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

(11) EP 3 741 995 A1

(12) # EUROPEAN PATENT APPLICATION
published in accordance with Art. 153(4) EPC

(43) Date of publication:
25.11.2020 Bulletin 2020/48

(21) Application number: **19757122.7**

(22) Date of filing: **15.01.2019**

(51) Int Cl.:
F04C 18/02 *(2006.01)* ***F01C 1/02*** *(2006.01)*

(86) International application number:
PCT/JP2019/000899

(87) International publication number:
WO 2019/163332 (29.08.2019 Gazette 2019/35)

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

(30) Priority: **21.02.2018 JP 2018028959**

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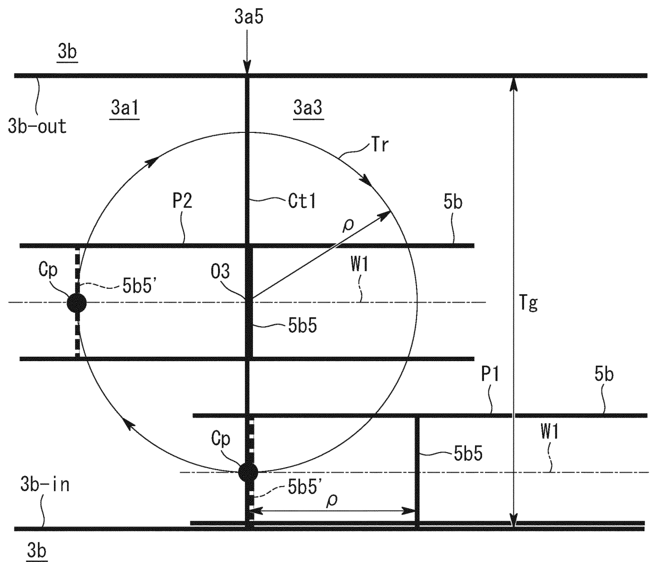
(54) **SCROLL FLUID MACHINE**

(57) An end plate inclined section (3a1) having a tooth bottom surface that faces a tooth tip of a wall inclined section, and that inclines in accordance with an inclination of the wall inclined section is provided in an end plate of a fixed scroll. A contour line (Ct1) is formed in a direction orthogonal to a spiral direction of a wall (3b), on the end plate inclined section (3a1), and a wall inclined connecting section (5b5) that connects the wall inclined section and a wall flat section is disposed with a phase delayed by a turning radius ρ with respect to an end plate inclined connecting section (3a5) that connects the end plate inclined section (3a1) and an end plate flat section (3a3).

FIG. 8



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Description

[Technical Field]

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

[Background Art]

[0002] Generally, there is known a scroll fluid machine in which a fixed scroll member and a turning scroll member provided with respective spiral walls on respective end plates are engaged and revolved to compress or expand fluid.

[0003] As such a scroll fluid machine, a so-called stepped scroll compressor disclosed in PTL 1 is known. In this stepped scroll compressor, respective step sections are provided at positions along the spiral directions of tooth tip surfaces and tooth bottom surfaces of spiral walls of a fixed scroll and a turning scroll, and the height of the outer circumferential side of the wall is made higher than the height of the inner circumferential side of the wall with each step section as a boundary. The stepped scroll compressor performs compression not only in the circumferential direction of the walls, but also in the height direction (three-dimensional compression), and therefore it is possible to increase displacement and increase compressor capacity compared to a general scroll compressor with no step section (two-dimensional compression).

[Citation List]

[Patent Literature]

[0004] [PTL 1] Japanese Unexamined Patent Application, Publication No. 2015-55173

[Summary of Invention]

[Technical Problem]

[0005] However, the stepped scroll compressor has a problem that fluid leakage at the step sections is large. Further, there is a problem that stress is concentrated on root portions of the step sections, and strength is reduced.

[0006] To cope with the above, the inventors are considering providing continuous inclined sections in place of the step sections provided on the walls and the end plates.

[0007] However, even when inclined sections are provided, reduction in fluid leakage due to a tip clearance between a tooth tip of a wall and a tooth bottom of an end plate is desired.

[0008] The present invention has been made in view of such a circumstance, and an object of the present invention is to provide a scroll fluid machine having inclined sections in a wall and an end plate capable of reducing a tip clearance between a tooth tip of the wall and a tooth bottom of the end plate.

[Solution to Problem]

[0009] In order to solve the aforementioned problems, a scroll fluid machine of the present invention employs the following solutions.

[0010] That is, a scroll fluid machine according to an aspect of the present invention is a scroll fluid machine including: a first scroll member provided with a spiral first wall on a first end plate; and a second scroll member that is provided with a spiral second wall on a second end plate disposed so as to face the first end plate, and that relatively revolves by engagement between the second wall and the first wall with the second wall being offset from the first wall by a turning radius, wherein an inclined section that continuously reduces an inter-facing-surface distance between the first end plate and the second end plate facing each other, from an outer circumferential side toward an inner circumferential side of each of the first wall and the second wall is provided, each of the inclined sections is provided over a range of 180° or more around a spiral center, at least one of the first wall and the second wall has a wall inclined section that has a height of the wall continuously reducing from the outer circumferential side toward the inner circumferential side so as to form the inclined section, at least one of the first end plate and the second end plate has an end plate inclined section having a tooth bottom surface that faces a tooth tip of the wall inclined section, and that inclines in accordance with an inclination of the wall inclined section, a contour line is formed in a direction orthogonal to a spiral direction of the wall, on the end plate inclined section, and the first scroll member and the second scroll member are disposed with phases shifted by the turning radius in a direction in which the facing inclined sections are separated from each other.

[0011] The inclined section that continuously reduces the inter-facing-surface distance between the first end plate and the second end plate from the outer circumferential side toward the inner circumferential side of each wall is provided, and therefore fluid sucked from the outer circumferential side is not only compressed by reduction of compression chambers in accordance with the spiral shape of the wall, but also further compressed by reduction of the inter-facing-surface distance between the end plates, toward the inner circumferential side.

[0012] The contour line is formed in the direction orthogonal to the spiral direction of the wall, on the end plate inclined section, that is, the tooth bottom. In this case, when the first scroll member and the second scroll member coincide with each other at the turning center position in the spiral direction, the tooth bottom and the tooth tip may interfere with each other at the time of turning movement of both the scroll members. To cope with the above, the first scroll member and the second scroll member are disposed with the phases shifted by the turning radius in the direction in which the facing inclined sections are separated from each other. Consequently, it is possible to avoid interference between the tooth bottom and the tooth tip. In a case where the phase advances by the turning radius, engagement is performed such that the positions of the inclined sections coincide with each other, and therefore it is possible to reduce a tip clearance between the tooth tip and the tooth bottom.

[0013] Further, in the scroll fluid machine according to the aspect of the present invention, at least one of the first end plate and the second end plate has the end plate inclined section having the tooth bottom surface that faces the tooth tip of the wall inclined section, and that inclines in accordance with the inclination of the wall inclined section, a wall flat section having no change in height is provided in an outermost circumferential part and/or an innermost circumferential part of each of the first wall and the second wall, an end plate flat section corresponding to the wall flat section is provided in each of the first end plate and the second end plate, and a wall inclined connecting section that connects the wall inclined section and the wall flat section is disposed with a phase delayed by the turning radius with respect to an end plate inclined connecting section that connects the end plate inclined section and the end plate flat section.

[0014] The contour line is formed in the direction orthogonal to the spiral direction of the wall, on the end plate inclined section, that is, the tooth bottom. In this case, when the end plate inclined connecting section that connects the end plate inclined section and the end plate flat section, and the wall inclined connecting section that connects the wall inclined section and the wall flat section coincide with each other at the turning center position in the spiral direction, the tooth bottom and the tooth tip may interfere with each other at the time of turning movement of both the scroll members. To cope with the above, the wall inclined connecting section is disposed with the phase delayed by the turning radius with respect to the end plate inclined connecting section. Consequently, it is possible to avoid interference between the tooth bottom and the tooth tip. In a case where the phase of the wall inclined connecting section advances by the turning radius with respect to the end plate inclined connecting section, the end plate inclined connecting section and the wall inclined connecting section engage with each other such that the positions thereof coincide with each other, and therefore it is possible to reduce a tip clearance between the tooth tip and the tooth bottom.

[0015] A scroll fluid machine according to an aspect of the present invention is a scroll fluid machine including: a first scroll member provided with a spiral first wall on a first end plate; and a second scroll member that is provided with a spiral second wall on a second end plate disposed so as to face the first end plate, and that relatively revolves by engagement between the second wall and the first wall with the second wall being offset from the first wall by a turning radius, wherein an inclined section that continuously reduces an inter-facing-surface distance between the first end plate and the second end plate facing each other, from an outer circumferential side toward an inner circumferential side of each of the first wall and the second wall is provided, each of the inclined sections is provided over a range of 180° or more around a spiral center, at least one of the first wall and the second wall has a wall inclined section that has a height of the wall continuously reducing from the outer circumferential side toward the inner circumferential side so as to form the inclined section, at least one of the first end plate and the second end plate has an end plate inclined section having a tooth bottom surface that faces a tooth tip of the wall inclined section, and that inclines in accordance with an inclination of the wall inclined section, one or a plurality of circular arcs each having an intersection with the wall as a contact point is formed as a contour line on the end plate inclined section, and the first scroll member and the second scroll member are disposed so as to have phases that coincide at a turning center position in a spiral direction at a time of the turning movement.

[0016] The inclined section that continuously reduces the inter-facing-surface distance between the first end plate and the second end plate from the outer circumferential side toward the inner circumferential side of each wall is provided, and therefore fluid sucked from the outer circumferential side is not only compressed by reduction of compression chambers in accordance with the spiral shape of the wall, but also further compressed by reduction of the inter-facing-surface distance between the end plates, toward the inner circumferential side.

[0017] The one or the plurality of circular arcs each having the intersection with the wall as the contact point is formed as the contour line on the end plate inclined section. In this case, when the first scroll member and the second scroll member are disposed so as to have phases that coincide at the turning center position in the spiral direction at the time of the turning movement, that is, the first scroll member and the second scroll member are disposed so as to have the same phase, the tooth tip and the tooth bottom do not interfere with each other at the time of the turning movement, and it is possible to reduce a tip clearance between the tooth tip and the tooth bottom.

[0018] When the one or the plurality of circular arcs each having the intersection with the wall as the contact point is formed as the contour line on the end plate inclined section, machining is preferably performed by use of an end mill having a diameter equal to or smaller than a tooth bottom width of the end plate inclined section.

[0019] A scroll fluid machine according to an aspect of the present invention is a scroll fluid machine including: a first scroll member provided with a spiral first wall on a first end plate; and a second scroll member that is provided with a spiral second wall on a second end plate disposed so as to face the first end plate, and that relatively revolves by engagement between the second wall and the first wall with the second wall being offset from the first wall by a turning radius, wherein an inclined section that continuously reduces an inter-facing-surface distance between the first end plate and the second end plate facing each other, from an outer circumferential side toward an inner circumferential side of each of the first wall and the second wall is provided, each of the inclined sections is provided over a range of 180° or more around a spiral center, at least one of the first wall and the second wall has a wall inclined section that has a height of the wall continuously reducing from the outer circumferential side toward the inner circumferential side so as to form the inclined section, at least one of the first end plate and the second end plate has an end plate inclined section having a tooth bottom surface that faces a tooth tip of the wall inclined section, and that inclines in accordance with an inclination of the wall inclined section, a wall flat section having no change in height is provided in an outermost circumferential part and/or an innermost circumferential part of each of the first wall and the second wall, an end plate flat section corresponding to the wall flat section is provided in each of the first end plate and the second end plate, one or a plurality of circular arcs each having an intersection of the wall and an end plate inclined connecting section that connects the end plate inclined section and the end plate flat section as a contact point is formed as a contour line on the end plate inclined section, and a wall inclined connecting section that connects the wall inclined section and the wall flat section is disposed so as to coincide with the end plate inclined connecting section at the turning center position in the spiral direction at the time of the turning movement.

[0020] The one or the plurality of circular arcs each having the intersection of the wall and the end plate inclined connecting section that connects the end plate inclined section and the end plate flat section as the contact point is formed as the contour line on the end plate inclined section. In this case, when the wall inclined connecting section is disposed so as to coincide with the end plate inclined connecting section at the turning center position in the spiral direction at the time of the turning movement, that is, the end plate inclined connecting section and the wall inclined connecting section are disposed so as to have the same phase, the tooth tip and the tooth bottom do not interfere with each other at the time of the turning movement, and it is possible to reduce a tip clearance between the tooth tip and the tooth bottom.

[0021] When the one or the plurality of circular arcs each having the intersection between the end plate inclined connecting section and the wall as the contact point is formed as the contour line on the end plate inclined section, machining is preferably performed by use of an end mill having a diameter equal to or smaller than a tooth bottom width of the end plate inclined section.

[0022] Further, according to the scroll fluid machine according to an aspect of the present invention, where a diameter of the circular arc forming the contour line is denoted by De, a tooth bottom width of the end plate inclined section is denoted by Tg, and the turning radius in the turning movement is denoted by p,

$$\{Tg^2 + (2\rho)^2\}/(2Tg) \leq De \leq Tg$$

is satisfied.

[0023] The aforementioned relational expression is satisfied, so that it is possible to avoid approaching of the tooth tip and the tooth bottom and interference between the tooth tip and the tooth bottom at the time of the turning movement.

[0024] Further, according to the scroll fluid machine of the present invention,

$$De = \{Tg^2 + (2\rho)^2\}/(2Tg)$$

is satisfied.

$$De = \{Tg2 + (2\rho)2\}/(2Tg)$$

is satisfied, so that when the tooth tip and the tooth bottom come closest to each other at the time of turning movement, a tip clearance between the contour line and the wall inclined connecting section can approach zero.

[Advantageous Effects of Invention]

[0025] In a case where the contour line is formed in the direction orthogonal to the spiral direction on the end plate inclined section, that is, the tooth bottom, the wall inclined connecting section is disposed with the phase delayed by the turning radius with respect to the end plate inclined connecting section. Consequently, the tooth tip and the tooth bottom do not interfere with each other at the time of the turning movement, and it is possible to reduce a tip clearance between the tooth tip and the tooth bottom.

[0026] In a case where the one or the plurality of circular arcs each having the intersection between the end plate inclined connecting section and the wall as the contact point is formed as the contour line on the end plate inclined section, the wall inclined connecting section is disposed so as to coincide with the end plate inclined connecting section at the turning center position in the spiral direction at the time of turning movement. Consequently, the tooth tip and the tooth bottom do not interfere with each other at the time of the turning movement, and it is possible to reduce a tip clearance between the tooth tip and the tooth bottom.

[Brief Description of Drawings]

[0027]

[Fig. 1A] Fig. 1A is a longitudinal sectional view illustrating a fixed scroll and a turning scroll of a scroll compressor according to one embodiment of the present invention.
[Fig. 1B] Fig. 1B is a plan view of the fixed scroll of Fig. 1A viewed from a wall side.
[Fig. 2] Fig. 2 is a perspective view illustrating the turning scroll of Fig. 1.
[Fig. 3] Fig. 3 is a plan view illustrating end plate flat sections provided in the fixed scroll.
[Fig. 4] Fig. 4 is a plan view illustrating a wall flat section provided in the fixed scroll.
[Fig. 5] Fig. 5 is a schematic diagram illustrating a wall represented so as to extend in the spiral direction.
[Fig. 6] Fig. 6 is a partially enlarged view illustrating an enlarged region of reference symbol Z in Fig. 1B.
[Fig. 7A] Fig. 7A is a side view illustrating a tip seal clearance of a portion illustrated in Fig. 6, and illustrating a state in which the tip seal clearance is relatively small.
[Fig. 7B] Fig. 7B is a side view illustrating the tip seal clearance of the portion illustrated in Fig. 6, and illustrating a state in which the tip seal clearance is relatively large.
[Fig. 8] Fig. 8 is a partially enlarged plan view illustrating a circumference of an end plate inclined connecting section.
[Fig. 9A] Fig. 9A illustrates positional relation between a tooth tip and a tooth bottom as a comparative example, and is a side view at a contact position.
[Fig. 9B] Fig. 9B illustrates positional relation between the tooth tip and the tooth bottom as the comparative example, and is a side view at a width center position.
[Fig. 9C] Fig. 9C illustrates positional relation between the tooth tip and the tooth bottom as the comparative example, and is a side view at a position advanced by 180° from the width center position.
[Fig. 10A] Fig. 10A illustrates positional relation between a tooth tip and a tooth bottom in a first embodiment, and is a side view at a contact position.
[Fig. 10B] Fig. 10B illustrates positional relation between the tooth tip and the tooth bottom in the first embodiment, and is a side view at a width center position.
[Fig. 10C] Fig. 10C illustrates positional relation between the tooth tip and the tooth bottom in the first embodiment, and is a side view at a position advanced by 180° from the width center position.
[Fig. 11A] Fig. 11A illustrates a machining method of a tooth bottom and a wall side surface according to a second embodiment, and is a plan view of the tooth bottom in plan view.
[Fig. 11B] Fig. 11B is a side view illustrating a machining method of the tooth bottom and the wall side surface according to the second embodiment.
[Fig. 12] Fig. 12 is a partially enlarged plan view illustrating a circumference of an end plate inclined connecting section.
[Fig. 13A] Fig. 13A illustrates positional relation between a tooth tip and a tooth bottom as a comparative example, and is a side view at a width center position.
[Fig. 13B] Fig. 13B illustrates positional relation between the tooth tip and the tooth bottom as the comparative example, and is a side view at a contact position.
[Fig. 13C] Fig. 13C illustrates positional relation between the tooth tip and the tooth bottom as the comparative example, and is a side view at a position advanced by 180° from the width center position.
[Fig. 14A] Fig. 14A illustrates positional relation between a tooth tip and the tooth bottom in the second embodiment, and is a side view at a contact position.
[Fig. 14B] Fig. 14B illustrates positional relation between the tooth tip and the tooth bottom in the second embodiment, and is a side view at a width center position.

[Fig. 14C] Fig. 14C illustrates positional relation between the tooth tip and the tooth bottom in the second embodiment, and is a side view at a position advanced by 180° from the width center position.

[Fig. 15] Fig. 15 is a partially enlarged longitudinal sectional view illustrating a circumference of a tip clearance.

[Fig. 16] Fig. 16 is a plan view illustrating a machining method of a tooth bottom and a wall side surface according to a third embodiment.

[Fig. 17] Fig. 17 is a partially enlarged plan view illustrating a circumference of an end plate inclined connecting section.

[Fig. 18] Fig. 18 is a schematic diagram representing geometrical relation of a contour line according to a third embodiment.

[Description of Embodiments]

[First Embodiment]

[0028] Hereinafter, a first embodiment according to the present invention will be described with reference to the drawings.

[0029] Fig. 1 illustrates a fixed scroll (first scroll member) 3 and a turning scroll (second scroll member) 5 of a scroll compressor (scroll fluid machine) 1. The scroll compressor 1 is used as a compressor that compresses a gas refrigerant (fluid) for performing refrigerating cycle of an air conditioner or the like, for example.

[0030] The fixed scroll 3 and the turning scroll 5 are a compression mechanism made of metal such as aluminum alloy and iron, and are housed in a housing (not illustrated). The fixed scroll 3 and the turning scroll 5 suck, from the outer circumferential side, fluid guided into the housing, and discharge the compressed fluid from a discharge port 3c at the center of the fixed scroll 3 to the outside.

[0031] The fixed scroll 3 is fixed to the housing, and includes a substantially disk-shaped end plate (first end plate) 3a, and a spiral wall (first wall) 3b erected on a side surface of the end plate 3a, as illustrated in Fig. 1A. The turning scroll 5 includes a substantially disk-shaped end plate (second end plate) 5a, and a spiral wall (second wall) 5b erected on a side surface of the end plate 5a. The respective spiral shapes of the walls 3b, 5b are each defined by using, for example, an involute curve or an Archimedes curve.

[0032] The center of the fixed scroll 3 and the center of the turning scroll 5 are separated by a turning radius p, are engaged such that the phases of the walls 3b, 5b are shifted by 180°, and are assembled so as to have slight clearances (tip clearances) in the height direction between tooth tips and tooth bottoms of the walls 3b, 5b of both the scrolls at normal temperature. Consequently, a plurality of pairs of compression chambers formed so as to be surrounded by the end plates 3a, 5a and the walls 3b, 5b are formed between the scrolls 3, 5 so as to be symmetrical with respect to the scroll centers. The turning scroll 5 revolves around the fixed scroll 3 by a rotation prevention mechanism such as an Oldham ring (not illustrated).

[0033] As illustrated in Fig. 1A, inclined sections that continuously reduce an inter-facing-surface distance L between the facing end plates 3a, 5a from the outer circumferential sides toward the inner circumferential sides of the spiral walls 3b, 5b are provided.

[0034] As illustrated in Fig. 2, a wall inclined section 5b1 having a height that continuously reduces from the outer circumferential side toward inner circumferential side is provided in the wall 5b of the turning scroll 5. An end plate inclined section 3a1 (see Fig. 1A) that inclines in accordance with inclination of the wall inclined section 5b1 is provided in a tooth bottom surface of the fixed scroll 3 facing a tooth tip of this wall inclined section 5b1. The continuous inclined section is formed by these wall inclined section 5b1 and end plate inclined section 3a1. Similarly, a wall inclined section 3b1 having a height that continuously inclines from the outer circumferential side toward inner circumferential side is provided in the wall 3b of the fixed scroll 3, and an end plate inclined section 5a1 facing a tooth tip of this wall inclined section 3b1 is provided in the end plate 5a of the turning scroll 5.

[0035] The meaning of "continuously" in the inclined section mentioned in this embodiment is not limited to smoothly connected inclination, but includes inclination that is formed by stepwisely connecting small steps inevitably generated in machining, and that is an inclined section continuously inclined as a whole. However, the above meaning does not include a large step such as a so-called stepped scroll.

[0036] The wall inclined sections 3b1, 5b1 and/or the end plate inclined sections 3a1, 5a1 are coated. Examples of the coating include manganese phosphate treatment, and nickel-phosphorus plating.

[0037] As illustrated in Fig. 2, wall flat sections 5b2, 5b3 each having a constant height are provided on the innermost circumferential side and the outermost circumferential side of the wall 5b of the turning scroll 5, respectively. These wall flat sections 5b2, 5b3 are each provided over a region of 180° around the center 02 (see Fig. 1A) of the turning scroll 5. Wall inclined connecting sections 5b4, 5b5 serving as bent sections are provided at respective positions where the wall flat sections 5b2, 5b3 and the wall inclined section 5b1 are connected.

[0038] Similarly, end plate flat sections 5a2, 5a3 each having a constant height are provided on a tooth bottom of the end plate 5a of the turning scroll 5. These end plate flat sections 5a2, 5a3 are also each provided over a region of 180°

around the center of the turning scroll 5. End plate inclined connecting sections 5a4, 5a5 serving as bent sections are provided at respective positions where the end plate flat sections 5a2, 5a3 and the end plate inclined section 5a1 are connected.

[0039] As illustrated by hatching in Fig. 3 and Fig. 4, end plate flat sections 3a2, 3a3, wall flat sections 3b2, 3b3, end plate inclined connecting sections 3a4, 3a5, and wall inclined connecting sections 3b4, 3b5 are provided in the fixed scroll 3, like the turning scroll 5.

[0040] Fig. 5 illustrates the walls 3b, 5b represented so as to extend in the spiral direction. As illustrated in Fig. 5, the wall flat sections 3b2, 5b2 on the innermost circumferential sides are each provided so as to extend over a distance D2, and the wall flat sections 3b3, 5b3 on the outermost circumferential sides are each provided so as to extend over a distance D3. The distance D2 and the distance D3 are equivalent to the lengths of the regions of 180° (180° or more and 360° or less, preferably 210° or less) around the centers O1, O2 of the scrolls 3, 5. The wall inclined sections 3b1, 5b1 are provided between the wall flat sections 3b2, 5b2 on the innermost circumferential sides and the wall flat sections 3b3, 5b3 on the outermost circumferential sides so as to extend over a distance D1. Where each of height differences between the wall flat sections 3b2, 5b2 on the innermost circumferential sides and the wall flat sections 3b3, 5b3 on the outermost circumferential sides is denoted by h, the inclination φ of each of the wall inclined sections 3b1, 5b1 is expressed by the following expression.

$$\Phi = \tan^{-1} (h/D1) \qquad ...(1)$$

[0041] Thus, the inclination φ in the inclined section is constant with respect to the circumferential direction in which each of the spiral walls 3b, 5b extends. The distance D1 is longer than the distance D2, and is longer than the distance D3.

[0042] For example, in this embodiment, the specifications of the scrolls 3, 5 are as follows.

(1) Turning radius ρ [mm]: 2 or more and 15 or less, preferably 3 or more and 10 or less
(2) The number of turns of each of the walls 3b, 5b: 1.5 or more and 4.5 or less, preferably 2.0 or more and 3.5 or less
(3) Height difference h [mm]: 2 or more and 20 or less, preferably 5 or more and 15 or less
(4) h/Lout (wall height on outermost circumferential side): 0.05 or more and 0.35 or less, preferably 0.1 or more and 0.25 or less
(5) Angular range of inclined section (angular range equivalent to distance D1) [°]: 180 or more and 1080 or less, preferably 360 or more and 720 or less
(6) Angle Φ [°] of inclined section: 0.2 or more and 4 or less, preferably 0.5 or more and 2.5 or less

[0043] In Fig. 6, an enlarged view of a region indicated by reference symbol Z in Fig. 1B is illustrated. As illustrated in Fig. 6, a tip seal 7 is provided on the tooth tip of the wall 3b of the fixed scroll 3. The tip seal 7 is made of resin, and comes into contact with the tooth bottom of the end plate 5a of the facing turning scroll 5 to seal fluid. The tip seal 7 is housed in a tip seal groove 3d formed in the circumferential direction of the tooth tip of the wall 3b. Compressed fluid enters this tip seal groove 3d, and the tip seal 7 is pressed from a back surface, and pressed out to the tooth bottom side to be brought into contact with the facing tooth bottom. Similarly, a tip seal is provided on the tooth tip of the wall 5b of the turning scroll 5.

[0044] When both the scrolls 3, 5 relatively revolve, the respective positions of the tooth tip and the tooth bottom relatively shift by a turning diameter (turning radius $\rho \times 2$). In the inclined section, a tip clearance between the tooth tip and the tooth bottom changes due to this position shift between the tooth tip and the tooth bottom. A tip clearance change amount Δh [mm] is, for example, 0.05 or more and 1.0 or less, preferably 0.1 or more and 0.6 or less. For example, the tip clearance T is small in Fig. 7A, and the tip clearance T is large in Fig. 7B. Even when this tip clearance T changes due to the turning movement, the tip seal 7 is pressed to the tooth bottom side of the end plate 5a from the back surface by compressed fluid, and therefore can seal following this pressing.

[0045] The aforementioned scroll compressor 1 is operated as follows.

[0046] The turning scroll 5 revolves around the fixed scroll 3 by a driving source such as an electric motor (not illustrated). Consequently, fluid is sucked from the outer circumferential sides of the scrolls 3, 5, and is taken in the compression chambers surrounded by the walls 3b, 5b and the end plates 3a, 5a. The fluid in the compression chambers is sequentially compressed in accordance with movement from the outer circumferential side to the inner circumferential side, and the compressed fluid is finally discharged from the discharge port 3c formed in the fixed scroll 3. When the fluid is compressed, the fluid is compressed also in the height direction of the walls 3b, 5b in the inclined sections formed by the end plate inclined sections 3a1, 5a1 and the wall inclined sections 3b1, 5b1, and is three-dimensionally compressed.

[0047] Fig. 8 is a partially enlarged plan view illustrating a circumference of the end plate inclined connecting section 3a5 of the fixed scroll 3. Descriptions of circumferences of other end plate inclined connecting sections 3a4, 5a4, 5a5 are similar, and therefore the circumference of the end plate inclined connecting section 3a5 of the fixed scroll 3 will be hereinafter described.

[0048] In Fig. 8, the end plate flat section 3a3 on the outermost circumferential side and the end plate inclined section 3a1 are provided between an inner side 3b-in of the wall 3b on the outer circumferential side and an outer side 3b-out of the wall 3b on the inner circumferential side of the fixed scroll 3. In Fig. 8, the wall 5b of the turning scroll 5 is illustrated. A state in which the wall 5b is located at a contact position P1 where the wall 5b is in contact with the inner side 3b-in of the wall 3b on the outer circumferential side of the fixed scroll 3, and a state in which the wall 5b is located at a width center position P2 located at a center in the direction of a tooth bottom width Tg being the size between the inner side 3b-in and the outer side 3b-out of the wall 3b are illustrated. The contact position P1 is a turning center position in the spiral direction (right and left direction in Fig. 8) at the time of turning movement. Reference symbol W1 denotes a center line in the width direction of the wall 5b.

[0049] A contour line Ct1 is illustrated at a position of the end plate inclined connecting section 3a5. The contour line Ct1 is a segment formed in the direction orthogonal to the spiral direction of the wall 3b. A turning locus Tr having a turning radius ρ is illustrated with an intermediate position of the contour line Ct1 in the direction of the tooth bottom width Tg as the center 03. This turning locus Tr is a locus of an intersection Cp obtained by intersecting the contour line Ct1 where the wall 5b is located at the contact position P1, and the center line W1 of the wall 5b.

[0050] As apparent from the contact position P1, the wall inclined connecting section 5b5 of the wall 5b is disposed with a phase delayed by the turning radius ρ with respect to the end plate inclined connecting section 3a5. The reason for this is as follows.

[0051] Hypothetically, when a wall inclined connecting section 5b5' illustrated by a broken line is disposed so as to coincide with the contour line Ct1 at the contact position P1, in other words, when the wall inclined connecting section 5b5' and the end plate inclined connecting section 3a5 have the same phase, the respective shapes of the tooth bottom (end plate 3a side) and the tooth tip (wall 5b side) coincide with each other at the contact position P1 as illustrated in Fig. 9A. When turning is advanced, and the wall 5b reaches at the width center position P2, the tooth bottom and the tooth tip interfere with each other as illustrated in Fig. 9B. Fig. 9C illustrates such a position that the phase further advances by 180° from the width center position P2.

[0052] Therefore, in a case where the contour line Ct1 is a segment formed in the direction orthogonal to the spiral direction of the wall 3b, the wall inclined connecting section 5b5' and the end plate inclined connecting section 3a5 cannot be disposed at the same phase.

[0053] In this embodiment, as illustrated in Fig. 8, the wall inclined connecting section 5b5 is disposed with the phase delayed by the turning radius ρ with respect to the end plate inclined connecting section 3a5 at the contact position P1. Consequently, as illustrated in Fig. 10A, the wall inclined connecting section 5b5 is disposed at a position offset by the turning radius ρ at the contact position P1, and the tip clearance T in the end plate inclined connecting section 3a5 is ($\rho \times \tan \varphi$). However, as illustrated in Fig. 10B, when turning is advanced and the wall 5b reaches the width center position P2, the tip clearance can be minimized. Φ denotes the inclination of the inclined section (see Fig. 5).

[0054] According to this embodiment, the following working effect is exhibited.

[0055] In a case where the contour lines Ct1 are formed in the directions orthogonal to the spiral directions of the walls 3b, 5b on the end plate inclined sections 3a1, 5a1, that is, the tooth bottoms, when the end plate inclined connecting sections 3a4, 3a5, 5a4, 5a5 and the wall inclined connecting sections 3b4, 3b5, 5b4, 5b5 coincide at the turning center positions (contact positions P1) in the spiral directions, the tooth bottoms and the tooth tips may interfere with each other at the time of turning movement of both the scrolls 3, 5. To cope with the above, the wall inclined connecting sections 3b4, 3b5, 5b4, 5b5 each are disposed with the phase delayed by the turning radius ρ with respect to corresponding one of the end plate inclined connecting sections 3a4, 3a5, 5a4, 5a5. Consequently, it is possible to avoid interference between the tooth bottoms and the tooth tips. In a case where the phase of each of the wall inclined connecting sections 3b4, 3b5, 5b4, 5b5 advances by the turning radius ρ with respect to corresponding one of the end plate inclined connecting sections 3a4, 3a5, 5a4, 5a5, and the end plate inclined connecting sections 3a4, 3a5, 5a4, 5a5 and the wall inclined connecting sections 3b4, 3b5, 5b4, 5b5 engage with each other such that the positions thereof coincide with each other, and therefore it is possible to minimize the tip clearances T between the tooth tips and the tooth bottoms.

[Second Embodiment]

[0056] Now, a second embodiment of the present invention will be described. This embodiment is different from the first embodiment in the shape of the circumference of the end plate inclined connecting section 3a5 illustrated in Fig. 8, and other configurations are similar to those of the first embodiment. Therefore, differences from the first embodiment will be described, and similar components are denoted by the same reference numerals, and will not be described.

[0057] In the first embodiment, the contour line Ct1 is the segment formed in the direction orthogonal to the spiral direction of the wall 3b. However, this embodiment is different in that a contour line has a circular arc.

[0058] When the contour line having the circular arc is formed on each of end plate inclined sections 3a1, 5a1, machining is performed by an end mill 10 as illustrated in Fig. 11. The diameter De of the end mill 10 is made to be equivalent to a tooth bottom width Tg, and machining of the tooth bottom and the wall side surface is performed in one inclination rising direction by one pass. The machining is performed such that a rotation axis of the end mill 10 is located perpendicular to a flat surface of each of end plate flat sections 3a2, 3a3, 5a2, 5a3. Consequently, a contour line having a semicircular arc illustrated in Fig. 11A is formed.

[0059] Fig. 12 illustrates a contour line Ct2 having a circular arc obtained by the aforementioned machining method. Fig. 12 is a diagram corresponding to Fig. 8 of the first embodiment.

[0060] As illustrated in Fig. 12, the diameter of the contour line Ct2 is made to be the tooth bottom width Tg, and the contour line Ct2 is a semicircular arc that projects on the end plate inclined section 3a1 side (left in Fig. 12). That is, the radius of the contour line Ct2 is Tg/2. In the contour line Ct2, an intersection Cp0 of an inner side 3b-in of a wall 3b and an end plate inclined connecting section 3a5, and an intersection Cp0 of an outer side 3b-out of the wall 3b and the end plate inclined connecting section 3a5 are contact points.

[0061] At a contact position P1, a wall inclined connecting section 5b5 of a wall 5b is disposed so as to coincide at a turning center position in the spiral direction (right and left direction in Fig. 12) at the time of turning movement. That is, the wall inclined connecting section 5b5 and the end plate inclined connecting section 3a5 have the same phase. The reason for this is as follows.

[0062] Hypothetically, when a wall inclined connecting section 5b5' illustrated by a broken line is disposed so as to coincide with the contour line Ct2 at the width center position P2, the wall inclined connecting section 5b5' is located at such a position that the phase advances by Tg/2-ρ from a position of the same phase, as illustrated in Fig. 13B. However, when the turning is advanced, and the wall 5b reaches the width center position P2, the tooth bottom and the tooth tip interfere with each other as illustrated in Fig. 13A. Fig. 13C illustrates such a position that the phase further advances by 180° from the width center position P2.

[0063] Therefore, in a case where the contour line Ct2 is a semicircular arc having a diameter equivalent to the tooth bottom width Tg, the phase of the wall inclined connecting section 5b5' cannot be advanced beyond that of the end plate inclined connecting section 3a5.

[0064] To cope with the above, in this embodiment, the wall inclined connecting section 5b5 is disposed so as to have the same phase as the end plate inclined connecting section 3a5 at the contact position P1, as illustrated in Fig. 14. Consequently, the side surface shape of the tooth tip and the side surface shape of the tooth bottom coincide at the contact position P1, as illustrated in Fig. 14A. When the phase advances by the turning movement, the tip clearance T in a width center of the contour line Ct2 is $\{(Tg/2 - \rho) \times \tan \varphi\}$ at the width center position P2 as illustrated in Fig. 14B.

[0065] According to this embodiment, the following working effects are exhibited.

[0066] The one semicircular arc having the intersections Cp0 of the end plate inclined connecting section 3a5 and the wall 3b as the contact points is formed as the contour line Ct2 on the end plate inclined section 3a1. When the wall inclined connecting section 5b5 is disposed so as to coincide with the end plate inclined connecting section 3a5 at the turning center position in the spiral direction (contact position P1) at the time of turning movement, that is, is disposed so as to have the same phase as the end plate inclined connecting section 3a5, the tooth tip and the tooth bottom do not interfere with each other at the time of the turning movement, and it is possible to reduce the tip clearance as much as possible.

[0067] When the wall 5b is located at the contact position P1, the tip clearance T between the tooth tip and the tooth bottom is minimized between the walls 3b, 5b being in contact with each other, and therefore it is possible to reduce leakage in the spiral direction of the wall 3b. That is, as illustrated in Fig. 15, although a region A surrounded by the tooth tip of the wall 5b, a tip seal 7, the tooth bottom of the end plate 3a, and the side surface of the wall 3b is a clearance of the leakage in the spiral direction, the tip clearance T can be minimized, and therefore it is possible to reduce leakage in the spiral direction of the wall 3b. Reference numeral 5d denotes a tip seal groove formed in a tip of the wall 5b.

[Third Embodiment]

[0068] Now, a third embodiment of the present invention will be described. This embodiment is different from the second embodiment in the shape of the circumference of the end plate inclined connecting section 3a5 illustrated in Fig. 12, and other configurations are similar to those of the second embodiment. Therefore, differences from the second embodiment will be described, and similar components are denoted by the same reference numerals, and will not be described.

[0069] In the second embodiment, the contour line Ct2 has the one semicircular arc. However, this embodiment is different in that a contour line has two circular arcs having the same diameter.

[0070] When the contour line having the two circular arcs is formed on each of end plate inclined sections 3a1, 5a1, machining is performed by an end mill 10 as illustrated in Fig. 16. Fig. 16 is a diagram corresponding to Fig. 11A, and machining is performed by cutting twice (2 passes) such that the end mill 10 rises on an inclination in the spiral direction of each of the walls 3b, 5b. That is, one side wall of the wall 3b and a tooth bottom continued to the same is machined in first cutting, and the other side wall of the wall 3b and a tooth bottom continued to the same is machined in second cutting. Consequently, a shape formed by connecting the two semicircular arcs at a width center is a contour line Ct3.

[0071] Therefore, in this embodiment, relation of (end mill diameter De < tooth bottom width Tg) is established.

[0072] Fig. 17 illustrates the contour line Ct3 having the circular arcs obtained by the aforementioned machining method. Fig. 17 is a diagram corresponding to Fig. 12 of the second embodiment.

[0073] As illustrated in Fig. 17, the contour line Ct3 has the shape in which the two circular arcs each having an end mill diameter De as the diameter are connected at the width center of the tooth bottom, and each circular arc projects on the end plate inclined section 3a1 side (left in Fig. 17). In the contour line Ct3, an intersection Cp0 of an inner side 3b-in of the wall 3b and the end plate inclined connecting section 3a5, and an intersection Cp0 of an outer side 3b-out of the wall 3b and the end plate inclined connecting section 3a5 are contact points.

[0074] At a contact point P1, a wall inclined connecting section 5b5 of the wall 5b is disposed so as to coincide at a turning center position in the spiral direction (right and left direction in Fig. 17) at the time of turning movement. That is, the wall inclined connecting section 5b5 and the end plate inclined connecting section 3a5 have the same phase. The reason is that the tooth tip and the tooth bottom do not come into contact with each other, and a tip clearance is reduced as much as possible, as described in the second embodiment.

[0075] When a distance R from a center 03 of a turning locus Tr to the contour line Ct3 in the spiral direction and the direction of the inclined section 3a1 is smaller than a turning radius ρ, the tooth bottom and the tooth tip interfere with each other, and therefore the following expression needs to be satisfied.

$$\{Tg^2 + (2\rho)^2\}/(2Tg) \leq De \leq Tg \qquad ...(2)$$

[0076] Referring to geometrical relation in Fig. 18, the distance R is expressed by the following expression.

$$R = (1/2) \times \{De^2 - (Tg - De)^2\}^{1/2} \qquad ...(3)$$

[0077] In this embodiment, a tip clearance in a case where the wall 5b advances and reaches the width center position P2 becomes smaller than the tip clearance in the second embodiment, and therefore this embodiment is advantageous. This is because the distance R from the center 03 of the turning locus Tr to the contour line Ct3 is shorter than a corresponding distance Tg/2 (see Fig. 12) in the second embodiment, as apparent from Fig. 17.

[0078] In order to minimize the tip clearance, the distance R is made to be equal to the turning radius ρ. When $R = \rho$ is substituted into the aforementioned Expression (3), and the substituted expression is solved, the following expression is derived.

$$De = \{Tg^2 + (2\rho)^2\}/(2Tg) \qquad ...(4)$$

[0079] That is, the contour line Ct3 only needs to be formed by the end mill diameter De so as to satisfy the aforementioned expression.

[0080] According to this embodiment, the following working effects are exhibited in addition to the working effects of the second embodiment.

[0081] The contour line Ct3 is composed of the two circular arcs, and therefore the distance R can be made shorter than Tg/2. Therefore, the tip clearance can be made smaller than that of the second embodiment, so that it is possible to reduce leakage.

[0082] Further, the contour line Ct3 is formed by the two circular arcs each having the end mill diameter De satisfying Expression (4), so that when the tooth tip and the tooth bottom come closest to each other at the time of turning movement, a tip clearance between the contour line Ct3 and the wall inclined connecting section 5b5 can approach zero.

[0083] In this embodiment, the contour line Ct3 is composed of the two circular arcs having the same diameter. However, a contour line composed of three or more circular arcs may be employed.

[0084] In each of the aforementioned embodiment, a configuration in which the flat sections 3a2, 3a3, 3b2, 3b3, 5a2, 5a3, 5b2, 5b3 are provided is employed. However, the present invention can be applied to a configuration in which any flat section is not provided on the outermost circumferential side and/or innermost circumferential side. For example, in a case of the first embodiment, a fixed scroll 3 and a turning scroll 5 are disposed with phases shifted by a turning radius in the direction in which the facing inclined sections are separated from each other. In a case of the second embodiment or the third embodiment, the fixed scroll 3 and turning scroll 5 are disposed so as to have phases that coincide at the turning center position in the spiral direction at the time of turning movement.

[0085] In each of the aforementioned embodiment, the scroll compressor is employed. However, the present invention can be also applied to a scroll expander used as an expander.

[Reference Signs List]

[0086]

1 scroll compressor (scroll fluid machine)
3 fixed scroll (first scroll member)
3a end plate (first end plate)
3a1 end plate inclined section
3a2 end plate flat section (inner circumferential side)
3a3 end plate flat section (outer circumferential side)
3a4 end plate inclined connecting section (inner circumferential side)
3a5 end plate inclined connecting section (outer circumferential side)
3b wall (first wall)
3b1 wall inclined section
3b2 wall flat section (inner circumferential side)
3b3 wall flat section (outer circumferential side)
3b4 wall inclined connecting section (inner circumferential side)
3b5 wall inclined connecting section (outer circumferential side)
3c discharge port
5 turning scroll (second scroll member)
5a end plate (second end plate)
5a1 end plate inclined section
5a2 end plate flat section (inner circumferential side)
5a3 end plate flat section (outer circumferential side)
5b wall (second wall)
5b1 wall inclined section
5b2 wall flat section (inner circumferential side)
5b3 wall flat section (outer circumferential side)
5b4 wall inclined connecting section (inner circumferential side)
5b5 wall inclined connecting section (outer circumferential side)
5d tip seal groove
7 tip seal
10 end mill
Ct1, Ct2, Ct3 contour line
L inter-facing-surface distance
T tip clearance
Tg tooth bottom width
Tr turning locus
W1 center line of wall
φ inclination

Claims

1. A scroll fluid machine comprising:

a first scroll member provided with a spiral first wall on a first end plate; and
a second scroll member that is provided with a spiral second wall on a second end plate disposed so as to face the first end plate, and that relatively revolves by engagement between the second wall and the first wall with the second wall being offset from the first wall by a turning radius, wherein
an inclined section that continuously reduces an inter-facing-surface distance between the first end plate and the second end plate facing each other, from an outer circumferential side toward an inner circumferential side of each of the first wall and the second wall is provided,
each of the inclined sections is provided over a range of 180° or more around a spiral center,
at least one of the first wall and the second wall has a wall inclined section that has a height of the wall continuously

reducing from the outer circumferential side toward the inner circumferential side so as to form the inclined section,
at least one of the first end plate and the second end plate has an end plate inclined section having a tooth bottom surface that faces a tooth tip of the wall inclined section, and that inclines in accordance with an inclination of the wall inclined section,
a contour line is formed in a direction orthogonal to a spiral direction of the wall, on the end plate inclined section, and
the first scroll member and the second scroll member are disposed with phases shifted by the turning radius in a direction in which the facing inclined sections are separated from each other.

2. The scroll fluid machine according to claim 1, wherein
a wall flat section having no change in height is provided in an outermost circumferential part and/or an innermost circumferential part of each of the first wall and the second wall,
an end plate flat section corresponding to the wall flat section is provided in each of the first end plate and the second end plate, and
a wall inclined connecting section that connects the wall inclined section and the wall flat section is disposed with a phase delayed by the turning radius with respect to an end plate inclined connecting section that connects the end plate inclined section and the end plate flat section.

3. A scroll fluid machine comprising:

a first scroll member provided with a spiral first wall on a first end plate; and
a second scroll member that is provided with a spiral second wall on a second end plate disposed so as to face the first end plate, and that relatively revolves by engagement between the second wall and the first wall with the second wall being offset from the first wall by a turning radius, wherein
an inclined section that continuously reduces an inter-facing-surface distance between the first end plate and the second end plate facing each other, from an outer circumferential side toward an inner circumferential side of each of the first wall and the second wall is provided,
each of the inclined sections is provided over a range of 180° or more around a spiral center,
at least one of the first wall and the second wall has a wall inclined section that has a height of the wall continuously reducing from the outer circumferential side toward the inner circumferential side so as to form the inclined section,
at least one of the first end plate and the second end plate has an end plate inclined section having a tooth bottom surface that faces a tooth tip of the wall inclined section, and that inclines in accordance with an inclination of the wall inclined section,
one or a plurality of circular arcs each having an intersection with the wall as a contact point is formed as a contour line on the end plate inclined section, and
the first scroll member and the second scroll member are disposed so as to have phases that coincide at a turning center position in a spiral direction at a time of the turning movement.

4. The scroll fluid machine according to claim 3, wherein
a wall flat section having no change in height is provided in an outermost circumferential part and/or an innermost circumferential part of each of the first wall and the second wall,
an end plate flat section corresponding to the wall flat section is provided in each of the first end plate and the second end plate,
one or a plurality of circular arcs each having an intersection of the wall and an end plate inclined connecting section that connects the end plate inclined section and the end plate flat section as a contact point is formed as a contour line on the end plate inclined section, and
a wall inclined connecting section that connects the wall inclined section and the wall flat section is disposed so as to coincide with the end plate inclined connecting section at the turning center position in the spiral direction at the time of the turning movement.

5. The scroll fluid machine according to claim 3 or 4, wherein
where a diameter of the circular arc forming the contour line is denoted by De, a tooth bottom width of the end plate inclined section is denoted by Tg, and the turning radius in the turning movement is denoted by p,

$$\{Tg^2 + (2\rho)^2\}/(2Tg) \leq De \leq Tg$$

is satisfied.

6. The scroll fluid machine according to claim 5, wherein

$$De = \{Tg^2 + (2\rho)^2\}/(2Tg)$$

is satisfied.

FIG. 1A

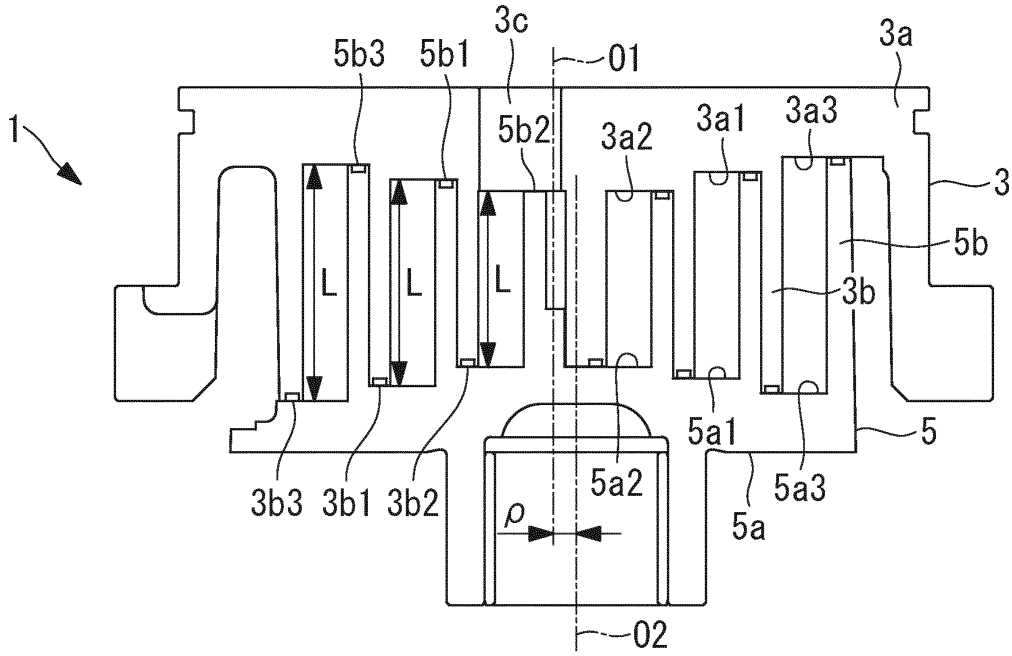

3c
5b3
5b1
01
3a
1
5b2
3a2
3a1
3a3
3
5b
L
L
L
3b
5a1
5
3b3
3b1
3b2
5a2
5a3
ρ
5a
02

FIG. 1B

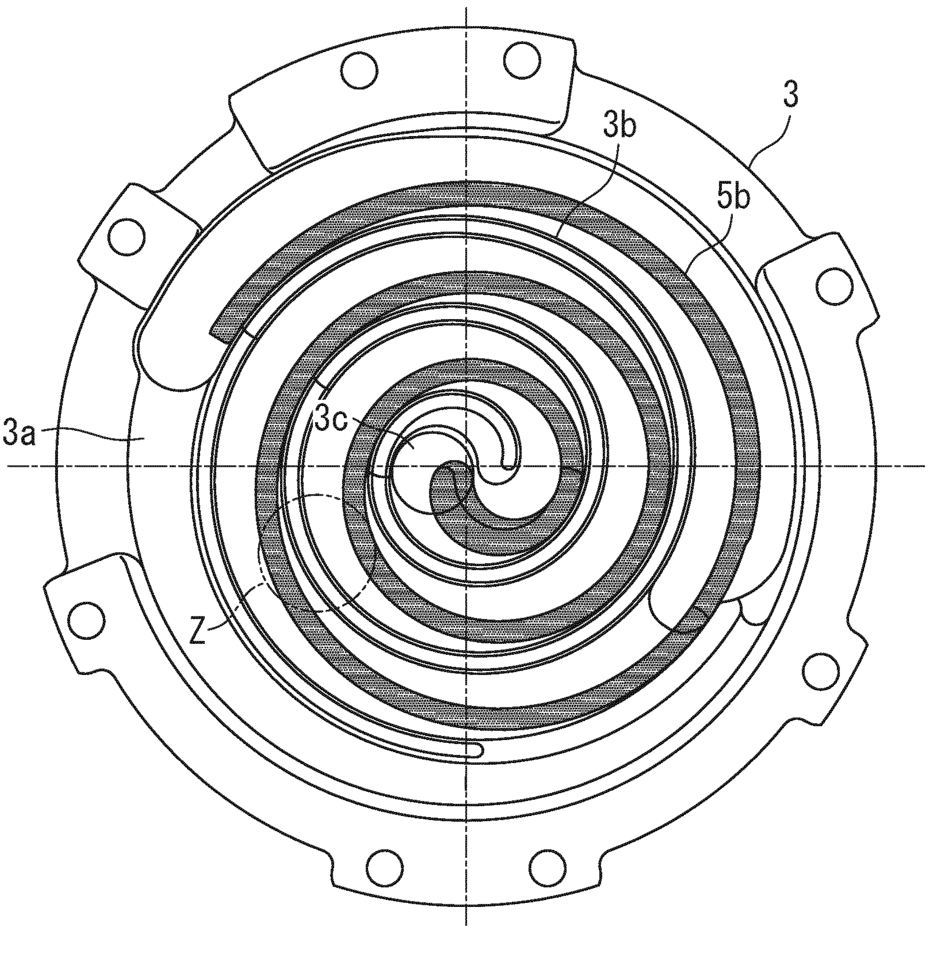

3
3b
5b
3a
3c
Z

FIG. 2

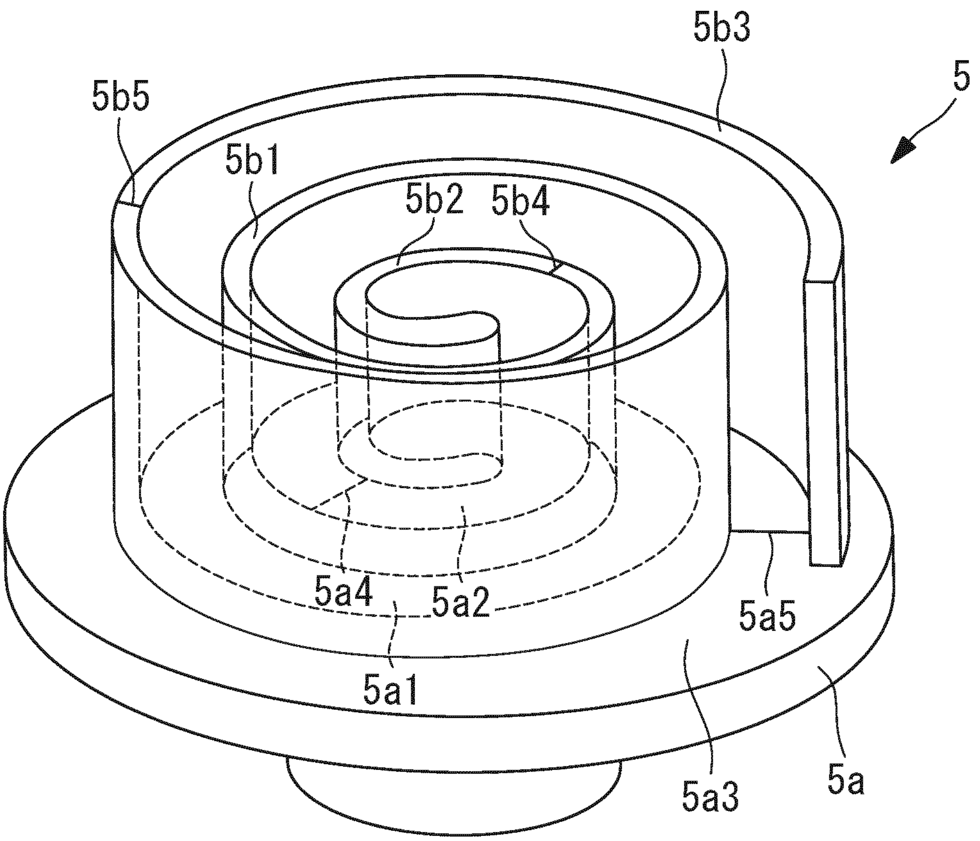


FIG. 3

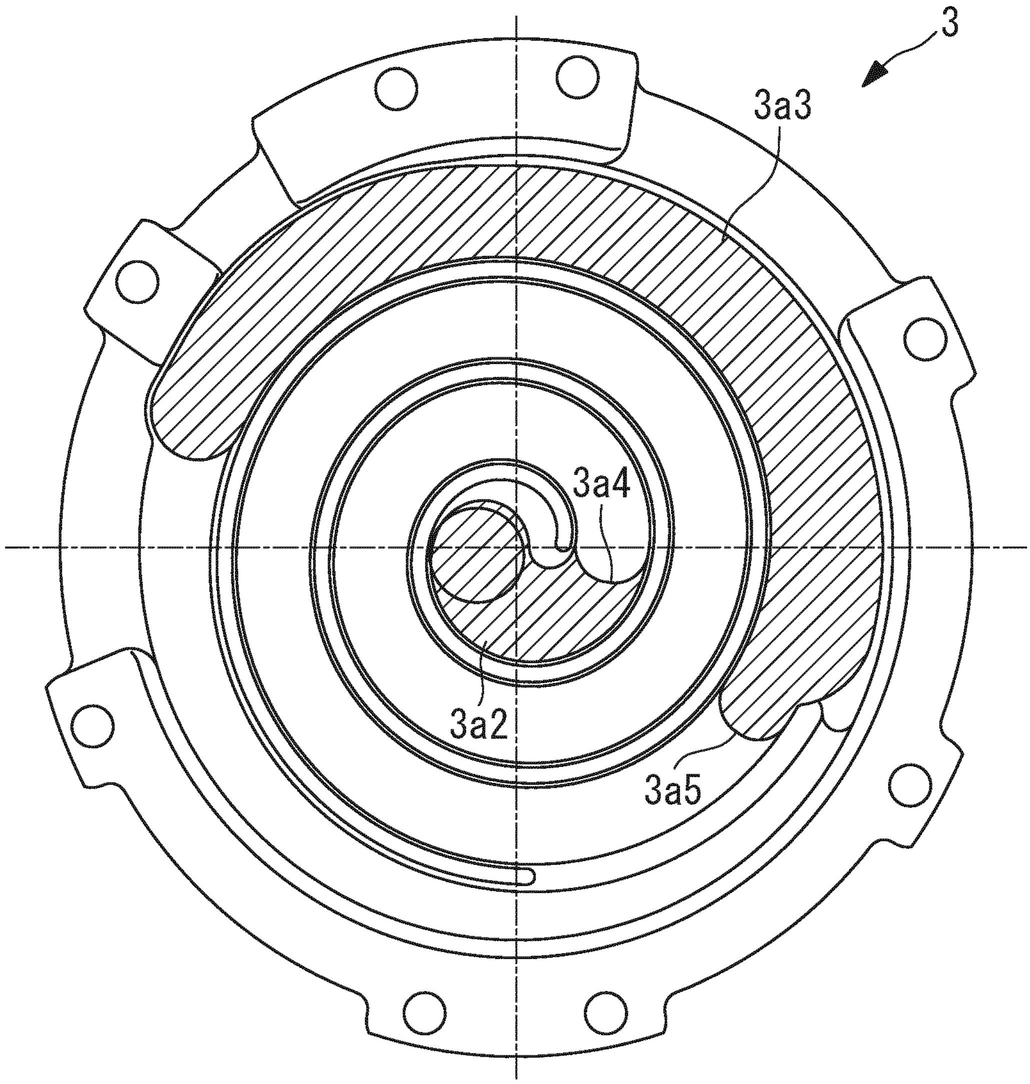


FIG. 4

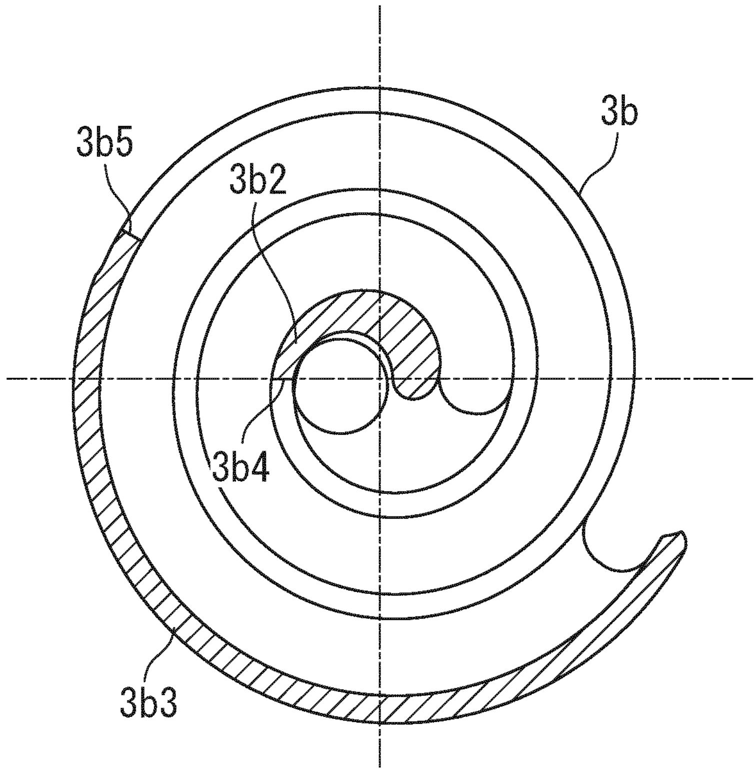


FIG. 5

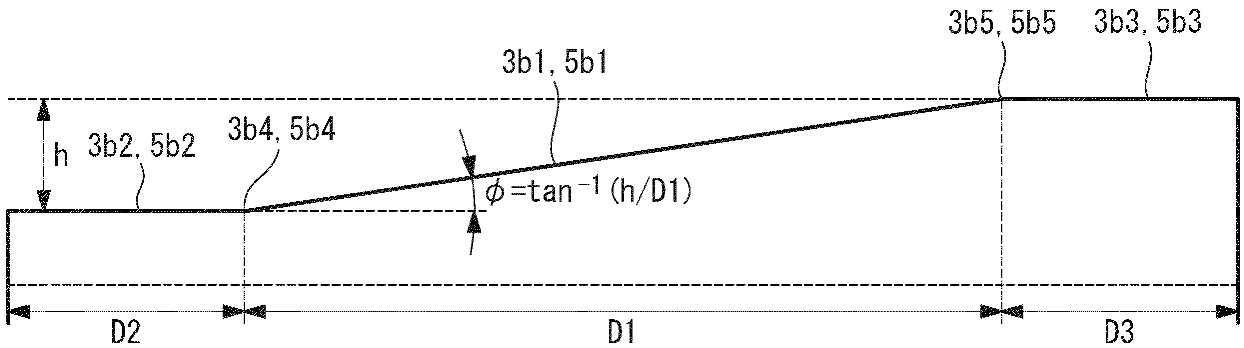


FIG. 6

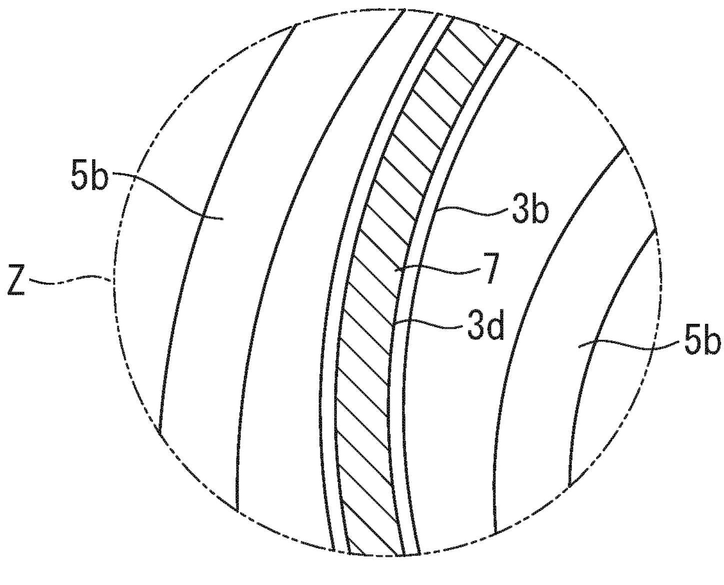


FIG. 7A

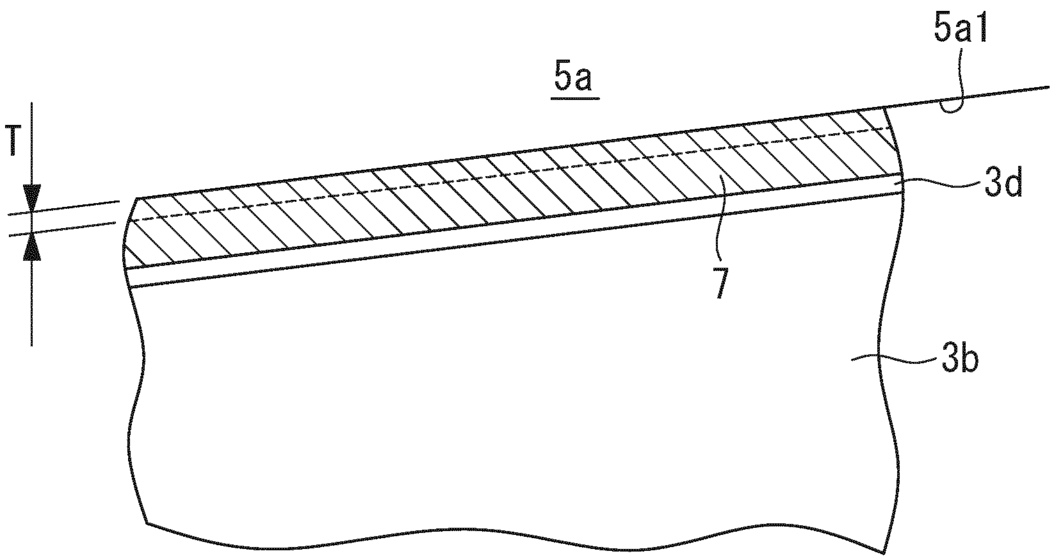


FIG. 7B

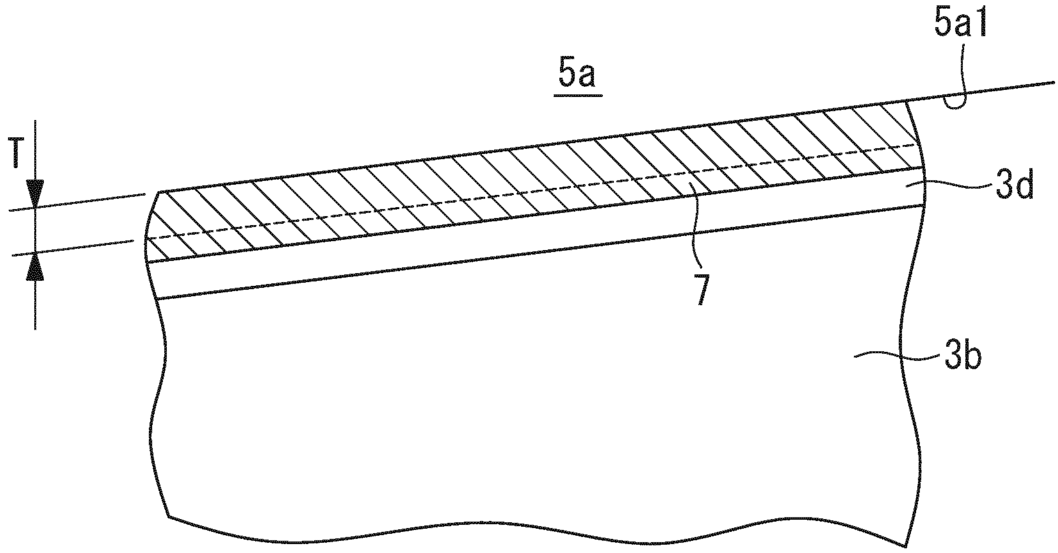


FIG. 8

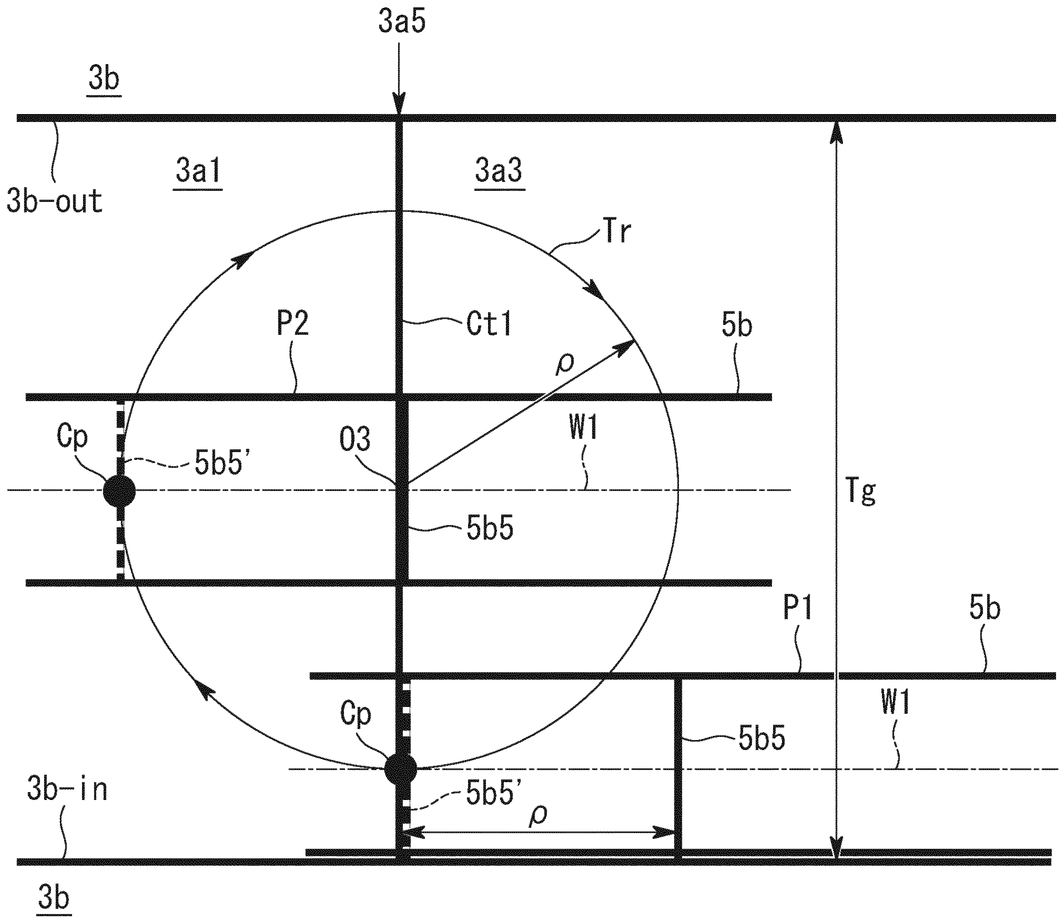

3a5
3b
3a1
3a3
3b-out
Tr
P2
Ct1
5b
ρ
Cp
5b5'
O3
W1
Tg
5b5
P1
5b
W1
Cp
5b5
3b-in
5b5'
ρ
3b

FIG. 9A

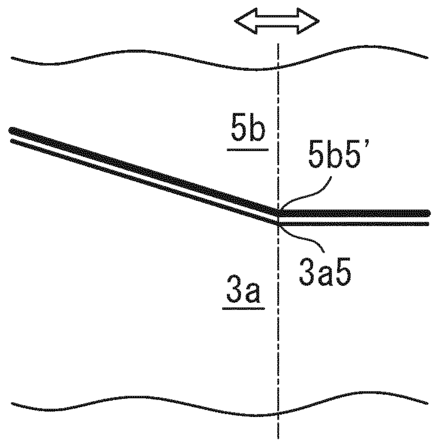


FIG. 9B

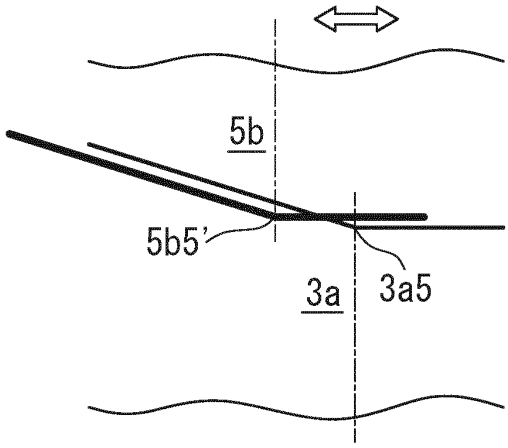


FIG. 9C

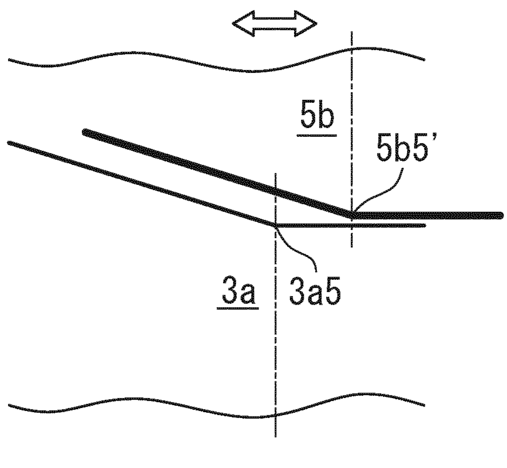


FIG. 10A

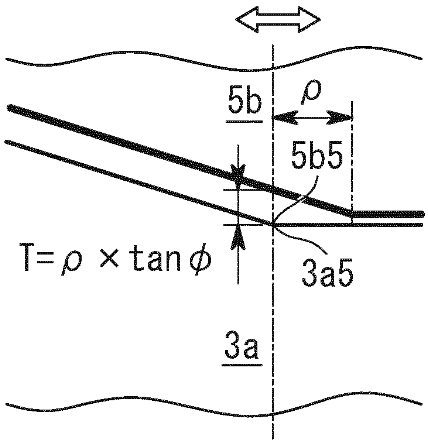


FIG. 10B

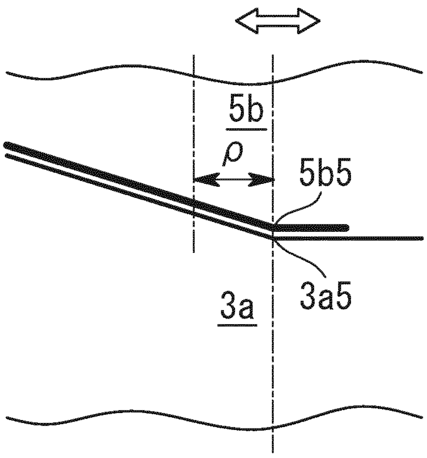


FIG. 10C

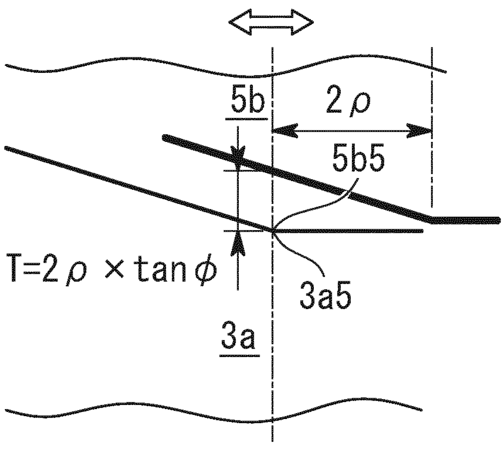


FIG. 11A

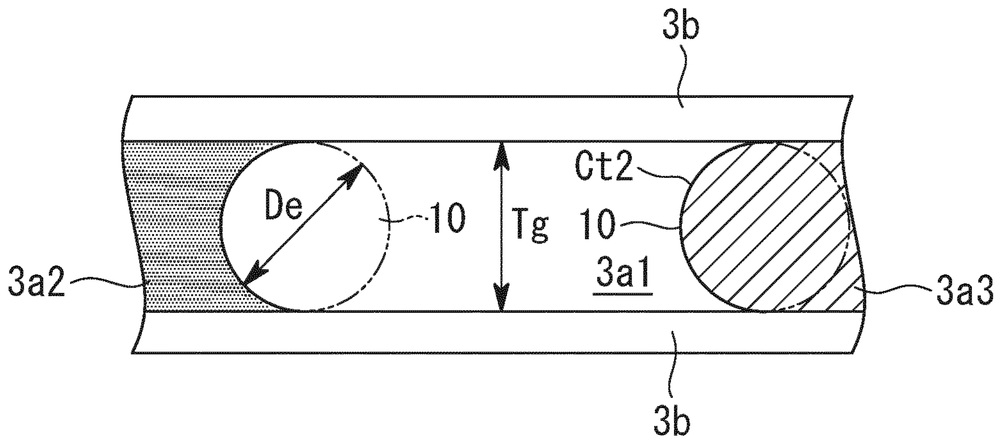


FIG. 11B

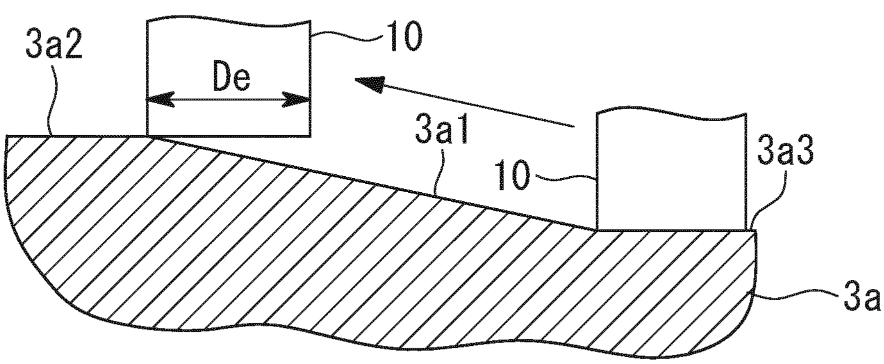


FIG. 12

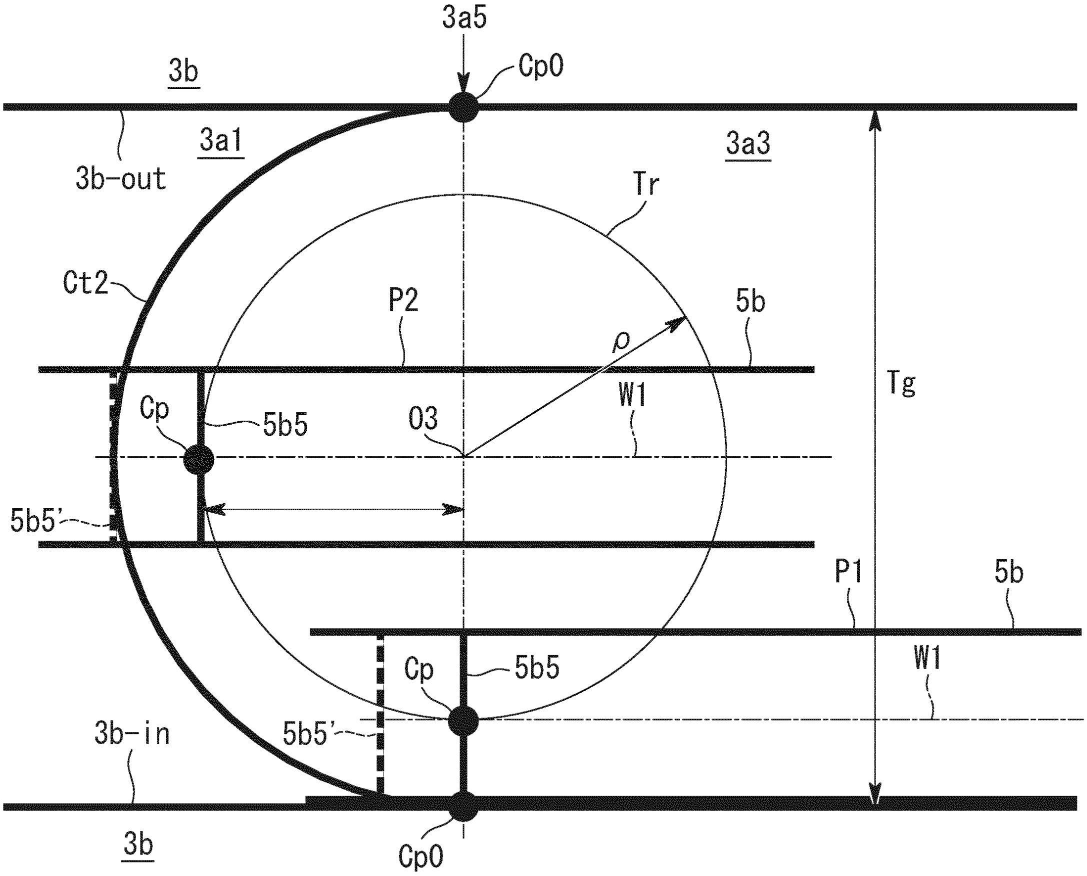

3a5
Cp0
3b
3a1
3a3
3b-out
Tr
Ct2
P2
5b
ρ
Tg
W1
Cp
5b5
O3
5b5'
P1
5b
W1
Cp
5b5
3b-in
5b5'
3b
Cp0

FIG. 13A

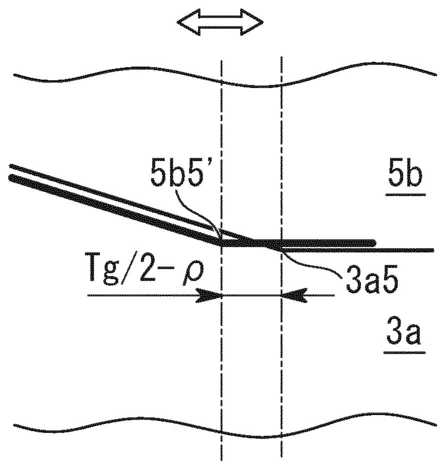


FIG. 13B

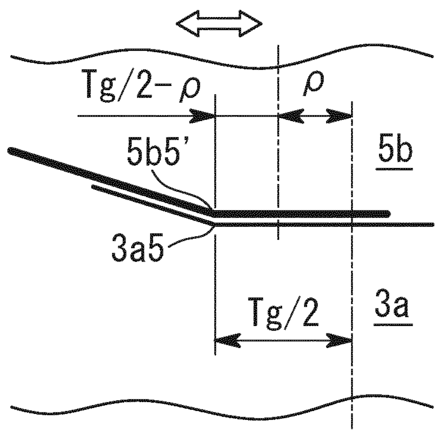


FIG. 13C

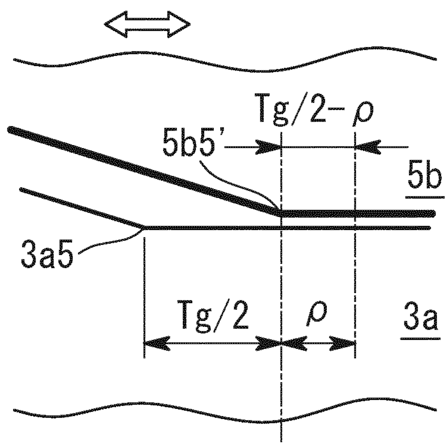


FIG. 14A

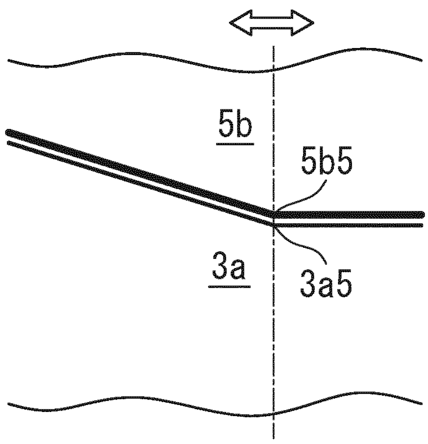


FIG. 14B

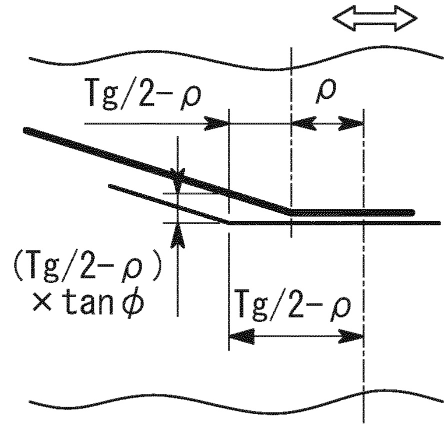


FIG. 14C

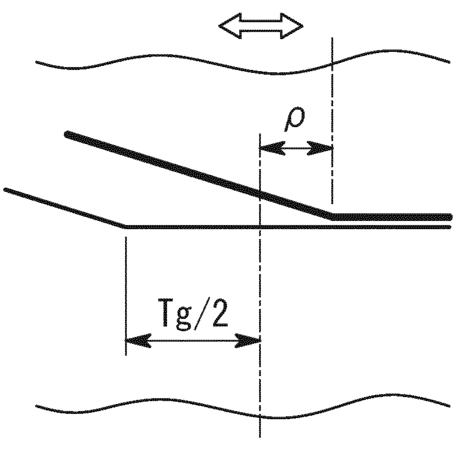


FIG. 15

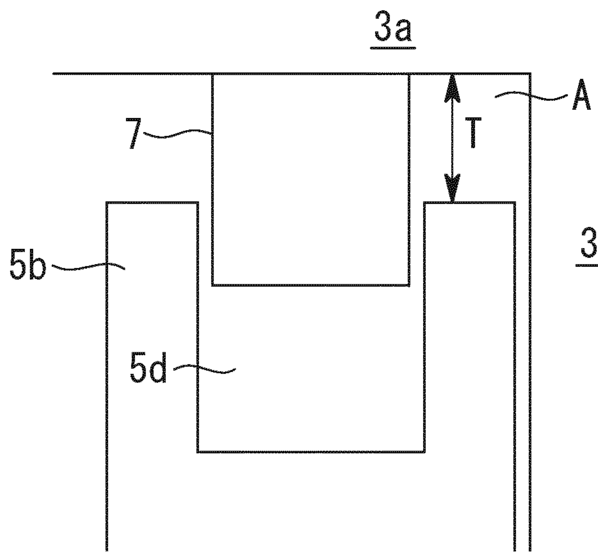


FIG. 16

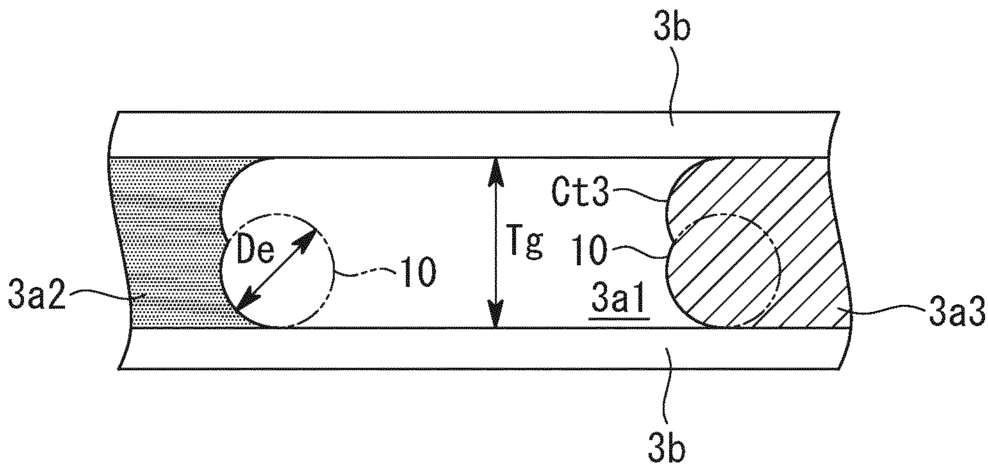


FIG. 17

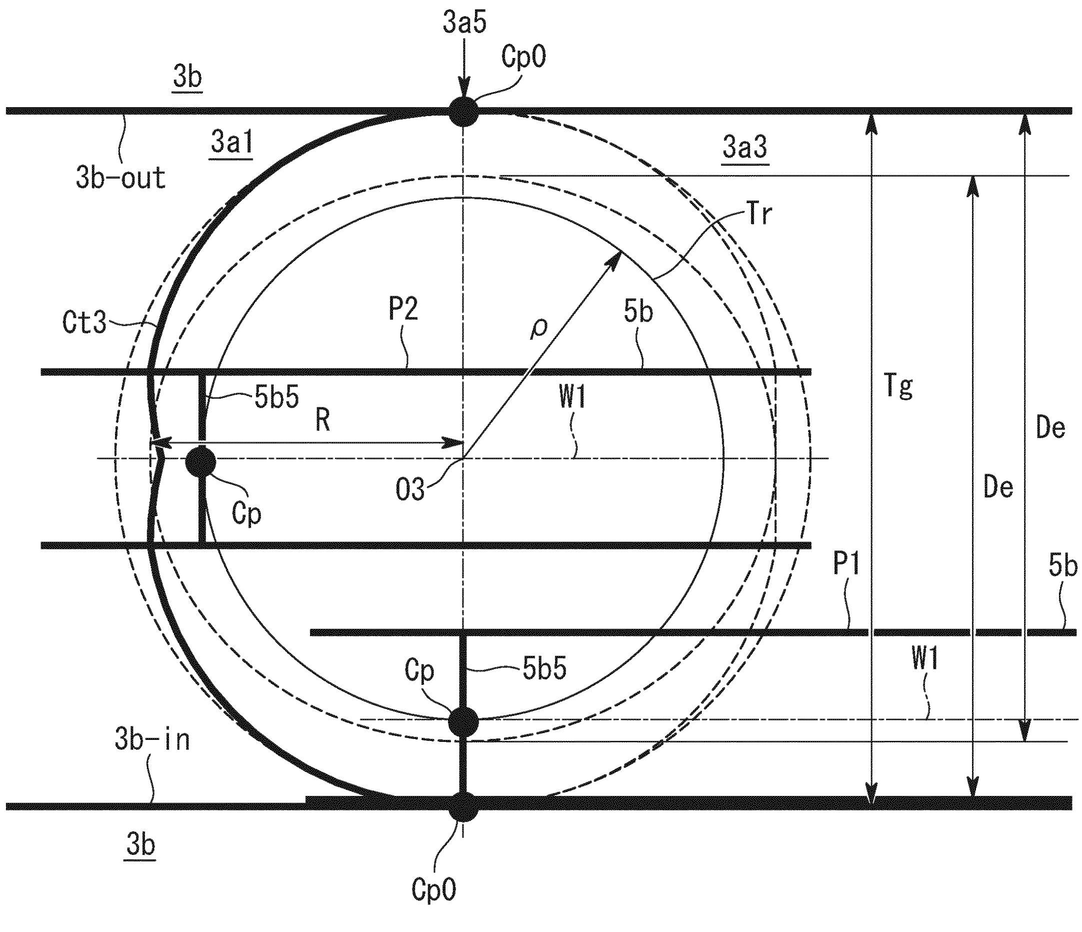
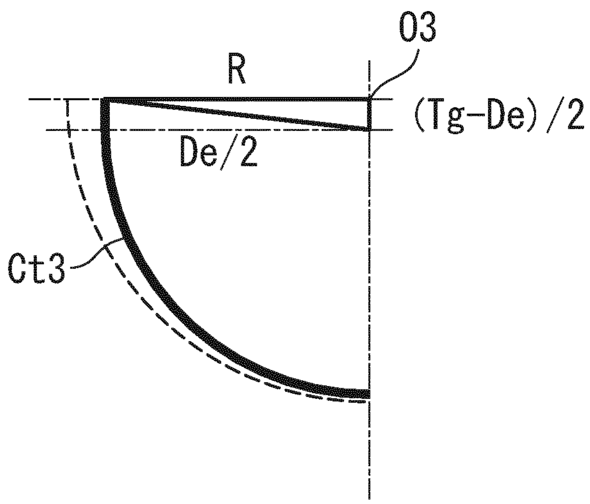

3a5
Cp0
3b
3a1
3a3
3b-out
Tr
Ct3
P2
ρ
5b
5b5
W1
Tg
De
R
De
O3
Cp
P1
5b
W1
Cp
5b5
3b-in
3b
Cp0

FIG. 18



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/000899

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl. F04C18/02(2006.01)i, F01C1/02(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)
Int. Cl. F04C18/02, F01C1/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2019
Registered utility model specifications of Japan 1996-2019
Published registered utility model applications of Japan 1994-2019

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	CN 204003446 U (CAI, JUNKAI) 10 December 2014, paragraphs [0037]-[0042], fig. 7-9 (Family: none)	1, 3 4-6 2
Y	JP 2010-196663 A (MITSUBISHI HEAVY INDUSTRIES, LTD.) 09 September 2010, paragraph [0038] (Family: none)	4-6
Y	JP 60-17956 B2 (SANKYO ELECTRIC CO.) 08 May 1985, fig. 7 & JP 58-30494 A	4-6
A	JP 2009-228476 A (DAIKIN INDUSTRIES, LTD.) 08 October 2009, paragraph [0064], fig. 4, 5 (Family: none)	1-6

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

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
27.02.2019	12.03.2019

Name and mailing address of the ISA/	Authorized officer
Japan Patent Office 3-4-3, Kasumigaseki, Chiyoda-ku, Tokyo 100-8915, Japan	Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/000899

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, X	JP 2018-28301 A (MITSUBISHI HEAVY INDUSTRIES THERMAL SYSTEMS, LTD.) 22 February 2018, paragraphs [0039]-[0063], all drawings & WO 2018/034272 A1	1-6

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2015055173 A **[0004]**