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(54) **SCROLL FLUID MACHINE**

SPIRALFLUIDMASCHINE

MACHINE À FLUIDE AVEC VOLUTES

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Description

{Technical Field}

[0001] The present invention relates to a scroll fluid machine that can be applied to compressors, pumps, expanders, etc.

{Background Art}

[0002] A scroll fluid machine includes a pair of scrolls, that is, a stationary scroll and an orbiting scroll, which are each typically constituted of spiral wraps vertically disposed on end plates, and has a configuration in which the stationary scroll and the orbiting scroll are engaged by opposing their spiral wraps with their phases shifted by 180 degrees. With such a scroll fluid machine, e.g., a compressor, the spiral wraps of the stationary scroll and the orbiting scroll are in contact with each other, and the gap between a tooth-tip surface of each spiral wrap and a tooth-bottom surface of the other scroll is sealed to form sealed compression chambers; in this way, leakage of compressed gas from wrap gaps, tip gaps, etc. is minimized so as to improve performance.

[0003] Thus, a scroll compressor is configured such that the orbiting scroll is driven to orbit around the stationary scroll by a crank shaft connected via a bush, etc. to a boss part, which is disposed at the center area of the back surface of the end plate of the orbiting scroll. Therefore, the orbiting scroll is driven to orbit while being tilted by a moment due to gas pressure acting in the height direction of the spiral wrap, which is vertically disposed on the opposite side of the end plate, and by a centrifugal force associated with the orbiting motion, and the tooth-tip part of each spiral wrap is in tight contact with the spiral wrap surface of the other scroll between the stationary scroll and the orbiting scroll. As a result, there are problems of accelerated wear of the tooth-tip parts of the spiral wraps, increased driving force, and additionally, higher stress applied to the base parts of the spiral wraps, deteriorating the durability of the scroll compressor.

[0004] Meanwhile, as shown in PTL 1, 2 and 3, etc., for example, scroll fluid machines in which the spiral wraps are prevented from coming in contact with each other by providing offset parts in directions of decreasing wrap thickness in certain regions in the spiral direction of the ventral surface and/or dorsal surface of the spiral wraps of the stationary scroll and the orbiting scroll have been proposed.

{Citation List}

{Patent Literature}

[0005]

{PTL 1} Japanese Unexamined Patent Application, Publication No. 2001-173584 (refer to Figs. 1 and 6)
{PTL 2} Japanese Unexamined Patent Application, Publication No. 2009-174406 (refer to Figs. 3 to 5)
{PTL 3} Japanese Patent No. 2971739 (refer to Figs. 1 and 6 to 8)

{Summary of Invention}

{Technical Problem}

[0006] However, the one according to PTL 1 prevents performance deterioration due to over-compression by providing offset parts in predetermined areas of the spiral wraps at the beginning of the winding of the spiral wrap in an attempt to improve efficiency, but does not provide a solution to the problems described above that are caused by the orbiting scroll tilting while being orbitally driven. The one according to PTL 2 prevents spiral wraps from locally contacting each other due to a difference in thermal expansion in the case where a stationary scroll and an orbiting scroll are made of different materials, by providing offset parts at a section including the beginning of the winding of the spiral wrap or a part including the end of the winding of the spiral wrap in an attempt to improve efficiency, but does not provide a solution to the problems described above, which are also caused by the orbiting scroll tilting while being orbitally driven.

[0007] Furthermore, as described in PTL 1 and 2, for scroll fluid machines having offset parts at part of the spiral wraps, in most cases, the offset parts are usually provided all along the height direction of the spiral wraps. However, with such a configuration, the amount of gas leakage from the offset parts increases, and efficiency is decreased by a corresponding amount; therefore, how to prevent the decrease in efficiency has been a problem.

[0008] The present invention has been conceived in light such circumstances, and it is an object thereof to provide a scroll fluid machine that provides solutions to the failure caused by an orbiting scroll tilting while being orbitally driven and that has improved performance and durability.

{Solution to Problem}

[0009] To solve the problems described above, the scroll fluid machine according to the present invention employs the following solutions.

[0010] That is, a scroll fluid machine according to the present invention is defined in appended claim 1. It includes a paired stationary scroll and orbiting scroll, including spiral wraps vertically disposed on end plates, wherein the stationary scroll and the orbiting scroll are engaged by making the spiral wraps oppose each other with the phases shifted, and offset parts are provided on a ventral surface and a dorsal surface of a tooth-tip part of the spiral wrap of at least one of the stationary scroll, and the orbiting scroll from the inner circumferential end to the outer circumferential end of the spiral wrap in a direction that reduces the wrap thickness along an entire range of the spiral wrap in the spiral direction of the spiral wraps.

[0011] With the scroll fluid machine according to the above-described aspect of the present invention, since offset parts are provided on a ventral surface and a dorsal surface of a tooth-tip part of a spiral wrap of at least one of a stationary scroll and an orbiting scroll, from the inner circumferential end to the outer circumferential end of the spiral wrap in a direction that reduces the wrap thickness, even when the orbiting scroll is tilted by being orbitally driven, the offset parts can prevent the tooth-tip part of each spiral wrap from contacting the spiral wrap surface of the other scroll, between the stationary scroll and the orbiting scroll. Therefore, accelerated wear, an increase in driving force, an increase in stress applied to the base part of the spiral wrap, etc. caused by the tight contact of the tooth-tip parts of the spiral wraps of the stationary scroll and the orbiting scroll due to tilting of the orbiting scroll are alleviated, and the performance and durability of the scroll fluid machine can be improved.

[0012] The scroll fluid machine described above may be configured such that stepped parts are provided on the stationary scroll and the orbiting scroll at arbitrary positions in the spiral direction of the spiral wraps, and, in the stationary scroll and the orbiting scroll, the wrap height on the outer circumferential side of each spiral wrap is larger than the wrap height of the inner circumferential side thereof, and the offset parts are provided on the spiral wraps from the inner circumferential end to the outer circumferential end of at least the outer circumferential side of the stepped parts, where the wrap height is large.

[0013] According to this configuration, in the scroll fluid machine, stepped parts are provided on the stationary scroll and the orbiting scroll at arbitrary positions along the spiral direction of the spiral wraps; the wrap height on the outer circumferential side of each spiral wrap is larger than the wrap height of the inner circumferential side; and the offset parts are provided on the spiral wraps from the inner circumferential ends to the outer circumferential ends of at least the outer circumferential side of the stepped parts, where the wrap height is large; therefore, by providing the offset parts at the tooth-tip parts of each spiral wrap on the outer circumferential side of the stepped part, where the wrap height is particularly increased by the stepped part, accelerated wear, increased driving force, increased stress applied to the base part, etc. at the spiral wrap parts on the outer circumferential side, where the wrap height is large, can be alleviated. Thus, the characteristics of the scroll fluid machine having stepped parts along the spiral direction of the scrolls are improved even more, and the performance of the scroll fluid machine can be improved even more.

[0014] The scroll fluid machine described above may be configured such that each of the offset parts is provided from the inner circumferential end to the outer circumferential end of the spiral wrap along the entire range, spanning the stepped part, from a spiral wrap part on the outer circumferential side of the stepped part to a spiral wrap part on the inner circumferential side of the stepped part.

[0015] In this configuration, each of the offset parts is provided from the inner circumferential end to the outer circumferential end of a spiral wrap along the entire range, spanning the stepped part, from a spiral wrap part on the outer circumferential side of the stepped part to a spiral wrap part on the inner circumferential side of the stepped part; therefore, in the entire range from the spiral wrap part on the outer circumferential side of the stepped part, where the wrap height is large, to the spiral wrap part on the inner circumferential side of the stepped part, where the wrap height is small, the offset parts can prevent the tooth-tip part of each spiral wrap and the spiral wrap surface of the other scroll from contacting each other, between the scrolls, even when the orbiting scroll is tilted to either the ventral side or the dorsal side of the spiral wrap by being orbitally driven. Thus, wear of the spiral wraps, the stress applied to the base part of the spiral wraps, and the driving force of the scroll fluid machine is reduced, and the performance and durability of the scroll fluid machine can be improved.

[0016] The scroll fluid machine described above may be configured such that each of the offset parts is provided on the outer circumferential part and the inner circumferential part of the spiral wrap, spanning the stepped part, on the tooth-tip part starting from the same wrap height.

[0017] In this configuration, since each of the offset parts is provided on the outer circumferential part and the inner circumferential part of the spiral wrap part, spanning the stepped part, on the tooth-tip part from the same height position, the offset parts can be processed all at once from the inner circumferential end to the outer circumferential end of the spiral wrap using a milling tool, such as an end mill, that is held at a constant height. Thus, the processing of the offset parts on the scrolls can be simplified. In such a case, for the offset parts on the inner circumferential side of the stepped part of a spiral wrap, the lengths in the wrap height direction of the offset parts with respect to the wrap height is small; however, since the initial wrap height is small, this does not cause any particular problems.

[0018] Any one of the scroll fluid machines described above may be configured such that the offset parts are provided by milling the ventral surface and the dorsal surface of the tooth-tip parts.

[0019] In this configuration, since the offset parts can be formed by milling the ventral and dorsal surfaces of the tooth-tip parts of the spiral wraps, the offset parts can be formed by performing the same milling on the ventral surface and the dorsal surface of the tooth-tip parts when milling the entire spiral wrap with an end mill, etc. Thus, the offset parts can be easily processed by slightly changing the scroll processing steps.

[0020] Any one of the scroll fluid machines described above may be configured such that the offset parts are provided substantially equally on the ventral surface and the dorsal surface of the tooth-tip part.

[0021] In this configuration, since the offset parts are provided substantially equally on the ventral surface and the dorsal surface of each tooth-tip part, the substantially equally provided offset parts can prevent the tooth-tip part of each spiral wrap and the spiral wrap surface of the other scroll from contacting each other, between the scrolls, even when the orbiting scroll is tilted to either the ventral side or the dorsal side of the spiral wrap by being orbitally driven. Thus, wear of the spiral wraps, stress applied to the base parts of the spiral wraps, and the driving force of the scroll fluid machine can be reduced, and the performance and durability of the scroll fluid machine can be improved.

[0022] Any one of the scroll fluid machines described above may be configured such that the offset parts have a thickness of approximately 10 to 50 μm in the wrap thickness direction of the spiral wraps.

[0023] In this configuration, since the offset parts have a thickness of approximately 10 to 50 μm in the wrap thickness direction of a spiral wrap, the tooth-tip part of each spiral wrap is reliably prevented from contacting the spiral wrap surface of the other scroll, between the scrolls, due to the orbiting scroll tilting while being orbitally driven, and gas leakage from the offset parts can be minimized. Thus, performance deterioration can be suppressed while reducing wear of the spiral wraps and stress applied to the base parts of the spiral wraps, and the durability of the scroll fluid machine can be improved.

[0024] Any one of the scroll fluid machines described above may be configured such that the offset parts are provided within a range of approximately 1/3 of the wrap height of the spiral wraps in the wrap height direction.

[0025] In this configuration, since the offset parts are provided within the range of approximately 1/3 of the spiral wraps in the wrap height direction, the position where the spiral wraps of the scrolls come into tight contact with each other due to the orbiting scroll tilting while being orbitally driven can be moved from the tooth-tip parts to relatively lower sections. Thus, the stress acting upon the base parts of the spiral wraps can be reduced by a corresponding amount, and the durability of the scroll fluid machine can be improved. Moreover, gas leakage from the offset parts can be reduced, and efficiency can be increased, compared with ones in which the offset parts are provided on the spiral wraps along the entire height direction. Furthermore, since the height of the spiral wraps can be relatively increased, the volume of the scroll fluid machine can be increased while maintaining the outer diameter thereof.

[0026] Any one of the scroll fluid machines described above may be configured such that the offset parts are provided within a range of approximately 1/3 of the spiral wraps in the wrap height direction on the outer circumferential side of the stepped parts having a large wrap height.

[0027] In this configuration, since the offset parts are provided within the range of approximately 1/3 of the wrap height of the spiral wraps on the outer circumferential side of the stepped parts, where the wrap height is large, at the outer circumferential part of the spiral wrap, where the wrap height is large, the position where the spiral wraps of the scrolls come into tight contact with each other due to the tilting of the orbiting scroll can be moved from the tooth-tip parts to relatively lower sections. Thus, the stress acting upon the base parts of the spiral wraps can be reduced by a corresponding amount, and the durability of the scroll fluid machine can be improved. Moreover, gas leakage from the offset parts can be reduced, and efficiency can be increased, compared with ones in which the offset parts are provided on the spiral wraps along the entire height direction. Furthermore, since the height of the spiral wraps can be relatively increased, the volume of the scroll fluid machine can be increased while maintaining the outer diameter thereof; and the performance of the scroll fluid machine having stepped parts along the spiral direction of the scrolls can be improved even more.

{Advantageous Effects of Invention}

[0028] According to the present invention, even when the orbiting scroll is tilted by being orbitally driven, the offset parts can prevent the tooth-tip part of each spiral wrap from contacting the spiral wrap surface of the other scroll between the stationary scroll and the orbiting scroll, so that they do not come into contact, and can alleviate accelerated wear, an increase in driving , or an increase in stress applied to the base part of the spiral wrap, etc. caused by tight contact of the tooth-tip parts of the spiral wraps of the stationary scroll and the orbiting scroll due to the tilting of the orbiting scroll, and the performance and durability of the scroll fluid machine can be improved.

{Brief Description of Drawings}

[0029]

{Fig. 1} Fig. 1 is a longitudinal sectional view of a scroll fluid machine (scroll compressor) according to a first embodiment of the present invention.

{Fig. 2} Fig. 2 is a plan view from the spiral wrap side of a stationary scroll and an orbiting scroll of the scroll fluid machine illustrated in Fig. 1.

{Fig. 3} Fig. 3 is a diagram corresponding to a sectional view taken along line a-a in Fig. 2.

{Fig. 4} Fig. 4 is a diagram corresponding to a sectional view taken along line b-b in Fig. 2.

{Fig. 5} Fig. 5 is a diagram corresponding to a sectional view taken along line c-c in Fig. 2.

{Fig. 6} Fig. 6 is a diagram corresponding to a sectional view taken along line d-d in Fig. 2.

{Fig. 7} Fig. 7 is an unfolded view of the dorsal side of each spiral wrap of the stationary scroll and the orbiting scroll illustrated in Fig. 2.

{Fig. 8} Fig. 8 is an unfolded view of the ventral surface of each spiral wrap of the stationary scroll and the orbiting scroll illustrated in Fig. 2.

{Fig. 9} Fig. 9 is a plan view from the spiral wrap side of a stationary scroll and an orbiting scroll of a scroll fluid machine according to a second embodiment of the present invention.

{Fig. 10} Fig. 10 is a diagram corresponding to a sectional view taken along line A-A in Fig. 9.

{Fig. 11} Fig. 11 is an unfolded view of the dorsal side of each spiral wrap of the stationary scroll and the orbiting scroll illustrated in Fig. 9.

{Fig. 12} Fig. 12 is an unfolded view of the ventral surface of each spiral wrap of the stationary scroll and the orbiting scroll illustrated in Fig. 9.

{Description of Embodiments}

[0030] Embodiments of the present invention will be described below with reference to the drawings.

First Embodiment

[0031] A first embodiment of the present invention will be described below with reference to Figs. 1 to 8.

[0032] Fig. 1 is a longitudinal sectional view of a scroll fluid machine according to the first embodiment of the present invention applied to a scroll compressor.

[0033] The scroll compressor (scroll fluid machine) 1 includes a housing 2, which constitutes an outer casing. The housing 2 has a configuration in which a front housing 3, including a cylindrical compressor-mechanism accommodating part 3A and a bearing part 3B provided with a plurality of bearings, and a rear housing 4, covering the open end of the compressor-mechanism accommodating part 3A, are joined to form a single unit with a plurality of bolts 5.

[0034] A scroll compressing mechanism (fluid mechanism) 6, which is constituted of a pair of scrolls, that is a stationary scroll 7 and an orbiting scroll 8, is inserted in the housing 2. As described in the related art, in the scroll compressing mechanism 6, the paired stationary scroll 7 and orbiting scroll 8, each having a spiral wrap vertically disposed on one surface of an end plate, are engaged such that their centers are separated by a distance equal to the orbiting radius, and the phases of the spiral wraps are shifted by 180 degrees; in this way, a pair of compression chambers 9 having point-symmetric scroll centers is formed. The stationary scroll 7 is fixed to the inner surface of the rear housing 4 with a plurality of bolts 10. Meanwhile, the orbiting scroll 8 is supported at the back surface of its end plate by a thrust bearing part 3C on the inner surface of the front housing 3 and is driven to orbit around the stationary scroll 7 by a driving mechanism and a rotation-prevention mechanism, which are described below.

[0035] The inside of the housing 2 is partitioned by the scroll compressing mechanism 6 into a low-pressure chamber 11, which surrounds the orbiting scroll 8, and a high-pressure chamber 12, which is formed on the back surface of the end plate of the stationary scroll 7. An intake port 13 provided on the housing 2 has an opening in the low-pressure chamber 11, and a discharge port, which is not shown, has an opening in the high-pressure chamber 12, so as to let coolant gas flow through the scroll compressing mechanism 6.

[0036] A main bearing 14 and a sub-bearing 15 are mounted on the bearing part 3B of the front housing 3, and a crank shaft (rotary shaft) 16 is supported by the bearings 14 and 15 in such a manner that it freely rotates around the axis L. One end of the crank shaft (rotary shaft) 16 protrudes outside through the front housing 3, and the protruding end is joined with a pulley having an electromagnetic clutch (not shown) to provide a configuration in which a driving force is fed from the outside. Moreover, a crank pin 17 is provided on the other end of the crank shaft 16.

[0037] The crank pin 17 is fitted into a drive bush 18, which is integrated with a balance weight 19, such that the drive bush 18 is slidable around the crank pin 17, and, furthermore, an orbiting boss, which is provided on the back surface of the end plate of the orbiting scroll 8, is fitted onto the outer circumference of the drive bush 18, with a floating bush 20 and an orbiting bearing 21 interposed therebetween. In this way, the orbiting scroll 8 is driven to orbit with a variable orbiting radius.

[0038] Moreover, pin-ring type rotation-prevention mechanisms 22, each including a ring 23 provided on the back surface of the end plate of the orbiting scroll 8 and a pin 24 provided on the thrust bearing part 3C side, are disposed between the back surface of the end plate of the orbiting scroll 8 and the thrust bearing part 3C of the front housing 3, so as to prevent rotation of the orbiting scroll 8. The pin-ring type rotation-prevention mechanisms 22 are provided at multiple positions (e.g., four positions) on the circumference.

[0039] Additionally, a lip-seal device 25 for closing off the inner side of the housing 2 from the outer side (atmosphere side) is disposed on the bearing part 3B of the front housing 3, between the main bearing 14 and the sub-bearing 15. The lip-seal device 25 is press-fitted into a lip-seal-device accommodating part (which may also be simply referred to as "accommodating part") 26, which is provided on the inner circumferential surface of the bearing part 3B, from the inner side of the front housing 3, such that it contacts a stepped part 27 provided on the outer side (atmosphere side) of the accommodating part 26.

[0040] With the scroll compressor 1, the stationary scroll 7 and the orbiting scroll 8 are configured as illustrated in Figs. 2 to 8. The configurations of the stationary scroll 7 and the orbiting scroll 8 will be described below with reference to Figs. 2 to 8.

[0041] The stationary scroll 7 and the orbiting scroll 8 are each constituted of a spiral wrap 31 vertically disposed on a surface of an end plate 30, and stepped parts

34 and 35, each having at least one step, are provided at predetermined positions along the spiral direction on a tooth-tip surface 32 and a tooth-bottom surface 33 of each spiral wrap 31. The tooth-tip surface 32 is high on the outer circumferential side of the stepped part 34 and low on the inner circumferential side, whereas the tooth-bottom surface 33 is deep (on the same plane as the surface of the end plate 30) on the outer circumferential side of the stepped part 35 and shallow on the inner circumferential side.

[0042] By providing the stepped parts 34 and 35 in this way, in the spiral wrap 31, as illustrated in Figs. 3 to 8, the wrap height of a spiral wrap part 31A on the outer circumferential side of the tooth-tip-side stepped part 34 is larger than the wrap height of a spiral wrap part 31B on the inner circumferential side of the stepped part 34. This constitutes the scroll compressing mechanism 6, which is capable of three-dimensionally compressing gas trapped inside the compression chambers 9 in both the circumferential direction and the axial direction.

[0043] Offset parts 36 and 37, which reduce the wrap thickness with respect to the reference curve of the spiral wrap 31, are provided on both the ventral surface and the dorsal surface of the tooth tip part of the spiral wrap 31. The offset parts 36 and 37 are provided from the inner circumferential end to the outer circumferential end of the spiral wrap 31, spanning the tooth-tip-side stepped part 34, along the entire range from the spiral wrap part 31A on the outer circumferential side of the stepped part 34 to the spiral wrap part 31B on the inner circumferential side of the stepped part 34.

[0044] The offset parts 36 and 37 are provided on the tooth-tip part at approximately the upper 1/3 of the wrap height of the spiral wrap part 31A on the outer circumferential side of the stepped part 34, where the height is large, and are provided on the spiral wrap part 31B, on the other side of the stepped part 34, on the inner circumferential side of the stepped part 34, where the height is small, on the tooth-tip part from the same wrap height. Consequently, the length in the height direction of the offset parts 36 and 37 on the spiral wrap part 31B on the inner circumferential side of the stepped part 34 is small, as illustrated in Figs. 7 and 8.

[0045] As illustrated in Figs. 3 to 6 in an extremely enlarged manner, the offset parts 36 and 37 have actual wrap thicknesses set in the range of approximately 10 to 50 μm and are provided substantially evenly on the ventral surface and the dorsal surface of the tooth-tip part. Furthermore, the offset parts 36 and 37 can be formed by performing the same milling on the dorsal surface and the ventral surface of the tooth-tip parts when milling the entire spiral wrap 31 with an end mill, etc.

[0046] With the configuration described above, the following advantages are achieved by this embodiment.

[0047] The scroll compressor 1 receives a driving force from an external driving source and is operated by rotating the crank shaft 16. When the crank shaft 16 is rotated, the orbiting scroll 8 of the scroll compressing mechanism 6 is orbitally driven around the stationary scroll 7, and the pair of compression chambers 9 move from the outer circumferential side toward the center as the volume decreases. In this way, low-pressure coolant gas taken in from the low-pressure chamber 11 to the compression chambers 9 is compressed into high-temperature, high-pressure gas, is discharged to the high-pressure chamber 12, and is then sent outside the compressor via a discharge port.

[0048] When the orbiting scroll 8 is orbitally driven around the stationary scroll 7, the wrap surfaces of the spiral wraps 31 slide against each other while orbiting; and the orbiting scroll 8 is orbitally driven while being tilted as a tilting moment is applied to the dorsal or ventral side because gas pressure is applied to the spiral wraps 31 in the height direction, and a centrifugal force associated with the orbiting motion is applied thereto. In this way, the tooth-tip part of each spiral wrap 31 tightly contacts the spiral wrap 31 of the other scroll, and a large stress is repeatedly applied to the base parts of the spiral wraps 31.

[0049] Thus, in the configuration according to this embodiment, since the offset parts 36 and 37 are provided on the tooth-tip parts of the spiral wraps 31 of the stationary scroll 7 and the orbiting scroll 8, even when the orbiting scroll 8 is tilted by being orbitally driven, the tooth-tip parts of the spiral wraps 31 between the stationary scroll 7 and the orbiting scroll 8 are prevented from contacting the spiral wrap surface of the other scroll by the offset parts 36 and 37, so that the tooth-tip parts do not come into contact.

[0050] Thus, accelerated wear, an increase in motive power, an increase in stress applied to the base parts of the spiral wraps 31, etc. caused by the tight contact of the tooth-tip parts of the spiral wraps 31 of the stationary scroll 7 and the orbiting scroll 8 due to the tilting of the orbiting scroll 8 are alleviated, and the performance and durability of the scroll compressor 1 can be improved.

[0051] In this embodiment, in a so-called stepped scroll compressor 1 in which steps are provided at arbitrary positions along the spiral direction of the spiral wraps, since the offset parts 36 and 37 are provided so as to span the stepped part 34, from the inner circumferential end to the outer circumferential end of the spiral wraps 31, along the entire range of the spiral wrap part 31A on the outer circumferential side of the stepped part 34 to the spiral wrap part 31B on the inner circumferential side, even when the orbiting scroll 8 is tilted in the entire range of the spiral wraps 31, inter-scroll contact of the tooth-tip parts of the spiral wraps 31 with the spiral wrap surface of the other scroll can be prevented by the offset parts 36 and 37; thus, wear of the spiral wraps 31, stress applied to the base parts of the spiral wraps 31, and the driving force of the scroll fluid machine are reduced, and the performance and durability of the stepped scroll compressor 1 can be improved.

[0052] In this embodiment, the offset parts 36 and 37 are provided so as to span the stepped part 34 along the entire range from the spiral wrap part 31A on the outer circumferential side of the stepped part 34 to the spiral wrap part 31B on the inner circumferential side; instead, the offset parts 36 and 37 may be provided only in the spiral wrap part 31A that is on the outer circumferential side of the stepped part 34, where the wrap height is large, from the inner circumferential end to the outer circumferential end, and the same advantages are achieved in such a case also. In particular, for the stepped scroll compressor 1, since the wrap height is large at the spiral wrap part 31A that is on the outer circumferential side of the stepped parts, by providing the offset parts 36 and 37 at the tooth-tip part thereof, accelerated wear at the spiral wrap part 31A, an increase in driving force, an increase in stress generated at the base parts, etc. can be alleviated. As a result, the characteristics of the so-called stepped scroll compressor 1 are further enhanced, and the performance of the scroll compressor 1 can be improved even more.

[0053] In processing the offset parts 36 and 37 in the stepped scroll compressor 1, the offset parts 36 and 37 are provided so as to span the stepped part 34 on the outer circumferential part and the inner circumferential part of the spiral wraps 31 from a constant height toward the tooth-tip parts; therefore, the offset parts 36 and 37 can be processed all at once from the inner circumferential end to the outer circumferential end of the spiral wraps 31 using a milling tool, such as an end mill, held at the constant height, and thus, the processing of the offset parts 36 and 37 on the scrolls 7 and 8 can be simplified. In such a case, for the offset parts 36 and 37 on the inner circumferential part of the stepped part 34, the lengths in the height direction of the offset parts 36 and 37 with respect to the wrap height is small with respect to wrap height; however, since the initial wrap height is small, this does not cause any particular problems.

[0054] The offset parts 36 and 37 are provided such that their thicknesses in the wrap thickness direction of each spiral wrap 31 are substantially equal by milling both the ventral surface and the dorsal surface of the tooth-tip part of the spiral wrap 31. Thus, when milling each spiral wrap 31 with an end mill, etc., the ventral and dorsal surfaces of tooth-tip part can be milled in a similar manner so as to form the offset parts 36 and 37; thus, the offset parts 36 and 37 can be easily processed by slightly changing the scroll processing steps, and the substantially equally formed offset parts 36 and 37 prevent the tooth-tip part of each spiral wrap 31 and the spiral wrap surface of the other scroll from contacting each other between the scrolls 7 and 8, even when the orbiting scroll 8 is tilted to either the ventral side or the dorsal side of the spiral wrap 31 by being orbitally driven; and, wear of the spiral wraps 31, stress applied to the base parts of the spiral wraps 31, and the driving force of the scroll compressor 1 can be reduced.

[0055] In particular, since the offset parts 36 and 37 are provided with a thickness of approximately 10 to 50 μm in the wrap thickness direction of the spiral wraps 31, the tooth-tip part of each spiral wrap 31 is reliably prevented from contacting the spiral wrap surface of the other scroll between the scrolls 7 and 8 due to the orbiting scroll 8 tilting, and gas leakage from the offset parts 36 and 37 can be minimized. That is, when the thickness of the offset parts 36 and 37 is less than 10 μm, the tooth-tip part might come into contact, whereas, when the thickness is 50 μm or greater, gas leakage may increase due to the widened gaps, causing performance deterioration. By setting the thickness between approximately 10 and 50 μm, performance deterioration can be suppressed while reducing wear of the spiral wraps 31 and stress applied to the base part of the spiral wraps 31, and thus, durability can be improved.

[0056] Furthermore, the offset parts 36 and 37 are provided within the range of approximately 1/3 of the wrap height in the wrap height direction of each spiral wrap 31. In particular, with the stepped scroll compressor 1 of this embodiment, the offset parts 36 and 37 are provided within the range of approximately 1/3 of the wrap height of the spiral wrap part 31A on the outer circumferential side of the stepped part 34, where the wrap height is large. Therefore, at the outer circumferential part of each spiral wrap 31, where the wrap height is large, the position where the spiral wraps 31 of the scrolls 7 and 8 come into tight contact with each other due to the orbiting scroll 8 tilting can be moved from tooth-tip parts to relatively lower sections.

[0057] As a result, the stress acting upon the base parts of the spiral wraps 31 can be reduced, and the durability of the scroll compressor 1 can be improved. Moreover, gas leakage from the offset parts 36 and 37 can be reduced as much as possible, and efficiency can be increased, compared with ones in which the offset parts 36 and 37 are provided on the spiral wraps 31 along the entire height direction. Furthermore, since the height of the spiral wraps 31 can be relatively increased, the volume of the scroll compressor 1 can be increased while maintaining the outer diameter thereof, enabling further improvement in the performance of the scroll compressor 1 or the stepped scroll compressor 1.

[0058] In the embodiment described above, a configuration in which the offset parts 36 and 37 are provided on the tooth-tip parts of the spiral wraps 31 of both the stationary scroll 7 and the orbiting scroll 8 is described. Instead, the offset parts 36 and 37 may be provided on the tooth-tip part of the spiral wrap 31 of a scroll of one of the stationary scroll 7 and the orbiting scroll 8, and this configuration may also be included in the scope of the present invention.

Second Embodiment

[0059] Next, a second embodiment of the present invention will be described with reference to Figs. 9 to 12.

[0060] This embodiment differs from the first embodiment described above in that the stationary scroll and the orbiting scroll are respectively a stationary scroll 47 and an orbiting scroll 48, which are conventional and do not include the stepped parts 34 and 35. Other parts are the same as those in the first embodiment, and thus, descriptions thereof are omitted.

[0061] In a conventional scroll compressor 1, spiral wraps 51 vertically disposed on end plates 50 of the stationary scroll 47 and the orbiting scroll 48 have a uniform wrap height from the inner circumferential end to the outer circumferential end.

[0062] Offset parts 56 and 57 are provided on both the ventral surface and the dorsal surface of a tooth-tip part of each spiral wrap 51.

[0063] Similar to the first embodiment, the offset parts 56 and 57 are provided within the range of approximately 1/3 of the wrap height in the wrap height direction of the spiral wrap 51 and have a thickness of approximately 10 to 50 μm in the wrap thickness direction of the spiral wrap 51.

[0064] Similar to the first embodiment, in this embodiment, when the orbiting scroll 48 is tilted while being orbitally driven, the offset parts 56 and 57 can prevent the tooth-tip part of each spiral wrap 51 from coming into contact with the spiral wrap surface of the other scroll, between the stationary scroll 47 and the orbiting scroll 48, so that they are not in contact. Therefore, accelerated wear, an increase in driving force, an increase in stress applied to the base part of the spiral wrap 51, etc. caused by tight contact of the tooth-tip parts of the spiral wraps 51 of the stationary scroll 47 and the orbiting scroll 48 due to the orbiting scroll 48 tilting while being orbitally driven are alleviated, and the performance and durability of the scroll compressor 1 can be improved.

[0065] The present invention is not limited to the embodiments described above, and appropriate modifications are possible without departing from the scope of the invention. For example, in the embodiments described above, examples in which the present invention is applied to open-type scroll compressors, which are not provided with a built-in driving source, have been described. Instead, the present invention may be applied to a sealed-type scroll compressor, which is provided with a built-in motor. Furthermore, the present invention is not limited to compressors and may be similarly applied to other scroll fluid machines, such as pumps, expanders, etc.

[0066] Furthermore, in the embodiments described above, examples in which the wrap thickness is decreased by performing offset processing (milling), with respect to a reference curve, on the tooth-tip parts of the spiral wraps of the stationary scroll and the orbiting scroll have been described. Instead, in a scroll having coating layers on the surfaces of the spiral wraps, it is possible to employ a configuration in which the spiral wraps, excluding the tooth-tip parts, are coated such that the wrap thickness of the tooth-tip parts is small. Such an embodiment is also included in the scope of the invention.

[0067] Furthermore, in the embodiments described above, an example in which one stepped part is formed at an arbitrary position in the spiral direction of each spiral wrap has been described. Instead, a configuration in which multiple stepped parts are formed in the spiral direction may be employed. Moreover, although not described in the embodiments described above, a configuration in which tip seals are applied to the tip surfaces of the spiral wraps may be employed.

{Reference Signs List}

[0068]

1	scroll compressor (scroll fluid machine)
7, 47	stationary scroll
8, 48	orbiting scroll
30, 50	end plate
31, 51	spiral wrap
31A	spiral wrap part on outer circumference side
31B	spiral wrap part on inner circumference side
34, 35	stepped part
36, 37, 56, 57	offset part

Claims

1. A scroll fluid machine (1) comprising:

   a paired stationary scroll (7, 47) and orbiting scroll (8, 48), including spiral wraps (31, 51) vertically disposed on end plates (30, 50), wherein the stationary scroll (7) and the orbiting scroll (8) are engaged by making the spiral wraps (31) oppose each other with shifted phases, and
   offset parts (36, 37, 56, 57) are provided on a ventral surface and a dorsal surface of a tooth-tip part of the spiral wrap (31) of at least one of the stationary scroll (7), and the orbiting scroll (8) in a direction that reduces the wrap thickness,
   characterized in that the offset parts (36, 37, 56, 57) are provided from the inner circumferential end to the outer circumferential end of the spiral wrap (31) along an entire range of the spiral wrap (31) in the spiral direction of the spiral wraps (31).

2. The scroll fluid machine (1) according to Claim 1, wherein

   stepped parts (34, 35) are provided on the stationary scroll (7) and the orbiting scroll (8) at arbitrary positions in the spiral direction of the spiral wraps (31), and, in the stationary scroll (7) and the orbiting scroll (8), the wrap height on the outer circumferential side of each spiral wrap (31) is larger than the wrap height of the inner

circumferential side thereof, and
the offset parts (36, 37) are provided on the spiral wraps (31) from the inner circumferential end to the outer circumferential end of at least the outer circumferential side of the stepped parts (34, 35), where the wrap height is large.

3. The scroll fluid machine (1) according to Claim 2, wherein each of the offset parts (36, 37) is provided from the inner circumferential end to the outer circumferential end of the spiral wrap (31) along the entire range, spanning the stepped part, from a spiral wrap part (31A) on the outer circumferential side of the stepped part (34) to a spiral wrap part (31B) on the inner circumferential side of the stepped part (34).

4. The scroll fluid machine (1) according to Claim 3, wherein each of the offset parts (36, 37) is provided on the outer circumferential part and the inner circumferential part of the spiral wrap (31), spanning the stepped part, on the tooth-tip part starting from the same wrap height.

5. The scroll fluid machine (1) according to one of Claims 1 to 4, wherein the offset parts (36, 37, 56, 57) are provided by milling the ventral surface and the dorsal surface of the tooth-tip parts.

6. The scroll fluid machine (1) according to one of Claims 1 to 5, wherein the offset parts (36, 37, 56, 57) are provided equally on the ventral surface and the dorsal surface of the tooth-tip part.

7. The scroll fluid machine according to one of Claims 1 to 6, wherein the offset parts (36, 37, 56, 57) have a thickness of 10 to 50 μm in the wrap thickness direction of the spiral wraps (31).

8. The scroll fluid machine (1) according to one of Claims 1 to 7, wherein the offset parts (36, 37, 56, 57) are provided within a range of 1/3 of the wrap height of the spiral wraps (31) in the wrap height direction.

9. The scroll fluid machine (1) according to one of Claims 2 to 7, wherein the offset parts (36, 37) are provided within a range of 1/3 of the spiral wraps (31) in the wrap height direction on the outer circumferential side of the stepped parts (34, 35) having a large wrap height.

10. The scroll fluid machine (1) according to one of Claims 1 to 9, wherein the offset parts (36, 37, 56, 57) are provided on both the ventral surface and the dorsal surface of the tooth-tip part of each spiral wrap.

Patentansprüche

1. Spiralfluidmaschine (1) umfassend:

eine Paarung aus feststehender Spirale (7, 47) und umlaufender Spirale (8, 48), die Spiralwindungen (31, 51) umfassen, die vertikal an Endplatten (30, 50) angeordnet sind, wobei
die feststehende Spirale (7) und die umlaufende Spirale (8) miteinander in Eingriff stehen, indem dafür gesorgt wird, dass die Spiralwindungen (31) einander mit verschobenen Phasen gegenüberliegen, und
versetzte Teile (36, 37, 56, 57), die an einer ventralen Oberfläche und einer dorsalen Oberfläche eines Zahnspitzenteils der Spiralwindung (31) von mindestens einer der feststehenden Spirale (7) und der umlaufenden Spirale (8) in eine Richtung vorgesehen sind, die die Windungsdicke reduziert,
dadurch gekennzeichnet, dass die versetzten Teile (36, 37, 56, 57) vom Innenumfangsende zum Außenumfangsende der Spiralwindung (31) längs eines gesamten Bereichs der Spiralwindung (31) in die Spiralrichtung der Spiralwindungen (31) vorgesehen sind.

2. Spiralfluidmaschine (1) nach Anspruch 1, wobei abgestufte Teile (34, 35) an der feststehenden Spirale (7) und der umlaufenden Spirale (8) an beliebigen Positionen in die Spiralrichtung der Spiralwindungen (31) vorgesehen sind, und in der feststehenden Spirale (7) und der umlaufenden Spirale (8) die Windungshöhe auf der Außenumfangsseite jeder Spiralwindung (31) größer als die Windungshöhe ihrer Innenumfangsseite ist, und
die versetzten Teile (36, 37) an den Spiralwindungen (31) von der Innenumfangsende zum Außenumfangsende mindestens der Außenumfangsseite der abgestuften Teile (34, 35) vorgesehen sind, wo die Windungshöhe groß ist.

3. Spiralfluidmaschine (1) nach Anspruch 2, wobei jeder der versetzten Teile (36, 37) von der Innenumfangsende zum Außenumfangsende der Spiralwindung (31) längs des gesamten Bereichs, der den abgestuften Teil überspannt, von einem Spiralwindungsteil (31A) auf der Außenumfangsseite des abgestuften Teils (34) zu einem Spiralwindungsteil (31B) auf der Innenumfangsseite des abgestuften Teils (34) vorgesehen ist.

4. Spiralfluidmaschine (1) nach Anspruch 3, wobei jeder der versetzten Teile (36, 37) am Außenumfangsteil und am Innenumfangsteil der Spiralwindung (31), die den abgestuften Teil überspannt, am Zahnspitzenteil ausgehend von derselben Windungshöhe vorgesehen ist.

5. Spiralfluidmaschine (1) nach einem der Ansprüche 1 bis 4, wobei die versetzten Teile (36, 37, 56, 57) durch Fräsen der ventralen Oberfläche und der dorsalen Oberfläche der Zahnspitzenteile bereitgestellt werden.

6. Spiralfluidmaschine (1) nach einem der Ansprüche 1 bis 5, wobei die versetzten Teile (36, 37, 56, 57) gleichermaßen auf der ventralen Oberfläche und der dorsalen Oberfläche des Zahnspitzenteils vorgesehen sind.

7. Spiralfluidmaschine nach einem der Ansprüche 1 bis 6, wobei die versetzten Teile (36, 37, 56, 57) eine Dicke von 10 bis 50 μm in die Windungsdickenrichtung der Spiralwindungen (31) aufweisen.

8. Spiralfluidmaschine (1) nach einem der Ansprüche 1 bis 7, wobei die versetzten Teile (36, 37, 56, 57) innerhalb eines Bereichs von 1/3 der Windungshöhe der Spiralwindungen (31) in die Windungshöhenrichtung vorgesehen sind.

9. Spiralfluidmaschine (1) nach einem der Ansprüche 2 bis 7, wobei die versetzten Teile (36, 37) innerhalb eines Bereichs von 1/3 der Spiralwindungen (31) in die Windungshöhenrichtung auf der Außenumfangsseite der abgestuften Teile (34, 35) vorgesehen sind, die eine große Windungshöhe aufweisen.

10. Spiralfluidmaschine (1) nach einem der Ansprüche 1 bis 9, wobei die versetzten Teile (36, 37, 56, 57) sowohl auf der ventralen Oberfläche als auch der dorsalen Oberfläche des Zahnspitzenteils jeder Spiralwindung vorgesehen sind.

Revendications

1. Machine à fluide à spirales (1) comprenant :

   une spirale fixe (7, 47) et une spirale à mouvement orbital (8, 48) appariées, comprenant des enroulements en spirale (31, 51) disposés verticalement sur des plaques d'extrémité (30, 50), dans laquelle
   la spirale fixe (7) et la spirale à mouvement orbital (8) sont engagées en amenant les enroulements en spirale (31) à s'opposer l'un à l'autre avec des phases décalées, et
   des parties décalées (36, 37, 56, 57) sont prévues sur une surface ventrale et une surface dorsale d'une partie de pointe de dent de l'enroulement en spirale (31) d'au moins une de la spirale fixe (7), et de la spirale à mouvement orbital (8) dans une direction qui réduit l'épaisseur d'enroulement,
   caractérisée en ce que les parties décalées (36, 37, 56, 57) sont prévues depuis l'extrémité circonférentielle intérieure jusqu'à l'extrémité circonférentielle extérieure de l'enroulement en spirale (31) le long d'une plage entière de l'enroulement en spirale (31) dans la direction de spirale des enroulements en spirale (31).

2. Machine à fluide à spirales (1) selon la revendication 1, dans laquelle
des parties étagées (34, 35) sont prévues sur la spirale fixe (7) et la spirale à mouvement orbital (8) dans des positions arbitraires dans la direction de spirale des enroulements en spirale (31), et, dans la spirale fixe (7) et la spirale à mouvement orbital (8), la hauteur d'enroulement sur le côté circonférentiel extérieur de chaque enroulement en spirale (31) est plus grande que la hauteur d'enroulement sur le côté circonférentiel intérieur de celui-ci, et
les parties décalées (36, 37) sont prévues sur les enroulements en spirale (31) depuis l'extrémité circonférentielle intérieure jusqu'à l'extrémité circonférentielle extérieure de au moins le côté circonférentiel extérieur des parties étagées (34, 35), où la hauteur d'enroulement est grande.

3. Machine à fluide à spirales (1) selon la revendication 2, dans laquelle chacune des parties décalées (36, 37) est prévue depuis l'extrémité circonférentielle intérieure jusqu'à l'extrémité circonférentielle extérieure de l'enroulement en spirale (31) le long de la plage entière, englobant la partie étagée, depuis une partie d'enroulement en spirale (31A) sur le côté circonférentiel extérieur de la partie étagée (34) jusqu'à une partie d'enroulement en spirale (31B) sur le côté circonférentiel intérieur de la partie étagée (34).

4. Machine à fluide à spirales (1) selon la revendication 3, dans laquelle chacune des parties décalées (36, 37) est prévue sur la partie circonférentielle extérieure et la partie circonférentielle intérieure de l'enroulement en spirale (31), englobant la partie étagée, sur la partie de pointe de dent qui part de la même hauteur d'enroulement.

5. Machine à fluide à spirales (1) selon l'une des revendications 1 à 4, dans laquelle les parties décalées (36, 37, 56, 57) sont procurées par fraisage de la surface ventrale et de la surface dorsale des parties de pointe de dent.

6. Machine à fluide à spirales (1) selon l'une des revendications 1 à 5, dans laquelle les parties décalées (36, 37, 56, 57) sont prévues également sur la surface ventrale et la surface dorsale de la partie de pointe de dent.

7. Machine à fluide à spirales selon l'une des revendications 1 à 6, dans laquelle les parties décalées (36,

37, 56, 57) ont une épaisseur de 10 à 50 μm dans la direction d'épaisseur d'enroulement des enroulements en spirale (31).

8. Machine à fluide à spirales (1) selon l'une des revendications 1 à 7, dans laquelle les parties décalées (36, 37, 56, 57) sont prévues dans une plage de 1/3 de la hauteur d'enroulement des enroulements en spirale (31) dans la direction de hauteur d'enroulement.

9. Machine à fluide à spirales (1) selon l'une des revendications 2 à 7, dans laquelle les parties décalées (36, 37) sont prévues dans une plage de 1/3 des enroulements en spirale (31) dans la direction de hauteur d'enroulement sur le côté circonférentiel extérieur des parties étagées (34, 35) ayant une grande hauteur d'enroulement.

10. Machine à fluide à spirales (1) selon l'une des revendications 1 à 9, dans laquelle les parties décalées (36, 37, 56, 57) sont prévues sur la surface ventrale et la surface dorsale de la partie de pointe de dent de chaque enroulement en spirale.

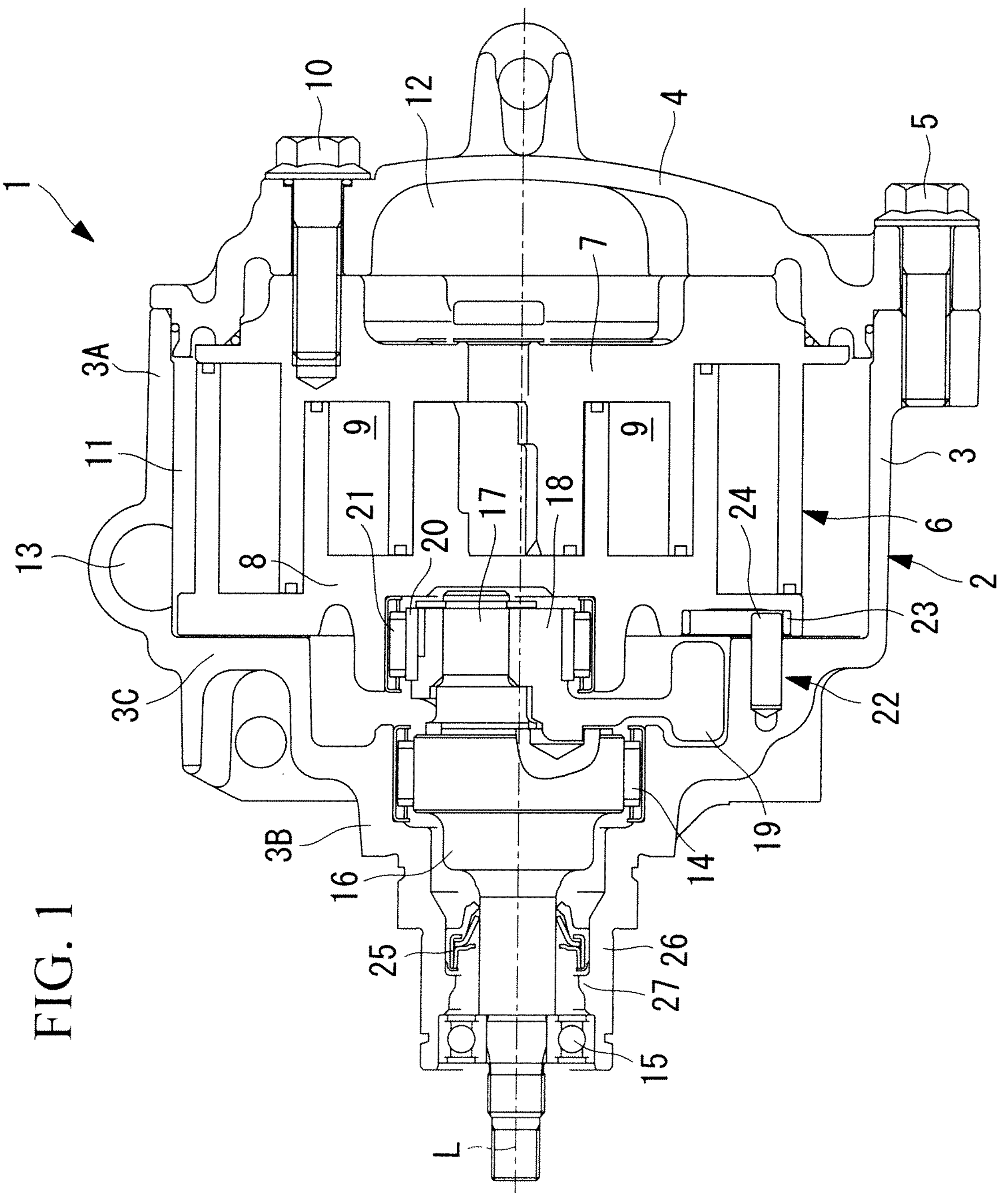
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FIG. 1

FIG. 2

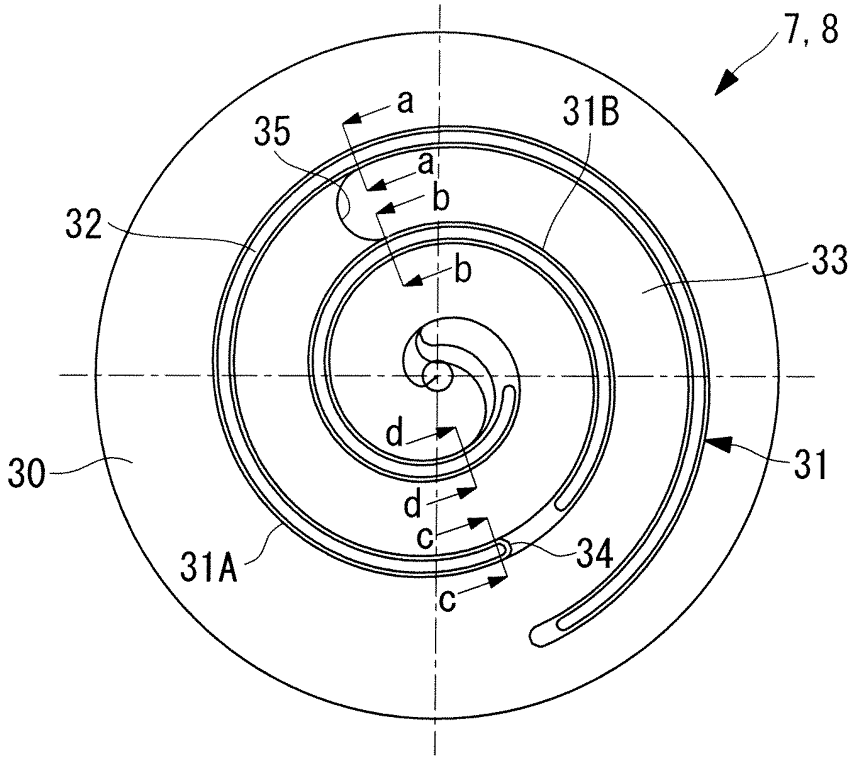


FIG. 3

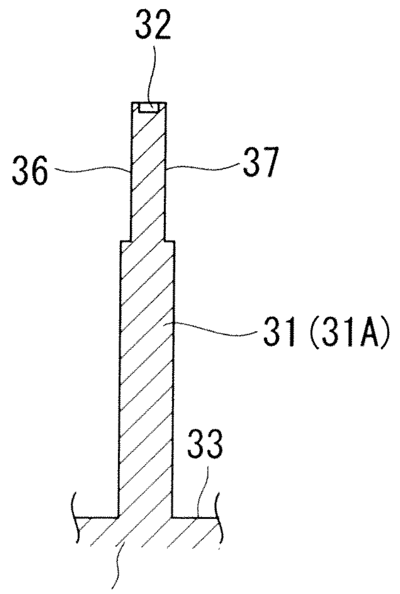


FIG. 4

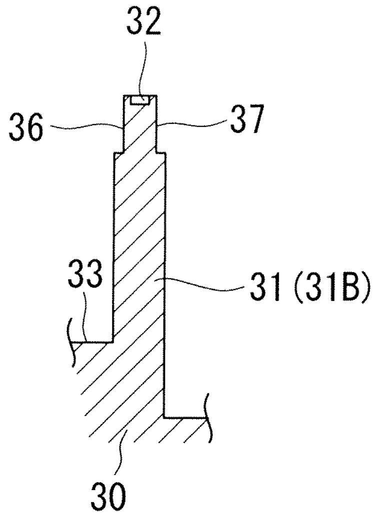


FIG. 5

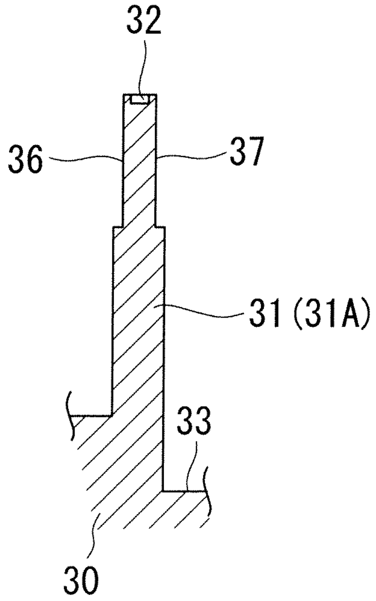


FIG. 6

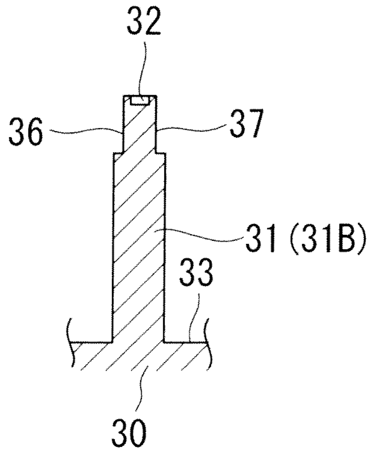


FIG. 7

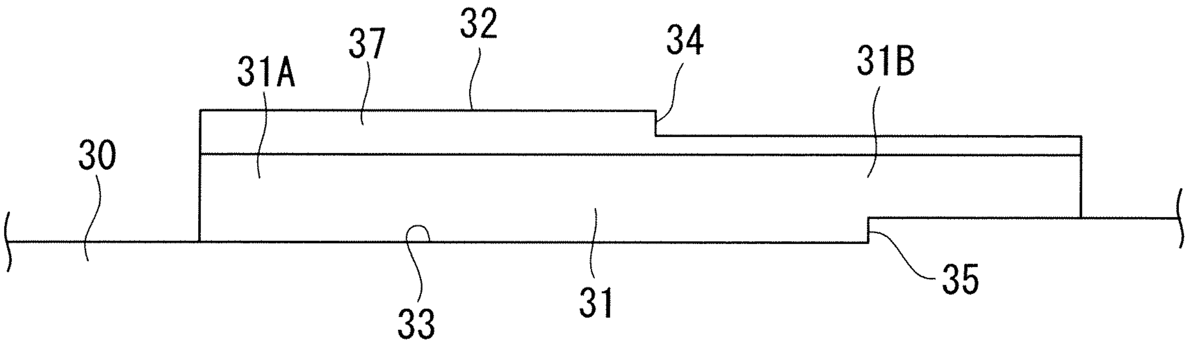


FIG. 8

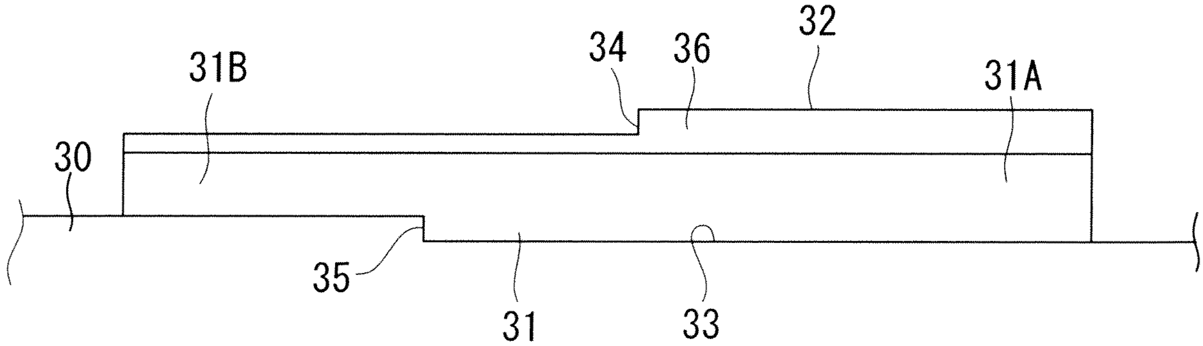


FIG. 9

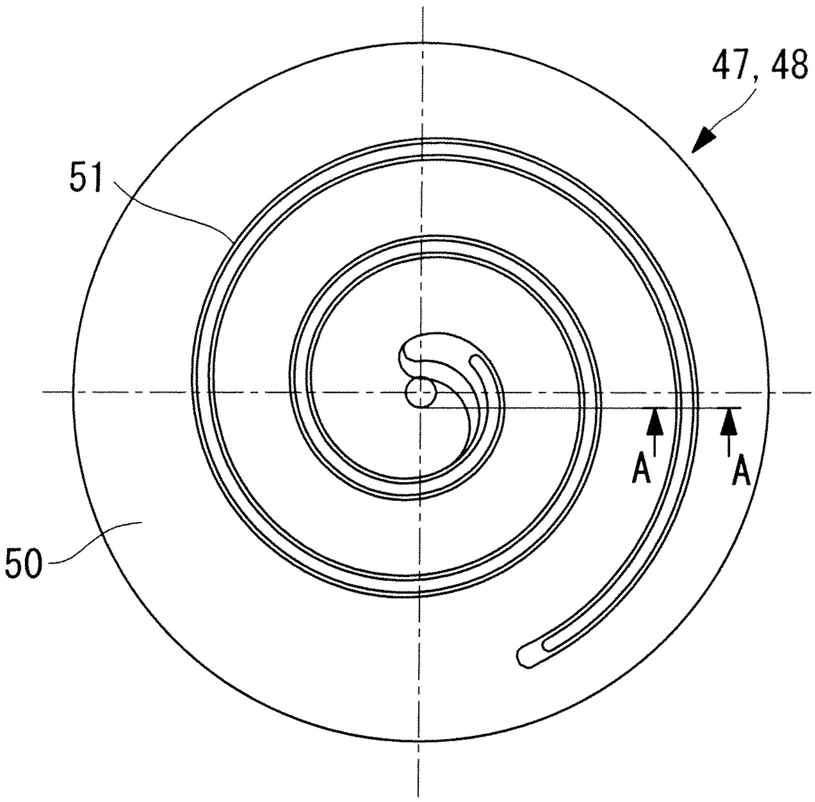


FIG. 10

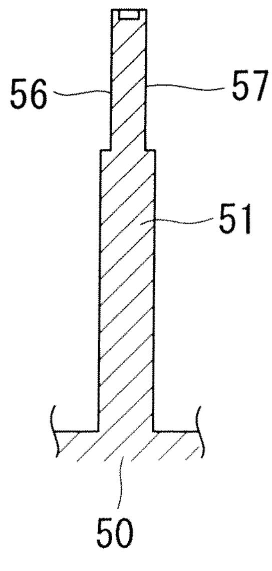


FIG. 11

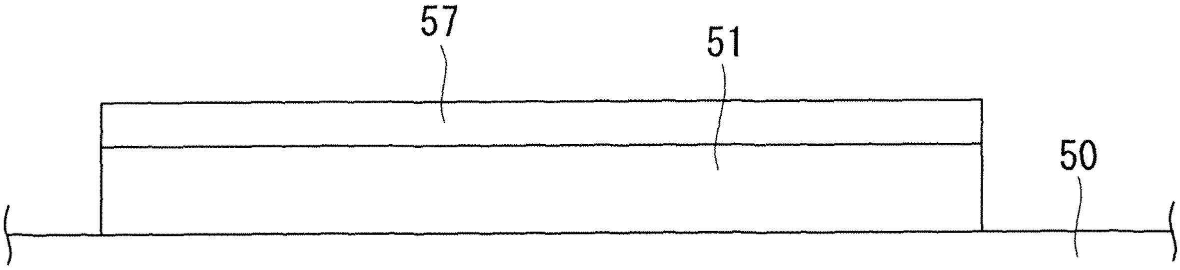
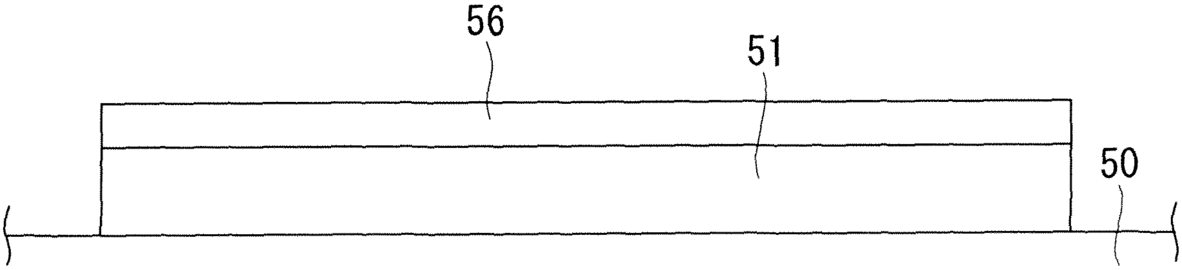


FIG. 12



REFERENCES CITED IN THE DESCRIPTION

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