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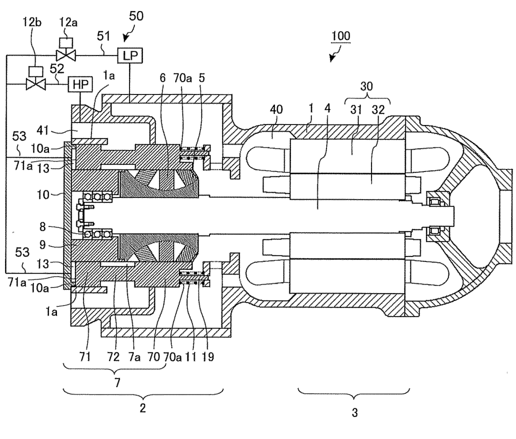
(54) **SCREW COMPRESSOR, AND REFRIGERATION CYCLE DEVICE**

(57) A screw compressor includes a casing, a screw rotor, a gate rotor, and a slide valve. A low-pressure flow path allowing low-pressure refrigerant before being suctioned into the screw rotor to flow therethrough, a high-pressure flow path allowing high-pressure refrigerant discharged from a discharge port to flow therethrough, and a merge flow path merging the low-pressure flow path and the high-pressure flow path are provided. A pressure switching mechanism switching pressure of the refrigerant is disposed in at least one of the low-pressure flow path, the high-pressure flow path, and the merge flow path. The merge flow path applies pressure applying refrigerant, pressure of which is switched by the pressure switching mechanism, from a downstream-side end part to one of end parts of the slide valve.

FIG. 1



EP 3 981 987 A1

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Description

Technical Field

[0001] The present disclosure relates to a screw compressor that includes a slide valve and a pressure driving mechanism moving the slide valve by pressure, and to a refrigeration cycle device.

Background Art

[0002] A screw compressor has been known as a type of a positive displacement compressor. The screw compressor is used as a component of a refrigerant circuit incorporated in, for example, a refrigerator.

[0003] As the screw compressor, for example, a single screw compressor in which one screw rotor and two gate rotors are housed inside a casing has been known. The one screw rotor has spiral tooth grooves, and the two gate rotors each include a plurality of gate rotor tooth portions fitted to the tooth grooves of the screw rotor.

[0004] In the single screw compressor, the tooth grooves of the screw rotor and the gate rotor tooth portions of the gate rotors engage with each other to form a plurality of compression chambers. One end of the screw rotor in a rotation axis direction is a suction side of refrigerant, and the other end in the rotation axis direction is a discharge side of the refrigerant. An inside of the casing is partitioned into a space for low-pressure refrigerant provided on the suction side of the compression chambers, and a space for high-pressure refrigerant provided on the discharge side of the compression chambers.

[0005] The screw rotor is fixed to a screw shaft that is rotated by a driving unit provided inside the casing. One of shaft end parts of the screw shaft is rotatably supported by a bearing housing internally including a bearing. The other shaft end part of the screw shaft is coupled to the driving unit.

[0006] When the screw rotor of the screw compressor is rotationally driven through the screw shaft rotated by the driving unit, the refrigerant in the low-pressure space is suctioned into and compressed by the compression chambers, and the refrigerant compressed in the compression chambers is discharged to the high-pressure space.

[0007] In some cases, paired slide valves are provided in the screw compressor. The paired slide valves are disposed in slide grooves provided on an inner cylindrical surface of the casing, and are slidable in the rotation axis direction of the screw rotor. The slide valves move in the rotation axis direction of the screw rotor, adjust a suction timing of the refrigerant into the compression chambers, a discharge timing of the high-pressure refrigerant compressed by the compression chambers, and an opening degree of a discharge port from which the high-pressure refrigerant is discharged, and adjusts an internal volume ratio (Vi) that is a ratio of a suction volume and a discharge volume.

[0008] Each of the slide valves includes a cylinder portion, a piston, and a coupling part. The cylinder portion is provided in the casing. The piston partitions an inside of the cylinder portion into two front and rear spaces, and moves in response to change of pressure difference between the two front and rear spaces. The coupling part couples the piston and the slide valve. A position of each of the slide valves is adjusted by these components.

[0009] Patent Literature 1 proposes a configuration in which pressure of a space for low-pressure refrigerant and pressure of a space for high-pressure refrigerant are detected by pressure detection sensors, and pressure of each of spaces partitioned by a piston is adjusted and a slide valve is moved to achieve an internal volume ratio corresponding to a high/low pressure ratio.

[0010] Patent Literature 2 proposes a configuration in which a cylinder portion is provided on a bearing holder holding one end of a screw rotor, and the bearing holder and the cylinder portion are integrated to achieve downsizing and light weight of a screw compressor.

Citation List

Patent Literature

[0011]

Patent Literature 1: Japanese Unexamined Patent Application Publication No. 2013-36403
Patent Literature 2: Japanese Patent No. 5943101

Summary of Invention

Technical Problem

[0012] In the technique disclosed in Patent Literature 2, to transmit driving force derived from pressure difference between the spaces in front of and behind the piston to the slide valves, one coupling part coupled to an end part of the piston, and two coupling rods coupling the coupling part to the respective slide valve are necessary. A driving component having such a configuration requires the number of components and an installation space for the components equivalent to those in the technique disclosed in Patent Literature 1. Therefore, it is desirable to reduce the number of components and the installation space in addition to downsizing and light weight.

[0013] The present disclosure is to solve the above-described issues, and an object of the present disclosure is to provide a screw compressor and a refrigeration cycle device that can reduce the number of components and an installation space with a simple configuration, to achieve downsizing and light weight.

Solution to Problem

[0014] A screw compressor according to one embodiment of the present disclosure includes: a casing including an inner cylindrical surface portion that has a cylindrical shape; a screw rotor rotatably housed in the inner cylindrical surface portion of the casing, and including a plurality of spiral grooves on an outer periphery; a gate rotor including teeth engaging with the plurality of spiral grooves of the screw rotor; and a slide valve configured to adjust an opening degree of a discharge port for high-pressure refrigerant compressed by the screw rotor. A low-pressure flow path allowing low-pressure refrigerant before being suctioned into the screw rotor to flow therethrough, a high-pressure flow path allowing the high-pressure refrigerant discharged from the discharge port to flow therethrough, and a merge flow path merging the low-pressure flow path and the high-pressure flow path are provided. A pressure switching mechanism switching pressure of the refrigerant is disposed in at least one of the low-pressure flow path, the high-pressure flow path, and the merge flow path. The merge flow path applies pressure applying refrigerant, pressure of which is switched by the pressure switching mechanism, from a downstream-side end part to one of end parts of the slide valve.

[0015] A refrigeration cycle device according to another embodiment of the present disclosure includes the above-described screw compressor.

Advantageous Effects of Invention

[0016] In the screw compressor and the refrigeration cycle device according to the embodiments of the present disclosure, the merge flow path applies the pressure applying refrigerant, the pressure of which is switched by the pressure switching mechanism, from the downstream-side end part to one of end parts of the slide valve. This makes it possible to eliminate driving components driving the slide valve by a piston from a rotation axis direction based on pressure difference, and to reduce the number of driving components and components relating to the driving components. In addition, it is possible to reduce an installation space where the driving components are mounted, thereby reducing a length of the compressor. Accordingly, the number of components and the installation space can be reduced with the simple configuration, and downsizing and light weight are achieved.

Brief Description of Drawings

[0017]

[Fig. 1] Fig. 1 is an explanatory diagram illustrating a vertical cross-section of a screw compressor according to Embodiment 1.

[Fig. 2] Fig. 2 is an explanatory diagram illustrating a suction process of a compression unit of the screw compressor according to Embodiment 1.

[Fig. 3] Fig. 3 is an explanatory diagram illustrating a compression process of the compression unit of the screw compressor according to Embodiment 1.

[Fig. 4] Fig. 4 is an explanatory diagram illustrating a discharge process of the compression unit of the screw compressor according to Embodiment 1.

[Fig. 5] Fig. 5 is an explanatory diagram illustrating a vertical cross-section of the compression unit of the screw compressor according to Embodiment 1 in a state where slide valves are positioned on a high Vi side.

[Fig. 6] Fig. 6 is an explanatory diagram illustrating the vertical cross-section of the compression unit of the screw compressor according to Embodiment 1 in a state where the slide valves are positioned on a low Vi side.

[Fig. 7] Fig. 7 is an explanatory diagram illustrating a vertical cross-section of a compression unit of a screw compressor according to Embodiment 2 in a state where slide valves are positioned on a high Vi side.

[Fig. 8] Fig. 8 is an explanatory diagram illustrating the vertical cross-section of the compression unit of the screw compressor according to Embodiment 2 in a state where the slide valves are positioned on a low Vi side.

[Fig. 9] Fig. 9 is an explanatory diagram illustrating a vertical cross-section of a compression unit of a screw compressor having an existing configuration.

[Fig. 10] Fig. 10 is a refrigerant circuit diagram illustrating a refrigeration cycle device to which the screw compressor is applied, according to Embodiment 3.

Description of Embodiments

[0018] In the following, some embodiments are described with reference to drawings. Note that, in the drawings, the same or equivalent components are denoted by the same reference numerals, and the same applies to the entire description of the specification. Further, in cross-sectional views, hatching is appropriately omitted in consideration of visibility. Further, forms of components described in the entire description of the specification are merely illustrative, and the forms of the components are not limited to the described forms.

Embodiment 1.

<Configuration of Screw Compressor 100>

[0019] Fig. 1 is an explanatory diagram illustrating a vertical cross-section of a screw compressor 100 according to Embodiment 1. In Embodiment 1, the screw compressor 100 is a single-stage single screw compressor.

[0020] As illustrated in Fig. 1, the screw compressor 100 includes a casing 1, and a compression unit 2 and a driving unit 3 provided inside the casing 1. The casing 1 has a cylindrical inner cylindrical surface portion configuring an outer shell. An inside of the casing 1 is partitioned into a low-pressure space 40 in which low-pressure refrigerant is present, and a high-pressure space 41 in which high-pressure refrigerant is present.

[0021] The compression unit 2 includes a screw shaft 4, a screw rotor 5 fixed to the screw shaft 4, paired gate rotors 6, paired slide valves 7, and a bearing housing 9 internally including a bearing 8 that rotatably supports an end of the screw shaft 4.

[0022] The screw shaft 4 extends in a pipe axis direction of the casing 1. One of shaft end parts of the screw shaft is rotatably supported by the bearing 8 that is disposed to face a discharge side of the screw rotor 5. The other shaft end part of the screw shaft 4 is coupled to the driving unit 3. The screw shaft 4 is rotated by the driving unit 3.

[0023] The screw rotor 5 is rotatably housed in the inner cylindrical surface portion of the casing 1. The screw rotor 5 includes spiral tooth grooves 5a as a plurality of spiral grooves on an outer periphery of a columnar body. The screw rotor 5 is fixed to the screw shaft 4. The screw rotor 5 is rotated together with the screw shaft 4 rotated by the driving unit 3. A side close to the low-pressure space 40, of the screw rotor 5 in a rotation axis direction is a suction side of the refrigerant. A side close to the high-pressure space 41, of the screw rotor 5 in the rotation axis direction is the discharge side.

[0024] Each of the gate rotors 6 includes, on an outer periphery, a plurality of gate rotor tooth portions 6a (see Fig. 2) engaging with the tooth grooves 5a of the screw rotor 5. The paired gate rotors 6 are disposed to sandwich the screw rotors 5 in a radial direction. In the compression unit 2, the tooth grooves 5a of the screw rotor 5 and the gate rotor tooth portions 6a of the gate rotors 6 engage with each other to form a compression chamber 20 (see Fig. 2). The screw compressor 100 has a configuration in which the two gate rotors 6 are disposed to face one screw rotor 5 while being displaced by 180 degrees around an axis of the screw shaft 4. Therefore, in Fig. 1, two compression chambers 20 are illustrated on an upper side and a lower side of the screw shaft 4.

[0025] The slide valves 7 are provided in slide grooves provided on an inner cylindrical surface of the casing 1. The slide valves 7 are slidable in the rotation axis direction of the screw rotor 5. Each of the slide valves 7 is, for example, an internal volume ratio regulating valve. Each of the slide valves 7 includes a valve body portion 70 facing the screw rotor 5, and a guide portion 71 having a sliding surface facing an outer peripheral surface of the bearing housing 9. The valve body portion 70 and the guide portion 71 are coupled by a coupling portion 72. In each of the slide valves 7, a space between the valve body portion 70 and the guide portion 71 serves as a discharge port 7a for the refrigerant compressed in the compression chamber 20. The refrigerant discharged from the discharge port 7a is discharged to the high-pressure space 41 through a discharge gas passage provided on a rear surface side of the guide portion 71.

[0026] The slide valves 7 are disposed between the low-pressure space 40 and the high-pressure space 41. The valve body portion 70 of each of the slide valves 7 includes a suction-side end part 70a at a position closer to the low-pressure space 40 than the high-pressure space 41. The guide portion 71 of each of the slide valves 7 includes a discharge-side end part 71a at a position closer to the high-pressure space 41 than the low-pressure space 40.

[0027] In the screw compressor 100, the valve body portions 70 of the slide valves 7 move in parallel with the screw shaft 4. As a result, a discharge timing of the refrigerant discharged from the compression chamber 20 of the screw rotor 5 is adjusted.

[0028] A specific method of adjusting the discharge timing is described. When the slide valves 7 are moved toward the suction side and opening port areas of the discharge ports 7a are increased, the discharge timing becomes early. In contrast, when the slide valves 7 are moved toward the discharge side and the opening port areas of the discharge ports 7a are reduced, the discharge timing becomes late. In other words, when the discharge timing is made early, the screw compressor 100 performs operation with low internal volume ratio (low Vi), whereas when the discharge timing is made late, the screw compressor 100 performs operation with high internal volume ratio (high Vi).

[0029] The driving unit 3 includes an electric motor 30. The electric motor 30 includes a stator 31 and a motor rotor 32. The stator 31 is in internal contact with and fixed to an inner portion of the casing 1. The motor rotor 32 is rotatably disposed inside the stator 31. The motor rotor 32 is connected to one of the shaft end parts of the screw shaft 4. The motor rotor 32 is disposed on the same axis as the screw rotor 5.

[0030] In the screw compressor 100, when the electric motor 30 is driven and the screw shaft 4 is rotated, the screw rotor 5 is rotated. The electric motor 30 is driven by an unillustrated inverter at a changeable rotation speed, and is operated by acceleration/deceleration of a rotation speed of the screw shaft 4.

<Compression Principle and Operation of Screw Compressor 100>

[0031] Fig 2 is an explanatory diagram illustrating a suction process of the compression unit 2 of the screw compressor 100 according to Embodiment 1. Fig. 3 is an explanatory diagram illustrating a compression process of the compression unit 2 of the screw compressor 100 according to Embodiment 1. Fig. 4 is an explanatory diagram illustrating a discharge process of the compression unit 2 of the screw compressor 100 according to Embodiment 1. In the following, each of the processes is described by focusing on the compression chamber 20 illustrated with dot hatching in Fig. 2, Fig. 3, and Fig. 4.

[0032] In the screw compressor 100, when the electric motor 30 is driven, the screw rotor 5 is rotated through the screw shaft 4. When the screw rotor 5 is rotated, the gate rotor tooth portions 6a of the gate rotors 6 are relatively rotated in the compression chamber 20. As a result, the suction process illustrated in Fig. 2, the compression process illustrated in Fig. 3, and the discharge process illustrated in Fig. 4 are repeated in this order as one cycle, in the compression chamber 20.

[0033] First, in the suction process illustrated in Fig. 2, the compression chamber 20 illustrated with dots communicates with the low-pressure space 40. Further, the spiral tooth grooves 5a engage with the gate rotor tooth portions 6a of the gate rotor 6 positioned on the lower side in the drawing. When the screw rotor 5 is rotated, the gate rotor tooth portions 6a relatively move toward terminal ends of the tooth grooves 5a, and a volume of the compression chamber 20 is accordingly increased. As a result, the low-pressure refrigerant gas in the low-pressure space 40 is suctioned into the compression chamber 20 through a suction port. When the screw rotor 5 is further rotated, the process proceeds to the compression process illustrated in Fig. 3.

[0034] Next, in the compression process illustrated in Fig. 3, the compression chamber 20 illustrated with dots is in a fully-closed state. The spiral tooth grooves 5a engage with the gate rotor tooth portions 6a of the gate rotor 6 positioned on the lower side in the drawing, and is partitioned from the low-pressure space 40 by the gate rotor tooth portions 6a. When the gate rotor tooth portion 6a moves toward the terminal ends of the tooth grooves 5a with rotation of the screw rotor 5, the volume of the compression chamber 20 is gradually reduced. As a result, the refrigerant gas in the compression chamber 20 is compressed. Thereafter, when the screw rotor 5 is further rotated, the process proceeds to the discharge process illustrated in Fig. 4.

[0035] Finally, in the discharge process illustrated in Fig. 4, the compression chamber 20 illustrated with dots communicates with the high-pressure space 41 through the discharge port 7a. When the gate rotor tooth portions 6a move toward the terminal ends of the tooth grooves 5a with rotation of the screw rotor 5, the compressed refrigerant gas is pushed out from the compression chamber 20 to the high-pressure space 41.

<Features of Embodiment 1 >

[0036] As illustrated in Fig. 1, the screw compressor 100 includes a pressure driving mechanism 50 that includes a low-pressure flow path 51, a high-pressure flow path 52, a merge flow path 53, a pressure switching mechanism 12a, and a pressure switching mechanism 12b. The pressure driving mechanism 50 applies pressure applying refrigerant that is any one of the low-pressure refrigerant and the high-pressure refrigerant, the pressure of which is switched by the pressure switching mechanism 12a and the pressure switching mechanism 12b, from downstream-side end parts of the merge flow path 53 to pressure receiving surfaces of the discharge-side end parts 71a of the guide portions 71 that are ones of end parts of the slide valves 7.

[0037] The low-pressure flow path 51 allows the low-pressure refrigerant of the low-pressure space 40 before being suctioned into the screw rotor 5, to flow therethrough. The high-pressure flow path 52 allows the high-pressure refrigerant of the high-pressure space 41 discharged from the discharge port 7a, to flow therethrough. The merge flow path 53 merges the low-pressure flow path 51 and the high-pressure flow path 52. The pressure switching mechanism 12a and the pressure switching mechanism 12b switch the pressure of the refrigerant flowing through the merge flow path 53.

[0038] The merge flow path 53 is branched on the way of the flow toward the downstream side, and applies the flowing pressure applying refrigerant to the pressure receiving surface of the discharge-side end part 71a of each of the paired slide valves 7.

[0039] A pressure applying space 13 where the pressure applying refrigerant is applied from one of the downstream-side end parts of the merge flow path 53 to the pressure receiving surface of the discharge-side end part 71a of the corresponding slide valve 7 is provided inside the casing 1. The pressure applying space 13 is provided for each of the paired slide valves 7. Each of the pressure applying spaces 13 is a surrounded closed space at least including the pressure receiving surface of the discharge-side end part 71a of the corresponding slide valve 7 and the casing 1. More specifically, each of the pressure applying spaces 13 is formed by being surrounded by the pressure receiving surface of the discharge-side end part 71a of the corresponding slide valve 7, the outer peripheral surface of the bearing housing 9, an end surface of a connection flange 10, and a cylindrical inner wall surface of a slide groove 1a provided on the inner cylindrical surface of the casing 1.

[0040] On an end surface of the connection flange 10 that serve as wall surface portions of the pressure applying spaces 13, stoppers 10a that prevent the end surface of the connection flange 10 from oppositely coming into contact with the pressure receiving surfaces of the discharge-side end parts 71a of the slide valves 7. Each of the stoppers 10a protrudes toward the corresponding slide valve 7 at a part of the end surface of the connection flange 10 that serve as the wall surface portions of the pressure applying spaces 13 oppositely coming into contact with the pressure receiving surfaces of the discharge-side end parts 71a of the slide valves 7. Even in a case where the slide valves 7 are positioned on the high Vi side, the pressure applying spaces 13 can be secured by the respective stoppers 10a.

[0041] The screw compressor 100 includes repulsive parts 11 assisting movement of the slide valves 7 by the pressure applying refrigerant. Each of the repulsive parts 11 is provided on the suction-side end part 70a of the corresponding slide valve 7 on a side opposite to the pressure receiving surface of the discharge-side end part 71a of the corresponding slide valve 7 to which the pressure applying refrigerant is applied. The repulsive parts 11 apply force to position the slide valves 7 on the high

Vi side. Each of the repulsive parts 11 includes an urging spring or other parts, and generates reactive force. A shaft-like guide structure 19 is provided on the suction-side end part 70a of each of the slide valves 7. The guide structures 19 are integrated with the respective slide valves 7. The repulsive parts 11 are inserted into the respective guide structures 19, and are positioned and fixed.

[0042] The pressure switching mechanism 12a and the pressure switching mechanism 12b are on-off valves provided in the low-pressure flow path 51 and the high-pressure flow path 52, respectively. Each of the on-off valves as the pressure switching mechanism 12a and the pressure switching mechanism 12b is a solenoid valve.

[0043] Fig. 5 is an explanatory diagram illustrating a vertical cross-section of the compression unit 2 of the screw compressor 100 according to Embodiment 1 in a state where the slide valves 7 are positioned on the high Vi side. As illustrated in Fig. 5, to position the slide valves 7 on the high Vi side, the high-pressure flow path 52 making the pressure applying spaces 13 and the high-pressure space 41 communicate with each other is blocked by the pressure switching mechanism 12b, and only the low-pressure flow path 51 making the pressure applying spaces 13 and the low-pressure space 40 communicate with each other is communicated by opening of the pressure switching mechanism 12a. Therefore, as the pressure applying refrigerant, the low-pressure refrigerant of the low-pressure space 40 flows through the merge flow path 53. At this time, low pressure (LP) uniformly acts on the pressure receiving surfaces of the discharge-side end parts 71a and the pressure receiving surfaces of the suction-side end parts 70a of the slide valves 7. Therefore, positions of the slide valves 7 are not uniquely determined. At this time, movement of the slide valves 7 in the high Vi direction is assisted by the reactive force of the repulsive parts 11. As a result, the slide valves 7 move toward the high Vi side.

[0044] Fig. 6 is an explanatory diagram illustrating the vertical cross-section of the compression unit 2 of the screw compressor 100 according to Embodiment 1 in a state where the slide valves 7 are positioned on the low Vi side. As illustrated in Fig. 6, to position the slide valves 7 on the low Vi side, the low-pressure flow path 51 making the pressure applying spaces 13 and the low-pressure space 40 communicate with each other is blocked by the pressure switching mechanism 12a, and only the high-pressure flow path 52 making the pressure applying spaces 13 and the high-pressure space 41 communicate with each other is communicated by opening of the pressure switching mechanism 12b. Therefore, as the pressure applying refrigerant, the high-pressure refrigerant of the high-pressure space 41 flows through the merge flow path 53. At this time, high pressure (HP) acts on the pressure receiving surfaces of the discharge-side end parts 71a of the slide valves 7, and low pressure (LP) acts on the pressure receiving surfaces of the suction-side end parts 70a of the slide valves 7. Therefore, when the high pressure (HP) acting on the pressure receiving surface of the discharge-side end part 71a of each of the slide valves 7 becomes greater than resultant force of the reactive force of the corresponding repulsive part 11 and the low pressure (LP), each of the slide valves 7 moves toward the low Vi side.

[0045] As described above, the repulsive parts 11 constantly generate reactive force in a direction in which the slide valves 7 are moved toward the high Vi side. Therefore, to position the slide valves 7 on the low Vi side, it is necessary to set the reactive force of each of the repulsive parts 11 such that the pressure acting on the pressure receiving surface of the discharge-side end part 71a of each of the slide valves 7 becomes greater than the resultant force of the low pressure acting on the pressure receiving surface of the suction-side end part 70a of the slide valves 7 and the reactive force of the corresponding repulsive part 11.

<Others>

[0046] In Embodiment 1 described above, the repulsive parts 11 applying force to position the slide valves 7 on the high Vi side are provided on the suction-side end parts 70a of the slide valves 7. In this case, each of the repulsive parts 11 uses reactive force to return to a natural length from a compressed state. The assisting force applied by the repulsive parts 11, however, is not limited thereto. Each of the repulsive parts 11 may be provided on the discharge-side end part 71a of the guide portion 71 of the corresponding slide valves 7 that is an end part to which the pressure applying refrigerant is applied. In this case, each of the repulsive parts 11 uses force to return to the natural length from an extended state. A part used for each of the repulsive parts 11 is not limited as long as the part generates action similar to the spring.

[0047] In Embodiment 1 described above, the shaft-like guide structures 19 provided on the suction-side end parts 70a of the slide valves 7 are used to position and fix the repulsive parts 11. The guide structures 19 may be integrated with the respective slide valves 7, or may be assembled as separated components to the respective slide valves 7 or a wall surface of the casing 1. Further, each of the guide structures 19 is not limited to the shaft shape. For example, each of the guide structures 19 may have a configuration in which a recess having a size enough to house one repulsive part 11 is provided on each of the end part of the corresponding slide valve 7 and the wall surface of the casing 1, and the repulsive part 11 may be housed in the recesses. The configuration is not limited thereto, and various configurations positioning and fixing the repulsive parts 11 are adoptable.

[0048] In Embodiment 1 described above, the stoppers 10a to secure the respective pressure applying spaces 13 in the case where the slide valves 7 are positioned on the high Vi side are provided integrally with the inner wall surfaces of the pressure applying spaces 13. The configuration, however, is not limited thereto. The stoppers 10a may be provided in other components and may be assembled to the connection flange 10 or the discharge-side end parts 71a of the slide valves 7. Further, the stoppers 10a may be integrated with the respective slide valves 7.

[0049] In Embodiment 1 described above, the pressure switching mechanism 12a and the pressure switching mechanism 12b are the on-off valves provided in the low-pressure flow path 51 and the high-pressure flow path 52, respectively. The pressure switching mechanism, however, is not limited thereto. The pressure switching mechanism may be one three-way valve provided at a position where the low-pressure flow path 51, the high-pressure flow path 52, and the merge flow path 53 are merged. The three-way valve may switch the low-pressure flow path 51 and the high-pressure flow path 52.

[0050] Note that, in Fig. 1, Fig. 5, and Fig. 6, the low-pressure flow path 51, the high-pressure flow path 52, and the merge flow path 53 are schematically illustrated by black lines. The low-pressure flow path 51, the high-pressure flow path 52, and the merge flow path 53 may be configured by pipes provided outside the casing 1. Alternatively, the low-pressure flow path 51, the high-pressure flow path 52, and the merge flow path 53 may be configured by components inside the casing 1. In a case where the flow paths are configured by the components, the components are processed to form passages.

<Effects of Embodiment 1 >

[0051] According to Embodiment 1, the screw compressor 100 includes the casing 1 having the cylindrical inner cylindrical surface portion. The screw compressor 100 includes the screw rotor 5 that is rotatably housed in the inner cylindrical surface portion of the casing 1 and has the spiral tooth grooves 5a as the plurality of spiral grooves on the outer periphery. The screw compressor 100 includes the gate rotors 6 each including the gate rotor tooth portions 6a as teeth engaging with the tooth grooves 5a of the screw rotor 5. The screw compressor 100 includes the slide valves 7 each adjusting the discharge timing from the screw rotor 5 and the opening degree of the discharge port 7a for the high-pressure refrigerant compressed by the screw rotor 5. The screw compressor 100 includes the low-pressure flow path 51 allowing the low-pressure refrigerant before being suctioned into the screw rotor 5, to flow therethrough. The screw compressor 100 includes the high-pressure flow path 52 allowing the high-pressure refrigerant discharged from the discharge port 7a, to flow therethrough. The screw compressor 100 includes the merge flow path 53 merging the low-pressure flow path 51 and the high-pressure flow path 52. In at least one of the low-pressure flow path 51, the high-pressure flow path 52, and the merge flow path 53, the pressure switching mechanism 12a and the pressure switching mechanism 12b switching the pressure of the refrigerant are disposed. The merge flow path 53 applies the pressure applying refrigerant that is any one of the low-pressure refrigerant and the high-pressure refrigerant, the pressure of which is switched by the pressure switching mechanism 12a and the pressure switching mechanism 12b, from the downstream-end parts to the pressure receiving surfaces of the discharge-side end parts 71a of the guide portions 71 that are ones of end parts of the slide valves 7.

[0052] With this configuration, it is possible to eliminate driving components driving the slide valves 7 by pistons from the rotation axis direction based on pressure difference, and to reduce the number of driving components and components relating to the driving components. In addition, it is possible to reduce an installation space where the driving components are mounted, thereby reducing the length of the compressor. Accordingly, the number of components and the installation space can be reduced with the simple configuration, and downsizing, light weight, and cost reduction can be achieved. The driving components include cylinder portions, pistons, and coupling parts provided in the connection flange 10. Further, the components relating to the driving components include bolts and nuts.

[0053] According to Embodiment 1, the two slide valves 7 are provided. The merge flow path 53 is branched on the way, and applies the pressure applying refrigerant to the pressure receiving surface of the discharge-side end part 71a of the guide portion 71 that is one of the end parts of each of the two slide valves 7.

[0054] With this configuration, the merge flow path 53 is configured as one flow path partway, which makes it possible to reduce the number of components and the installation space with the simple configuration.

[0055] According to Embodiment 1, the pressure applying spaces 13 where the pressure applying refrigerant is applied from the downstream-side end parts of the merge flow path 53 are provided on the pressure receiving surface side of the discharge-side end parts 71a that are one of ends of the slide valves 7.

[0056] With this configuration, it is possible to uniformly apply the pressure applying refrigerant to the entire pressure receiving surfaces of the discharge-side end parts 71a of the slide valves 7 in the pressure applying spaces 13, and the slide valves 7 are easily operated by the pressure applying refrigerant.

[0057] According to Embodiment 1, the two slide valves 7 are provided. The pressure applying space 13 is provided for each of the two slide valves 7.

[0058] With this configuration, it is possible to uniformly apply the pressure applying refrigerant to the entire pressure receiving surfaces of the discharge-side end parts 71a of the two slide valves 7 in the two pressure applying spaces 13, and the two slide valves 7 are easily operated by the pressure applying refrigerant.

[0059] According to Embodiment 1, on the end surface of the connection flange 10 that is the wall surface portions of the pressure applying spaces 13, the stoppers 10a that prevent the end surface of the connection flange

10 from oppositely coming into contact with the pressure receiving surfaces of the discharge-side end parts 71a of the slide valves 7.

[0060] With this configuration, it is possible to prevent the pressure receiving surfaces of the discharge-side end parts 71a of the slide valves 7 from oppositely coming into contact with and adhering to the end surface of the connection flange 10 in the pressure applying spaces 13.

[0061] According to Embodiment 1, the slide valves 7 are disposed between the low-pressure space 40 and the high-pressure space 41. Each of the slide valves 7 includes the discharge-side end part 71a at the position closer to the high-pressure space 41 than the low-pressure space 40. The pressure applying refrigerant, the pressure of which is switched by the pressure switching mechanism 12a and the pressure switching mechanism 12b, is applied from the downstream-side end parts of the merge flow path 53 to the discharge-side end parts 71a of the slide valves 7.

[0062] According to Embodiment 1, each of the pressure applying spaces 13 is a surrounded closed space at least including the pressure receiving surface of the discharge-side end part 71a of the corresponding slide valve 7 and the casing 1.

[0063] With this configuration, the pressure applying refrigerant flows into the pressure applying spaces 13 that are configured as the closed spaces, and the pressure of the pressure applying refrigerant can be completely applied to the pressure receiving surfaces of the discharge-side end parts 71a of the slide valves 7.

[0064] According to Embodiment 1, the screw compressor 100 includes the repulsive parts 11 assisting movement of the slide valves 7 by the pressure applying refrigerant.

[0065] With this configuration, the reactive force of the repulsive parts 11 can assist movement of the slide valves 7 by the pressure applying refrigerant, and the slide valves 7 can be driven by the pressure applying refrigerant and the reactive force of the repulsive parts 11.

[0066] According to Embodiment 1, each of the repulsive parts 11 is provided on the suction-side end part 70a side opposite to the discharge-side end part 71a to which the pressure applying refrigerant is applied.

[0067] According to Embodiment 1, each of the repulsive parts 11 is provided on the discharge-side end part 71a side to which the pressure applying refrigerant is applied.

[0068] According to Embodiment 1, the low-pressure flow path 51, the high-pressure flow path 52, and the merge flow path 53 are configured by the pipes provided outside the casing 1.

[0069] With this configuration, the low-pressure flow path 51, the high-pressure flow path 52, and the merge flow path 53 can be configured by the pipes outside the casing 1, which makes it possible to simplify a layout of the flow path configuration in a compressor main body.

[0070] According to Embodiment 1, the low-pressure flow path 51, the high-pressure flow path 52, and the merge flow path 53 are configured by the components inside the casing 1.

[0071] With this configuration, the driving components can be previously processed and installed inside the compressor main body, which facilitates assembly of the compressor main body and can reduce the number of components.

[0072] According to Embodiment 1, the pressure switching mechanism 12a and the pressure switching mechanism 12b are the on-off valves provided in the low-pressure flow path 51 and the high-pressure flow path 52, respectively.

[0073] With this configuration, opening and closing control of the flow of the low-pressure refrigerant can be performed by the pressure switching mechanism 12a in the low-pressure flow path 51, opening and closing control of the flow of the high-pressure refrigerant can be performed by the pressure switching mechanism 12b in the high-pressure flow path 52, and the pressure applying refrigerant that is any one of the low-pressure refrigerant and the high-pressure refrigerant, the pressure of which is switched, can flow through the merge flow path 53.

[0074] According to Embodiment 1, each of the pressure switching mechanism 12a and the pressure switching mechanism 12b is the solenoid valve.

[0075] With this configuration, opening and closing control of the flow of various kinds of refrigerant can be performed by the solenoid valves with high accuracy.

Embodiment 2.

<Features of Embodiment 2>

[0076] Fig. 7 is an explanatory diagram illustrating a vertical cross-section of the compression unit 2 of the screw compressor 100 according to Embodiment 2 in a state where the slide valves 7 are positioned on the high Vi side. Fig. 8 is an explanatory diagram illustrating the vertical cross-section of the compression unit 2 of the screw compressor 100 according to Embodiment 2 in a state where the slide valves 7 are positioned on the low Vi side. In Embodiment 2, descriptions of the matters same as the matters in Embodiment 1 are omitted, and only feature portions are described.

[0077] As illustrated in Fig. 7 and Fig. 8, the pressure applying refrigerant that is any one of the low-pressure refrigerant and the high-pressure refrigerant, the pressure of which is switched by the pressure switching mechanism 12a and the pressure switching mechanism 12b is applied from the downstream-side end parts of the merge flow path 53 to the suction-side end parts 70a of valve body portions 70 of the slide valves 7.

[0078] Each of the pressure applying spaces 13 is a surrounded closed space at least including the pressure receiving surface of the suction-side end part 70a of the corresponding slide valve 7 and the casing 1. More specifically, each of the pressure applying spaces 13 is configured by a part of the suction-side end part 70a of the corresponding slide valve 7 and a cylindrical inner wall surface of the slide groove 1a provided on the inner cylindrical surface of the casing 1. The pressure applying spaces 13 communicate with the respective downstream-side end parts of the merge flow path 53. In each of the pressure applying spaces 13, the repulsive part 11 disposed on the suction-side end part 70a side of the corresponding slide valve 7 is provided.

[0079] High-pressure spaces 14 corresponding to the positions of the pressure applying spaces 13 in Embodiment 1 constantly communicate with the high-pressure space 41 through holes 10b provided in the connection flange 10. Therefore, high pressure (HP) constantly acts on the pressure receiving surfaces of the discharge-side end parts 71a of the guide portions 71 of the slide valves 7. The high-pressure spaces 14 are provided with the respective stoppers 10a.

[0080] As illustrated in Fig. 7, to position the slide valves 7 on the high Vi side, the low-pressure flow path 51 making the pressure applying spaces 13 and the low-pressure space 40 communicate with each other is blocked by the pressure switching mechanism 12a, and only the high-pressure flow path 52 making the pressure applying spaces 13 and the high-pressure space 41 communicate with each other is communicated by opening of the pressure switching mechanism 12b. Therefore, as the pressure applying refrigerant, the high-pressure refrigerant of the high-pressure space 41 flows through the merge flow path 53. At this time, high pressure (HP) uniformly acts on the pressure receiving surfaces of the discharge-side end parts 71a of the slide valves 7. In contrast, in the suction-side end parts 70a of the slide valves 7, high pressure (HP) acts on only the pressure receiving surfaces of the suction-side end parts 70a configuring the pressure applying spaces 13, and low pressure (LP) acts on the suction-side end parts 70a not configuring the pressure applying spaces 13. Therefore, the repulsive parts 11 assisting movement of the slide valves 7 in the high Vi direction are provided on the suction-side end parts 70a of the slide valves 7. The slide valves 7 move toward the high Vi side by reactive force of the repulsive parts 11.

[0081] As illustrated in Fig. 8, to position the slide valves 7 on the low Vi side, the high-pressure flow path 52 making the pressure applying spaces 13 and the high-pressure space 41 communicate with each other is blocked by the pressure switching mechanism 12b, and only the low-pressure flow path 51 making the pressure applying spaces 13 and the low-pressure space 40 communicate with each other is communicated by opening of the pressure switching mechanism 12a. Therefore, as the pressure applying refrigerant, the low-pressure refrigerant of the low-pressure space 40 flows through the merge flow path 53. At this time, high pressure (HP) uniformly acts on the pressure receiving surfaces on the discharge-side end parts 71a of the slide valves 7, and low pressure (LP) uniformly acts on the pressure receiving surfaces of the suction-side end parts 70a in the pressure applying spaces 13. The repulsive parts 11 constantly urge the slide valves 7 in a direction in which the slide valves 7 move toward the high Vi side. Therefore, when the high pressure (HP) acting on the pressure receiving surface of the discharge-side end part 71a of each of the slide valves 7 becomes greater than resultant force of the reactive force of the corresponding repulsive part 11 and the low pressure (LP), each of the slide valves 7 moves toward the low Vi side.

[0082] As described above, the repulsive parts 11 constantly generate reactive force in a direction in which the slide valves 7 are moved toward the high Vi side. Therefore, to position the slide valves 7 on the low Vi side, it is necessary to design the reactive force of each of the repulsive parts 11 such that the pressure acting on the pressure receiving surface of the discharge-side end parts 71a of each of the slide valves 7 becomes greater than the resultant force of the low pressure acting on the entire pressure receiving surface of the suction-side end part 70a and the reactive force of the corresponding repulsive part 11.

<Effects of Embodiment 2>

[0083] According to Embodiment 2, the slide valves 7 are disposed between the low-pressure space 40 and the high-pressure space 41. Each of the slide valves 7 includes the suction-side end part 70a at the position closer to the low-pressure space 40 than the high-pressure space 41. The pressure applying refrigerant, the pressure of which is switched by the pressure switching mechanism 12a and the pressure switching mechanism 12b, is applied from the downstream-side end parts of the merge flow path 53 to the suction-side end parts 70a of the valve body portions 70 of the slide valves 7.

[0084] According to Embodiment 2, each of the pressure applying spaces 13 is a surrounded closed space at least including the pressure receiving surface of the suction-side end part 70a of the corresponding slide valve 7 and the casing 1.

[0085] With this configuration, the pressure applying refrigerant flows into the pressure applying spaces 13 that are configured as the closed spaces, and the pressure of the pressure applying refrigerant can be completely applied to the pressure receiving surfaces of the suction-side end parts 70a of the valve body portions 70 of the slide valves 7.

<Effects of Embodiment 1 and Embodiment 2 to Existing Configuration>

[0086] Fig. 9 is an explanatory diagram illustrating a vertical cross-section of the compression unit 2 of a screw compressor 200 having an existing configuration. In an existing slide valve driving method illustrated in Fig. 9, to transmit driving force derived from pressure difference between spaces in front of and behind a piston 215 installed in a cylinder space 213, to the slide valves 7, the piston 215, one coupling part 216 coupled to an end part of the piston 215, two coupling rods 217 coupling the coupling part 216 to the respective slide valves 7, and fastening components coupling these parts, such as bolts and nuts are necessary. Further, a cylinder lid 218 to seal a cylindrical portion configuring the cylinder space 213 provided in the connection flange 10, is also necessary.

[0087] In contrast, in the configuration in each of Embodiment 1 and Embodiment 2, the piston 215, the coupling part 216, the coupling rods 217, the cylinder lid 218, and the fastening components coupling these parts, such as bolts and nuts, are unnecessary. Further, in Embodiment 1, these parts are eliminated, and the pressure applying spaces 13 corresponding to the cylinder space 213 are provided adjacently to the pressure receiving surfaces of the discharge-side end parts 71a of the guide portions 71 of the slide valves 7 in the casing 1. In Embodiment 2, the pressure applying spaces 13 corresponding to the cylinder space 213 are provided adjacently to the pressure receiving surfaces of the suction-side end parts 70a of the valve body portions 70 of the slide valves 7 in the casing 1. This makes it possible to significantly reduce the total length of the screw compressor 100.

[0088] As described above, in each of Embodiment 1 and Embodiment 2, it is possible to move the slide valves 7 to the positions where the internal volume ratio corresponding to the high/low pressure ratio is achieved, by using the relatively small number of relatively simple components, and to achieve downsizing, light weight, and cost reduction of the screw compressor 100.

Embodiment 3.

<Refrigeration Cycle Device 101>

[0089] Fig. 10 is a refrigerant circuit diagram illustrating a refrigeration cycle device 101 to which a screw compressor 100 is applied, according to Embodiment 3.

[0090] As illustrated in Fig. 10, the refrigeration cycle device 101 includes the screw compressor 100, a condenser 102, an expansion valve 103, and an evaporator 104. The screw compressor 100, the condenser 102, the expansion valve 103, and the evaporator 104 are connected by refrigerant pipes to form a refrigerant circuit. Refrigerant flowing out from the evaporator 104 is suctioned into the screw compressor 100, and is turned into high-temperature high-pressure refrigerant. The high-temperature high-pressure refrigerant is condensed by the condenser 102, and is turned into liquid refrigerant. The liquid refrigerant is decompressed and expanded by the expansion valve 103, and is turned into low-temperature low-pressure two-phase gas-liquid refrigerant. The two-phase gas-liquid refrigerant exchanges heat in the evaporator 104.

[0091] The screw compressor 100 in each of Embodiment 1 and Embodiment 2 is applicable to such a refrigeration cycle device 101. Note that examples of the refrigeration cycle device 101 include an air-conditioning device, a refrigeration device, and a water heater.

<Effects of Embodiment 3>

[0092] According to Embodiment 3, the refrigeration cycle device 101 includes the above-described screw compressor 100.

[0093] With this configuration, since the refrigeration cycle device 101 includes the above-described screw compressor 100, it is possible to reduce the number of components and the installation space with the simple configuration, and to achieve downsizing, light weight, and cost reduction.

Reference Signs List

[0094] 1: casing, 1a: slide groove, 2: compression unit, 3: driving unit, 4: screw shaft, 5: screw rotor, 5a: tooth groove, 6: gate rotor, 6a: gate rotor tooth portion, 7: slide valve, 7a: discharge port, 8: bearing, 9: bearing housing, 10: connection flange, 10a: stopper, 10b: hole, 11: repulsive part, 12a: pressure switching mechanism, 12b: pressure switching mechanism, 13: pressure applying space, 14: high-pressure space, 19: guide structure, 20: compression chamber, 30: electric motor, 31: stator, 32: motor rotor, 40: low-pressure space, 41: high-pressure space, 50: pressure driving mechanism, 51: low-pressure flow path, 52: high-pressure flow path, 53: merge flow path, 70: valve body portion, 70a: suction-side end part, 71: guide portion, 71a: discharge-side end part, 72: coupling portion, 100: screw compressor, 101: refrigeration cycle device, 102: condenser, 103: expansion valve, 104: evaporator, 200: screw compressor, 213: cylinder space, 215: piston, 216: coupling part, 217: coupling rod, 218: cylinder lid

Claims

1. A screw compressor, comprising:

a casing including an inner cylindrical surface portion that has a cylindrical shape;
a screw rotor rotatably housed in the inner cylindrical surface portion of the casing, and including a plurality of spiral grooves on an outer periphery;
a gate rotor including teeth engaging with the plurality of spiral grooves of the screw rotor; and
a slide valve configured to adjust an opening degree of a discharge port for high-pressure refrigerant compressed by the screw rotor, wherein
a low-pressure flow path allowing low-pressure refrigerant before being suctioned into the screw rotor to flow therethrough, a high-pressure flow path allowing the high-pressure refrigerant dis-

charged from the discharge port to flow therethrough, and a merge flow path merging the low-pressure flow path and the high-pressure flow path are provided,

a pressure switching mechanism switching pressure of the refrigerant is disposed in at least one of the low-pressure flow path, the high-pressure flow path, and the merge flow path, and

the merge flow path applies pressure applying refrigerant, pressure of which is switched by the pressure switching mechanism, from a downstream-side end part to one of end parts of the slide valve.

2. The screw compressor of claim 1, wherein

the slide valve is provided at each of two positions, and

the merge flow path is branched on a way, and applies the pressure applying refrigerant to one of end parts of each of the two slide valves.

3. The screw compressor of claim 1 or 2, wherein a pressure applying space where the pressure applying refrigerant is applied from the downstream-side end part of the merge flow path is provided on one of end parts of the slide valve.

4. The screw compressor of claim 3, wherein

the slide valve is provided at each of two positions, and

the pressure applying space is provided for each of the two slide valves.

5. The screw compressor of claim 3 or 4, wherein a stopper preventing a wall surface portion of the pressure applying space from oppositely coming into contact with one of the end parts of the slide valve is provided on the wall surface portion of the pressure applying space.

6. The screw compressor of any one of claims 1 to 5, wherein

the slide valve is disposed between a low-pressure space where the low-pressure refrigerant is present and a high-pressure space where the high-pressure refrigerant is present, and includes a discharge-side end part at a position closer to the high-pressure space than the low-pressure space, and

the pressure applying refrigerant, pressure of which is switched by the pressure switching mechanism, is applied from the downstream-side end part of the merge flow path to the discharge-side end part of the slide valve.

7. The screw compressor of claim 6 as dependent on any one of claims 3 to 5, wherein the pressure applying space is a surrounded closed space at least including the discharge-side end part of the slide valve and the casing.

8. The screw compressor of any one of claims 1 to 5, wherein

the slide valve is disposed between a low-pressure space where the low-pressure refrigerant is present and a high-pressure space where the high-pressure refrigerant is present, and includes a suction-side end part at a position closer to the low-pressure space than the high-pressure space, and

the pressure applying refrigerant, pressure of which is switched by the pressure switching mechanism, is applied from the downstream-side end part of the merge flow path to the suction-side end part of the slide valve.

9. The screw compressor of claim 8 as dependent on any one of claims 3 to 5, wherein the pressure applying space is a surrounded closed space at least including the suction-side end part of the slide valve and the casing.

10. The screw compressor of any one of claims 1 to 9, further comprising a repulsive part configured to assist movement of the slide valve by the pressure applying refrigerant.

11. The screw compressor of claim 10, wherein the repulsive part is provided on a side provided with an end part opposite to the end part to which the pressure applying refrigerant is applied.

12. The screw compressor of claim 10, wherein the repulsive part is provided on a side provided with the end part to which the pressure applying refrigerant is applied.

13. The screw compressor of any one of claims 1 to 12, wherein the low-pressure flow path, the high-pressure flow path, and the merge flow path are configured by pipes provided outside the casing.

14. The screw compressor of any one of claims 1 to 12, wherein the low-pressure flow path, the high-pressure flow path, and the merge flow path are configured by components inside the casing.

15. The screw compressor of any one of claims 1 to 14, wherein the pressure switching mechanism is an on-off valve provided in each of the low-pressure flow path and the high-pressure flow path.

16. The screw compressor of any one of claims 1 to 15, wherein the pressure switching mechanism is a solenoid valve.

17. A refrigeration cycle device comprising the screw compressor of any one of claims 1 to 16.

FIG. 1

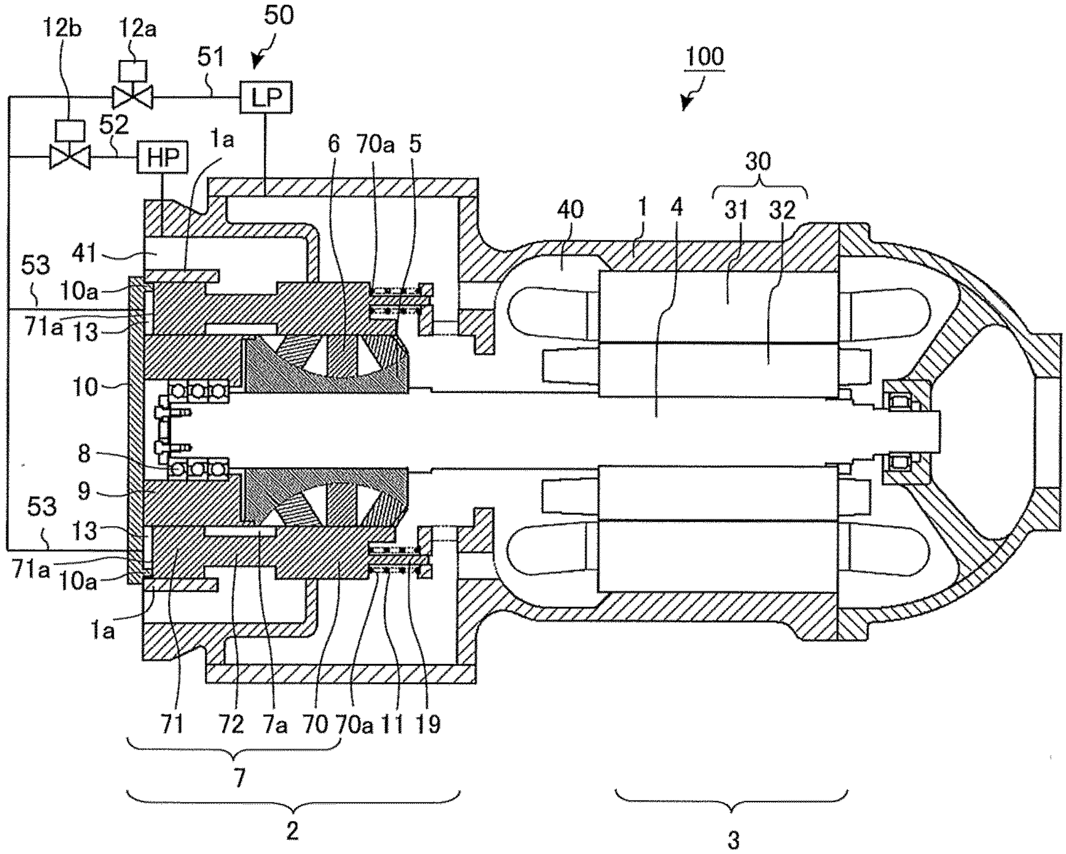
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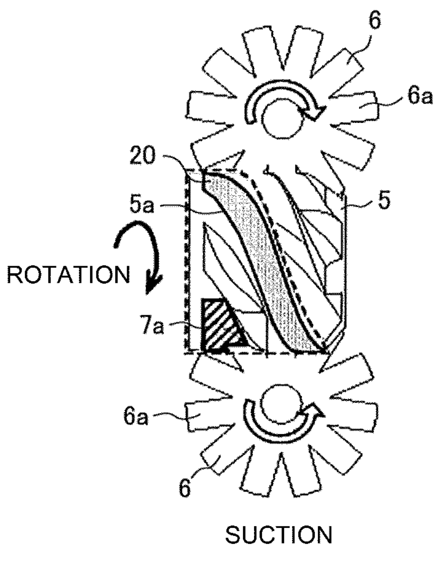
FIG. 2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ROTATION
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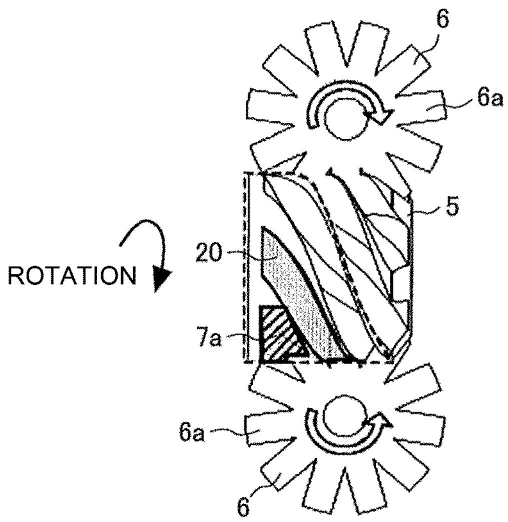
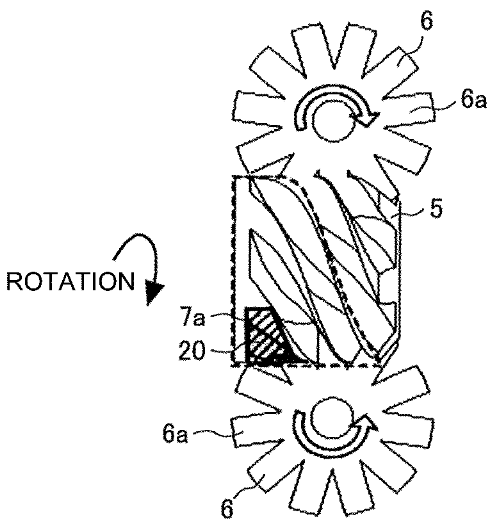
6
SUCTION

FIG. 3



COMPRESSION

FIG. 4



DISCHARGE

FIG. 5

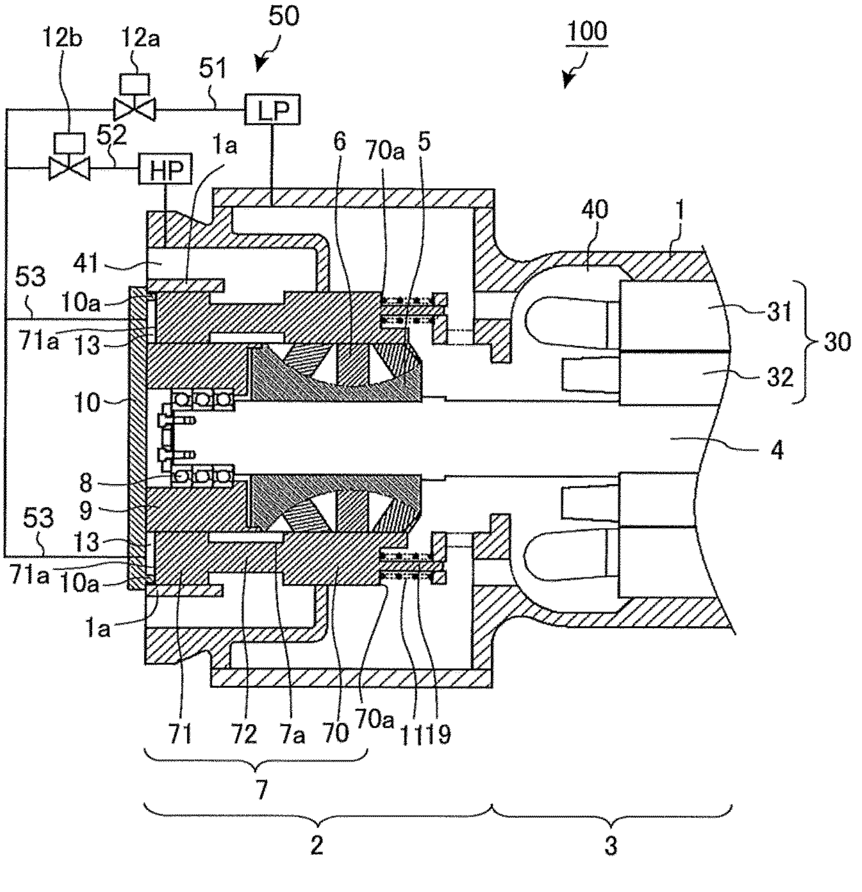


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FIG. 6

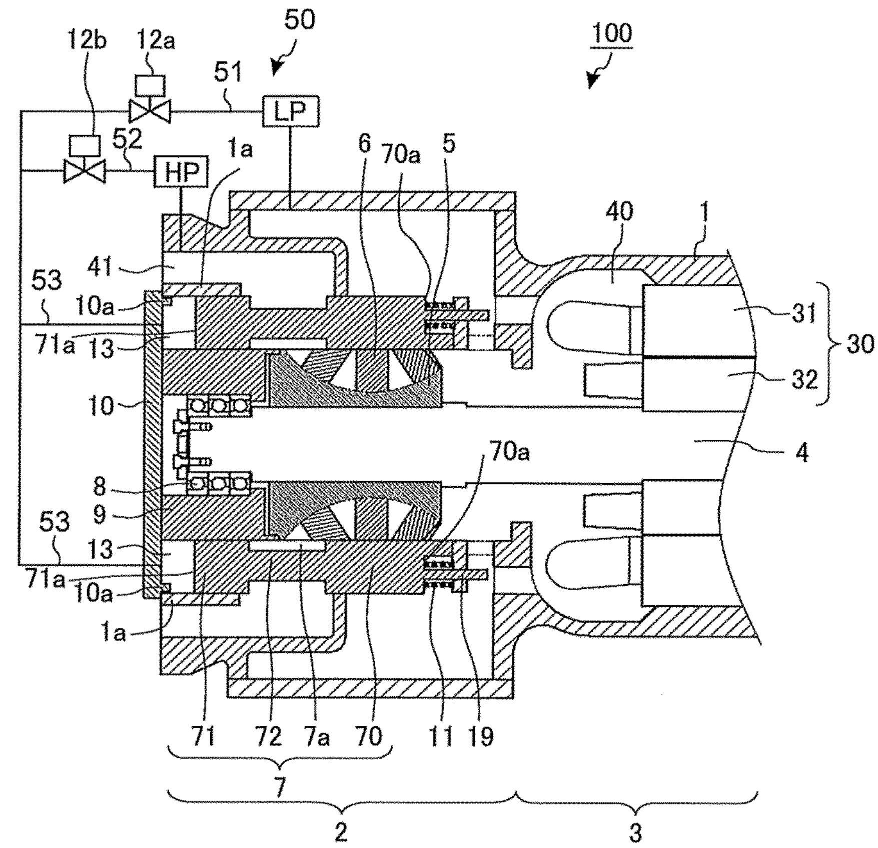
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FIG. 7

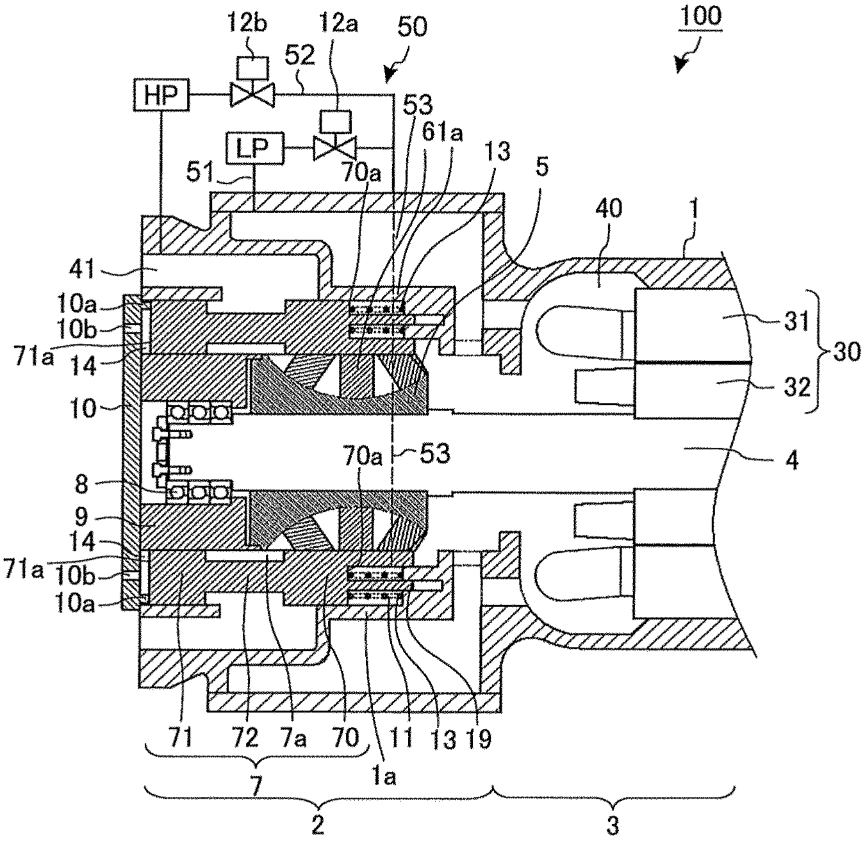
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FIG. 8

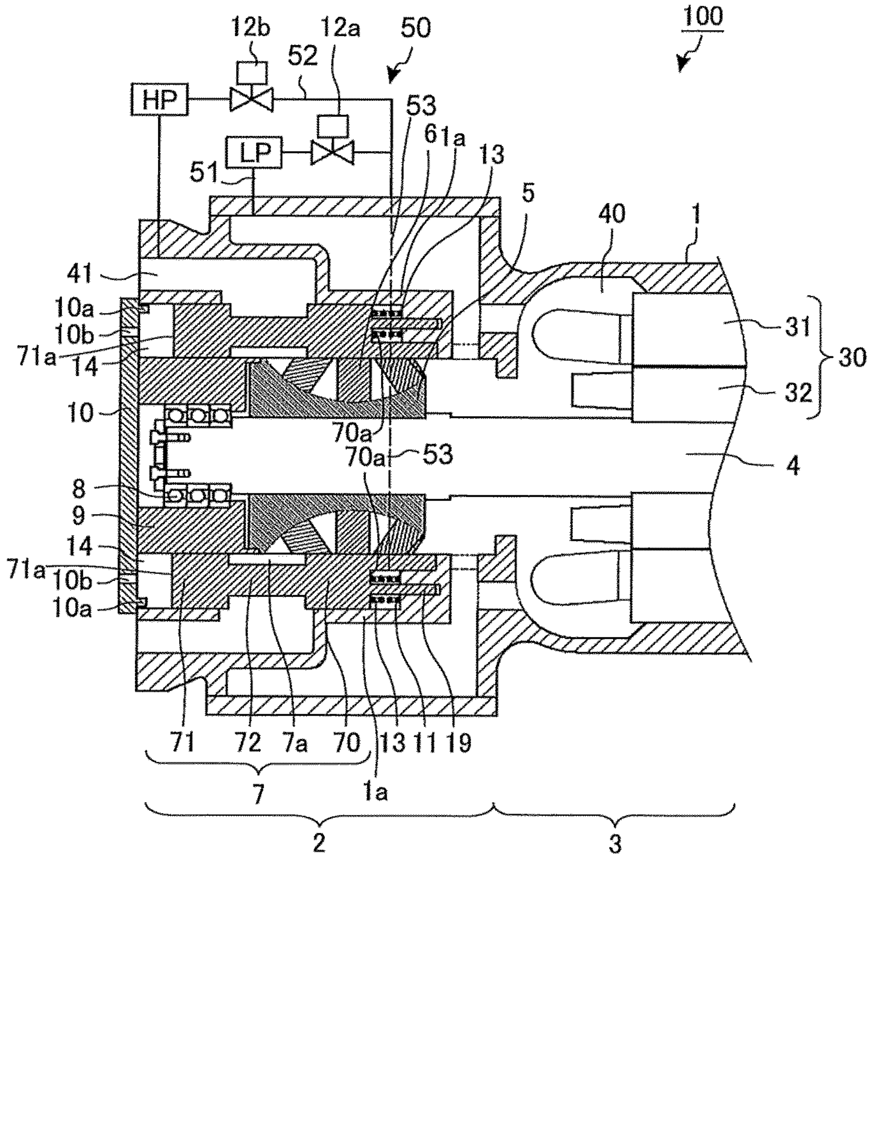

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FIG. 9

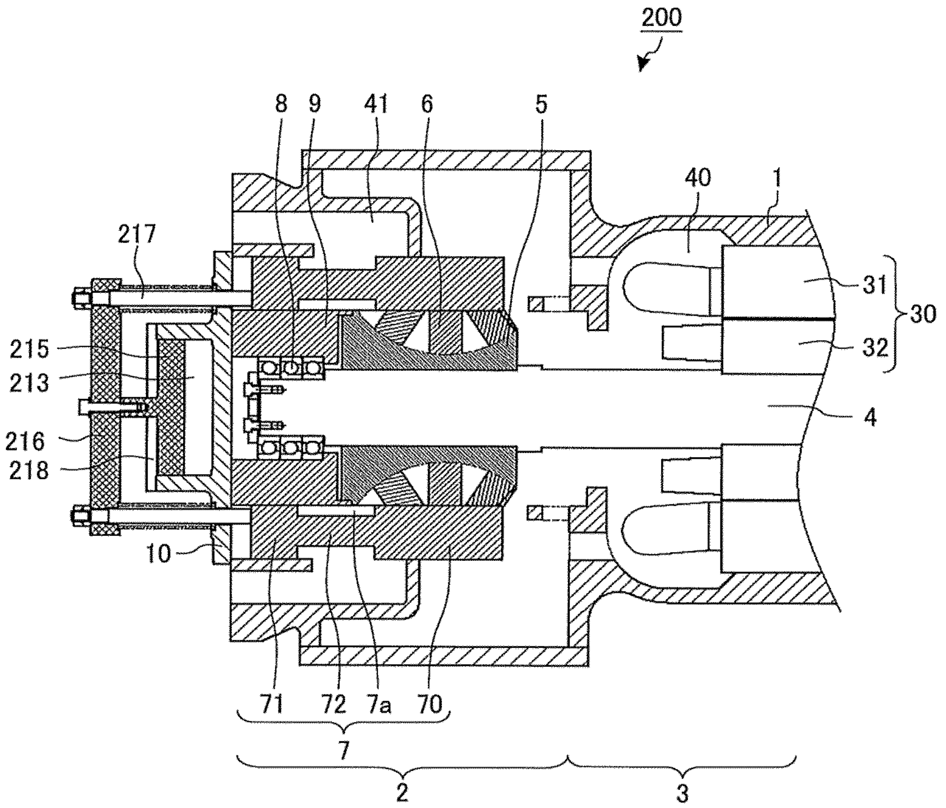
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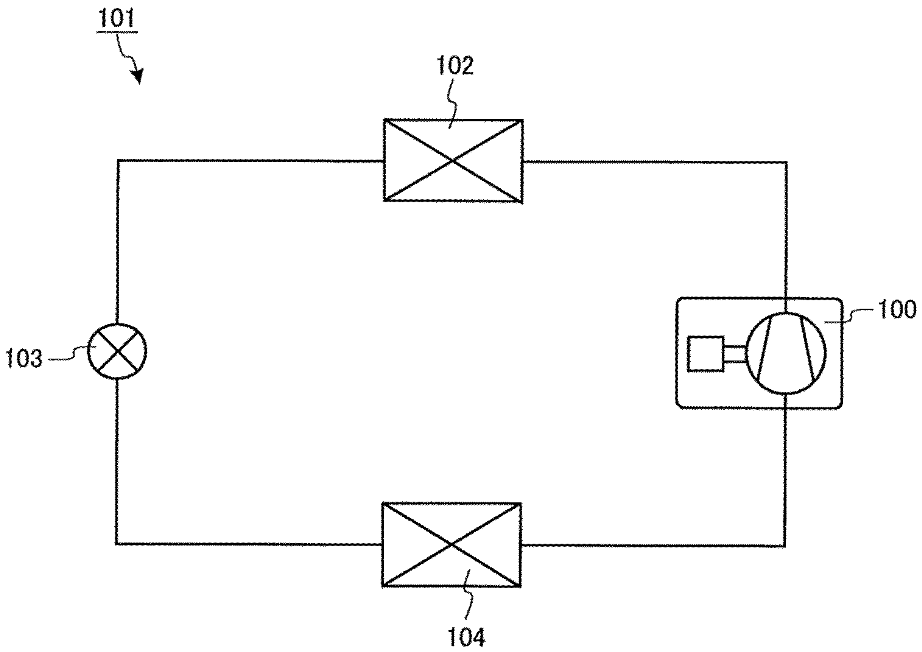
FIG. 10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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/022282

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl. F04C18/52(2006.01)i
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl. F04C18/52

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Published examined utility model applications of Japan	1922-1996
Published unexamined utility model applications of Japan	1971-2019
Registered utility model specifications of Japan	1996-2019
Published registered utility model applications of Japan	1994-2019

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2013-124600 A (MITSUBISHI ELECTRIC CORP.) 24 June 2013, paragraphs [0001], [0011]-[0015], all drawings (Family: none)	1-17
Y	JP 60-164693 A (DAIKIN INDUSTRIES, LTD.) 27 August 1985, publication gazette, page 2, upper right column, line 18 to lower left column, line 6, fig. 2 (Family: none)	1-17

☒ Further documents are listed in the continuation of Box C.

☐ See patent family annex.

* Special categories of cited documents:
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"P" document published prior to the international filing date but later than the priority date claimed
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 August 2019 (14.08.2019)	27 August 2019 (27.08.2019)

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

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2019/022282

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2012-509436 A (AAF MCQUAY INCORPORATED) 19 April 2012, paragraph [0039], fig. 3-4 & US 2011/0256011 A1, paragraph [0055], fig. 3-4 & WO 2010/058182 A2 & CA 2742729 A1 & CN 102216619 A	1-17
A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 151917/1987 (Laid-open No. 56592/1989) (DAIKIN INDUSTRIES, LTD.) 07 April 1989, fig. 2 (Family: none)	1-17
A	JP 59-32689 A (ZIMMERN, Bernard) 22 February 1984, fig. 11 & US 4534719 A, fig. 11 & GB 2119856 A & DE 3317330 A1 & FR 2526880 A1	1-17
A	WO 2017/145251 A1 (MITSUBISHI ELECTRIC CORP.) 31 August 2017, paragraph [0054], fig. 1 & EP 3421800 A1, paragraph [0103], fig. 1	1-17
A	JP 4-228893 A (ZIMMERN, Bernard) 18 August 1992, fig. 1-2 & GB 2243652 A, fig. 1-2 & FR 2661457 A1	1-17
A	JP 2012-102967 A (MITSUBISHI ELECTRIC CORP.) 31 May 2012, fig. 2, 6 (Family: none)	1-17

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REFERENCES CITED IN THE DESCRIPTION

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- JP 2013036403 A **[0011]**
- JP 5943101 B **[0011]**