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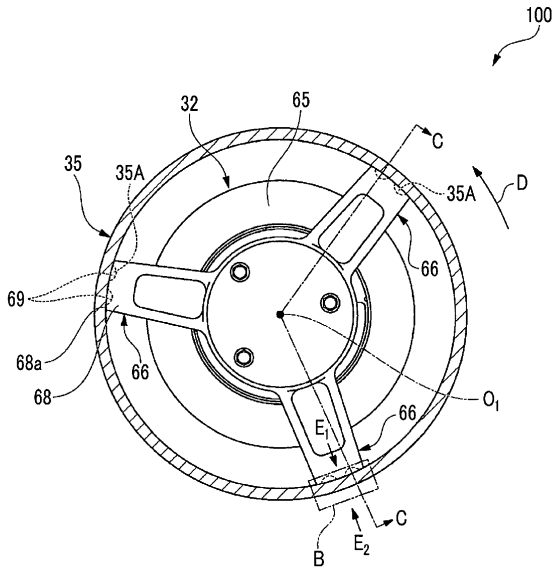
(54) ROTARY MACHINE

(57) The present invention is provided with: a housing including a tubular side wall section (35) and a plurality of protruding sections (35A) provided to the inner side of the side wall section (35); and a first radial bearing (32) that is accommodated within the housing and that includes a bearing main body (65) and extending sections (66) which extend in a direction from the bearing main body (65) toward the side wall section (35) to reach the inner side of the side wall section (35). The plurality of protruding sections (35A) and a plurality of recessed sections (69) are disposed in a direction intersecting the radial direction D and the thrust direction of a rotating shaft and/or a radial direction D, and the protruding sections (35A) are thermocompression bonded to the plurality of recessed sections (69).

FIG. 2



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Description

Technical Field

[0001] The present invention relates to a rotary machine including a housing that accommodates a rotating shaft, and a radial bearing that rotatably supports the rotating shaft and is thermocompression bonded to an inner side of the housing.

[0002] Priority is claimed on Japanese Patent Application No. 2016-020978, filed February 5, 2016, the content of which is incorporated herein by reference.

Background Art

[0003] In the related art, as one of rotary machines including a housing that accommodates a rotating shaft, and a radial bearing that rotatably supports the rotating shaft and is thermocompression bonded to an inner side of the housing, there is, for example, a scroll compressor.

[0004] The scroll compressor may have a housing including a plurality of protruding sections accommodated within recessed sections disposed in a thrust direction of the rotating shaft, and a radial bearing that is disposed side by side in the thrust direction and includes a plurality of recessed sections. In the scroll compressor having such a configuration, the radial bearing is fixed to the housing by thermocompression bonding the housing corresponding to formation regions of the plurality of protruding sections and the radial bearing corresponding to formation regions of the plurality of recessed sections to each other to bring the plurality of recessed sections into close contact with the protruding sections of the housing. In addition, in the following description, portions in which the thermocompression bonding occurs are referred to as thermocompression-bonded sections.

[0005] In the related art, as a method of bringing the protruding sections and the recessed sections into close contact with each other, there is, for example, a caulking fastening method disclosed in PTL 1.

Citation List

Patent Literature

[0006] [PTL 1] Japanese Unexamined Patent Application Publication No. 3-99731

Summary of Invention

Technical Problem

[0007] Meanwhile, in a case where the plurality of recessed sections provided at a radial shaft are thermocompression bonded to the plurality of protruding sections provided at the housing, a tensile residual stress in the thrust direction between the thermocompression-bonded sections is generated. In this way, if a thrust force is applied in the thrust direction between the thermocompression-bonded sections by the rotating shaft in a state where the residual stress is generated, there is a concern that cracking may occur in a portion of the housing where the residual stress is generated.

[0008] Thus, the invention provides a rotary machine capable of suppressing damage of a housing resulting from a thrust force of a rotating shaft in a structure in which the housing and a radial bearing are thermocompression bonded to each other.

Solution to Problem

[0009] A rotary machine related to a first aspect of the invention includes a rotating shaft that rotates around an axis; a housing that includes a tubular side wall section and a plurality of protruding sections provided to an inner side of the side wall section and accommodates the rotating shaft; and a radial bearing that is accommodated within the housing and includes a bearing main body which rotatably supports the rotating shaft and an extending section which extends in a direction from the bearing main body toward the side wall section to reaches the inner side of the side wall section of the housing. The extending section includes a plurality of recessed sections that accommodate the protruding sections and are thermocompression bonded to the protruding sections. The plurality of protruding section and the plurality of recessed sections are disposed side by side in a direction intersecting a radial direction and a thrust direction of the rotating shaft and/or in the radial direction.

[0010] According to the invention, by disposing the plurality of recessed sections and the plurality of protruding sections that are thermocompression bonded to each other in the direction intersecting the radial direction and the thrust direction of the rotating shaft and/or the radial direction, it is possible to generate the residual stress resulting from the thermocompression bonding in a direction that intersects and/or is orthogonal to a direction (thrust direction) in which a thrust force generated by the rotating shaft is applied. Accordingly, damage of the housing resulting from the thrust force of the rotating shaft can be suppressed. In addition, the thermocompression bonding in the invention means a state where the recessed sections are respectively fitted into the protruding sections, in a compressed state after heating.

[0011] Additionally, in the rotary machine related to the aspect of the above invention, a plurality of the extending sections may be provided in a state where the extending sections are separated from each other in the radial direction.

[0012] In this way, the damage of the housing resulting from the thrust force of the rotating shaft can be suppressed even in a case where the plurality of extending sections are provided in a state where the extending sections are separated from each other in the radial direction.

[0013] Additionally, in the rotary machine related to the aspect of the above invention, at least some recessed

sections and at least some protruding sections among the plurality of recessed sections and the plurality of protruding sections may be disposed at positions which pass through a gravity center of the radial bearing in the thrust direction of the rotating shaft and through which an imaginary plane orthogonal to the thrust direction passes.

[0014] By adopting such a configuration, the resistance against the force applied in the rotational direction of the shaft orthogonal to the thrust direction when the thrust force is applied can be enhanced compared to a case where the plurality of recessed sections and the plurality of protruding sections are disposed not to pass through the imaginary plane.

[0015] Additionally, in the rotary machines related to the aspect of the above invention, the plurality of recessed sections and the plurality of protruding sections may be disposed at positions passing through the imaginary plane.

[0016] By adopting such a configuration, the resistance against the force applied in the rotational direction of the shaft orthogonal to the thrust direction when the thrust force is applied can be further enhanced.

[0017] Additionally, in the rotary machine related to the aspect of the invention, a shape of the protruding sections and the recessed sections may be a shape that extends in the direction intersecting the thrust direction and the radial direction.

[0018] In this way, by making the protruding sections and the recessed sections extend in the direction intersecting the thrust direction and the radial direction to increase the contact area between the protruding sections and the recessed sections, concentration of a residual stress resulting from the thermocompression bonding occurring between the protruding sections and between the recessed sections can be relaxed. Additionally, since it is possible to enhance the adhesion between the housing and the radial bearing as the contact area between the protruding sections and the recessed sections increases, shifting of the position of the radial bearing with respect to the housing when the thrust force is received can be suppressed. Moreover, the resistance against the radial force resulting from the rotation of the rotating shaft as well as the thrust force can be enhanced.

[0019] Additionally, in the rotary machine related to the aspect of the invention, the plurality of recessed sections may be configured such that projected areas of the respective recessed sections in the thrust direction are equal to each other, and projected areas of the respective recessed sections in the radial direction are equal to each other, and the plurality of protruding sections may be configured such that projected areas of the respective protruding sections in the thrust direction are equal to each other, and projected areas of the respective protruding sections in the radial direction are equal to each other.

[0020] By adopting such a configuration, the resistance against the radial force resulting from the rotation of the rotating shaft as well as the thrust force can be further enhanced.

[0021] Additionally, in the rotary machine related to the aspect of the above invention, the plurality of protruding sections and the plurality of recessed sections may include different shapes.

[0022] The damage of the housing resulting from the thrust force of the rotating shaft can be suppressed even in the case of such a configuration.

Advantageous Effects of Invention

[0023] According to the invention, it is possible to suppress the damage of the housing resulting from the thrust force of the rotating shaft in the structure in which the housing and the radial bearing are thermocompression bonded to each other.

Brief Description of Drawings

[0024]

Fig. 1 is a partial sectional view of a rotary machine related to a first embodiment of the invention.

Fig. 2 is a partial sectional view, as seen from A, of only a first radial bearing and a side wall section of a housing illustrated in Fig. 1.

Fig. 3 is a side view, as seen from E_1, of the side wall section surrounded by a region B illustrated in Figs. 1 and 2.

Fig. 4 is a side view, as seen from E_2, of an extending section surrounded by the region B illustrated in Figs. 1 and 2.

Fig. 5 is a side view of the side wall section and the extending section for illustrating a first modification example of a plurality of protruding sections and a plurality of recessed sections.

Fig. 6 is a side view of the side wall section and the extending section for illustrating a second modification example of the plurality of protruding sections and the plurality of recessed sections.

Fig. 7 is a side view of a portion of a side wall section and a portion of a second radial bearing, which constitute a rotary machine related to a second embodiment of the invention, and is a view seen from the outside of the side wall section and from the side.

Fig. 8 is a side view of the side wall section and the extending section for illustrating the first modification example of the plurality of protruding sections and the plurality of recessed sections.

Fig. 9 is a side view of the side wall section and the extending section for illustrating the second modification example of the plurality of protruding sections and the plurality of recessed sections.

Fig. 10 is a side view of the side wall section and the extending section for illustrating a third modification example of the plurality of protruding sections and the plurality of recessed sections.

Fig. 11 is a side view of the side wall section and the extending section for illustrating a fourth modification

example of the plurality of protruding sections and the plurality of recessed sections.

Description of Embodiments

[0025] Hereinafter, embodiments to which the invention is applied will be described in detail with reference to the drawings. In addition, the drawings used in the following description is for illustrating the configuration of the embodiments of the invention, and the sizes, thicknesses, dimensions, and the like of respective sections that are illustrated may be different from the actual dimensional relationship of a rotary machine.

[First Embodiment]

[0026] Fig. 1 is a partial sectional view of a rotary machine related to a first embodiment of the invention. In Fig. 1, a scroll compressor is illustrated as an example of the rotary machine 10. A cutting position of Fig. 1 corresponds to line C-C illustrated in Fig. 2 to be described below. In Fig. 1, D represents a radial direction (hereinafter referred to as "a radial direction D") of a rotating shaft 23, O_1 represents an axis (hereinafter referred to as "an axis O_1") of the rotating shaft 23, and O_2 represents an eccentric axis (hereinafter referred to as "an eccentric axis O_2") passing through the center of an eccentric shaft 25 parallel to the axis O_1.

[0027] Additionally in Fig. 1, an X direction represents a direction parallel to an imaginary plane F (a plane that passes through a gravity center G of a first radial bearing 32 and is orthogonal to the Z direction) and orthogonal to a Y direction and a Z direction, a Y direction represents a direction parallel to the imaginary plane F and orthogonal to the Z direction, and the Z direction represents a thrust direction of the rotating shaft 23. Moreover, only one extending sections 73 among a plurality of extending sections 73 of a second radial bearing 34 is illustrated in Fig. 1.

[0028] Fig. 2 is a partial sectional view, as seen from A, of only the first radial bearing and a side wall section of a housing illustrated in Fig. 1. In Fig. 2, for the sake of convenience, only the side wall section 35 is illustrated in a state where the side wall section is cut at the imaginary plane F illustrated in Fig. 1. In Fig. 2, the same components as those of a structure illustrated in Fig. 1 are denoted by the same reference signs.

[0029] Referring to Figs. 1 and 2, the rotary machine 10 has a housing 11, a suction pipe 13, a discharge pipe 14, a discharge cover 16, a discharge valve 18, a discharge chamber 19, a compressor main body 21, a compression space 22, the rotating shaft 23, the eccentric shaft 25, a driving motor 26, a bush assembly 28, a support plate 29, an oil supply pump 31, the first radial bearing 32, an Oldham ring 33, and the second radial bearing 34.

[0030] Fig. 3 is a side view, as seen from E_1, of the side wall section surrounded by a region B illustrated in Figs. 1 and 2. In Fig. 3, for convenience of description, the extending sections 66 are illustrated by dotted lines. In Fig. 3, the same components as those of the structure illustrated in Figs. 1 and 2 are denoted by the same reference signs.

[0031] Referring to Figs. 1 to 3, the housing 11 has the side wall section 35, an upper cover section 36, and a lower cover section 38. The side wall section 35 is a tubular member that extends in the Z direction. An upper end and a lower end of the side wall section 35 are open ends. The side wall section 35 has a plurality of protruding sections 35A disposed in the radial direction D.

[0032] The plurality of protruding sections 35A protrude in a direction toward the extending sections 66. The plurality of protruding sections 35A are disposed such that the imaginary plane F passes through center positions of the protruding sections 35A. The plurality of protruding sections 35A are provided in portions, to which the plurality of extending sections 66 constituting the first radial bearing 32 are thermocompression bonded, in an inner side of the side wall section 35. Two protruding sections 35A are provided at a portion that faces one extending section 66. The shape of the plurality of protruding sections 35A may be, for example, a shape obtained by cutting a portion of a sphere. In this case, the shape of the plurality of protruding sections 35A becomes a circular shape in a state as seen from E_1 (refer to Fig. 3).

[0033] The above thermocompression bonding means a state where the protruding sections 35A are respectively fitted into the recessed sections 69 to be described below, in a compressed state after heating. Additionally, in the following description, portions in which the protruding sections 35A and the recessed sections 69 are thermocompression bonded to each other may be referred to thermocompression-bonded sections. Additionally, a tensile residual stress resulting from the thermocompression bonding is generated between the thermocompression-bonded sections.

[0034] The upper cover section 36 is provided at the upper end of the side wall section 35 via the discharge cover 16 disposed at an open end on the upper end side of the side wall section 35. The lower cover section 38 is provided at the lower end of the side wall section 35 so as to cover the open end on the lower end side of the side wall section 35.

[0035] The suction pipe 13 is provided at the side wall section 35. The suction pipe 13 is a pipe for suctioning refrigerant gas serving as a working fluid into the housing 11 from the outside. The discharge pipe 14 is provided at the upper end of the upper cover section 36. The discharge pipe 14 discharges the refrigerant gas brought into a high-pressure state within the discharge chamber 19 after being compressed by the compressor main body 21.

[0036] The discharge cover 16 is provided between the upper cover section 36 and the upper end of the side wall section 35. The discharge cover 16 is a substantially disk-shaped member that defines a space formed within

the housing 11 in a direction of the axis O_1 of the rotating shaft 23 (thrust direction). The discharge cover 16 has a discharge port 41, allowing communication of the refrigerant gas after compression with the discharge chamber 19, at a central section thereof.

[0037] The discharge valve 18 is provided on the discharge cover 16. The discharge valve 18 is disposed such that a portion thereof face the discharge port 41. The discharge valve 18 is configured to be capable of opening and closing the discharge port 41. The discharge chamber 19 is a space defined by the upper cover section 36 and the discharge cover 16.

[0038] The compressor main body 21 has a fixed scroll 43 and an orbiting scroll 45. The fixed scroll 43 is accommodated within the housing 11. The fixed scroll 43 is fixed to the first radial bearing 32 with bolts or the like via a flange section 52.

[0039] The fixed scroll 43 has a disk-shaped end plate 47, a fixed wrap 49, an outer peripheral wall 51, and the flange section 52. The end plate 47 extends in a planar direction orthogonal to the axis O_1, The end plate 47 has projecting sections on an upper surface thereof. Upper ends of the projecting sections are connected to the discharge cover 16. A fixed scroll discharge port 47A passing through the end plate 47 is formed at a central section of the end plate 47.

[0040] The fixed wrap 49 is erected in the direction of the axis O_1 from one surface of the end plate 47. The fixed wrap 49 is a wall that is spirally formed as seen from the direction of the axis O_1, More specifically, the fixed wrap 49 is constituted of a plate-shaped member wound around the center of the end plate 47. It is preferable that the fixed wrap 49 is configured to form, for example, an involute curve centered on the axis O_1 as seen from the direction of the axis O_1.

[0041] The outer peripheral wall 51 s provided radially outward of the fixed wrap 49. The outer peripheral wall 51 extends in a tubular shape with respect to a lower side of the end plate 47 along an outer periphery of the end plate 47. The flange section 52 is provided at a lower end of the outer peripheral wall 51. The flange section 52 is an annular member that widens from a radial inner side of the rotating shaft toward a radial outer side thereof. The flange section 52 is fixed to the first radial bearing 32 with bolts or the like.

[0042] The orbiting scroll 45 has a disk-shaped end plate 55, a spiral orbiting wrap 57, a boss section 58, and a bearing 59. The end plate 55 is disposed under the fixed scroll 43 so as to face a lower surface of the fixed scroll 43. A lower surface side of the end plate 55 is supported by the first radial bearing 32.

[0043] The orbiting wrap 57 is provided on an upper surface side of the end plate 55. The orbiting wrap 57 extends in the Z direction from the upper surface of the end plate 55. The orbiting wrap 57 is disposed so as to overlap mutually in a direction intersecting the axis O_1, In other words, the fixed wrap 49 and the orbiting wrap 57 mesh with each other. In this way, a constant space is formed between the fixed wrap 49 and the orbiting wrap 57 as the fixed wrap 49 and the orbiting wrap 57 mesh with each other. The volume of the space varies with the orbiting of the orbiting wrap 57. This makes it possible to compress the refrigerant gas. It is desirable that the orbiting wrap 57 is configured to form, for example, an involute curve.

[0044] The boss section 58 is formed in a cylindrical shape, and is provided on the lower surface side of the end plate 55. The boss section 58 projects toward the lower side (Z direction) of the end plate 55. The boss section 58 is disposed so as to face the eccentric shaft 25. A central axis of the boss section 58 is coaxial with an axis O_2. The eccentric shaft 25 formed at the rotating shaft 23 is fitted to an inner space of the boss section 58 from the direction of the axis O_1 via the bush assembly 28.

[0045] The bearing 59 is provided inside the boss section 58. The bearing 59 is disposed between a bush 62 to be described below and the boss section 58.

[0046] The compressor main body 21 having the above configuration compresses the working fluid with the rotational energy obtained by the driving motor 26, and discharges the working fluid to the outside in a high-pressure pressure state. The high-pressure working fluid is used as, for example, a refrigerant in an air conditioner or the like.

[0047] The compression space 22 is a space formed between the fixed scroll 43 and the orbiting scroll 45. The rotating shaft 23 is accommodated within the housing 11, and extends in the Z direction. The rotating shaft 23 is rotatably supported by the first and second radial bearings 32 and 34. The shape of the rotating shaft 23 may be formed, for example, in a columnar shape. In addition, lubricating oil is supplied from an oil supply pump 80 to the rotating shaft 23. The lubricating oil lubricates between the bush 62 of the bush assembly 28 and the bearing 59 of the orbiting scroll 45, then moves downward within the housing 11, and is then recovered.

[0048] The eccentric shaft 25 is provided at an upper end of the rotating shaft 23. The eccentric shaft 25 is disposed such that the eccentric axis O_2 that is a position (made eccentric) offset with respect to the axis O_1 coincides with the center position of the eccentric shaft 25. The eccentric shaft 25 extends in the Z direction. The shape of the eccentric shaft 25 may be formed, for example, in a columnar shape. The eccentric shaft 25 revolves around the axis O_1 of the rotating shaft 23 in a state where the rotating shaft 23 rotates around the axis O_1.

[0049] The driving motor 26 is disposed around the rotating shaft 23 located between the first radial bearing 32 and the second radial bearing 34. The driving motor 26 rotates the rotating shaft 23 in the radial direction D. The rotational energy generated by the driving motor 26 is immediately transmitted to the compressor main body 21 via the rotating shaft 23.

[0050] The bush assembly 28 is provided between the eccentric shaft 25 and the first radial bearing 32. The

bush assembly 28 has the bush 62.

[0051] The support plate 29 is provided at a position that faces a lower end of the rotating shaft 23. The support plate 29 supports the lower end of the rotating shaft 23 via a thrust bearing. A space is formed between the support plate 29 and the lower cover section 37. The oil supply pump 31 is provided on a lower surface side of the support plate 29. The oil supply pump 31 supplies the lubricating oil to the rotating shaft 23.

[0052] Fig. 4 is a side view, as seen from E_2, of an extending section surrounded by the region B illustrated in Figs. 1 and 2. In Fig. 4, the same components as those of the structure illustrated in Fig. 1 and 2 are denoted by the same reference signs.

[0053] Referring to Figs. 1, 2, and 4, the first radial bearing 32 is accommodated within the housing 11, and is thermocompression bonded to the housing 11. The first radial bearing 32 has a bearing main body 65 and a plurality of (three as an example, in the case of the drawing) extending sections 66. The bearing main body 65 is disposed so as to face an outer peripheral side surface of an upper end section of the rotating shaft 23. The bearing main body 65 rotatably supports the rotating shaft 23.

[0054] The plurality of extending sections 66 are provided outside the bearing main body 65, and are integrated with the bearing main body 65. The plurality of extending sections 66 are disposed at predetermined intervals in the radial direction D. The extending sections 66 extend in a direction from the bearing main body 65 toward the side wall section 35 of the housing 11, and reach the inner side of the side wall section 35 of the housing 11. Each extending section 66 has an extending section main body 68 and a plurality of recessed sections 69 (two in the case of Figs. 2 and 4). The extending section main body 68 extends in the direction from the bearing main body 65 toward the side wall section 35 of the housing 11. The extending section main body 68 has a surface 68a that faces an inner surface of the side wall section 35.

[0055] The plurality of recessed sections 69 are portions thermocompression bonded to the protruding sections 35A formed in the side wall section 35. The plurality of recessed sections 69 are provided in the surface 68a of the extending section main body 68, and are disposed in the radial direction D. The shape of the plurality of recessed sections 69 is a shape that is in contact with entire inner surfaces of the protruding sections 35A, in a state where the first radial bearing 32 is thermocompression bonded to the side wall section 35. For example, in a case where the shape illustrated in Fig. 3 is used as the shape of the protruding sections 35A, the shape of the plurality of recessed sections 69 may be a shape obtained by cutting a portion of a sphere at a plane.

[0056] Referring to Fig. 1, the Oldham ring 33 is provided on the first radial bearing 32. The Oldham ring 33 has a function of restricting the rotation (rotation around the eccentric axis O_2) of the orbiting scroll 45. The Oldham ring 33 has a projection (not illustrated) fitted into a groove formed in the end plate 55 of the orbiting scroll 45.

[0057] The second radial bearing 34 has a bearing main body 72 and the plurality of extending sections 73 (only one is illustrated in Fig. 1). The bearing main body 72 is disposed so as to face an outer peripheral side surface of a lower end section of the rotating shaft 23. The bearing main body 72 rotatably supports the rotating shaft 23.

[0058] The plurality of extending sections 73 are provided outside the bearing main body 72, and are integrated with the bearing main body 72. The plurality of extending sections 73 are disposed at predetermined intervals in the radial direction D. The extending sections 73 extend in a direction from the bearing main body 72 toward the side wall section 35 of the housing 11, and reach the inner side of the side wall section 35 of the housing 11. The extending sections 73 are thermocompression bonded to the housing 11.

[0059] According to the rotary machine 10 of the first embodiment, by disposing the plurality of recessed sections 69 and the plurality of protruding sections 35 that are thermocompression bonded to each other in the radial direction D of the rotating shaft 23, it is possible to generate the residual stress resulting from the thermocompression bonding in a direction orthogonal to a direction (thrust direction) in which a thrust force generated by the rotating shaft 23 is applied. Accordingly, damage of the housing 11 resulting from the thrust force of the rotating shaft 23 can be suppressed.

[0060] Additionally, by disposing the plurality of recessed sections 69 and the plurality of protruding sections 35A at positions passing through the imaginary plane F, resistance against a force applied in a rotational direction of a shaft orthogonal to the thrust direction when the thrust force is applied can be further enhanced.

[0061] Moreover, by making the shapes of the plurality of recessed sections 69 the same shape and a shape obtained by cutting a sphere and making and the shapes of the plurality of protruding sections 35A the same shape and a shape corresponding to the shape of the recessed sections 69, it is possible to make the projected area of each of the plurality of recessed sections 69 in the thrust direction and the projected area of the recessed section in the radial direction D equal to each other, and it is possible to make the projected area of each of the plurality of protruding sections 35A in the thrust direction and the projected area of the protruding section in the radial direction D equal to each other. Accordingly, resistance against a radial force resulting from the rotation of the rotating shaft 23 as well as the thrust force can be enhanced.

[0062] In addition, a case where the plurality of recessed sections 69 are provided only in the first radial bearing 32 has been described as an example in Fig. 1. However, if necessary, the plurality of recessed sections 69 may also be provided in the plurality of extending sections 73 of the second radial bearing 34, and the protruding sections 35A may be provided inside the housing 11

that are in contact with the plurality of recessed sections 69 provided in the plurality of extending sections 73.

[0063] Fig. 5 is a side view of the side wall section and the extending section for illustrating a first modification example of the plurality of protruding sections and the plurality of recessed sections. Fig. 5 is a view seen from the outside of the housing 11 and from the side. In Fig. 5, the same components as those of the structure illustrated in Fig. 3 and 4 are denoted by the same reference signs.

[0064] In the first embodiment, a case where the plurality of protruding sections 35A and the plurality of recessed sections 69 are disposed in the radial direction D has been described as an example. For example, as illustrated in Fig. 5, the plurality of protruding sections 35A and the plurality of recessed sections 69 may be disposed in a direction intersecting the radial direction D and the thrust direction (an extending direction of the axis O_1). By disposing the plurality of protruding sections 35A and the plurality of recessed sections 69 at such positions, in a structure where the housing 11 and the first radial bearing 32 are thermocompression bonded to each other, the damage of the housing 11 resulting from the thrust force of the rotating shaft 23 can be suppressed, and resistance against the radial force can be enhanced. Additionally, in this case, the plurality of protruding sections 35A and the plurality of recessed sections 69 may be disposed at position near the imaginary plane F.

[0065] In addition, in the first embodiment, a case where the three extending sections 66 are provided has been described as an example. However, the number of extending sections 66 may be one or more, and is not limited to three. In addition, in a case where one extending section, a ring-shaped extending section may be provided.

[0066] Additionally, in the first embodiment, a case where the shapes of the plurality of protruding sections 35A are the same shape and the shapes of the plurality of recessed sections 69 are the same shape has been described as an example. However, for example, the shapes of the plurality of protruding sections 35A may be made from each other and the shapes of the plurality of recessed sections 69 may be made from each other. The damage of the housing 11 resulting from the thrust force of the rotating shaft 23 can be suppressed even in the case of such a configuration.

[0067] Moreover, in the first embodiment, a case where the plurality of protruding sections 35A and the plurality of recessed sections 69 are disposed such that such that the imaginary plane F passes through some of the plurality of protruding sections 35A and the plurality of recessed sections 69. However, the plurality of protruding sections 35A and the plurality of recessed sections 69 may be disposed at positions shifted from the imaginary plane F. In this case, it is preferable that the plurality of protruding sections 35A and the plurality of recessed sections 69 are disposed in the vicinity of the imaginary plane F.

[0068] Fig. 6 is a side view of the side wall section and the extending section for illustrating a second modification example of the plurality of protruding sections and the plurality of recessed sections. Fig. 6 is a view seen from the outside of the housing 11 and from the side. In Fig. 6, the same components as those of the structure illustrated in Fig. 3 and 4 are denoted by the same reference signs.

[0069] As illustrated in Fig. 6, in a case where a plurality of, specifically, four protruding sections 35A and a plurality of, specifically, four recessed sections 69 are respectively provided, one pair of (two) a protruding section 35A and a recessed section 69 may be disposed in the radial direction D, and the other pair of (two) a protruding section 35A and a recessed section 69 may be disposed in the direction intersecting the radial direction D and the thrust direction (the extending direction of the axis O_1). Even in this case, the same effects as those of the rotary machine 10 of the first embodiment can be obtained. Moreover, in a case where four or more protruding sections 35A and four or more recessed sections 69 are provided, the four or more protruding sections 35A and the four or more recessed sections 69 may be disposed in the direction intersecting the radial direction D and the thrust direction (Z direction).

[0070] Additionally, in a case where the four or more recessed sections 69 and the four or more protruding sections 35A are disposed, at least some recessed sections 69 and at least some protruding sections 35A may be disposed so as to pass through the imaginary plane F.

[0071] By disposing the four or more recessed sections 69 and the four or more protruding sections 35A at such positions, the resistance against the force applied in the rotational direction of the shaft orthogonal to the thrust direction when the thrust force is applied can be enhanced compared to a case where the plurality of recessed sections 69 and the plurality of protruding sections 35A are disposed not to pass through the imaginary plane F.

[Second Embodiment]

[0072] Fig. 7 is a side view of a portion of a side wall section and a portion of a second radial bearing, which constitute a rotary machine related to a second embodiment of the invention, and is a view seen from the outside of the side wall section and from the side. In Fig. 7, the same components as those of a structure illustrated in Figs. 1 to 4 are denoted by the same reference signs.

[0073] Referring to Fig. 7, the rotary machine related to the second embodiment of the invention has the same configuration as the rotary machine 10 except for having a side wall section 75 and a first radial bearing 76, instead of the side wall section 35 and the first radial bearing 32 provided at the rotary machine 10 of the first embodiment.

[0074] The side wall section 75 has the same configuration as the side wall section 35 except for having a plurality of protruding sections 78 disposed in the radial

direction D instead of the plurality of protruding sections 35A constituting the side wall section 35. The plurality of protruding sections 78 has the same configuration except that protruding sections 78 are different in shape from the plurality of protruding sections 35A described in the first embodiment. That is, similar to the plurality of protruding sections 35A, the plurality of protruding sections 78 are disposed such that center positions thereof pass through the imaginary plane F. Additionally, two protruding sections 78 are provided at two portions that face one extending section 81 constituting the first radial bearing 76.

[0075] The shape of the plurality of protruding sections 78 is formed in a shape that extends in the direction intersecting the thrust direction (the direction in which the axis O_1 extends) and the radial direction D. The shape of the plurality of protruding sections 78 is formed in a shape (round shape) that is rounded at both ends thereof. Although it is preferable that an angle formed by the extending direction (longitudinal direction) of the plurality of protruding sections 78 and the imaginary plane F is for example, 45°, it is possible to appropriately set the angle.

[0076] The first radial bearing 76 has the same configuration as the first radial bearing 32 except for having a plurality of recessed sections 83 disposed in the radial direction D, instead of the plurality of recessed sections 69 constituting the first radial bearing 32. The plurality of recessed sections 83 has the same configuration except that recessed sections 83 are different in shape from the plurality of recessed sections 69 described in the first embodiment. That is, similar to the plurality of recessed sections 69, the plurality of recessed sections 83 are disposed such that center positions thereof pass through the imaginary plane F.

[0077] The plurality of recessed sections 83 are portions thermocompression bonded to the protruding sections 78 formed in the side wall section 75. In addition, in the following description, portions in which the recessed sections 83 and the protruding sections 78 are thermocompression bonded to each other may be referred to as thermocompression-bonded sections. The plurality of recessed sections 83 are provided in the surface 68a of the extending section main body 68, and are disposed in the radial direction D. The plurality of recessed sections 83 are provided at positions where the protruding sections 78 are capable of being accommodated. The shape of the plurality of recessed sections 83 is a shape that is in contact with entire inner surfaces of the protruding sections 78, in a state where the first radial bearing 76 is thermocompression bonded to the side wall section 75. That is, the shape of the plurality of recessed sections 83 is formed in a shape that extends in the direction intersecting the thrust direction (the direction in which the axis O_1 extends) and the radial direction D.

[0078] According to the rotary machine of the second embodiment, by making the plurality of protruding sections 78 and the plurality of recessed sections 83 extend in the direction intersecting the thrust direction and the radial direction D to increase the contact area between the protruding sections 78 and the recessed sections 83, concentration of a residual stress resulting from the thermocompression bonding occurring between the thermocompression-bonded sections can be relaxed.

[0079] Additionally, since it is possible to enhance the adhesion between the side wall section 75 and the first radial bearing 76 as the contact area between the protruding sections 78 and the recessed sections 83 increases, shifting of the position of the first radial bearing 76 with respect to the side wall section 75 when the thrust force is received can be suppressed.

[0080] Moreover, by making the plurality of protruding sections 78 and the plurality of recessed sections 83 extend in the direction intersecting the thrust direction and the radial direction D, resistance against the radial force resulting from the rotation of the rotating shaft rotating as well as the thrust force can be enhanced.

[0081] Additionally in the second embodiment, the plurality of recessed sections 83 may be configured such that the projected areas of the respective recessed sections 83 in the thrust direction are equal to each other, the projected areas of the respective recessed sections 83 in the radial direction D are equal to each other, and the plurality of protruding sections 78 are configured such that the projected areas of the respective protruding sections 78 in the thrust direction are equal to each other, and the projected areas of the respective protruding sections 78 in the radial direction D are equal to each other. Accordingly, the resistance against the radial force resulting from the rotation of the rotating shaft as well as the thrust force can be further enhanced.

[0082] Fig. 8 is a side view of the side wall section and the extending section for illustrating a first modification example of the plurality of protruding sections and the plurality of recessed sections. Fig. 8 is a view seen from the outside of the side wall section 75 and from the side. In Fig. 8, the same components as those of a structure illustrated in Fig. 7 are denoted by the same reference signs.

[0083] In the second embodiment, a case where the plurality of protruding sections 78 and the plurality of recessed sections 83 are disposed in the radial direction D has been described as an example. For example, as in the first modification example illustrated in Fig. 8, the plurality of protruding sections 78 and the plurality of recessed sections 83 may be disposed in the direction intersecting the radial direction D and the thrust direction (the extending direction of the axis O_1). By disposing the plurality of protruding sections 78 and the plurality of recessed sections 83 at such positions, in a structure where the side wall section 75 and the first radial bearing 76 are thermocompression bonded to each other, the damage of the housing resulting from the thrust force of the rotating shaft can be suppressed, and the resistance against the radial force can be enhanced. Additionally, in this case, the plurality of protruding sections 78 and the plu-

rality of recessed sections 83 may be disposed such that the imaginary plane F passes through some of the plurality of protruding sections 78 and the plurality of recessed sections 83.

[0084] Fig. 9 is a side view of the side wall section and the extending section for illustrating a second modification example of the plurality of protruding sections and the plurality of recessed sections. Fig. 8 is a view seen from the outside of the side wall section 75 and from the side. In Fig. 8, the same components as those of a structure illustrated in Fig. 7 are denoted by the same reference signs.

[0085] In Fig. 8 described earlier, a case where the imaginary plane F passes through some of the plurality of protruding sections 78 and some of the plurality of recessed sections 83 in the radial direction D has been described as an example. However, as in the second modification example illustrated in Fig. 9, the plurality of protruding sections 78 and the plurality of recessed sections 83 may be disposed such that some of the plurality of protruding sections 78 and some of the plurality of recessed sections 83 do not pass through the imaginary plane F in the radial direction D, and some of the plurality of protruding sections 78 and some of the plurality of recessed sections 83 do not overlap each other in the radial direction D.

[0086] Fig. 10 is a side view of the side wall section and the extending section for illustrating a third modification example of the plurality of protruding sections and the plurality of recessed sections. Fig. 10 is a view seen from the outside of the side wall section 75 and from the side. In Fig. 10, the same components as those of a structure illustrated in Fig. 7 are denoted by the same reference signs.

[0087] In the second embodiment, a case where the plurality of protruding sections 78 having the same shape and the plurality of recessed sections 83 having the same shape are disposed to incline at the same angle with respect to the thrust direction and the radial direction D has been described as an example. For example, as in the third modification example illustrated in Fig. 10, protruding sections 78 and 85 having different shapes and recessed sections 83 and 86 having different shapes may be provided, and the protruding sections 78 and 85 may be disposed at different inclination angles and the recessed sections 83 and 86 may be disposed at different inclination angles.

[0088] Fig. 11 is a side view of the side wall section and the extending section for illustrating a fourth modification example of the plurality of protruding sections and the plurality of recessed sections. Fig. 11 is a view seen from the outside of the side wall section 75 and from the side. In Fig. 11, the same components as those of a structure illustrated in Fig. 7 are denoted by the same reference signs.

[0089] As in the fourth modification example illustrated in Fig. 11, protruding sections 78 and 91 and recessed sections 83 and 92 having different shapes such that the projected areas of the respective recessed sections 83 and 92 in the thrust direction are equal to each other, the projected areas of the respective recessed sections 83 and 92 in the radial direction D are equal to each other, the projected areas of the respective protruding sections 78 and 91 are equal to each other in the thrust direction, and the projected areas of the respective protruding sections 78 and 91 in the radial direction D are equal to each other may be provided. Even in this case, the resistance against the radial force resulting from the rotation of the rotating shaft as well as the thrust force can be further enhanced.

[0090] Additionally, the protruding sections 78 and 85 and the recessed sections 83 and 85 that are illustrated in Fig. 10, and the protruding sections 78 and 91 and the recessed sections 83 and 92 that are illustrated in Fig. 11 may be disposed in the direction intersecting the thrust direction and the radial direction, or may be disposed at positions through which the imaginary plane F does not pass. Moreover, the protruding sections 78, 85, and 91 and the recessed sections 83, 86, and 92 that are illustrated in Figs. 7 to 11 may be combined together.

[0091] Additionally, certain four protruding sections and recessed sections among the protruding sections 78, 85, and 91 and the recessed sections 83, 86, and 92 that are illustrated among Figs. 7 to 11 may be provided, one pair of (two) a protruding section and a recessed section may be disposed in the radial direction, and the other pair of (two) a protruding section and a recessed section may be disposed in the direction intersecting the radial direction D and the thrust direction (the extending direction of the axis O_1). Even in this case, the same effects as those of the rotary machine of the second embodiment can be obtained.

[0092] Additionally, in a case where the four or more protruding sections and the four or more recessed sections described in the second embodiment are disposed, at least some recessed sections and at least some protruding sections may be disposed so as to pass through the imaginary plane F.

[0093] By disposing the four or more recessed sections and the four or more protruding sections at such positions, the resistance against the force applied in the rotational direction of the shaft orthogonal to the thrust direction when the thrust force is applied can be enhanced compared to a case where the plurality of recessed sections and the plurality of protruding sections are disposed not to pass through the imaginary plane F.

[0094] Although the preferable embodiments for carrying out the invention have been described above in detail, the invention is not limited to the relevant specific embodiments, and various alterations and changes can be made within the scope of the invention described in the claims. For example, the protruding sections 35A, 78, 85, and 91 and the recessed sections 69, 83, 86, and 92 that are described in the first and second embodiments may be used in combination.

Industrial Applicability

[0095] The invention is applicable to a rotary machine including a housing that accommodates a rotating shaft, and a radial bearing that rotatably supports the rotating shaft and is thermocompression bonded to an inner side of the housing.

Reference Signs List

[0096]

10:	ROTARY MACHINE
11:	HOUSING
13:	SUCTION PIPE
14:	DISCHARGE PIPE
16:	DISCHARGE COVER
19:	DISCHARGE CHAMBER
18:	DISCHARGE VALVE
21:	COMPRESSOR MAIN BODY
22:	COMPRESSION SPACE
23:	ROTATING SHAFT
25:	ECCENTRIC SHAFT
26:	DRIVING MOTOR
28:	BUSH ASSEMBLY
29:	SUPPORT PLATE
31:	OIL SUPPLY PUMP
32, 76:	FIRST RADIAL BEARING
33:	OLDHAM RING
34:	SECOND RADIAL BEARING
35, 75:	SIDE WALL SECTION
35A, 78, 85, 91:	PROTRUDING SECTION
36:	UPPER COVER SECTION
37:	LOWER COVER SECTION
41:	DISCHARGE PORT
43:	FIXED SCROLL
45:	ORBITING SCROLL
47, 55:	END PLATE
47A:	FIXED SCROLL DISCHARGE PORT
49:	FIXED WRAP
51:	OUTER PERIPHERAL WALL
52:	FLANGE SECTION
57:	ORBITING WRAP
58:	BOSS SECTION
59:	BEARING
62:	BUSH
65,	72: BEARING MAIN BODY
66, 73, 81:	EXTENDING SECTION
68:	EXTENDING SECTION MAIN BODY
68a:	SURFACE
69, 83, 86, 92:	RECESSED SECTION
B:	REGION
D:	RADIAL DIRECTION
F:	IMAGINARY PLANE
G:	GRAVITY CENTER
O_1:	AXIS
O_2:	ECCENTRIC AXIS

Claims

1. A rotary machine comprising:

a rotating shaft that rotates around an axis;
a housing that includes a tubular side wall section and a plurality of protruding sections provided to an inner side of the side wall section and accommodates the rotating shaft; and
a radial bearing that is accommodated within the housing and includes a bearing main body which rotatably supports the rotating shaft and an extending section which extends in a direction from the bearing main body toward the side wall section to reaches the inner side of the side wall section of the housing,
wherein the extending section includes a plurality of recessed sections that accommodate the protruding sections and are thermocompression bonded to the protruding sections, and
wherein the plurality of protruding section and the plurality of recessed sections are disposed side by side in a direction intersecting a radial direction and a thrust direction of the rotating shaft and/or in the radial direction.

2. The rotary machine according to Claim 1,
wherein a plurality of the extending sections are provided in a state where the extending sections are separated from each other in the radial direction.

3. The rotary machine according to Claim 1 or 2,
wherein at least some recessed sections and at least some protruding sections among the plurality of recessed sections and the plurality of protruding sections are disposed at positions which pass through a gravity center of the radial bearing in the thrust direction of the rotating shaft and through which an imaginary plane orthogonal to the thrust direction passes.

4. The rotary machines according to Claim 3,
wherein the plurality of recessed sections and the plurality of protruding sections are disposed at positions passing through the imaginary plane.

5. The rotary machine according to any one of Claims 1 to 4,
wherein a shape of the protruding sections and the recessed sections is a shape that extends in the direction intersecting the thrust direction and the radial direction.

6. The rotary machine according to Claims 1 to 5,
wherein the plurality of recessed sections are con-

figured such that projected areas of the respective recessed sections in the thrust direction are equal to each other, and projected areas of the respective recessed sections in the radial direction are equal to each other, and
wherein the plurality of protruding sections are configured such that projected areas of the respective protruding sections in the thrust direction are equal to each other, and projected areas of the respective protruding sections in the radial direction are equal to each other.

7. The rotary machine according to any one of Claims 1 to 6,
wherein the plurality of protruding sections and the plurality of recessed sections include different shapes.

Amended claims under Art. 19.1 PCT

1. (Amended) A rotary machine comprising:

a rotating shaft that rotates around an axis;
a housing that includes a tubular side wall section and a plurality of protruding sections provided to an inner side of the side wall section and accommodates the rotating shaft; and
a radial bearing that is accommodated within the housing and includes a bearing main body which rotatably supports the rotating shaft and an extending section which extends in a direction from the bearing main body toward the side wall section to reaches the inner side of the side wall section of the housing,
wherein the extending section includes a plurality of recessed sections that accommodate the protruding sections and are thermocompression bonded to the protruding sections,
wherein the plurality of protruding section and the plurality of recessed sections are disposed side by side in a direction intersecting a radial direction and a thrust direction of the rotating shaft and/or in the radial direction, and
wherein at least some recessed sections and at least some protruding sections among the plurality of recessed sections and the plurality of protruding sections are disposed at positions which pass through a gravity center of the radial bearing in the thrust direction of the rotating shaft and through which an imaginary plane orthogonal to the thrust direction passes.

2. The rotary machine according to Claim 1,
wherein a plurality of the extending sections are provided in a state where the extending sections are separated from each other in the radial direction.

3. (Deleted]

4. (Amended) The rotary machines according to Claim 1 or 2,
wherein the plurality of recessed sections and the plurality of protruding sections are disposed at positions passing through the imaginary plane.

5. (Amended) The rotary machine according to any one of Claims 1, 2 and 4,
wherein a shape of the protruding sections and the recessed sections is a shape that extends in the direction intersecting the thrust direction and the radial direction.

6. (Amended) The rotary machine according to any one of Claims 1, 2, 4, and 5,
wherein the plurality of recessed sections are configured such that projected areas of the respective recessed sections in the thrust direction are equal to each other, and projected areas of the respective recessed sections in the radial direction are equal to each other, and
wherein the plurality of protruding sections are configured such that projected areas of the respective protruding sections in the thrust direction are equal to each other, and projected areas of the respective protruding sections in the radial direction are equal to each other.

7. [Amended] The rotary machine according to any one of Claims 1, 2, and 4 to 6,
wherein the plurality of protruding sections and the plurality of recessed sections include different shapes.

Statement under Art. 19.1 PCT

Claim 1 of the claims is amended as described in the attached sheets. That is, the configuration of Claim 3 before being amended was added to Claim 1 before being amended.

Claim 3 was deleted.

Regarding Claims 4 to 7, dependencies were revised in accordance with the deletion of Claim 3 before being amended

FIG. 1

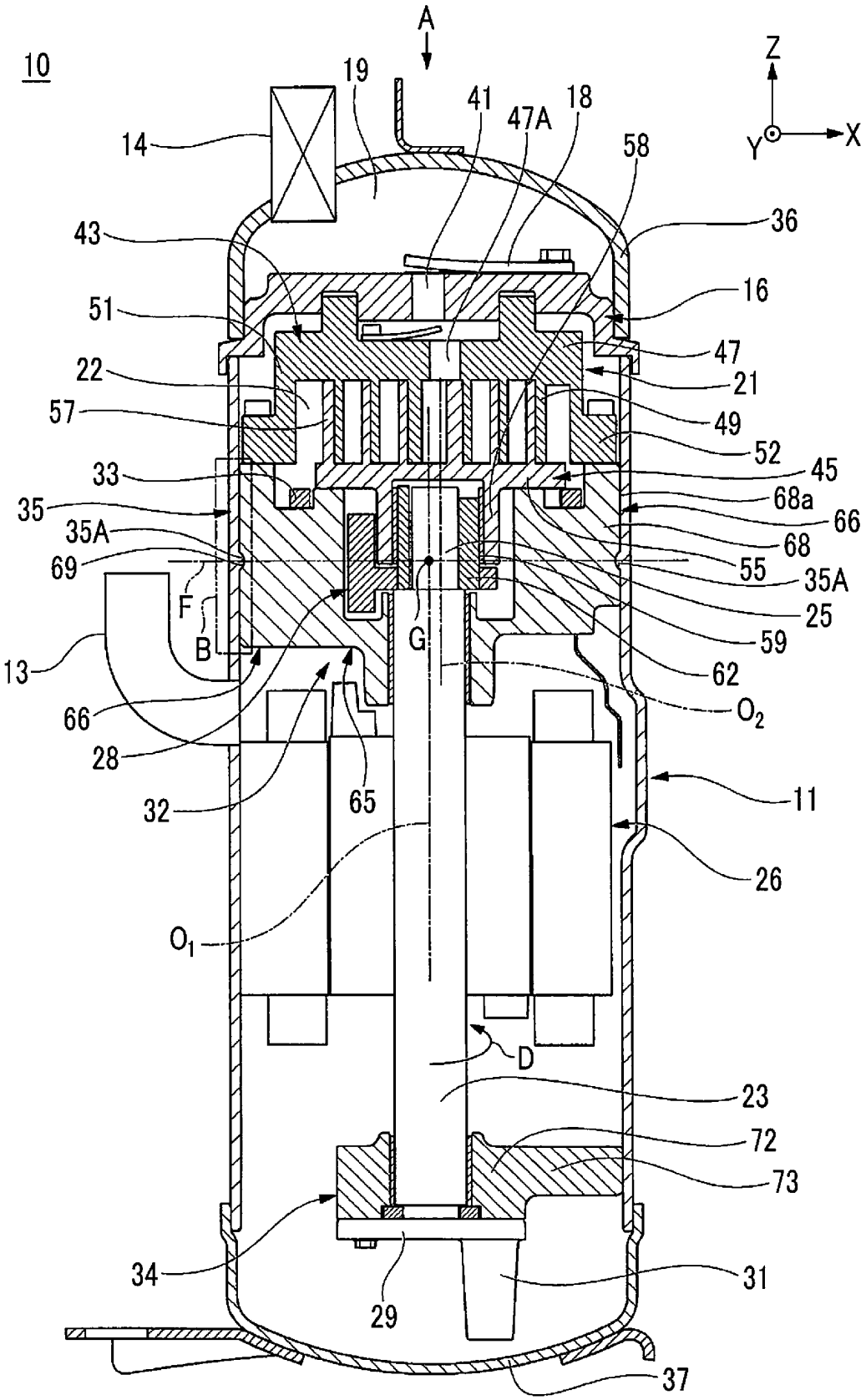
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FIG. 2

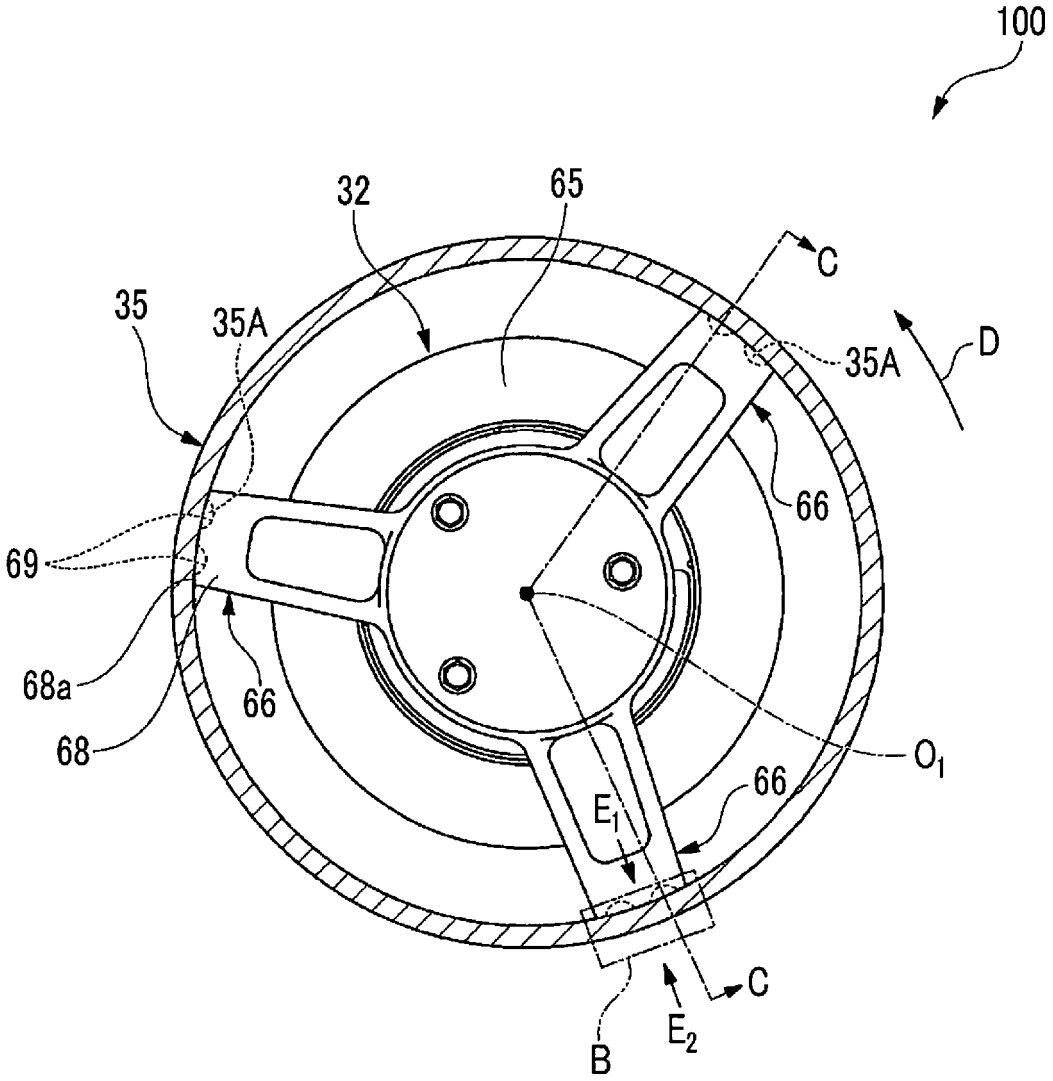


FIG. 3

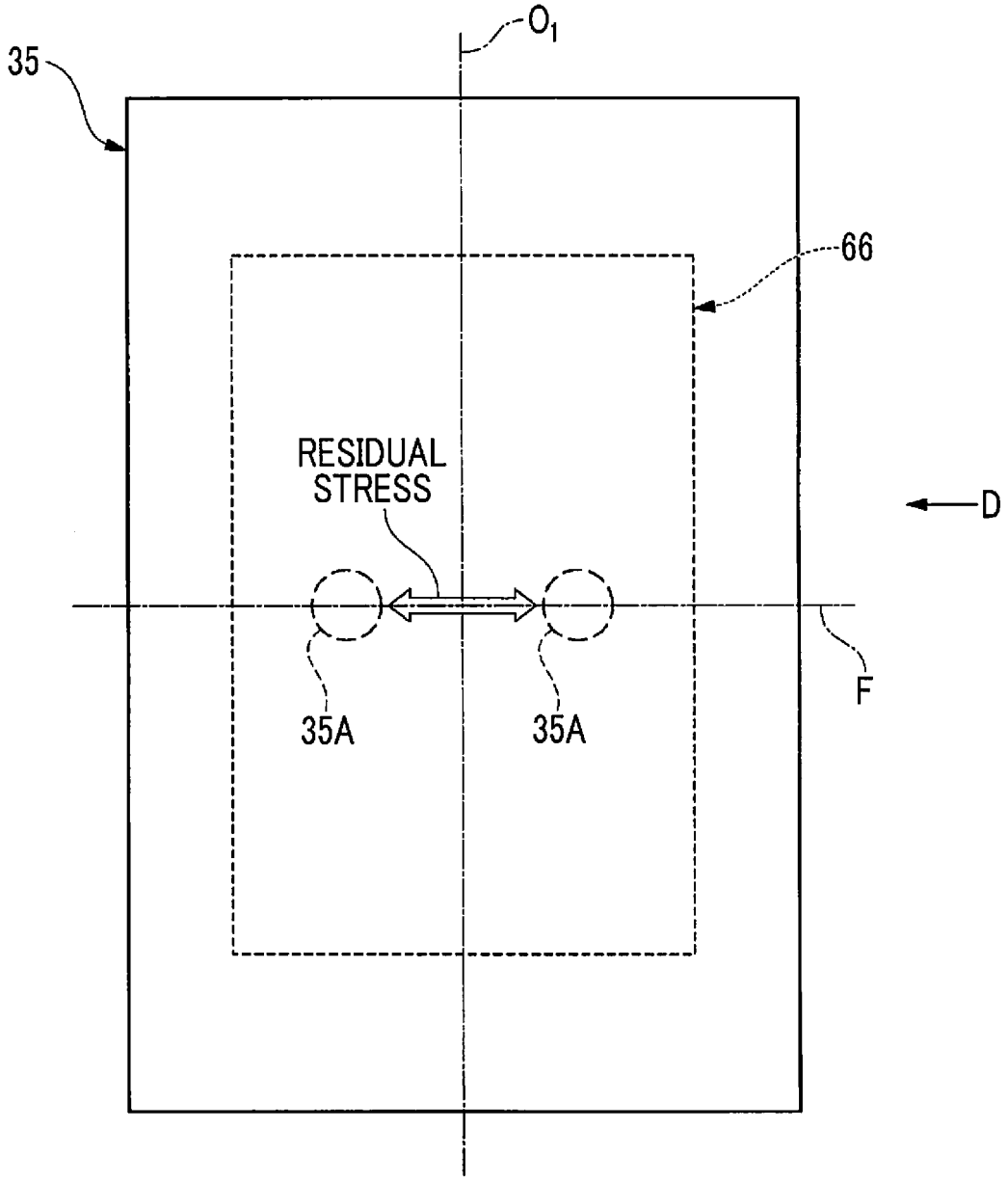


FIG. 4

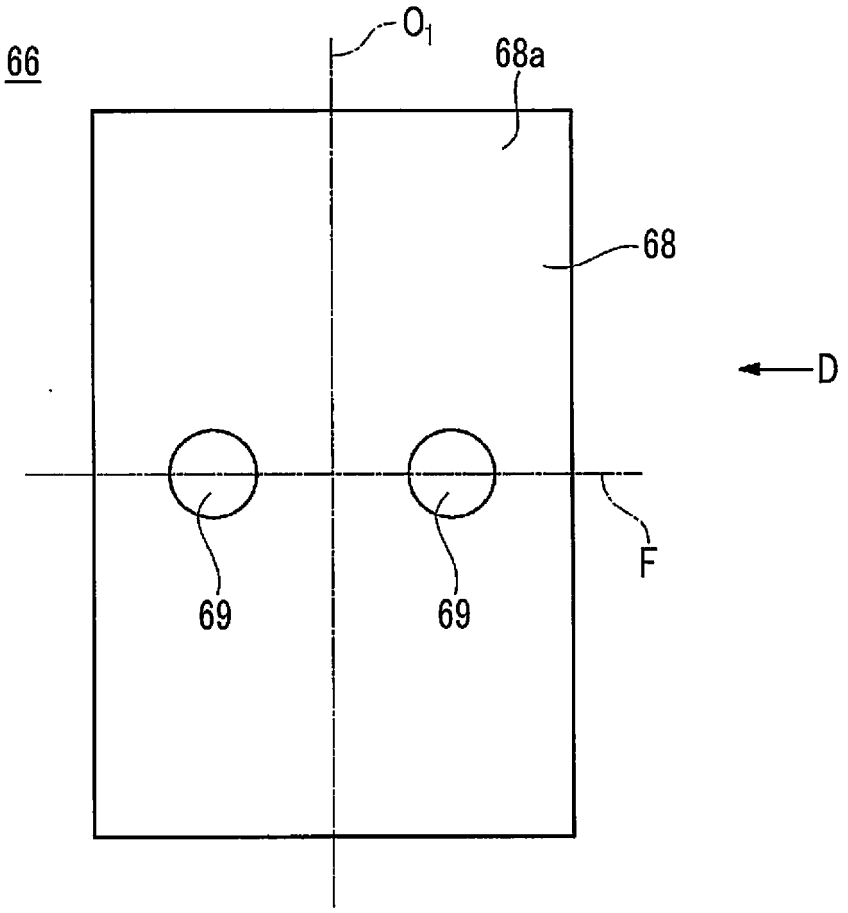


FIG. 5

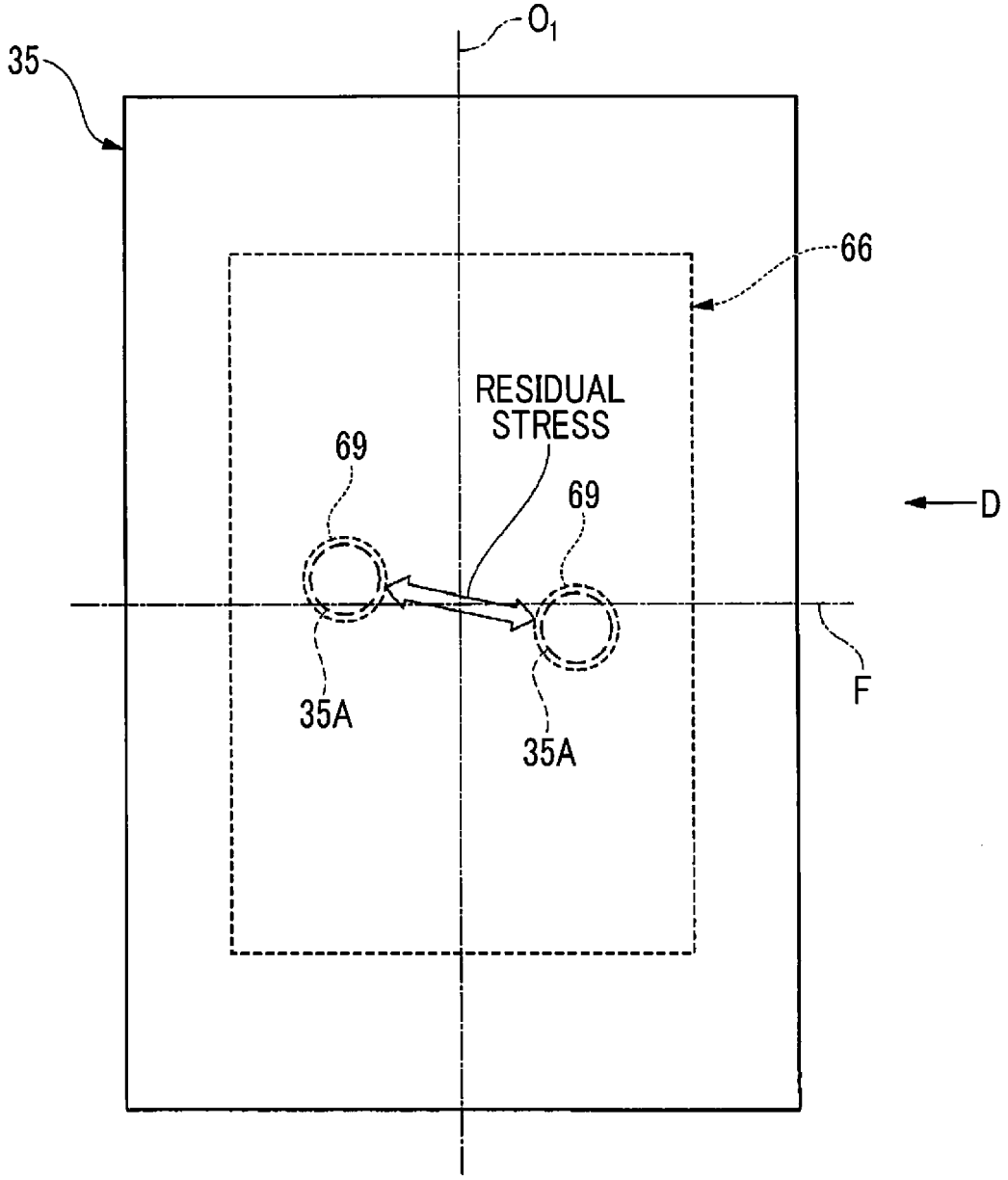


FIG. 6

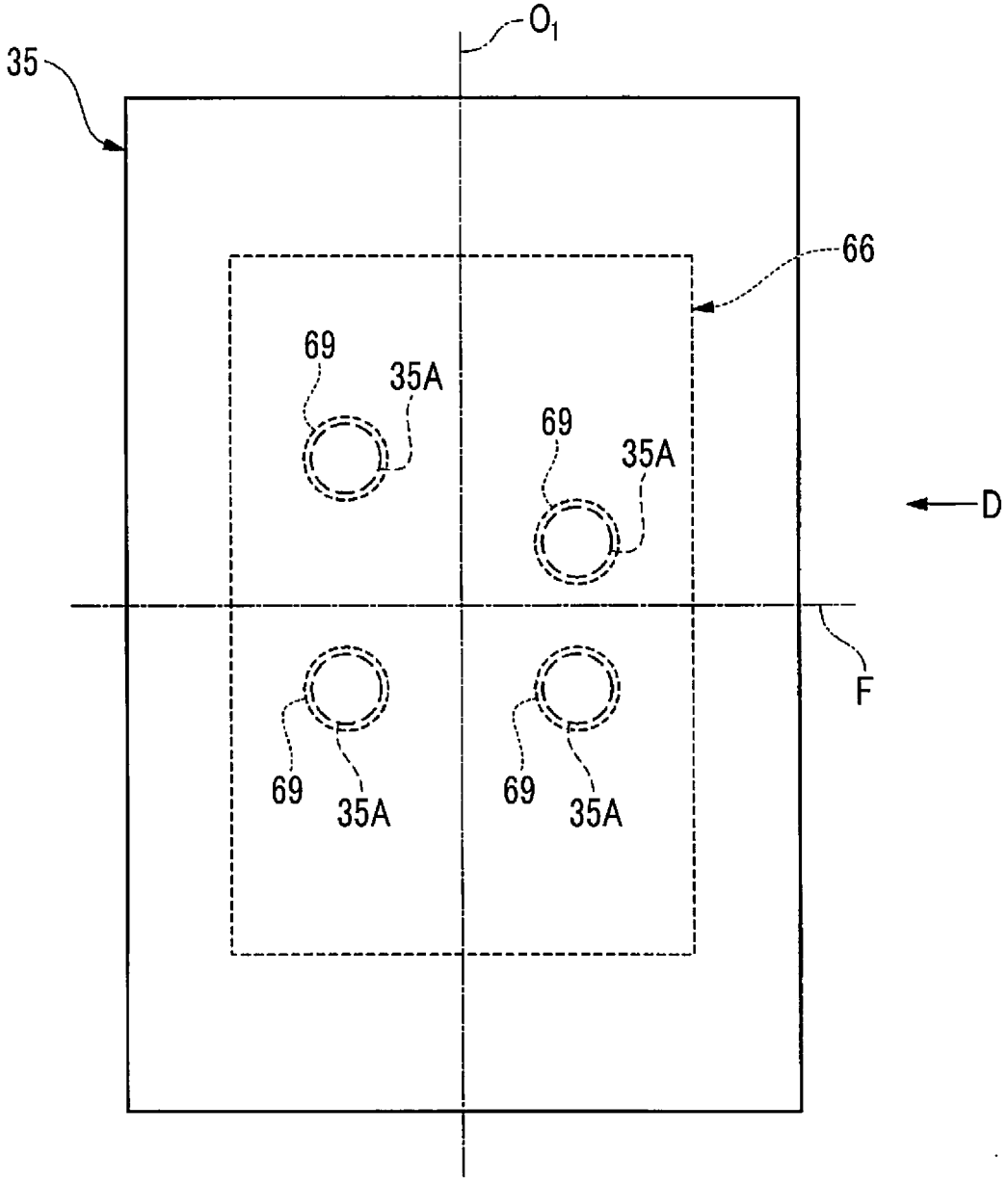


FIG. 7

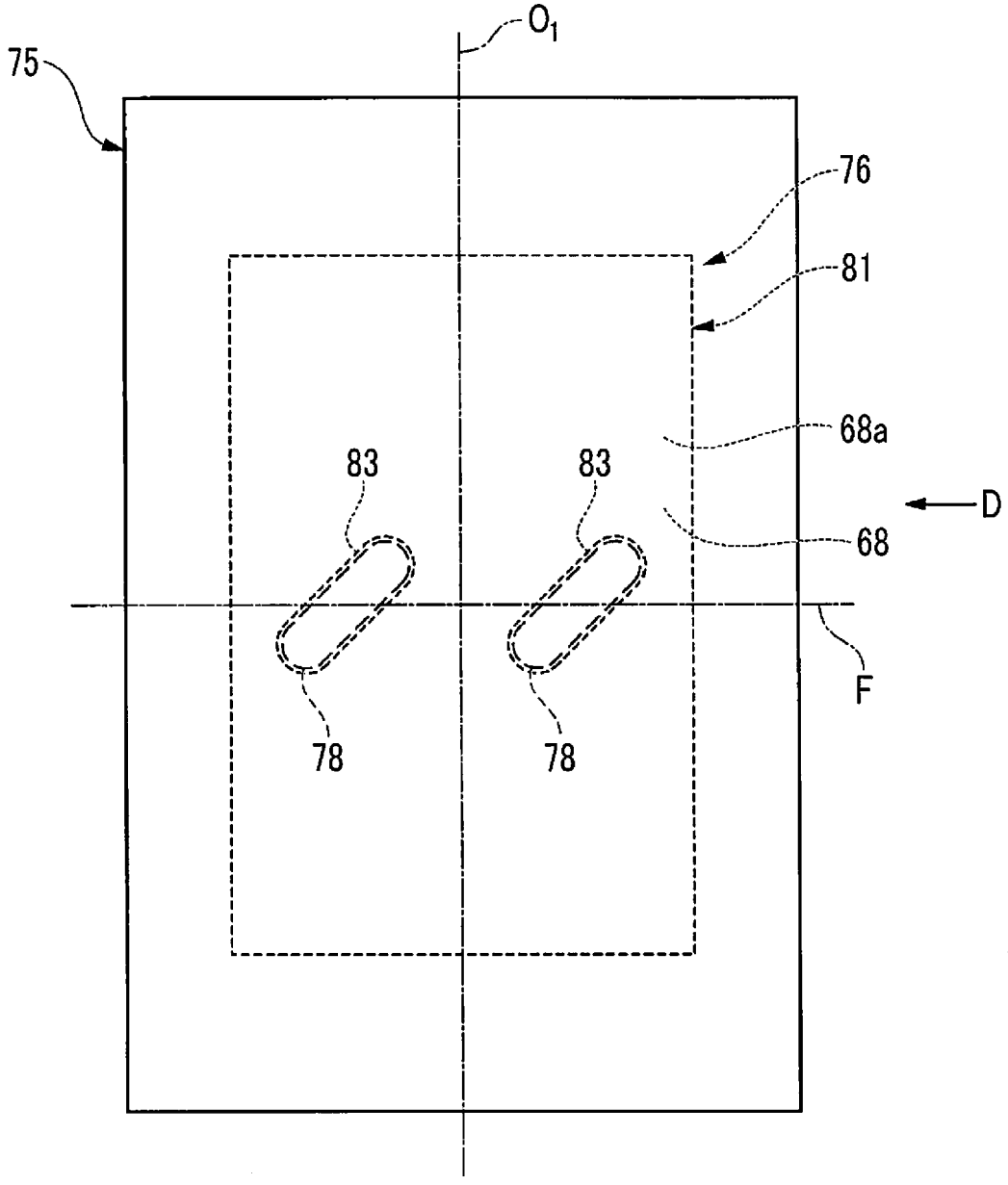


FIG. 8

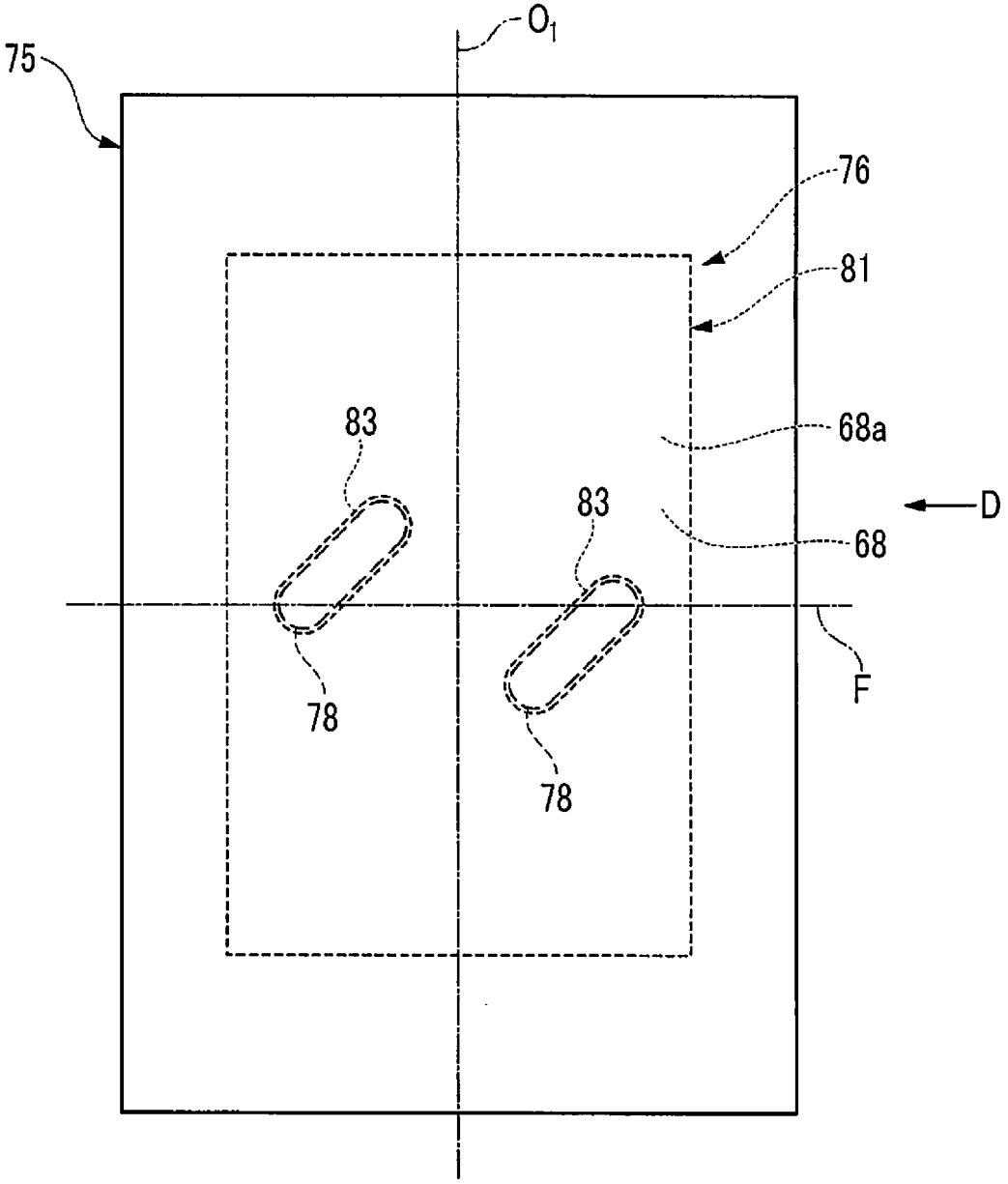


FIG. 9

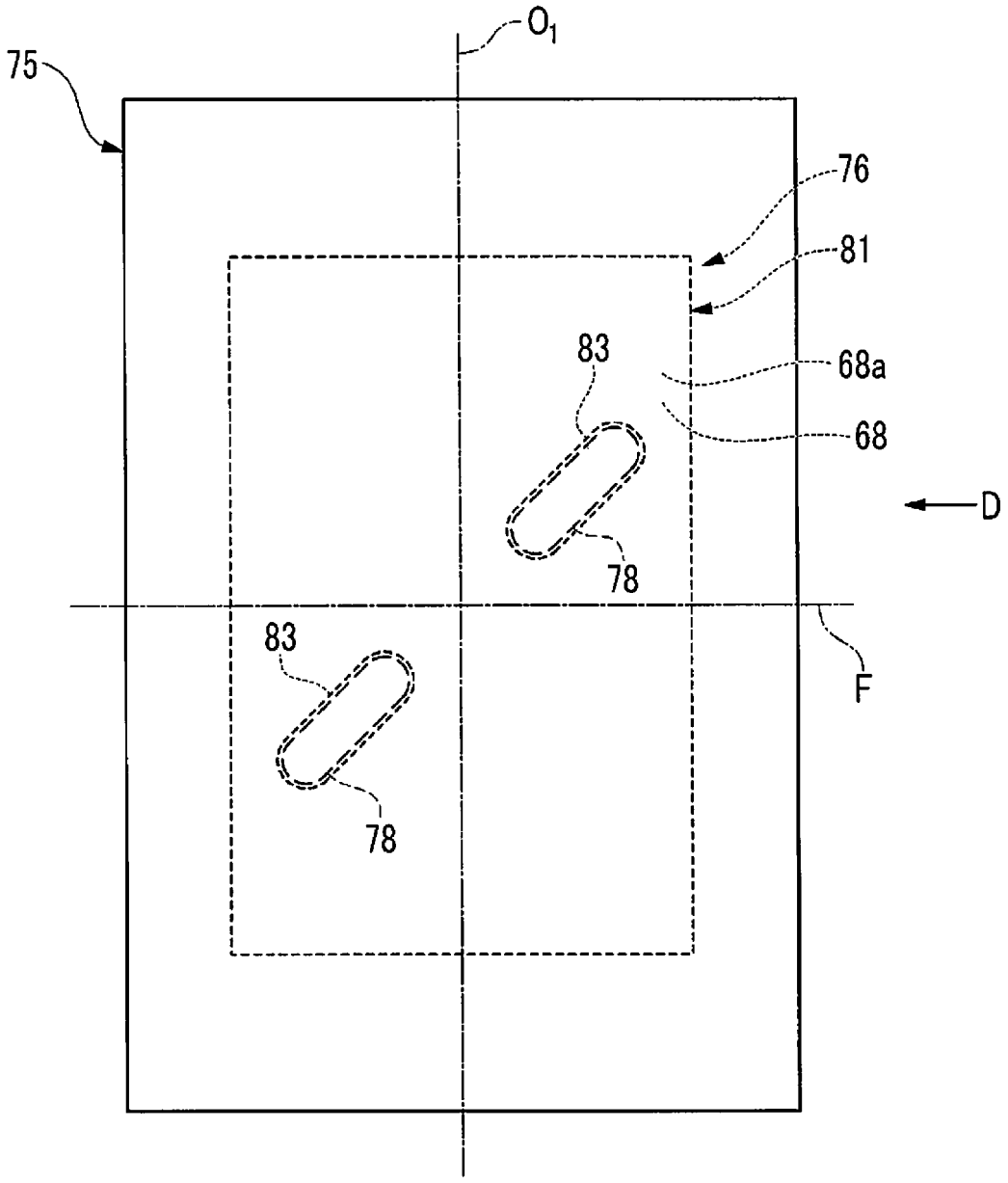


FIG. 10

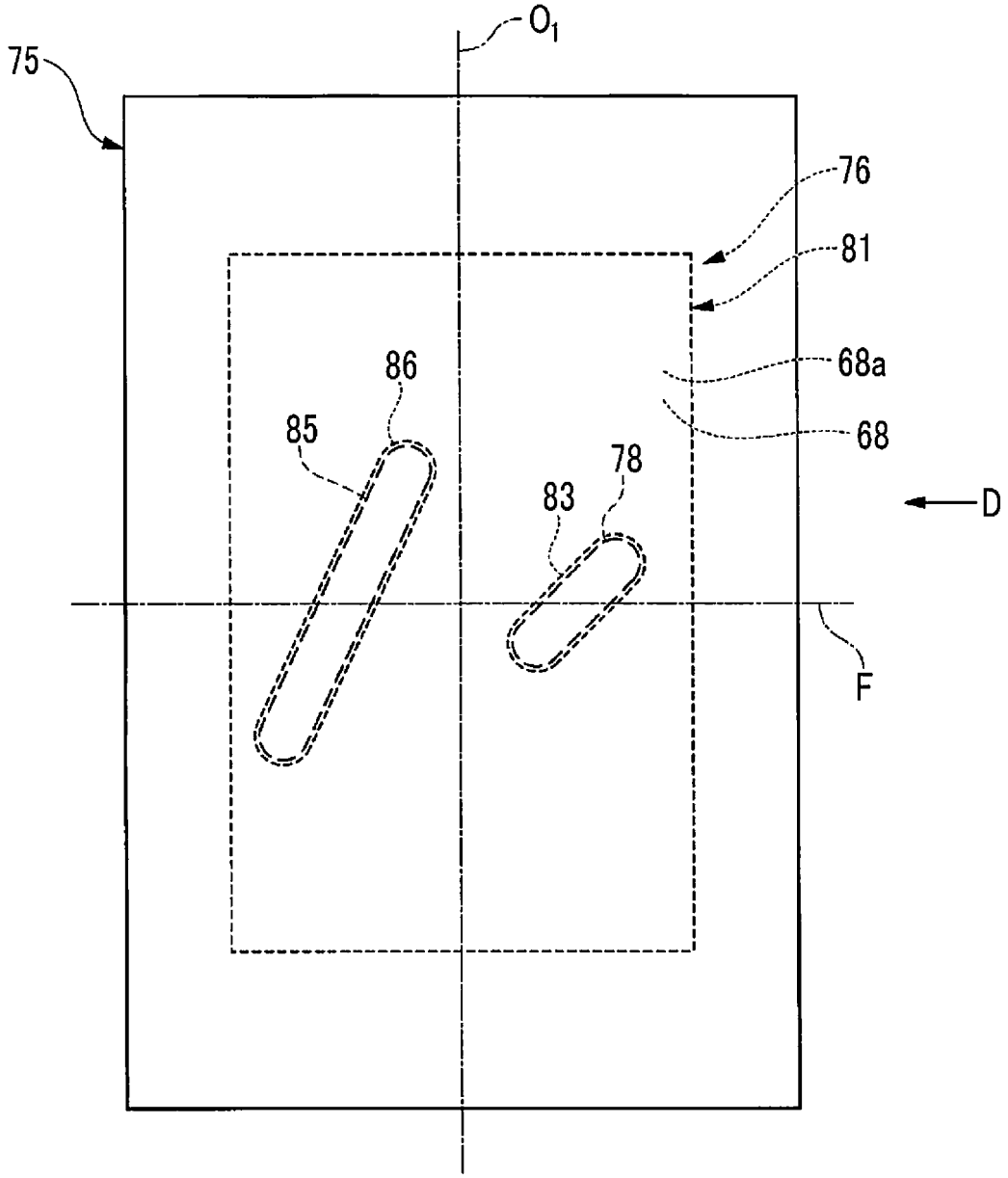
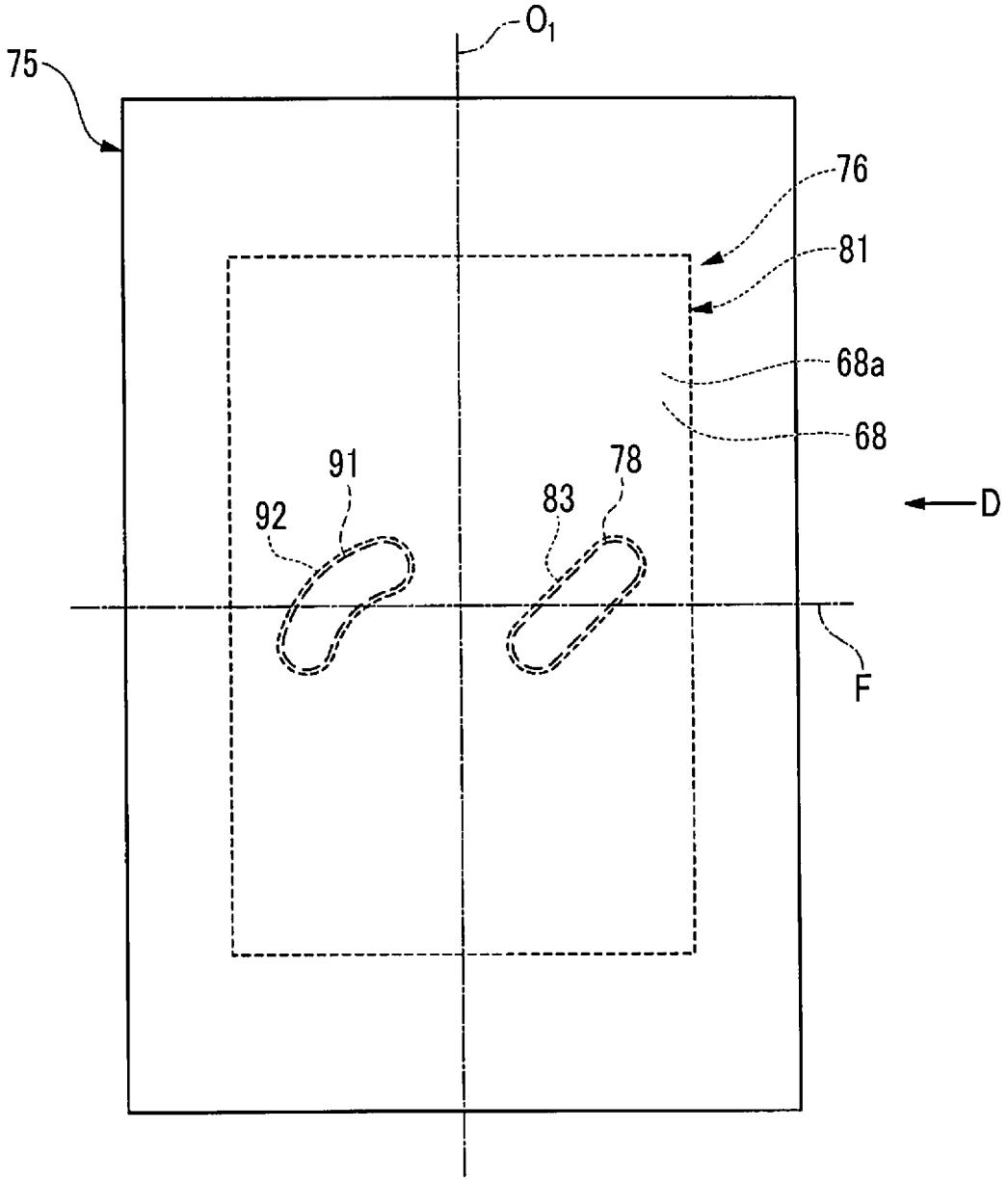


FIG. 11



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2017/004197

A. CLASSIFICATION OF SUBJECT MATTER
F04C29/00(2006.01)i, *B23P11/02*(2006.01)i, *F04B39/12*(2006.01)i, *F04C18/02*(2006.01)i

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04C29/00, B23P11/02, F04B39/12, F04C18/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017
Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	JP 2011-174472 A (Mitsubishi Electric Corp.), 08 September 2011 (08.09.2011), paragraphs [0013] to [0025], [0140]; fig. 1 to 9, 47 to 48 (Family: none)	1,6 2 3-5,7
Y A	JP 2006-200363 A (Fujitsu General Ltd.), 03 August 2006 (03.08.2006), paragraph [0014]; fig. 1 to 2 (Family: none)	2 3-7
A	WO 2015/056364 A1 (Panasonic Intellectual Property Management Co., Ltd.), 23 April 2015 (23.04.2015), paragraphs [0026] to [0038]; fig. 1 to 5 & CN 105492769 A	1-7

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
17 March 2017 (17.03.17)	28 March 2017 (28.03.17)
Name and mailing address of the ISA/ Japan Patent Office 3-4-3,Kasumigaseki,Chiyoda-ku, Tokyo 100-8915,Japan	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2016020978 A **[0002]**
- JP 3099731 A **[0006]**