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

(11) EP 4 446 589 A1

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

(43) Date of publication:
16.10.2024 Bulletin 2024/42

(21) Application number: **21967069.2**

(22) Date of filing: **06.12.2021**

(51) International Patent Classification (IPC):
F04C 18/02 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F04C 18/02

(86) International application number:
PCT/JP2021/044652

(87) International publication number:
WO 2023/105562 (15.06.2023 Gazette 2023/24)

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

(71) Applicant: **MITSUBISHI ELECTRIC CORPORATION**
Chiyoda-ku
Tokyo 100-8310 (JP)

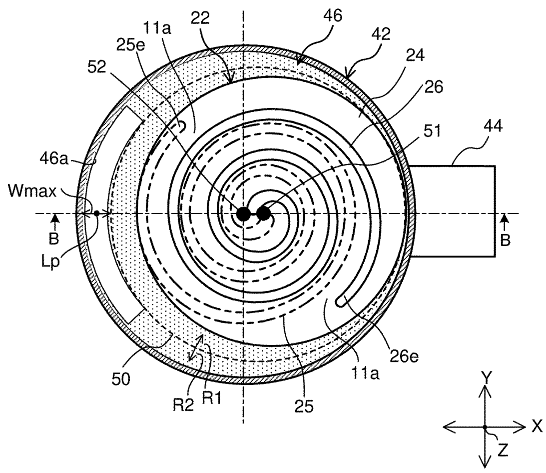
(72) Inventors:
- **KATO, Keisuke**
  Tokyo 100-8310 (JP)
- **TATSUWAKI, Kohei**
  Tokyo 100-8310 (JP)

(74) Representative: **Witte, Weller & Partner Patentanwälte mbB**
Postfach 10 54 62
70047 Stuttgart (DE)

(54) SCROLL COMPRESSOR

(57) A scroll compressor is provided with a compression mechanism unit that has a fixed scroll and an orbiting scroll and is configured to compress refrigerant, a rotation shaft that has an eccentric portion, a motor unit configured to drive the compression mechanism unit by use of the rotation shaft, a pressure vessel in which the compression mechanism unit and the motor unit are housed, and a frame that is fixed to the inside of the pressure vessel and supports the orbiting scroll in an axial direction in which the rotation shaft extends. The orbiting scroll has an orbiting-base plate portion, an orbiting scroll wrap provided in a first face of the orbiting-base plate portion that faces the fixed scroll, and a boss portion provided in a second face of the orbiting-base plate portion that is opposite to the first face and in which the eccentric portion is fitted with each other. The orbiting-base plate portion and the boss portion are located such that the position of the center of the orbiting-base plate portion differs from the position of the center of the boss portion when the orbiting-base plate portion and the boss portion are viewed in the axial direction.

FIG. 4



EP 4 446 589 A1

Description

Technical Field

[0001] The present disclosure relates to a scroll compressor that has a compression mechanism unit.

Background Art

[0002] A scroll compressor is provided with a compression mechanism unit that compresses refrigerant, a rotation shaft, and a motor unit that drives the compression mechanism unit by use of the rotation shaft. The compression mechanism unit has a fixed scroll and an orbiting scroll. These scrolls have respective scroll wraps that are provided opposite to each other and are thus engaged with each other. Between these scroll wraps, a compression chamber is defined. The fixed scroll is fixed to the inside of a pressure vessel. The orbiting scroll has a base plate portion and a boss portion. At one face of the base plate portion, the scroll wrap of the orbiting scroll is located. At the other face opposite to the one face, the boss portion is located. In the boss portion, an eccentric shaft portion of a rotation shaft is fitted. The scroll compressor is also provided with a frame that is fixed to the inside of the pressure vessel and that supports the orbiting scroll. In the scroll compressor, when the motor unit rotates the rotation shaft, the orbiting scroll, which is fitted in the eccentric shaft portion, orbitally rotates, the compression chamber changes in capacity, and the refrigerant is thus compressed. Among such compressors, one has a suction port formed at an outer circumference portion of a frame and through which refrigerant sucked from a suction pipe is allowed to pass to a compression mechanism unit. Such a compressor is referable to, for example, Patent Literature 1. There is also usually a case in which a scroll compressor has, for example, at an outer circumference portion of a thrust face of its frame, not only a hole as a suction port or other element but also a convex portion such as a partition wall separated from the suction port is provided. Such a structural element in a frame outer circumference portion is provided further outside than a motion range in which a base plate portion is movable at the frame such that the base plate portion does not block the structural element.

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Patent No. 6678762

Summary of Invention

Technical Problem

[0004] A scroll compressor described in Patent Literature 1 has an orbiting scroll configured to orbitally rotate on its frame such that the center in a motion range of a base plate portion coincides with the center of a rotation shaft, that is, the center of the frame. In other words, in Patent Literature 1, at the upper face of the frame, a non-motion range, which is a range that does not face the base plate portion and its motion range, is evenly provided at any points at the upper face of the frame in its circumferential direction. In a configuration, as described in Patent Literature 1, in which the center of the motion range of the base plate portion coincides with the center of the frame, the base plate portion is thus limited in size such that a structural element such as a suction port provided to a portion of a frame outer circumference portion in a circumferential direction and a motion range of the base plate portion of the orbiting scroll do not overlap with each other and, for example, blockage of refrigerant supply to a compression mechanism unit is then prevented. Alternatively, the base plate portion causes the structural element in the frame outer circumference portion to be limited in size. When the base plate portion is limited in size, the orbiting scroll is also limited in size and its capacity thus reduces. In contrast, when the suction port is limited in size, its suction pressure for refrigerant reduces. As a result, provision of a high-performance scroll compressor is not accomplished.

[0005] The present disclosure is made to solve such a problem described above. An object of the present disclosure is to reduce limitation on the size of the orbiting scroll and limitation on the size of the structural element in the frame outer circumference portion and to therefore provide a high-performance scroll compressor.

Solution to Problem

[0006] A scroll compressor according to an embodiment of the present disclosure has a compression mechanism unit that has a fixed scroll and an orbiting scroll and is configured to compress refrigerant, a rotation shaft that has an eccentric portion, a motor unit configured to drive the compression mechanism unit by use of the rotation shaft, a pressure vessel in which the compression mechanism unit and the motor unit are housed, and a frame that is fixed to the inside of the pressure vessel and supports the orbiting scroll in an axial direction in which the rotation shaft extends. The orbiting scroll has an orbiting-base plate portion, an orbiting scroll wrap provided in a first face of the orbiting-base plate portion that faces the fixed scroll, and a boss portion provided in a second face of the orbiting-base plate portion that is opposite to the first face and in which the eccentric portion is fitted with each other. The orbiting-base plate portion and the boss portion are located such that the position of the center of the orbiting-base plate portion differs from the position of the center of the boss portion when the orbiting-base plate portion and the boss portion are viewed in the axial direction. Advantageous Effects of Invention

[0007] According to an embodiment of the present disclosure, the orbiting-base plate portion and the boss portion are located such that the position of the center of the orbiting-base plate portion differs from the position of the center of the boss portion when the orbiting-base plate portion and the boss portion are viewed in the axial direction and the center in a motion range in which the orbiting-base plate portion is movable is thus eccentric from the center of the frame. A non-motion range in which the orbiting-base plate portion is immovable at the frame progressively reduces and is narrower in an eccentric direction, meanwhile the non-motion range progressively increases and is wider in a direction opposite to the eccentric direction. Even when a structural element is provided to a portion of the frame present in the direction opposite to the eccentric direction of the motion range of the orbiting-base plate portion, the non-motion range thus still has a blank space that allows the orbiting-base plate portion or the structural element to be increased in size. As a result, limitation on the size of the orbiting scroll and limitation on the size of the structural element in the frame outer circumference portion are reduced and a high-performance scroll compressor is therefore provided.

Brief Description of Drawings

[0008]

[Fig. 1] Fig. 1 is a vertical cross-sectional view that illustrates a schematic configuration of a compressor according to Embodiment 1.

[Fig. 2] Fig. 2 is a partially enlarged view that illustrates a structure around an eccentric axis in the compressor illustrated in Fig. 1.

[Fig. 3] Fig. 3 is a plan view that illustrates a schematic configuration of a first frame in the compressor illustrated in Fig. 1.

[Fig. 4] Fig. 4 is an A-A cross-sectional view that schematically illustrates the positional relationship between an orbiting scroll and the first frame when the orbiting scroll moves rightward in the compressor illustrated in Fig. 1.

[Fig. 5] Fig. 5 is a B-B cross-sectional view that schematically illustrates the positional relationship between the orbiting scroll, the first frame, and a rotation shaft in the compressor illustrated in Fig. 4.

[Fig. 6] Fig. 6 is a vertical cross-sectional view that schematically illustrates the positional relationship between the orbiting scroll, the first frame, and the rotation shaft when the orbiting scroll moves leftward in the compressor illustrated in Fig. 5.

[Fig. 7] Fig. 7 is a horizontal cross-sectional view that schematically illustrates a first modification of a compression mechanism unit in the compressor illustrated in Fig. 1.

[Fig. 8] Fig. 8 is a horizontal cross-sectional view that schematically illustrates a second modification of the compression mechanism unit in the compressor illustrated in Fig. 1.

[Fig. 9] Fig. 9 is a horizontal cross-sectional view that schematically illustrates a third modification of the compression mechanism unit in the compressor illustrated in Fig. 1.

[Fig. 10] Fig. 10 is a partial cross-sectional view that schematically illustrates a configuration of a compressor according to Embodiment 2.

[Fig. 11] Fig. 11 is a horizontal cross-sectional view that schematically illustrates the positional relationship between an orbiting scroll and a first frame when the orbiting scroll moves rightward in the compressor according to Embodiment 2.

[Fig. 12] Fig. 12 is a vertical cross-sectional view that schematically illustrates the positional relationship between the orbiting scroll and the first frame when the orbiting scroll moves leftward in the compressor illustrated in Fig. 11.

[Fig. 13] Fig. 13 is a horizontal cross-sectional view that schematically illustrates the positional relationship between an orbiting scroll and a first frame when the orbiting scroll moves rightward in a compressor according to Embodiment 3.

[Fig. 14] Fig. 14 is a vertical cross-sectional view that schematically illustrates the positional relationship between the orbiting scroll and the first frame when the orbiting scroll moves leftward in the compressor illustrated in Fig. 13.

Description of Embodiments

[0009] Embodiments of the present disclosure are described below with reference to drawings. The present disclosure is not limited to the embodiments described below. In addition, a relationship in size between components in the drawings illustrated below may differ from actual one. In addition, in following description, directional terms, such as "upper", "lower", "left", "right", "front", and "rear", used as appropriate for ease of comprehension are merely for explanation, and the present disclosure is not limited by such directional terms. Unless other specific description is provided, these directional terms are each a direction in a case in which a direction in which a rotation shaft 33 of a scroll compressor extends, which is also referred as an axial direction, is defined as a height direction and the scroll compressor is viewed from its front face, which is also referred as a front side, and these directional terms are each a direction indicated in Fig. 1, which is a vertical cross-sectional view of the scroll compressor viewed from its front side. Elements that have the same reference signs in the drawings are the same or equivalent elements and the reference signs are common in the full text of the specification. In following description, the scroll compressor may also be simply referred to as a compressor.

Embodiment 1

[0010] Fig. 1 is a vertical cross-sectional view that illustrates a schematic configuration of a compressor 100 according to Embodiment 1. In Fig. 1, the direction of arrows X indicates a width direction of the compressor 100, the direction of arrows Y indicates a front-rear direction of the compressor 100, and the direction of arrows Z indicates a height direction of the compressor 100. Fig. 2 is a partially enlarged view that illustrates a structure around an eccentric axis in the compressor 100 illustrated in Fig. 1. Fig. 3 is a plan view that illustrates a schematic configuration of a first frame 46 in the compressor 100 illustrated in Fig. 1. The configuration of the compressor 100 is described below with reference to Fig. 1 to Fig. 3.

[0011] The compressor 100 is to serve as a component in a refrigeration cycle apparatus, such as a refrigerator, a freezer, an air-conditioning apparatus, a water heater, and a vending machine. The compressor 100 is a fluid machine configured to suck refrigerant that circulates in a refrigeration cycle, compress and discharge the sucked refrigerant.

[0012] As illustrated in Fig. 1, the compressor 100 is provided with a compression mechanism unit 10, which compresses refrigerant, a rotation shaft 33, a motor unit 30, which drives the compression mechanism unit 10 by use of the rotation shaft 33, and a pressure vessel 40 in which the compression mechanism unit 10 and the motor unit 30 are housed. The compressor 100 is also provided with the first frame 46, which supports the compression mechanism unit 10 in an axial direction.

[0013] Inside the compression mechanism unit 10, a compression chamber 11 is defined. The compression chamber 11 changes in capacity together with rotation of the rotation shaft 33 and refrigerant is thus compressed in the compression chamber 11. In addition, in the compression mechanism unit 10, a discharge port 3 is formed. Through the discharge port 3, refrigerant compressed in the compression chamber 11 is discharged out from the compression mechanism unit 10 in the pressure vessel 40. The pressure vessel 40 has, for example, an intermediate vessel 42, which is cylindrically shaped, an upper vessel 41, which is welded to an upper opening portion of the intermediate vessel 42, and a lower vessel 43, which is welded to a lower opening portion of the intermediate vessel 42. In addition, to the pressure vessel 40, a suction pipe 44, through which refrigerant present outside is sucked into the pressure vessel 40, and a discharge pipe 45, through which refrigerant compressed in the compression mechanism unit 10 is discharged to the outside of the pressure vessel 40, are connected. The compression mechanism unit 10 is driven by the motor unit 30 and is thus configured to compress gas refrigerant sucked through the suction pipe 44 in the compression chamber 11 and discharge the refrigerant out from the compression mechanism unit 10 in the pressure vessel 40 through the discharge port 3. The compression mechanism unit 10 has a fixed scroll 21 and an orbiting scroll 22. The first frame 46 supports the orbiting scroll 22 in the compression mechanism unit 10.

[0014] In an example illustrated in Fig. 1, the motor unit 30 is located in a lower portion of the pressure vessel 40 and the compression mechanism unit 10 is located in an upper portion of the pressure vessel 40. Also in the example, the fixed scroll 21 is an upper portion of the compression mechanism unit 10 and the orbiting scroll 22 is a lower portion of the compression mechanism unit 10. In addition, the first frame 46 is located below the orbiting scroll 22 and the discharge port 3 is formed in an upper portion of the fixed scroll 21. Also in the example illustrated in Fig. 1, the suction pipe 44 is located on the right of the intermediate vessel 42 of the pressure vessel 40 and the discharge pipe 45 is located in the upper vessel 41 of the pressure vessel 40. In addition, the suction pipe 44 is located such that the suction pipe 44 communicates with a space lower than the first frame 46. In addition, in a bottom portion of the pressure vessel 40, an oil reservoir, in which lubricating oil is stored, is provided.

[0015] The compressor 100 is also provided with a chamber 4 provided in the pressure vessel 40 and located on the fixed scroll 21. The chamber 4 has a concave-shaped portion 4a formed in its lower face. In the concave-shaped portion 4a thus formed, refrigerant discharged from the discharge port 3 in the compression mechanism unit 10 is caused to be temporarily stored. At a middle portion of the concave-shaped portion 4a, a chamber discharge port 4b is formed. The chamber discharge port 4b extends in a height direction, which is the direction of the arrows Z. The discharge port 3 in the compression mechanism unit 10 and the concave-shaped portion 4a of the chamber 4 communicate with each other and the concave-shaped portion 4a of the chamber 4 and the chamber discharge port 4b of the chamber 4 communicate with each other. This configuration causes the refrigerant compressed in the compression chamber 11 in the compression mechanism unit 10 to be discharged into a space located in the pressure vessel 40 and located higher than the compression mechanism unit 10 through the discharge port 3, the concave-shaped portion 4a of the chamber 4, and the chamber discharge port 4b of the chamber 4.

[0016] In following description, among spaces in the pressure vessel 40, a space that is higher than the fixed scroll 21 may also be referred to as a discharge space So and a space that is lower than the first frame 46 and in which the motor unit 30 is located may also be referred to as a motor space Sm.

[0017] The compressor 100 is also provided with a discharge valve 5a and a valve presser 5b provided on the chamber 4. Respective proximal ends of the discharge valve 5a and the valve presser 5b are fixed onto the chamber 4 by a fixture 5c such as a bolt. In following description, the discharge valve 5a, the valve presser 5b, and the fixture 5c are collectively referred to as a discharge-valve mechanism 5.

[0018] The discharge port 3 described above and formed in the fixed scroll 21 is formed at a substantially middle portion of a fixed-base plate portion 23 and gas refrigerant compressed in the compression chamber 11 into a high-pressure state is discharged through the discharge port 3 thus formed. In addition, the discharge-valve mechanism 5 described above and located on the fixed scroll 21 is located on a face of the fixed-base plate portion 23 at which an outlet of the discharge port 3 is located, which is the upper face of the fixed-base plate portion 23 specified in Embodiment 1. The discharge-valve mechanism 5 thus located is configured to open and close the discharge port 3 according to a discharge pressure of refrigerant and also prevent a reverse flow of refrigerant.

[0019] The fixed scroll 21 has the fixed-base plate portion 23 and a fixed scroll wrap 25, which is an involute-curve shaped projection that stands on one face of the fixed-base plate portion 23, which is the lower face of the fixed-base plate portion 23 illustrated in Fig. 1. The fixed scroll 21 is fixed to the inner wall surface of the pressure vessel 40 by shrink-fit, welding, or other method. Specifically, to the inner wall surface of the intermediate vessel 42 of the pressure vessel 40, an unillustrated difference in level is provided and an outer circumferential edge portion of the fixed-base plate portion 23 is fitted into and joined with such a level difference.

[0020] The orbiting scroll 22 has an orbiting-base plate portion 24 and an orbiting scroll wrap 26, which is an involute-curve shaped projection that stands on one face of the orbiting-base plate portion 24, which is the upper face of the orbiting-base plate portion 24 illustrated in an example of Fig. 1. The orbiting scroll 22 is supported by the first frame 46 such that the orbiting scroll 22 is rotatable. In addition, to the other face of the orbiting-base plate portion 24, a boss portion 27, which is cylindrically shaped, is provided. Into the boss portion 27, an eccentric shaft portion 33a of the rotation shaft 33, which is described later, is fitted. The compressor 100 of the present disclosure is formed such that, as illustrated in Fig. 2, a center line 53 of the boss portion 27 and a center line 54 of the orbiting-base plate portion 24 are not present on the same line in a vertical direction. The center line 53 of the boss portion 27 illustrated in Fig. 2 coincides with a center line Ax2 of the eccentric shaft portion 33a illustrated in Fig. 1. The center line 53 of the boss portion 27 is not illustrated in Fig. 1 and the center line Ax2 of the eccentric shaft portion 33a is not illustrated in Fig. 2. In following description, the eccentric shaft portion 33a may also be referred to as an eccentric portion of the rotation shaft 33.

[0021] In addition, as illustrated in Fig. 2, at locations that are in the other face of the orbiting-base plate portion 24, which is the lower face of the orbiting-base plate portion 24, and are further outside than the boss portion 27, respective first Oldham grooves 24a are formed. In the first Oldham grooves 24a, respective top protrusions 29b of an Oldham ring 29, which is described later, are provided. The first Oldham grooves 24a are thus formed such that the first Oldham grooves 24a guide the respective top protrusions 29b of the Oldham ring 29. The first Oldham grooves 24a are each elongated in a radial direction and, when the first Oldham grooves 24a are viewed in the axial direction, are each, for example, oval-shaped. The first Oldham grooves 24a are located such that a pair of the first Oldham grooves 24a face each other.

[0022] While the Oldham ring 29 prevents the orbiting scroll 22 from rotating about its own axis against the fixed scroll 21, the orbiting scroll 22 orbitally rotates by use of the eccentric shaft portion 33a. In other words, the orbiting scroll 22 makes revolution movement, which is also referred to as orbiting movement.

[0023] As illustrated in Fig. 1, the fixed scroll 21 and the orbiting scroll 22 are fitted into each other and installed in the pressure vessel 40 such that the fixed scroll wrap 25 and the orbiting scroll wrap 26 are engaged with each other. The compression chamber 11 described above is defined between the fixed scroll wrap 25 and the orbiting scroll wrap 26. In the pressure vessel 40, the orbiting scroll 22 makes orbiting movement and the fixed scroll wrap 25 and the orbiting scroll wrap 26 thus change in relative positional relationship. The compression chamber 11 thus changes in capacity and refrigerant is compressed in the compression chamber 11.

[0024] The fixed scroll 21 is defined to be fixed directly to the pressure vessel 40; however, how the fixed scroll 21 is fixed to the pressure vessel 40 is not particularly limited to such direct fixity. The fixed scroll 21 may also be fixed to the pressure vessel 40 by use of an outer wall provided to the first frame 46, which supports the orbiting scroll 22, and secured to the fixed-base plate portion 23 of the fixed scroll 21 with screws.

[0025] In a case in which the fixed scroll 21 is fixed directly to the pressure vessel 40; however, an increased space between an outer circumference portion of the orbiting scroll 22 and the inner wall surface of the intermediate vessel 42 is obtained because an outer wall that is provided to the first frame 46 and extends to the fixed scroll 21, that is, upward is not required. In a case in which the fixed scroll 21 is fixed directly to the pressure vessel 40, an outer wall thus no longer limits the orbiting scroll 22 in size and an outer diameter of the orbiting-base plate portion 24 and a winding diameter of the orbiting scroll wrap 26 are allowed to be increased. In this case, the maximum possible refrigeration capacity of the compressor 100 is increasable with the diameter of the intermediate vessel 42 unchanged. In addition, with an increase in size of the orbiting-base plate portion 24, a thrust load is also designed to be reducible. Alternatively, in a case in which the fixed scroll 21 is fixed directly to the pressure vessel 40 and the orbiting scroll 22 is not changed in size, the diameter of the intermediate vessel 42 is reducible. In this case, the compressor 100 is allowed to be downsized without its maximum possible refrigeration capacity decreased.

[0026] The first frame 46 is formed by, for example, ferrous magnetic material. At a portion of the upper face of the first frame 46 that faces the orbiting-base plate portion 24, a thrust plate 46s is provided. The thrust plate 46s supports the orbiting scroll 22 such that the orbiting scroll 22 is slidable. In other words, when the orbiting scroll 22 makes revolution movement, the lower face of the orbiting scroll 22 slides at a portion higher than the upper face of the thrust plate 46s of the first frame 46.

[0027] In addition, as illustrated in Fig. 2 and Fig. 3, to a middle portion of the first frame 46, a boss housing portion 46f is provided in which the boss portion 27 of the orbiting scroll 22 is housed. In addition, to a portion of the first frame 46 that is lower than the boss housing portion 46f, a shaft bearing portion 46b is provided that protrudes inward and supports the rotation shaft 33 such that the rotation shaft 33 is rotatable. In addition, to a portion of the first frame 46 that is higher than the boss housing portion 46f, an Oldham housing portion 46o is formed that has an expanded inner diameter and in which a ring portion 29r of the Oldham ring 29, which is described later and referable to Fig. 2, is housed. In addition, as illustrated in Fig. 3, at the bottom face of the Oldham housing portion 46o of the first frame 46, second Oldham grooves 46o1 are formed. At the second Oldham grooves 46o1 in the first frame 46, unillustrated respective bottom protrusions of the Oldham ring 29 are provided. The second Oldham grooves 46o1 are thus formed such that the second Oldham grooves 46o1 guide the bottom protrusions of the Oldham ring 29. The second Oldham grooves 46o1 each extend in a radial direction and are located such that a pair of the second Oldham grooves 46o1 face each other. Fig. 3 illustrates an alternate long and short dashed line that connects the pair of the second Oldham grooves 46o1 in the first frame 46 and an alternate long and two short dashed line that connects the pair of the first Oldham grooves 24a in the orbiting-base plate portion 24 illustrated in Fig. 2. These lines cross at right angles.

[0028] In addition, as illustrated in Fig. 1, to supply refrigerant sucked through the suction pipe 44 to the compression chamber 11, a suction port 46a passes from a motor space Sm, which is located lower than the first frame 46, through a counter face of the first frame 46 that faces the orbiting scroll 22. As illustrated in Fig. 1, the suction port 46a is located in phase opposite to the suction pipe 44 across the rotation shaft 33.

[0029] As illustrated in Fig. 1, the motor unit 30 has a stator 31 fixed to the pressure vessel 40 and a rotor 32 provided in the inner circumference of the stator 31. The rotor 32 is attached to the stator 31 such that the rotor 32 is rotatable. When electricity is supplied through the stator 31, the rotor 32 is driven to rotate. At the center of the rotor 32, the rotation shaft 33 is attached. The rotation shaft 33 is configured rotate when the rotor 32 is driven to rotate. At the uppermost end of the rotation shaft 33, the eccentric shaft portion 33a is formed, which is fitted into the boss portion 27 of the orbiting scroll 22 with each other such that the eccentric shaft portion 33a is rotatable. When the motor unit 30 drives the orbiting scroll 22 by use of the rotation shaft 33, gas refrigerant is compressed in the compression mechanism unit 10.

[0030] At a portion in the pressure vessel 40 that is located lower than the motor unit 30, a second frame 47 is fixed. At a center portion of the second frame 47, a ball bearing 48 is press-fitted and fixed. The second frame 47 supports the ball bearing 48 in the pressure vessel 40. The second frame 47 supports the lowermost end of the rotation shaft 33 by use of the ball bearing 48 such that the rotation shaft 33 is rotatable.

[0031] The rotation shaft 33 is a rod-shaped component made of metal. The rotation shaft 33 has a main shaft portion 33b, which is a main portion of the rotation shaft 33, and the eccentric shaft portion 33a, which is an uppermost end portion of the rotation shaft 33. The main shaft portion 33b of the rotation shaft 33 is located such that its center line Ax1 coincides with the center axis of the intermediate vessel 42. The main shaft portion 33b is fixed in a through hole at the center of the rotor 32 in the motor unit 30 by shrink-fit or other similar method. The main shaft portion 33b is supported by the shaft bearing portion 46b located at the middle portion of the first frame 46 and the ball bearing 48 located at a middle portion of the second frame 47 such that the main shaft portion 33b is rotatable.

[0032] The eccentric shaft portion 33a of the rotation shaft 33 is located such that its center line Ax2 is eccentric to the center line Ax1 of the main shaft portion 33b. The eccentric shaft portion 33a is fitted into the boss portion 27 of the orbiting scroll 22 and supported by the boss portion 27 such that the eccentric shaft portion 33a is rotatable. The rotation shaft 33 rotates together with rotation of the rotor 32 in the motor unit 30 and thus makes the orbiting scroll 22 to circle around by use of the eccentric shaft portion 33a. In addition, an oil passage 33c is provided in and vertically passes through the main shaft portion 33b and the eccentric shaft portion 33a. Through the oil passage 33c, lubricating oil sucked from the oil reservoir is supplied, with rotation of the rotation shaft 33, to between parts that are mechanically in contact with each other, such as the compression mechanism unit 10.

[0033] In addition, the compressor 100 is provided with the Oldham ring 29, which prevents the orbiting scroll 22 from rotating about its own axis, and a bushing 28, which connects the orbiting scroll 22 and the eccentric shaft portion 33a with each other. With reference to Fig. 2, the configuration of the Oldham ring 29 and the bushing 28 is described below. The bushing 28 is attached on an outer circumference side of the eccentric shaft portion 33a of the rotation shaft 33 and located in the boss housing portion 46f in the first frame 46. The Oldham ring 29 is located on an outer circumference side of the bushing 28 and located in the Oldham housing portion 46o in the first frame 46.

[0034] The Oldham ring 29 is provided with the ring portion 29r, the two top protrusions 29b located at the upper face of the ring portion 29r, and the unillustrated two bottom protrusions located at the lower face of the ring portion 29r. The two top protrusions 29b are located at positions opposite to each other at the ring portion 29r. The two bottom protrusions are also located at positions opposite to each other at the ring portion 29r.

[0035] When rotation of the rotation shaft 33 causes the orbiting scroll 22 to make revolution movement, the top protrusions 29b slide in the respective first Oldham grooves 24a in the orbiting-base plate portion 24 and the bottom protrusions also slide in the respective second Oldham grooves 46o1 in the first frame 46 while moving ranges within which these Oldham grooves move are limited by respective inner groove walls. Such a configuration causes the orbiting scroll 22 not to rotate about its own axis.

[0036] The bushing 28 is formed by, for example, metal, such as iron. The bushing 28 has, for example, a slider 28a and a balance weight 28b. The slider 28a is a cylindrical component at which a flange is formed. A cylindrical portion of the slider 28a is located in the inner circumference of the boss portion 27 of the orbiting scroll 22 and fitted in each of the eccentric shaft portion 33a and the boss portion 27. The balance weight 28b is a component that is doughnut-shaped when the balance weight 28b is viewed in the axial direction. The balance weight 28b is fitted in the flange of the slider 28a with each other by shrink-fit or other similar method. The balance weight 28b is provided with a weight portion 28b1, which is substantially C-shaped when the weight portion 28b1 is viewed in the axial direction. In an example illustrated in Fig. 2, the weight portion 28b1 is located at only the left portion of the balance weight 28b. The balance weight 28b is provided with the weight portion 28b1, which is located at only a portion among the circumferential portion of the balance weight 28b, and thus counterbalances centrifugal force of the orbiting scroll 22.

[0037] Operation of the compressor 100 is next described with reference to Fig. 1. In the compressor 100, when electricity is supplied through the stator 31 in the motor unit 30, the rotor 32 and the rotation shaft 33 attached to the rotor 32 rotate. When the rotation shaft 33 rotates, the orbiting scroll 22, which is attached to the eccentric shaft portion 33a of the rotation shaft 33 by use of the bushing 28, makes orbiting movement against the fixed scroll 21. This operation continuously changes the capacity of the compression chamber 11 defined between the fixed scroll wrap 25 of the fixed scroll 21 and the orbiting scroll wrap 26 of the orbiting scroll 22. At this time, when the capacity of the compression chamber 11 increases, the pressure in the compression chamber 11 reduces and is lower than the pressure in a suction space in the pressure vessel 40, which is the motor space Sm in the example illustrated in Fig. 1, and refrigerant in the suction space is thus sucked through the suction port 46a into the compression chamber 11.

[0038] In a case in which, as illustrated in Fig. 1, the suction port 46a in the first frame 46 is located at a side, which is a half on the left of the center line Ax1 of the main shaft portion 33b, that is opposite to the other side on which the suction pipe 44 is located and, which is, for example, the other half on the right of the center line Ax1 of the main shaft portion 33b, across the center line Ax1 of the main shaft portion 33b, that is the center of the first frame 46, refrigerant cools the motor unit 30 while the refrigerant flows from the suction pipe 44 into the motor space Sm and is sucked into the compression chamber 11.

[0039] Subsequently, the orbiting scroll 22 makes orbiting movement, the compression chamber 11 thus reduces in capacity, the refrigerant sucked in the compression chamber 11 is compressed, and the pressure in the compression chamber 11 increases. When the pressure in the compression chamber 11 increases and is higher than a preset pressure, the refrigerant thus compressed pushes up the discharge valve 5a in the discharge-valve mechanism 20 and is discharged through the discharge space So and the discharge pipe 45 to the outside of the pressure vessel 40, such as a condenser in the refrigeration cycle.

[0040] Fig. 4 is an A-A cross-sectional view that schematically illustrates the positional relationship between the orbiting scroll 22 and the first frame 46 when the orbiting scroll 22 moves rightward in the compressor 100 illustrated in Fig. 1. Fig. 4 also illustrates the fixed scroll wrap 25 by use of an alternate one long and two short dashed line. Fig. 5 is a B-B cross-sectional view that schematically illustrates the positional relationship between the orbiting scroll 22, the first frame 46, and the rotation shaft 33 in the compressor 100 illustrated in Fig. 4. Fig. 6 is a vertical cross-sectional view that schematically illustrates the positional relationship between the orbiting scroll 22, the first frame 46, and the rotation shaft 33 when the orbiting scroll 22 moves leftward in the compressor 100 illustrated in Fig. 5. To simplify description, Fig. 5 and Fig. 6 do not illustrate the bushing 28 and the Oldham ring 29, which are illustrated in Fig. 1.

[0041] With reference to Fig. 4 to Fig. 6, a motion range R1 and a non-motion range R2 of the orbiting-base plate portion 24, which is located higher than the first frame 46, are described below. The motion range R1 and the non-motion range R2 are two spaces into which a round-columnar-shaped space is divided in a space in the intermediate vessel 42. This round-columnar-shaped space includes the orbiting-base plate portion 24, which is located higher than the first frame 46, and an outer space of the orbiting-base plate portion 24. As illustrated in Fig. 4, the motion range R1 is a range within which the orbiting-base plate portion 24 moves when the orbiting scroll 22 makes revolution movement at a space higher than the first frame 46. The motion range R1 is round-columnar-shaped. On the other hand, the non-motion range R2 is a range located outside a boundary 50, which defines the motion range R1, and into which the orbiting-base plate portion 24 does not move. The non-motion range R2 is round-cylindrical-shaped.

[0042] As illustrated in Fig. 5 and Fig. 6, in the present disclosure, the orbiting scroll 22 is formed such that the center line 53 of the boss portion 27 and the center line 54 of the orbiting-base plate portion 24 are not present on the same straight line in the vertical direction, which is the direction of the arrows Z. In other words, the orbiting scroll 22 makes orbiting movement in a state in which, to the center line Ax2, which is referable to Fig. 1, of the eccentric shaft portion 33a, which is eccentric to the main shaft portion 33b, the center line 54 of the orbiting-base plate portion 24 is further eccentric.

[0043] With this configuration, as illustrated in Fig. 4, when this configuration is viewed in the axial direction, a center line 51 in the motion range R1 of the orbiting-base plate portion 24 while the orbiting scroll 22 is making orbiting movement is eccentric from the center line Ax1, which is referable to Fig. 1, of the main shaft portion 33b, that is a center line 52 of the first frame 46. At a space higher than the first frame 46, the non-motion range R2 of the orbiting-base plate portion 24 is round-cylindrical-shaped such that radial widths of its circumference differ from each other. More specifically, a radial width of the non-motion range R2 reduces and is narrow in an eccentric direction of the center line 51 in the motion range R1 and the radial width of the non-motion range R2 increases and is wide in a direction opposite to the eccentric direction.

[0044] In an example illustrated in Fig. 4, at a space higher than the first frame 46, the center line 51 in the motion range R1 of the orbiting-base plate portion 24 is eccentric from the center line 52 of the first frame 46 to the right side on which the suction pipe 44 is located. A radial width of the non-motion range R2 at the left of the non-motion range R2 is wider than any of radial widths at the right, the rear, and the front.

[0045] To make the orbiting scroll 22 not to cover the suction port 46a, the size of the orbiting-base plate portion 24 is set. To secure the dimensions of the suction port 46a, in the example illustrated in Fig. 4, the suction port 46a is located in a half of the first frame 46 present in a direction opposite to the eccentric direction, in which the center line 51 in the motion range R1 of the orbiting-base plate portion 24 is eccentric, that is the left half of the first frame 46. Also in the example illustrated in Fig. 4, the suction port 46a, which is circular-arc-shaped, is located only one position in the first frame 46.

[0046] As observable from the boundary 50 of the motion range R1 illustrated in Fig. 4, the orbiting-base plate portion 24 does not overlap the suction port 46a at any timing in which the orbiting scroll 22 makes orbiting movement. Even in a state in which the orbiting scroll 22 orbits and reaches an end closest to the suction port 46a, which is on the left side in Fig. 6, in the width direction, which is the direction of the arrows X illustrated in Fig. 6, the orbiting scroll 22 is not located above the suction port 46a.

[0047] Also in the example illustrated in Fig. 4, a winding end portion 26e of the orbiting scroll wrap 26 in the orbiting scroll 22 is located frontward at 45 degrees from the suction pipe 44. The fixed scroll wrap 25 indicated by the alternate one long and two short dashed line illustrated in Fig. 4 has the orbiting scroll wrap 26 and a target scroll shape. The winding end portion 25e of the fixed scroll wrap 25 is located at 180 degrees from the winding end portion 26e of the orbiting scroll wrap 26. In other words, in the example illustrated in Fig. 4, the winding end portion 25e of the fixed scroll wrap 25 is located rearward at 135 degrees from the suction pipe 44. The refrigerant from the suction port 46a located in the first frame 46 flows into the compression chamber 11 through a gap between the winding end portion 26e of the orbiting scroll wrap 26 and the fixed scroll wrap 25 or a gap between the winding end portion 25e of the fixed scroll wrap 25 and the orbiting scroll wrap 26. These gaps, which are each an inlet of refrigerant into the compression chamber 11, are each referred to as a compression-chamber inlet 11a in some cases described below. In the example illustrated in Fig. 4, the compression-chamber inlets 11a are located at two respective positions, which are one located frontward at almost 135 degrees and one located rearward at almost 45 degrees from a middle position Lp in a circumferential direction of the suction port 46a. The compression-chamber inlet 11a located frontward opens leftward and the compression-chamber inlet 11a located rearward opens rightward. Also in the example illustrated in Fig. 4, the suction port 46a, which is circular-arc-shaped, is located at the left portion in the first frame 46 within an angular range of 90 degrees from an end located frontward at 45 degrees to the other end located rearward at 45 degrees. The positions of the winding end portions 25e and 26e, the positions of the compression-chamber inlets 11a, and the angular range of the suction port 46a in the circumferential direction are not limited to the case described above. Modifications are described later.

[0048] Also in the present disclosure, the center line 51 in the motion range R1 is eccentric and the position of a winding start portion from which the fixed scroll wrap 25 starts to be wound is thus also eccentric to the center of the fixed-base plate portion 23 when the fixed scroll wrap 25 is viewed in the axial direction such that the orbiting scroll wrap 26 and the fixed scroll wrap 25 are engaged with each other. Specifically, the position of the winding start portion of the fixed scroll wrap 25 is shifted from the center of the fixed-base plate portion 23 in a direction same as the eccentric direction of the center line 51 in the motion range R1 of the orbiting-base plate portion 24 when the fixed scroll wrap 25 is viewed in the axial direction. The position of the winding start portion of the fixed scroll wrap 25 is thus eccentric from the center line Ax1 of the main shaft portion 33b illustrated in Fig. 1 and also from the center line 52 of the first frame 46 illustrated in Fig. 4 in a direction same as the eccentric direction of the center line 51 in the motion range R1 of the orbiting-base plate portion 24 when the fixed scroll wrap 25 is viewed in the axial direction. The position of the winding start portion of the fixed scroll wrap 25 is eccentric from the center of the fixed-base plate portion 23 when the fixed scroll wrap 25 is viewed in the axial direction and the discharge port 3 in the fixed-base plate portion 23 illustrated in Fig. 1 is thus also eccentric similarly to the position of the winding start portion.

[0049] As described above, the orbiting-base plate portion 24 and the boss portion 27 are located such that the center of the orbiting-base plate portion 24 and the center of the boss portion 27 differ from each other and the orbiting scroll wrap 26 is thus also further shifted in the eccentric direction than in a case of some compressor. Together with this configuration, the fixed scroll wrap 25 and the discharge port 3 in the fixed scroll 21 are located such that the fixed scroll wrap 25 is also shifted from the center of the fixed-base plate portion 23 and the discharge port 3 in the fixed scroll 21 is also shifted from the center of the intermediate vessel 42.

[0050] Incidentally, as in a case of some compressor, in a case in which the center line 53 of the boss portion 27 and the center line 54 of the orbiting-base plate portion 24 coincide with each other when the boss portion 27 and the orbiting-base plate portion 24 are viewed in the axial direction, the center line 51 in the motion range R1 of the orbiting-base plate portion 24 while the orbiting scroll 22 is making orbiting movement coincides with the center line 52 of the first frame 46. In a case of some compressor, the radial widths of the non-motion range R2 are even at any points in its circumferential direction and are each smaller than the maximum width Wmax in a radial direction of the non-motion range R2 described in the present disclosure.

[0051] In the present disclosure, as illustrated in Fig. 4, at a space higher than the first frame 46, the center line 51 in the motion range R1 of the orbiting-base plate portion 24 is eccentric from the center line 52 of the first frame 46 and the maximum width Wmax in a radial direction of the non-motion range R2 is thus allowed to be increased and larger than in a case of some compressor. The space in the intermediate vessel 42 is thus effectively usable. For example, in a case in which the inner diameter of the intermediate vessel 42 and the diameter of the motion range R1 of the orbiting-base plate portion 24 are each designed to be the same as in a case of some compressor, the area of the suction port 46a may be increased. In this case, suction pressure loss of refrigerant is more reduced than in a case of some compressor and efficiency of the compressor 100 is thus improved.

[0052] In addition, for example, in a case in which the inner diameter of the intermediate vessel 42 and the area of the suction port 46a are each designed to be the same as in a case of some compressor, at a space higher than the first frame 46, the diameter of the motion range R1 of the orbiting-base plate portion 24 may be increased or the diameter of the orbiting-base plate portion 24 may be increased. In this case, the capacity of the compressor 100 is increased with its size unchanged and efficiency of the compressor 100 is thus improved.

[0053] In addition, in the present disclosure, as long as the fixed scroll 21 is fixed directly to the pressure vessel 40, that is, an outer wall secured to the fixed-base plate portion 23 of the fixed scroll 21 with screws is not provided to the first frame 46, an advantage of this configuration is still offered. As illustrated in Fig. 5, in the eccentric direction in which the center line 51 in the motion range R1 of the orbiting-base plate portion 24 is eccentric, the motion range R1 of the orbiting-base plate portion 24 is allowed to be increased to the vicinity of the inner wall surface of the intermediate vessel 42.

[0054] In addition, as the example illustrated in Fig. 2, the weight portion 28b1 is located at the bushing 28 attached to the boss portion 27 of the orbiting scroll 22 and the weight portion 28b1 is located in a portion of the bushing 28 present in a direction opposite to the eccentric direction, in which the center line 51 in the motion range R1 is eccentric, and vibration produced by eccentricity during orbiting movement is thus reduced.

[0055] Fig. 7 is a horizontal cross-sectional view that schematically illustrates a first modification of the compression mechanism unit 10 in the compressor 100 illustrated in Fig. 1. With reference to Fig. 7, the positional relationship between the fixed scroll wrap 25 and the orbiting scroll wrap 26 in the first modification is described below.

[0056] In the first modification illustrated in Fig. 7, similarly to a case illustrated in Fig. 4, the fixed scroll wrap 25 and the orbiting scroll wrap 26 also have respective target scroll shapes. In the first modification, however, the winding end portion 26e of the orbiting scroll wrap 26 is located at 180 degrees from the winding end portion 25e of the fixed scroll wrap 25. Also in the first modification, the compression-chamber inlets 11a are located at circumferential positions different from the case illustrated in Fig. 4.

[0057] Specifically, in the first modification, the winding end portion 26e of the orbiting scroll wrap 26 is located at a rear portion in the orbiting-base plate portion 24 and the winding end portion 25e of the fixed scroll wrap 25 is located at a front portion in the orbiting-base plate portion 24. The compression-chamber inlets 11a are formed at two respective positions, which are one located frontward at almost 90 degrees and one located rearward at almost 90 degrees from the middle position Lp of the suction port 46a in the circumferential direction. A front one of the compression-chamber inlets 11a opens leftward and a rear one of the compression-chamber inlets 11a opens rightward.

[0058] As in the first modification, the two compression-chamber inlets 11a are equal to each other in distance from the suction port 46a and refrigerant from the suction port 46a is thus equally sucked into the inside of the compression chamber 11 by use of the orbiting scroll wrap 26 and the fixed scroll wrap 25. In this case, efficiency is further improved than in a configuration in which only one of the winding end portions 25e and 26e is located closer to the suction port 46a than is the other one.

[0059] Fig. 8 is a horizontal cross-sectional view that schematically illustrates a second modification of the compression mechanism unit 10 in the compressor 100 illustrated in Fig. 1. In the second modification illustrated in Fig. 8, similarly to a case of the first modification illustrated in Fig. 7, the fixed scroll wrap 25 and the orbiting scroll wrap 26 also have respective target scroll shapes and the winding end portion 26e of the orbiting scroll wrap 26 is located at 180 degrees from the winding end portion 25e of the fixed scroll wrap 25. In the second modification, however, the compression-chamber inlets 11a are located at circumferential positions different from the case of the first modification. Specifically, in the second modification, among the two compression-chamber inlets 11a, one compression-chamber inlet 11a that does not face the suction port 46a, that is, one compression-chamber inlet 11a that faces rightward is located closer to the suction port 46a than is the other compression-chamber inlet 11a, which faces leftward. The fixed scroll wrap 25 and the orbiting scroll wrap 26 are thus located at circumferential positions to which circumferential positions illustrated in Fig. 7 are rotated at an angle θ, which is for example, 30 degrees. In an example illustrated in Fig. 8, the compression-chamber inlets 11a are located at two respective positions, which are one located frontward at almost 120 degrees and one located rearward at almost 60 degrees from the middle position Lp of the suction port 46a illustrated in Fig. 7 in the circumferential direction. One of the compression-chamber inlets 11a that is located rearward and faces rightward is thus smaller in direct distance from the suction port 46a, which is referable to Fig. 7, than the other one of the compression-chamber inlets 11a, which is located frontward and faces leftward.

[0060] The compression-chamber inlet 11a that faces rightward and the compression-chamber inlet 11a that faces leftward are equal to each other in direct distance from the suction port 46a as in the first modification; however, refrigerant actually has to flow around and thus does not easily flows into the compression-chamber inlet 11a that faces rightward. In contrast, as in the second modification, direct distances from the suction port 46a are made different from each other according to respective directions in which the compression-chamber inlets 11a face and, unlike a case of the first modification, refrigerant is thus equally sucked from the two compression-chamber inlets 11a into the compression chamber 11. The angle θ at which the fixed scroll wrap 25 and the orbiting scroll wrap 26 are inclined in the circumferential direction is not limited to the case as described above; however, the angle θ is preferably within a rotation range larger than 0 degrees and smaller than or equal to 30 degrees.

[0061] Fig. 9 is a horizontal cross-sectional view that schematically illustrates a third modification of the compression mechanism unit 10 in the compressor 100 illustrated in Fig. 1. With reference to Fig. 9, the positional relationship between the fixed scroll wrap 25 and the orbiting scroll wrap 26 in the third modification is described below.

[0062] In the third modification illustrated in Fig. 9, the orbiting scroll wrap 26 and the fixed scroll wrap 25 are located such that the compression-chamber inlet 11a is in the vicinity of the suction port 46a and the circumferential position of the winding end portion 26e of the orbiting scroll wrap 26 and the circumferential position of the winding end portion 25e of the fixed scroll wrap 25 are the same. In the third modification, respective winding lengths of which the orbiting scroll wrap 26 and the fixed scroll wrap 25 are wound are specified such that the compression-chamber inlet 11a is located, in the circumferential direction, within an angle range that corresponds to the position of the suction port 46a, which is circular-arc-shaped.

[0063] In an example illustrated in Fig. 9, the winding end portion 26e of the orbiting scroll wrap 26 and the winding end portion 25e of the fixed scroll wrap 25 are each located, in the circumferential direction, at substantially the same as the middle position Lp of the suction port 46a and the compression-chamber inlet 11a is thus designed to open rearward.

[0064] As described above, both the winding end portion 26e of the orbiting scroll wrap 26 and the winding end portion 25e of the fixed scroll wrap 25 are located, in the circumferential direction, at a position at which the suction port 46a is located and the compression-chamber inlet 11a is thus located in the vicinity of the suction port 46a. Refrigerant sucked from the suction port 46a is thus more effectively guided into the compression chamber 11 by use of the orbiting scroll wrap 26 and the fixed scroll wrap 25 and refrigerant supply is then caused to be improved.

[0065] In the third modification, the circumferential position of the compression-chamber inlet 11a is not limited to the same circumferential position of the middle position Lp of the suction port 46a and the circumferential position of the compression-chamber inlet 11a is only required to be located on a side on which the suction port 46a is located in a radial direction. For example, the compression-chamber inlet 11a is located on the left side in a left-right direction. In other words, the compression-chamber inlet 11a, which is formed by the winding end portion 26e of the orbiting scroll wrap 26 and the winding end portion 25e of the fixed scroll wrap 25, is only required to be located within, as an angle position in the circumferential direction, the range between the position located frontward at 90 degrees and the position located rearward at 90 degrees from the middle position Lp of the suction port 46a in the circumferential direction.

[0066] As described above, the scroll compressor according to Embodiment 1 is provided with the compression mechanism unit 10, which compresses refrigerant, the rotation shaft 33, which has the eccentric shaft portion

33a, and the motor unit 30, which drives the compression mechanism unit 10 by use of the rotation shaft 33. The compression mechanism unit 10 has the fixed scroll 21 and the orbiting scroll 22. The scroll compressor is also provided with the pressure vessel 40 in which the compression mechanism unit 10 and the motor unit 30 are housed and a frame, namely the first frame 46, which is fixed to the inside of the pressure vessel 40 and supports the orbiting scroll 22 in the axial direction in which the rotation shaft 33 extends. The orbiting scroll 22 has the orbiting-base plate portion 24, the orbiting scroll wrap 26 located in the first face of the orbiting-base plate portion 24, which faces the fixed scroll 21, and the boss portion 27 located in the second face of the orbiting-base plate portion 24, which is opposite to the first face, and in which the eccentric shaft portion 33a is fitted with each other. The orbiting-base plate portion 24 and the boss portion 27 are located such that the position of the center line 54 of the orbiting-base plate portion 24 differs from the position of the center line 53 of the boss portion 27 when the orbiting-base plate portion 24 and the boss portion 27 are viewed in the axial direction.

[0067] With this configuration, the center of the orbiting-base plate portion 24 and the center of the boss portion 27 are designed to be not present on the same straight line in the vertical direction, which is the direction of the arrows Z. The center line 51 in the motion range R1 of the orbiting-base plate portion 24 is thus eccentric from the center line 52 of the first frame. In the first frame 46, the width of the non-motion range R2 thus reduces and is narrow in the eccentric direction and increases and is wide in a direction opposite to the eccentric direction. Even when a structural element is provided to a portion of the first frame 46 present in the direction opposite to the eccentric direction of the motion range R1 of the orbiting-base plate portion 24, the non-motion range R2 thus still has a blank space that allows the orbiting-base plate portion 24 or the structural element to be increased in size. As a result, limitation on the size of the orbiting scroll 22 and limitation on the size of the structural element in an outer circumference portion of the first frame 46 are reduced and a high-performance scroll compressor is therefore provided.

[0068] In addition, within the non-motion range R2 of the orbiting-base plate portion 24, which is located further outside than the motion range R1, when the first frame 46 is viewed in the axial direction, the suction port 46a through which refrigerant is supplied to the compression mechanism unit 10, is formed in the frame, namely the first frame 46. As in this configuration, the suction port 46a is located in the non-motion range R2, pressure loss caused by the orbiting-base plate portion 24 is thus prevented, and refrigerant is allowed to be supplied to the compression chamber 11.

[0069] In addition, the suction port 46a is formed in a portion of the frame, namely the first frame 46, that is present in the direction opposite to the eccentric direction of the center line 51 in the motion range R1 of the orbiting-base plate portion 24 when the suction port 46a is viewed in the axial direction. With this configuration, the suction port 46a is thus increasable in size and the amount of refrigerant supplied to the compression chamber 11 is also increasable.

[0070] In addition, the fixed scroll 21 has the fixed-base plate portion 23 and the fixed scroll wrap 25 located in a face of the fixed-base plate portion 23 that faces the orbiting scroll 22. The two compression-chamber inlets 11a defined by the orbiting scroll wrap 26 and the fixed scroll wrap 25 are equal to each other in direct distance from the suction port 46a when the compression-chamber inlets 11a are viewed in the axial direction.

[0071] With this configuration, refrigerant from the suction port 46a is equally sucked into the inside of the compression chamber 11 by use of the orbiting scroll wrap 26 and the fixed scroll wrap 25. In this case, efficiency is further improved than in a configuration in which only one of the winding end portions 25e and 26e is located closer to the suction port 46a than is the other one.

[0072] In addition, the fixed scroll 21 has the fixed-base plate portion 23 and the fixed scroll wrap 25 located in a face of the fixed-base plate portion 23 that faces the orbiting scroll 22. When the two compression-chamber inlets 11a are viewed in the axial direction, among the two compression-chamber inlets 11a defined by the orbiting scroll wrap 26 and the fixed scroll wrap 25, one inlet faces toward the suction port 46a and the other inlet faces toward the other side of the suction port 46a and the direct distance between the other inlet and the suction port 46a is shorter than the direct distance between the one inlet and the suction port 46a. With this configuration, irrespective of respective directions in which the compression-chamber inlets 11a face, refrigerant is allowed to be equally sucked into the inside of the compression chamber 11 by use of the orbiting scroll wrap 26 and the fixed scroll wrap 25.

[0073] In addition, the fixed scroll 21 has the fixed-base plate portion 23 and the fixed scroll wrap 25 located in a face of the fixed-base plate portion 23 that faces the orbiting scroll 22. One of the orbiting scroll wrap 26 and the fixed scroll wrap 25 is designed longer than the other one such that the respective circumferential positions of the winding end portion 25e and 26e are at the same. In the example illustrated in Fig. 9, the orbiting scroll wrap 26 is longer than the fixed scroll wrap 25. The compression-chamber inlet 11a defined by the orbiting scroll wrap 26 and the fixed scroll wrap 25 is located on a side on which the suction port 46a is located in a radial direction. With this configuration, the compression-chamber inlet 11a is allowed to be located in the vicinity of the suction port 46a, refrigerant sucked from the suction port 46a is thus more effectively guided into the compression chamber 11 by use of the orbiting scroll wrap 26 and the fixed scroll wrap 25, and refrigerant supply is then caused to be improved.

[0074] In addition, the fixed scroll 21 is fixed directly to the pressure vessel 40 without the frame, namely the first frame 46, in between. With this configuration, the first frame 46 is only required to be located lower than the orbiting-base plate portion 24 and a space between the outer circumference portion of the orbiting scroll 22 and the inner wall surface of the intermediate vessel 42 is increased and larger than in a case in which the first frame 46 is provided with an outer wall. In comparison with a case in which the outer wall is thus located, the orbiting scroll 22 is thus no longer limited in size and the outer diameter of the orbiting-base plate portion 24 and the winding diameter of the orbiting scroll wrap 26 are allowed to be increased. In addition, such an increased scroll effectively ensures performance with low GWP refrigerant, which is low-density refrigerant.

Embodiment 2

[0075] Fig. 10 is a partial cross-sectional view that schematically illustrates a configuration of a compressor according to Embodiment 2. Fig. 11 is a horizontal cross-sectional view that schematically illustrates the positional relationship between the orbiting scroll 22 and the first frame 46 when the orbiting scroll 22 moves rightward in the compressor 100 according to Embodiment 2. Fig. 12 is a vertical cross-sectional view that schematically illustrates the positional relationship between the orbiting scroll 22, the first frame 46, and the rotation shaft 33 when the orbiting scroll 22 moves leftward in the compressor 100 illustrated in Fig. 11.

[0076] As illustrated in Fig. 10, Embodiment 2 differs from Embodiment 1 in that a structural element that limits the diameter of the orbiting-base plate portion 24 or the size of the motion range R1 of the orbiting-base plate portion 24, which is referable to Fig. 11, is a concave portion provided to the first frame 46. In an example illustrated in Fig. 11, at both sides of the concave portion in the first frame 46 in the circumferential direction, respective suction ports 46a are provided. These concave portion and two suction ports 46a are structural elements that limit the diameter or other dimensions of the orbiting-base plate portion 24. Parts described in Embodiment 2 that are the same as parts described in Embodiment 1 have the same reference signs. Points in Embodiment 2 that differ from Embodiment 1 are mainly described below.

[0077] In Embodiment 2, as illustrated in Fig. 10, in the upper face of the outer circumference portion of the first frame 46, a concave portion 46a1 is formed, which is used to locate the phase of the first frame 46 when the fixed-base plate portion 23 of the fixed scroll 21 is assembled with the first frame 46. In the example illustrated in Fig. 11, when the concave portion 46a1 in the first frame 46 is viewed in the axial direction, the concave portion 46a1 is circular-shaped and located on a left portion of the first frame 46, that is between the two suction ports 46a. In addition, as illustrated in Fig. 10, in the lower face of the fixed-base plate portion 23, a hole 23a is provided at a position that faces the concave portion 46a1 in the first frame 46 when the fixed-base plate portion 23 is viewed in the axial direction. The hole 23a in the fixed-base plate portion 23 is shaped the same as the concave portion 46a1 in the first frame 46 when hole 23a and the concave portion 46a1 are viewed in the axial direction.

[0078] The hole 23a in the fixed-base plate portion 23 may also be a through hole as illustrated in Fig. 10 and alternatively may also be a concave portion that is recessed upward from the lower face of the fixed-base plate portion 23. In addition, in the lower face of the fixed-base plate portion 23, a protrusion portion may also be provided at a position that faces the concave portion 46a1 in the first frame 46 when the fixed-base plate portion 23 is viewed in the axial direction and the hole 23a may then also be located at the lower face of the protrusion portion. In addition, the positions of the concave portion 46a1 and the suction ports 46a in the first frame 46 are not limited to the positions described above. These plurality of structural elements are, however, preferably concentrated in one range, such as the left half, of the outer circumference portion of the first frame 46.

[0079] In a production process of the compressor 100, a phase positioner 6 is used to locate phases such that the first frame 46 and the fixed-base plate portion 23 face each other at predetermined phases in the intermediate vessel 42. The phase positioner 6 is, for example, a round-columnar-shaped pin. Phases are to be located in assembly, the uppermost end of the phase positioner 6 is inserted in the hole 23a in the fixed-base plate portion 23 and the lowermost end of the phase positioner 6 is inserted in the concave portion 46a1 in the first frame 46. After phases are located in assembly, the phase positioner 6 is drawn out. The configuration may also be designed such that the phase positioner 6 is not to be drawn out after assembly. In a case in which the phase positioner 6 is designed to be drawn out, an unillustrated sealing component that prevents refrigerant from flowing through the hole 23a in the fixed-base plate portion 23 is preferably provided to the hole 23a. As the sealing component, the phase positioner 6 may be drawn out from the concave portion 46a1 and left in the hole 23a.

[0080] As illustrated in Fig. 12, also in Embodiment 2, similarly to a case of Embodiment 1, the position of the center line 54 in the orbiting-base plate portion 24 is eccentric from the position of the center line 53 in the boss portion 27 when the orbiting-base plate portion 24 and the boss portion 27 are viewed in the axial direction. As illustrated in Fig. 11, the center line 51 in the motion range R1 of the orbiting-base plate portion 24 is thus eccentric from the center line 52 of the first frame 46.

[0081] As illustrated in Fig. 11, the concave portion 46a1 in the first frame 46 is located in the non-motion range R2 of the orbiting-base plate portion 24 when the concave portion 46a1 is viewed in the axial direction. As illustrated in Fig. 12, while the compressor 100 is driving and even when the orbiting-base plate portion 24 moves closest to the concave portion 46a1 in the first frame 46, the concave portion 46a1 is thus not covered by the orbiting-base plate portion 24.

[0082] As described above, also in the compressor 100 in Embodiment 2, similarly to a case of Embodiment 1, the center line 54 in the orbiting-base plate portion 24 of the orbiting scroll 22 differs from the center line 53 in the boss portion 27 of the orbiting scroll 22 when the orbiting scroll 22 is viewed in the axial direction. The maximum width Wmax, which is referable to Fig. 4, of the non-motion range R2 of the orbiting-base plate portion 24 in the present disclosure thus increases and is larger than in a case of some compressor and a blank space thus provided allows the orbiting-base plate portion 24 or a structural element such as the concave portion 46a1 to be increased in size. As a result, the compressor 100 according to Embodiment 2 also obtains the same advantageous effects in a case of Embodiment 1.

[0083] In addition, in the compressor 100 according to Embodiment 2, the concave portion 46a1 is formed in the counter face of the frame, namely the first frame 46, which faces the second face, which is the lower face of the orbiting-base plate portion 24, and is located in the non-motion range R2 located further outside than the motion range R1 of the orbiting-base plate portion 24 when the first frame 46 is viewed in the axial direction. The concave portion 46a1 thus located in the non-motion range R2 facilitates positioning of the first frame 46 at an intended phase in the pressure vessel 40.

[0084] In addition, in the example illustrated in Fig. 11, the suction port 46a is separated into two positions and a shrink-fitted portion is left and, in comparison with a case, as in Embodiment 1, in which the suction port 46a is located at one position with a wide range, a position at which a fixed scroll is shrink-fitted and fixed is thus ensured and holding force with shrink fit is ensured.

[0085] Also in Embodiment 2, the fixed scroll wrap 25 and the orbiting scroll wrap 26 may also be located as in the first modification to the third modification of Embodiment 1.

Embodiment 3

[0086] Fig. 13 is a horizontal cross-sectional view that schematically illustrates the positional relationship between the orbiting scroll 22 and the first frame 46 when the orbiting scroll 22 moves rightward in the compressor 100 according to Embodiment 3. Fig. 14 is a vertical cross-sectional view that schematically illustrates the positional relationship between the orbiting scroll 22, the first frame 46, and the rotation shaft 33 when the orbiting scroll 22 moves leftward in the compressor 100 illustrated in Fig. 13. Open arrows illustrated in Fig. 13 and Fig. 14 each represent flow of refrigerant.

[0087] As illustrated in Fig. 13 and Fig. 14, Embodiment 3 differs from Embodiment 1 in that a structural element that limits the diameter of the orbiting-base plate portion 24 or the size of the motion range R1 of the orbiting-base plate portion 24 is the convex portion located at the first frame 46. Parts described in Embodiment 3 that are the same as parts described in Embodiment 1 have the same reference signs. Points in Embodiment 3 that differ from Embodiment 1 are mainly described below.

[0088] As illustrated in Fig. 14, in Embodiment 3, the suction port 46a according Embodiment 1, which is referable to Fig. 5, is not provided to the orbiting-base plate portion 24 and the suction pipe 44 is located between the first frame 46 and the fixed scroll 21 in the height direction, which is the direction of the arrows Z, of the intermediate vessel 42. That is, in Embodiment 3, refrigerant from the suction pipe 44 is supplied directly to a refrigerant-suction space Si without flowing through the motor space Sm. In addition, in Embodiment 3, the discharge pipe 45 is located in the motor space Sm, which is lower than the first frame 46 in the height direction, which is the direction of the arrows Z, of the intermediate vessel 42. That is, in Embodiment 3, among a space in the pressure vessel 40, a space located higher than the fixed scroll 21 is a high-pressure space that has no opening and the motor space Sm located lower than the first frame 46 serves as a discharge space.

[0089] As illustrated in Fig. 13, in Embodiment 3, a portion of the outer circumference portion of the first frame 46 in the circumferential direction is cut out. As illustrated in Fig. 14, at an edge portion of such a notch portion 46c thus cut out in the first frame 46, a partition wall 46a2 is provided and extends upward and toward the fixed-base plate portion 23, which is referable to Fig. 1. As illustrated in Fig. 13, when the partition wall 46a2 is viewed in the axial direction, both side edge portions of the partition wall 46a2 are connected to the inner wall surface of the intermediate vessel 42 and a communication passage 7 is formed by being surrounded by the partition wall 46a2 and the inner wall surface of the intermediate vessel 42. As illustrated in Fig. 14, the communication passage 7 allows an unillustrated high-pressure space located higher than the communication passage 7 and the motor space Sm located lower than the communication passage 7 to communicate with each other.

[0090] Although no illustration is provided, an opening portion is formed in the fixed-base plate portion 23, which is referable to Fig. 1, at a position that faces the notch portion 46c in the first frame 46 in the axial direction, the opening portion thus formed serves as a refrigerant inlet of the communication passage 7, and the notch portion 46c in the first frame 46 serves as a refrigerant outlet of the communication passage 7. High-pressure refrigerant that is discharged from the compression mechanism unit 10 and fills the high-pressure space flows through the communication passage 7, moves into the motor space Sm, and is discharged to the outside of the compressor, such as a condenser, through the discharge pipe 45.

[0091] As illustrated in Fig. 14, also in Embodiment 3, similarly to a case of Embodiment 1, the position of the center line 54 in the orbiting-base plate portion 24 is eccentric from the position of the center line 53 in the boss portion 27 when the orbiting-base plate portion 24 and the boss portion 27 are viewed in the axial direction. As illustrated in Fig. 13, the center line 51 in the motion range R1 of the orbiting-base plate portion 24 is thus eccentric from the center line 52 of the first frame 46.

[0092] As illustrated in Fig. 13, the partition wall 46a2 of the first frame 46 is located in the non-motion range R2 of the orbiting-base plate portion 24 when the partition wall 46a2 is viewed in the axial direction. As illustrated in Fig. 14, while the compressor 100 is driving and even when the orbiting-base plate portion 24 moves closest to the partition wall 46a2, the orbiting-base plate portion 24 thus does not interfere with the partition wall 46a2.

[0093] As described above, also in the compressor 100 in Embodiment 3, similarly to a case of Embodiment 1, the center line 54 in the orbiting-base plate portion 24 of the orbiting scroll 22 differs from the center line 53 in the boss portion 27 of the orbiting scroll 22. The maximum width Wmax of the non-motion range R2 of the orbiting-base plate portion 24 in the present disclosure thus increases and is larger than in a case of some compressor and a blank space thus provided allows the orbiting-base plate portion 24 or the communication passage 7 to be increased in size. As a result, the compressor 100 according to Embodiment 3 also obtains the same advantageous effects in a case of Embodiment 1.

[0094] In addition, in the compressor 100 according to Embodiment 3, the convex portion, which is the partition wall 46a2, is formed in the counter face of the frame, namely the first frame 46, which faces the second face, which is the lower face of the orbiting-base plate portion 24, and is located in the non-motion range R2 located further outside than the motion range R1 of the orbiting-base plate portion 24 when the first frame 46 is viewed in the axial direction.

[0095] With this configuration, in a case in which the communication passage 7 is located, the communication passage 7 and the refrigerant-suction space Si are separated from each other by the partition wall 46a2 and airtightness is thus ensured. As a result, high-pressure refrigerant that fills the communication passage 7 is prevented from leaking into the refrigerant-suction space Si, loss of power input is thus prevented, and performance is to be improved.

[0096] Also in Embodiment 3, the fixed scroll wrap 25 and the orbiting scroll wrap 26 may also be located as in the first modification to the third modification of Embodiment 1. In Embodiment 3, however, the position of the compression-chamber inlet 11a is preferably specified according to the positional relationship with the suction pipe 44. The suction pipe 44 is located on the right side illustrated in Fig. 13 and the compression-chamber inlets 11a are thus to be located the same as in a case of Fig. 7 or the compression-chamber inlet 11a is thus to be located at a position opposite to a case of Fig. 9. In addition, in a case in which the suction pipe 44 is located lower than the first frame 46, the fixed scroll wrap 25 and the orbiting scroll wrap 26 are designed to be located at their phases rotated according to such a lower position of the suction pipe 44.

[0097] Embodiments may also be combined with each other and part of an embodiment may also be modified or omitted as long as a resultant embodiment is suited. For example, also in Embodiment 1, similarly to a case of Embodiment 2, the suction port 46a is separated into two positions.

Reference Signs List

[0098] 3: discharge port, 4: chamber, 4a: concave-shaped portion, 4b: chamber discharge port, 5: discharge-valve mechanism, 5a: discharge valve, 5b: valve presser, 5c: fixture, 6: phase positioner, 7: communication passage, 10: compression mechanism unit, 11: compression chamber, 11a: compression-chamber inlet, 20: discharge-valve mechanism, 21: fixed scroll, 22: orbiting scroll, 23: fixed-base plate portion, 23a: hole, 24: orbiting-base plate portion, 24a: first Oldham groove, 25: fixed scroll wrap, 25e: winding end portion, 26: orbiting scroll wrap, 26e: winding end portion, 27: boss portion, 28: bushing, 28a: slider, 28b: balance weight, 28b1: weight portion, 29: Oldham ring, 29b: top protrusion, 29r: ring portion, 30: motor unit, 31: stator, 32: rotor, 33: rotation shaft, 33a: eccentric shaft portion, 33b: main shaft portion, 33c: oil passage, 40: pressure vessel, 41: upper vessel, 42: intermediate vessel, 43: lower vessel, 44: suction pipe, 45: discharge pipe, 46: first frame, 46a: suction port, 46a1: concave portion, 46a2: partition wall, 46b: shaft bearing portion, 46c: notch portion, 46f: boss housing portion, 46o: Oldham housing portion, 46o1: second Oldham groove, 46s: thrust plate, 47: second frame, 48: ball bearing, 50: boundary, 51: center line, 52: center line, 53: center line, 54: center line, 100: compressor, Ax1: center line, Ax2: center line, R1: motion range, R2: non-motion range, Si: refrigerant-suction space, Sm: motor space, So: discharge space, Lp: middle position, Wmax: maximum width

Claims

1. A scroll compressor comprising:

> a compression mechanism unit that has a fixed scroll and an orbiting scroll and is configured to compress refrigerant;
> a rotation shaft that has an eccentric portion;
> a motor unit configured to drive the compression mechanism unit by use of the rotation shaft;
> a pressure vessel in which the compression mechanism unit and the motor unit are housed; and
> a frame that is fixed to an inside of the pressure vessel and supports the orbiting scroll in an axial

direction in which the rotation shaft extends,
the orbiting scroll having
an orbiting-base plate portion,
an orbiting scroll wrap provided in a first face of the orbiting-base plate portion that faces the fixed scroll, and
a boss portion provided in a second face of the orbiting-base plate portion that is opposite to the first face and in which the eccentric portion is fitted with each other,
the orbiting-base plate portion and the boss portion being located such that a position of a center of the orbiting-base plate portion differs from a position of a center of the boss portion when the orbiting-base plate portion and the boss portion are viewed in the axial direction.

2. The scroll compressor of claim 1, wherein a suction port through which refrigerant is supplied to the compression mechanism unit is formed in the frame and within a non-motion range located further outside than a motion range of the orbiting-base plate portion when the frame is viewed in the axial direction.

3. The scroll compressor of claim 1, wherein a concave portion is formed in a counter face of the frame that faces the second face of the orbiting-base plate portion and is located in a non-motion range located further outside than a motion range of the orbiting-base plate portion when the frame is viewed in the axial direction.

4. The scroll compressor of claim 1, wherein a convex portion is formed in a counter face of the frame that faces the second face of the orbiting-base plate portion and is located in a non-motion range located further outside than a motion range of the orbiting-base plate portion when the frame is viewed in the axial direction.

5. The scroll compressor of claim 2, wherein the suction port is formed in a portion of the frame present in a direction opposite to an eccentric direction of a center of a motion range of the orbiting-base plate portion when the frame is viewed in the axial direction.

6. The scroll compressor of claim 2 or 5, wherein

the fixed scroll has a fixed-base plate portion and a fixed scroll wrap provided to a face of the fixed-base plate portion that faces the orbiting scroll, and
two compression-chamber inlets defined by the orbiting scroll wrap and the fixed scroll wrap are equal to each other in direct distance from the suction port when the two compression-chamber inlets are viewed in the axial direction.

7. The scroll compressor of claim 2 or 5, wherein

the fixed scroll has a fixed-base plate portion and a fixed scroll wrap provided to a face of the fixed-base plate portion that faces the orbiting scroll, and
among two compression-chamber inlets defined by the orbiting scroll wrap and the fixed scroll wrap, one inlet faces toward the suction port and the other inlet faces toward the other side of the suction port, and a direct distance between the other inlet and the suction port is shorter than a direct distance between the one inlet and the suction port when the two compression-chamber inlets are viewed in the axial direction.

8. The scroll compressor of claim 2 or 5, wherein

the fixed scroll has a fixed-base plate portion and a fixed scroll wrap provided to a face of the fixed-base plate portion that faces the orbiting scroll,
one of the orbiting scroll wrap and the fixed scroll wrap is longer than the other one such that respective circumferential positions of winding end portions are at the same, and
a compression-chamber inlet defined by the orbiting scroll wrap and the fixed scroll wrap is provided on a side on which the suction port is located in a radial direction.

9. The scroll compressor of any one of claims 1 to 8, wherein the fixed scroll is fixed directly to the pressure vessel without the frame in between.

FIG. 1

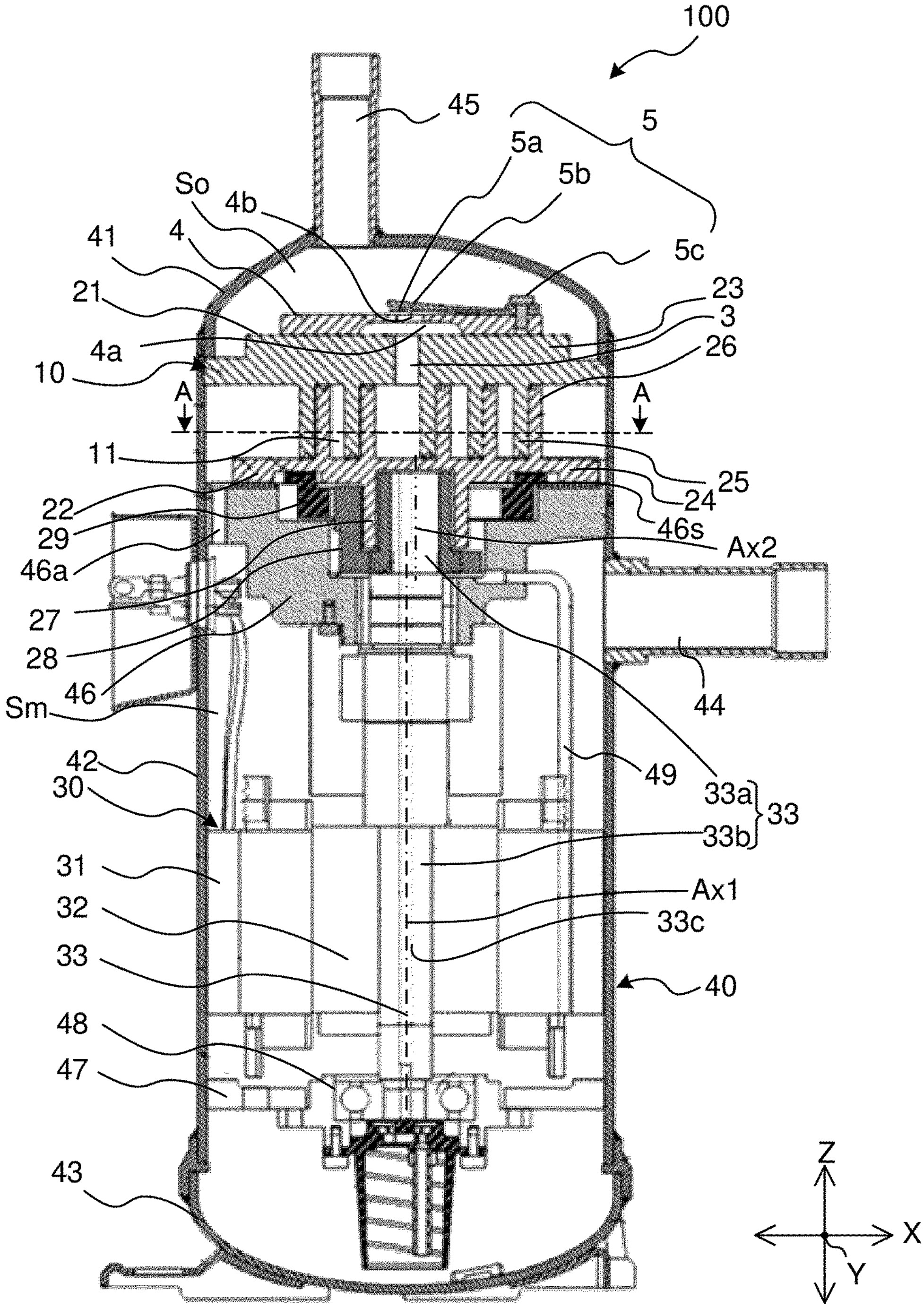

100
45
5
5a
5b
So
4b
41
4
5c
21
23
3
4a
26
10
A
A
11
25
24
22
29
46s
46a
Ax2
27
44
28
46
Sm
42
49
30
33a
33
33b
31
Ax1
32
33c
33
40
48
47
43
Z
X
Y

FIG. 2

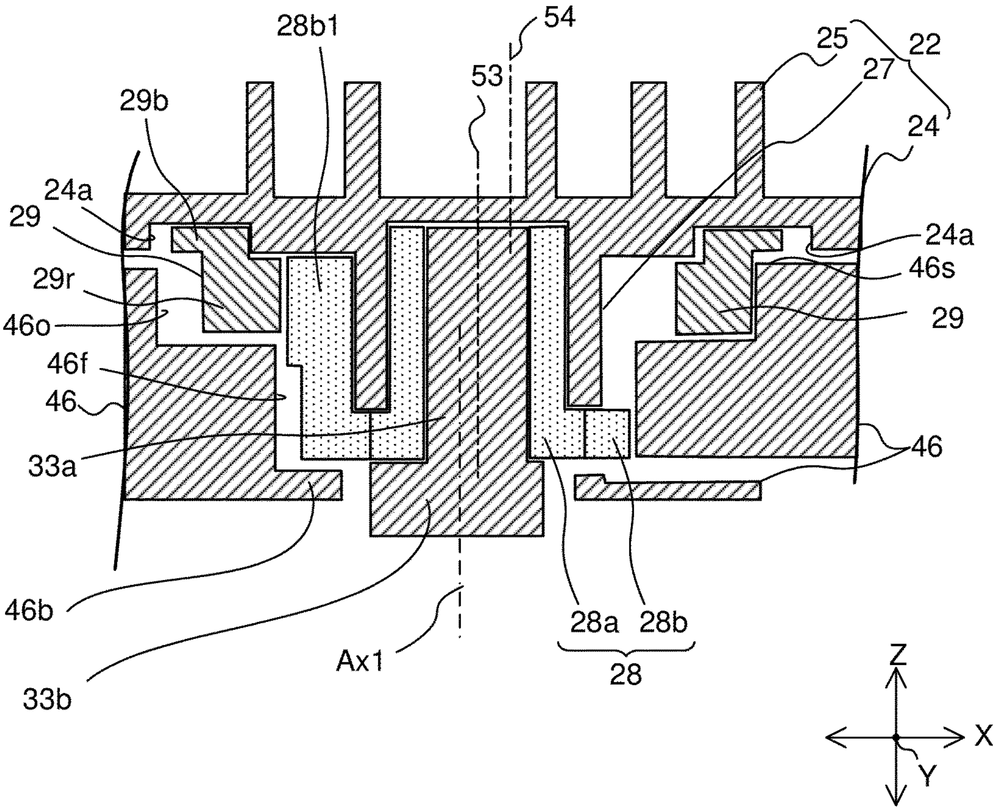

28b1
54
53
25
22
27
24
29b
24a
29
24a
29r
46s
29
46o
46f
46
46
33a
46b
33b
Ax1
28a
28b
28
Z
X
Y

FIG. 3

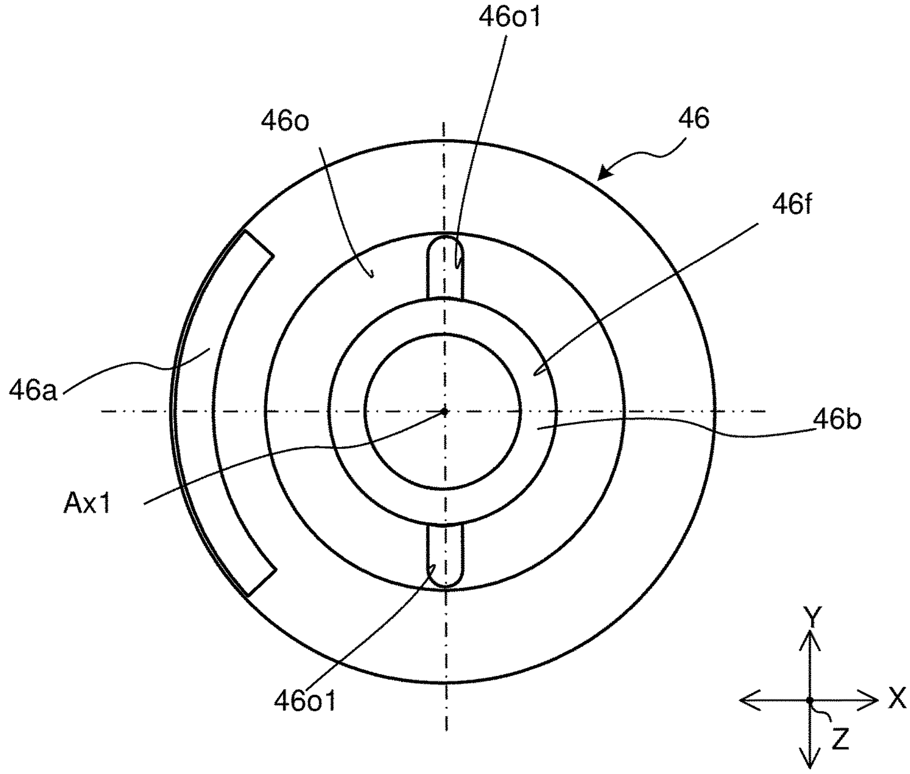

46o1
46o
46
46f
46a
46b
Ax1
46o1
Y
X
Z

FIG. 4

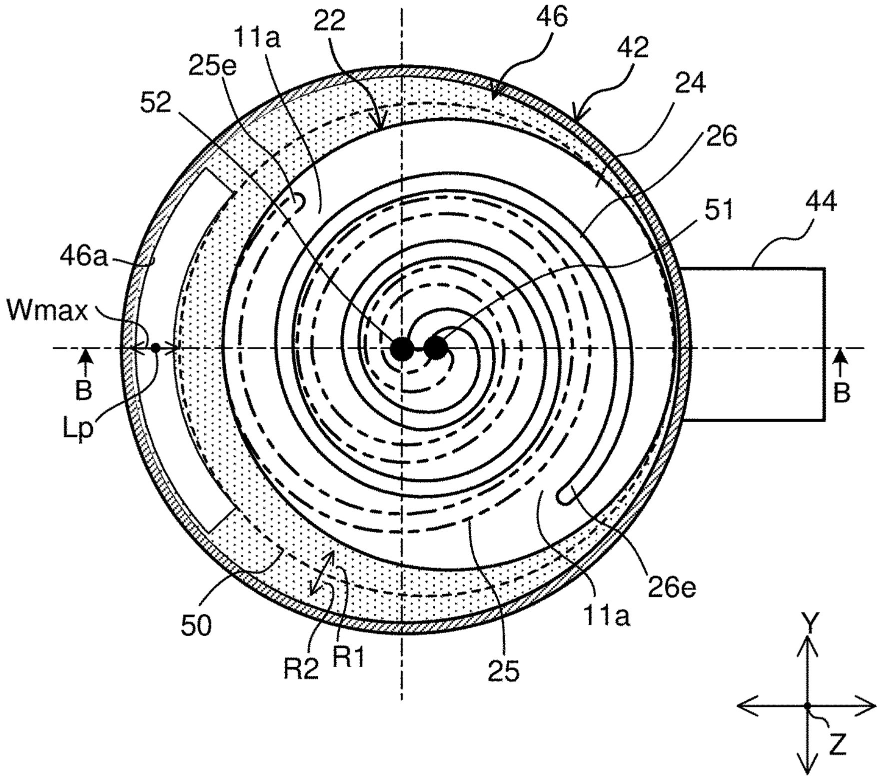

22
11a
46
42
25e
24
52
26
51
44
46a
Wmax
B
B
Lp
50
11a
26e
R2
R1
25
Y
X
Z

FIG. 5

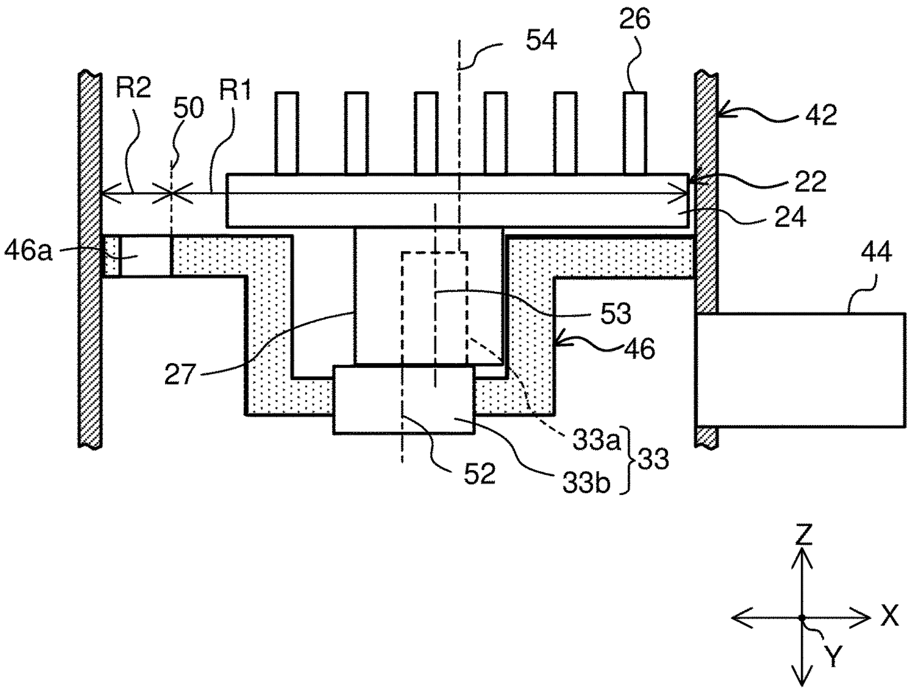

26
54
R2
50
R1
42
22
24
46a
44
53
46
27
33a
33
52
33b
Z
X
Y

FIG. 6

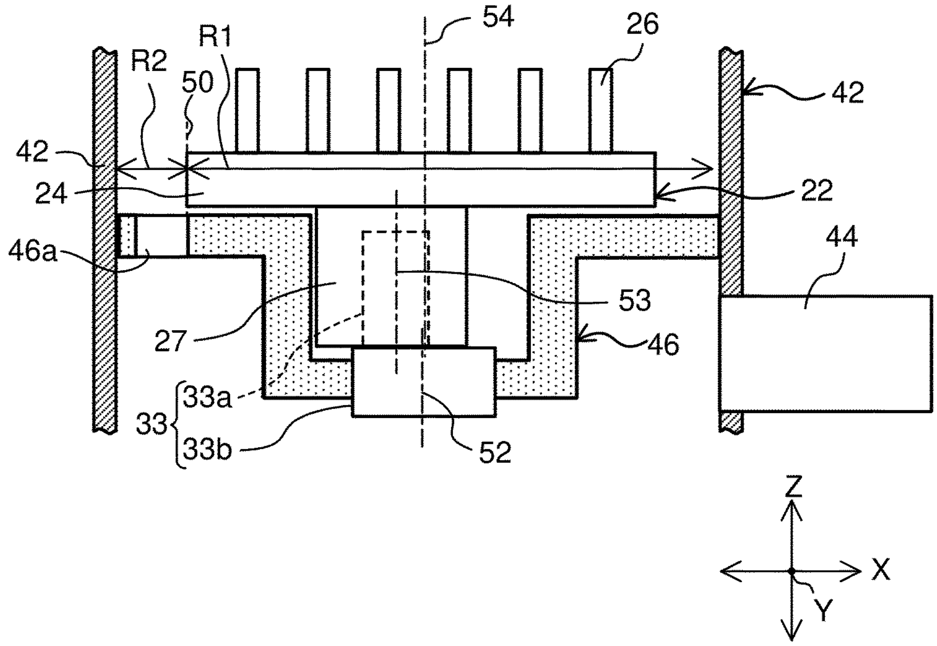

54
26
R1
R2
50
42
42
24
22
44
46a
53
27
46
33a
33
33b
52
Z
X
Y

FIG. 7

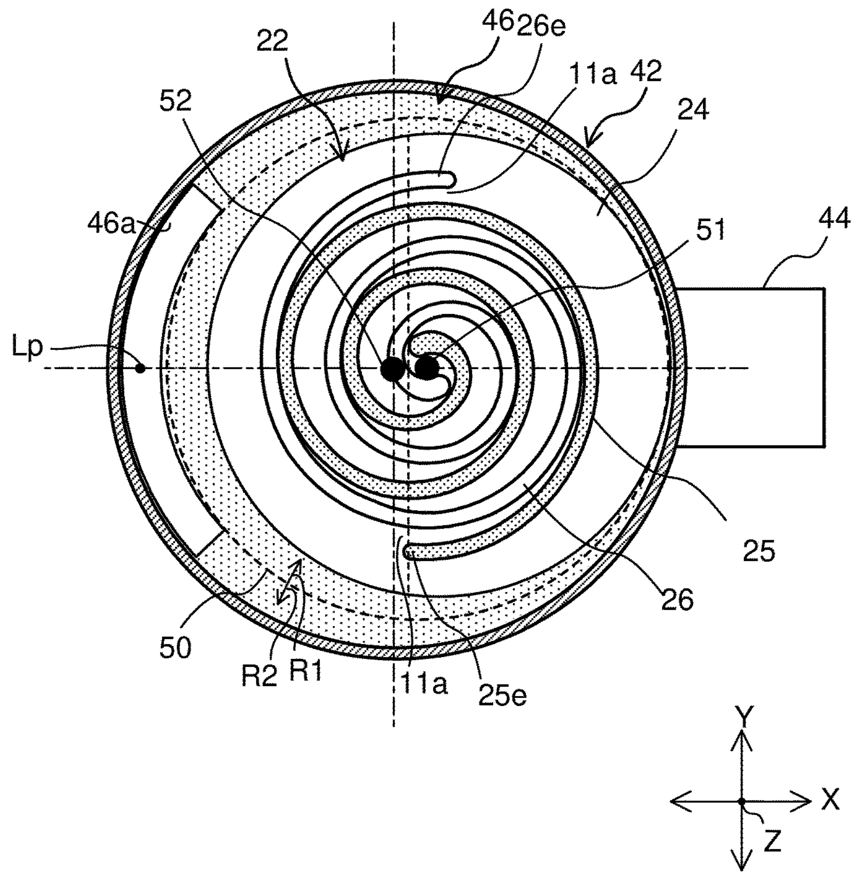

46
26e
22
11a
42
52
24
46a
51
44
Lp
25
26
50
R2
R1
11a
25e
Y
X
Z

FIG. 8

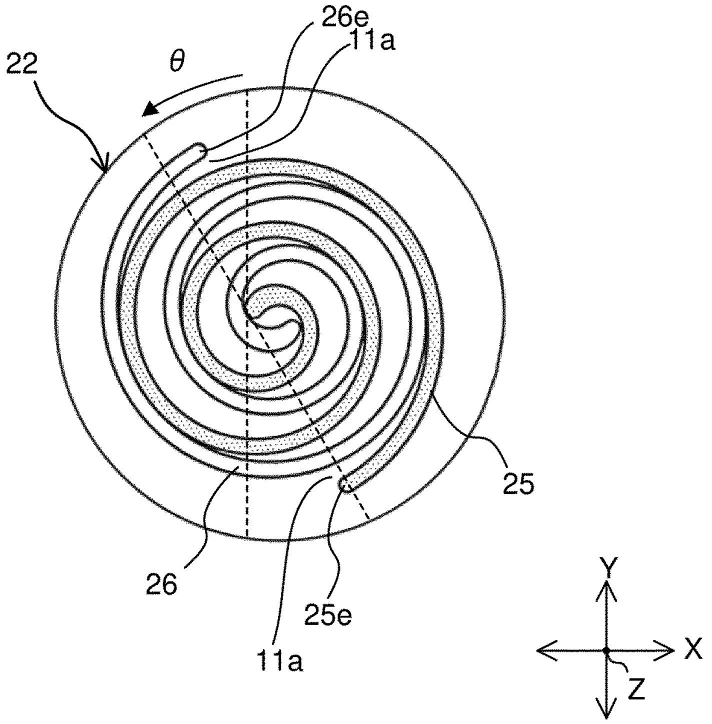

26e
11a
22
θ
25
26
25e
11a
Y
X
Z

FIG. 9

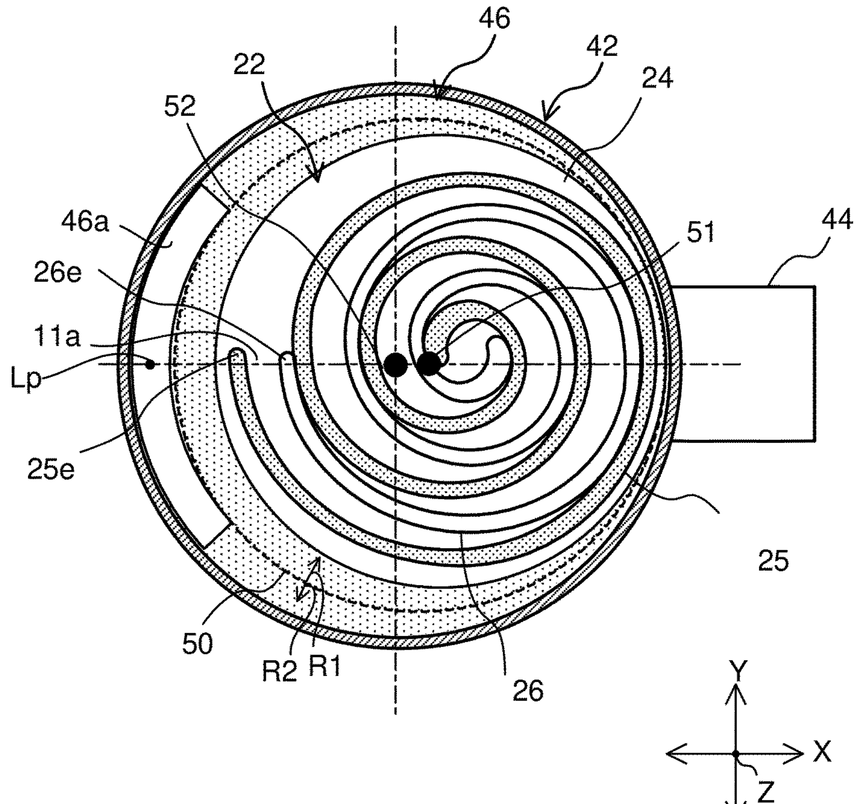

46
42
22
24
52
46a
51
44
26e
11a
Lp
25e
25
50
R2
R1
26
Y
X
Z

FIG. 10

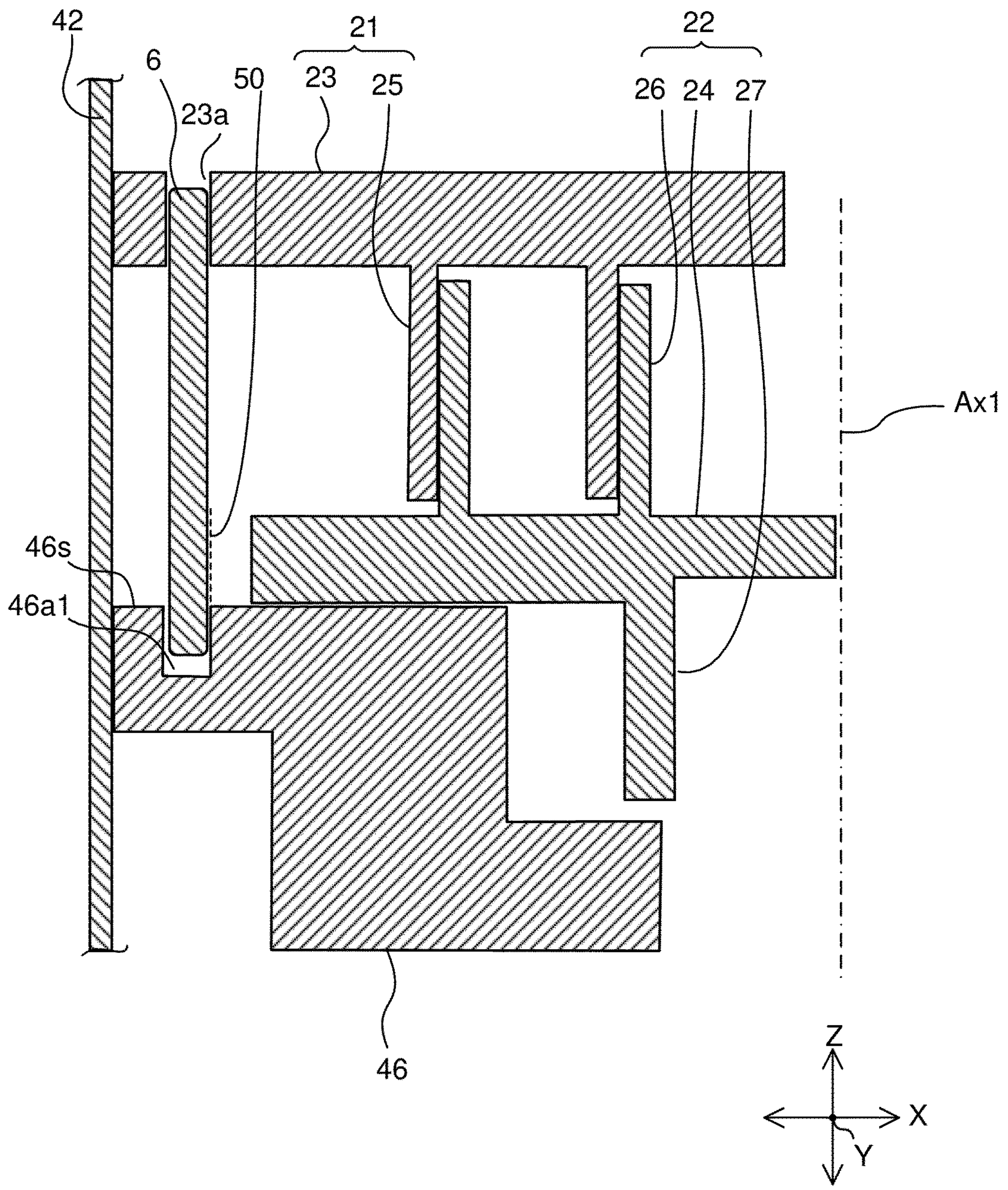


FIG. 11

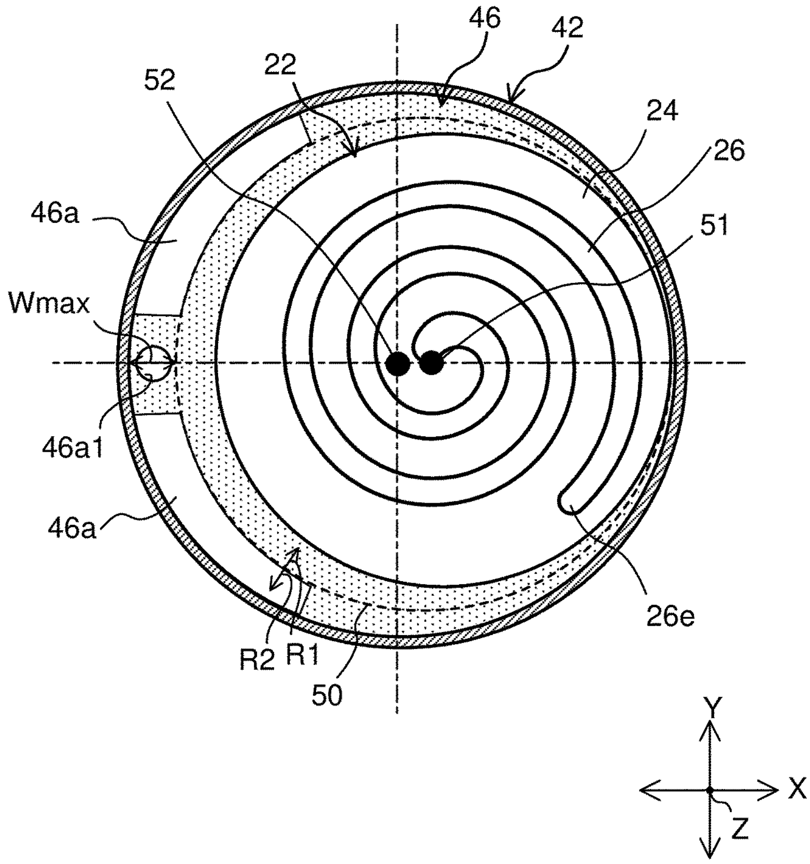

46
42
52
22
24
26
46a
51
Wmax
46a1
46a
26e
R2
R1
50
Y
X
Z

FIG. 12

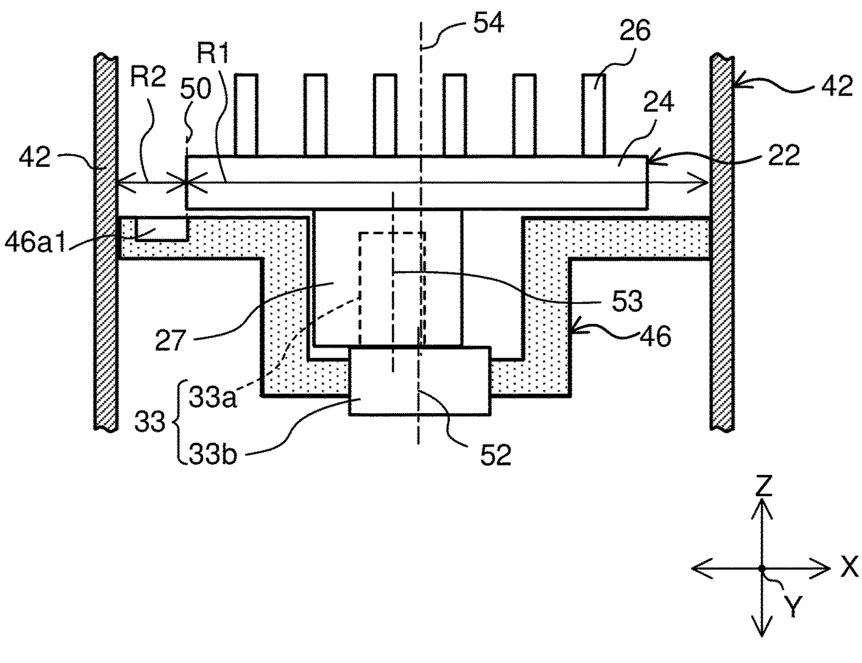

54
26
R1
42
R2
50
24
42
22
46a1
53
27
46
33a
33
33b
52
Z
X
Y

FIG. 13

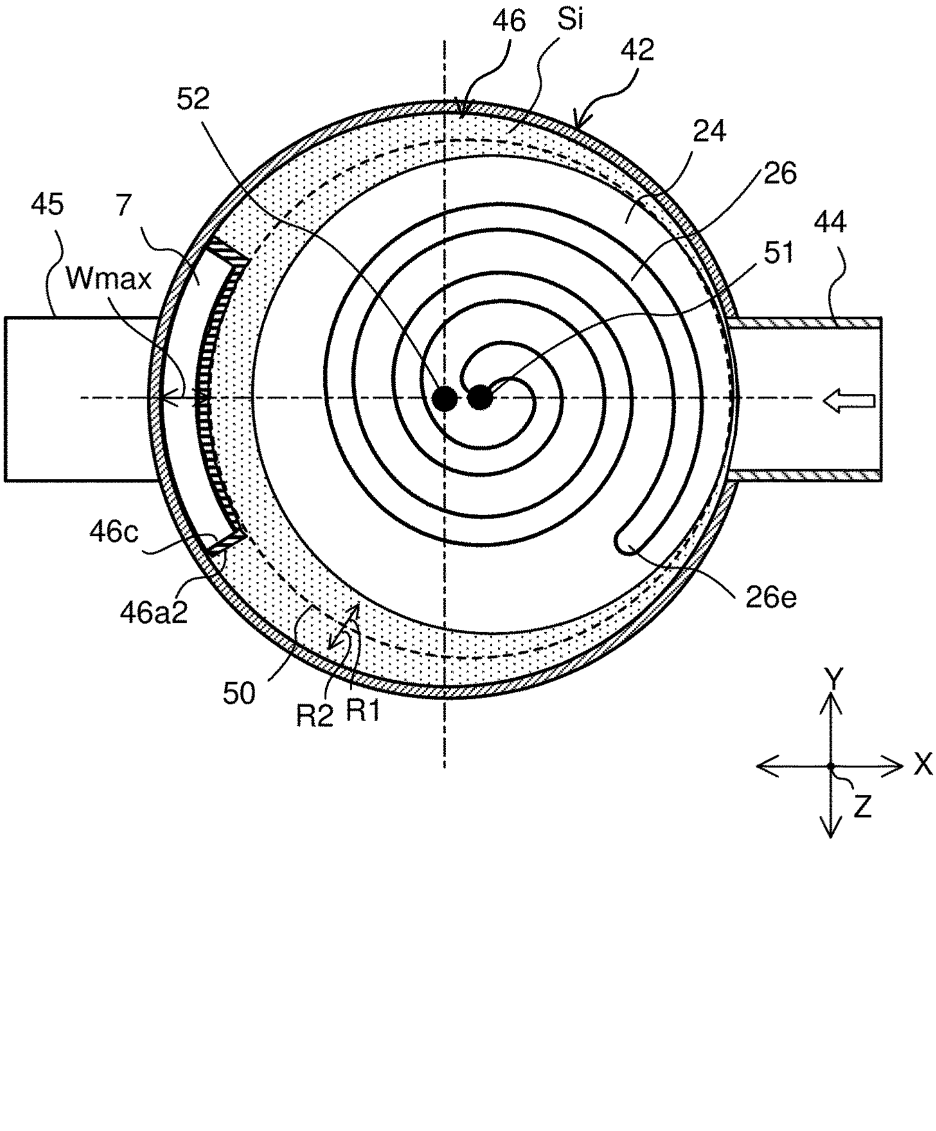
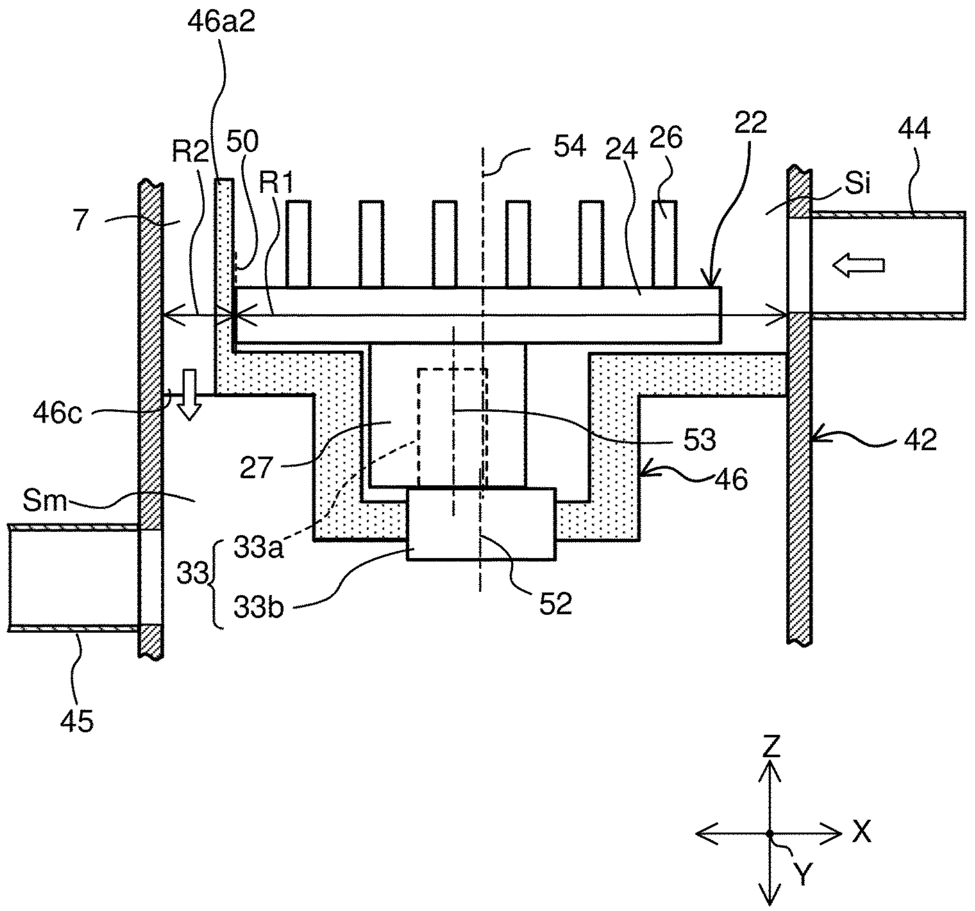


FIG. 14



46a2
R2
50
R1
54
24
26
22
44
Si
7
46c
53
42
27
46
Sm
33a
33
33b
52
45
Z
X
Y

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2021/044652

A. CLASSIFICATION OF SUBJECT MATTER

F04C 18/02(2006.01)i
FI: F04C18/02 311Q

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)

F04C18/02

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

Published examined utility model applications of Japan 1922-1996
Published unexamined utility model applications of Japan 1971-2022
Registered utility model specifications of Japan 1996-2022
Published registered utility model applications of Japan 1994-2022

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 60-19979 A (HITACHI LTD) 01 February 1985 (1985-02-01) p. 2, upper left column, line 13 to p. 4, upper left column, line 20, fig. 1-9	1
Y		9
A		2-8
Y	JP 6678762 B2 (MITSUBISHI ELECTRIC CORP) 08 April 2020 (2020-04-08) paragraphs [0013], [0026], fig. 1-4	9
A		2, 5-8
A	JP 58-172404 A (HITACHI LTD) 11 October 1983 (1983-10-11) fig. 9	1-9
A	JP 2003-239876 A (LG ELECTRONICS INC) 27 August 2003 (2003-08-27)	1-9

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
18 January 2022	**01 February 2022**

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

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/JP2021/044652

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
JP 60-19979 A	01 February 1985	(Family: none)	
JP 6678762 B2	08 April 2020	US 2020/0025200 A1 paragraphs [0028], [0041], fig. 1-4 GB 2569914 A WO 2018/078787 A1 CN 109863307 A	
JP 58-172404 A	11 October 1983	US 4494914 A fig. 10 DE 3312280 A1 KR 10-1988-0000832 B1	
JP 2003-239876 A	27 August 2003	US 2003/0152472 A1 KR 10-2003-0067997 A CN 1436933 A	

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 6678762 B **[0003]**