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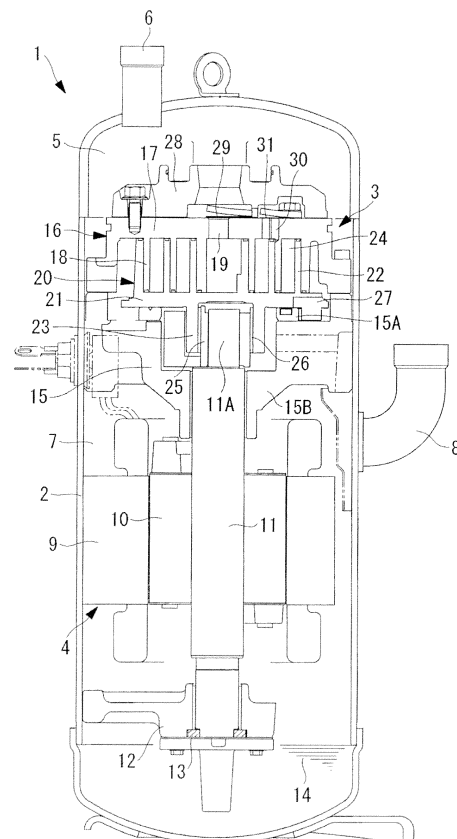
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(57) Scroll compressor provided with a compression mechanism (3) that is formed by engaging a paired fixed scroll and orbiting scroll (16, 20) in which spiral wraps (18 and 22) are vertically provided on one surface of end plates thereof, numerous fine depressions (32) are provided on one or both of a side surface (18A, 188) of a spiral wrap (18) of the fixed scroll and a side surface (22A, 22B) of a spiral wrap (22) of the orbiting scroll, which are in sliding contact with each other.

FIG. 1



Description

{Summary of Invention}

{Technical Field}

{Technical Problem}

[0001] The present invention relates to a scroll compressor and a scroll processing method with which it is possible to reduce refrigerant leakage from side surfaces of spiral wraps of a fixed scroll and an orbiting scroll that are in sliding contact with each other.

{Background Art}

[0002] Compression chambers of a scroll compressor are formed by engaging a pairing of a fixed scroll and an orbiting scroll. In one example, a pairing of a fixed scroll and an orbiting scroll in which spiral wraps vertically provided on one surface of each of end plates are engaged so that the phases thereof are shifted 180° and also so that centers thereof are shifted by an amount corresponding to the orbiting radius. In addition, spaces between wrap top surfaces of the individual spiral wraps and wrap bottom surfaces of the engaged scrolls are sealed by means of a tip seal or the like. Furthermore, the space between the side surface of the spiral wrap of the fixed scroll and side surface of the spiral wrap of the orbiting scroll is sealed by pressing them into contact by means of a passive crank mechanism or the like. By doing so, a pair of sealed compression chambers are formed. The compression chamber compresses refrigerant by moving it from the outer-circumferential side to the center of the chamber while decreasing the volume thereof in accordance with revolving orbiting of the orbiting scroll.

[0003] In such a scroll compressor, although sealing of the side surfaces of the spiral wraps is achieved by actively bringing the side surfaces of the spiral wraps into contact with each other by means of a passive crank mechanism, as described above, some amount of sliding loss occurs due to the contact, thus causing a slight deterioration in efficiency.

On the other hand, Patent Literatures 1 and 2, among others, disclose systems in which numerous fine dimples are provided on thrust sliding surfaces of various component members of a compression mechanism so that friction and wear are prevented by improving lubrication at sliding surface by holding oil in the fine dimples, and also so that internal leakage of working fluid is reduced.

{Citation List}

{Patent Literature}

[0004]

{PTL 1} Japanese Laid-open Patent Publication No. H5-332272

{PTL 2} Japanese Laid-open Patent Publication No. 2011-21597

[0005] Although Patent Literatures 1 and 2 described above disclose systems in which numerous fine dimples are provided on the thrust sliding surfaces of various component members forming the compression mechanism, the fine dimples are not provided on the side surfaces formed by curves of the spiral wraps. In the case in which the fine dimples are provided on the thrust sliding surfaces, shot peening is generally performed. Specifically, the sliding surfaces are blasted with spherical particles, thus forming dimples randomly thereon. In this case, it may be also considered that, by holding oil in the dimples, the sliding loss may be reduced and wear resistance may also be enhanced. However, in a configuration in which sealing is the main purpose, as in the case of sliding contact of the side surfaces of the spiral wraps, it may not be possible to expect stable sealing affects when employing randomly provided dimples. This may be the reason why the idea of providing dimples has not been adopted.

[0006] On the other hand, the use of heat pumps or the like employing high-pressure refrigerant, such as CO₂ refrigerant, has been increasing in recent years. In this case, because the pressure difference of the refrigerant by being compressed increases, it is even more important to take measures against internal leakage during compression, which presents a challenge for providing a side-surface seal in spiral wraps. Conventional measures considered for enhancing the side-surface seal in spiral wraps include, adjustment of the pressing force exerted by a passive crank mechanism coating the side surfaces using a high-conformability film, and so forth. However, there are problems that with an increase in the pressing force sliding loss increases wear debris of the film is produced, and so forth, and thus, these measures have not been employed in a practical use.

[0007] The present invention has been made in light of the circumstances described above, and an object thereof is to provide a scroll compressor and a scroll processing method with which further efficiency enhancement can be achieved by realizing both leakage reduction and sliding-loss reduction at the same time by enhancing the side-surface seal in spiral wraps that are in sliding contact with each other.

{Solution to Problem}

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[0008] In order to solve the problems described above, a scroll compressor and scroll processing method of the present invention employ the following solutions.

A scroll compressor according to an aspect of the present invention is a scroll compressor comprising a compression mechanism formed by engaging a pairing of a fixed scroll and an orbiting scroll in each of which a spiral wrap is vertically provided on one surface of an end plate there-

of, wherein a plurality of fine depressions are provided on one or both of a side surface of the spiral wrap of the fixed scroll and a side surface of the spiral wrap of the orbiting scroll, which are in sliding contact with each other.

[0009] With this aspect, plurality of fine depressions are provided on one or both of the side surface of the spiral wrap of the fixed scroll and the side surface of the spiral wrap of the orbiting scroll, which are in sliding contact with each other, in the paired fixed scroll and orbiting scroll that form the compression mechanism. Because of this, during the compression operation, by holding oil that has been taken into the compression chamber along with the refrigerant gas by means of the plurality of fine depressions provided on the side surfaces of the spiral wraps that are in sliding contact with each other, sliding contact surfaces can be sealed with that oil, and the sliding friction coefficient due to the contact can also be reduced. Therefore, re-compression loss can be reduced by reducing refrigerant-gas leakage. In addition, the compression efficiency of the scroll compressor can be further enhanced by reducing the sliding loss by lowering the sliding friction coefficient.

[0010] In addition, in a scroll compressor of another aspect, the fine depressions are formed as dimples elongated in a revolving direction of the orbiting scroll which is revolved about the fixed scroll in an orbital manner.

[0011] With this aspect, the fine depressions are formed as dimples elongated in a revolving direction of the orbiting scroll which is revolved about the fixed scroll in an orbital manner. Because of this, by holding the oil in the dimples elongated in the revolving direction, it is possible to seal and lubricate a longer portion of the sliding contact surfaces that move in association with orbital driving of the orbiting scroll. Therefore, the reduction effects on re-compression loss and sliding loss can be further enhanced.

[0012] With a scroll compressor of yet another aspect, in any one of the scroll compressors described above, multiple rows of the fine depressions are arranged in a staggered manner along the height direction of the spiral wraps.

[0013] With this aspect, multiple rows of the fine depressions are arranged in a staggered manner along the height direction of the spiral wraps. Because of this, by means of the multiple rows of plurality of fine depressions arranged in a staggered manner, the oil can be held substantially evenly over the entire areas of the side surfaces of the spiral wraps that are in sliding contact with each other. Therefore, the reduction effects on re-compression loss and sliding loss can be further enhanced.

[0014] With a scroll compressor of yet another aspect, in any one of the scroll compressors described above, each of the fixed scroll and the orbiting scroll is provided with a step portion at a wrap top side and at a wrap bottom side of the spiral wrap thereof, and height of each of the spiral wraps is made higher in a portion closer to the outer circumference thereof relative to the step portion than a

portion closer to the inner circumference thereof relative to the step portion; and the fine depressions are also provided on a sliding contact surface of each of the step portions.

[0015] With this aspect, so-called stepped scrolls are employed as the fixed scroll and the orbiting scroll, and the fine depressions are also provided on sliding contact surfaces of the step portions thereof. Because of this, the sliding contact surfaces of the step portions can also be sealed with oil by holding the oil by providing the fine depressions on the sliding contact surfaces formed in the step portions. Therefore, refrigerant leakage can effectively be reduced at the step portions, where, structurally, refrigerant leakage tends to occur, and thus, it is possible to further enhance the efficiency of a so-called stepped scroll compressor.

[0016] With a scroll compressor of yet another aspect, in any one of the scroll compressors described above, the scroll compressor is a CO₂-refrigerant compressor for a supercritical cycle system using CO₂-refrigerant.

[0017] With this aspect, the scroll compressor is a CO₂-refrigerant compressor for a supercritical cycle system using CO₂ refrigerant. Because of this, even if the present invention is employed in a scroll compressor for CO₂ refrigerant which is a higher-pressure refrigerant than HFC refrigerant and with which the pressure difference during compression increases, refrigerant leakage can effectively be reduced, as described above. Therefore, it is possible to further increase the performance of a CO₂-refrigerant scroll compressor, and it is possible to enhance the COP (coefficient of performances of supercritical-cycle air conditioners, refrigerators, heat pumps, and so forth employing the compressor.

[0018] Furthermore, a scroll processing method according to an aspect of the present invention is a scroll processing method for forming a plurality of fine depressions on side surface of a spiral wrap of one or both of a fixed scroll and an orbiting scroll that form a scroll compressor, wherein the fine depressions are processed on the side surfaces of the spiral wraps by pressing and rotating a burnishing tool, which has a plurality of rolling elements that roll while vibrating at an outer circumferential surface thereof, against the side surfaces of the spiral wraps so as to dent the processed surfaces to form the deformations.

[0019] With this aspect, plurality of fine depressions can be processed on the side surfaces of the spiral wraps by pressing and rotating the burnishing tool, in which numerous rolling elements that roll while vibrating are held at the outer circumferential surface thereof, against the side surfaces of the spiral wraps of the fixed scroll and/or the orbiting scroll so as to dent the processed surfaces to cause deformation thereof. Because of this, merely by pressing and rolling the burnishing tool against the side surfaces of the spiral wraps, plurality of fine depressions having the desired shape and size can easily be processed in cut regular arrangement. Then, by employing these fine depressions for holding the oil, re-compression

loss can be reduced by reducing refrigerant-gas leakage in the scroll compressor, the sliding loss can also be reduced by lowering the sliding friction coefficient, and thus, enhanced compression efficiency can be achieved. In addition, this processing is a type of deformation processing for enhancing surface hardness, surface roughness, and so forth, and thus, durability, wear resistance, and so forth of the spiral wraps can also be enhanced by this processing.

{Advantageous Effects of Invention}

[0020] With a scroll compressor of the present invention, during the compression operation, by holding oil that has been taken into the compression chamber along with refrigerant gas by means of plurality of fine depressions provided on side surfaces of spiral wraps that are in sliding contact with each other, sliding contact surfaces can be sealed with that oil, and the sliding friction coefficient due to the contact can also be reduced. Because of this, re-compression loss can be reduced by reducing refrigerant-gas leakage, the sliding loss can also be reduced by lowering the sliding friction coefficient, and thus, the compression efficiency of the scroll compressor can be further enhanced.

[0021] With a scroll processing method of the present invention, merely by pressing and rolling a burnishing tool against side surfaces of spiral wraps, plurality of fine depressions having a desired size can easily be processed in a regular arrangement. Because of this, by employing these fine depressions for holding oil, re-compression loss can be reduced by reducing refrigerant-gas leakage in the scroll compressor, the sliding loss can also be reduced by lowering the sliding friction coefficient, and thus, enhanced compression efficiency can be achieved. In addition this burnishing processing is a type of deformation processing for enhancing surface hardness, surface roughness, and so forth, and thus, durability, wear resistance, and so forth of the spiral wraps can also be enhanced by this processing.

{Brief Description of Drawings}

[0022]

{Fig. 1} Fig. 1 is a longitudinal sectional view showing entirely a scroll compressor according to a first embodiment of the present invention.

{Fig. 2} Fig. 2 is a plan view showing a fixed or an orbiting scroll of the scroll compressor shown in Fig. 1, viewed from a spiral wrap side.

{Fig. 3} Fig. 3 is a longitudinal sectional view of the fixed or the orbiting scroll shown in Fig. 2.

{Fig. 4} Fig. 4 is a partially enlarged view (A) and its sectional view (B) of a side surface of the spiral wrap of the fixed or the orbiting scroll shown in Fig. 3.

{Fig. 5} Fig. 5 is a perspective view of a fixed or an orbiting scroll according to a second embodiment of

the present invention.

{Description of Embodiments}

[0023] Embodiments according to the present invention will be described below with reference to the drawings.

{First Embodiment}

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[0024] A first embodiment of the present invention will be described below by using Figs. 1 to 4.

Fig. 1 is a longitudinal sectional view showing entirely a scroll 1 compressor according to the first embodiment of the present invention, Fig. 2 is a plan view showing a fixed or an orbiting scroll, viewed from a spiral wrap side, and Fig. 3 shows a sectional view thereof. Note that, although an example of a sealed-type electric scroll compressor for CO₂-refrigerant will be described in this embodiment, the present invention is not limited thereto.

A scroll compressor 1 is provided with a sealed-type housing 2 using steel plate that is elongated in the top-to-bottom direction and that has a bottomed-cylinder shape. A scroll compression mechanism (compression mechanism) 3 is installed at a top portion inside the sealed housing 2, and an electric motor 4 is installed at a bottom portion thereof.

[0025] In the interior of the sealed housing 2, the portion above the scroll compression mechanism 3 serves as a discharge chamber 5 to which high-pressure compressed by the scroll compression mechanism 3 is discharged, a discharge pipe 6 being connected to said discharge chamber. In addition, the portion below the scroll compression mechanism 3 serves as an intake chamber 7 for taking in low-pressure intake gas, to which an intake pipe 8 is connected. The electric motor 4, formed of a stator 9 and a rotor 10, is installed inside the sealed housing 2 on the intake-chamber 7 side by means of press fitting or the like, and a crankshaft 11 that is joined with the rotor 10 of the electric motor 4 extends in the top-to-bottom direction.

[0026] The bottom end of the crankshaft 11 is supported by a lower bearing 12 provided inside the sealed housing 2. With this compressor 1, lubrication oil 14 that is filled in the bottom of the sealed housing 2 is supplied to required lubrication portions of the scroll compression mechanism 3 and a top bearing member 15 through oil supply holes (not shown) provided in the crankshaft 11 by means of a known oil-supply pump 13 provided between the bottom end of the crankshaft 11 and the lower bearing 12 so that these portions can be lubricated.

[0027] The scroll compression mechanism 3 is installed inside the sealed housing 2 via the top bearing member 15. The scroll compression mechanism 3 is formed of a fixed scroll 16 that is securely installed on the top bearing member 15 and an orbiting scroll 20 that is supported on the top bearing member 15 so as to be capable of revolvingly orbiting about the fixed scroll 16.

The fixed scroll 16 is provided with a fixed end plate 17 and a fixed spiral wrap 18 that is vertically provided on one surface thereof, and a discharge port 19 is provided at a center portion of the fixed end plate 17.

[0028] In addition, the orbiting scroll 20 is provided with an orbiting end plate 21 and an orbiting spiral wrap 22 that is vertically provided on one surface thereof, and an orbiting boss 23 is integrally provided on the back face of the orbiting end plate 21. With the fixed scroll 16 and the orbiting scroll 20, a pair of compression chambers 24 are formed between the two scrolls 16 and 20 by engaging the fixed spiral wrap 18 and the orbiting spiral wrap 22 in a known manner so that the phases thereof are shifted 180°. The pair of compression chambers 24 are configured so that with revolving of the orbiting scroll 20, gas is moved toward the center portion from an outer-circumferential position while decreasing in volume, thus achieving compression.

[0029] The back face of the orbiting end plate 21 is supported on a thrust bearing 15A of the top bearing member 15, and a crank pin 11A provided at the top end of the crankshaft 11 is joined with the orbiting boss 23 by means of a drive bush 25 and an orbiting bearing 26 that form a known passive crank mechanism, thereby configuring the orbiting scroll 20 so that it can be revolved about the fixed scroll 16 in an orbital manner, allowing to make the orbiting radius variable. Rotation preventing means 27 formed of an Oldham ring or the like that prevents rotation of the orbiting scroll 20 on its axis is installed between the back face of the orbiting end plate 21 of the orbiting scroll 20 and the thrust bearing 15A of the top bearing member 15.

[0030] Note that, the top portion of the crankshaft 11 is supported by a journal bearing 15B of the top bearing member 15 in a freely rotatable manner. In addition, in the fixed end plate 17 of the fixed scroll 16, a discharge cover 28 is provided on the back face thereof, a reed-valve-type discharge valve 29 that opens and closes the discharge port 19 is provided. Furthermore, for the discharge port 19 the fixed scroll 16, multiple pairs of relief ports 30 formed of multiple groups of holes that communicate between the compression chambers 24 and the discharge chamber 5 and relief valves 31 that open and close the ports 30 are provided at multiple locations at different orbiting-angle positions along the spiral direction of the fixed spiral wrap 18 on the outer-circumferential side.

[0031] Furthermore, this embodiment employs a configuration in which, in the scroll compressor 1 described above, as shown in Fig. 4, numerous fine depressions (dimples) 32 are provided on side surfaces of the spiral wraps 18 and 22, such that the fine depressions are provided one or both of a ventral side (radially inside) surface 18A of the spiral wrap 18 of the fixed scroll 16 and a dorsal side (radially outside) surface 22A of the spiral wrap 22 of the orbiting scroll 20, and such that the fine depressions are provided one or both of a dorsal side (radially outside) surface 18B of the spiral wrap 18 of the

fixed scroll 16 and a ventral side (radially inside) surface 22B of the spiral wrap 22 of the orbiting scroll 20, as shown in Figs. 2 to 4. The spiral wraps 18 and 22 are in sliding contact with each other. Multiple rows of the fine depressions 32 are regularly arranged along the wrap-height direction in a staggered manner, and the shape thereof is a substantially elliptical shape elongated along the sliding direction (direction of the arrow), as shown in Fig. 4.

[0032] As shown in Figs. 2 and 3, the fine depressions 32 can be processed by pressing a burnishing tool 40, in which numerous rolling elements (balls) 41 that roll while vibrating are held at the outer circumferential surface thereof, against the side surfaces of the spiral wraps 18 and 22, and also by rolling it along the side surfaces of the spiral wraps 18 and 22 while rotating it. In this example, the fine depressions (dimples) 32 having a desired depth and size are processed on the spiral wraps 18 and 22 having a wrap height of 45 mm by rolling the burnishing tool 40, in which multiple rows of rolling-elements each having twelve rolling elements 41 arranged lengthwise are provided on the outer circumferential surface along the circumferential direction, while applying a pressing force of about 10 N (Newton) on each rolling element. Note that, as the burnishing tool 40, there are known tools such as those disclosed in the Publication of Japanese Patent No. 4575899, and so forth.

[0033] With the configuration described above, this embodiment affords the following operational advantages.

When the electric motor 4 is driven in the scroll compressor 1 described above, low-pressure refrigerant gas (CO₂ refrigerant) is taken into the sealed housing 2 via the intake pipe 8, and this refrigerant gas is taken into the compression chambers 24 of the scroll compression mechanism 3 through a refrigerant flow path provided in the top bearing member 15 and so forth. When the orbiting scroll 20 is revolved about the fixed scroll 16 in an orbital manner, the refrigerant gas taken into the compression chambers 24 is compressed into high-temperature, high-pressure gas while the compression chamber 24 moves toward the center from outer circumferential positions of the compression mechanism 3 while decreasing in volume.

[0034] The compressed gas is discharged into the discharge chamber 5 via the discharge port 19 and the discharge valve 29 provided at the center portion of the fixed scroll 16 to be discharged outside the compressor via the discharge pipe 6 connected to the discharge chamber 5. In some cases, depending on the operating conditions, excessive compression or an abnormal increase in pressure in the compression chambers 24 due to liquid compression occurs during this compression process. In such cases, in an intermediate stage before the compression chambers 24 communicate with the discharge port 19, the relief valves 31 are opened so that the relief ports 30 communicate with the discharge chamber 5, and thus, the high-pressure gas or the liquid are released into the

discharge chamber 5 through the relief ports 30.

[0035] On the other hand, when the crankshaft 11 is rotated by being driven by the electric motor 4, the lubrication oil 14 that is filled in the bottom of the sealed housing 2 is supplied to the required lubrication portions of the scroll compression mechanism 3, the top bearing member 15, and so forth by means of the oil-supply pump 13, thus lubricating those portions. A portion of this lubrication oil is taken into the compression chambers 24 along with the refrigerant gas to be supplied for sealing the compression chambers 24. The compression chambers 24 are sealed by bringing tooth-tip surfaces of the spiral wraps 18 and 22 and tooth-bottom surfaces of the engaged scroll into contact, with the tip seal (not shown) interposed therebetween.

[0036] In addition, because the spiral wrap 22 of the orbiting scroll 20 is pressed against the spiral wrap 18 of the fixed scroll 16 due to compression reaction force, centrifugal force, or the like exerted via the passive crank mechanism, the side surfaces of the spiral wraps 18 and 22 of the two scrolls 16 and 20, that is, the predetermined pair of the ventral side surface 18A of the spiral wrap 18 of the fixed scroll 16 and the dorsal side surface 22A of the spiral wrap 22 of the orbiting scroll 20, and also the predetermined pair of the dorsal side surface 18B of the spiral wrap 18 of the fixed scroll 16 and the ventral side surface 22B of the spiral wrap 22 of the orbiting scroll 20 are in sliding contact with each other, so that this achieves sealing therebetween, thus suppressing leakage of compressed gas.

[0037] At this time, numerous fine depressions 32 are provided on one or both of the ventral side surface 18A of the spiral wrap 18 of the fixed scroll 16 and the dorsal side surface 22A of the spiral wrap 22 of the orbiting scroll 20, and the numerous fine depressions 32 are also provided on one or both of the dorsal side surface 18B of the spiral wrap 18 of the fixed scroll 16 and the ventral side surface 22B of the spiral wrap 22 of the orbiting scroll 20. Because of this, the lubrication oil 14 that has been taken into the compression chamber 24 along with the refrigerant gas, as described above, is held by means of numerous fine depressions 32 provided on the ventral side surfaces 18A, 22B and/or the dorsal side surfaces 18B, 22A of the spiral wraps 18 and 22 that are in sliding contact with each other, and thus, the oil 14 seals the sliding contact surfaces together, and the sliding friction coefficient due to the contact can be reduced at the same time.

[0038] In this way, with this embodiment, re-compression loss can be reduced by reducing the internal leakage during the refrigerant-gas compression, the sliding loss can also be reduced by lowering the sliding friction coefficient, and thus, the compression efficiency of the scroll compressor 1 can be further enhanced.

[0039] In addition the fine depressions 32 are formed as dimples elongated in the direction in which sliding occurs when the orbiting scroll 20 is revolved about the fixed scroll 16 in the orbital manner. In this way, by holding

the oil in the dimples elongated in the sliding direction, it is possible to seal and lubricate a longer portion of the sliding contact surfaces of the spiral wraps 18 and 22 that move in association with the orbital driving of the orbiting scroll 20. Because of this the reduction effects on re-compression loss and sliding loss can be further enhanced.

[0040] Furthermore, multiple rows of the fine depressions 32 are arranged in a staggered manner along the height direction of the spiral wraps 18 and 22. With these multiple rows of numerous fine depressions 32 arranged in a staggered manner, oil can be held substantially evenly over the entire areas of the ventral side surface 18A and the dorsal side surface 22A of the spiral wraps 18 and 22 that are in sliding contact with each other. As a result, the reduction effects on re-compression loss and sliding loss can be further enhanced.

[0041] In addition, in a supercritical-cycle scroll compressor in which CO₂ refrigerant is used, because the CO₂ refrigerant is a higher-pressure refrigerant than HFC refrigerant and the pressure difference during compression increases, refrigerant leakage tends to occur. This embodiment may be employed in such a CO₂-refrigerant compressor, and refrigerant leakage can effectively be reduced as described above. Because of this it is possible to further increase the performance of a CO₂-refrigerant Scroll compressor, and it is possible to enhance the COP of supercritical-cycle air conditioners, refrigerators, heat pumps, and so forth employing the compressor.

[0042] Furthermore, numerous fine depressions 32 provided on the side surfaces of the spiral wraps 18 and 22 of the fixed scroll 16 and/or the orbiting scroll 20 described above can be processed in the ventral side surfaces 18A, 22B and/or the dorsal side surfaces 18B, 22A of the spiral wraps 18 and 22 by rotating, while pressing it against them, the burnishing tool 40, in which numerous rolling elements 41 that roll while vibrating are held in the outer circumferential surface thereof, so as to dent the processed surfaces to form deformation thereof. Because of this, merely by pressing and rolling the burnishing tool 40 against the side surfaces of the spiral wraps 18 and 22, numerous fine depressions 32 having the desired shape and size can easily be processed in a regular arrangement.

[0043] Then, by employing the fine depressions 32 for holding the oil, as described above, re-compression loss can be reduced by reducing refrigerant-gas leakage in the scroll compressor 1, the sliding loss can also be reduced by lowering the sliding friction coefficient, and thus, enhanced compression efficiency can be achieved. In addition this burnishing processing is a type of deformation processing for enhancing surface hardness, surface roughness, and so forth, and thus durability, wear resistance, and so forth of the spiral wraps can also be enhanced by this processing.

{Second Embodiment}

[0044] Next, a second embodiment of the present invention will be described with reference to Fig. 5.

This embodiment differs from the first embodiment described above. In this embodiment, stepped scrolls are employed as the fixed scroll 16 and the orbiting scroll 20. Because other points are the same as those of the first embodiment, descriptions thereof will be omitted.

As shown in Fig. 5, in this embodiment, at arbitrary positions in the spiral direction of the spiral wraps 18 and 22 of the fixed scroll 16 and the orbiting scroll 20, step portions 33 and 34 are provided at the tooth-tip surfaces and tooth-bottom surfaces, respectively, and the wrap heights of portions closer to the outer circumference thereof relative to the step portions 33 and 34 are made higher than the wrap heights of portions closer to the inner circumference thereof relative to the step portions 33 and 34.

[0045] With the stepped scroll compressor provided the above-described step portions 33 and 34, it is not only possible to compress the refrigerant in the circumferential direction but also to compress it in the wrap-height direction. Accordingly, three-dimensional compression is possible, which increase the compression ratio as compared with an ordinary scroll compressor, and therefore size reduction and performance enhancement are possible. However, structurally, refrigerant leakage tends to occur at the step portions. In this embodiment, in addition to providing the fine depressions 32 in the ventral side surfaces 18A, 22B and/or the dorsal side surfaces 18B, 22A of the spiral wraps 18 and 22 as in the first embodiment, the fine depressions 32 are also provided on sliding contact surfaces of the step portions 33 and 34, as shown in Fig. 4.

[0046] In this way, in the stepped scroll compressor in which a so-called stepped scrolls are employed as the fixed scroll 16 and the orbiting scroll 20 the fine depressions 32 are also provided on the sliding contact surfaces of the step portions 33 and 34 in addition to the ventral side surfaces 18A, 22B and/or the dorsal side surfaces 18B, 22A of the spiral wrap 18 and 22 and the sliding contact surface of each of the step portions 33 and 34 can also be sealed with oil by holding the oil in those fine depressions 32. Therefore refrigerant leakage can effectively be reduced at the step portions 33 and 34, where, structurally, refrigerant leakage tends to occur, and thus, it is possible to further enhance the efficiency of a so-called stepped scroll compressor

[0047] Note that the present invention is not limited to the invention according to the embodiments described above, and appropriate modifications are permissible within a range that does not depart from the scope thereof. For example, although examples in which the present invention is employed in a sealed-type electric scroll compressor have been described in the above-described embodiments, it is of course possible to employ the present invention similarly to an open scroll compressor whose

power source is externally provided. In addition, although CO₂-refrigerant scroll compressors have been described in the above-described embodiments, the present invention may naturally be employed in compressors using other refrigerants, such as HFC refrigerant or the like. Furthermore, the present invention can also be employed in a multi-stage compressor or the like and the present invention encompasses such a case so long as one of a plurality of compression mechanisms is a scroll compression mechanism.

{Reference Signs List}

[0048]

1	scroll compressor
3	scroll compression mechanism (compression mechanism)
16	fixed scroll
17	fixed end plate
18	fixed spiral wrap
18A	ventral side surface (radially inside surface) of fixed spiral wrap
18B	dorsal side surface (radially outside surface) of fixed spiral wrap
20	orbiting scroll
21	orbiting end plate
22	orbiting spiral wrap
22A	dorsal side surface (radially outside surface) of orbiting spiral wrap
22B	ventral side surface (radially inside surface) of orbiting spiral wrap
32	fine depression (dimple)
33, 34	step portion
40	burnishing tool
41	rolling element (ball)

Claims

1. A scroll compressor comprising a compression mechanism (3) formed by engaging a pairing of a fixed scroll (16) and an orbiting scroll (20) in each of

which a spiral wrap (18, 22) is vertically provided on one surface of an end plate (17, 21) thereof, wherein a plurality of fine depressions (32) are provided on one or both of a side surface (18A, 18B) of the spiral wrap (18) of the fixed scroll (16) and a side surface (22A, 22B) of the spiral wrap (22) of the orbiting scroll (20), which are in sliding contact with each other. 5

2. A scroll compressor according to Claim 1, wherein the fine depressions (32) are formed as dimples elongated in a revolving direction of the orbiting scroll (20) which is revolved about the fixed scroll (16) in an orbital manner. 10
3. A scroll compressor according to Claim 1 or 2, wherein multiple rows of the fine depressions (32) are arranged in a staggered manner along the height direction of the spiral wraps (18, 22). 15
4. A Scroll compressor according to any one of Claims 1 to 3, wherein each of the fixed scroll (16) and the orbiting scroll (20) is provided with a step portion (33, 34) at a wrap top side and at a wrap bottom side of the spiral wrap (18, 22) thereof, and height of each of the spiral wraps (18, 22) is made higher in a portion closer to the outer circumference thereof relative to the step portion than a portion closer to the inner circumference thereof relative to the step portion; and the fine depressions (32) are also provided on a sliding contact surface of each of the step portions. 20 25 30
5. A scroll compressor according to any one of Claims 1 to 4, wherein the scroll compressor is a CO₂-refrigerant compressor for a supercritical cycle system using CO₂-refrigerant. 35
6. A scroll processing method for forming a plurality of fine depressions (32) on a side surface (18A, 18B, 22A, 22B) of a spiral wrap (18, 22) of one or both of a fixed scroll (16) and an orbiting scroll (20) that form a scroll compressor, wherein the fine depressions (32) are processed on the side surface (18A, 18B, 22A, 22B) of the spiral wraps (18, 22) by pressing and rotating a burnishing tool (40), which has a plurality of rolling elements that roll while vibrating at an outer circumferential surface thereof, against the side surfaces (18A, 18B, 22A, 22B) of the spiral wraps (18, 22) so as to dent the processed surfaces to form the deformations. 40 45 50

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FIG. 1

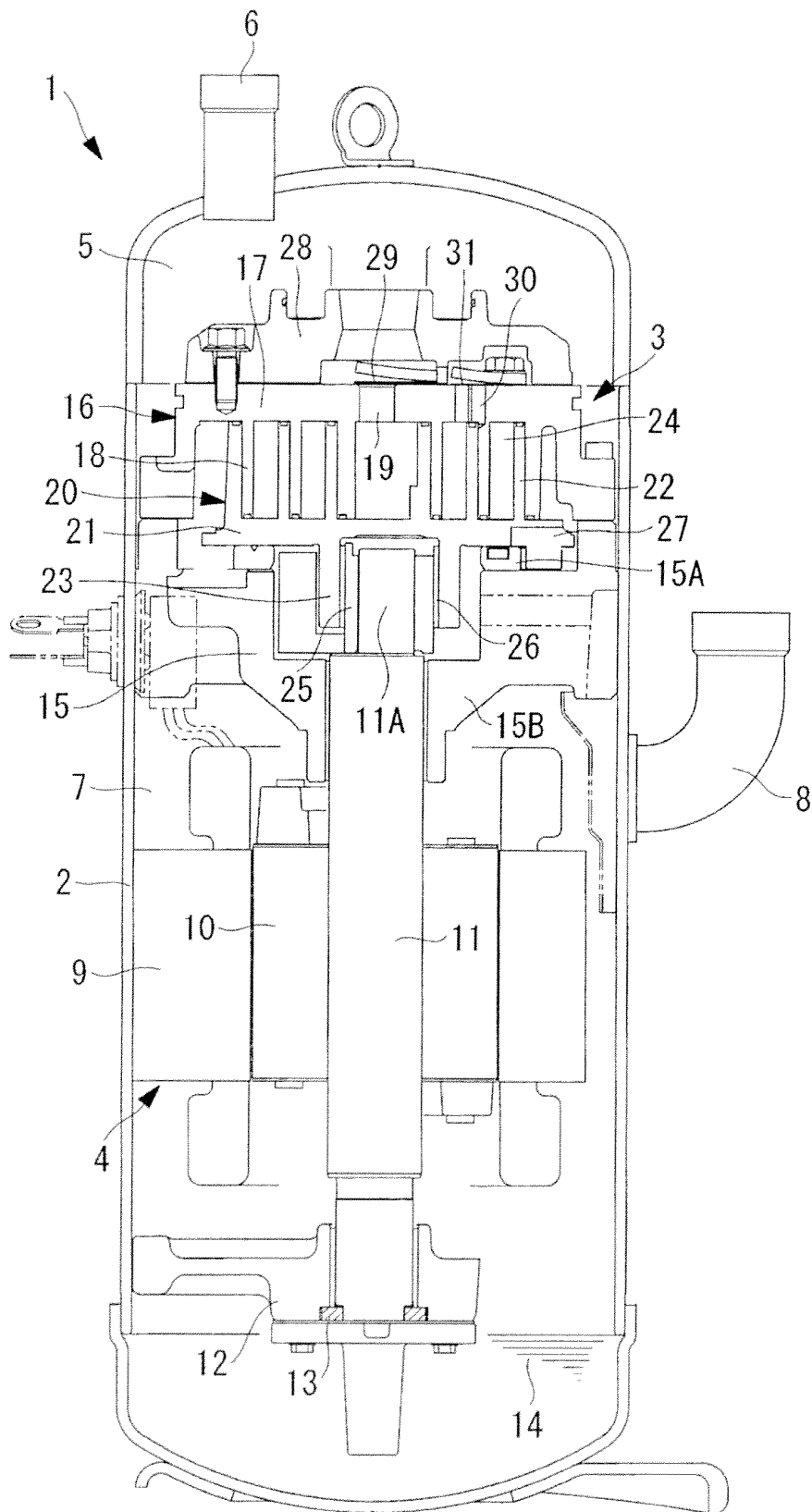


FIG. 2

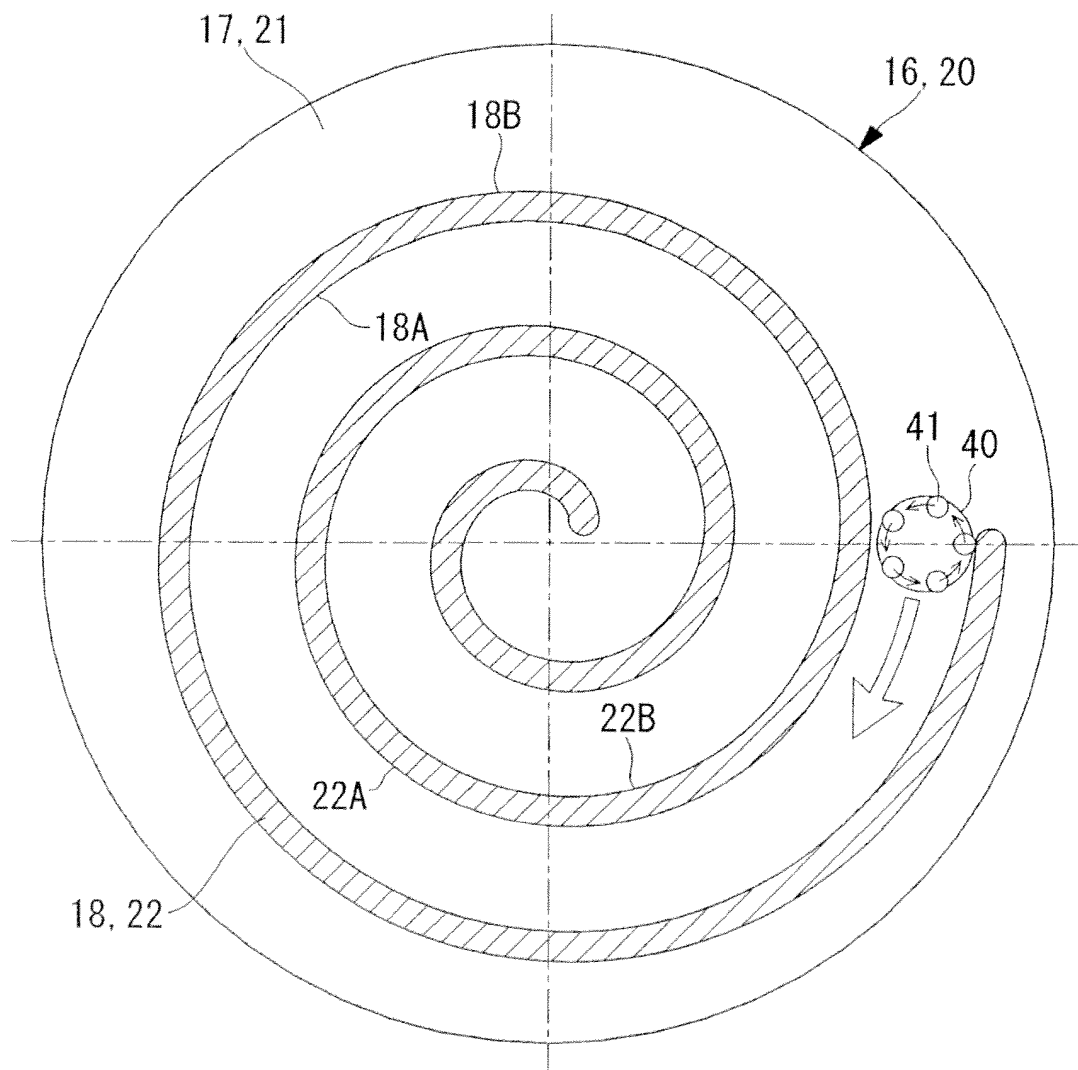


FIG. 3

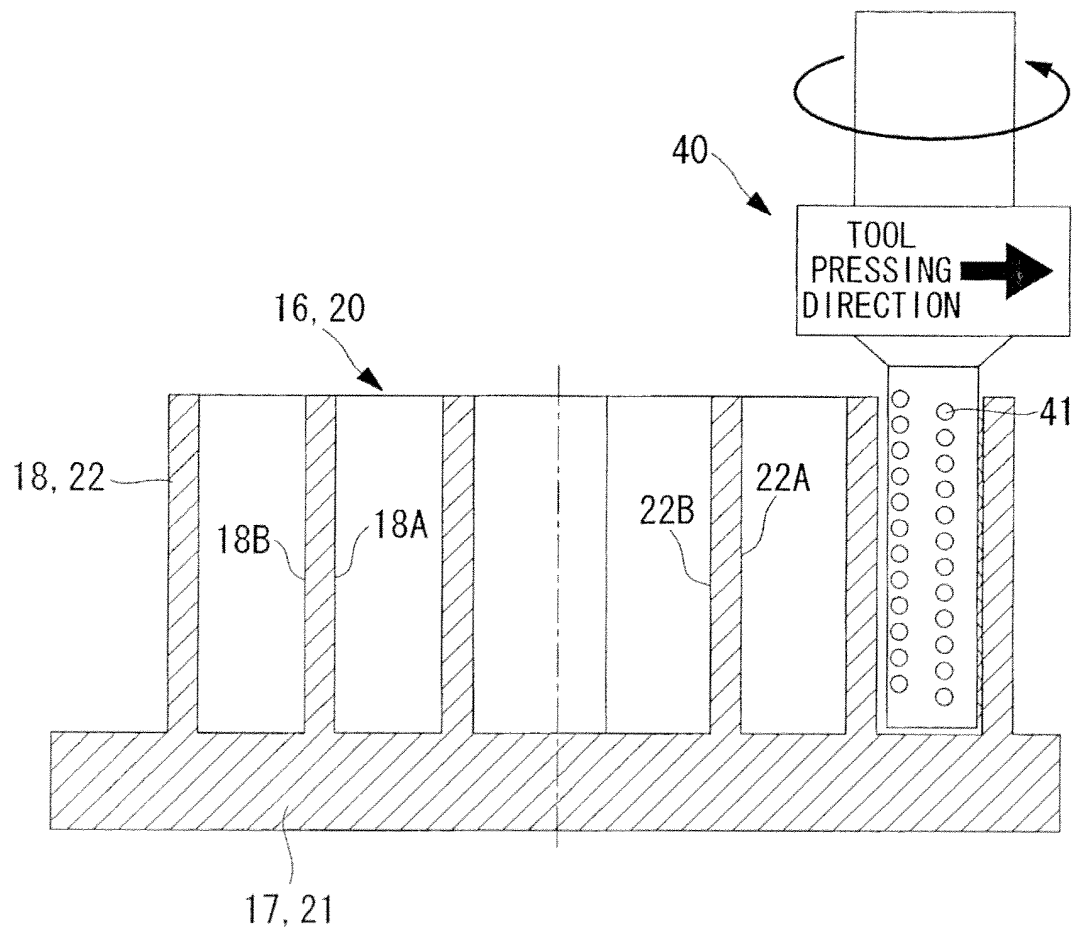


FIG. 4

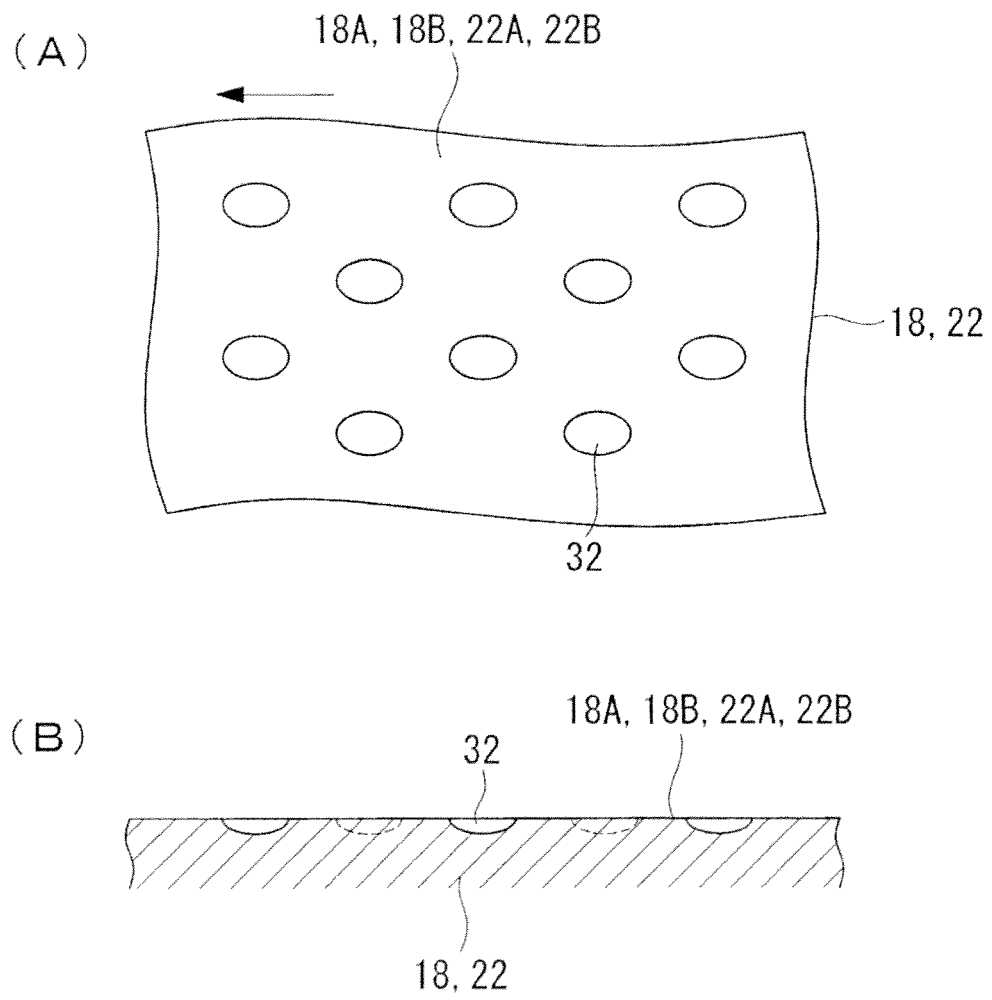
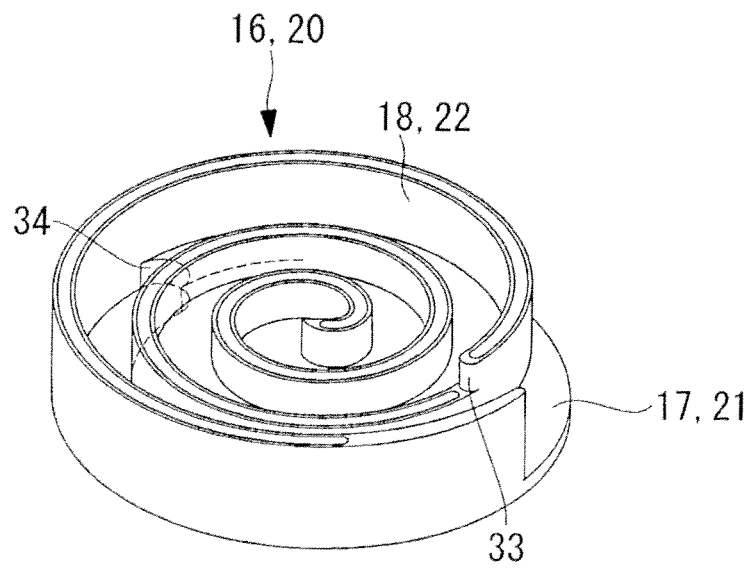


FIG. 5



REFERENCES CITED IN THE DESCRIPTION

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