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(54) **SCROLL FLUID MACHINE**

SPIRALFLUIDMASCHINE

MACHINE HYDRAULIQUE À SPIRALE

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Description

[Technical Field]

5 **[0001]** The present invention relates to a scroll fluid machine.

[Background Art]

10 **[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.

15 **[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).

20 **[0004]** PTL 2 discloses a scroll fluid machine including a wall body and an end plate that are capable of reducing a tip clearance between a tooth tip of the wall body and a tooth bottom of the end plate. PTL 3 discloses a scroll compressor in which a bottom surface is provided with a stratum with several height differences, so that an axial volume-variation is provided in operation.

[Citation List]

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[Patent Literature]

[0005]

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

 [PTL 2] Japanese Patent Application Publication No. JP2018028301A

 [PTL 3] Chinese Patent Application Publication No. CN204003446U

[Summary of Invention]

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[Technical Problem]

40 **[0006]** 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.

45 **[0007]** 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.

[0008] 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.

50 **[0009]** 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]

55 **[0010]** In order to solve the aforementioned problems, a scroll fluid machine of the present invention employs the following solutions.

[0011] That is, a scroll fluid machine according to a non-claimed example 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.

[0012] 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 volume 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.

[0013] 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.

[0014] Further, in the scroll fluid machine according to this example, 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.

[0015] 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.

[0016] According to the invention a scroll fluid machine according to claim 1 is provided.

[0017] 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 volume 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.

[0018] 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.

[0019] 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.

[0020] Further, according to the scroll fluid machine according to an aspect of the present invention, the scroll fluid machine may be provided according to claim 2.

[0021] 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.

[0022] 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.

[0023] 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 D_e , a tooth bottom width of the end plate inclined section is denoted by T_g , and the turning radius in the turning movement is denoted by ρ ,

$$\{T_g^2 + (2\rho)^2\} / (2T_g) \leq D_e \leq T_g$$

is satisfied.

[0024] 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.

[0025] Further, according to the scroll fluid machine of the present invention,

$$D_e = \{T_g^2 + (2\rho)^2\} / (2T_g)$$

is satisfied.

$$D_e = \{T_g^2 + (2\rho)^2\} / (2T_g)$$

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]

[0026] 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.

[0027] 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]

[0028]

[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]

[0029] Hereinafter, a first embodiment according to the present invention will be described with reference to the drawings.

[0030] 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.

[0031] 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.

[0032] 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.

[0033] The center of the fixed scroll 3 and the center of the turning scroll 5 are separated by a turning radius ρ , 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).

[0034] 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.

[0035] 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.

[0036] 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.

[0037] 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.

[0038] 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 O2 (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.

[0039] 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.

[0040] 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.

[0041] 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.

$$\Phi = \tan^{-1} (h/D1) \quad \dots (1)$$

[0042] 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.

[0043] 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/L_{out} (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 $D1$) [$^{\circ}$]: 180 or more and 1080 or less, preferably 360 or more and 720 or less
 (6) Angle Φ [$^{\circ}$] of inclined section: 0.2 or more and 4 or less, preferably 0.5 or more and 2.5 or less

[0044] 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.

[0045] 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.

[0046] The aforementioned scroll compressor 1 is operated as follows.

[0047] 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.

[0048] 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.

[0049] 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 T_g 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.

[0050] 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 T_g as the center O3. 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.

[0051] 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.

[0052] 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.

[0053] 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.

[0054] 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 $(\rho \times \tan \phi)$. 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).

[0055] According to this embodiment, the following working effect is exhibited.

[0056] 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]

[0057] 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.

[0058] 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.

[0059] 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.

[0060] 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.

[0061] 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.

[0062] 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.

[0063] 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.

[0064] 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.

[0065] 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 $\{(Tg/2 - \rho) \times \tan \phi\}$ at the width center position P2 as illustrated in Fig. 14B.

[0066] According to this embodiment, the following working effects are exhibited.

[0067] 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.

[0068] 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]

[0069] 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.

[0070] 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.

[0071] 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.

[0072] Therefore, in this embodiment, relation of (end mill diameter $De < \text{tooth bottom width } Tg$) is established.

[0073] 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.

[0074] 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.

[0075] 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.

[0076] When a distance R from a center O3 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.

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

[0077] Referring to geometrical relation in Fig. 18, the distance R is expressed by the following expression.

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

[0078] 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 O3 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.

[0079] 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.

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

[0080] That is, the contour line Ct3 only needs to be formed by the end mill diameter De so as to satisfy the aforementioned expression.

[0081] According to this embodiment, the following working effects are exhibited in addition to the working effects of the second embodiment.

[0082] 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.

[0083] 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.

[0084] 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.

[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
 5 Ct1, Ct2, Ct3 contour line
 L inter-facing-surface distance
 T tip clearance
 Tg tooth bottom width
 Tr turning locus
 10 W1 center line of wall
 ϕ inclination

Claims

1. A scroll fluid machine comprising:

a first scroll member (1) provided with a spiral first wall (3b) on a first end plate (3a); and
 a second scroll member (5) that is provided with a spiral second wall (5b) on a second end plate (5a) disposed
 so as to face the first end plate (3a), and that relatively revolves by engagement between the second wall (5b)
 and the first wall (3b) with the second wall (5b) being offset from the first wall (3b) by a turning radius, wherein
 an inclined section that continuously reduces an inter-facing-surface distance between the first end plate (3a)
 and the second end plate (5a) facing each other, from an outer circumferential side toward an inner circumferential
 side of each of the first wall (3b) and the second wall (5b) is provided,
 the inclined section is provided over a range of 180° or more around a spiral center,
 each of the first wall (3b) and the second wall (5b) has a wall inclined section (3b1, 5b1) 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,
 each of the first end plate (3a) and the second end plate (5a) has an end plate inclined section (3a1, 5a1) having
 a tooth bottom surface that faces a tooth tip of the wall inclined section (3b1, 5b1), and that inclines in accordance
 with an inclination of the wall inclined section (3b1, 5b1),
 a wall flat section (3b2, 3b3, 5b2, 5b3) having no change in height is provided in an outermost circumferential
 part and/or an innermost circumferential part of each of the first wall (3b) and the second wall (5b),
 a wall inclined connecting section (3b4, 3b5, 5b4, 5b5) is provided to connect the wall inclined section (3b1,
 5b1) and the wall flat section (3b2, 3b3, 5b2, 5b3),
 an end plate flat section (3a2, 3a3, 5a2, 5a3) corresponding to the wall flat section (3b2, 3b3, 5b2, 5b3) is
 provided in each of the first end plate (3a) and the second end plate (5a),
 an end plate inclined connecting section (3a4, 3a5, 5a4, 5a5) is provided to connect the end plate flat section
 (3a2, 3a3, 5a2, 5a3) and the end plate inclined section (3a1, 5a1),
 one or a plurality of circular arcs each having an intersection with the wall and the end plate inclined connecting
 section (3a4, 3a5, 5a4, 5a5) as a contact point is formed as a contour line (Ct1, Ct2, Ct3) on the end plate
 inclined section (3a1, 5a1),
 the first scroll member (1) and the second scroll member (5) are disposed such that the contact point and a
 turning locus center position (Tr) of the second scroll member (5) are at a same position in a spiral direction at
 a time of the revolving, and
characterized in that the inclined section has an angle of 0.2° or more and 4° or less.

2. The scroll fluid machine according to claim 1, wherein

where a diameter of the circular arc forming the contour line (Ct1, Ct2, Ct3) is denoted by De, a tooth bottom width
 of the end plate inclined section (3a1, 5a1) is denoted by Tg, and the turning radius in the turning movement is
 denoted by ρ ,

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

is satisfied.

3. The scroll fluid machine according to claim 2, wherein $De = \{Tg^2 + (2\rho)^2\} / (2Tg)$ is satisfied.

Patentansprüche

1. Spiralf fluidmaschine, umfassend:

ein erstes Spiralelement (1), das mit einer ersten Spiralwand (3b) auf einer ersten Endplatte (3a) versehen ist; und
 ein zweites Spiralelement (5), das mit einer zweiten Spiralwand (5b) auf einer zweiten Endplatte (5a) versehen
 ist, die so angeordnet ist, dass sie der ersten Endplatte (3a) gegenüberliegt, und die sich relativ durch Eingriff
 zwischen der zweiten Wand (5b) und der ersten Wand (3b) dreht, wobei die zweite Wand (5b) von der ersten
 Wand (3b) durch einen Drehradius versetzt ist, wobei
 ein geneigter Abschnitt, der kontinuierlich eine Zwischenoberflächendistanz zwischen der ersten Endplatte (3a)
 und der zweiten Endplatte (5a), die einander gegenüberliegen, von einer äußeren Umfangsseite hin zu einer
 inneren Umfangsseite jeder der ersten Wand (3b) und der zweiten Wand (5b) reduziert, bereitgestellt ist,
 der geneigte Abschnitt über einen Bereich von 180° oder mehr um ein Spiralzentrum bereitgestellt ist,
 jede der ersten Wand (3b) und der zweiten Wand (5b) einen geneigten Wandabschnitt (3b1, 5b1) aufweist, der
 eine Höhe der Wand aufweist, die sich kontinuierlich von der äußeren Umfangsseite hin zur inneren Umfangs-
 seite reduziert, um den geneigten Abschnitt zu bilden,
 jede der ersten Endplatte (3a) und der zweiten Endplatte (5a) einen geneigten Endplattenabschnitt (3a1, 5a1)
 aufweist, der eine untere Zahnfläche aufweist, die einer Zahnschnecke des geneigten Wandabschnitts (3b1, 5b1)
 gegenüberliegt, und die sich gemäß einer Neigung des geneigten Wandabschnitts (3b1, 5b1) neigt,
 ein flacher Wandabschnitt (3b2, 3b3, 5b2, 5b3), der keine Veränderung in der Höhe aufweist, in einem äußersten
 Umfangsteil und/oder einem innersten Umfangsteil jeder der ersten Wand (3b) und der zweiten Wand (5b)
 bereitgestellt ist,
 ein geneigter Verbindungsabschnitt (3b4, 3b5, 5b4, 5b5) bereitgestellt ist, um den geneigten Wandabschnitt
 (3b1, 5b1) und den flachen Wandabschnitt (3b2, 3b3, 5b2, 5b3) zu verbinden,
 ein flacher Endplattenabschnitt (3a2, 3a3, 5a2, 5a3), der dem ersten flachen Wandabschnitt (3b2, 3b3, 5b2,
 5b3) entspricht, in jeder der ersten Endplatte (3a) und der zweiten Endplatte (5a) bereitgestellt ist,
 ein geneigter Endplattenverbindungsabschnitt (3a4, 3a5, 5a4, 5a5) bereitgestellt ist, um den flachen Endplat-
 tenabschnitt (3a2, 3a3, 5a2, 5a3) und den geneigten Endplattenabschnitt (3a1, 5a1) zu verbinden,
 einer oder eine Vielzahl von kreisförmigen Bögen, die jeweils eine Schnittstelle mit der Wand und dem geneigten
 Endplattenverbindungsabschnitt (3a4, 3a5, 5a4, 5a5) als Kontaktpunkt aufweisen, als eine Umfangslinie (Ct1,
 Ct2, Ct3) auf dem geneigten Endplattenabschnitt (3a1, 5a1) gebildet ist,
 das erste Spiralelement (1) und das zweite Spiralelement (5) derart angeordnet sind, dass der Kontaktpunkt
 und eine Drehmittelposition (Tr) des zweiten Spiralelements (5) an einer gleichen Position in einer Sprial-
 richtung zu einem D sind und
dadurch gekennzeichnet, dass der geneigte Abschnitt einen Winkel von 0,2° oder mehr und 4° oder weniger
 aufweist.

2. Spiralf fluidmaschine nach Anspruch 1, wobei

ein Durchmesser des kreisförmigen Bogens, der die Umfangslinie (Ct1, Ct2, Ct3) bildet, mit De bezeichnet ist, eine
 Zahnbodenbreite des geneigten Endplattenabschnitts (3a1, 5a1) mit Tg bezeichnet ist und der Drehradius in der
 Drehbewegung mit ρ bezeichnet ist,

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

erfüllt ist.

3. Spiralf fluidmaschine nach Anspruch 2, wobei

De = {Tg² + (2ρ)²}/(2Tg) erfüllt ist.

Revendications

1. Machine hydraulique à spirale comprenant :

un premier élément en spirale (1) équipé d'une première paroi en spirale (3b) sur une première plaque d'extrémité
 (3a) ; et
 un deuxième élément en spirale (5) qui est équipé d'une deuxième paroi en spirale (5b) sur une deuxième

plaque d'extrémité (5a) disposée de façon à faire face à la première plaque d'extrémité (3a), et qui tourne de manière relative par engagement entre la deuxième paroi (5b) et la première paroi (3b) avec la deuxième paroi (5b) qui est décalée par rapport à la première paroi (3b) selon un rayon de rotation, dans laquelle une section inclinée qui réduit en continu une distance de surface d'interface entre la première plaque d'extrémité (3a) et la deuxième plaque d'extrémité (5a) qui se font face, d'un côté circonférentiel externe vers un côté circonférentiel interne de chacune de la première paroi (3b) et de la deuxième paroi (5b), est prévue, la section inclinée est prévue sur une plage de 180° ou plus autour d'un centre de spirale, chacune de la première paroi (3b) et de la deuxième paroi (5b) possède une section inclinée de paroi (3b1, 5b1) qui présente une hauteur de paroi qui réduit continûment du côté circonférentiel externe vers le côté circonférentiel interne de façon à former la section inclinée, chacune de la première plaque d'extrémité (3a) et de la deuxième plaque d'extrémité (5a) possède une section inclinée de plaque d'extrémité (3a1, 5a1) ayant une surface inférieure de dent qui fait face à une extrémité de dent de la section inclinée de paroi (3b1, 5b1), et qui s'incline selon une inclinaison de la section inclinée de paroi (3b1, 5b1), une section plate de paroi (3b2, 3b3, 5b2, 5b3) qui ne présente aucun changement de hauteur est prévue dans une partie circonférentielle la plus externe et/ou une partie circonférentielle la plus interne de chacune de la première paroi (3b) et de la deuxième paroi (5b), une section de liaison inclinée de paroi (3b4, 3b5, 5b4, 5b5) est prévue afin de relier la section inclinée de paroi (3b1, 5b1) et la section plate de paroi (3b2, 3b3, 5b2, 5b3), une section plate de plaque d'extrémité (3a2, 3a3, 5a2, 5a3) qui correspond à la section plate de paroi (3b2, 3b3, 5b2, 5b3) est prévue dans chacune de la première plaque d'extrémité (3a) et de la deuxième plaque d'extrémité (5a), une section de liaison inclinée de plaque d'extrémité (3a4, 3a5, 5a4, 5a5) est prévue afin de relier la section plate de plaque d'extrémité (3a2, 3a3, 5a2, 5a3) et la section inclinée de plaque d'extrémité (3a1, 5a1), un ou plusieurs arc(s) circulaire(s) ayant chacun une intersection avec la paroi et la section de liaison inclinée de plaque d'extrémité (3a4, 3a5, 5a4, 5a5) en guise de point de contact est/sont formé(s) comme une ligne de contour (Ct1, Ct2, Ct3) sur la section inclinée de plaque d'extrémité (3a1, 5a1), le premier élément en spirale (1) et le deuxième élément en spirale (5) sont disposés de sorte que le point de contact et un emplacement de centre de rotation (Tr) du deuxième élément en spirale (5) soient à un même endroit dans une direction de spirale à un moment de la rotation, et

caractérisée en ce que la section inclinée présente un angle de 0,2° ou plus et de 4° ou moins.

2. Machine hydraulique à spirale selon la revendication 1, dans laquelle lorsqu'un diamètre de l'arc circulaire qui forme la ligne de contour (Ct1, Ct2, Ct3) est indiqué par De, une largeur de bas de dent de la section inclinée de plaque d'extrémité (3a1, 5a1) est indiquée par Tg, et le rayon de rotation lors du mouvement de rotation est indiqué par ρ ,

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

est satisfait.

3. Machine hydraulique à spirale selon la revendication 2, dans laquelle $De = \{Tg^2 + (2\rho)^2\} / (2Tg)$ est satisfait.

FIG. 1A

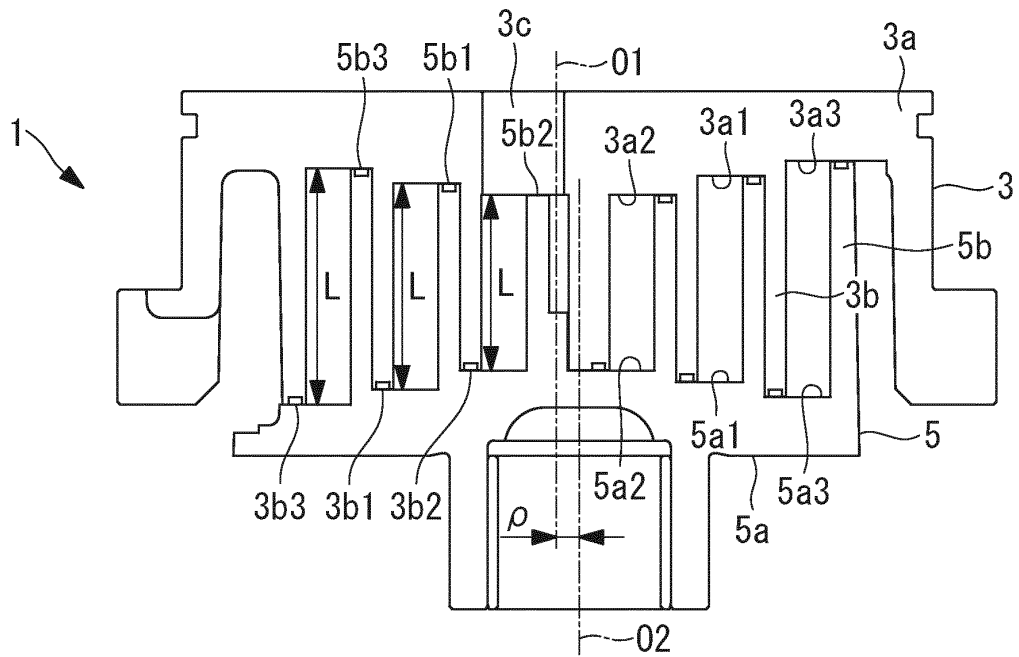


FIG. 1B

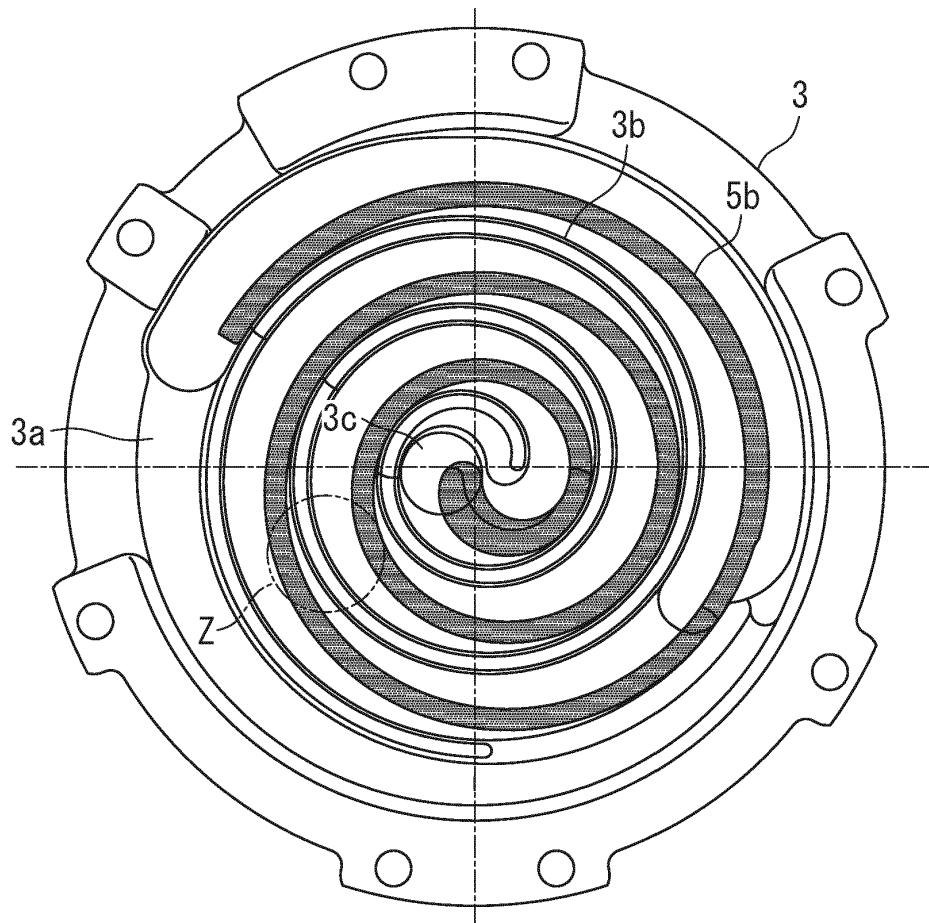


FIG. 2

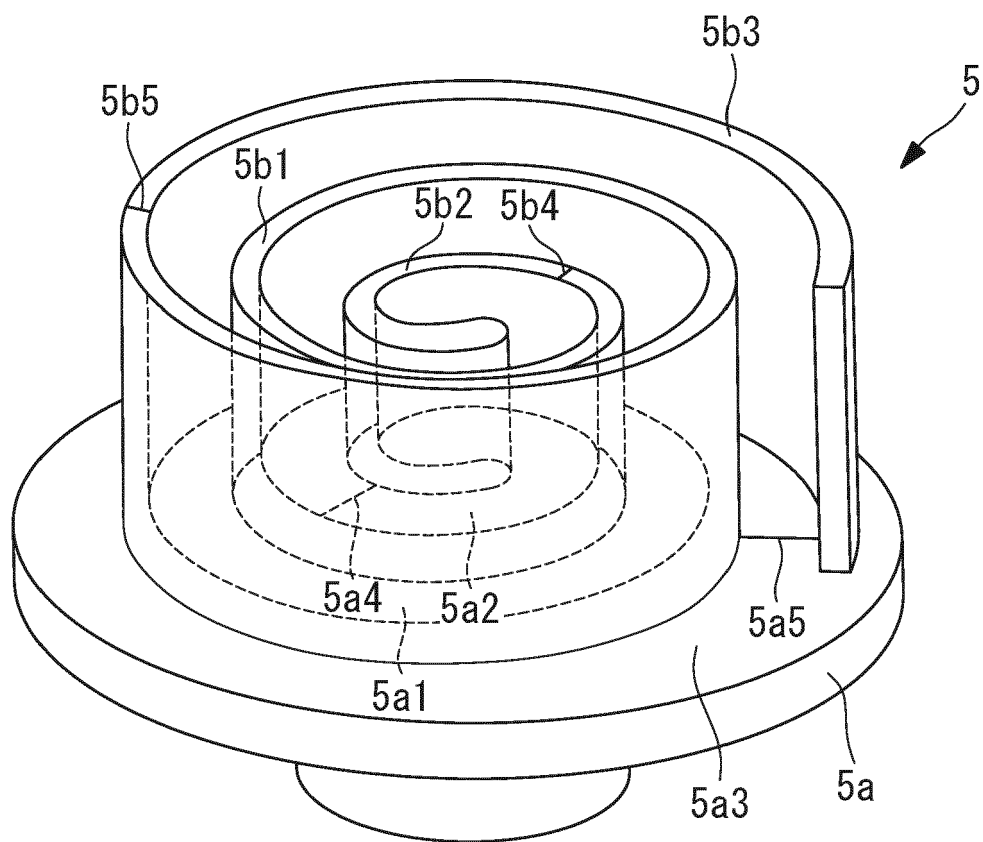


FIG. 3

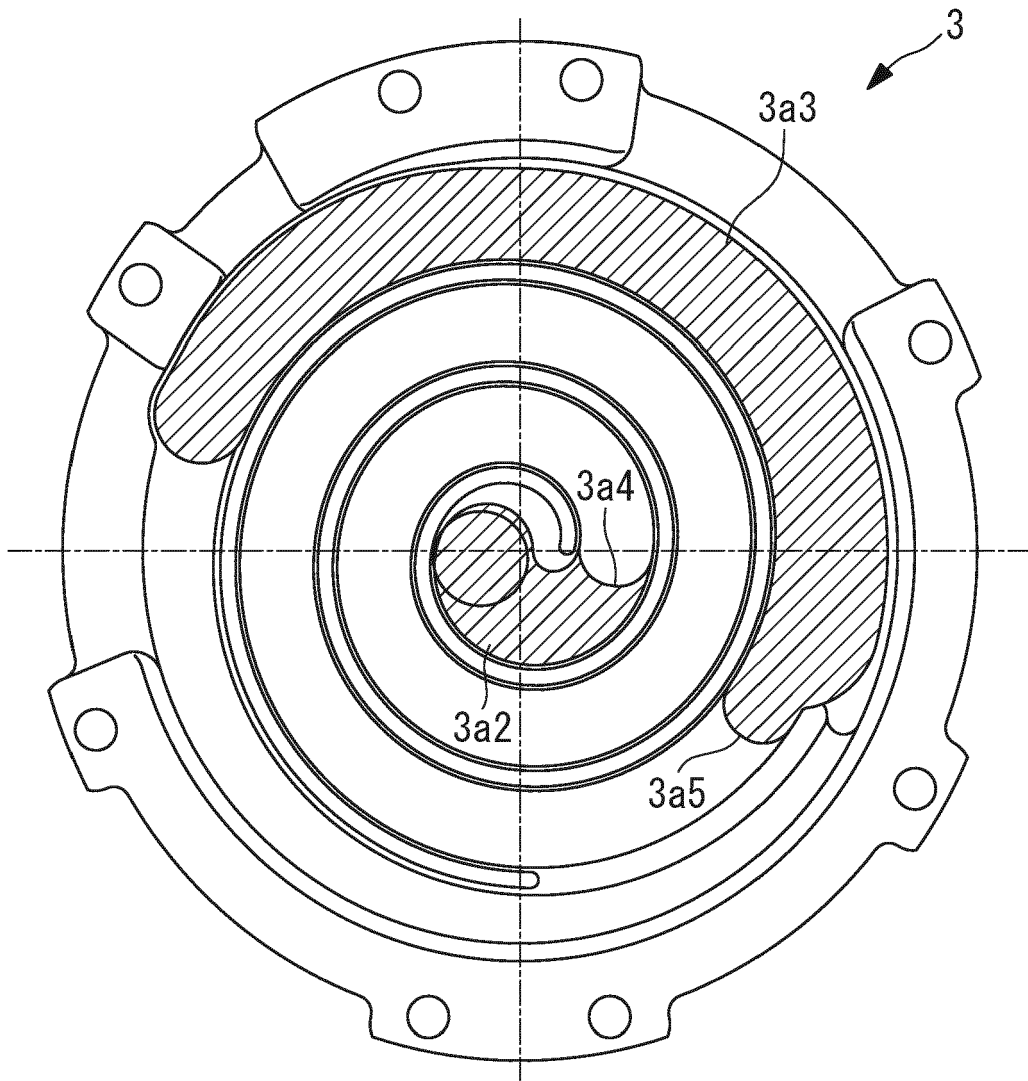


FIG. 4

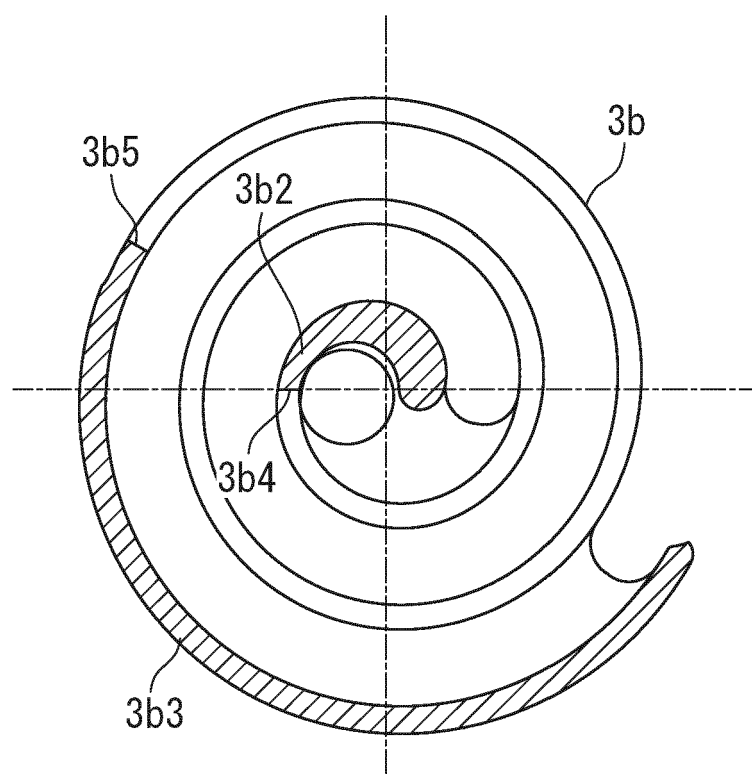


FIG. 5

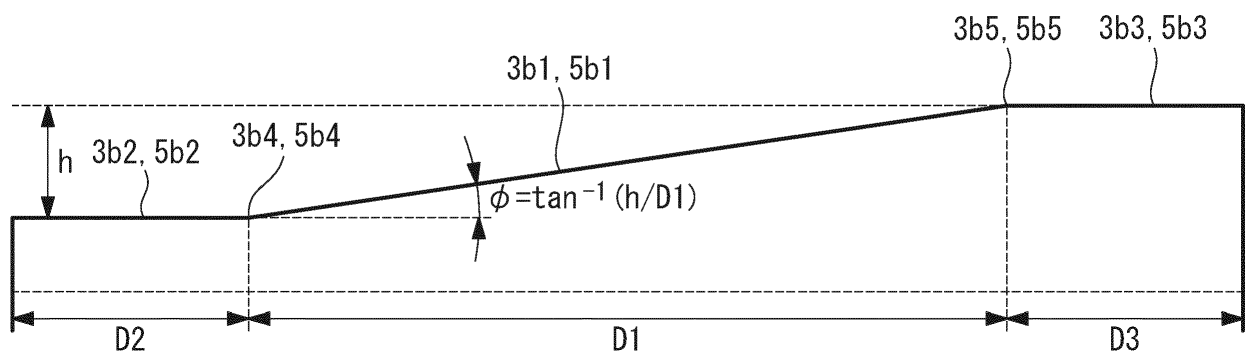


FIG. 6

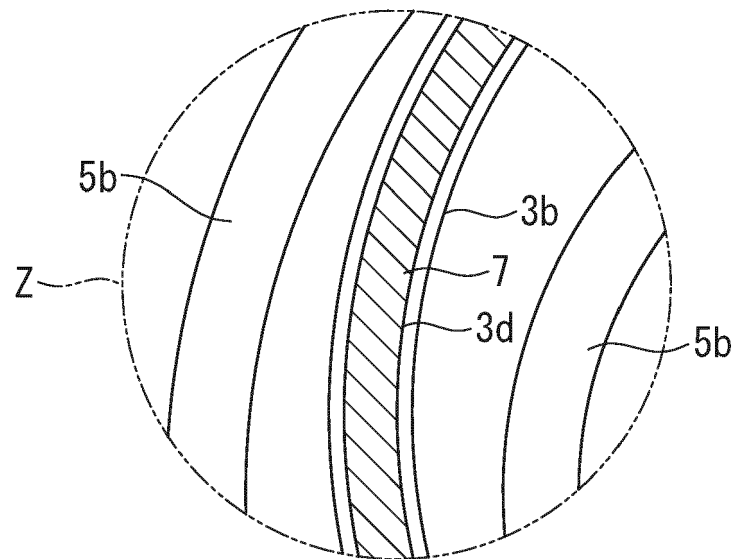


FIG. 7A

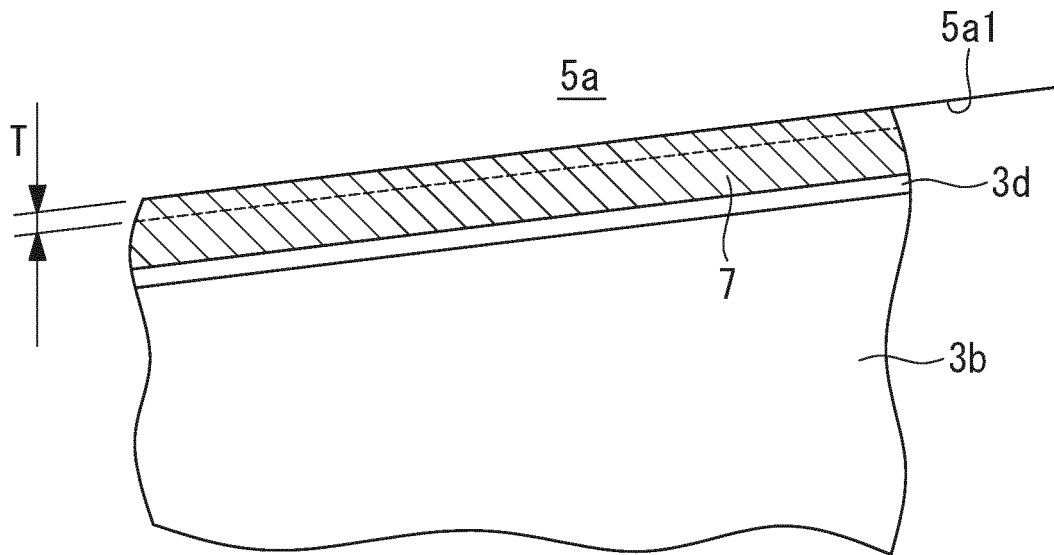


FIG. 7B

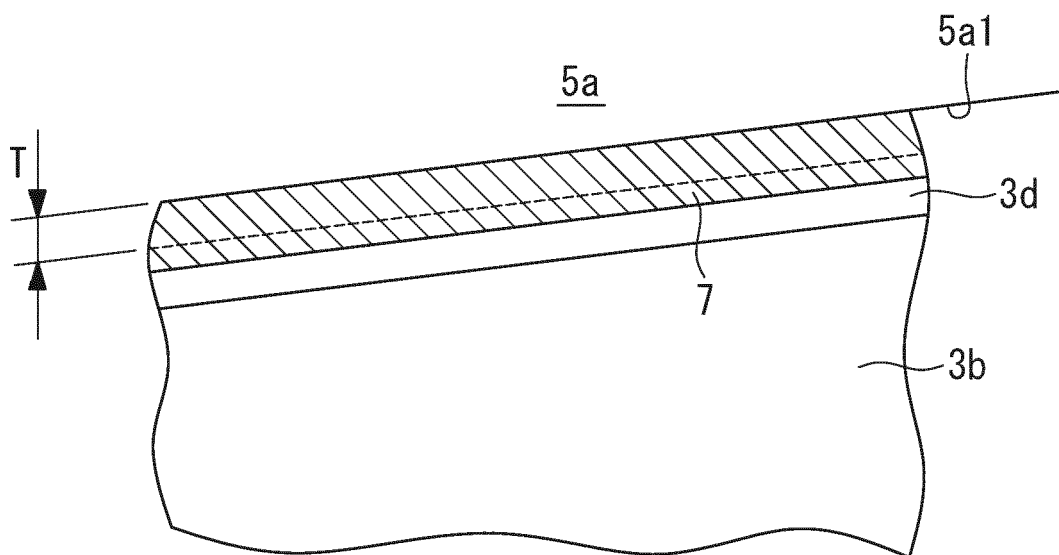


FIG. 8

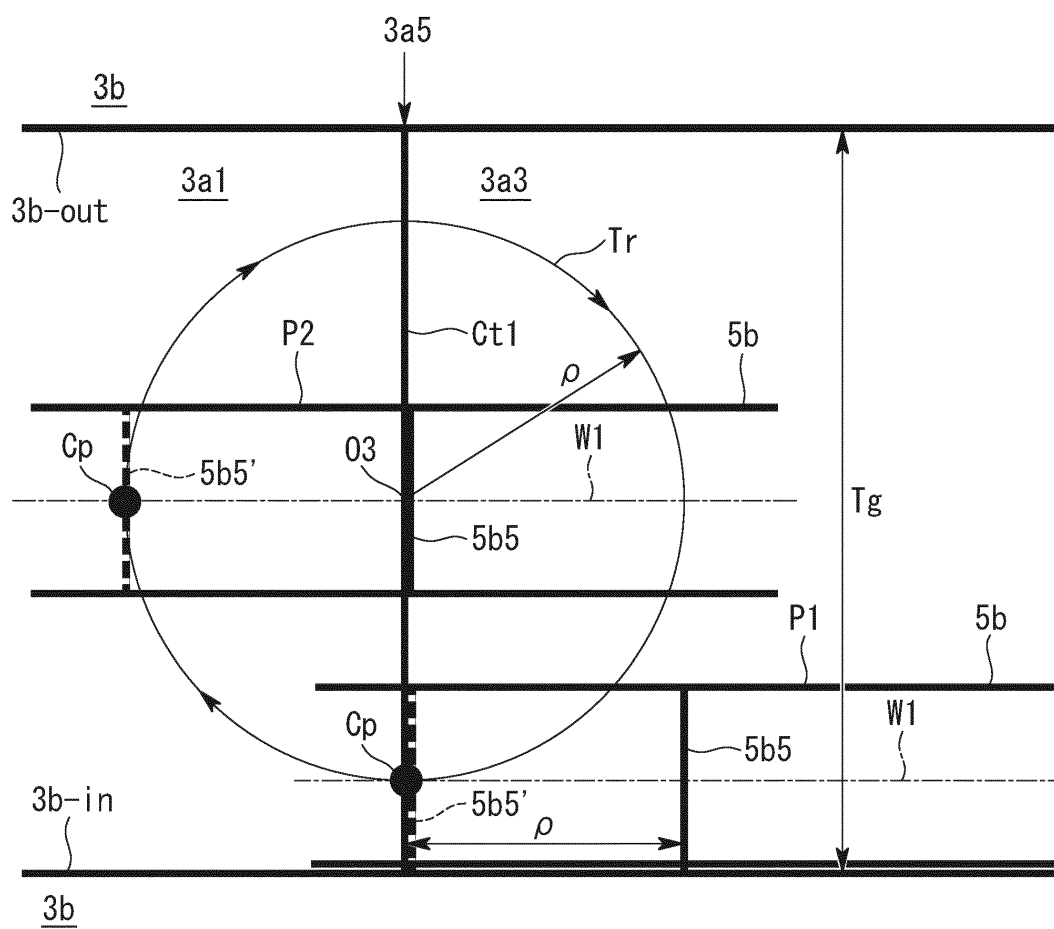


FIG. 9A

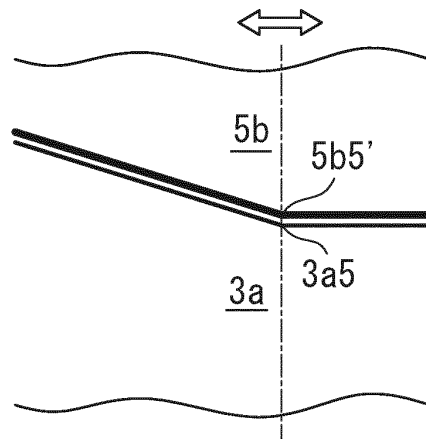


FIG. 9B

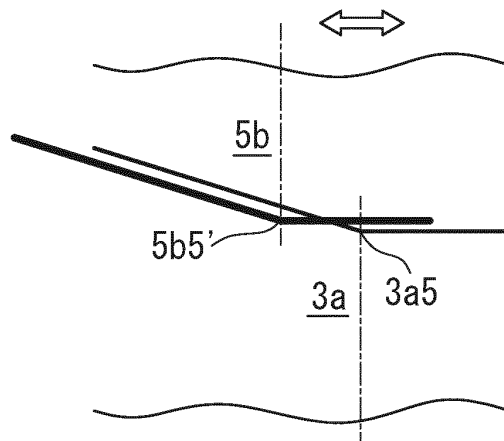


FIG. 9C

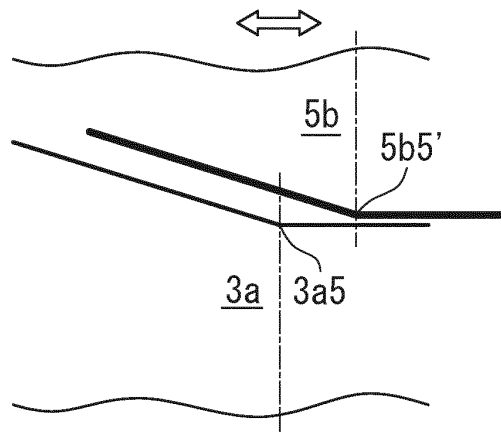


FIG. 10A

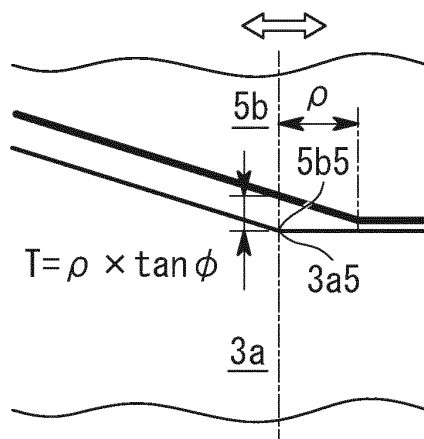


FIG. 10B

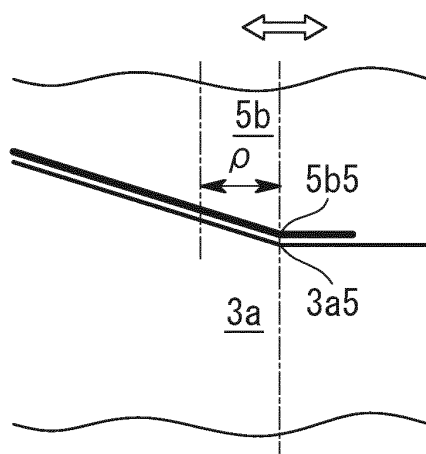


FIG. 10C

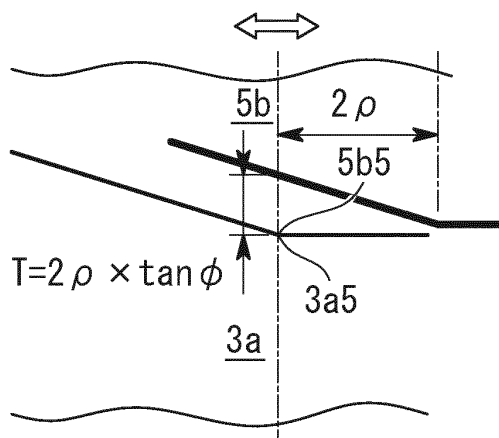


FIG. 11A

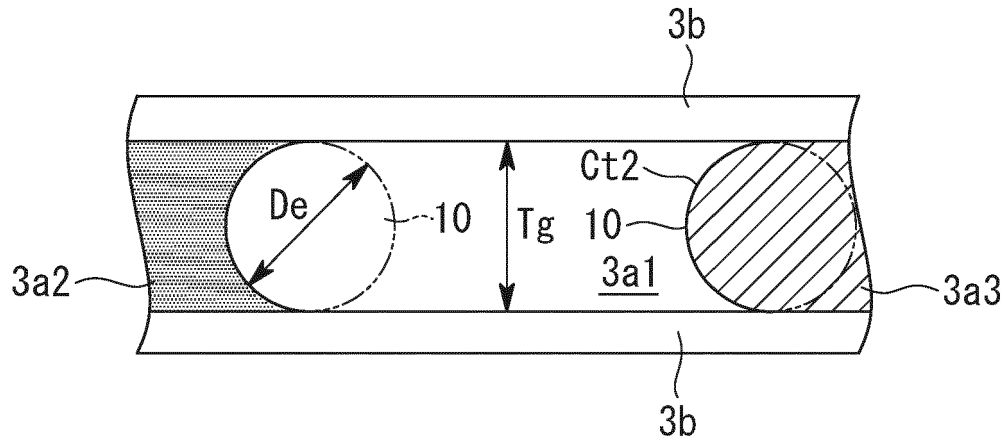


FIG. 11B

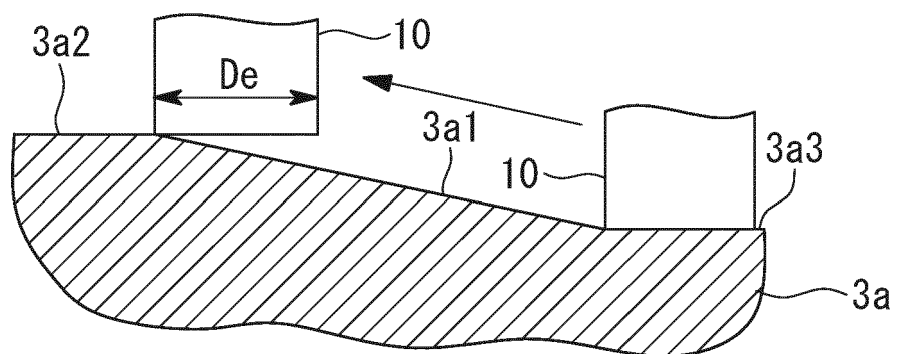


FIG. 12

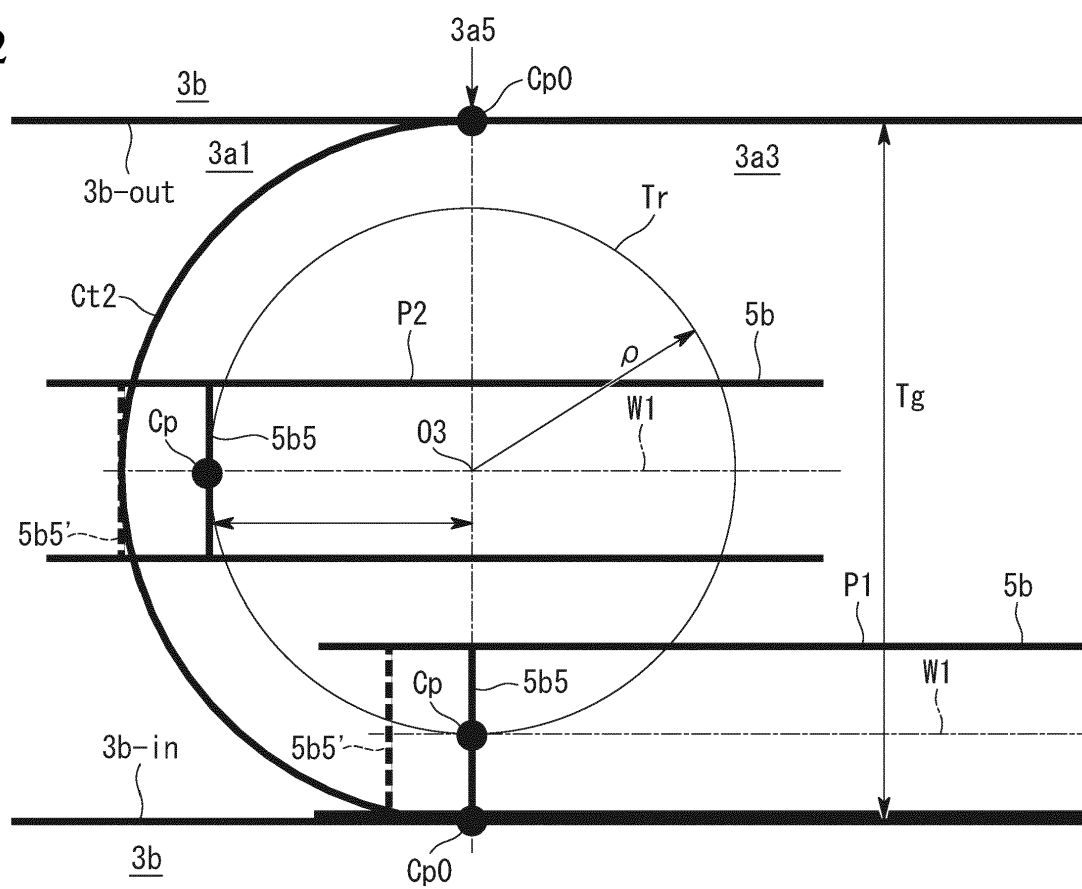


FIG. 13A

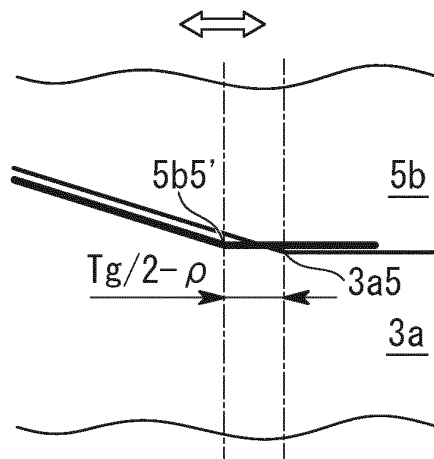


FIG. 13B

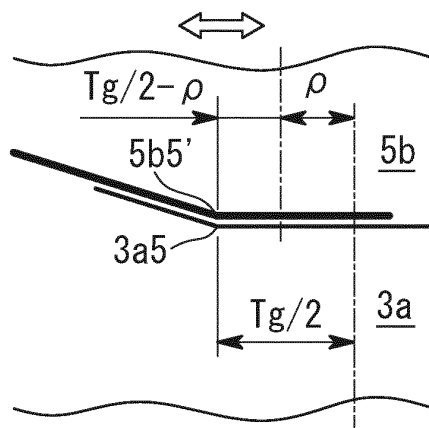


FIG. 13C

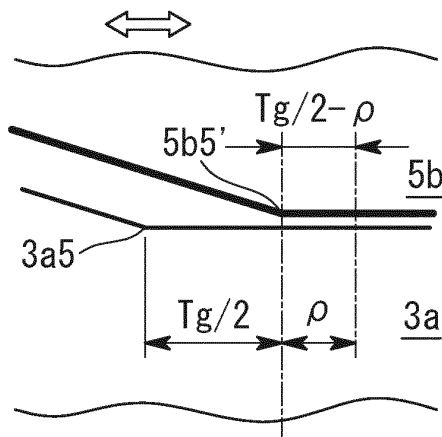


FIG. 14A

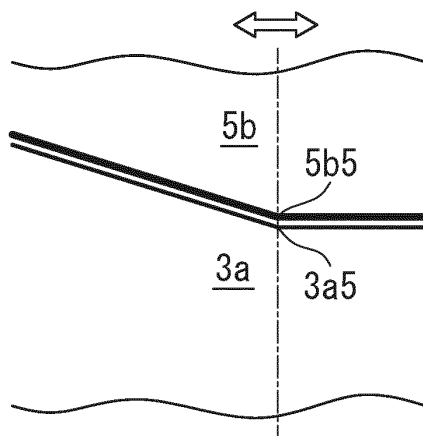


FIG. 14B

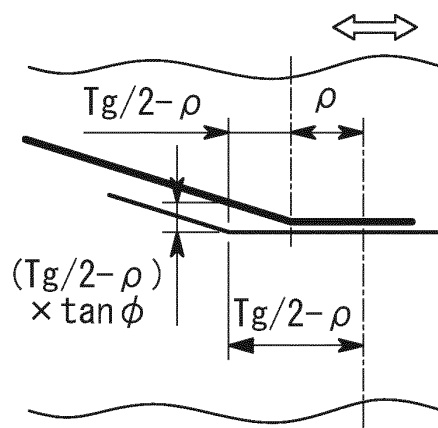


FIG. 14C

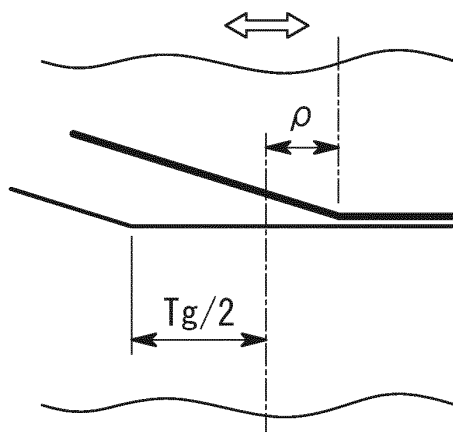


FIG. 15

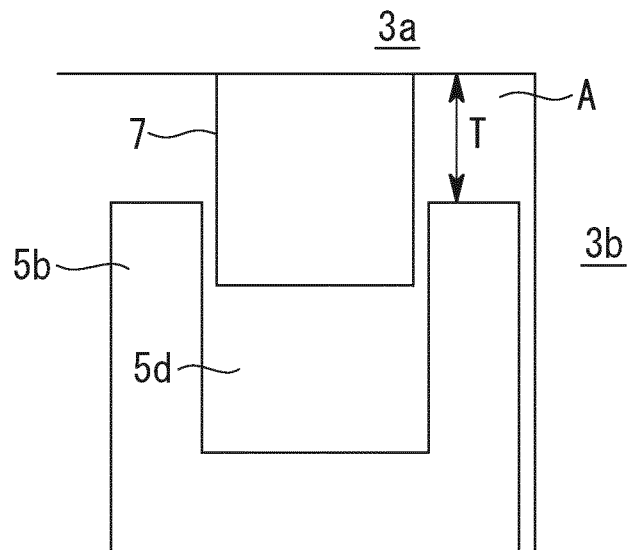


FIG. 16

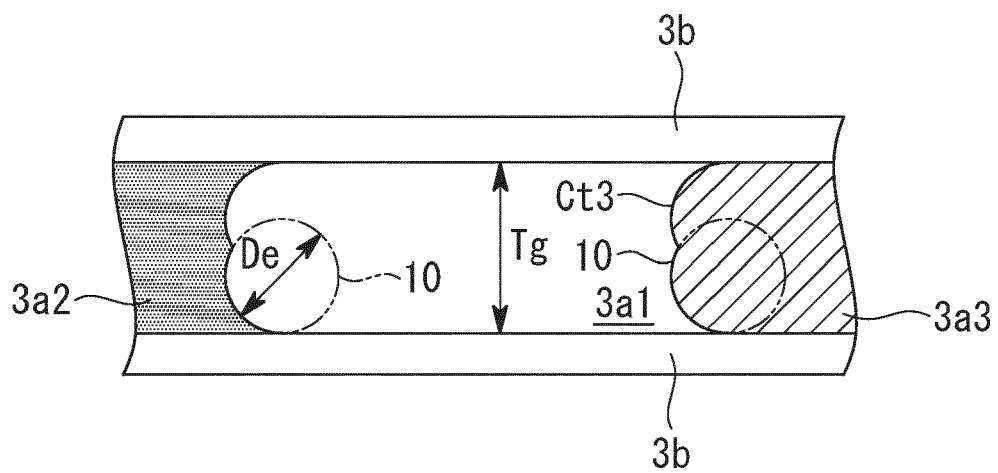


FIG. 17

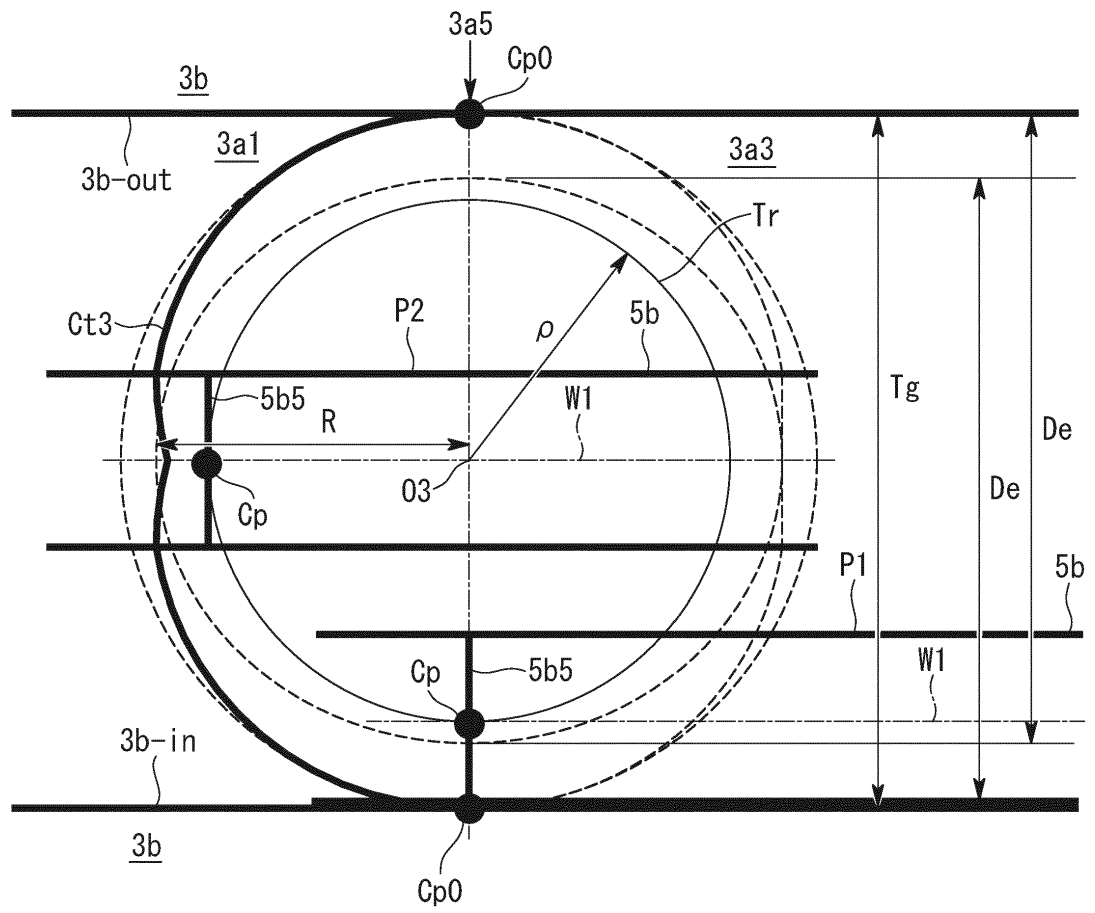
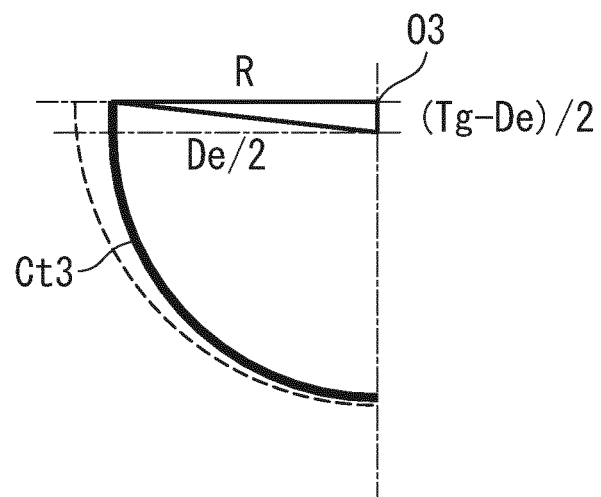


FIG. 18



REFERENCES CITED IN THE DESCRIPTION

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