(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 3 557 067 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
23.10.2019 Bulletin 2019/43

(21) Application number: **19169260.7**

(22) Date of filing: **15.04.2019**

(51) Int Cl.:
F04C 29/00 *(2006.01)* ***F04C 18/34*** *(2006.01)*
F04C 23/00 *(2006.01)*

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
KH MA MD TN

(30) Priority: **17.04.2018 JP 2018079336**

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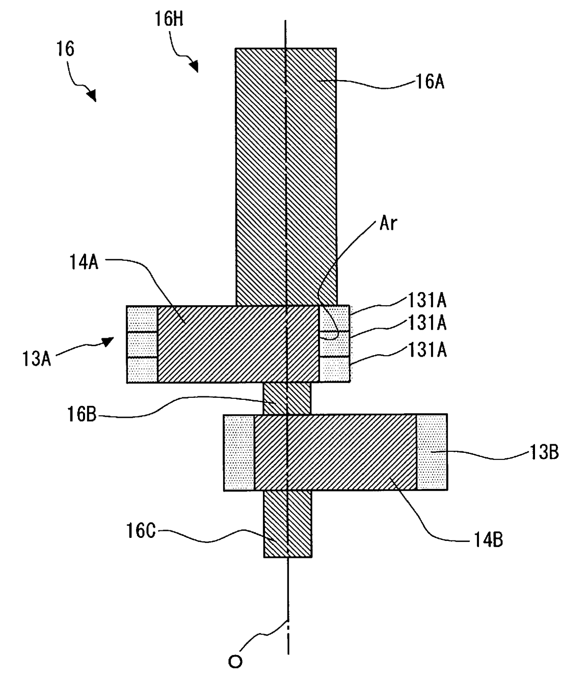
(54) PISTON ROTOR, CRANKSHAFT, ROTARY COMPRESSOR, AND ASSEMBLING METHOD OF CRANKSHAFT

(57) A first piston rotor (13A) is a piston rotor of the crankshaft (16) which is configured to rotate around an axis O in a rotary compressor and has a plurality of rotor separate bodies (131A) respectively formed in an annular shape centered on a center line. The plurality of rotor separate bodies (131A) are movable relative to each other in a state in which the plurality of rotor separate bodies (131A) are in contact with each other in a direction in which the center line extends.

FIG. 2



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Description

Technical Field

[0001] The present invention relates to a piston rotor, a crankshaft, a rotary compressor, and an assembling method of the crankshaft.

Background Art

[0002] For example, as an apparatus used for compression of a refrigerant in an air conditioner, an apparatus including an accumulator and a compressor is known. The accumulator separates the refrigerant into gas and liquid prior to introduction into the compressor. The compressor and the accumulator are connected by a suction pipe. The compressor compresses only the gas phase refrigerant supplied from the accumulator through the suction pipe and generates a high pressure gas phase refrigerant.

[0003] For example, PTL 1 describes a compressor including a shaft (a crankshaft), a roller (a rotor) installed at an eccentric portion of the shaft, a cylinder having a cylinder chamber which accommodates the roller, and a front head and a rear head which serve as bearings at an end surface of the cylinder.

Citation List

Patent Literature

[0004] [PTL1] Japanese Unexamined Patent Application, First Publication No. 2010-223034

Summary of Invention

Technical Problem

[0005] Here, in the above-described compressor, the crankshaft may be bent due to a gas load when the refrigerant is compressed, and the crankshaft may be inclined with respect to the rotor. As a result, the rotor may come into partial contact with the crankshaft. When such partial contact occurs, stress generated in the crankshaft may be partially increased, thus a friction loss may increase, and the performance of the compressor may deteriorate, or reliability may be lowered. Therefore, the demand for a compressor which can limit influences from deflection of the crankshaft is increasing.

[0006] The present invention has been realized to solve the above-described problems, and an object thereof is to provide a piston rotor, a crankshaft, a rotary compressor, and an assembling method of the crankshaft capable of minimizing deterioration in performance of the compressor due to deflection.

Solution to Problem

[0007] According to a first aspect of the present invention, there is provided a piston rotor of a crankshaft which is configured to rotate around an axis in a rotary compressor, including a plurality of rotor separate bodies respectively formed in an annular shape, wherein the plurality of rotor separate bodies are movable relative to each other in a state in which they are in contact with each other.

[0008] With such a constitution, even when the crankshaft is bent, a position of each of the rotor separate bodies in the radial direction is shifted to follow the deflection of the crankshaft. Therefore, a region of the piston rotor in contact with the crankshaft is enlarged, and an influence of partial contact can be minimized. As a result, the friction loss between the piston rotor and the crankshaft can be reduced. Therefore, the reliability can also be improved.

[0009] According to a second aspect of the present invention, the plurality of rotor separate bodies may have the same lengths in a thickness direction.

[0010] With such a constitution, it is possible to easily form the piston rotor.

[0011] According to a third aspect of the present invention, there is provided a

crankshaft including a first shaft portion which extends along an axis, a first eccentric shaft portion which is provided on one side of the first shaft portion in a direction of the axis in which the axis extends, is eccentric in a radial direction with respect to the axis and has a radial length greater than that of the first shaft portion, a second shaft portion which extends along the axis and is installed on one side of the first eccentric shaft in the direction of the axis, and the piston rotor according to the above-described aspect, wherein the piston rotor is disposed to cover the first eccentric shaft portion from outside in the radial direction.

[0012] With such a constitution, even when the crankshaft is bent and the first eccentric shaft portion is inclined, the position of each of the rotor separate bodies in the radial direction is shifted to follow the inclination of the first eccentric shaft portion. Therefore, the region of the piston rotor in contact with the first eccentric shaft portion is increased, and the influence of partial contact can be minimized. As a result, the friction loss between the piston rotor and the first eccentric shaft portion can be reduced. Therefore, the reliability of a crankshaft can also be improved.

[0013] According to a fourth aspect of the present invention, the crankshaft may further include a second eccentric shaft portion which is provided on one side of the second shaft portion in the direction of the axis, is eccentric in a direction different from that of the first eccentric shaft portion and has a radial length larger than that of the second shaft portion and smaller than that of the first eccentric shaft portion, an annular second piston rotor which covers the second eccentric shaft portion from an outside in the radial direction, and a third shaft portion which extends along the axis and is installed on one side of the second eccentric shaft portion in the direction of the axis, and each of the second shaft portion and the third shaft portion may have a radial length smaller than that of the first eccentric shaft portion, the first eccentric shaft portion is disposed to be partially recessed inward with respect to the first shaft portion in the radial direction, and a length of each of the rotor separate bodies in the direction of the axis may be equal to or less than a length of the second shaft portion in the direction of the axis.

[0014] With such a constitution, an axial center of the first eccentric shaft portion and an axial center of the respective rotor separate bodies are made to coincide with each other by moving the rotor separate bodies from the third shaft portion side in the direction of the axis to a position of the second shaft portion and moving them in the radial direction. That is, the plurality of rotor separate bodies can be smoothly fitted to the first eccentric shaft portion. Therefore, the length of the second shaft portion in the direction of the axis can be reduced regardless of the length of the first piston rotor as a whole in the direction of the axis. In the crankshaft, the second shaft portion is most likely to be bent with respect to the first shaft portion and the third shaft portion. Deflection can be effectively minimized by reducing the length of the second shaft portion. Furthermore, the overall length of the shaft main body in the direction of the axis can be reduced by shortening the second shaft portion. Accordingly, the rigidity of the shaft main body can be increased, and the likelihood of deflection can be reduced.

[0015] According to a fifth aspect of the present invention, there is a rotary compressor including the crankshaft according to the above-described aspect, a compression mechanism portion which accommodates the first eccentric shaft portion and has a compression chamber that is configured to compress a fluid in accordance with rotation of the crankshaft, and a bearing portion which is configured to rotatably support the first shaft portion.

[0016] According to a sixth aspect of the present invention, there is provided an assembling method of a crankshaft which includes a first shaft portion which extends along an axis, a first eccentric shaft portion which is provided on one side of the first shaft portion in a direction of the axis in which the axis extends, is eccentric in a radial direction with respect to the axis and has a radial length greater than that of the first shaft portion, a second shaft portion which extends along the axis and is installed on one side of the first eccentric shaft in the direction of the axis, a first piston rotor having a plurality of rotor separate bodies respectively formed in an annular shape to cover the first eccentric shaft portion from an outside in the radial direction with respect to the axis, a second eccentric shaft portion which is provided on one side of the second shaft portion in the direction of the axis, is eccentric in a direction different from the first eccentric shaft portion and has a radial length larger than that of the second shaft portion, an annular second piston rotor which covers the second eccentric shaft portion from an outside in the radial direction, and a third shaft portion which extends along the axis and is installed on one side of the second eccentric shaft portion in the direction of the axis, including fitting the plurality of rotor separate bodies one by one from the third shaft portion side to an outer peripheral surface of the first eccentric shaft portion and bringing the plurality of rotor separate bodies into contact with each other in a relatively movable state.

Advantageous Effects of Invention

[0017] According to the present invention, it is possible to minimize deterioration in performance of the compressor due to deflection.

Brief Description of Drawings

[0018]

FIG. 1 is a cross-sectional view showing a constitution of a compressor system according to a first embodiment of the present invention.
FIG. 2 is a cross-sectional view showing a constitution of a crankshaft according to the first embodiment of the present invention.
FIG. 3 is a process diagram showing processes of an assembling method of the crankshaft according to the first embodiment of the present invention.
FIG. 4 is an explanatory view showing the assembling method of the crankshaft according to the first embodiment of the present invention.
FIG. 5 is a cross-sectional view showing a constitution of a crankshaft according to a second embodiment of the present invention.
FIG. 6 is an explanatory view showing an assembling method of the crankshaft according to the second embodiment of the present invention.

Description of Embodiments

[First embodiment]

[0019] A first embodiment of the present invention will be described with reference to FIGS. 1 to 4. In addition, the expression "same" used in the following means substantially the same, and for example, design tolerances and manufacturing errors are acceptable.

[0020] As shown in FIG. 1, a compressor system 100 according to the embodiment includes an accumulator 24, suction pipes 26A and 26B (a first suction pipe 26A and a second suction pipe 26B), and a compressor 10. The compressor 10 according to the embodiment is a two-cylinder type rotary compressor. The compressor 10 includes a motor 18 driven by an external power supply, and a compression mechanism portion 10A which is driven by the motor 18 and compresses a refrigerant (fluid), and a housing 11 which covers the motor 18 and the compression mechanism portion 10A.

[0021] The compression mechanism portion 10A includes a crankshaft 16 rotated by the motor 18, piston rotors 13A and 13B (a first piston rotor 13A and a second piston rotor 13B) which eccentrically rotate in accordance with rotation of the crankshaft 16, and cylinders 12A and 12B (a first cylinder 12A and a second cylinder 12B) in which compression chambers for accommodating the piston rotors 13A and 13B are formed therein.

[0022] In the compression mechanism portion 10A, the disk-shaped first cylinder 12A and second cylinder 12B are provided in two upper and lower stages in the cylindrical housing 11. The housing 11 forms a discharge space V, in which the compressed refrigerant is discharged, by surrounding the first cylinder 12A and the second cylinder 12B. The cylindrical first piston rotors 13A and second piston rotors 13B each having an external form smaller than an inside between inner wall surfaces of each of the first cylinder 12A and the second cylinder 12B are disposed inside the first cylinder 12A and the second cylinder 12B. The first piston rotor 13A and the second piston rotor 13B are respectively inserted and fixed into eccentric shaft portions 14A and 14B (a first eccentric shaft portion 14A and a second eccentric shaft portion 14B) in the crankshaft 16.

[0023] Phases of the first piston rotor 13A of the upper cylinder 12A and the second piston rotor 13B of the lower cylinder 12B are provided to be different from each other by 180 °. That is, the first piston rotor 13A is eccentric so that a position thereof in a peripheral direction around an axis O is opposite to that of the second piston rotor 13B. Further, a disk-shaped partition plate 15 is provided between the upper and lower first cylinder 12A and second cylinder 12B. A space R in the upper first cylinder 12A and a space R in the lower second cylinder 12B are partitioned from each other by the partition plate 15, and thus an upper compression chamber R1 and a lower compression chamber R2 are formed.

[0024] The first cylinder 12A and the second cylinder 12B are fixed to the housing 11 by an upper bearing portion 17A and a lower bearing portion 17B. More specifically, the upper bearing portion 17A is fixed to an upper portion of the first cylinder 12A and formed in a disk shape. An outer peripheral surface of the upper bearing portion 17A is fixed to an inner peripheral surface of the housing 11. The lower bearing portion 17B is fixed to a lower portion of the second cylinder 12B and formed in a disk shape. An outer peripheral surface of the lower bearing portion 17B is fixed to the inner peripheral surface of the housing 11. That is, the first cylinder 12A and the second cylinder 12B are not directly fixed to the housing 11 but are fixed to the housing 11 via the upper bearing portion 17A and the lower bearing portion 17B.

[0025] In the compressor 10, the accumulator 24 for gas-liquid separation of the refrigerant prior to supply to the compressor 10 is fixed to the housing 11 via a stay 25. A refrigerant before compression is stored in the accumulator 24. The first suction pipe 26A and the second suction pipe 26B for suctioning the refrigerant in the accumulator 24 to the compressor 10 are provided between the accumulator 24 and the compressor 10. First ends (one ends) of the first suction pipe 26A and the second suction pipe 26B are connected to a lower portion of the accumulator 24. Second ends (the other ends) of the first suction pipe 26A and the second suction pipe 26B are respectively connected to suction ports 23A and 23B (a first suction port 23A and a second suction port 23B) formed in the first cylinder 12A and the second cylinder 12B through openings 22A and 22B.

[0026] Next, a constitution of the crankshaft 16 will be described in detail with reference to FIG. 2. As shown in the drawing, the crankshaft 16 extends along the axis O. The crankshaft 16 is rotatably supported around the axis O by the upper bearing portion 17A and the lower bearing portion 17B. The crankshaft 16 includes a shaft main body 16H, a first piston rotor 13A, and a second piston rotor 13B. The shaft main body 16H includes a first shaft portion (a main shaft) 16A, a first eccentric shaft portion (an upper crank pin) 14A, and a second shaft portion (an intermediate shaft) 16B, a second eccentric shaft (a lower crank pin) 14B, and a third shaft (a subshaft) 16C.

[0027] The first shaft portion 16A extends along the axis O. The first shaft portion 16A is formed to have the longest length in a direction of the axis O in the shaft main body 16H.

[0028] The first eccentric shaft portion 14A is integrally provided on one side of (a side below) the first shaft portion 16A in the direction of the axis O. The first eccentric shaft portion 14A is eccentric in a radial direction with respect to the axis O and is formed in a disk shape having a radial length greater than that of the first shaft portion 16A. Therefore, a portion of an outer peripheral surface of the first eccentric shaft portion 14A which coincides with an eccentric direction protrudes outward from an outer peripheral surface of the first shaft portion 16A in the radial direction. Further, a portion (a retracted portion Ar) of the outer peripheral surface of the first eccentric shaft portion 14A which is opposite to the eccentric direction is located inward from the outer peripheral surface of the first shaft portion 16A in radial direction with respect to the direction of the axis O. That is, the first eccentric shaft portion 14A is formed to be recessed from the outer peripheral surface of the first shaft portion 16A in the retracted portion Ar. The first eccentric shaft portion 14A is accommodated in the above-described compression chamber R1. The first piston rotor 13A is installed in the first eccentric shaft portion 14A. The detailed constitution of the first piston rotor 13A will be described later.

[0029] The second shaft portion 16B extends along the axis O and is integrally provided on one side of the first eccentric shaft portion 14A in the direction of the axis O. The second shaft portion 16B has a smaller radial length than that of the first shaft portion 16A. The second shaft portion 16B is disposed coaxially with the first shaft portion 16A. A length of the second shaft portion 16B in the direction of the axis O is smaller than any of the first shaft portion 16A, the first eccentric shaft portion 14A, the second eccentric shaft portion 14B, and the third shaft portion 16C.

[0030] The second eccentric shaft portion 14B is integrally provided on one side of the second shaft portion 16B in the direction of the axis O. The second eccentric shaft portion 14B is formed in a disk shape having a larger diameter than that of the second shaft portion 16B. The second eccentric shaft portion 14B protrudes outward in the radial direction from the outer peripheral surfaces of the second shaft portion 16B and the third shaft portion 16C over the entire periphery thereof. An annular second piston rotor 13B is installed on the outer peripheral surface of the second eccentric shaft portion 14B to cover the second eccentric shaft portion 14B from the outside in the radial direction. A radial length of the second eccentric shaft portion 14B is the same as a radial length of the first eccentric shaft portion 14A. An outer radial length of the second eccentric shaft portion 14B needs to be larger than a radial length of the first eccentric shaft portion 14A.

[0031] The third shaft portion 16C extends along the axis O and is integrally installed on one side of the second eccentric shaft portion 14B in the direction of the axis O. The third shaft portion 16C has a radial length smaller than that of the first shaft portion 16A and the same as that of the second shaft portion 16B. The third shaft portion 16C is disposed coaxially with the first shaft portion 16A.

[0032] The first shaft portion 16A protrudes upward (in a direction in which the motor 18 is located) from the upper bearing portion 17A. A rotor 19A of a motor 18 for rotationally driving the crankshaft 16 is integrally provided at a portion of the first shaft portion 16A which protrudes upward from the upper bearing portion 17A. A stator 19B is fixed to the inner peripheral surface of the housing 11 to face an outer peripheral portion of the rotor 19A.

[0033] The first piston rotor 13A is a piston rotor having a plurality of (three in the embodiment) rotor separate bodies 131A which are in contact with each other in the direction of the axis O. The respective rotor separate bodies 131A in an annular shape are in contact with each other in the direction of the axis O. lengths (lengths of the thickness direction) of the respective rotor separate bodies 131A in the direction of the axis O are the same as each other and have the same shape. That is, the first piston rotor 13A is equally divided (equally divided into three portions) in the direction of the axis O. In other words, a length of the first eccentric shaft portion 14A in the direction of the axis O is the same as a length of the three rotor separate bodies 131A. Furthermore, a length of one rotor separate body 131A in the direction of the axis O is less than or equal to a length of the second shaft portion 16B in the direction of the axis O. More specifically, the lengths of the respective rotor separate bodies 131A in the direction of the axis O are preferably slightly smaller than the length of the second shaft portion 16B in the direction of the axis O.

[0034] Further, the retracted portion Ar of the first eccentric shaft portion 14A is located inward from the outer peripheral surface of the first shaft portion 16A in the radial direction with respect to the direction of the axis O. As a result, among the three rotor separate bodies 131A, the rotor separate body 131A located furthest toward the other side (that is, the uppermost side) in the direction of the axis O is in contact with an end surface A1 of the first shaft portion 16A. Unlike the first piston rotor 13A, the second piston rotor 13B is formed as one member without being divided in the direction of the axis O. A length of the second piston rotor 13B in the direction of the axis O is equal to a length of the second eccentric shaft portion 14B in the direction of the axis O.

[0035] Subsequently, an assembling method of the crankshaft 16 according to the embodiment will be described with reference to FIGS. 3 and 4. As shown in FIG. 3, the assembling method of the crankshaft includes a preparation process S1, a first rotor installation process S2, and a second rotor installation process S3.

[0036] In the preparation process S1, the above-described shaft main body 16H is prepared. In manufacturing the shaft main body 16H, for example, a method of sequentially welding the first shaft portion 16A, the first eccentric shaft portion 14A, the second shaft portion 16B, the second eccentric shaft portion 14B, and the third shaft portion 16C in the direction of the axis O or a method of integrally cutting and forming them may be used.

[0037] Next, in the first rotor installation process S2, the above-described first piston rotor 13A is installed on the first eccentric shaft portion 14A in the shaft main body 16H.

[0038] In installing the first piston rotor 13A, the rotor separate bodies 131A are installed on the first eccentric shaft portion 14A one by one. That is, in the embodiment, since the first piston rotor 13A has the three rotor separate bodies 131A, the rotor separate bodies 131A are installed on the first eccentric shaft portion 14A in order on three occasions.

[0039] When installing the respective rotor separate bodies 131A, as shown in FIG. 4, the respective rotor separate bodies 131A are inserted through the shaft main body 16H from an one side in the direction of the axis O. That is, the rotor separate bodies 131A are inserted from the third shaft portion 16C side.

[0040] Next, the rotor separate bodies 131A are further moved upward (to the other side in the direction of the axis O) and pass through the second eccentric shaft portion 14B. Here, as described above, since the radial length of the second eccentric shaft portion 14B is the same as the radial length of the first eccentric shaft portion 14A, the rotor separate bodies 131A can pass through the second eccentric shaft portion 14B smoothly.

[0041] Further, the rotor separate bodies 131A which have passed through the second eccentric shaft portion 14B are moved to the same position as the second shaft portion 16B in the direction of the axis O. Thereafter, the rotor separate bodies 131A are moved in a direction orthogonal to the axis O. Specifically, as shown in FIG. 4, the rotor separate bodies 131A are moved in the eccentric direction of the first eccentric shaft portion 14A, and an axial center of the respective rotor separate bodies 131A and an axial center of the first eccentric shaft portion 14A coincide with each other. From this state, the rotor separate bodies 131A are moved upward. The above-described processes are repeatedly performed for each of the plurality (three) of rotor separate bodies 131A. Thereafter, the plurality of rotor separate bodies 131A are in contact with each other in a state in which they can move relative to each other in the peripheral direction and the radial direction. Thereby, the first rotor installation process S2 is completed.

[0042] Next, a second rotor installation process S3 is performed. In the second rotor installation step S3, the annular second piston rotor 13B formed as one member is fitted from the third shaft portion 16C side to the outer peripheral side of the second eccentric shaft portion 14B. Accordingly, all the processes of the assembling method of the crankshaft according to this embodiment are completed.

[0043] Subsequently, an operation of the compressor system 100 according to the embodiment will be described. In operating the compressor system 100, first, the motor 18 is driven by external power supply. As the motor 18 is driven, the shaft main body 16H rotates around the axis O. As the shaft main body 16H rotates, the first eccentric shaft portion 14A and the second eccentric shaft portion 14B revolve around a central axis (the axis O) of the shaft main body 16H. The first piston rotor 13A and the second piston rotor 13B eccentrically rotate in the compression chambers R1 and R2 to follow this revolution. Due to the eccentric rotation of the first piston rotor 13A and the second piston rotor 13B, volumes of the compression chambers R1 and R2 change, and the refrigerant introduced into the compression chambers R1 and R2 is compressed. The compressed refrigerant is taken out to the outside through the discharge space V in the housing 11.

[0044] Here, deflection may occur in the shaft main body 16H in accordance with continuous operation of the compressor system 100. In particular, in a twin rotary compressor having two first cylinder 12A and second cylinder 12B, as in the compressor system 100 according to the embodiment, a length (a length in the direction of the axis O) of the shaft main body 16H is longer than that in a single rotary compressor having only one cylinder. As a result, deflection of the shaft main body 16H easily occurs between the upper bearing portion 17A and the lower bearing portion 17B. When deflection occurs in the shaft main body 16H, the first eccentric shaft portion 14A formed in the vicinity of a center of the shaft main body 16H in the direction of the axis O may be inclined, and the first piston rotor 13A may come into partial contact with the first eccentric shaft portion 14A. As a result, stress generated in the first eccentric shaft portion 14A by the first piston rotor 13A may partially increase, and a friction loss in the shaft main body 16H may increase. In addition, this may lead to an increase in noise and vibration.

[0045] However, in the above-described constitution, the first piston rotor 13A is constituted by the plurality of rotor separate bodies 131A which can move relative to each other in a state in which they are in contact with each other in the direction of the axis O. That is, the first piston rotor 13A is divided into a plurality of parts in the direction of the axis O. Therefore, even when the shaft main body 16H is bent and the first eccentric shaft portion 14A is inclined, a position of each of the rotor separate bodies 131A in the radial direction is shifted to follow the inclination of the first eccentric shaft portion 14A. Thus, a region of the first piston rotor 13A in contact with the first eccentric shaft portion 14A increases, and an influence of the partial contact can be minimized. As a result, the friction loss between the first piston rotor 13A and the first eccentric shaft portion 14A can be reduced. As a result, performance of the compressor 10 due to the deflection of the crankshaft 16 can be further improved. Further, the reliability of the crankshaft 16 and the reliability of the compressor 10 can be improved.

[0046] Here, in installing the first piston rotor 13A on the first eccentric shaft portion 14A, a process in which the annular first piston rotor 13A is inserted through the shaft main body 16H from an end thereof in the direction of the axis O is performed. However, since the first eccentric shaft portion 14A is disposed to be partially recessed outward in the radial direction with respect to the first shaft portion 16A and the retracted portion Ar is formed, the first piston rotor 13A cannot be inserted from the first shaft portion 16A side in the direction of the axis O. Therefore, it is necessary to pass the first piston rotor 13A from the one side in the direction of the axis O in the order of the third shaft portion 16C and the second shaft portion 16B.

[0047] At this time, for example, unlike the constitution of the above-described embodiment, when the first piston rotor is integrally formed and the length of the first piston rotor in the direction of the axis O is larger than the length of the second shaft portion 16B, since the second shaft portion 16B and the second eccentric shaft portion 14B interfere with each other, the first piston rotor cannot reach the first eccentric shaft portion 14A and cannot be correctly installed.

[0048] However, in the constitution of the above-described embodiment, the plurality of rotor separate bodies 131A have the same lengths in the direction of the axis O, and the length of each of the rotor separate bodies 131A in the direction of the axis O is set equal to or less than the length of the second shaft portion 16B. Therefore, the axial center of the first eccentric shaft portion 14A and the axial center of the respective rotor separate bodies 131A can be made to coincide with each other by moving the rotor separate bodies 131A from the third shaft portion 16C side in the direction of the axis O to a position of the second shaft portion 16B and moving the rotor separate bodies 131A in the radial direction. That is, the plurality of rotor separate bodies 131A can be smoothly fitted to the first eccentric shaft portion 14A. Therefore, because the plurality of rotor separate bodies 131A are independent of each other, assemblability when the first piston rotor 13A is installed at the shaft main body 16H can be improved, as compared to the case in which the first piston rotor is integrally formed or the case in which the rotor separate bodies 131A are partially connected. Furthermore, the length of the second shaft portion 16B in the direction of the axis O can be reduced regardless of a length of the entire first piston rotor 13A in the direction of the axis O. Thus, the length of the shaft main body 16H in the direction of the axis O can be reduced as a whole. As a result, the rigidity of the shaft main body 16H increases, and the likelihood of deflection can be reduced. That is, according to the above-described constitution and the assembling method, the compressor 10 with improved performance can be provided more simply.

[0049] Further, the first piston rotor 13A can be easily formed by forming the first piston rotor 13A with the rotor separate bodies 131A having the same shape instead of different shapes.

[Second embodiment]

[0050] Next, a second embodiment of the present invention will be described with reference to FIGS. 5 and 6. The same components as those in the above-described first embodiment are designated by the same reference numerals, and detailed description thereof will be omitted. As shown in FIG. 5, in the embodiment, a second shaft portion 216B of a crankshaft 216 has a second shaft portion main body 40, a first reinforcing portion 41, and a second reinforcing portion 42.

[0051] The second shaft main body 40 extends along the axis O and is integrally installed on one side of the first eccentric shaft portion 14A in the direction of the axis O. The second shaft portion main body 40 has a smaller radial length than the first shaft portion 16A. The second shaft portion main body 40 is formed so that a length of the second shaft portion main body 40 in the direction of the axis O which is disposed coaxially with the first shaft portion 16A is substantially the same as the length of the third shaft portion 16C in the direction of the axis O. That is, the length of the second shaft portion main body 40 in the direction of the axis O is longer than that of the second shaft portion 16B of the first embodiment. In other words, it is formed longer than the length of the respective rotor separate bodies 131A in the direction of the axis O.

[0052] The first reinforcing portion 41 is provided at a position in which a gap is not formed in the direction of the axis O with respect to the first eccentric shaft portion 14A. The first reinforcing portion 41 is eccentric in the same direction as the eccentric direction of the first eccentric shaft portion 14A. The first reinforcing portion 41 is integrally formed of the same material with respect to the second shaft portion main body 40 and the first eccentric shaft portion 14A. An end surface (a lower surface A1 of a compensating portion) of the first reinforcing portion 41 on one side in the direction of the axis O faces an end surface (an upper surface A2 of the eccentric shaft portion) of the second eccentric shaft portion 14B on the other side of the direction of the axis O with a gap G1. A length of the gap G1 in the direction of the axis O is slightly larger than the length of the respective rotor separate bodies 131A in the direction of the axis O.

[0053] The second reinforcing portion 42 is provided at a position in which a gap is not formed in the direction of the axis O with respect to the second eccentric shaft portion 14B. The second reinforcing portion 42 is eccentric in the same direction as the eccentric direction of the second eccentric shaft portion 14B. That is, the second reinforcing portion 42 is eccentric in a direction opposite to the eccentric direction of the first eccentric shaft portion 14A and the first reinforcing portion 41. The second reinforcing portion 42 is integrally formed of the same material with respect to the second shaft portion main body 40 and the second eccentric shaft portion 14B. An end surface (an upper surface A3 of the compensating portion) of the second reinforcing portion 42 on the other side in the direction of the axis O faces an end surface (a lower surface A4 of the eccentric shaft portion) of the first eccentric shaft portion 14A on one side of the direction of the axis O with a gap G2. A length of the gap G2 in the direction of the axis O is slightly larger than the length of the rotor separate bodies 131A in the direction of the axis O.

[0054] The first piston rotor 13A is installed at the crankshaft 216 having such a constitution through the processes as shown in FIG. 6. Specifically, similarly to the assembling method of the crankshaft described in the first embodiment, first, the rotor separate bodies 131A are inserted from the third shaft portion 16C side in the direction of the axis O and moved upward. When the respective rotor separate bodies 131A reach the same position as the second reinforcing portion 42 in the direction of the axis O, the respective rotor separate bodies 131A are moved in a direction (the radial direction) orthogonal to the axis O. Specifically, the respective rotor separate bodies 131A are moved in the same direction as the eccentric direction of the first reinforcing portion 41 and the first eccentric shaft portion 14A. From this state, the respective rotor separate bodies 131A are further moved upward. When the respective rotor separate bodies 131A reach the same position as the first reinforcing portion 41 in the direction of the axis O, the respective rotor separate bodies 131A are further moved in the direction orthogonal to the axis O, and the axial center of the respective rotor separate bodies 131A and the axial center of the first eccentric shaft portion 14A coincide with each other. From this state, the rotor separate bodies 131A are further moved upward and fitted to the first eccentric shaft portion 14A. The first piston rotor 13A is installed at the crankshaft 216 by repeating this process for the number of rotor separate bodies 131A.

[0055] With such a constitution, as in the first embodiment, the region of the first piston rotor 13A in contact with respect to the first eccentric shaft portion 14A is increased by the plurality of rotor separate bodies 131A, and the influence of the partial contact can be minimized. As a result, the friction loss between the first piston rotor 13A and the first eccentric shaft portion 14A can be reduced. As a result, the performance of the compressor 10 can be further improved.

[0056] Further, with such a constitution, the first reinforcing portion 41 and the second reinforcing portion 42 are provided on the second shaft portion 216B. Accordingly, a large length of the second shaft portion 216B in the radial direction can be secured. As a result, the rigidity of the second shaft portion 216B as a whole can be increased, and the deflection of the crankshaft 216 can be reduced.

[0057] Here, each of the first reinforcing portion 41 and the second reinforcing portion 42 are eccentric with respect to the axis O. Furthermore, a separation distance in the direction of the axis O between the lower surface A1 of the compensating portion and the upper surface A2 of the eccentric shaft portion is slightly larger than the length of the respective rotor separate bodies 131A in the direction of the axis O. Further, the separation distance in the direction of the axis O between the upper surface A3 of the compensating portion and the lower surface A4 of the eccentric shaft portion is slightly larger than the length of the respective rotor separate bodies 131A in the direction of the axis O. Therefore, as shown in FIG. 6, when the rotor separate bodies 131A are installed, the rotor separate bodies 131A can smoothly pass through the second eccentric shaft portion 14B. Therefore, since the first piston rotor 13A is equally divided, it is possible to secure the large length of the first piston rotor 13A in the direction of the axis O while forming a region in which the length in the radial direction is enlarged to secure the rigidity of the second shaft portion 216B without assembly restrictions. As a result, the compressor 10 with improved performance can be provided more simply.

(Other modified examples of embodiment)

[0058] Although the embodiments of the present invention have been described above in detail with reference to the drawings, each constitution in the embodiment and the combination thereof are one example, and addition, omission, substitution, and other modifications of the constitution are possible without departing from the spirit of the present invention. Further, the present invention is not limited by the embodiments and is limited only by the scope of claims.

[0059] For example, in the above-described embodiment, the example in which the second piston rotor 13B is integrally formed in the direction of the axis O has been described. However, it is also possible to adopt a constitution in which the second piston rotor 13B is divided in the direction of the axis O similarly to the first piston rotor 13A. According to this configuration, it is possible to further improve the performance of the compressor 10 by minimizing an increase in the friction loss in the second piston rotor 13B.

[0060] Further, the first piston rotor 13A is not limited to the constitution in which it is formed by the rotor separate bodies 131A having the same shape as in the embodiment. For example, the first piston rotor 13A may be constituted by rotor separate bodies having different lengths in the direction of the axis O.

Industrial Applicability

[0061] According to the present invention, it is possible to minimize deterioration in performance of the compressor due to deflection.

Reference Signs List

[0062]

100 Compressor system
10 Compressor
10A Compression mechanism portion
11 Housing
12A First cylinder (cylinder)
12B Second cylinder (cylinder)
R1, R2 Compression chamber
13A First piston rotor (piston rotor)
13B Second piston rotor (piston rotor)
14A First eccentric shaft portion
14B Second eccentric shaft portion
16 Crankshaft
16A First shaft portion
16B, 216B Second shaft portion
16C Third shaft portion
17A Upper bearing portion
17B Lower bearing portion
18 Motor
19A Rotor
19B Stator
22A First opening (opening)
22B Second opening (opening)
23A First suction port (suction port)
23B Second suction port (suction port)
24 Accumulator
25 Stay
26A First suction pipe (suction pipe)
26B Second suction pipe (suction pipe)
131A Rotor separate body
40 Second shaft portion main body
41 First reinforcing portion
42 Second reinforcing portion
A1 Lower surface of compensating portion

A2 Upper surface of eccentric shaft portion
A3 Upper surface of compensating portion
A4 Lower surface of eccentric shaft portion
Ar Retracted portion
G1, G2 Gap
O Axis
V Discharge space
S1 Preparation process
S2 First rotor installation process
S3 Third rotor installation process

Claims

1. A piston rotor (13A) of a crankshaft (16) which is configured to rotate around an axis in a rotary compressor (10), comprising:

a plurality of rotor separate bodies (131A) respectively formed in an annular shape,
wherein the plurality of rotor separate bodies are movable relative to each other in a state in which they are in contact with each other.

2. The piston rotor according to Claim 1, wherein the plurality of rotor separate bodies (131A) have the same lengths in a thickness direction.

3. A crankshaft (16) comprising:

a first shaft portion (16A) which extends along an axis;
a first eccentric shaft portion (14A) which is provided on one side of the first shaft portion in a direction of the axis in which the axis extends, is eccentric in a radial direction with respect to the axis and has a radial length greater than that of the first shaft portion;
a second shaft portion (16B) which extends along the axis and is installed on one side of the first eccentric shaft in the direction of the axis; and
the piston rotor (13A) according to Claim 1 or 2 which covers the first eccentric shaft portion (14A) from an outside in the radial direction,
wherein the piston rotor (13A) is disposed to cover the first eccentric shaft portion (14A) from the outside in the radial direction.

4. The crankshaft according to Claim 3, further comprising:

a second eccentric shaft portion (14B) which is provided on one side of the second shaft portion (16B) in the direction of the axis, is eccentric in a direction different from that of the first eccentric shaft portion (14A) and has a radial length larger than that of the second shaft portion and smaller than that of the first eccentric shaft portion;
an annular second piston rotor (13B) which covers the second eccentric shaft portion from an outside in the radial direction; and
a third shaft portion (16C) which extends along the axis and is installed on one side of the second eccentric shaft portion in the direction of the axis,
wherein each of the second shaft portion (16B) and the third shaft portion (16C) has a radial length smaller than that of the first eccentric shaft portion,
wherein the first eccentric shaft portion (14A) is disposed to be partially recessed inward with respect to the first shaft portion in the radial direction, and
wherein a length of each of the rotor separate bodies (131A) in the direction of the axis is equal to or less than a length of the second shaft portion in the direction of the axis.

5. A rotary compressor (10) comprising:

the crankshaft (16) according to Claim 3 or 4;
a compression mechanism portion (10A) which accommodates the first eccentric shaft portion (14A) and has a compression chamber (R1) that is configured to compress a fluid in accordance with rotation of the crankshaft; and
a bearing portion (17A) which is configured to rotatably support the first shaft portion.

6. An assembling method of a crankshaft (16) which includes a first shaft portion (16A) which extends along an axis (O), a first eccentric shaft portion (14A) which is provided on one side of the first shaft portion in a direction of the axis in which the axis extends, is eccentric in a radial direction with respect to the axis and has a radial length greater than that of the first shaft portion, a second shaft portion (16B which extends along the axis and is installed on one side of the first eccentric shaft in the direction of the axis, a first piston rotor (13A) having a plurality of rotor separate bodies (131A) respectively formed in an annular shape to cover the first eccentric shaft portion from an outside in the radial direction with respect to the axis, a second eccentric shaft portion (14B) which is provided on one side of the second shaft portion in the direction of the axis, is eccentric in a direction different from the first eccentric shaft portion and has a radial length larger than that of the second shaft portion, an annular second piston rotor (13B) which covers the second eccentric shaft portion from an outside in the radial direction, and a third shaft portion (16C) which extends along the axis and is installed on one side of the second eccentric shaft portion in the direction of the axis, comprising:
fitting the plurality of rotor separate bodies (131A)

one by one from the third shaft portion side to an outer peripheral surface of the first eccentric shaft portion and bringing the plurality of rotor separate bodies into contact with each other in a relatively movable state.

FIG. 1

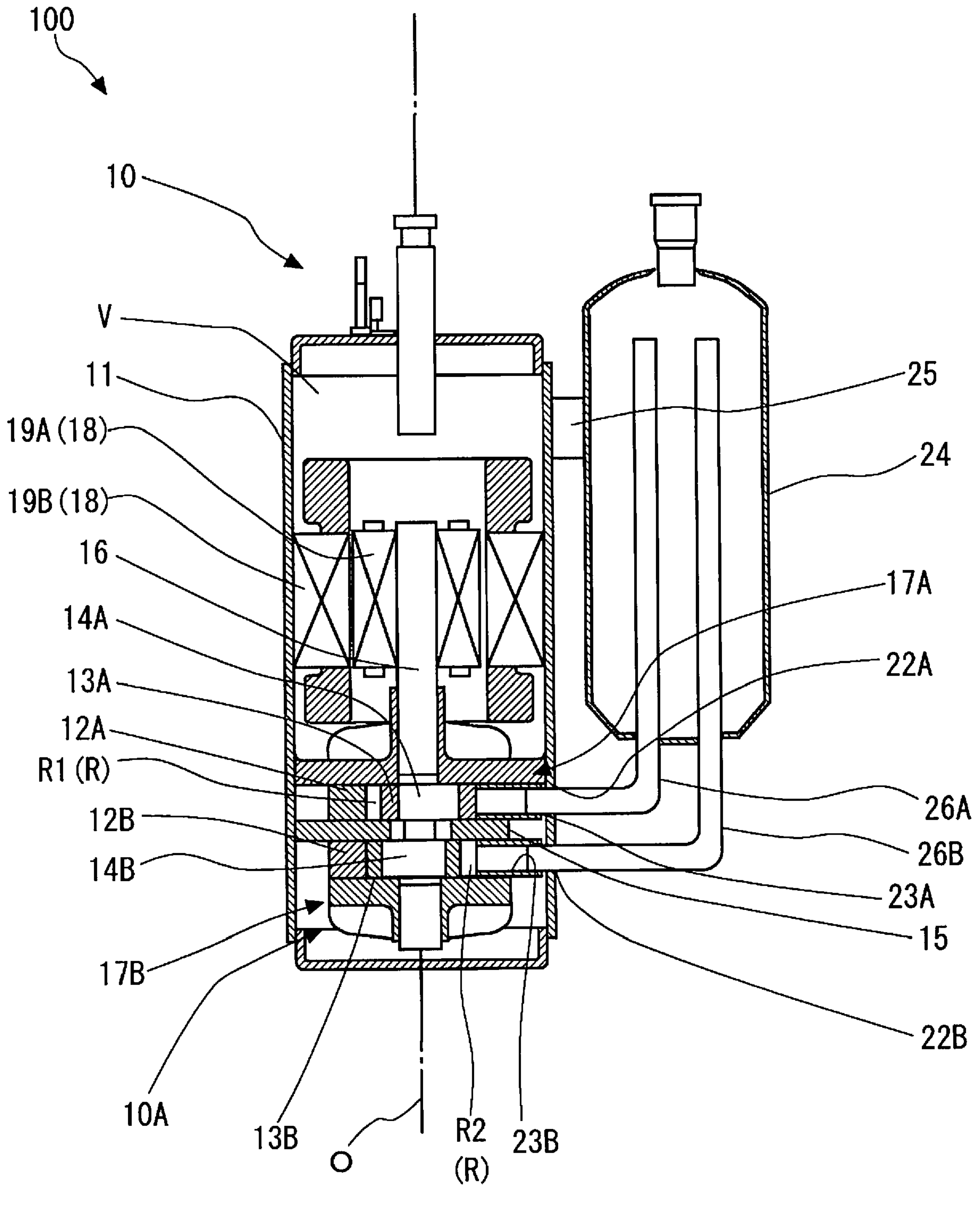

100
10
V
11
19A (18)
19B (18)
16
14A
13A
12A
R1 (R)
12B
14B
17B
10A
13B
O
R2
(R)
23B
25
24
17A
22A
26A
26B
23A
15
22B

FIG. 2

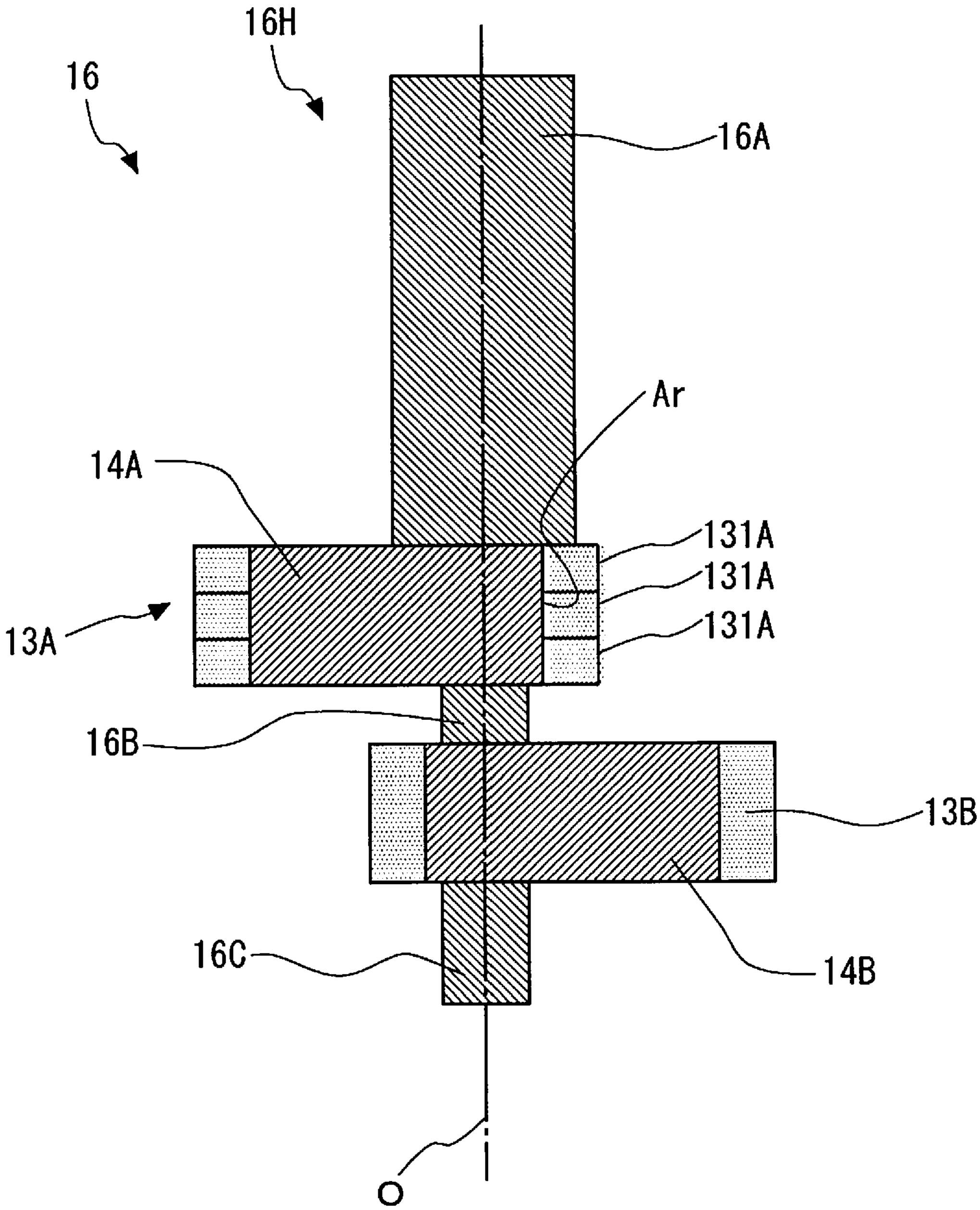


FIG. 3

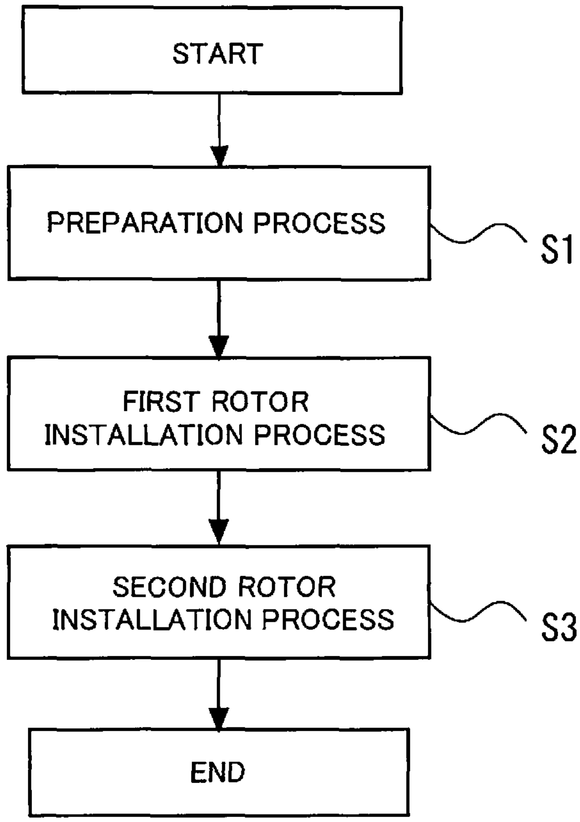

START
PREPARATION PROCESS
S1
FIRST ROTOR INSTALLATION PROCESS
S2
SECOND ROTOR INSTALLATION PROCESS
S3
END

FIG. 4

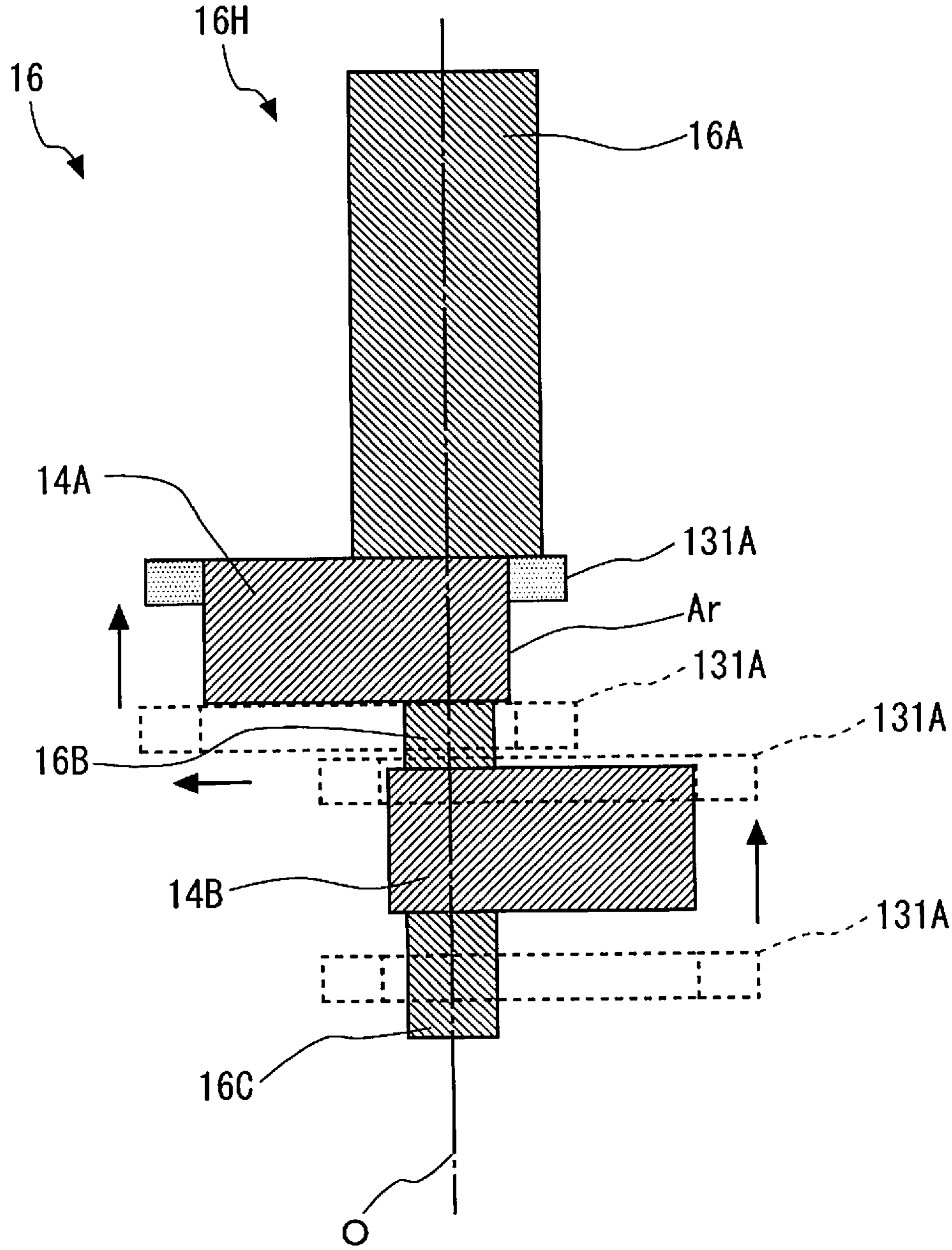


FIG. 5

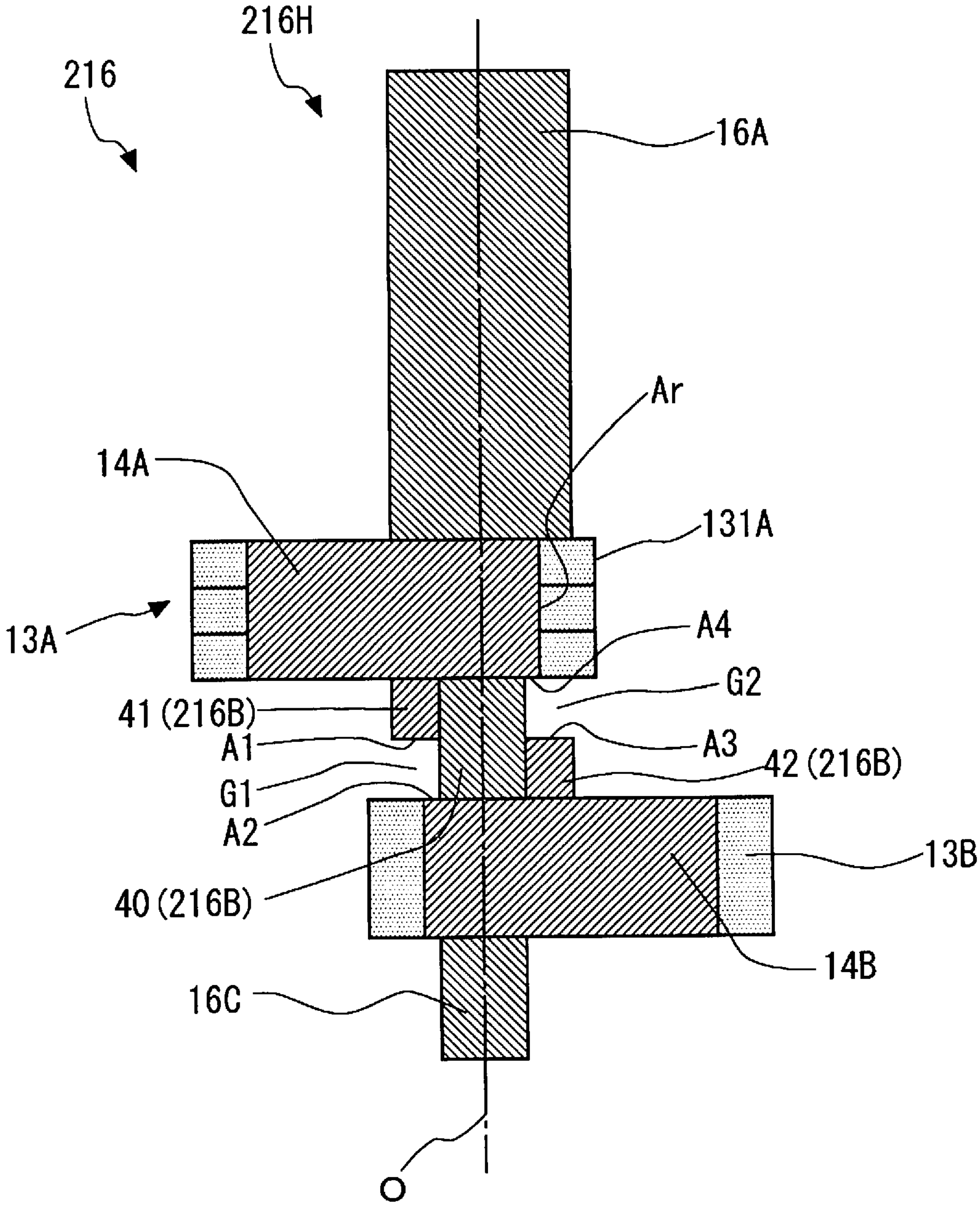
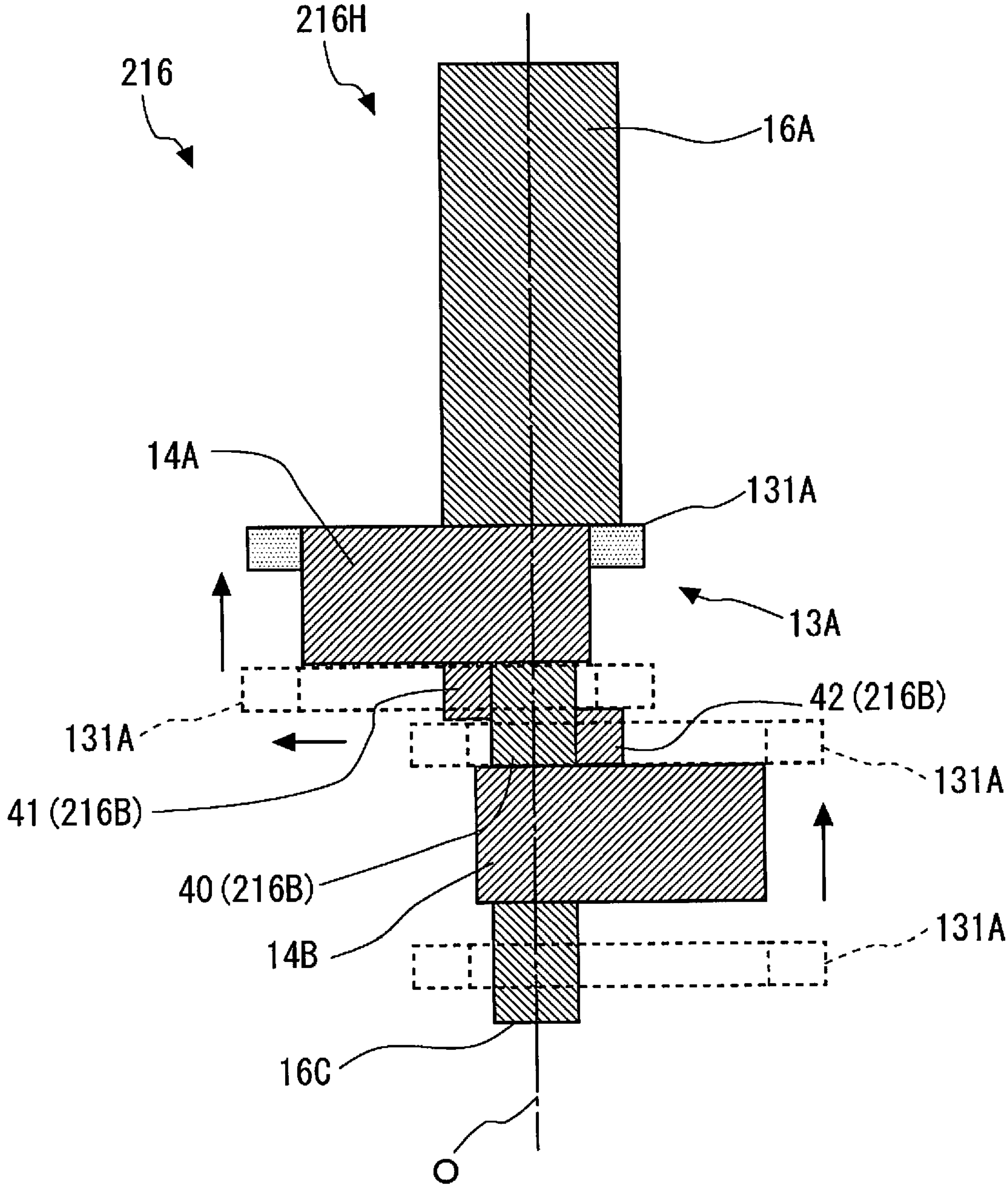

216H
216
16A
Ar
14A
131A
13A
A4
G2
41 (216B)
A1
A3
42 (216B)
G1
A2
13B
40 (216B)
14B
16C
O

FIG. 6


216H
216
16A
14A
131A
13A
42 (216B)
131A
131A
41 (216B)
40 (216B)
14B
131A
16C
O

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EUROPEAN SEARCH REPORT

Application Number
EP 19 16 9260

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	CN 103 711 699 A (MITSUBISHI ELECTRIC CORP) 9 April 2014 (2014-04-09) * paragraphs [0034] - [0042], [0048], [0056] - [0058] * * figures 1,2,6 *	1-6	INV. F04C29/00 F04C18/34 ADD. F04C23/00
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A	* figures 1,7-16 * * paragraphs [0078] - [0089] *	4,6	
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A	* paragraphs [0013], [0018], [0026], [0027] * * claim 1; figures 1-3 *	2-6	
A	WO 2005/124156 A1 (TOSHIBA CARRIER CORP [JP]; ONODA IZUMI [JP] ET AL.) 29 December 2005 (2005-12-29) * abstract *; figures 1,4,5,13B,14,19 *	1-6	TECHNICAL FIELDS SEARCHED (IPC) F04C

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	22 July 2019	Bocage, Stéphane

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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