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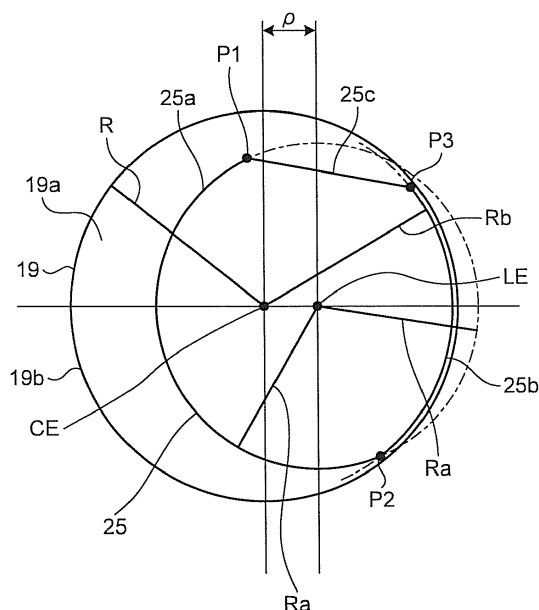
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(54) **SCROLL FLUID MACHINE**

(57) An outer shape of an eccentric pin (25) of a rotating shaft (19) has: a first circular arc (25a) formed in a range of an outer shape of the rotating shaft (19), with a first radius (Ra) having a length exceeding a part of an outer edge (19b) of the rotating shaft (19), the first radius (Ra) having a center at a position of an eccentric center (LE); and a second circular arc (25b) formed in a portion where the first radius (Ra) exceeds the outer edge (19b), with a second radius (Rb) having a length equal to or less than a radius (R) forming the outer edge (19b), the second radius (Rb) having a center at a position of a shaft center (CE).

FIG.2



Description

Field

[0001] The present invention relates to a scroll fluid machine.

Background

[0002] In a scroll compressor, which is a scroll fluid machine, a fixed scroll, an orbiting scroll, a rotating shaft, and a drive unit, are mainly provided inside a closed housing. Fluid is compressed, by the rotating shaft being rotated by the drive unit, and the orbiting scroll, to which this rotation is transmitted, engaging and orbiting with the fixed scroll.

[0003] Conventionally, for example, in Patent Literature 1, a slide bush for adjusting, in a scroll fluid machine, an orbiting radius of an orbiting scroll, according to a spiral shape thereof, has been disclosed. Each of spirally shaped laps of the orbiting scroll and a fixed scroll is designed based on a predetermined optimum orbiting radius, but there is a problem that when a gap is generated between the engaged laps due to dimensional tolerance thereof, fluid leaks out from the gap. The slide bush is formed of: a bush, which is inserted in a cylindrical boss of the orbiting scroll, and in which an eccentric pin of a rotating shaft is inserted; a connected portion connected with a side portion of the bush; and a balance weight integrally formed with the connected portion. Since the bush is configured to be able to slidably move in a radial direction of the rotating shaft with respect to the eccentric pin; the respective laps of the orbiting scroll and fixed scroll are caused to contact each other and generation of a gap between the laps is prevented, by the slide bush: slidably moving in the radial direction due to action of gas pressure in a scroll compression chamber, centrifugal force on the orbiting scroll, and centrifugal force on the balance weight; and causing the orbiting radius of the boss, in which the bush has been inserted, to be changed.

Citation List

Patent Literature

[0004] Patent Literature 1: Japanese Patent Application Laid-open No. 2003-343454

Summary

Technical Problem

[0005] Force acting on the bush also acts on the eccentric pin inserted in the bush. When the rotating shaft is rotated at high speed for improving performance, centrifugal force is increased, and thus action of the centrifugal force on the eccentric pin becomes too large and

bending of the eccentric pin in the radial direction is caused. There is a problem that partial contact is caused in a bearing that supports the rotating shaft, the problem is caused by this bending of the eccentric pin.

[0006] The present invention solves the above described problems, and an object thereof is to provide a scroll fluid machine, which enables bending of an eccentric pin therein to be prevented.

Solution to Problem

[0007] To achieve the above described object, a scroll fluid machine of the present invention includes:

- 15 a fixed scroll fixed to a housing;
- an orbiting scroll that engages with the fixed scroll and is provided to be orbitally movable;
- a rotating shaft that is supported rotatably with respect to the housing and has an eccentric pin eccentric with respect to a shaft center; and
- 20 a bush that is interposed between the eccentric pin and the orbiting scroll and transmits rotational movement of the eccentric pin as orbital movement of the orbiting scroll.

[0008] In the scroll fluid machine, an outer shape of the eccentric pin has: a first circular arc formed in a range of an outer shape of the rotating shaft, with a first radius Ra having a length exceeding a part of an outer edge of the rotating shaft, the first radius Ra having a center at a position of an eccentric center; and a second circular arc formed in a portion where the first radius Ra exceeds the outer edge, with a second radius Rb having a length equal to or less than a radius R forming the outer edge, the second radius Rb having a center at a position of the shaft center.

[0009] According to this scroll fluid machine, since the outer shape of the eccentric pin has the first circular arc formed in the range of the outer shape of the rotating shaft, with the first radius Ra having the length exceeding the portion of the outer edge of the rotating shaft, the first radius Ra having the center at the position of the eccentric center, the outer shape of the eccentric pin is made to have a large diameter that exceeds the portion of the outer edge of the rotary shaft, and rigidity of the eccentric pin is improved. As a result, bending of the eccentric pin is prevented.

[0010] What is more, according to this scroll fluid machine, since the outer shape of the eccentric pin has the second circular arc formed in the portion where the first radius Ra exceeds the outer edge, with the second radius Rb having the length equal to or less than the radius R forming the outer edge, the second radius Rb having the center at the position of the shaft center, the outer shape of the eccentric pin is prevented from going over the outer edge of the rotating shaft. If the outer shape of the eccentric pin goes over the outer edge of the rotating shaft, processing the rotating shaft requires labor with the ec-

centric pin being an obstacle, or assembly requires labor when the rotating shaft is inserted in the bearings with the eccentric pin being an obstacle, and such inconvenience is eliminated.

[0011] Furthermore, according to the scroll fluid machine of the present invention, the first radius R_a , the second radius R_b , the radius R , and a distance p between the position of the shaft center and the position of the eccentric center satisfy a relation of $(R_a^2 + p^2)^{1/2} \leq R_b \leq R$.

[0012] The second circular arc is formed with the second radius R_b having the length equal to or less than the radius R forming the outer edge of the rotating shaft, the second radius R_b having the center at the position of the shaft center, but if the second radius R_b becomes too much less than the radius R , a diameter of the outer shape of the eccentric pin becomes too small. According to this scroll fluid machine, since the lower limit of the second radius R_b is set by the relation, $(R_a^2 + p^2)^{1/2} \leq R_b \leq R$, the diameter of the outer shape of the eccentric pin is prevented from becoming too small. As a result, the effect of increasing the rigidity of the eccentric pin, and preventing the bending of the eccentric pin, is achieved.

[0013] Furthermore, according to the scroll fluid machine of the present invention, having a bush assembly, the bush assembly includes:

a bush, into which the eccentric pin is inserted, which has a contact end surface that comes into contact with an end surface of the rotating shaft, and which is inserted in a boss that is provided at a bottom surface of the orbiting scroll and that is cylindrically shaped;

a balance weight that has a connected portion arranged in an outer peripheral portion of the bush and near the contact end surface, and a weight provided, in a cantilevered shape, in a portion of an outer periphery of the connected portion, so as to stick out in a direction of going away from the contact end surface;

a stepped portion provided between the connected portion and the contact end surface of the bush; and a joining portion that is provided in the stepped portion and joins the bush and the connected portion together.

[0014] According to this scroll fluid machine, in association with the action of the centrifugal force of the weight, which is provided in the portion of the outer periphery of the connected portion so as to stick out in the direction going away from the contact end surface in the cantilevered shape, the moment having the starting point at the connected portion acts so that the weight is rotated towards the contact end surface, and in the stepped portion, this moment acts so that the connected portion is caused to approach the bush. Therefore, excessive load is not applied to the joining portion provided in the stepped portion, rigidity of the joining between the bush

and the connected portion is increased, and removal of the connected portion from the bush, or positional displacement of the connected portion with respect to the bush is prevented.

[0015] What is more, according to this scroll fluid machine, since the joining portion joining the bush and the connected portion together is provided in the stepped portion, the joining portion is prevented from protruding to the contact end surface of the bush coming into contact with the end surface of the rotating shaft, and thus the joining portion is prevented from interfering with the end surface of the rotating shaft and processing of the joining portion for preventing the interference is omitted. Further, since the weight is provided in the direction going away from the contact end surface, so as to stick out from the connected portion in the cantilevered shape; and in the stepped portion, the joining portion is provided between the connected portion and the contact end surface at the side opposite to the side to which the weight sticks out: regardless of the presence of the weight, the joining portion is provided easily.

[0016] Furthermore, according to the scroll fluid machine of the present invention, in the bush assembly, the joining portion is provided at plural positions in a circumferential direction of the bush.

[0017] According to this scroll fluid machine, if the joining portion is formed by welding, when the joining portion is provided at plural positions in the circumferential direction of the bush, rather than being provided on the whole circumference in the circumferential direction of the bush, thermal deformation of the bush and the joining portion due to the welding heat is reduced.

[0018] Furthermore, according to the scroll fluid machine of the present invention, in the bush assembly, the joining portion is evenly arranged in the circumferential direction of the bush.

[0019] According to this scroll fluid machine, when the joining portion is formed by welding, by the joining portion being arranged evenly in the circumferential direction of the bush, even if thermal deformation of the bush or the joining portion due to the welding heat is caused, the thermal deformation is equalized and local deformation is reduced.

[0020] Furthermore, according to the scroll fluid machine of the present invention, in the bush assembly, more of the positions of the joining portion are situated near where the weight is provided.

[0021] According to this scroll fluid machine, in association with the action of the centrifugal force of the weight, the moment having the starting point at the connected portion acts near where the weight is provided, and thus when the joining portion is provided at plural positions in the circumferential direction of the bush, by more of the positions of the joining portion being situated near where the weight is provided, the effect of increasing the rigidity of the joining between the bush and the connected portion is achieved.

[0022] Furthermore, according to the scroll fluid ma-

chine of the present invention, in the bush assembly, an oil feeding groove is provided along an extending direction of a cylindrical shape, on an outer peripheral portion of the bush, and the joining portion is arranged separately from a radial direction range of the oil feeding groove.

[0023] According to this scroll fluid machine, the oil feeding groove is for feeding the lubricating oil, and when the joining portion is formed by welding, by the joining portion being arranged separately from the radial direction range of the oil feeding groove, thermal deformation of the oil feeding groove due to the welding heat is reduced, and the lubricating oil is fed smoothly by the oil feeding groove.

[0024] Furthermore, according to the scroll fluid machine of the present invention, in the bush assembly, the bush is formed of a sintered material, and the balance weight is formed of a cast iron material.

[0025] According to this scroll fluid machine, since the bush is a sliding member connected to the eccentric pin or the orbiting scroll, the bush is preferably formed of a sintered material having a hardness that is comparatively high. Further, since the balance weight has the weight, which balances the dynamic unbalance generated due to the unbalanced weights associated with the orbiting motion of the orbiting scroll, the balance weight is preferably formed of a cast iron material having a density that is comparatively high.

[0026] Furthermore, according to the scroll fluid machine of the present invention, in the bush assembly, the bush and the connected portion of the balance weight are fixed by shrinkage fitting or interference fitting.

[0027] According to this scroll fluid machine, since the bush and the connected portion of the balance weight are fixed by shrinkage fitting or interference fitting, synergistically with the inclusion of the joining portion, the effect of increasing the rigidity of the joining between the bush and the connected portion is achieved.

[0028] Furthermore, according to the scroll fluid machine of the present invention, the bush assembly is configured to slidably move with respect to the eccentric pin, by a bush side slide surface, which comes into contact with a pin side slide surface provided on a side portion of the eccentric pin, being provided on an inner peripheral portion of the bush, and the joining portion is arranged separately from a radial direction range of the bush side slide surface.

[0029] According to this scroll fluid machine, the bush side slide surface is a portion supporting sliding movement of the bush assembly, and when the joining portion is formed by welding, by the joining portion being arranged separately from the radial direction range of the bush side slide surface, thermal deformation of the bush side slide surface due to the welding heat is reduced, and the sliding movement of the bush assembly is performed smoothly.

[0030] Furthermore, according to the scroll fluid machine of the present invention, the maximum number of rotations per second of the rotating shaft exceeds 145

rps.

[0031] According to this scroll fluid machine, since by the above described configuration, bending of the eccentric pin is prevented and the rigidity of the joining between the bush and the connected portion in the bush assembly is increased; the scroll fluid machine having the maximum number of rotations per second of the rotating shaft exceeding 145 rps is realized.

10 Advantageous Effects of Invention

[0032] According to the present invention, bending of the eccentric pin is prevented.

15 Brief Description of Drawings

[0033]

FIG. 1 is an overall cross sectional view of a scroll fluid machine according to an embodiment of the present invention.

FIG. 2 is a plan view of a rotating shaft in the scroll fluid machine according to the embodiment of the present invention.

FIG. 3 is a sectional side elevation of a combination of the rotating shaft and a bush assembly in the scroll fluid machine according to the embodiment of the present invention.

FIG. 4 is a plan view of the bush assembly in the scroll fluid machine according to the embodiment of the present invention.

FIG. 5 is a bottom view of the bush assembly in the scroll fluid machine according to the embodiment of the present invention.

FIG. 6 is a plan view of a rotating shaft of another example of the scroll fluid machine according to the embodiment of the present invention.

FIG. 7 is an overall cross sectional view of another example of the scroll fluid machine according to the embodiment of the present invention.

FIG. 8 is a sectional side elevation of a combination of a rotating shaft and a bush assembly of the another example of the scroll fluid machine according to the embodiment of the present invention.

FIG. 9 is a bottom view of the bush assembly of the another example of the scroll fluid machine according to the embodiment of the present invention.

Description of Embodiments

[0034] Hereinafter, an embodiment according to the present invention will be described in detail, based on the drawings. This invention is not limited by this embodiment. Further, components in the embodiment described below include any component easily substitutable by those skilled in the art or any component substantially identical thereto.

[0035] FIG. 1 is an overall cross sectional view of a

scroll fluid machine according to this embodiment.

[0036] In FIG. 1, as the scroll fluid machine, a scroll compressor 1, which compresses and discharges intake fluid, is illustrated. Further, the scroll compressor 1 of this embodiment is interposed in a refrigerant flow channel, through which a refrigerant is circulated in an air conditioner, a freezer, or the like.

[0037] As illustrated in FIG. 1, the scroll compressor 1 includes, inside a housing 3, a motor 5, which is a driving means, and a scroll compression mechanism 7, which is driven by the motor 5.

[0038] The housing 3 includes: a housing main body 3a, which extends vertically and is cylindrical; a bottom portion 3b, which closes a lower end of the housing main body 3a; and a lid portion 3c, which closes an upper end of the housing main body 3a, and the housing 3 forms a pressure vessel, the whole of which is closed. At a side portion of the housing main body 3a, an inlet pipe 9, through which the refrigerant is introduced into the housing 3, is provided. At an upper portion of the lid portion 3c, a discharge pipe 11, through which the refrigerant compressed by the scroll compression mechanism 7 is discharged, is provided. Between the housing main body 3a and the lid portion 3c, in the housing 3, a discharge cover 13 is provided, and the interior of the housing 3 is partitioned into a low pressure chamber 3A lower than the discharge cover 13, and a high pressure chamber 3B upper than the discharge cover 13. In the discharge cover 13, an opening hole 13a, which communicates the low pressure chamber 3A with the high pressure chamber 3B, is formed, and a discharge reed valve 13b, which opens and closes the opening hole 13a, is provided. Further, a bottom in the housing 3 is formed as an oil sump, where lubricating oil is stored.

[0039] The motor 5 includes a stator 15, a rotor 17, and a rotating shaft 19. The stator 15 is fixed to an inner wall surface substantially at a vertical direction center of the housing main body 3a. The rotor 17 is provided rotatably with respect to the stator 15. A longitudinal direction of the rotating shaft 19 is arranged vertically, with respect to the rotor 17. The motor 5 rotates the rotor 17 when power is supplied from outside of the housing 3, and the rotating shaft 19 is rotated with the rotor 17.

[0040] The rotating shaft 19 is provided, such that its end portions protrude upward and downward from the rotor 17, and the upper end portion is supported by an upper bearing 21 and the lower end portion is supported by a lower bearing 23, rotatably around a shaft center CE extending in the vertical direction, with respect to the housing main body 3a. At an upper end of the rotating shaft 19, an eccentric pin 25, which protrudes upward along an eccentric center LE eccentric with respect to the shaft center CE, is formed. The scroll compression mechanism 7 is connected to the upper end of the rotating shaft 19 having this eccentric pin 25. A detailed configuration of this eccentric pin 25 will be described later. Further, inside the rotating shaft 19 and the eccentric pin 25, an oil feeding hole 27 penetrating vertically there-

through is formed. Furthermore, a lower end of the rotating shaft 19 is provided to reach the oil sump, and an oil feeding pump 29 is provided at that lower end. The oil feeding pump 29 feeds the lubricating oil stored in the oil sump with the rotation of the rotating shaft 19, to the oil feeding hole 27 of the rotating shaft 19.

[0041] The upper bearing 21 rotatably supports the rotating shaft 19 with the upper end portion of the rotating shaft 19 penetrating therethrough. On an upper surface of the upper bearing 21, a recessed portion 21a is formed to surround the upper end portion of the rotating shaft 19 penetrating through the upper bearing 21. The recessed portion 21a accommodates therein a bush assembly 37, which will be described later, and stores therein the lubricating oil fed by the oil feeding pump 29 through the oil feeding hole 27. The stored lubricating oil is supplied to the scroll compression mechanism 7.

[0042] Further, at a portion of an outer periphery of the upper bearing 21, a notch 21b is formed such that a gap is formed between an inner wall surface of the housing main body 3a of the housing 3 and the upper bearing 21, and an oil discharging hole 21c that provides communication between the notch 21b and the recessed portion 21a is formed in the upper bearing 21. Furthermore, below the notch 21b of the upper bearing 21, a cover plate 31 is provided. The cover plate 31 is provided to extend in the vertical direction. The cover plate 31 is formed such that both side ends of the cover plate 31 face the inner wall surface of the housing main body 3a to cover a periphery of the notch 21b, and is formed such that a lower end of the cover plate 31 is bent to gradually approach the inner wall surface of the housing main body 3a. The oil discharging hole 21c discharges the lubricating oil stored excessively in the recessed portion 21a to an outer periphery of the upper bearing 21 from the notch 21b. The cover plate 31 receives the lubricating oil discharged from the notch 21b and guides the received lubricating oil towards the inner wall surface of the housing main body 3a. The lubricating oil guided towards the inner wall surface by the cover plate 31 goes along the inner wall surface and returns to the oil sump at the bottom inside the housing 3 by the cover plate 31.

[0043] The scroll compression mechanism 7 is arranged above the upper bearing 21 in the low pressure chamber 3A below the discharge cover 13 inside the housing 3, and includes a fixed scroll 33, an orbiting scroll 35, and the bush assembly 37.

[0044] In the fixed scroll 33, on an inner surface (lower surface in FIG. 1) of a fixed end plate 33a fixed inside the housing 3, a fixed lap 33b, which is spiral, is formed. At a central portion of the fixed end plate 33a, a discharge hole 33c is formed.

[0045] On an inner surface (upper surface in FIG. 1) of a movable end plate 35a facing the inner surface of the fixed end plate 33a of the fixed scroll 33, a movable lap 35b, which is spiral, is formed. By the movable lap 35b of the orbiting scroll 35 engaging with the fixed lap 33b of the fixed scroll 33 with their phases shifted from

each other, a compression chamber partitioned by the respective end plates 33a and 35a and the respective laps 33b and 35b is formed. Further, in the orbiting scroll 35, on an outer surface (lower surface in FIG. 1) of the movable end plate 35a, a boss 35c, to which the eccentric pin 25 of the rotating shaft 19 is connected, to which eccentric rotation of the eccentric pin 25 is transmitted, and which is cylindrically shaped, is formed. Furthermore, the orbiting scroll 35 is caused to orbit with its rotation prevented, based on the eccentric rotation of the eccentric pin 25, by a rotation preventing mechanism 39, such as a known Oldham link, which is arranged between the outer surface of the movable end plate 35a and the upper bearing 21.

[0046] The bush assembly 37 is accommodated in the above described recessed portion 21a of the upper bearing 21, is interposed between the eccentric pin 25 of the rotating shaft 19 and the boss 35c of the orbiting scroll 35, and transmits the rotational movement of the eccentric pin 25 as orbital movement of the orbiting scroll 35. Further, the bush assembly 37 is provided to be slidingly movable in a radial direction of the eccentric pin 25 in order to maintain the engagement between the movable lap 35b of the orbiting scroll 35 and the fixed lap 33b of the fixed scroll 33. A detailed configuration of this bush assembly 37 will be described later.

[0047] In this scroll compression mechanism 7, a low pressure refrigerant introduced into the low pressure chamber 3A in the housing 3 via the inlet pipe 9 is compressed while being intaken in the compression chamber between the fixed scroll 33 and orbiting scroll 35, by the orbiting scroll 35 orbiting. The compressed high pressure refrigerant is discharged to an outer surface side of the fixed end plate 33a from the discharge hole 33c of the fixed scroll 33, opens the discharge reed valve 13b of the discharge cover 13 by its own pressure, reaches the high pressure chamber 3B from the opening hole 13a, and is discharged outside the housing 3 via the discharge pipe 11.

[0048] FIG. 2 is a plan view of the rotating shaft in the scroll fluid machine according to this embodiment. FIG. 3 is a sectional side elevation of a combination of the rotating shaft and the bush assembly in the scroll fluid machine according to this embodiment.

[0049] As illustrated in FIG. 2, in the rotating shaft 19, the eccentric pin 25, which has the eccentric center LE eccentric with respect to the shaft center CE, is formed, as described above. The eccentric pin 25 is formed so as to protrude upward from an upper end surface 19a of the rotating shaft 19. An outer shape of this eccentric pin 25, the outer shape projected in an extending direction of the shaft center CE (or eccentric center LE), is mainly formed of a first circular arc 25a, a second circular arc 25b, and a pin side slide surface 25c.

[0050] The first circular arc 25a corresponds to a range of P1 to P2 in FIG. 2, and is formed in a range of an outer shape of the rotating shaft 19, with a first radius Ra having a length exceeding a part of an outer edge 19b of the

outer shape of the rotating shaft 19, the first radius Ra having a center at a position of the eccentric center LE.

[0051] The second circular arc 25b is formed in a portion where the first radius Ra exceeds the outer edge 19b of the outer shape of the rotating shaft 19, the portion being a range of P2 to P3 in FIG. 2, with a second radius Rb having a length equal to or less than a radius R forming the outer edge 19b of the rotating shaft 19, the second radius Rb having a center at a position of the shaft center CE.

[0052] That is, in the scroll compressor 1 of this embodiment, the outer shape of the eccentric pin 25 of the rotating shaft 19 is configured to have: the first circular arc 25a formed in the range of the outer shape of the rotating shaft 19, with the first radius Ra having the length exceeding the part of the outer edge 19b of the rotating shaft 19, the first radius Ra having the center at the position of the eccentric center LE; and the second circular arc 25b formed in the portion where the first radius Ra exceeds the outer edge 19b, with the second radius Rb having the length equal to or less than the radius R forming the outer edge 19b, the second radius Rb having the center at the position of the shaft center CE.

[0053] According to this scroll compressor 1, since the outer shape of the eccentric pin 25 has the first circular arc 25a formed in the range of the outer shape of the rotating shaft 19, with the first radius Ra having the length exceeding the part of the outer edge 19b of the rotating shaft 19, the first radius Ra having the center at the position of the eccentric center LE; the outer shape of the eccentric pin 25 has a large diameter that exceeds the part of the outer edge 19b of the rotating shaft 19 and rigidity of the eccentric pin 25 is increased. As a result, bending of the eccentric pin 25 is prevented.

[0054] What is more, since the outer shape of the eccentric pin 25 has the second circular arc 25b formed in the portion where the first radius Ra exceeds the outer edge 19b, with the second radius Rb having the length equal to or less than the radius R forming the outer edge 19b, the second radius Rb having the center at the position of the shaft center CE; the outer shape of the eccentric pin 25 is prevented from going over the outer edge 19b of the rotating shaft 19. If the outer shape of the eccentric pin 25 goes over the outer edge 19b of the rotating shaft 19, processing the rotating shaft 19 requires labor with the eccentric pin 25 being an obstacle, or assembly requires labor when the rotating shaft 19 is inserted in the bearings 21 and 23 with the eccentric pin 25 being an obstacle, and such inconvenience is eliminated.

[0055] Further, in the scroll compressor 1 of this embodiment, the first radius Ra, the second radius Rb, the radius R, and a distance p between the position of the shaft center CE and the position of the eccentric center LE preferably satisfy a relation of $(Ra^2 + p^2)^{1/2} \leq Rb \leq R$.

[0056] The second circular arc 25b is formed with the second radius Rb having the length equal to or less than the radius R forming the outer edge 19b of the rotating

shaft 19, the second radius R_b having the center at the position of the shaft center CE, but if the second radius R_b becomes too much less than the radius R , the diameter of the outer shape of the eccentric pin 25 becomes too small. According to this scroll compressor 1, by setting a lower limit of the second radius R_b with the relation, $(Ra^2 + \rho^2)^{1/2} \leq R_b \leq R$, the diameter of the outer shape of the eccentric pin 25 is prevented from becoming too small. As a result, the effect of increasing the rigidity of the eccentric pin 25, and preventing the bending of the eccentric pin 25 is achieved.

[0057] FIG. 4 is a plan view of the bush assembly in the scroll fluid machine according to this embodiment.

[0058] As illustrated in FIG. 3 and FIG. 4, the bush assembly 37 includes a bush 41 and a balance weight 43.

[0059] As illustrated in FIG. 3 and FIG. 4, the eccentric pin 25 is inserted in a hole portion 41a cylindrically formed in the bush 41. The bush 41 has a contact end surface 41b, which comes into contact with the upper end surface 19a of the rotating shaft 19 when the eccentric pin 25 is inserted into the hole portion 41a. Further, the bush 41 is inserted into the boss 35c of the orbiting scroll 35, as illustrated in FIG. 3. Therefore, an outer shape of the bush 41 is circularly formed according to the cylindrical shape of the boss 35c. Between an outer peripheral surface of the bush 41 and an inner peripheral surface of the boss 35c, an orbiting bearing 45, which is cylindrical, is interposed, in order to smoothly transmit eccentric rotation of the bush 41 to the orbiting of the orbiting scroll 35.

[0060] Further, a bush side slide surface 41c facing the pin side slide surface 25c of the eccentric pin 25 is provided in an internal shape of the hole portion 41a of the bush 41. Furthermore, in the bush 41, a diameter of the internal shape of the hole portion 41a is formed more largely than that of the outer shape of the eccentric pin 25 in a direction along the radial direction of the eccentric center LE on the pin side slide surface 25c. Therefore, correspondingly with the hole portion 41a having the diameter larger than that of the outer shape of the eccentric pin 25, the bush side slide surface 41c slides along the pin side slide surface 25c, and thereby, the bush 41 is configured to be able to slidably move along the pin side slide surface 25c.

[0061] The balance weight 43 includes a connected portion 43A and a weight 43B.

[0062] The connected portion 43A is formed in a ring shape, and a hole portion 43Aa thereof is joined to an outer peripheral portion of the bush 41. As described above, since the bush 41 is inserted in the boss 35c of the orbiting scroll 35, the connected portion 43A is joined to the bush 41 at a position near the rotating shaft 19 (contact end surface 41b) in order to prevent interference between the connected portion 43A and the boss 35c of the orbiting scroll 35.

[0063] The weight 43B is provided in a portion of an outer periphery of the connected portion 43A, so as to stick out, in a direction going away from the contact end surface 41b of the bush 41 (upward in FIG. 3), in a can-

tilevered shape. As illustrated in FIG. 3 and FIG. 4, the weight 43B is arranged in a direction reverse to a direction in which the eccentric pin 25 is eccentric with respect to the rotating shaft 19, in a state where the eccentric pin 25 of the rotating shaft 19 has been inserted in and attached to the bush assembly 37. Positioning upon this arrangement of the weight 43B is performed by causing the bush side slide surface 41c of the hole portion 41a of the bush 41 to face the pin side slide surface 25c of the eccentric pin 25. That is, the bush assembly 37 is attached to be able to slidably move with respect to the eccentric pin 25 in a state of being prevented from rotating.

[0064] Further, as described above, since the bush 41 is inserted in the boss 35c of the orbiting scroll 35, the weight 43B is arranged with a gap from the bush 41, the gap allowing the boss 35c (and the orbiting bearing 45) to be inserted therethrough, and is arranged in a circular arc shape (or a fan shape) along an outer shape of the bush 41.

[0065] In the bush assembly 37 configured as described above, the rotational movement of the eccentric pin 25 is transmitted as the orbiting movement of the orbiting scroll 35; and upon this transmission, in the bush assembly 37, since the weight 43B arranged at a side opposite to the eccentricity of the eccentric pin 25 with respect to the shaft center CE rotationally moves with the eccentric pin 25, dynamic unbalance generated due to unbalanced weights of the orbiting scroll 35, the boss 35c, the orbiting bearing 45, the bush assembly 37, and the like, the dynamic unbalance associated with the orbiting motion of the orbiting scroll 35, is balanced by centrifugal force acting on the weight 43B. What is more, since the bush assembly 37 is able to slidably move with respect to the eccentric pin 25: orbiting radius of the boss 35c, in which the bush 41 has been inserted, is changed (that is, the orbiting scroll 35 is slidably moved); the respective laps 33b and 35b are caused to come into contact with each other with orbiting radius of the orbiting scroll 35 being adjusted so as to eliminate a gap between the fixed lap 33b of the fixed scroll 33 and the movable lap 35b of the orbiting scroll 35, the gap due to dimensional tolerance; and thereby generation of the gap therebetween is prevented and leakage of the fluid from the gap is prevented.

[0066] In the bush assembly 37, a moment acts in a direction, in which the whole balance weight 43 goes away from the bush 41, with the connected portion 43A being the starting point, due to the centrifugal force acting on the weight 43B. Since this moment acts on a portion joining the bush 41 and the connected portion 43A together, there is a problem that the connected portion 43A may be removed from the bush 41 or the connected portion 43A may be positionally shifted with respect to the bush 41.

[0067] Thus, in this embodiment, joining between the bush 41 and the balance weight 43 in the bush assembly 37 has been improved.

[0068] As illustrated in FIG. 3, in the scroll compressor 1 of this embodiment, the connected portion 43A is arranged to be displaced in a lengthwise direction (upward in FIG. 3) of the bush 41 with respect to the bush 41, and a stepped portion 47 is formed between the contact end surface 41b of the bush 41, the contact end surface 41b facing the upper end surface 19a of the rotating shaft 19, and a lower surface 43Ab of the connected portion 43A. In the stepped portion 47, the connected portion 43A is formed to be attached to the bush 41, such that the lower surface 43Ab of the connected portion 43A is a little separate from the upper end surface 19a of the rotating shaft 19, more than the contact end surface 41b of the bush 41. In this stepped portion 47, a joining portion 49, which joins the bush 41 and the connected portion 43A together, is provided. The joining portion 49 is formed on the lower surface 43Ab of the connected portion 43A and on a side surface of the bush 41, in the stepped portion 47, and is formed such that the joining portion 49 does not protrude towards the upper end surface 19a of the rotating shaft 19, more than the contact end surface 41b of the bush 41. The joining portion 49 is formed by laser welding. Not being limited to laser welding, the joining portion 49 may be formed by other welding.

[0069] As described above, the scroll compressor 1 of this embodiment has the bush assembly 37 including: the bush 41, into which the eccentric pin 25 is inserted, which has the contact end surface 41b that comes into contact with the end surface 19a of the rotating shaft 19, and which is inserted in the cylindrically shaped boss 35c provided at the bottom surface of the orbiting scroll 35; the balance weight 43 having the connected portion 43A and the weight 43B, the connected portion 43A arranged in the outer peripheral portion of the bush 41 and near the contact end surface 41b, and the weight 43B provided, in the cantilevered shape, in the portion of the outer periphery of the connected portion 43A, so as to stick out in the direction going away from the contact end surface 41b; the stepped portion 47 provided between the connected portion 43A and the contact end surface 41b of the bush 41; and the joining portion 49, which is provided in the stepped portion 47 and joins the bush 41 and the connected portion 43A together.

[0070] According to this scroll compressor 1, in association with the action of the centrifugal force of the weight 43B, which is provided in the portion of the outer periphery of the connected portion 43A, so as to stick out in the direction going away from the contact end surface 41b, in the cantilevered shape, the moment having the starting point at the connected portion 43A acts so that the weight 43B is rotated towards the contact end surface 41b, and in the stepped portion 47, this moment acts so that the connected portion 43A is caused to approach the bush 41. Therefore, excessive load is not applied to the joining portion 49 provided in the stepped portion 47, rigidity of the joining between the bush 41 and the connected portion 43A is increased, and removal of the connected portion 43A from the bush 41, or positional displacement of

the connected portion 43A with respect to the bush 41 is prevented.

[0071] What is more, since the joining portion 49 joining the bush 41 and the connected portion 43A together is provided in the stepped portion 47, the joining portion 49 is prevented from protruding to the contact end surface 41b of the bush 41 coming into contact with the end surface 19a of the rotating shaft 19, and thus the joining portion 49 is prevented from interfering with the end surface 19a of the rotating shaft 19 and processing of the joining portion 49 for preventing the interference is omitted. Further, since the weight 43B is provided in the direction going away from the contact end surface 41b, so as to stick out from the connected portion 43A, in the cantilevered shape, and in the stepped portion 47, the joining portion 49 is provided between the connected portion 43A and the contact end surface 41b at the side opposite to the side to which the weight 43B sticks out; regardless of the presence of the weight 43B, the joining portion 49 is provided easily.

[0072] FIG. 5 is a bottom view of the bush assembly in the scroll fluid machine according to this embodiment.

[0073] Further, in the bush assembly 37 in the scroll compressor 1 of this embodiment, the joining portion 49 may be provided on the whole circumference in a circumferential direction of the bush 41, but as illustrated in FIG. 5, the joining portion 49 is preferably provided at plural positions (three positions in FIG. 5) in the circumferential direction of the bush 41. The circumferential direction of the bush 41 refers to a circumferential direction with reference to the position of the eccentric center LE of the eccentric pin 25.

[0074] According to this scroll compressor 1, if the joining portion 49 is formed by welding, when the joining portion 49 is provided at plural positions in the circumferential direction of the bush 41, rather than being provided on the whole circumference in the circumferential direction of the bush 41, thermal deformation of the bush 41 and the connected portion 43A due to the welding heat is reduced.

[0075] Further, in the bush assembly 37 in the scroll compressor 1 of this embodiment, when the joining portion 49 is provided at plural positions in the circumferential direction of the bush 41, the joining portion 49 is preferably arranged evenly in the circumferential direction of the bush 41. In FIG. 5, the joining portion 49 is provided at three positions in the circumferential direction of the bush 41, and is evenly arranged at 120° intervals with reference to the eccentric center LE of the eccentric pin 25.

[0076] According to this scroll compressor 1, when the joining portion 49 is formed by welding, by the joining portion 49 being arranged evenly in the circumferential direction of the bush 41, even if thermal deformation of the bush 41 or the connected portion 43A due to the welding heat is caused, the thermal deformation is equalized and local deformation is prevented.

[0077] Further, in the bush assembly 37 in the scroll

compressor 1 of this embodiment, when the joining portion 49 is provided at plural positions in the circumferential direction of the bush 41, more of the positions of the joining portion 49 are preferably situated near where the weight 43B is provided. When the joining portion 49 is evenly arranged in the circumferential direction of the bush 41, as illustrated in FIG. 5, in a configuration where the joining portion 49 is provided at an odd number of positions in the circumferential direction of the bush 41, more of the positions of the joining portion 49 are situated near where the weight 43B is provided.

[0078] According to this scroll compressor 1, in association with the action of the centrifugal force of the weight 43B, the moment having the starting point at the connected portion 43A acts near where the weight 43B is provided, and thus when the joining portion 49 is provided at plural positions in the circumferential direction of the bush 41, by the positions of the joining portion 49 being situated more near where the weight 43B is provided, the effect of increasing the rigidity of the joining between the bush 41 and the connected portion 43A is achieved.

[0079] Further, preferably in the bush assembly 37 in the scroll compressor 1 of this embodiment, as illustrated in FIG. 4 and FIG. 5, an oil feeding groove 51 is provided in the outer peripheral portion of the bush 41 and along the extending direction of the cylindrical shape, and the joining portion 49 is arranged to be separate from a radial direction range of the oil feeding groove 51.

[0080] According to this scroll compressor 1, the oil feeding groove 51 is for feeding the lubricating oil to the scroll compression mechanism 7, and when the joining portion 49 is formed by welding, by the joining portion 49 being arranged separately from the radial direction range of the oil feeding groove 51, thermal deformation of the oil feeding groove 51 due to the welding heat is reduced, and the lubricating oil is fed smoothly by the oil feeding groove 51.

[0081] Further, preferably in the bush assembly 37 in the scroll compressor 1 of this embodiment, the bush 41 is formed of a sintered material, and the balance weight 43 is formed of a cast iron material.

[0082] According to this scroll compressor 1, since the bush 41 is a sliding member connected to the eccentric pin 25 of the bush 41 and the boss 35c of the orbiting scroll 35, the bush 41 is preferably formed of a sintered material having a hardness that is comparatively high. Further, since the balance weight 43 has the weight 43B, which balances the dynamic unbalance generated due to the unbalanced weights of the orbiting scroll 35, the boss 35c, the orbiting bearing 45, the bush assembly 37, and the like, in association with the orbiting motion of the orbiting scroll 35; the balance weight 43 is preferably formed of a cast iron material having a density that is comparatively high.

[0083] Further, in the bush assembly 37 in the scroll compressor 1 of this embodiment, the bush 41 and the connected portion 43A of the balance weight 43 are preferably fixed by shrinkage fitting or interference fitting.

[0084] According to this scroll compressor 1, since the bush 41 and the connected portion 43A of the balance weight 43 are fixed by shrinkage fitting or interference fitting, synergistically with the inclusion of the joining portion 49, the effect of increasing the rigidity of the joining between the bush 41 and the connected portion 43A is achieved. When the bush 41 and the connected portion 43A are joined together (when the joining portion 49 is provided), an inner diameter of the hole portion 43Aa of the connected portion 43A is formed smaller than the outer diameter of the bush 41, the bush 41 and the connected portion 43A are fitted to each other by shrinkage fitting or interference fitting, and thereafter, the joining portion 49 is formed by welding. As described above, by fitting together the bush 41 and the connected portion 43A in advance by shrinkage fitting or interference fitting, the joining portion 49 is formed by welding without causing any displacement between the bush 41 and the connected portion 43A.

[0085] Further, in the bush assembly 37 in the scroll compressor 1 of this embodiment, when the joining portion 49 is provided at plural positions in the circumferential direction of the bush 41, as illustrated in FIG. 5, the joining portion 49 is preferably arranged separately from a radial direction range of the bush side slide surface 41c.

[0086] According to this scroll compressor 1, the bush side slide surface 41c is a portion supporting sliding movement of the bush assembly 37, and when the joining portion 49 is formed by welding, by the joining portion 49 being arranged separately from the radial direction range of the bush side slide surface 41c, thermal deformation of the bush side slide surface 41c due to the welding heat is reduced, and the sliding movement of the bush assembly 37 is performed smoothly.

[0087] Further, in the scroll compressor 1 of this embodiment, the maximum number of rotations per second of the rotating shaft 19 exceeds 145 rps.

[0088] According to this scroll compressor 1, since by the above described configuration, bending of the eccentric pin 25 is reduced and the rigidity of the joining between the bush 41 and the connected portion 43A in the bush assembly 37 is increased; the scroll compressor 1 having the maximum number of rotations per second of the rotating shaft 19 exceeding 145 rps is realized.

[0089] FIG. 7 is an overall cross sectional view of another example of the scroll fluid machine according to this embodiment. FIG. 8 is a sectional side elevation of a combination of a rotating shaft and a bush assembly of the another example of the scroll fluid machine according to this embodiment. FIG. 9 is a bottom view of the bush assembly of the another example in the scroll fluid machine according to this embodiment.

[0090] In FIG. 7, as the scroll fluid machine, a scroll compressor 101, which compresses and discharges in-taken fluid, is illustrated. Further, the scroll compressor 101 is interposed in a refrigerant flow channel, through which a refrigerant is circulated in an air conditioner, a freezer, or the like, and is used, in particular, in an air

conditioner for a vehicle.

[0091] As illustrated in FIG. 7, in the scroll compressor 101, a housing 103, an inverter motor 105, a fixed scroll 133 and an orbiting scroll 135 that compress the refrigerant, a rotating shaft 119 that drives the orbiting scroll 135, and a bush assembly 137, are provided. As illustrated in FIG. 8, the fixed scroll 133, the orbiting scroll 135, and the bush assembly 137 form a scroll compression mechanism 107 driven by the inverter motor 105.

[0092] The housing 103 is a case accommodating therein the fixed scroll 133, the orbiting scroll 135, the rotating shaft 119, the inverter motor 105, and the like, and a first housing 103a, a second housing 103b, and a motor case 103c, are provided therein.

[0093] The first housing 103a is a member formed in a bottomed cylindrical shape, and the fixed scroll 133 is fixed to a bottom surface thereof. Between the fixed scroll 133 and the first housing 103a, a discharge chamber 103A, into which the refrigerant compressed by the fixed scroll 133 and the orbiting scroll 135 flows, is formed.

[0094] In the first housing 103a, a discharge portion (not illustrated) that guides the refrigerant in the discharge chamber 103A to outside, and a first flange portion 103aa, are provided. The first flange portion 103aa is used when the first housing 103a, the second housing 103b, and the motor case 103c are integrally fixed by use of a housing bolt 104, and is a member extending outward in a radial direction, at an end portion of the first housing 103a, the end portion at an opening side.

[0095] The second housing 103b is, as illustrated in FIG. 7, a member, in which a first bearing 121 cylindrically formed, and a flange portion 103ba extending outward in the radial direction from an end portion of the second housing 103b, the end portion at the first housing 103a side, are provided. The flange portion 103ba of the second housing 103b is arranged to be sandwiched between the first housing 103a and the motor case 103c.

[0096] In the first bearing 121 of the second housing 103b, a radial bearing 122 rotatably supporting the rotating shaft 119 is provided. An inlet flow channel 124 extending along the shaft center CE of the rotating shaft 119 is provided in a wall surface of the first bearing 121. Further, in the flange portion 103ba of the second housing 103b, a second flange portion 103bb, which is used when the first housing 103a, the second housing 103b, and the motor case 103c are integrally fixed by use of the housing bolt 104, is provided. The second flange portion 103bb is a member extending outward in a radial direction from the flange portion 103ba.

[0097] The motor case 103c is, as illustrated in FIG. 7, a member formed in a bottomed cylindrical shape, and a stator 115 of the inverter motor 105 is fixed inside the motor case 103c. In the motor case 103c: an inlet portion (not illustrated), into which the refrigerant flows from outside; a box 103ca; and a case flange portion 103cb, are provided.

[0098] The box 103ca opens outward in a radial direction of the motor case 103c, and an inverter unit 179 of

the inverter motor 105 is accommodated inside the box 103ca. The case flange portion 103cb is used when the first housing 103a, the second housing 103b, and the motor case 103c are integrally fixed by use of the housing bolt 104, and is a member extending outward in a radial direction, from an end portion of the motor case 103c, the end portion at the opening side.

[0099] The inverter motor 105 is a motor rotationally driven by alternating electric current subjected to frequency control, and is an electrically powered unit that orbitally drives the orbiting scroll 135. In the inverter motor 105, as illustrated in FIG. 7, a rotor 117 and the stator 115, which cause the orbiting scroll 135 to orbit via the rotating shaft 119 and the bush assembly 137, and the inverter unit 179, which controls alternating electric current supplied to the stator 115, are provided.

[0100] The rotor 117 generates rotational drive power with an alternating magnetic field formed by the stator 115, and is a permanent magnet formed cylindrically. The rotating shaft 119 is fixed to the rotor 117. The stator 115 rotates the rotor 117 by generating the alternating magnetic field, based on the alternating electric current supplied from the inverter unit 179. The stator 115 is fixed to an inner peripheral surface of the motor case 103c, by use of a fixing method, such as shrinkage fitting.

[0101] The inverter unit 179 controls the alternating electric current supplied to the stator 115, and is arranged inside the box 103ca. In the inverter unit 179, a capacitor (condenser) 181, plural substrates 185 including electronic elements, such as power transistors 183, and a terminal 187, are provided.

[0102] The capacitor 181 temporarily stores electric current. The electronic elements, such as the power transistors 183, included in the substrates 185, control frequency of alternating electric current supplied from outside. The terminal 187 supplies the alternating electric current to the stator 115. The substrate 185 including the power transistors 183 is configured to be fixed by contacting with the motor case 103c in the box 103ca, and to release heat generated from the power transistors 183 to the motor case 103c. The other substrates 185 are fixed at positions separate from the motor case 103c. In other words, the substrates 185 are fixed in a state of being layered over one another. The terminal 187 supplies the alternating electric current controlled by the power transistors 183 and the like, to the stator 115.

[0103] The inverter motor 105 may be used as the electrically powered unit as described above, but not being particularly limited thereto, any other known motor may be used as the electrically powered unit.

[0104] As illustrated in FIG. 7, the fixed scroll 133 and the orbiting scroll 135 compress the refrigerant by forming a closed compression chamber C. In the fixed scroll 133, a fixed end plate 133a, and a fixed lap 133b, which extends towards the orbiting scroll 135 from the fixed end plate 133a and is spiral, are provided. The fixed scroll 133 is fixed to a bottom surface of the first housing 103a. At a central portion of the fixed end plate 133a, a dis-

charge hole 133c is provided. The refrigerant compressed in the compression chamber C is discharged to the discharge chamber 103A via the discharge hole 133c.

[0105] In the orbiting scroll 135, a movable end plate 135a, and a movable lap 135b, which extends toward the fixed scroll 133 from the movable end plate 135a and is spiral, are provided. The orbiting scroll 135 is orbitably supported by the rotating shaft 119 and a rotation preventing portion 139. In the orbiting scroll 135, a boss 135c, which extends toward the rotating shaft 119 and is cylindrical, is provided on a surface (also referred to as "bottom surface") of the movable end plate 135a, the surface facing the rotating shaft 119. Orbital drive power by the rotating shaft 119 is transmitted to the boss 135c via the bush assembly 137.

[0106] The rotating shaft 119 is, as illustrated in FIG. 7, a member, which extends toward the orbiting scroll 135 from the inverter motor 105, and is cylindrical. With respect to the housing 103, one end portion of the rotating shaft 119 is supported by the first bearing 121, and the other end portion thereof is supported by the second bearing 123, rotatably, based on the shaft center CE extending in a horizontal direction (left-right direction in FIG. 7). The rotating shaft 119, has, as illustrated in FIG. 8, a disk portion 119A, an eccentric pin 125, and a limit hole 126.

[0107] The disk portion 119A is provided at one end of the rotating shaft 119, and has a diameter formed more largely than that of the rotating shaft 119, with the shaft center CE centered therein. This disk portion 119A is arranged inside a penetrating portion 121a formed in the first bearing 121, a peripheral surface of the disk portion 119A is supported by the bearing 122, which is fixed in the penetrating portion 121a, and the disk plate portion 119A is rotatably provided, with the shaft center CE centered therein, with respect to the first bearing 121. The eccentric pin 125 is formed in a cylindrical shape extending along the eccentric center LE eccentric with respect to the shaft center CE from an end surface 119Aa of the disk portion 119A. The limit hole 126 is a hole recessed from the end surface 119Aa of the disk portion 119A, and is formed along another eccentric center LE' eccentric with respect to the shaft center CE.

[0108] As illustrated in FIG. 8, the bush assembly 137 is accommodated in the penetrating portion 121a of the first bearing 121, is interposed between the eccentric pin 125 of the rotating shaft 119 and the boss 135c of the orbiting scroll 135, and transmits rotational movement of the eccentric pin 125 as orbital movement of the orbiting scroll 135. The bush assembly 137 includes a bush 141, a limit pin 142, and a balance weight 143.

[0109] In a circular hole portion 141a cylindrically formed in the bush 141, the eccentric pin 125 is inserted. The bush 141 has a contact end surface 141b, which comes into contact with the end surface 119Aa of the disk portion 119A of the rotating shaft 119 by the eccentric pin 125 being inserted in the circular hole portion 141a. Further, the bush 141 is inserted in the boss 135c of the

orbiting scroll 135. Therefore, an outer shape of the bush 141 is circularly formed according to the cylindrical shape of the boss 135c. Between an outer peripheral surface of the bush 141 and an inner peripheral surface of the boss 135c, an orbiting bearing 145, which is cylindrical, is interposed, in order to smoothly transmit eccentric rotation of the bush 141 to the orbiting motion of the orbiting scroll 135.

[0110] The limit pin 142 is arranged between the bush 141 and the disk portion 119A, and is a member, which adjusts, together with the limit hole 126, orbiting radius of the orbiting scroll 135, and which is cylindrical. As illustrated in FIG. 8, the limit pin 142 is provided by being fitted in a fitting hole 141c formed in the bush 141, and is provided so as to protrude from the contact end surface 141b along the eccentric center LE', to be inserted in the limit hole 126 when the eccentric pin 125 is inserted in the circular hole portion 141a of the bush 141. A gap is formed between peripheral surfaces of the limit pin 142 and the limit hole 126 when the limit pin 142 is inserted in the limit hole 126. Further, a fitting groove 142a, which is recessed, is formed over a circumferential surface of a side portion of a portion of the limit pin 142, the portion of the limit pin 142 being inserted in the limit hole 126. An elastic portion 142b is fitted in the fitting groove 142a. The limit pin 142 is not particularly limited thereto, and may be formed as a cylindrical member, or may be formed as a columnar member having another cross sectional shape.

[0111] The elastic portion 142b is a substantially cylindrical elastic member that is arranged to contact an outer peripheral surface of the limit pin 142 and an inner peripheral surface of the limit hole 126, when the elastic portion 142b has been fitted in the fitting groove 142a of the limit pin 142 and the limit pin 142 has been inserted in the limit hole 126. A material forming the elastic portion 142b is desirably rubber, which has suitability with respect to and does not swell in the refrigerant and lubricating oil of the scroll compressor 101. Specifically, hydrogenated nitrile butadiene rubber (HNBR) is an example, but correspondingly to the refrigerant and lubricating oil used, any suitable rubber may be used.

[0112] The elastic portion 142b is formed such that a diameter of an outer peripheral surface thereof is equal to or greater than a diameter of the limit hole 126, and a diameter of an inner peripheral surface thereof is equal to or less than a diameter of the limit pin 142. Over an inner peripheral surface of the elastic portion 142b, a ridge shaped convex portion, which fits in the fitting groove 142a, is provided. The elastic portion 142b at least has rigidity to support the own weight of the orbiting scroll 135 and to hold the limit pin 142 separately from the inner peripheral surface of the limit hole 126, when the orbiting scroll 135 is not being orbitally driven. However, the rigidity of the elastic portion 142b is limited to an extent where the elastic portion 142b is squashed and the limit pin 142 directly contacts the inner peripheral surface of the limit hole 126, when the orbiting scroll 135 is being

orbitally driven and the centrifugal force and reaction force due to the compression of the refrigerant are working.

[0113] An example of a relative positional relation between the circular hole portion 141a and the limit pin 142 is, as illustrated in FIG. 9, a case where the limit pin 142 is arranged in an eight o'clock direction when the circular hole portion 141a is arranged in a two o'clock direction, when the bush assembly 137 is viewed from the disk portion 119A side (left side in FIG. 7 and FIG. 8).

[0114] The balance weight 143 is a member that adjusts and balances pressing force of the orbiting scroll 135 against the fixed scroll 133. As illustrated in FIG. 8 and FIG. 9, the balance weight 143 is a brim shaped member, which extends semi-circularly, outward in a radial direction from a circumferential surface of the bush 141, the circumferential surface of the bush 141 being at the disk portion 119A side. A range in which the balance weight 143 extends is, as illustrated in FIG. 9, a range between a three o'clock direction and a nine o'clock direction when the circular hole portion 141a is arranged in the two o'clock direction, and the balance weight 143 is provided off-set in a six o'clock direction from a line passing the center of the bush 141.

[0115] The balance weight 143 includes a connected portion 143A and a weight 143B. The connected portion 143A is formed in a ring shape, and a hole portion 143Aa thereof is joined to an outer peripheral portion of the bush 141. As described above, since the bush 141 is inserted in the boss 135c of the orbiting scroll 135, the connected portion 143A is joined to the bush 141 at a position near the rotating shaft 119 (contact end surface 141b) in order to prevent interference between the connected portion 143A and the boss 135c of the orbiting scroll 135. The weight 143B is provided, in a cantilevered shape, at a portion of an outer periphery of the connected portion 143A, so as to increase in thickness and stick out in a direction going away from the contact end surface 141b.

[0116] As illustrated in FIG. 8, the rotating shaft 119 and the bush assembly 137 are combined together, such that the eccentric pin 125 is inserted in the circular hole portion 141a and the limit pin 142 is inserted in the limit hole 126. The elastic portion 142b of the limit pin 142 is inserted, together with the limit pin 142, inside the limit hole 126, and contacts the inner peripheral surface of the limit hole 126. Because of such combination, the bush assembly 137 is able to rotate in a range restricted by the limit pin 142 and the limit hole 126, with the eccentric pin 125 being the center of rotation.

[0117] When the orbiting scroll 135 is orbitally driven, the compression chamber C formed between the orbiting scroll 135 and the fixed scroll 133 takes in and compresses the refrigerant that has flown into the scroll compressor 101 from the motor case 103c. Specifically, the compression chamber C takes in the refrigerant at an outer peripheral end of the fixed scroll 133 and orbiting scroll 135. By the orbiting motion of the orbiting scroll 135, the refrigerant taken in is compressed, with volume of the com-

pression chamber C becoming smaller towards the center from the outer peripheral edge along the fixed lap 133b and the movable lap 135b. The refrigerant compressed by the compression chamber C is discharged to the discharge chamber 103A via the discharge hole 133c of the fixed scroll 133, and is discharged outside the first housing 103a from inside the discharge chamber 103A.

[0118] On the orbiting scroll 135, a centrifugal force due to the orbiting motion, and a compression reaction force of the refrigerant compressed by the compression chamber C work in a direction of enlarging the orbiting radius. By these forces, the orbiting scroll 135 and the bush assembly 137 rotate around the eccentric pin 125, and the orbiting radius is enlarged. The limit pin 142 and the limit hole 126 then approach and contact each other while squashing the elastic portion 142b. By contacting each other, the limit pin 142 and the limit hole 126 restrict the rotational range of the bush assembly 137 and the orbiting scroll 135 around the eccentric pin 125. The centrifugal force and compression reaction force working on the orbiting scroll 135 are sufficiently large to squash the elastic portion 142b, and, for example, are forces of a magnitude of about several thousand N.

[0119] In such operation, if, for example, a liquid refrigerant (hereinafter, referred to as "liquid refrigerant") is present in the compression chamber C, or if foreign matter is stuck in between the orbiting scroll 135 and the fixed scroll 133, the orbiting radius of the orbiting scroll 135 is decreased and an escape passage for the liquid refrigerant or foreign matter is formed. That is, by the liquid compression reaction force generated when the liquid refrigerant is compressed and the resistance force generated when foreign matter is stuck, the bush assembly 137, together with the orbiting scroll 135, squashes the elastic portion 142b and rotates in a direction of decreasing the orbiting radius around the eccentric pin 125. By this rotation, the escape passage between the orbiting scroll 135 and the fixed scroll 133 is formed.

[0120] When the operation of the scroll compressor 101 is stopped and the orbiting motion of the orbiting scroll 135 is stopped, the centrifugal force and the compression reaction force that have been working on the orbiting scroll 135 are eliminated, and the force increasing the orbiting radius of the orbiting scroll 135 is eliminated. The orbiting scroll 135 rotationally moves around the eccentric pin 125 due to a gravitational force working downward in a vertical direction, and the limit pin 142 and the limit hole 126 separate from each other. The elastic portion 142b, which has been squashed between the limit pin 142 and the limit hole 126 due to the centrifugal force and the like during the operation of the scroll compressor 101, separates the limit pin 142 and the limit hole 126 from each other by a force of returning to the original form from the squashed form. Further, the elastic portion 142b holds the limit pin 142 in a state separated from the limit hole 126. Although a squashing force works on the elastic portion 142b due to the gravitational force acting on the orbiting scroll 135 and the bush assembly 137, since a

magnitude of that force is about several N and is comparatively smaller than the centrifugal force and compression reaction force, the elastic portion 142b is able to hold the limit pin 142 in the state separated from the limit hole 126. Therefore, clacking noise, which is generated by the contact between the limit pin 142 and the limit hole 126 when the operation of the scroll compressor 101 is stopped, is reduced.

[0121] Further, when the operation of the scroll compressor 101 is stopped and the liquid refrigerant is present in the compression chamber C, as described above, the orbiting radius of the orbiting scroll 135 is decreased. That is, the limit pin 142 and the limit hole 126 separate from each other and the orbiting radius of the orbiting scroll 135 is decreased. When the limit pin 142 separates from a predetermined region on the inner peripheral surface of the limit hole 126 and contacts (collides) with a region at an opposite side, the shape of the elastic portion 142b is deformed and momentum upon the contact between the limit pin 142 and the limit hole 126 is reduced. Thus, clacking noise, which is generated by the contact between the limit pin 142 and the limit hole 126 when the liquid refrigerant is present in the compression chamber C, is reduced.

[0122] Further, clacking noise when the orbiting radius of the orbiting scroll 135 has not been stabilized, or when foreign matter has been stuck between the orbiting scroll 135 and the fixed scroll 133, is similarly reduced, due to the above described functions of the elastic portion 142b.

[0123] The present invention is not limited to the configuration, in which the escape passage is formed between the orbiting scroll 135 and the fixed scroll 133 by the limit pin 142 and the limit hole 126. For example, although not specifically illustrated in the drawings, without the provision of the limit pin 142 and limit hole 126, the bush assembly 137 may be made movable in a radial direction of the eccentric pin 125 by providing a gap between the circular hole portion 141a of the bush 141 in the bush assembly 137 and the eccentric pin 125, and thereby, an escape passage may be formed between the orbiting scroll 135 and the fixed scroll 133.

[0124] FIG. 6 is a plan view of a rotating shaft of another example of the scroll fluid machine according to this embodiment. As illustrated in FIG. 6, in the configuration where the gap is formed between the circular hole portion 141a of the bush 141 in the bush assembly 137 and the eccentric pin 125, an outer shape of the eccentric pin 125, the outer shape projected in the extending direction of the shaft center CE (or eccentric center LE), is mainly formed of a first circular arc 125a and a second circular arc 125b.

[0125] The first circular arc 125a corresponds to a range of P11 to P12 in FIG. 6, and is formed in a range of an outer shape of the rotating shaft 119 (the disk portion 119A, herein) with a first radius Ra having a length exceeding a part of an outer edge 119Ab of the outer shape of the disk portion 119A of the rotating shaft 119, the first radius Ra having a center at the position of the eccentric

center LE.

[0126] The second circular arc 125b is formed in a portion where the first radius Ra exceeds the outer edge 119Ab of the outer shape of the rotating shaft 119, the portion being a range of P12 to P11 in FIG. 6, with the second radius Rb having a length equal to or less than the radius R forming the outer edge 119Ab of the rotating shaft 119, the second radius Rb having a center at the position of the shaft center CE.

[0127] That is, in the scroll compressor 101 of this embodiment, the outer shape of the eccentric pin 125 of the rotating shaft 119 is configured to have: the first circular arc 125a, which is formed in the range of the outer shape of the rotating shaft 119 with the first radius Ra having the length exceeding the part of the outer edge 119Ab of the rotating shaft 119 (disk portion 119A herein), the first radius Ra having the center at the position of the eccentric center LE; and the second circular arc 125b formed in the portion where the first radius Ra exceeds the outer edge 119Ab, with the second radius Rb having the length equal to or less than the radius R forming the outer edge 119Ab, the second radius Rb having the center at the position of the shaft center CE.

[0128] According to this scroll compressor 101, since the outer shape of the eccentric pin 125 has the first circular arc 125a formed in the range of the outer shape of the rotating shaft 119, with the first radius Ra having the length exceeding the part of the outer edge 119Ab of the rotating shaft 119 (disk portion 119A herein), the first radius Ra having the center at the position of the eccentric center LE; the outer shape of the eccentric pin 125 has a large diameter that exceeds the part of the outer edge 119Ab of the rotating shaft 119 and rigidity of the eccentric pin 125 is improved. As a result, the eccentric pin 125 is prevented from being bent.

[0129] What is more, since the outer shape of the eccentric pin 125 has the second circular arc 125b formed in the portion where the first radius Ra exceeds the outer edge 119Ab, with the second radius Rb having the length equal to or less than the radius R forming the outer edge 119Ab, the second radius Rb having the center at the position of the shaft center CE, the outer shape of the eccentric pin 125 is prevented from going over the outer edge 119Ab of the rotating shaft 119. If the outer shape of the eccentric pin 125 goes over the outer edge 119Ab of the rotating shaft 119 (disk portion 119A herein), the processing of the rotating shaft 119 requires labor with the eccentric pin 125 being an obstacle in the processing, and the assembly requires labor with the eccentric pin 125 being an obstacle in inserting the rotating shaft 119 in the bearings 121 and 123, and thus such inconvenience is eliminated.

[0130] Further, in the scroll compressor 101 of this embodiment, the first radius Ra, the second radius Rb, the radius R, and the distance p between the position of the shaft center CE and the position of the eccentric center LE preferably satisfy the relation of $(Ra^2 + p^2)^{1/2} \leq Rb \leq R$.

[0131] The second circular arc 125b is formed with the

second radius R_b having the length equal to or less than the radius R forming the outer edge 119Ab of the rotating shaft 119, the second radius R_b having the center at the position of the shaft center CE, and if the second radius R_b becomes too much less than the radius R , a diameter of the outer shape of the eccentric pin 125 becomes too small. According to this scroll compressor 101, since a lower limit of the second radius R_b is set by the relation, $(Ra^2 + p^2)^{1/2} \leq R_b \leq R$, the diameter of the outer shape of the eccentric pin 125 is prevented from becoming too small. As a result, an effect of enabling the rigidity of the eccentric pin 125 to be improved, and the bending of the eccentric pin 125 to be reduced, is achieved.

[0132] In the bush assembly 137 configured as described above, a moment acts in a direction, in which the whole balance weight 143 goes away from the bush 141, with the connected portion 143A being the starting point, due to the centrifugal force acting on the weight 143B. Since this moment acts on a portion joining the bush 141 and the connected portion 143A together, there is a problem that the connected portion 143A may be removed from the bush 141 or the connected portion 143A may be positionally shifted with respect to the bush 141.

[0133] Thus, in this embodiment, joining between the bush 141 and the balance weight 143 in the bush assembly 137 is improved.

[0134] As illustrated in FIG. 8, in the scroll compressor 101 of this embodiment, the connected portion 143A is arranged displaced in a lengthwise direction (rightward in FIG. 8) of the bush 141 with respect to the bush 141, and a stepped portion 147 is formed between the contact end surface 141b of the bush 141, the contact end surface 141b facing the end surface 119Aa of the disk portion 119A of the rotating shaft 119, and an end surface 143Ab of the connected portion 143A. The stepped portion 147 is formed by the connected portion 143A being attached to the bush 141, such that the end surface 143Ab of the connected portion 143A is a little separate from the end surface 119Aa of the disk portion 119A of the rotating shaft 119 more than the contact end surface 141b of the bush 141. In this stepped portion 147, a joining portion 149, which joins the bush 141 and the connected portion 143A together, is provided. The joining portion 149 is formed on the end surface 143Ab of the connected portion 143A and on a side surface of the bush 141, in the stepped portion 147, and is formed such that the joining portion 149 does not protrude towards the end surface 119Aa of the disk portion 119A of the rotating shaft 119, more than the contact end surface 141b of the bush 141. The joining portion 149 is formed by laser welding. Not being limited to laser welding, the joining portion 149 may be formed by any other welding.

[0135] As described above, in the scroll compressor 101 of this embodiment, the bush assembly 137 includes: the bush 141, into which the eccentric pin 125 is inserted, which has the contact end surface 141b that comes into contact with the end surface 119Aa of (the disk portion 119A of) the rotating shaft 119, and which is inserted in

the cylindrically shaped boss 135c provided at the bottom surface of the orbiting scroll 135; the balance weight 143 having the connected portion 143A and the weight 143B, the connected portion 143A arranged in the outer peripheral portion of the bush 141 and near the contact end surface 141b, and the weight 143B provided, in the cantilevered shape, in the portion of the outer periphery of the connected portion 143A, so as to stick out in the direction going away from the contact end surface 141b; the stepped portion 147 provided between the connected portion 143A and the contact end surface 141b of the bush 141; and the joining portion 149, which is provided in the stepped portion 147 and joins the bush 141 and the connected portion 143A together.

[0136] According to this scroll compressor 101, in association with the action of the centrifugal force of the weight 143B, which is provided in the portion of the outer periphery of the connected portion 143A, so as to stick out in the direction going away from the contact end surface 141b, in the cantilevered shape, the moment having the starting point at the connected portion 143A acts so that the weight 143B is rotated towards the contact end surface 141b, and in the stepped portion 147, this moment acts so that the connected portion 143A is caused to approach the bush 141. Therefore, excessive load is not applied to the joining portion 149 provided in the stepped portion 147, rigidity of the joining between the bush 141 and the connected portion 143A is increased, and removal of the connected portion 143A from the bush 141, or positional displacement of the connected portion 143A with respect to the bush 141, is prevented.

[0137] What is more, since the joining portion 149 joining the bush 141 and the connected portion 143A together is provided in the stepped portion 147, the joining portion 149 is prevented from protruding to the contact end surface 141b of the bush 141 coming into contact with the end surface 119Aa of the rotating shaft 119, and thus the joining portion 149 is prevented from interfering with the end surface 119Aa of the rotating shaft 119 and processing of the joining portion 149 for preventing the interference is omitted. Further, since the weight 143B is provided in the direction going away from the contact end surface 141b, so as to stick out from the connected portion 143A, in the cantilevered shape, and in the stepped portion 147, the joining portion 149 is provided between the connected portion 143A and the contact end surface 141b at the side opposite to the side to which the weight 143B sticks out; regardless of the presence of the weight 143B, the joining portion 149 is provided easily.

[0138] Further, in the bush assembly 137 in the scroll compressor 101 of this embodiment, the joining portion 149 may be provided on the whole circumference in a circumferential direction of the bush 141, but as illustrated in FIG. 9, the joining portion 149 is preferably provided at plural positions (three positions in FIG. 9) in the circumferential direction of the bush 141. The circumferential direction of the bush 141 refers to a direction along a peripheral surface of the bush 141, with reference to a

center O of the bush 141.

[0139] According to this scroll compressor 101, if the joining portion 149 is formed by welding, when the joining portion 149 is provided at plural positions in the circumferential direction of the bush 141, rather than being provided on the whole circumference in the circumferential direction of the bush 141, thermal deformation of the bush 141 and the connected portion 143A due to the welding heat is reduced.

[0140] Further, in the bush assembly 137 in the scroll compressor 101 of this embodiment, when the joining portion 149 is provided at plural positions in the circumferential direction of the bush 141, the joining portion 149 is preferably arranged evenly in the circumferential direction of the bush 141. In FIG. 9, the joining portion 149 is provided at three positions in the circumferential direction of the bush 141, and is evenly arranged at 120° intervals with reference to the center O of the bush 141.

[0141] According to this scroll compressor 101, when the joining portion 149 is formed by welding, since the joining portion 149 is arranged evenly in the circumferential direction of the bush 141, even if thermal deformation of the bush 141 or the joining portion 143A due to the welding heat is caused, the thermal deformation is equalized and local deformation is reduced.

[0142] Further, in the bush assembly 137 in the scroll compressor 101 of this embodiment, when the joining portion 149 is provided at plural positions in the circumferential direction of the bush 141, more of the positions of the joining portion 149 are preferably situated near where the weight 143B is provided. When the joining portion 149 is evenly arranged in the circumferential direction of the bush 141, as illustrated in FIG. 9, in a configuration where the joining portion 149 is provided at an odd number of positions in the circumferential direction of the bush 141, more of the positions of the joining portion 149 are situated near where the weight 143B is provided.

[0143] According to this scroll compressor 101, in association with the action of the centrifugal force of the weight 143B, the moment having the starting point at the connected portion 143A acts near where the weight 143B is provided, and thus when the joining portion 149 is provided at plural positions in the circumferential direction of the bush 141, by more of the positions of the joining portion 149 being situated near where the weight 143B is provided, the effect of increasing the rigidity of the joining between the bush 141 and the connected portion 143A is achieved.

[0144] Further, preferably in the bush assembly 137 in the scroll compressor 101 of this embodiment, as illustrated in FIG. 9, an oil feeding groove 151 is provided in the outer peripheral portion of the bush 141 and along the extending direction of the cylindrical shape, and the joining portion 149 is arranged separately from a radial direction range of the oil feeding groove 151.

[0145] According to this scroll compressor 101, the oil feeding groove 151 is for feeding the lubricating oil to the

scroll compression mechanism 107, and when the joining portion 149 is formed by welding, by the joining portion 149 being arranged separately from the radial direction range of the oil feeding groove 151, thermal deformation of the oil feeding groove 151 due to the welding heat is reduced, and the lubricating oil is fed smoothly by the oil feeding groove 151.

[0146] Further, preferably in the bush assembly 137 in the scroll compressor 101 of this embodiment, the bush 141 is formed of a sintered material, and the balance weight 143 is formed of a cast iron material.

[0147] According to this scroll compressor 101, since the bush 141 is a sliding member connected to the eccentric pin 125 and the boss 135c of the orbiting scroll 135, the bush 141 is preferably formed of a sintered material having a hardness that is comparatively high. Further, since the balance weight 143 has the weight 143B, which balances the dynamic unbalance generated due to unbalanced weights of the orbiting scroll 135, the boss 135c, the orbiting bearing 145, the bush assembly 137, and the like, in association with the orbiting motion of the orbiting scroll 135; the balance weight 143 is preferably formed of a cast iron material having a density that is comparatively high.

[0148] Further, in the bush assembly 137 in the scroll compressor 101 of this embodiment, the bush 141 and the connected portion 143A of the balance weight 143 are preferably fixed by shrinkage fitting or interference fitting.

[0149] According to this scroll compressor 101, because the bush 141 and the connected portion 143A of the balance weight 143 are fixed by shrinkage fitting or interference fitting, synergistically with the inclusion of the joining portion 149, the effect of obtaining the rigidity of the joining between the bush 141 and the connected portion 143A is achieved. When the bush 141 and the connected portion 143A are joined together (when the joining portion 149 is provided), an inner diameter of the hole portion 143Aa of the connected portion 143A is formed smaller than the outer diameter of the bush 141, the bush 141 and the connected portion 143A are fitted to each other by shrinkage fitting or interference fitting, and thereafter, the joining portion 149 is formed by welding. As described above, by fitting together the bush 141 and the connected portion 143A in advance by shrinkage fitting or interference fitting, the joining portion 149 is formed by welding without displacement between the bush 141 and the connected portion 143A being caused.

[0150] Further, preferably in the bush assembly 137 in the scroll compressor 101 of this embodiment: the bush 141 is provided rotatably with respect to the eccentric pin 125; the limit pin 142, which is inserted in the limit hole 126 formed on the end surface 119Aa of the rotating shaft 119 and restricts the rotational range, is provided; and the joining portion 149 is arranged separately from the radial direction range of the part where the limit pin 142 is attached (the fitting hole 141c, in which the limit pin 142 is fitted).

[0151] According to this scroll compressor 101, when the joining portion 149 is formed by welding, since the joining portion 149 is arranged separately from the radial direction range of the part where the limit pin 142 is attached, thermal deformation of the part where the limit pin 142 is attached due to the welding heat is reduced, and the attachment of the limit pin 142 is prevented from being hindered.

[0152] In the above described scroll compressor 101, the configuration, in which the limit hole 126 is formed on the end surface 119Aa of the rotating shaft 119 and the limit pin 142 is attached to the bush 141, is adopted, but limitation is not made thereto. Although not illustrated specifically in the drawings, the limit pin 142 may be attached to the end surface 119Aa of the rotating shaft 119 and the limit hole 126 may be formed in the bush 141.

[0153] In this case, preferably in the bush assembly 137 in the scroll compressor 101 of this embodiment: the bush 141 is provided rotatably with respect to the eccentric pin 125; the limit hole 126, in which the limit pin 142 is fixed to the end surface 119Aa of the rotating shaft 119 is inserted and which restricts the rotational range, is provided; and the joining portion 149 is arranged separately from a radial direction range of a part where the limit hole 126 is formed.

[0154] According to this scroll compressor 101, when the joining portion 149 is formed by welding, since the joining portion 149 is arranged separately from the radial direction range of the part where the limit hole 126 is formed, thermal deformation of the part where the limit hole 126 is formed due to the welding heat is reduced, and accuracy of the rotational range restricted by the limit hole 126 is prevented from being reduced.

[0155] Further, in the scroll compressor 101 of this embodiment, the maximum number of rotations per second of the rotating shaft 119 exceeds 145 rps.

[0156] According to this scroll compressor 101, by the above described configuration, bending of the eccentric pin 125 is reduced, and rigidity of the joining between the bush 141 and the connected portion 143A in the bush assembly 137 is increased, and thus the scroll compressor 101 having the maximum number of rotations per second of the rotating shaft 119 exceeding 145 rps is realized.

[0157] The scroll fluid machine is not limited to the scroll compressor 1 or 101, and may be a scroll expander. Although not illustrated specifically in the drawings, in a scroll expander, which is a scroll fluid machine, an orbiting scroll engaging with a fixed scroll is caused to orbit by compressed fluid, causing the fluid to expand and causing rotational drive power to be generated in a rotating shaft. That is, the above described configurations of the eccentric pin 25 or 125 of the rotating shaft 19 or 119 and configuration of the bush assembly 37 or 137 of the scroll compression mechanism 7 or 107 are also applicable to the scroll expander.

Reference Signs List

[0158]

5	1, 101	SCROLL COMPRESSOR (SCROLL FLUID MACHINE)
	3, 103	HOUSING
	19, 119	ROTATING SHAFT
	19a, 119Aa	UPPER END SURFACE (END SURFACE)
10	19b, 119Ab	OUTER EDGE
	25, 125	ECCENTRIC PIN
	25a, 125a	FIRST CIRCULAR ARC
	25b, 125b	SECOND CIRCULAR ARC
15	25c	PIN SLIDE SURFACE
	33, 133	FIXED SCROLL
	35, 135	ORBITING SCROLL
	35c, 135c	BOSS
	37, 137	BUSH ASSEMBLY
20	41, 141	BUSH
	41b, 141b	CONTACT END SURFACE
	41c	BUSH SIDE SLIDE SURFACE
	43, 143	BALANCE WEIGHT
	43A, 143A	CONNECTED PORTION
25	43Aa, 143Aa	HOLE PORTION
	43B, 143B	WEIGHT
	47, 147	STEPPED PORTION
	49, 149	JOINING PORTION
	51, 151	OIL FEEDING GROOVE
30	CE	SHAFT CENTER
	LE	ECCENTRIC CENTER
	R	RADIUS
	Ra	FIRST RADIUS
	Rb	SECOND RADIUS
35	ρ	DISTANCE

Claims

- 40 1. A scroll fluid machine (1, 101), comprising:
- 45 a fixed scroll (31) fixed to a housing (3, 103);
an orbiting scroll (35) that is configured to engage with the fixed scroll (31) and is configured to be orbitally movable;
a rotating shaft (19, 119) that is configured to be supported rotatably with respect to the housing (3, 103) and has an eccentric pin (25, 125) eccentric with respect to a shaft center (CE); and
50 a bush (41, 141) that is interposed between the eccentric pin (25, 125) and the orbiting scroll (35) and is configured to transmit rotational movement of the eccentric pin (25, 125) as orbital movement of the orbiting scroll (35), wherein
- 55 an outer shape of the eccentric pin (25, 125) has: a first circular arc (25a, 125a) formed in a range of an outer shape of the rotating shaft (19, 119), with a first

- radius (Ra) having a length exceeding a part of an outer edge (19b, 119Ab) of the rotating shaft (19, 119), the first radius (Ra) having its center at a position of an eccentric center (LE); and a second circular arc (25b, 125b) formed in a portion where the first radius (Ra) exceeds the outer edge (19b, 119Ab), with a second radius (Rb) having a length equal to or less than a radius (R) forming the outer edge (19b, 119Ab), the second radius (Rb) having its center at a position of the shaft center (CE).
2. The scroll fluid machine (1, 101) according to claim 1, wherein the first radius (Ra), the second radius (Rb), the radius (R), and a distance (p) between the position of the shaft center (CE) and the position of the eccentric center (LE) satisfy a relation of $(Ra^2 + p^2)^{1/2} \leq Rb \leq R$.
 3. The scroll fluid machine (1, 101) according to claim 1 or 2, having a bush assembly (37, 137), the bush assembly (37, 137) comprising:
 - a bush (41, 141), into which the eccentric pin (25, 125) is inserted, which has a contact end surface (41b, 141b) that is configured to come into contact with an end surface (19a, 119a) of the rotating shaft (19, 119), and which is configured to be inserted in a boss (35c, 135c) that is provided at a bottom surface of the orbiting scroll (35) and that is cylindrically shaped;
 - a balance weight (43, 143) that has a connected portion (43A, 143A) arranged in an outer peripheral portion of the bush (41, 141) and near the contact end surface (41b, 141b), and a weight (43B, 143B) provided, in a cantilevered shape, in a portion of an outer periphery of the connected portion (43A, 143A), so as to stick out in a direction of going away from the contact end surface (41b, 141b);
 - a stepped portion (47, 147) provided between the connected portion (43A, 143A) and the contact end surface (41b, 141b) of the bush (41, 141); and
 - a joining portion (49, 149) that is provided in the stepped portion (47, 147) and joins the bush (41, 141) and the connected portion (43A, 143A) together.
 4. The scroll fluid machine (1, 101) according to claim 3, wherein in the bush assembly (37, 137), the joining portion (49, 149) is provided at plural positions in a circumferential direction of the bush (41, 141).
 5. The scroll fluid machine (1, 101) according to claim 4, wherein in the bush assembly (37, 137), the joining portion (49, 149) is evenly arranged in the circumferential direction of the bush (41, 141).
 6. The scroll fluid machine (1, 101) according to claim 4 or 5, wherein in the bush assembly (37, 137), more of the positions of the joining portion (49, 149) are situated near where the weight (43B, 143B) is provided.
 7. The scroll fluid machine (1, 101) according to any one of claims 4 to 6, wherein in the bush assembly (37, 137), an oil feeding groove (51, 151) is provided along an extending direction of a cylindrical shape, on an outer peripheral portion of the bush (41, 141), and the joining portion (49, 149) is arranged separately from a radial direction range of the oil feeding groove (51, 151).
 8. The scroll fluid machine (1, 101) according to any one of claims 3 to 7, wherein in the bush assembly (37, 137), the bush (41, 141) is formed of a sintered material, and the balance weight (43, 143) is formed of a cast iron material.
 9. The scroll fluid machine (1, 101) according to any one of claims 3 to 8, wherein in the bush assembly (37, 137), the bush (41, 141) and the connected portion (43A, 143A) of the balance weight (43, 143) are fixed by shrinkage fitting or interference fitting.
 10. The scroll fluid machine (1) according to any one of claims 4 to 9, wherein the bush assembly (37) is configured to slidably move with respect to the eccentric pin (25), by a bush side slide surface (41c), which comes into contact with a pin side slide surface (25c) provided on a side portion of the eccentric pin (25), being provided on an inner peripheral portion of the bush (41), and the joining portion (49) is arranged separately from a radial direction range of the bush side slide surface (41c).
 11. The scroll fluid machine (1, 101) according to any one of claims 1 to 10, wherein the rotating shaft (19, 119) is configured to reach a maximum number of rotations per second exceeding 145 rps.

FIG.1

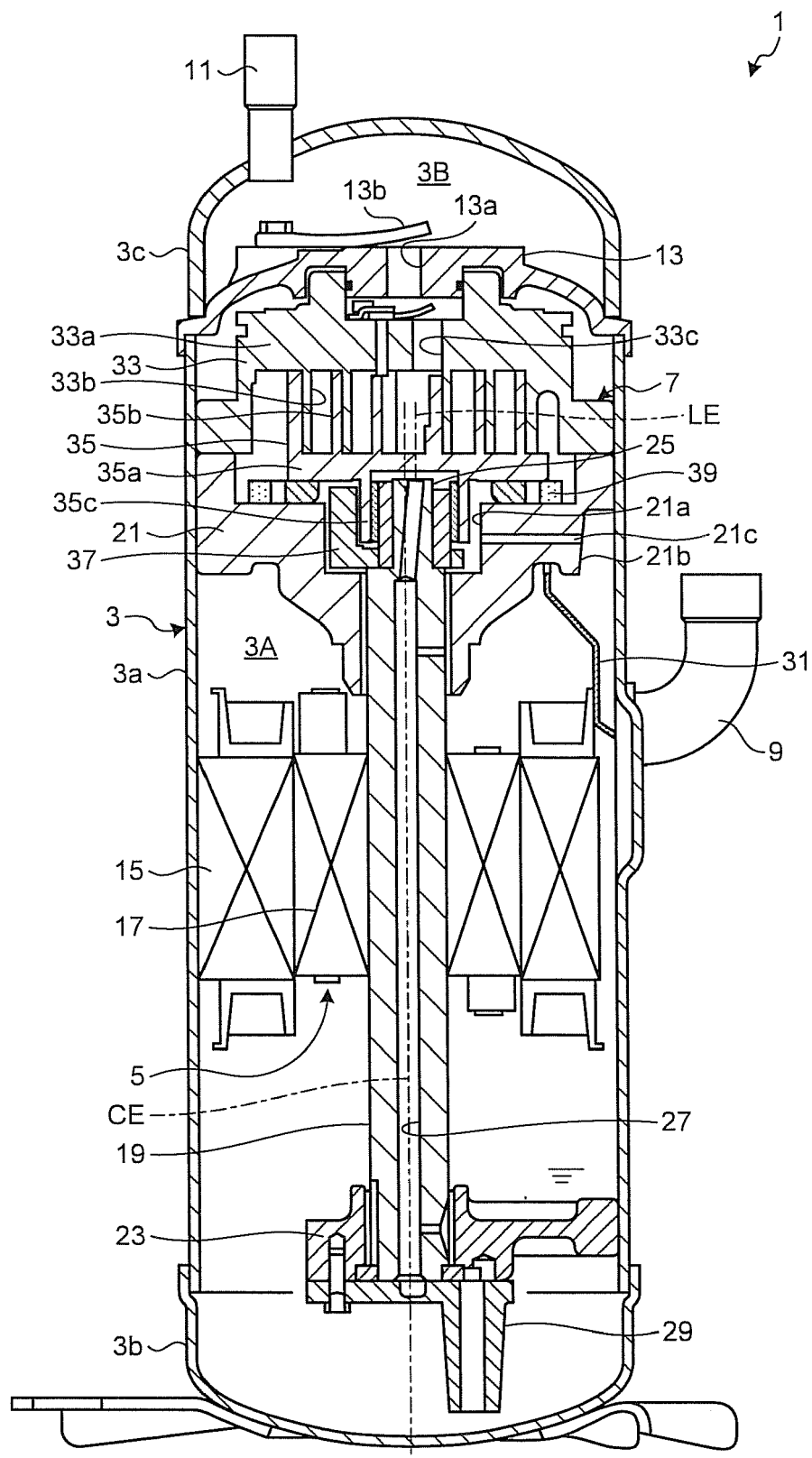


FIG.2

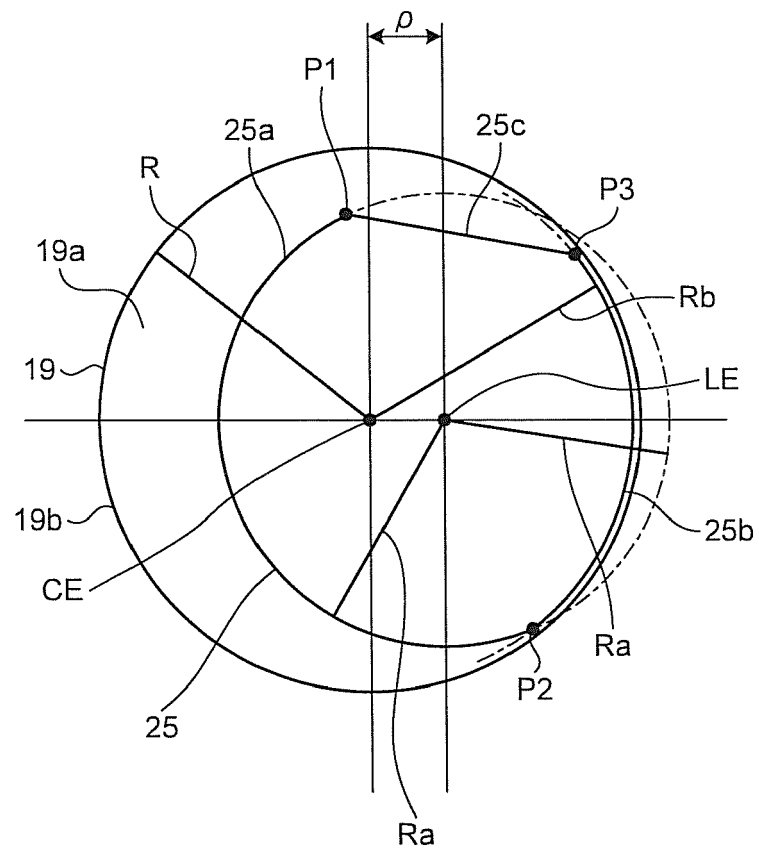


FIG.3

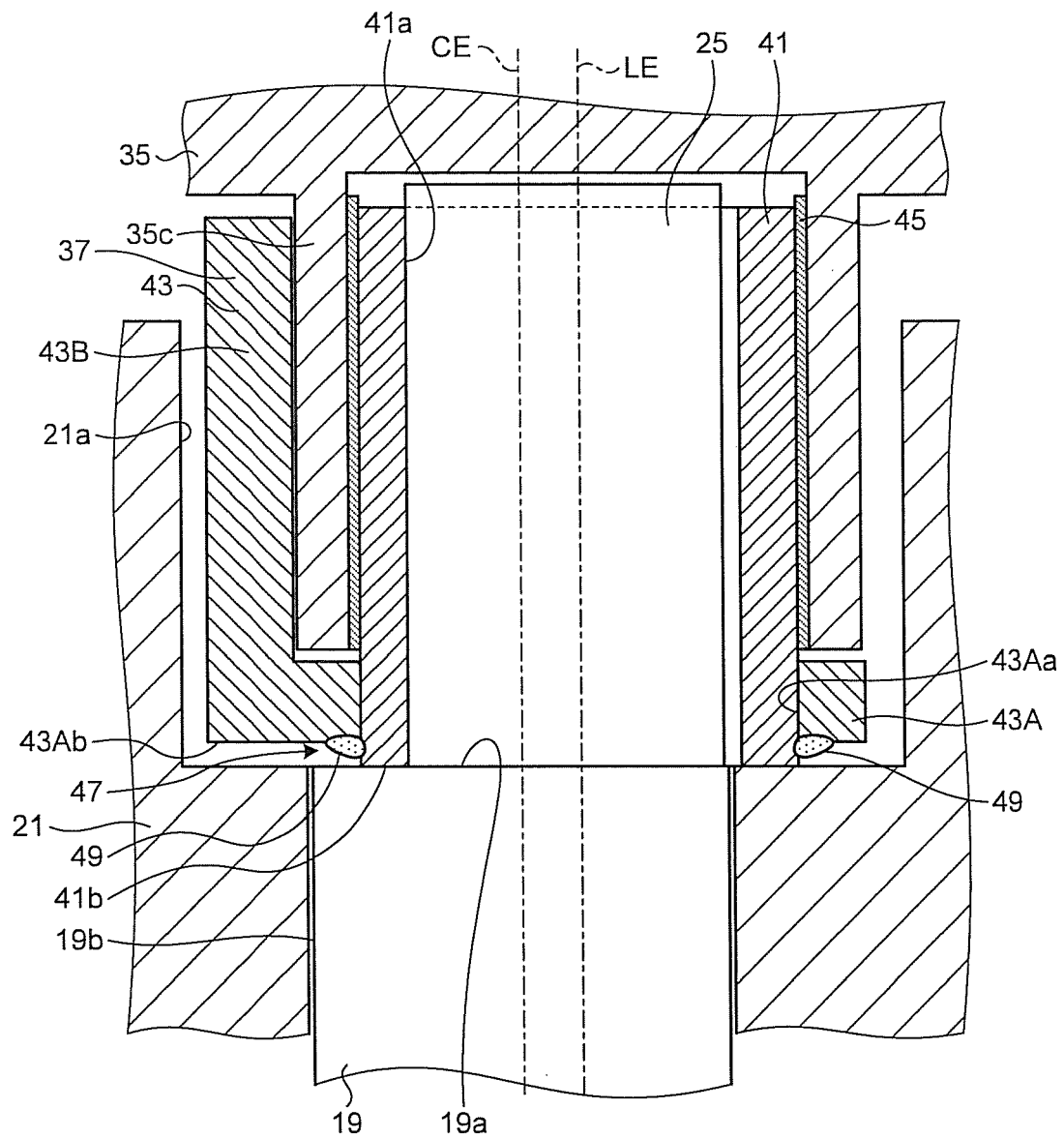


FIG.4

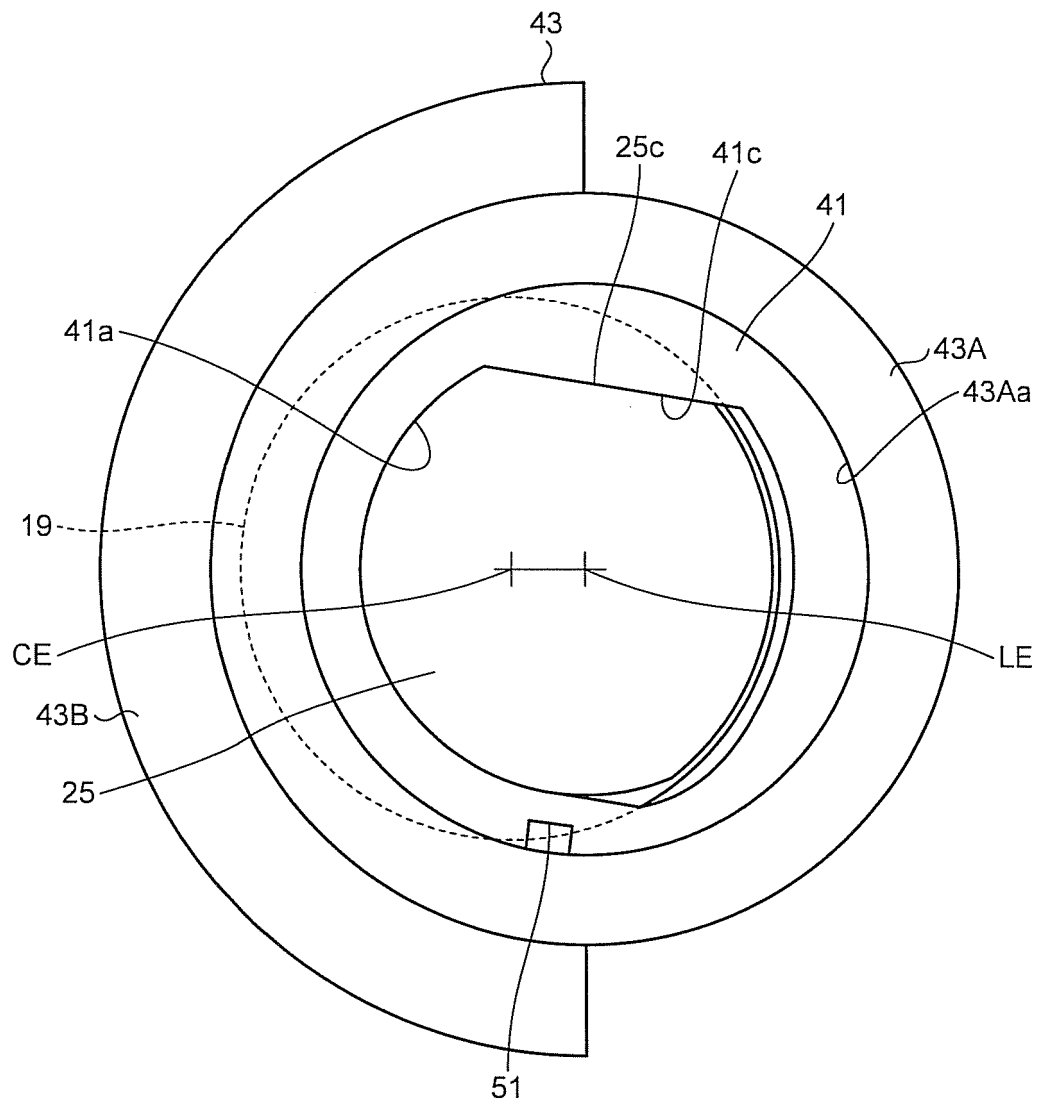


FIG.5

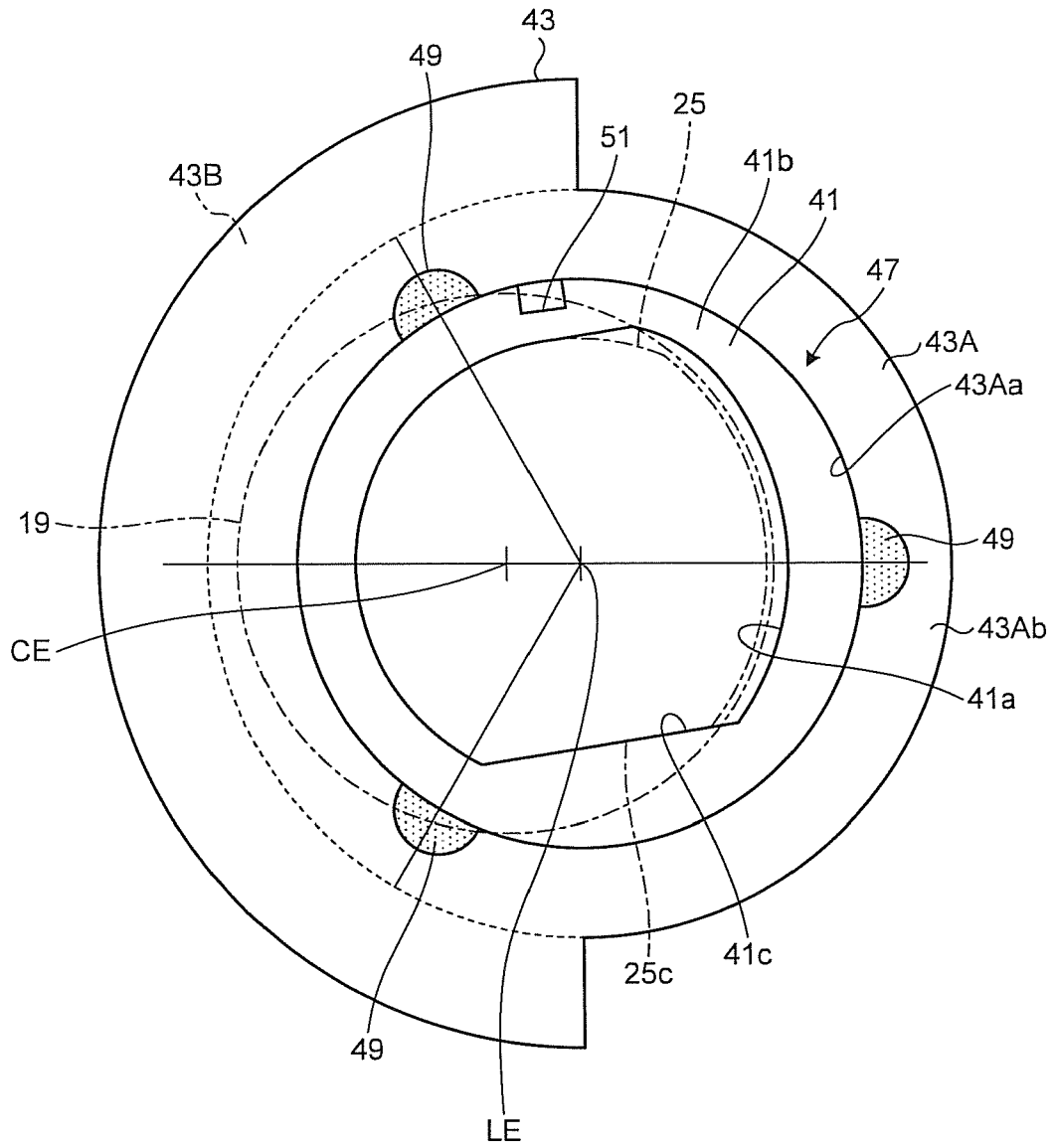


FIG.6

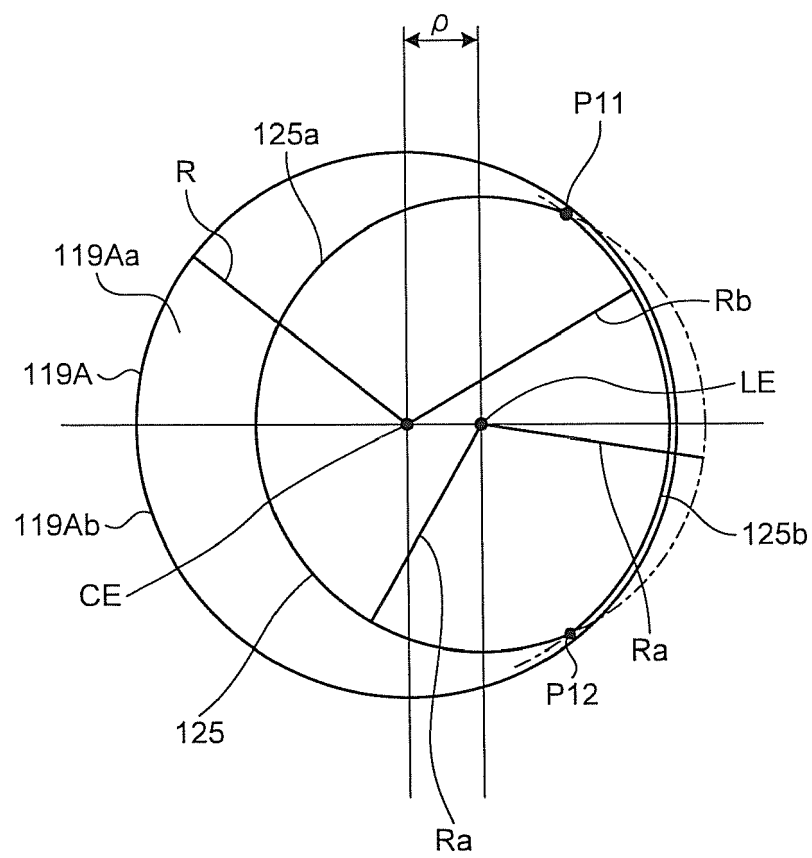


FIG. 7

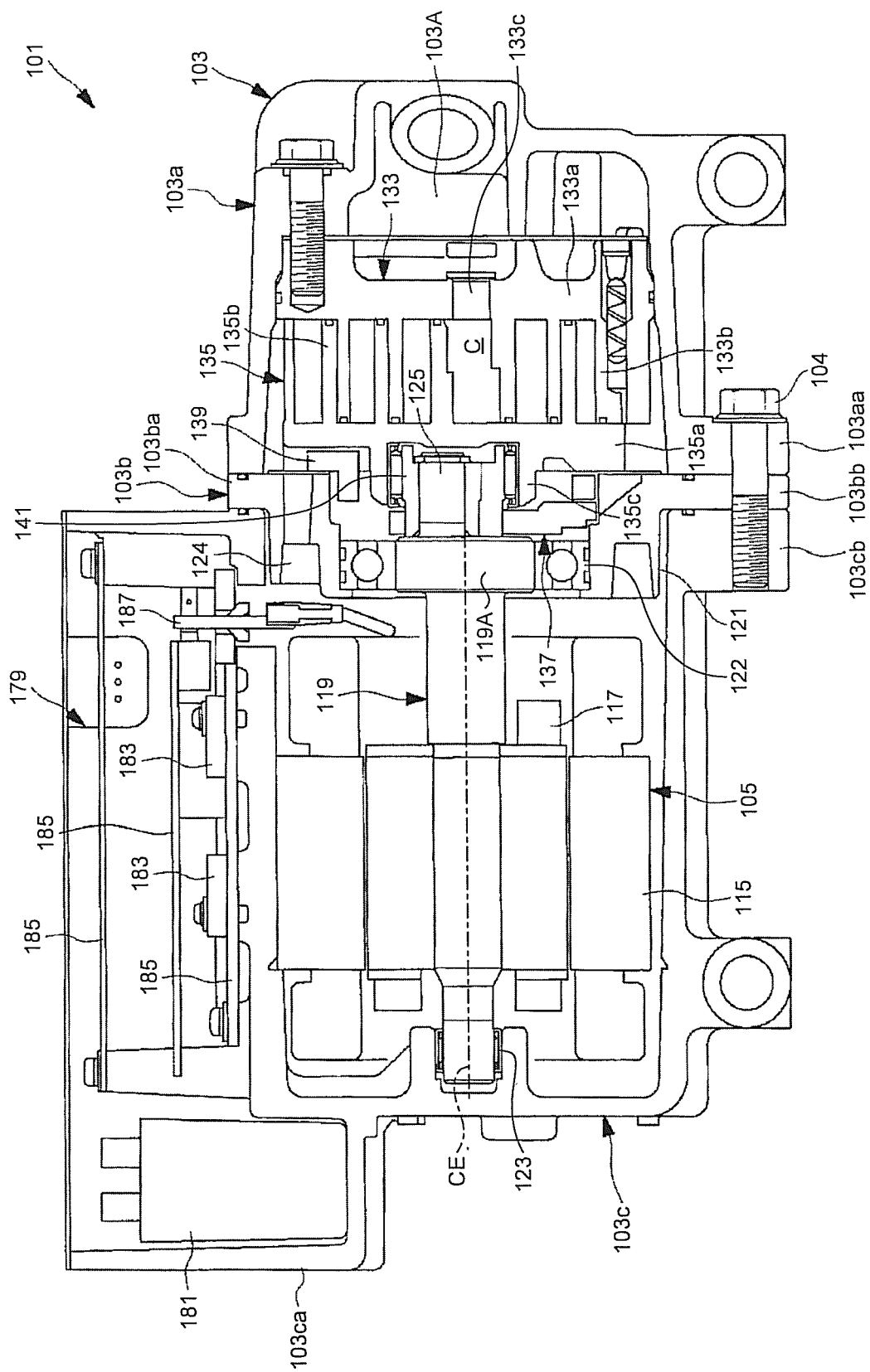


FIG.8

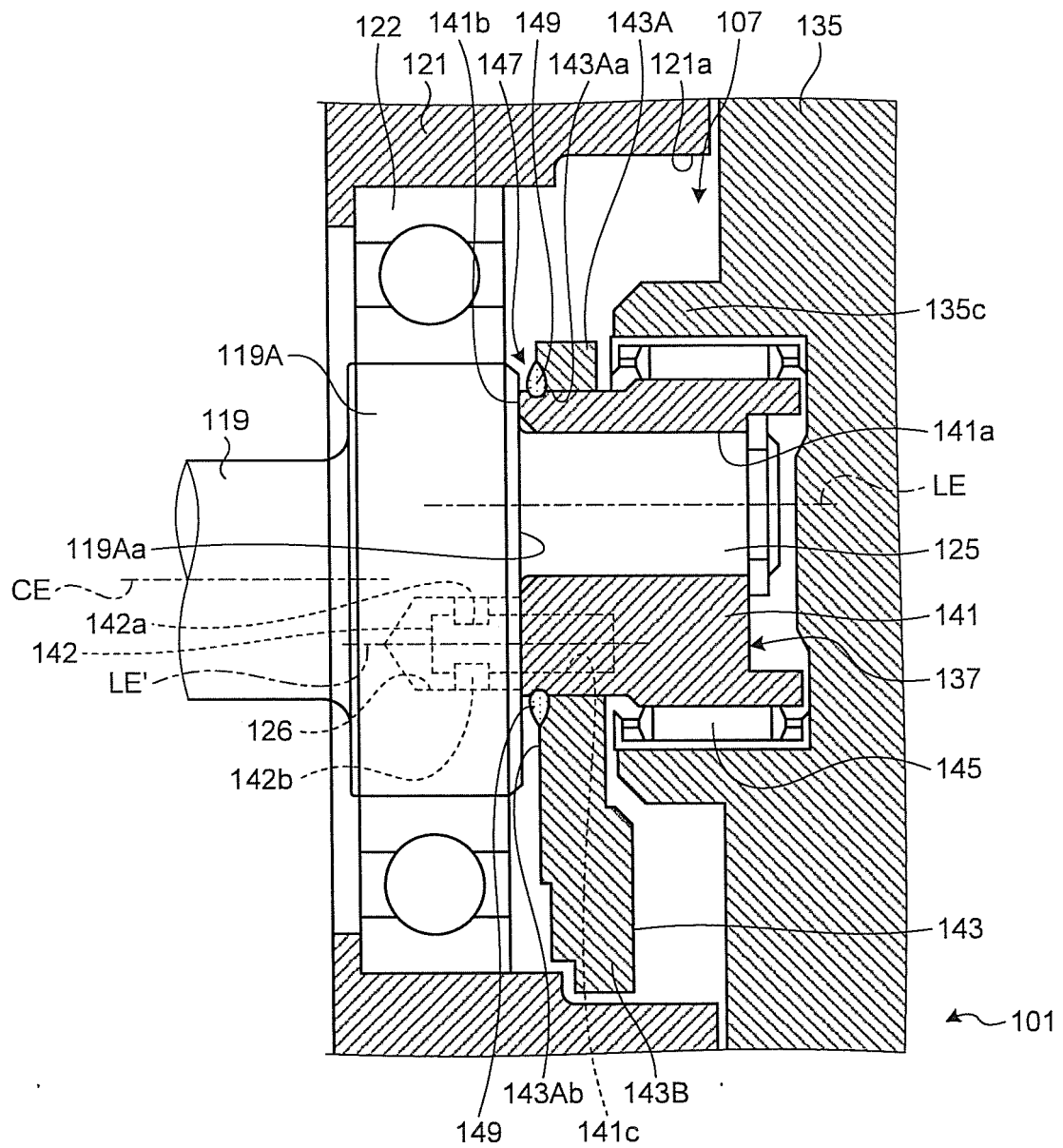
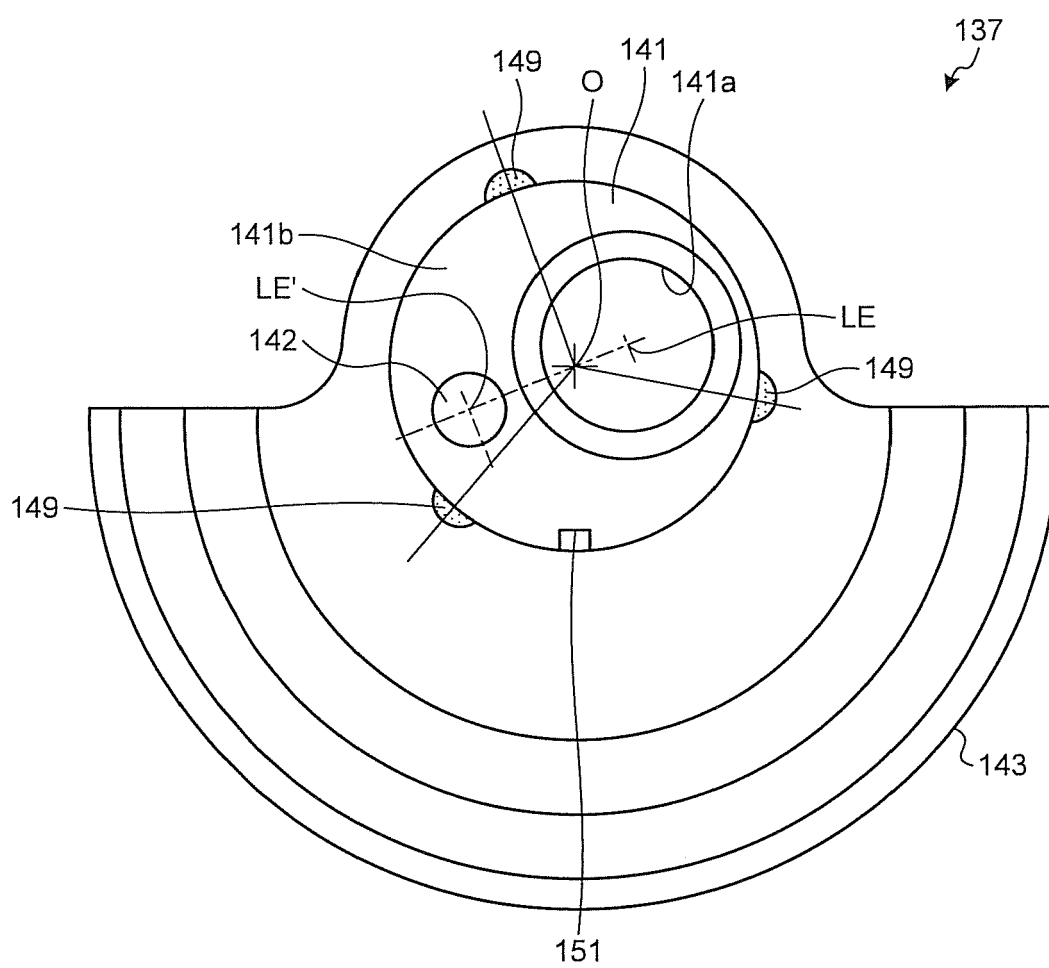


FIG.9





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Application Number
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