compressor according to the second embodiment of the present invention, although an example is described in which the permanent magnets 42 are arranged in the displaced manner on the upper side of the rotor 13 in order to reduce the bending caused by the centrifugal force of the first balance weight 35, the present invention is not limited to this example.

[0063] Specifically, it is sufficient that the magnetic attraction force increases on the upper side of the rotor 13 in the direction that alleviates the bending of the drive shaft 14, namely, in the radial direction opposite to the first balance weight 35 with respect to the axis of the drive shaft 14. For example, a magnetic force of the permanent magnets arranged remote from the first balance weight 35, with respect to the axis of the drive shaft 14, is larger than that of the permanent magnets arranged adjacent to the first balance weight 35 with respect to the axis of the drive shaft 14.

[0064] In this case also, the magnetic attraction force is generated in the direction that alleviates the bending of the drive shaft 14, namely, in the radial direction opposite to the first balance weight 35 with respect to the axis of the drive shaft 14, and the bending of the drive shaft 14 can thus be alleviated.

[0065] Further, in the above-described embodiment, although an example is described in which the permanent magnets 42, which are arranged on the upper side of the rotor 13, are arranged such that the magnetic attraction force increases in the radial direction opposite to the first balance weight 35 with respect to the axis of the drive shaft 14, the permanent magnets arranged on the lower side of the rotor 13 may also be arranged in the same manner. In this case, the permanent magnets arranged on the lower side of the rotor 13 are arranged such that the magnetic attraction force increases in the radial direction opposite to the second balance weight 36 with respect to the axis of the drive shaft 14.

[0066] Further, although, with respect to the above-described compressors according to the first and second embodiments, a case is described in which the multi-cylinder rotary compressor is used as the compressor, the present invention is not limited to this type of compressor. For example, the present invention may also be applied to a rotary compressor in which only one rotary-type compression mechanism is provided, or to a scroll compressor and the like, in which one or a plurality of scroll-type compression mechanisms are provided.

Reference Signs List

[0067]

- | | |
|----|--|
| 5 | 1 Compressor |
| | 2 Sealed container |
| | 5 Motor (motor portion) |
| | 6 Compression mechanism (compression portion) |
| | 6A First compression mechanism |
| 10 | 6B Second compression mechanism |
| | 8 Discharge pipe |
| | 9 Accumulator |
| | 10, 11 Intake pipe |
| | 12 Stator |
| 15 | 13 Rotor |
| | 13A, 13B, 13C, 13D, 13E Steel plate |
| | 14 Drive shaft |
| | 15 First eccentric pin |
| | 16 Second eccentric pin |
| 20 | 17 First cylinder chamber |
| | 18 Second cylinder chamber |
| | 19 First cylinder main body |
| | 20 Second cylinder main body |
| | 24 First roller |
| 25 | 25 Second roller |
| | 35 First balance weight (weight portion) |
| | 36 Second balance weight (second weight portion) |
| | 40 Through-hole |
| | 41 Protrusion section |
| 30 | 42, 50 Permanent magnet |

Claims

- | | |
|----|---|
| 35 | 1. A compressor comprising: |
| | a compression portion; |
| | a motor portion including a rotor formed by a plurality of metal plates stacked on top of each other, and a stator provided around an outer circumferential portion of the rotor; and |
| 40 | a drive shaft connecting the motor portion and the compression portion, |
| | the rotor including a weight portion on a surface thereof on one side in an axial direction of the drive shaft, and |
| 45 | of the stacked metal plates, the metal plate located adjacent to the weight portion protruding toward the stator located remote from the weight portion in a radial direction of the rotor with respect to an axis of the drive shaft. |
| 50 | |
| | 2. The compressor according to claim 1, wherein, |
| | of the stacked metal plates, the metal plate located adjacent to the weight portion is stacked so as to be displaced toward the stator located remote from the weight portion in the radial direction of the rotor with respect to the axis of the drive shaft. |
| 55 | |

3. The compressor according to claim 1, wherein, of the stacked metal plates, the metal plate located adjacent to the weight portion has a metal coating applied thereto so as to protrude toward the stator located remote from the weight portion in the radial direction of the rotor with respect to the axis of the drive shaft.
4. The compressor according to any one of claims 1 to 3, wherein a weight of a section of the metal plate located adjacent to the weight portion with respect to the axis of the drive shaft is reduced, taking into account a weight of a section of the metal plate that protrudes in the radial direction of the rotor.
5. The compressor according to any one of claims 1 to 4, wherein a second weight portion is provided on a surface of the rotor on an other side opposite to the one side in the axial direction of the drive shaft, and of the stacked metal plates, the metal plate located adjacent to the second weight portion protrudes toward the stator located remote from the second weight portion in the radial direction of the rotor with respect to the axis of the drive shaft.
6. A compressor comprising:
 - a compression portion;
 - a motor portion including a rotor formed by a plurality of metal plates stacked on top of each other, and a stator provided around an outer circumferential portion of the rotor; and
 - a drive shaft connecting the motor portion and the compression portion, the rotor including a weight portion on a surface thereof located remote from the compression portion in an axial direction of the drive shaft and including a plurality of permanent magnets therein, and the permanent magnets provided remote from the compression portion in the axial direction of the drive shaft being arranged such that a magnetic force increases in a direction toward the stator located remote from the weight portion in a radial direction of the rotor with respect to an axis of the drive shaft in comparison to a magnetic force of other permanent magnets.
7. The compressor according to claim 6, wherein the permanent magnets provided remote from the compression portion in the axial direction of the drive shaft are arranged so as to be shifted toward the stator in the radial direction of the rotor in comparison to the other permanent magnets or have a larger magnetic force than a magnetic force of the other permanent magnets.

Amended claims under Art. 19.1 PCT

1. A compressor comprising:
 - a compression portion;
 - a motor portion including a rotor formed by a plurality of metal plates stacked on top of each other, each having an identical planar shape, and a stator provided around an outer circumferential portion of the rotor; and
 - a drive shaft connecting the motor portion and the compression portion, the rotor including a weight portion on a surface thereof on one side in an axial direction of the drive shaft, and
 - of the stacked metal plates, the metal plate adjacent to the weight portion protruding toward the stator located remote from the weight portion in a radial direction of the rotor with respect to an axis of the drive shaft.
2. The compressor according to claim 1, wherein, of the stacked metal plates, the metal plate adjacent to the weight portion is stacked so as to be displaced toward the stator located remote from the weight portion in the radial direction of the rotor with respect to the axis of the drive shaft.
3. The compressor according to claim 1, wherein, of the stacked metal plates, the metal plate adjacent to the weight portion has a metal coating applied thereto so as to protrude toward the stator located remote from the weight portion in the radial direction of the rotor with respect to the axis of the drive shaft.
4. The compressor according to any one of claims 1 to 3, wherein a weight of a section of the metal plate adjacent to the weight portion with respect to the axis of the drive shaft is reduced, taking into account a weight of a section of the metal plate that protrudes in the radial direction of the rotor.
5. The compressor according to any one of claims 1 to 4, wherein a second weight portion is provided on a surface of the rotor on an other side opposite to the one side in the axial direction of the drive shaft, and of the stacked metal plates, the metal plate adjacent to the second weight portion protrudes toward the stator located remote from the second weight portion in the radial direction of the rotor with respect to the axis of the drive shaft.
6. A compressor comprising:
 - a compression portion;
 - a motor portion including a rotor formed by a

plurality of metal plates stacked on top of each other, and a stator provided around an outer circumferential portion of the rotor; and a drive shaft connecting the motor portion and the compression portion, 5
the rotor including a weight portion on a surface thereof located remote from the compression portion in an axial direction of the drive shaft and including a plurality of permanent magnets therein, and the permanent magnets provided 10
remote from the compression portion in the axial direction of the drive shaft being arranged such that a magnetic force increases in a direction toward the stator located remote from the weight 15
portion in a radial direction of the rotor with respect to an axis of the drive shaft in comparison to a magnetic force of other permanent magnets.

7. The compressor according to claim 6, wherein 20
the permanent magnets provided remote from the compression portion in the axial direction of the drive shaft are arranged so as to be shifted toward the stator in the radial direction of the rotor in comparison to the other permanent magnets or have a larger 25
magnetic force than a magnetic force of the other permanent magnets.

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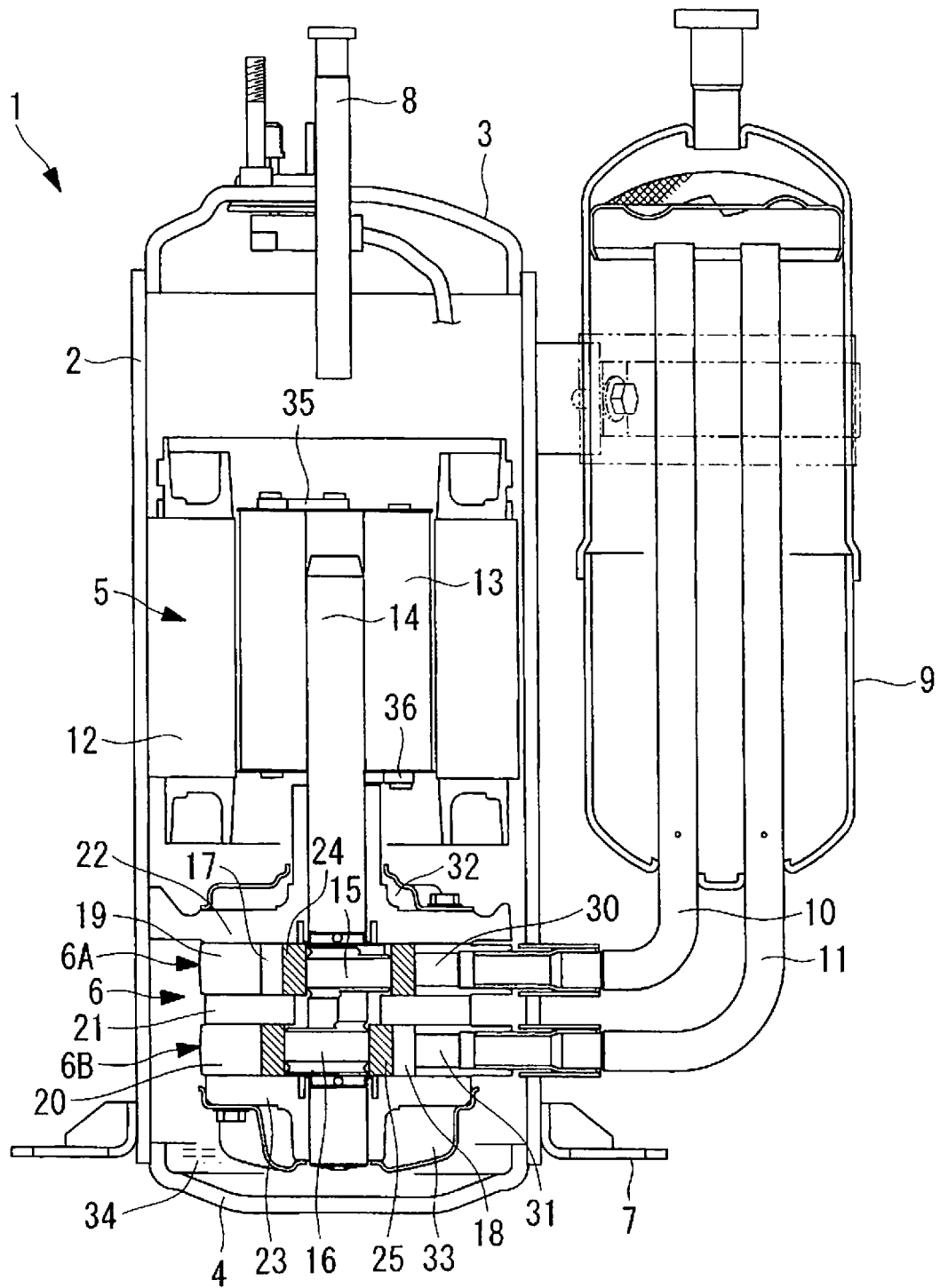


FIG. 1

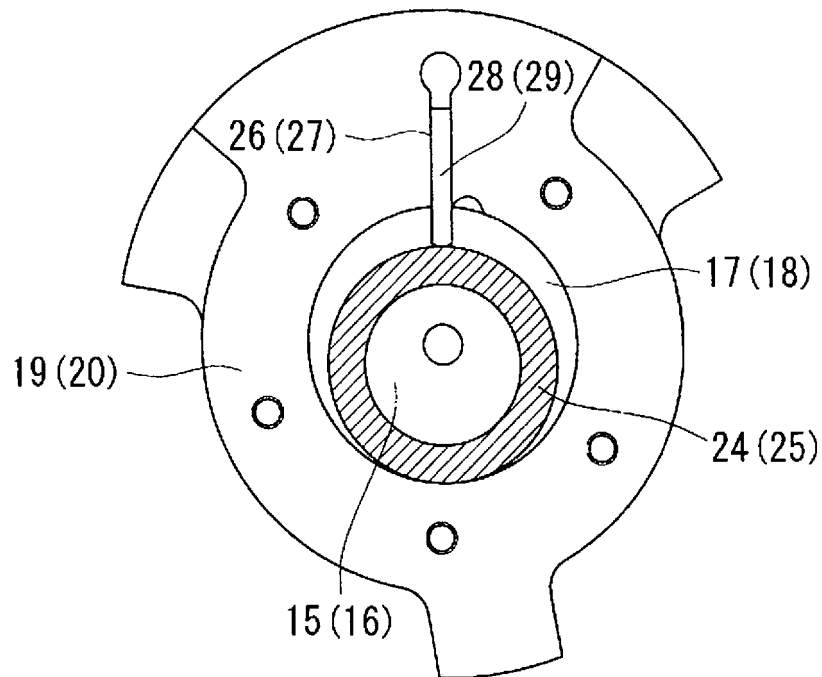


FIG. 2

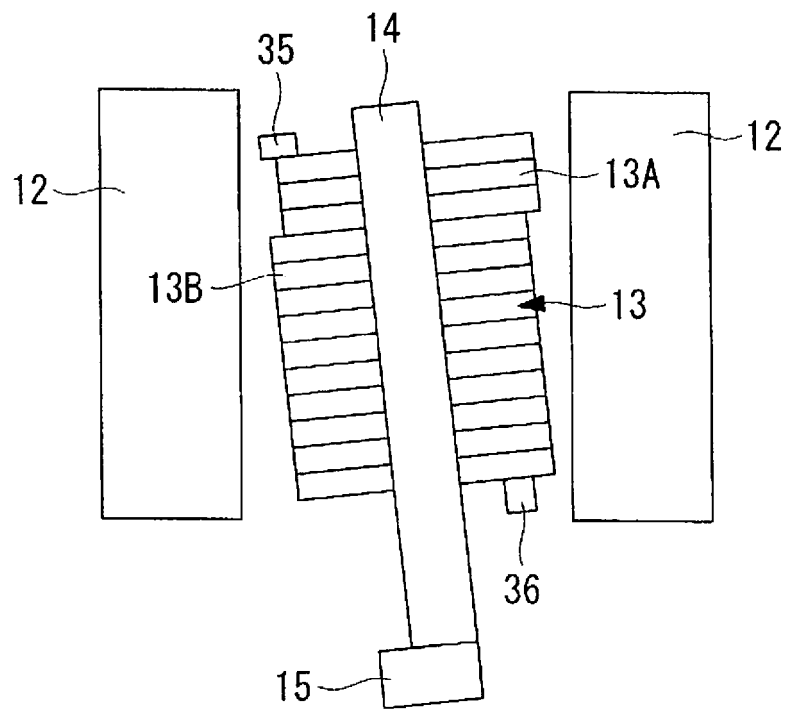


FIG. 3

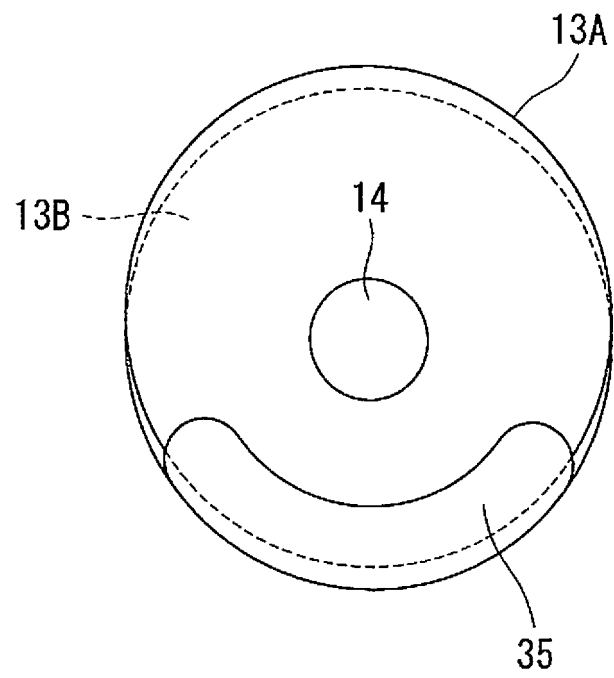


FIG. 4

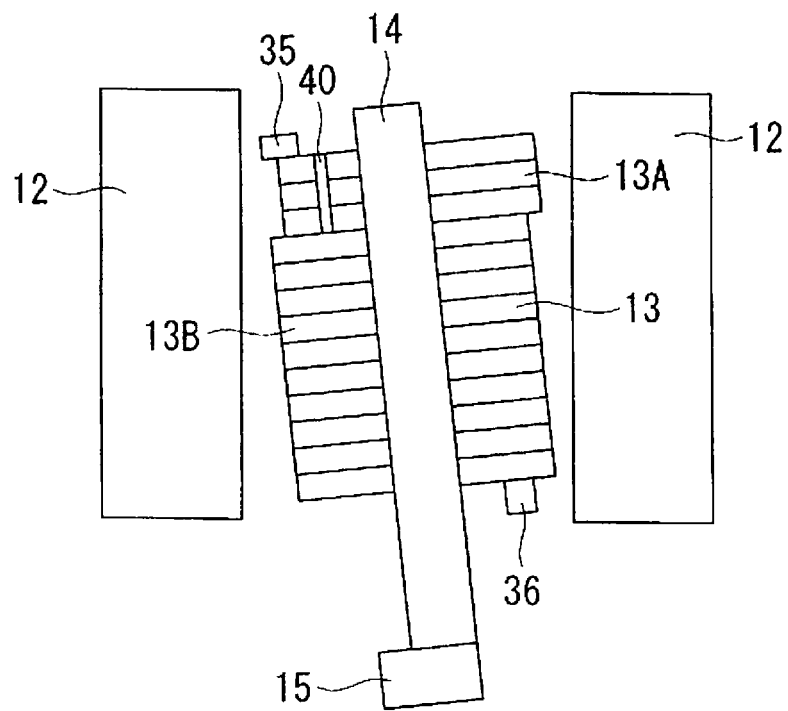


FIG. 5

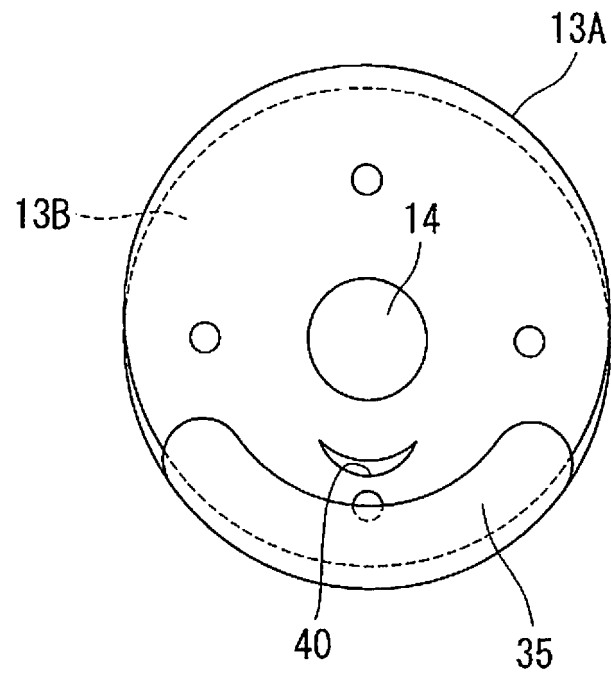


FIG. 6

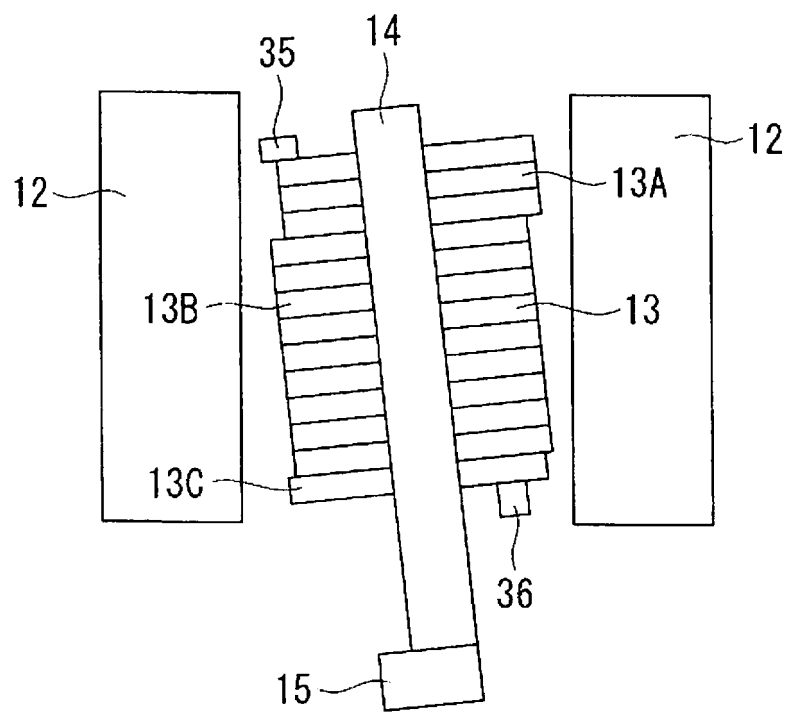


FIG. 7

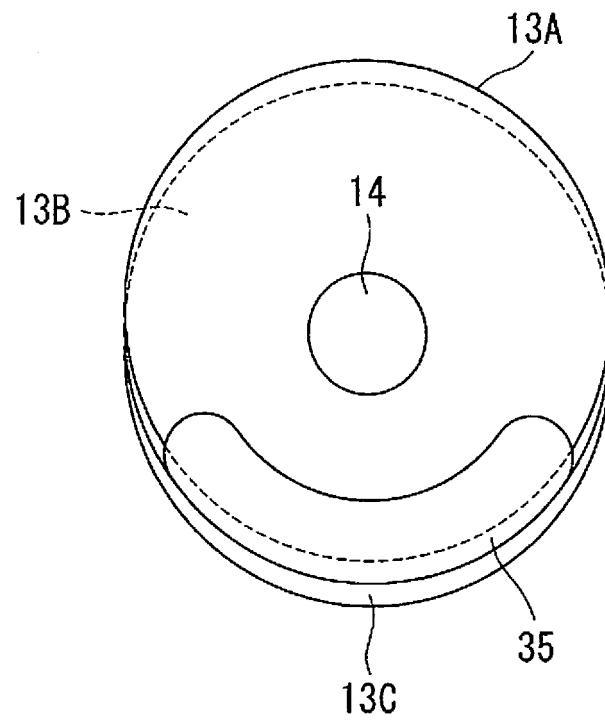


FIG. 8

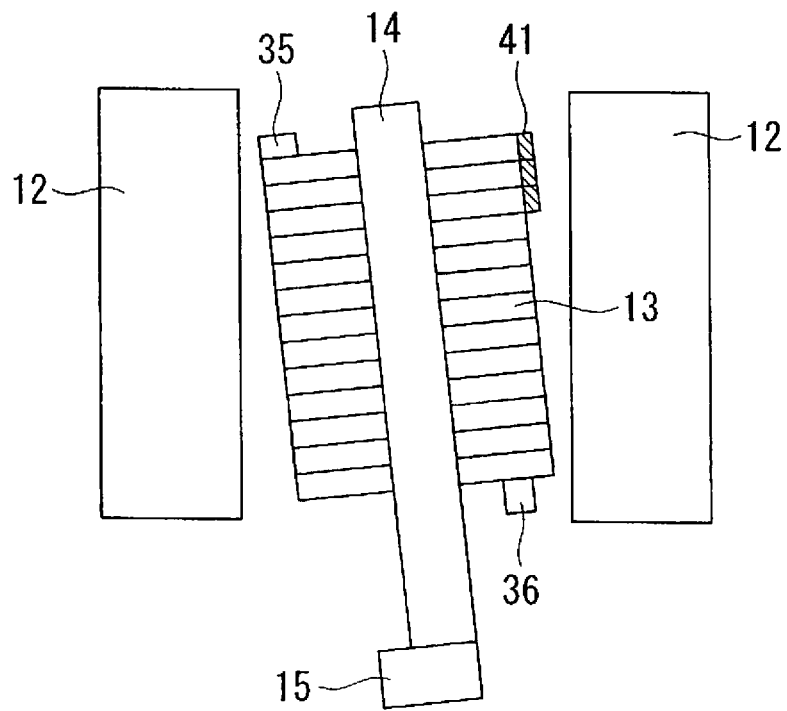


FIG. 9

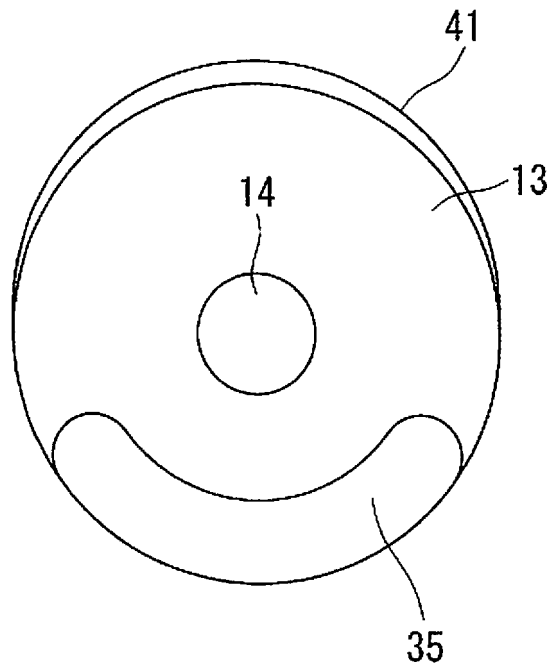


FIG. 10

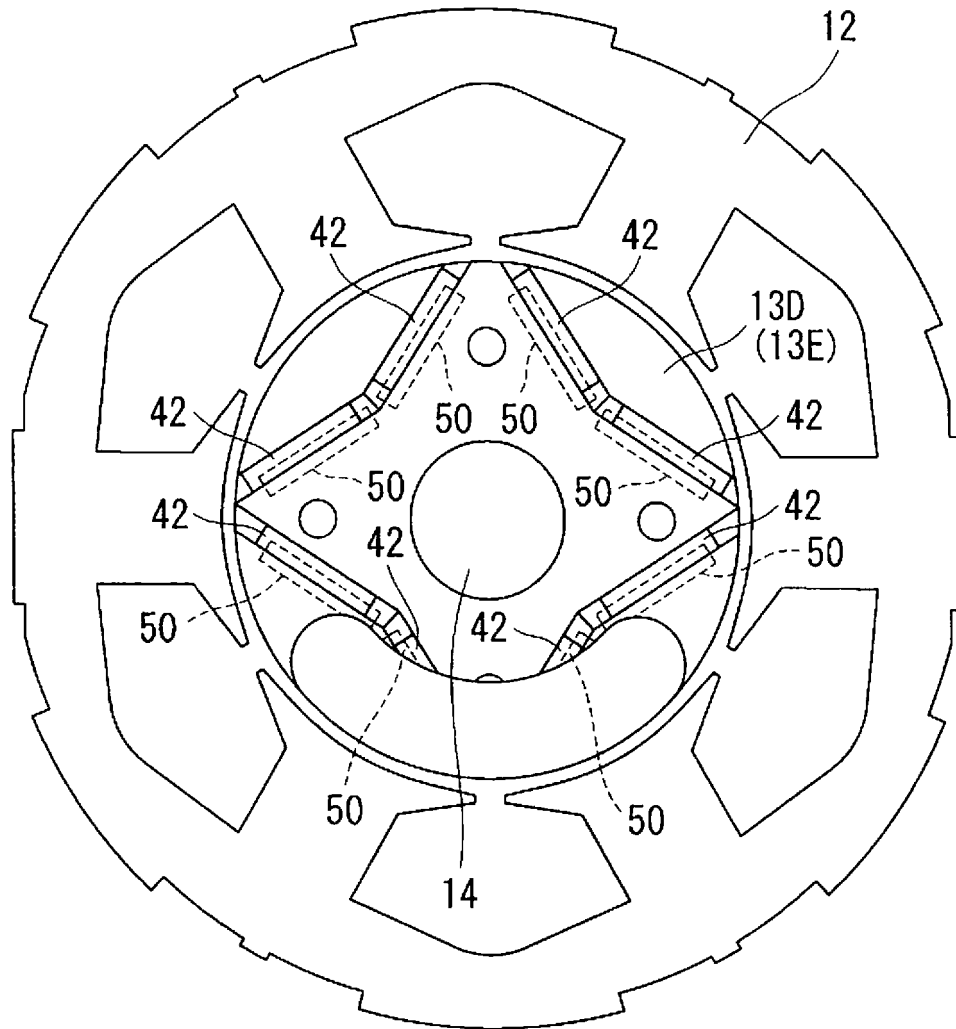


FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/072828

A. CLASSIFICATION OF SUBJECT MATTER

F04C23/02(2006.01)i, F04C29/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

F04C23/02, F04C29/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2015
Kokai Jitsuyo Shinan Koho	1971-2015	Toroku Jitsuyo Shinan Koho	1994-2015

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 107816/1987(Laid-open No. 13282/1989) (Sanyo Electric Co., Ltd.), 24 January 1989 (24.01.1989), page 2, line 1 to page 8, line 7; fig. 1 to 5 (Family: none)	1,5 2-4
Y	JP 2002-272073 A (Nissan Motor Co., Ltd.), 20 September 2002 (20.09.2002), paragraphs [0035] to [0048]; fig. 3 to 5 (Family: none)	2-4

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"I" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search
28 October 2015 (28.10.15)Date of mailing of the international search report
10 November 2015 (10.11.15)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/072828

C (Continuation).	DOCUMENTS CONSIDERED TO BE RELEVANT	
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2006-507941 A (Deka Products Ltd. Partnership), 09 March 2006 (09.03.2006), paragraphs [0046] to [0047] & WO 2004/043566 A2 page 19, line 30 to page 20, line 13	3-4
Y	JP 2006-42544 A (Matsushita Electric Industrial Co., Ltd.), 09 February 2006 (09.02.2006), paragraph [0007] (Family: none)	4
A	JP 57-208842 A (Tokyo Shibaura Electric Co., Ltd.), 22 December 1982 (22.12.1982), page 1, left column, line 11 to right column, line 5; fig. 1 to 5 (Family: none)	2

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/072828

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:
See extra sheet.

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-5

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2015/072828

Continuation of Box No. III of continuation of first sheet (2)

Supplementation of Box No. III:

The technical feature common to the invention in claim 1 and the invention in claim 6 is a compressor "provided with a compression part, a motor part having a rotor in which a plurality of metal plates are stacked and a stator provided around the outer periphery of the rotor, and a drive shaft coupling the motor part and the compression part, wherein in the rotor, a weight part is provided on a surface on the side opposite to the compression part side in the axial direction of the drive shaft", and a means for making magnetic attraction force generated on the stator side larger in a portion on the side opposite to the weight part in the radial direction of the rotor than in the other portions is provided.

Further, the above-said technical feature cannot be considered to be a special technical feature, since the search revealed that the technical feature is addition, conversion and so on of a well-known art or a conventionally used art onto a technique disclosed in the document 1 (Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 107816/1987 (Laid-open No. 13282/1989) (Sanyo Electric Co., Ltd.), 24 January 1989 (24.01.1989), page 2, line 1 to page 8, line 7; fig. 1 to 5) and does not exhibit any new effect.

Further, there is no other same or corresponding special technical feature between these inventions.

Accordingly, claims are classified into two inventions each of which has a special technical feature indicated below.

(Invention 1) claims 1-5

A compressor provided with a compression part, a motor part having a rotor in which a plurality of metal plates are stacked and a stator provided around the outer periphery of the rotor, and a drive shaft coupling the motor part and the compression part, wherein in the rotor, a weight part is provided on a surface on one end side in the axial direction of the drive shaft, and the metal plate on the weight part side among the stacked metal plates protrudes toward the stator side opposite to the weight part in the radial direction of the rotor with respect to the axis of the drive shaft.

Claim 1 having no special technical feature is classified into Invention 1.

(Invention 2) claims 6-7

A compressor provided with a compression part, a motor part having a rotor in which a plurality of metal plates are stacked and a stator provided around the outer periphery of the rotor, and a drive shaft coupling the motor part and the compression part, wherein in the rotor, a weight part is provided on a surface on the side opposite to the compression part side in the axial direction of the drive shaft, a plurality of permanent magnets are installed inside the rotor, and the permanent magnet provided on the side opposite to the compression part side in the axial direction of the drive shaft is disposed such that magnetic force in a direction toward the stator side opposite to the weight part in the radial direction of the rotor with respect to the axis of the drive shaft is made larger than in the other portions.

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 2006200527 A [0005]
- JP 2009074464 A [0005]