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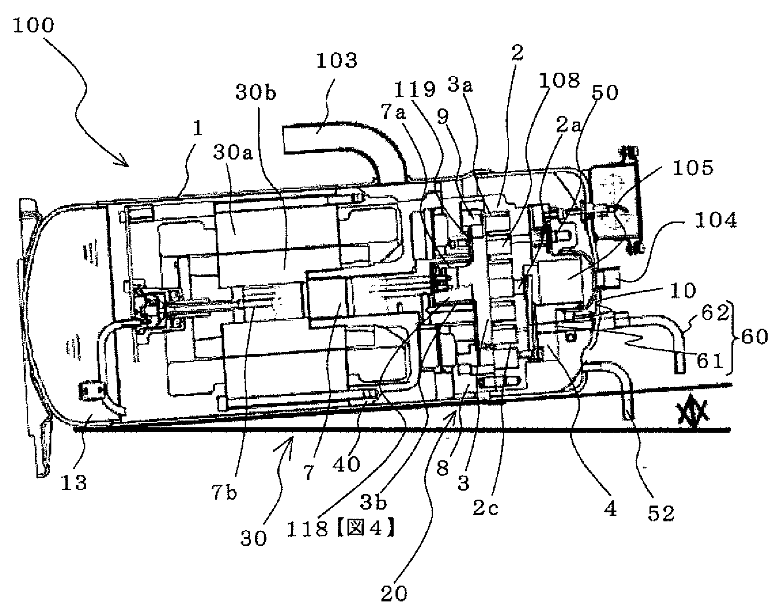
(54) **HORIZONTAL SCROLL COMPRESSOR**

(57) A compressor 100 includes a hermetic vessel 1 formed with an oil reservoir 13; a fixed scroll 2 configured to constitute a portion of a fluid compression mechanism 20, the fixed scroll 2 being arranged in the hermetic vessel 1; a reed valve 10 configured to open and close a discharge port 2a of the fixed scroll 2, the reed valve 10 being arranged on a back surface of the fixed scroll 2; a valve cover 4 configured to cover the reed valve 10, the valve cover 4 being arranged on a back surface side of the fixed scroll 2; a capacity control mechanism 50 configured to guide a refrigerant in the course of compression to a low-pressure side through a plurality of capacity control ports 51 formed in the fixed scroll 2; and an injection mechanism 60 configured to inject a liquid refrigerant to one of a plurality of compression chambers through a single injection port 61 formed in the fixed scroll 2, the plurality of compression chambers being formed by the scroll member 2c of the fixed scroll 2.

F I G. 1



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Description

Technical Field

[0001] The present invention relates to a horizontal scroll compressor that is mounted as an element of a refrigeration cycle that constitutes, for example, an air-conditioning apparatus, a refrigeration apparatus, and the like, and that compresses a refrigerant.

Background Art

[0002] A horizontal scroll compressor has hitherto existed. As such a horizontal scroll compressor, a horizontal scroll compressor is disclosed that includes a capacity control mechanism that includes, in a fixed-scroll base-plate portion, a bypass hole that is capable of bypassing a portion of a compressed fluid from a portion before being in communication with the outlet port of a compression chamber, a valve that opens and closes the bypass hole, and a discharge hole from which the fluid from the bypass hole from the portion before being in communication with the outlet port is discharged to a low-pressure portion, and a float valve that opens and closes the discharge port provided in the central portion of the base plate (see Patent Literature 1, for example).

Citation List

Patent Literature

[0003] Patent Literature 1: Japanese Unexamined Patent Application Publication No. 4-298693 (page 4, Fig. 1)

Summary of Invention

Technical Problem

[0004] In the horizontal scroll compressor described in Patent Literature 1, since the temperature of the compression chamber becomes high when a heating operation is carried out under a low outdoor air state, an injection mechanism, which injects a liquid refrigerant in a spiral manner, is typically provided to prevent damages caused by pressing a scroll member. Furthermore, in conventional horizontal scroll expanders, since the vertical motion of a float valve intensifies due to increase in pressure difference when under a high-compression ratio operation, a reed valve, whose lifting of the valve is constant and vertical motion is stable having one end of the reed valve supported, is typically provided. However, in conventional horizontal scroll compressors, internal space allowing all the specified components to be configured on the back surface side of the fixed scroll cannot be obtained, and there is a problem in that all of the specified components cannot be configured.

[0005] In particular, when a horizontal scroll compressor is mounted on a vehicle such as a train, since size restriction is further added, obtaining internal space becomes even more difficult for conventional horizontal scroll compressors.

[0006] The present invention addresses to solve the above problems and an object thereof is to provide a horizontal scroll compressor that is mounted with the reed valve, the capacity control mechanism, and the injection mechanism without increasing their sizes.

Solution to Problem

[0007] A horizontal scroll compressor according to the present invention includes a hermetic vessel formed with an oil reservoir; a fixed scroll configured to constitute a portion of a fluid compression mechanism along with an orbiting scroll including a scroll member, the fixed scroll including a scroll member and being arranged in the hermetic vessel; a reed valve configured to open and close a discharge port of the fixed scroll, the reed valve being arranged on a back surface of the fixed scroll; a valve cover configured to cover the fixed scroll along with the reed valve, the valve cover being arranged on a back surface side of the fixed scroll; a capacity control mechanism configured to guide a refrigerant in the course of compression to a low-pressure side through a plurality of capacity control ports formed in the fixed scroll; and an injection mechanism configured to inject a liquid refrigerant to one of a plurality of compression chambers through a single injection port formed in the fixed scroll, the plurality of compression chambers being formed by the scroll member of the orbiting scroll and the scroll member of the fixed scroll. The valve cover is formed with a first through hole that is in communication with the discharge port of the fixed scroll, second through holes that are in communication with the plurality of capacity control ports formed in the fixed scroll, and a third through hole that is in communication with the injection port formed in the fixed scroll. The capacity control mechanism is connected to the capacity control ports formed in the fixed scroll through the second through holes. The injection mechanism is connected to the injection port formed in the fixed scroll through the third through hole.

Advantageous Effects of Invention

[0008] The horizontal scroll compressor according to the present invention can be equipped with a reed valve, a capacity control mechanism, and an injection mechanism without increasing the size of the horizontal scroll compressor. Accordingly, the horizontal scroll compressor according to the present invention can be mounted even if space is limited and the high compression ratio operation can be achieved.

Brief Description of Drawings

[0009]

[Fig. 1] Fig. 1 is a longitudinal sectional view illustrating an explanatory configuration of a horizontal scroll compressor according to Embodiment of the present invention.

[Fig. 2] Fig. 2 is an exploded perspective view illustrating an outline of a portion of a fluid compression mechanism of the horizontal scroll compressor according to Embodiment of the present invention in an exploded state.

[Fig. 3] Fig. 3 is a schematic enlarged view illustrating an enlarged valve cover portion of the horizontal scroll compressor according to Embodiment of the present invention.

[Fig. 4] Fig. 4 is a graph for describing a steady operation range of the horizontal scroll compressor according to Embodiment of the present invention.

[Fig. 5] Fig. 5 is a schematic perspective view illustrating a portion of the configuration of the back surface side of the fixed scroll of the horizontal scroll compressor according to Embodiment of the present invention.

[Fig. 6] Fig. 6 is an explanatory diagram for describing a position where an injection port of the horizontal scroll compressor according to Embodiment of the present invention is formed.

[Fig. 7] Fig. 7 illustrates explanatory diagrams for describing the position where the injection port of the horizontal scroll compressor according to Embodiment of the present invention is formed.

[Fig. 8] Fig. 8 is an explanatory diagram for describing a diameter of the injection port of the horizontal scroll compressor according to Embodiment of the present invention.

Description of Embodiment

[0010] Embodiment of the invention will be described below with reference to the drawings.

[0011] Fig. 1 is a longitudinal sectional view illustrating an explanatory configuration of a horizontal scroll compressor (hereinafter, referred to as a compressor 100) according to Embodiment of the present invention. Fig. 2 is an exploded perspective view illustrating an outline of a portion of a fluid compression mechanism 20, which is illustrated in Fig. 1, in an exploded state. Fig. 3 is a schematic enlarged view illustrating an enlarged valve cover 4 portion illustrated in Fig. 1. A configuration and an operation of the compressor 100 will be described with reference to Figs. 1 to 3. Note that the dimensional relationships of the components in the subsequent drawings including Fig. 1 may be different from the actual ones. Furthermore, a horizontal scroll compressor is a compressor in which the shaft direction of a main shaft is oriented laterally (a direction inclined in a predetermined angle with respect to the vertical direction).

[0012] The compressor 100 is mounted as an element of a refrigeration cycle that constitutes, for example, a refrigeration apparatus such as a refrigerator or a freezer, or a refrigeration cycle apparatus such as a vending machine, an air-conditioning apparatus, or a water heater, and is used to compress a refrigerant. The compressor 100 draws in a working fluid, such as a refrigerant, that circulates in the refrigeration cycle, discharges the working fluid after compressing the working fluid into a high-temperature high-pressure state. Furthermore, in the compressor 100, a reed valve 10, a capacity control mechanism 50, and an injection mechanism 60 are included inside a hermetic vessel 1 without any increase in size.

[0013] Note that in Fig. 1, a horizontal scroll compressor that is in a inclined state in which one end side (the fluid compression mechanism 20 side) of a main shaft 7 is arranged at a higher position than the other end side (an oil reservoir 13 side) of the main shaft 7 is illustrated as an example. However, the main shaft 7 may be inclined 90 degrees with respect to the vertical direction so that the horizontal scroll compressor is arranged in a horizontal manner.

[Configuration of Compressor 100]

[0014] The compressor 100 includes, as its main elements, the hermetic vessel 1, the fluid compression mechanism 20, a motor 30, a first frame 8, an Oldham ring 9, and the main shaft 7. The hermetic vessel 1 is a pressure vessel and constitutes the outer wall of the compressor 100. The fluid compression mechanism 20 and the motor 30 are housed inside the hermetic vessel 1. As illustrated in Fig. 1, the fluid compression mechanism 20 is arranged on the discharge side of the hermetic vessel 1 and the motor 30 is arranged on the oil reservoir 13 side of the hermetic vessel 1.

[0015] The first frame 8 is fixed to the inner circumferential surface of the hermetic vessel 1 and rotatably supports an orbiting scroll 3 in the shaft direction. Further, the first frame 8 rotatably supports, in the radial direction, the main shaft 7 that transmits the driving force generated by the motor 30 to the fluid compression mechanism 20. The Oldham ring 9 is a component that prevents the orbiting scroll 3 from rotating. The main shaft 7 is a component that transmits the driving force generated by the motor 30 to the fluid compression mechanism 20.

[0016] Note that the bottom portion of the hermetic vessel 1 is the oil reservoir 13 that stores lubricant oil. Furthermore, a suction-side pipe 103 for drawing in the working fluid and a discharge-side pipe 104 for discharging the working fluid are connected to the hermetic vessel 1.

[0017] The fluid compression mechanism 20 has a function of compressing the working fluid such as a refrigerant gas that has been drawn in from the suction-side pipe 103 and discharging the working fluid inside the hermetic vessel 1 into a discharge space 105. The working fluid that has been discharged into the discharge space 105 is discharged from the discharge-side pipe 104 to the outside of the compressor 100. The motor 30 exerts a function of driving the orbiting scroll 3 that constitutes the fluid compression mechanism 20 so that the fluid compression mechanism 20 compresses the working fluid. In other words, the motor 30 drives the orbiting scroll 3 through the main shaft 7 so that the working fluid is compressed in the fluid compression mechanism 20.

[0018] A fixed scroll 2 and the orbiting scroll 3 are arranged in a combined manner in the fluid compression mechanism 20. The fixed scroll 2 is arranged on the discharge side and the orbiting scroll 3 is arranged on the oil reservoir 13 side. The fixed scroll 2 is formed with a scroll member 2c that is a scroll protrusion erected on one of the surfaces. Furthermore, the orbiting scroll 3 is also formed with a scroll member 3a that is a scroll protrusion erected on one of the surfaces. The orbiting scroll 3 and the fixed scroll 2 are installed inside the hermetic vessel 1 while the scroll member 3a and the scroll member 2c are meshed together. Compression chambers 108, whose capacities relatively change, are formed between the scroll member 3a and the scroll member 2c.

[0019] The fixed scroll 2 is fixed to a second frame 40 with bolts or the like (not shown). A discharge port 2a that discharges the working fluid that has been compressed and that has become high in pressure is formed in a central portion of a base plate of the fixed scroll 2. The working fluid that has been compressed and that has become high in pressure is discharged into the discharge space 105 provided on the discharge side (the right side of the drawing) of the fixed scroll 2. Furthermore, the back surface (the surface on the discharge space 105 side) of the base plate of the fixed scroll 2 is provided with a valve seat 2b to which the reed valve 10 is attached.

[0020] In addition, a protrusion 2d that is protruded towards the valve cover 4 side is formed on the periphery of the discharge port 2a (the portion in communication with the valve seat 2b is open) on the back surface side of the fixed scroll 2. The protrusion 2d is fitted into a through hole 4a of the valve cover 4 such that positioning of the fixed scroll 2 and the valve cover 4 is facilitated. In other words, the protrusion 2d functions as a guide when the valve cover 4 is installed. Accordingly, not only the ease of assembly of the fixed scroll 2, a packing 5, and the valve cover 4 is increased but also assembling accuracy thereof can be increased. Note that a recess in which the protrusion 2d fits in may be preferably formed around the through hole 4a of the valve cover 4. Furthermore, the formation of a locking portion or a lock receiving portion in a portion of the protrusion 2d or in a portion of the recess allows the positioning to be carried out even more securely.

[0021] Furthermore, capacity control ports 51 and an injection port 61 are formed in the fixed scroll 2 so as to penetrate through the fixed scroll 2. Additionally, the base plate of the fixed scroll 2 is made as thin as possible to achieve downsizing of the compressor 100. Note that the position where the injection port 61 is formed will be described later in detail with reference to Figs. 6 and 7.

[0022] A valve presser 11 applies load to the reed valve 10 that is installed in the valve seat 2b. In other words, the reed valve 10 is driven when a pressure of a specified value or higher is transmitted through the compressed refrigerant and opens the discharge port 2a. Furthermore, a valve cover 4 that is installed on the back surface side of the fixed scroll 2 covers the reed valve 10. The valve presser 11 is intended to reduce fatigue fracture of the reed valve 11.

[0023] A valve cover 4 for supplying the high-pressure fluid, which has exited the discharge port 2a, to the discharge-side pipe 104 while preventing the high-pressure fluid from leaking into the low-pressure space is provided on the back surface side of the fixed scroll 2. The through hole 4a that is in communication with the discharge port 2a of the fixed scroll 2 is formed in a central portion of the valve cover 4. Furthermore, through holes 4c that are in communication with the capacity control ports 51 formed in the fixed scroll 2 and a through hole 4d that is in communication with the injection port 61 are formed in the valve cover 4. In addition, valve seats 4b are formed on the back surface (surface on the discharge side) of the valve cover 4. The valve seats 4b are provided with the capacity control mechanism 50 that guides the compressed refrigerant to the suction side. A pipe (a capacity control pipe 52) that guides the discharge pressure of the capacity control mechanism 50 is brazed to the hermetic vessel 1.

[0024] The capacity control mechanism 50 includes a plurality of capacity control ports 51 that are formed in the fixed scroll 2, capacity-control-mechanism bodies 55 that are provided with valves and springs and that are mounted on the valve seats 4b of the valve cover 4, a bypass pipe 53 that connects the plurality of capacity-control-mechanism bodies 55 to each other, the capacity control pipe 52 that is connected midway of the bypass pipe 53, and the through holes 4c that is formed in the valve cover 4. This capacity control mechanism 50 has a function of controlling the capacity control operation by opening and closing the fluid discharge ports (the through holes 4c that are formed in the valve cover 4) with the valves provided in the capacity-control-mechanism bodies 55. Note that it is only sufficient to have at least two capacity control ports 51. The position of each of the capacity control ports 51 and the number thereof are determined in accordance with the operating range of the compressor 100.

[0025] The capacity control mechanism 50 carries out the capacity control operation by bypassing the refrigerant that is in the course of compression to the suction side. Specifically, during a full-load operation, the capacity control mechanism 50 applies the high-pressure refrigerant to each of the valves provided in the capacity-control-mechanism bodies 55 as a back pressure to press the valves against the fixed scroll 2 such that the plurality of capacity control ports 51 are shut off, such that the refrigerant that has flowed into the compression chambers 108 is entirely guided into the compression port 2a, and such that the refrigerant does not return to the low-pressure side. On the other hand, during a light-load operation, the capacity control mechanism 50 does not apply the high-pressure refrigerant to each of the valves provided in the capacity-control-mechanism bodies 55 such that the valves are lifted from the compression chambers 108 with springs or the like, and such that the portion of the refrigerant that has flowed into the compression chambers 108 leaks into the low-pressure side through the plurality of capacity control ports 51. Accordingly, the capacity is set to correspond to the load.

[0026] Furthermore, an injection pipe 62 is attached to the through hole 4d of the valve cover 4 that is in communication with the injection port 61. Along with the injection port 61, the injection pipe 62 constitutes an injection mechanism 60 from which a liquid refrigerant flows into the compression chamber 108. Note that the injection pipe 62 is brazed to the hermetic vessel 1.

[0027] The injection mechanism 60 includes the injection port 61 that is formed in the fixed scroll 2, the injection pipe 62 that is attached to the through hole 4d formed in the valve cover 4, and the through hole 4d that is formed in the valve cover 4. The injection mechanism 60 has a function of carrying out injection of (injecting) the liquid refrigerant into the compression chambers 108 that is formed in the fluid compression mechanism 20. Furthermore, the injection mechanism 60 is configured to increase the volume (density) of the refrigerant in the compression chamber 108 and cool the fluid compression mechanism 20.

[0028] The packing 5 is provided between the fixed scroll 2 and the valve cover 4 so as to perform sealing between the discharge port 2a of the fixed scroll 2 and the valve cover 4. The packing 5 is formed with through holes 5b that are in communication with the capacity control ports 51 formed in the fixed scroll 2 and a through hole 5c that is in communication with the injection port 61. Furthermore, the packing 5 is formed with a through hole 5a at a position corresponding to the position of the valve seat 2b of the fixed scroll 2 so as to penetrate through the packing 5.

[0029] The orbiting scroll 3 performs an orbital and revolving motion relative to the fixed scroll 2 without any rotational motion. A solid cylindrical shaped orbiting scroll boss portion 118 is formed in a substantially central portion of the surface (hereinafter, referred to as a thrust surface 119) on other side of the scroll member 3a forming surface of the orbiting scroll 3. The orbiting scroll boss portion 118 is fitted into (engaged to) an eccentric hole 7a that is provided at one end (end portion on the fluid compression mechanism 20 side) of the main shaft 7 that will be described later. Note that the orbiting scroll 3 is slidable through a thrust bearing portion of the thrust surface 119.

[0030] The first frame 8 is press fitted and fixed to the second frame 40 and rotatably supports the orbiting scroll 3. Furthermore, a through hole is formed in a central portion of the first frame 8 for the main shaft 7 to penetrate therethrough. This through hole functions as a main bearing that rotatably and pivotally supports the portion of the main shaft 7 on the fluid compression mechanism 20 side. Furthermore, an oil discharge hole that penetrates through the first frame 8 from the thrust surface 119 of the orbiting scroll 3 to the motor 30 side in the shaft direction may be preferably formed in the first frame 8. Additionally, an accommodation space for accommodating the Oldham ring 9 is formed in the first frame 8. Note that the space in which the orbiting scroll boss portion 118 of the eccentric hole 7a of the main shaft 7 is accommodated is the rocker bearing 3b.

[0031] The Oldham ring 9 is arranged, for example, between the orbiting scroll 3 and the first frame 8 and carries out a function such as restricting rotational motion while allowing orbital motion of the orbiting scroll 3. In other words, the Oldham ring 9 functions as a rotation prevention mechanism of the orbiting scroll 3. Claws are formed on one of the surfaces of the Oldham ring 9, and accommodation spaces that accommodate the claws of the Oldham ring 9 are formed on one of the surfaces of the orbiting scroll 3 and one of the surfaces of the first frame 8. The claws of the Oldham ring 9 are accommodated in the accommodation spaces and the claws are made to slide in the accommodation spaces; accordingly, rotational motion of the orbiting scroll 3 is restricted while orbital motion of the orbiting scroll 3 is allowed.

[0032] The motor 30 broadly includes a stator 30a that is fixed to and supported by the hermetic vessel 1 and a rotor 30b that generates torque by combination with the stator 30a, which are housed in the hermetic vessel 1. The stator 30a is configured by implementing a winding (not shown) with a plurality of phases to a laminated iron core (not shown). The rotor 30b is maintained with a predetermined gap with the inner wall surface of the stator 30a and is rotatably driven upon start of energization of the stator 30a, and rotates the main shaft 7. Note that, although not illustrated in Fig. 1, wiring is applied to the fluid compression mechanism 20 side of the stator 30a that is included in the electric motor.

[0033] The main shaft 7 is fixed to and supported by the rotor 30b, and one of the ends (eccentric hole 7a) is joined to the orbiting scroll boss portion 118. The main shaft 7 rotates in accordance with the rotation of the rotor 30b and revolves the orbiting scroll 3. The eccentric hole 7a that is rotatably fitted to the orbiting scroll boss portion 118 is formed on one of the ends of the main shaft 7. Furthermore, an oil feeding passage 7b that penetrates through the main shaft 7 in the shaft direction is formed inside the main shaft 7. The oil feeding passage 7b serves as a passage of the lubricant oil that is stored in the oil reservoir 13. The lubricant oil that is accumulated in the oil reservoir 13 is drawn up by driving of an oil pump or the like that is driven in association with the rotation of the main shaft 7, flows through the oil feeding passage 7b, and is supplied to various sliding portions (the main bearing, the rocker bearing 3b, the thrust bearing, and the like) of the fluid compression mechanism 20.

[0034] The second frame 40 is fixed to the hermetic vessel 1 in order to support a portion of the main shaft 7 on the other end side. The second frame 40 is fixed onto the inner circumferential surface of the hermetic vessel 1, and a through hole (a sub bearing) for rotatably and pivotally supporting the main shaft 7 is formed in a central portion of the second frame 40.

[0035] The suction-side pipe 103 is connected to the compressor 100 and draws in the working fluid into the hermetic vessel 1 from between the fluid compression mechanism 20 and the motor 30. The suction-side pipe 103 is configured to be opened to the low-pressure space inside the hermetic vessel 1. The discharge-side pipe 104 is connected to the compressor 100 and discharges the working fluid that has been compressed in the fluid compression mechanism 20. The discharge-side pipe 104 is configured to be opened to the discharge space 105 that becomes high in pressure in the hermetic vessel 1.

[Regarding Fixed Scroll 2, Reed Valve 10, Valve Cover 4, Capacity Control Mechanism 50, and Injection Mechanism 60]

[0036] Referring to Fig. 2, the configuration of each of the fixed scroll 2, the reed valve 10, the valve cover 4, the capacity control mechanism 50, and the injection mechanism 60 will be described in detail. Fig. 2(a) illustrates a state in which the fixed scroll 2 is viewed from the orbiting scroll 3 side, and Fig. 2(b) illustrates an exploded state of the fixed scroll 2, the reed valve 10, the valve cover 4, the capacity control mechanism 50, and the injection mechanism 60. Note that in Fig. 2(b), the valve presser 11 and the packing 5 are also illustrated.

[0037] As described above, the discharge port 2a is formed in the fixed scroll 2 so as to penetrate through the fixed scroll 2. Furthermore, the valve seat 2b is formed on the back surface of the fixed scroll 2. The valve seat 2b is configured by forming a recess in a portion of the back surface side of the fixed scroll 2. Furthermore, the valve seat 2b is in communication with the discharge port 2a. The protrusion 2d that protrudes towards the valve cover 4 side is formed in the periphery of the discharge port 2a on the back surface side of the fixed scroll 2. In addition, the capacity control ports 51 and the injection port 61 are formed in the fixed scroll 2 so as to penetrate through the fixed scroll 2.

[0038] The reed valve 10 can be used in operations with high compression ratio and reliability can be improved so that fatigue fracture does not occur. As described above, the reed valve 10 is attached to the valve seat 2b that is formed in the fixed scroll 2. Load is applied with the valve presser 11 to the reed valve 10 that is attached to the valve seat 2b.

[0039] As described above, the valve cover 4 is provided on the back surface side of the fixed scroll 2 and covers the fixed scroll 2 along with the reed valve 10 that is attached to the valve seat 2b formed in the fixed scroll 2. The through hole 4a is formed in the valve cover 4 so as to penetrate through the valve cover 4. The through hole 4a is open to the high-pressure space 104 inside the hermetic vessel 1. When the valve cover 4 is attached to the fixed scroll 2, the through hole 4a of the valve cover 4 becomes in communication with the discharge port 2a of the fixed scroll 2. Accordingly, by attaching the valve cover 4 to the fixed scroll 2, the valve cover 4 guides the high-pressure fluid that has come out from the discharge port 2a to the discharge-side pipe 104 without any leakage to the low-pressure space.

[0040] Furthermore, as described above, the through holes 4c that are in communication with the capacity control ports 51 formed in the fixed scroll 2 and the through hole 4d that is in communication with the injection port 61 are formed in the valve cover 4 so as to penetrate through the valve cover 4. In other words, when the valve cover 4 is attached to the fixed scroll 2, not only the through hole 4a becomes in communication with the discharge port 2a but the through holes 4c become in communication with the capacity control port 51 and the through hole 4d becomes in communication with the injection port 61. Note that the recess-shaped valve seats 4b to which the capacity-control-mechanism bodies 55 are attached are formed in the periphery of the through holes 4c of the valve cover. Furthermore, a protrusion 4e that protrudes towards the discharge space 105 is formed in the periphery of the through hole 4a of the valve cover 4.

[0041] The capacity control mechanism 50 includes the plurality of capacity control ports 51 formed in the fixed scroll 2, the capacity-control-mechanism bodies 55 that are in communication with the plurality of capacity control ports 51 formed in the fixed scroll 2 through the through holes 4c that are formed in the valve cover 4, the bypass pipe 53 connecting the capacity-control-mechanism bodies 55 to each other, the capacity control pipe 52 that is connected midway of the bypass pipe 53, and the through holes 4c that connect the capacity control ports 51 and the capacity-control-mechanism bodies 55.

[0042] The injection mechanism 60 includes the injection port 61 formed in the fixed scroll 2, the injection pipe 62 that is in communication with the injection port 61 formed in the fixed scroll 2 through the through hole 4d formed in the valve cover 4, and the through hole 4d that connects the injection port 61 and the injection pipe 62.

[0043] Referring to Fig. 3, a state in which the fixed scroll 2, the reed valve 10, the valve cover 4, the capacity control mechanism 50, and the injection mechanism 60 are assembled will be described in detail. Note that in Fig. 3, a portion of the fixed scroll 2, the reed valve 10, the valve cover 4, a portion of the capacity control mechanism 50, and a portion of the injection mechanism 60 are illustrated in the area X.

[0044] The reed valve 10 is attached to the valve seat 2b that is formed in the fixed scroll 2. As described above, the reed valve 10 is one that can be used in operations with high compression ratio; however, in order to achieve operations with high compression ratio, the base plate of the fixed scroll 2 needs to be made thick. However, if the base plate of the fixed scroll 2 is made thick, the size of the compressor 100 is disadvantageously increased.

[0045] Accordingly, in the compressor 100, the back surface side of the fixed scroll 2 is provided with the valve cover 4. As described above, the valve cover 4 is provided on the back surface side of the fixed scroll 2 and covers the fixed scroll 2 along with the reed valve 10 that is attached to the valve seat 2b formed in the fixed scroll 2. In other words, the valve cover 4 has a function of reinforcing the strength of the fixed scroll 2, as well as a function of securing the installation positions of the capacity-control-mechanism bodies 55 that constitutes the capacity control mechanism 50. Therefore, by providing the valve cover 4, there will be no need for another component positioned between the fixed scroll 2 and each of the capacity control mechanism 50 and the injection mechanism 60 to fix the capacity control mechanism 50; and the base plate of the fixed scroll 2 can be made thin.

[Operation of Compressor 100]

[0046] Now, an operation of the compressor 100 will be described briefly.

[0047] The rotor 30b is rotated by receiving torque from the rotating magnetic field generated by the stator 30a. In association with this, the main shaft 7 that is fixed to the rotor 30b is rotatably driven. The orbiting scroll 3 is engaged to the eccentric hole 7a of the main shaft 7. The rotation prevention mechanism of the Oldham ring 9 converts the rotational motion of the orbiting scroll 3 into an orbital and revolving motion. With the rotation and drive of the main shaft 7, the working fluid in the hermetic vessel 1 flows into one of the compression chambers 108 formed of the scroll member 2c of the fixed scroll 2 and the scroll member 3a of the orbiting scroll 3; accordingly, a suction process is started.

[0048] When the working fluid is drawn into the compression chamber 108, the process proceeds to a compression process that reduces the capacity of the compressor chamber 108 with the orbital and revolving motion of the decentered orbiting scroll 3. In other words, in the fluid compression mechanism 20, when the orbiting scroll 3 carries out the orbital and revolving motion, the working fluid is taken in from the opening at the most outer periphery of the scroll member 3a of the orbiting scroll 3 and the opening at the most outer periphery of the scroll member 2c of the fixed scroll 2, which serves as the suction port. With the revolution of the orbiting scroll 3, the working fluid is gradually compressed while moving towards the center portion. Note that the refrigerant in a low-pressure state that has circulated through the refrigeration cycle is made to flow into the hermetic vessel 1 from the suction-side pipe 103.

[0049] Next, the working fluid that has been compressed in the compression chamber 108 proceeds to a discharge process. In other words, the working fluid passes through the discharge port 2a of the fixed scroll 2, passes through the reed valve 10 and the valve cover 4, and is discharged to the outside of the hermetic vessel 1 from the discharge-side pipe 104 via the discharge space 105. The refrigerant, which is in a high-temperature high-pressure state, that has been discharged from the discharge-side pipe 104 of the compressor 100 first flows into a condenser that constitutes the refrigeration cycle, then, circulates through the various components constituting the refrigeration cycle, and is drawn into the compressor 100 again. After that, when energization of the stator 30a is stopped, the compressor 100 stops.

[0050] When the motor 30 is driven, the main shaft 7 is rotated. In accordance with the rotation, an oil pump (not shown) is driven, and the lubricant oil accumulated in the oil reservoir 13 is drawn up, is made to flow through the oil feeding passage 7b, and is supplied to the fluid compression mechanism 20. The lubricant oil that has lubricated each bearing flows into the accommodation spaces of the Oldham ring 9 that are formed in the first frame 8. Since an oil discharge hole is formed in each accommodation space, the lubricant oil that has flowed into each accommodation space is discharged from the corresponding oil discharge hole.

[0051] When the capacity control mechanism 50 provided on the valve cover 4 is not driven and the compressor 100 is operated at full capacity, by guiding the discharge pressure to the capacity control pipe 52, valves (not shown) that are one of the components of the capacity control mechanism 50 are pressed down, and the fluid discharge ports of the capacity control mechanism 50 are closed. By performing the above, the fluid discharge ports of the capacity control mechanism 50 is closed, the refrigerant is made not to flow into the bypass pipe 53 that constitute the capacity control mechanism 50, and the refrigerant that has been compressed in the fluid compression mechanism 20 is discharged to the outside of the compressor 1.

[0052] Furthermore, when the capacity control mechanism 50 is driven and an operation is carried out while capacity control of the compressor 100 is performed, the suction pressure is guided to the capacity control pipe 52 so that the valves are lifted by springs that are one of the components of the capacity control mechanism 50, the fluid discharge ports are opened, the bypass pipe 53 is made to be in communication, a portion of the refrigerant inside the compression chambers 108 is discharged to the outside of the fixed scroll 2, and the capacity inside the compression chamber 108 is controlled.

[0053] In addition, when an operation that uses the injection mechanism 60 is carried out, a liquid refrigerant (a refrigerant that is in a state after condensation and before decompression) that has a higher pressure than the pressure inside the compression chambers 108 is guided to the injection pipe 62, the liquid refrigerant is made to flow into the compression chambers 108, the volume of the refrigerant inside the compression chamber 108 is increased, and the inside of the compression chamber 108 is cooled. By performing the above, the highly-compressed refrigerant that has been compressed by the fluid compression mechanism 20 passes through the discharge port 2a, passes through the valve cover 4 and the discharge-side pipe 104 after passing through the reed valve 10, and is discharged to the outside of the compressor 100.

[Comparison with Conventional Technique]

[0054] Fig. 4 is a graph for describing a steady operation range of the compressor 100. A heater heating method has hitherto been largely adopted for heating operations of vehicles. In other words, scroll compressors became to be used exclusively for cooling operations. Accordingly, there had been no need to consider heating operations and there had been no need to actively provide injection mechanisms in scroll compressors. Furthermore, since the compression ratio does not become high during operation of such scroll compressors, there had been no need to use a reed valve and a valve with a simple structure (for example, a round valve or the like) was sufficient enough. However, from the viewpoint of environmental problems of recent years, a need for making the scroll compressor mounted on a vehicle to also execute a heating operation has been increasing.

[0055] However, when attempting to execute a heating operation with a conventionally used scroll compressor, lack of capacity in the heating operation region becomes prominent (see Fig. 4), and since the operation becomes high in compression ratio, many fatigue fracture occurred in the valve with a simple structure. Therefore, the compressor 100 is provided with an injection mechanism 60 so as to compensate for the lack of capacity in the heating operation region and has adopted a reed valve 10 that can withstand the operation with high compression ratio. In addition to the above arrangement, the compressor 100 also adopts a capacity control mechanism 50.

[0056] In conventional scroll compressors, the discharge valve is frequently driven during the operation with high compression ratio. The reed valve can be used in operations with high compression ratio and reliability can be improved so that fatigue fracture does not occur. The reed valve is typically configured with a shape illustrated in Fig. 1. Accordingly, an installing space for the reed valve will be needed on the back surface (the discharge side surface) of the fixed scroll. Furthermore, in order to use the reed valve, other than the fixed scroll, another component that covers the reed valve is separately needed. In addition, this another component needs to be formed with a through hole that is in communication with the discharge port of the fixed scroll; however, a displacement may occur between the center of the discharge port of the fixed scroll and the center of the through hole of the another component when the fixed scroll is fixed with bolts.

[0057] Typically, the capacity control mechanism serves a role in reducing the capacity of the scroll compression chamber by carrying out bypassing control of the volume of the refrigerant in the compression chamber. Accordingly, even when the scroll compressor is controlled at a constant speed, the performance of the scroll compressor can be varied. Typically, the capacity control mechanism is installed in the fixed scroll, and when a reed valve is used, another component that covers the reed valve is installed on the back surface of the fixed scroll. Accordingly, when installing the reed valve and the capacity control mechanism in the fixed scroll, a different component is further separately needed for installing the capacity control mechanism. Therefore, the size of the hermetic vessel needs to be made lager accordingly.

[0058] Typically, the injection mechanism increases the refrigerant amount by carrying out an injection of (injecting) a liquid refrigerant into the compression chamber that is in the course of compression and serves a role in securing the capacity (especially the heating capacity) of the scroll compressor, as well as reducing the temperature of the discharge refrigerant. Accordingly, the operation range of the scroll compressor can be increased. However, the injection port needs to be opened to the compression chamber at all times so that the injected refrigerant is not bypassed to the suction space.

[0059] When the reed valve, the capacity control mechanism, and the injection mechanism are all mounted in a single hermetic vessel while taking the above into consideration, the hermetic vessel becomes large in size in order to secure the installation space of the another component. Additionally, not only the installation space for the capacity control mechanism is needed but also the relation between the capacity control mechanism and the another component needs to be considered, which also leads to increase in size of the hermetic vessel. Concurrently, since the injection port is opened to the compression chamber at all times, positioning of the injection port needs to be carried out with high accuracy. Note that, needless to mention, there are other problems to be solved such as improving the assembling accuracy, reducing cost, and increasing reliability.

[0060] When the capacity control mechanism is controlled electrically by use of a switching element or the like, there is a case in which the electrical devices disposed around the place where the scroll compressor is installed are affected. When assuming that the scroll compressor is mounted on a carriage of a train or the like, it may not be possible to avoid a case in which precision machines, other than the refrigeration cycle apparatus in which the scroll compressor acts as one of the constituent devices, that are mounted in multiple numbers are affected and the reliability of the entire vehicle is reduced. From the above point, it is requested that the capacity control mechanism is mechanically controlled. However, when attempting to mechanically control the capacity control mechanism, in addition to the above described problems, further increase in the size of the scroll compressor is brought about. In such a case, the scroll compressor cannot be applied for use on vehicle. Accordingly, the compressor 100 adopts a configuration described below while considering the problems described above.

[Specific Configuration of Compressor 100]

[0061]

(1) in the compressor 100, the reed valve 10, the capacity control mechanism 50, and the injection mechanism 60 are mounted in a single hermetic vessel 1.
(2) As described above, the capacity control mechanism 50 is installed in the valve cover 4.
(3) The valve cover 4 is easily positioned with respect to the fixed scroll 2 with the protrusion 2d that is formed on the back surface of the fixed scroll 2.
(4) A single injection port 61 is provided at a position that allows an injection to be carried out to each of the two compression chambers 108.
(5) The injection port 61 is formed at a position that is within 360 degrees (on the low pressure side as much as possible) from the winding end of the scroll member 2c and that does not interfere with the capacity control pipe 52 and the reed valve 10.
(6) The diameter of the injection port 61 is smaller than the tooth thickness of the scroll member 3a (the compression chambers 108 are not connected to each other in order to reduce refrigerant leakage loss).
(7) The base plate of the fixed scroll 2 is made as thin as possible. Furthermore, the position of a bolt hole 2e for fixing the reed valve 10 is on the outside (a position in which the pressure difference is small with the low pressure) with respect to the most outer periphery of the scroll member 2c (reduction of leakage loss).

(Refrigerant and Refrigerating Machine Oil Used in Compressor 100)

[0062] The type of refrigerant employed in the compressor 100 is not limited in particular and any of a natural refrigerant, such as carbon dioxide, a hydrocarbon, or helium, an alternative refrigerant that does not contain chlorine, such as HFC410A, HFC407C, or HFC404A, or a fluorocarbon refrigerant that is used in existing products, such as R22 or R134a, may be used. Furthermore, the type of refrigerating machine oil employed in the compressor 100 is not limited in particular and, for example, MEL32R (for refrigerators) or the like may be used.

(Forming Position of Injection Port 61)

[0063] In the compressor 100, capacity in the heating range is secured with the injection mechanism 60. The refrigerant that is injected in the compressor 100 is in a state after condensation and before decompression, in other words, the refrigerant is in a high-pressure liquid state.

[0064] Fig. 5 is a schematic perspective view illustrating a portion of the configuration of the back surface side of the fixed scroll 2. As illustrated in Fig. 5, the capacity-control-mechanism bodies 55, the capacity control pipe 52, the bypass pipe 53, and the injection pipe 62 are installed on the back surface side of the valve cover 4. As described above, the injection pipe 62 is connected to the injection port 61. The capacity-control-mechanism bodies 55 are attached to the valve seat 4b of the valve cover 4. The bypass pipe 53 connects the capacity-control-mechanism bodies 55 to each other. The capacity control pipe 52 is connected midway of the bypass pipe 53. Accordingly, in the limited space of the back surface side of the valve cover 4, the injection port 61 is formed in a position that allows the injection pipe 62 to be directly extended in the upper portion of the hermetic vessel 1.

[0065] Specifically, the injection port 61 is formed in a position that allows the injection pipe 62 to directly extend in the upper portion of the hermetic vessel 1 without interfering with the capacity control pipe 52 (including the bypass pipe 53), the reed valve 10, and a terminal box (not shown, installed outside the upper portion of the hermetic vessel 1). Note that, since the space on the back surface side of the valve cover 4 is complicated, it is structurally difficult to form two injection ports 61. Accordingly, in the compressor 100, only one injection port 61 is formed.

[0066] Figs. 6 and 7 are diagrams for describing the forming position of the injection port 61. Fig. 8 is an explanatory diagram for describing the diameter of the injection port 61. The injection port 61 will be described with reference to Figs. 6 to 8.

[0067] As described above, the refrigerant that is injected in the compressor 100 is in a high-pressure state. Accordingly, as shown in Fig. 6, the injection of the refrigerant is facilitated by installing the injection port 61 on the low-pressure side (area A or area B illustrated in Fig. 6) that is near the compression starting point. Furthermore, the injection port 61 is formed with a single port shape at a position that enables an injection to be carried out to each of the two compression chambers 108 that is formed by the combination of the scroll member 2c and the scroll member 3a. Accordingly, as illustrated in Fig. 7, it can be understood that an injection is carried out to each of the two compression chambers 108.

[0068] Furthermore, the injection port 61 is formed within 360 degrees from the winding end of the scroll member 2c. Within 360 degrees from the winding end of the scroll member 2c indicates within an area 360 degrees spirally extended from the inlet side of the spiral flow passage that is formed from the inlet side of the refrigerant towards the center. By forming the injection port 61 at such a position, an injection can be carried out at an early stage in the course of the compression. In other words, as illustrated in Fig. 7, even if the orbiting scroll 3 revolves 360 degrees, the injection port 61 is in communication with the compression chamber 10 that is close to the suction side, and an injection can be carried out at an early stage in the course of the compression.

[0069] As described above, the diameter of the injection port 61 is to be smaller than the tooth thickness of the scroll member 3a. Accordingly, the compressed refrigerant does not leak into the compression chamber 108 on the low-pressure side through the injection port 61. Therefore, leakage loss of the refrigerant can be efficiently reduced. On the other hand, if the diameter of the injection port is larger than the tooth thickness of the scroll member 3a, as illustrated in Fig. 8, the injection port disadvantageously connects the two compression chambers 108.

[Other Configurations]

[0070] Since the compressor 100 is a horizontal type, the suction-side pipe 103 is positioned on the upper side of the hermetic vessel 1 when the compressor 100 is installed. Additionally, the suction port of the fixed scroll 2 is also positioned on the upper side when the compressor 100 is installed. Accordingly, a countermeasure for liquid compression of the liquid refrigerant can be achieved. In other words, fatigue fracture, which occurs when a liquid refrigerant enters the compression chamber 108 and liquid compression is carried out, can be suppressed.

[0071] As described above, since the compressor 100 is provided with the valve cover 4, the fixed scroll 2 can be made thin. Accordingly, even if the capacity control mechanism 50, the injection mechanism 60, and the reed valve 10 are provided, the hermetic vessel 1 does not become large. Furthermore, since the compressor 100 is provided with the valve cover 4, valve fracture due to pressure difference during a high compression ratio operation can be suppressed. Additionally, since the compressor 100 is provided with the injection mechanism 60, a heating operation under a low-outside air state can be carried out. In other words, the compressor 100 does not lead to size increase of the hermetic vessel 1 and allows the capacity control mechanism 50, the injection mechanism 60, and the reed valve 10 to fully exert each of their functions.

[0072] The compressor 100 is especially effective when installing to a place, such as a vehicle, where installation space is limited. In other words, the compressor 100 can achieve size reduction and enables high compression ratio operation; accordingly, even if the compressor 100 is installed in a vehicle or the like, it is possible to supply the desired cooling capacity and heating capacity.

Reference Signs List

[0073] 1 hermetic vessel, 2 fixed scroll, 2a discharge port, 2b valve seat, 2c scroll member, 2d protrusion, 2e bolt hole, 3 orbiting scroll, 3a scroll member, 3b rocker bearing, 4 valve cover, 4a through hole (first through hole), 4b valve seat, 4c through hole (second through hole), 4d through hole (third through hole), 4e protrusion, 5 packing, 5a through hole, 5b through hole, 5c through hole, 7 main shaft, 7a eccentric hole, 7b oil feeding passage, 8 first frame, 9 Oldham ring, 10 reed valve, 11 valve presser, 13 oil reservoir, 20 fluid compression mechanism, 30 motor, 30a stator, 30b rotor, 40 second frame, 50 capacity control mechanism, 51 capacity control port, 52 capacity control pipe, 53 bypass pipe, 55 capacity-control-mechanism body, 60 injection mechanism, 61 injection port, 62 injection pipe, 100 compressor, 103 suction-side pipe, 104 discharge-side pipe, 105 discharge space, 108 compression chamber, 118 orbiting scroll boss portion, 119 thrust surface.

Claims

1. A horizontal scroll compressor, comprising:

a hermetic vessel formed with an oil reservoir;
a fixed scroll configured to constitute a portion of a fluid compression mechanism along with an orbiting scroll including a scroll member, the fixed scroll including a scroll member and being arranged in the hermetic vessel;
a reed valve configured to open and close a discharge port of the fixed scroll, the reed valve being arranged on a back surface of the fixed scroll;
a valve cover configured to cover the fixed scroll along with the reed valve, the valve cover being arranged on a back surface side of the fixed scroll;
a capacity control mechanism configured to guide a refrigerant in the course of compression to a low-pressure side through a plurality of capacity control ports formed in the fixed scroll; and
an injection mechanism configured to inject a liquid refrigerant to one of a plurality of compression chambers through a single injection port formed in the fixed scroll, the plurality of compression chambers being formed by the scroll member of the orbiting scroll and the scroll member of the fixed scroll,
wherein the valve cover is formed with

a first through hole that is in communication with the discharge port of the fixed scroll,
second through holes that are in communication with the plurality of capacity control ports formed in the fixed scroll, and
a third through hole that is in communication with the injection port formed in the fixed scroll,

wherein the capacity control mechanism is connected to the capacity control ports formed in the fixed scroll through the second through

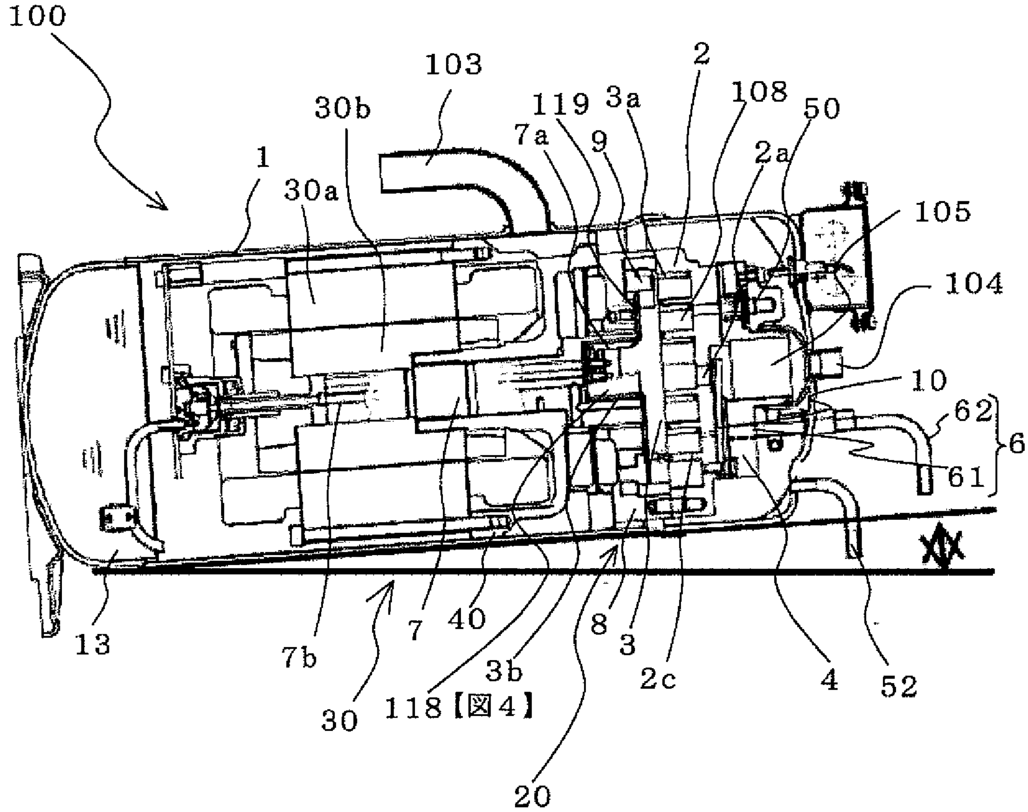
holes, and
wherein the injection mechanism is connected to the injection port formed in the fixed scroll through the third through hole.

2. The horizontal scroll compressor of claim 1, wherein a protrusion that protrudes towards a valve cover side is provided on a rim of the discharge port of the fixed scroll so as to fit into a through hole formed in the valve cover.

3. The horizontal scroll compressor of claim 1 or 2, wherein spiral flow passages spirally extend from inlet sides of the refrigerant towards a center and the injection port is formed within an area 360 degrees spirally extended from the inlet sides.

4. The horizontal scroll compressor of any one of claims 1 to 3, wherein a diameter of the injection port is smaller than a tooth thickness of the scroll member of the orbiting scroll.

FIG. 1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8
3
2c
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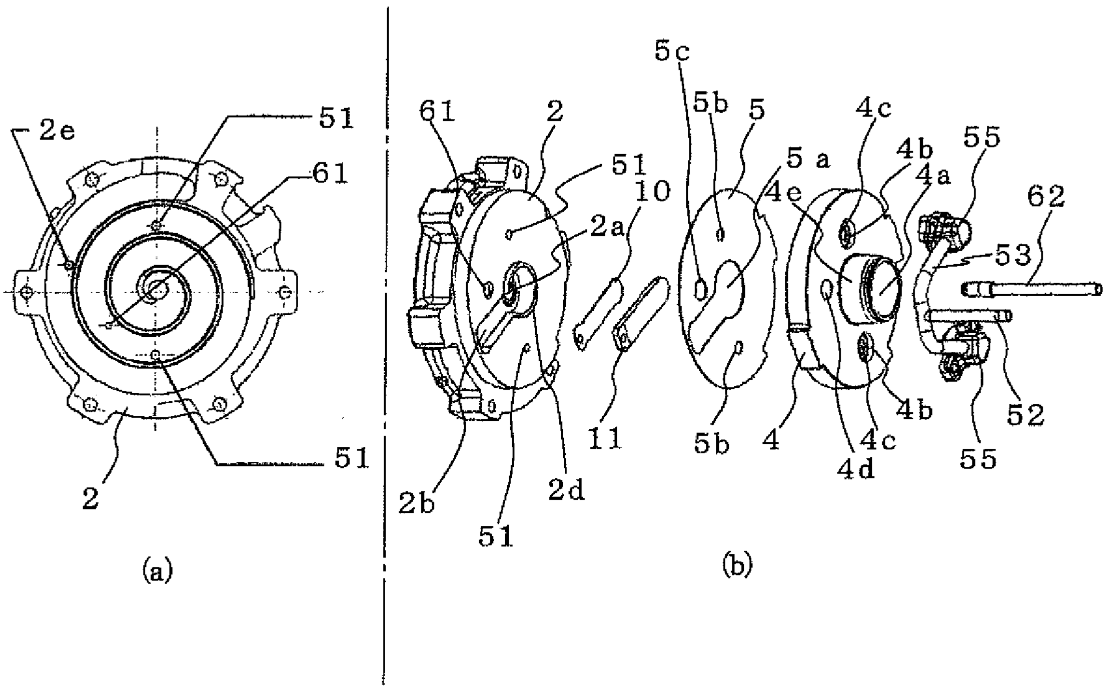
52
3b
30
118【図4】
20

FIG. 2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4a
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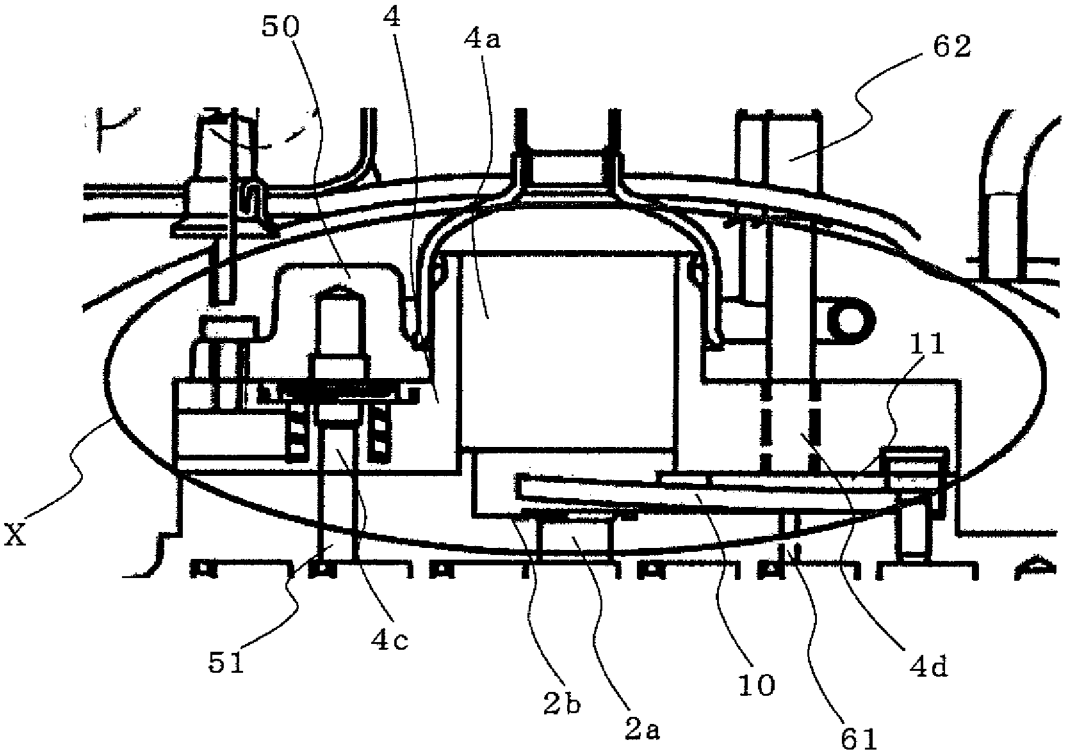
(b)

F I G. 3



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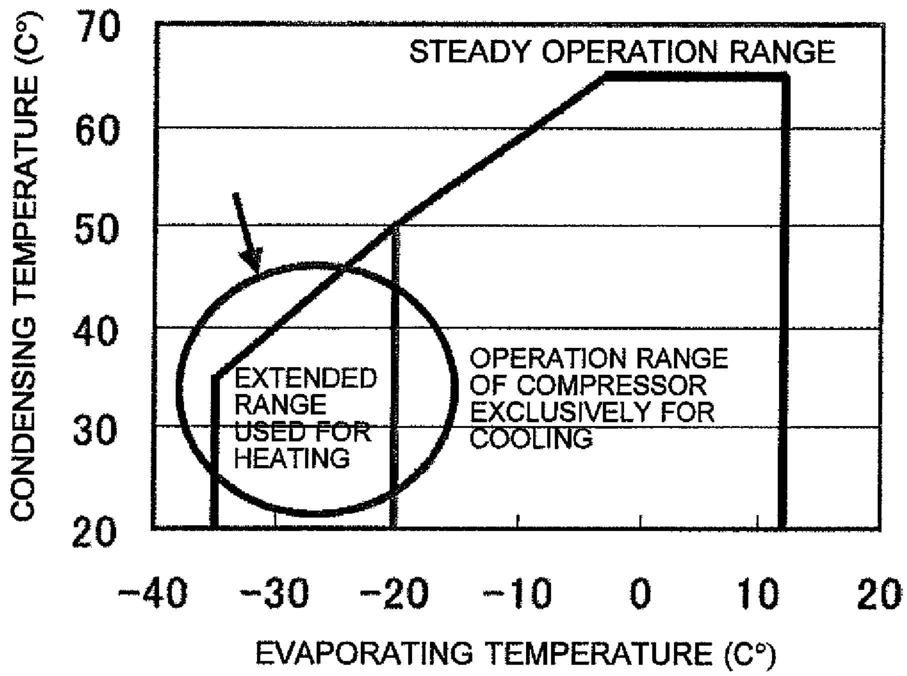
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USED FOR
HEATING
OPERATION RANGE
OF COMPRESSOR
EXCLUSIVELY FOR
COOLING
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−30
−20
−10
0
10
20
EVAPORATING TEMPERATURE (C°)

F I G. 5

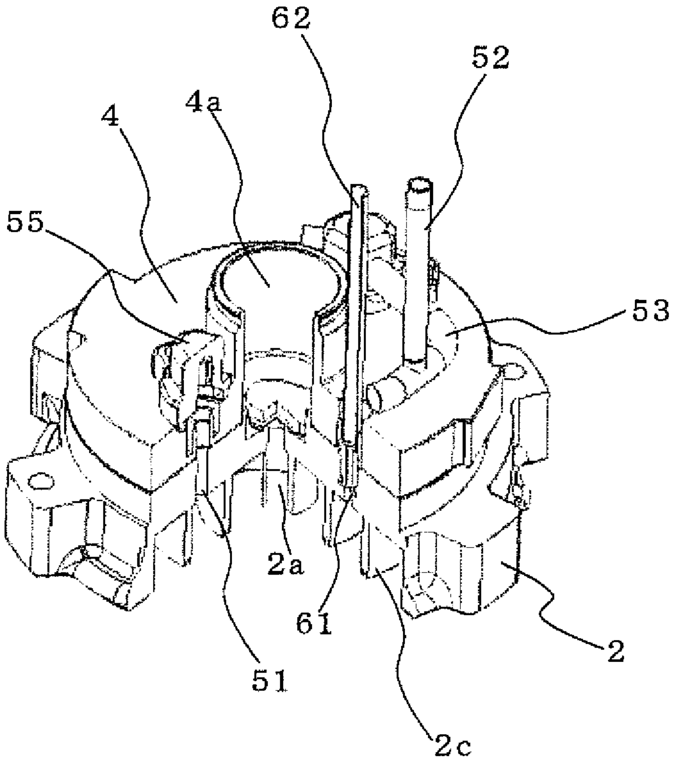


FIG. 6

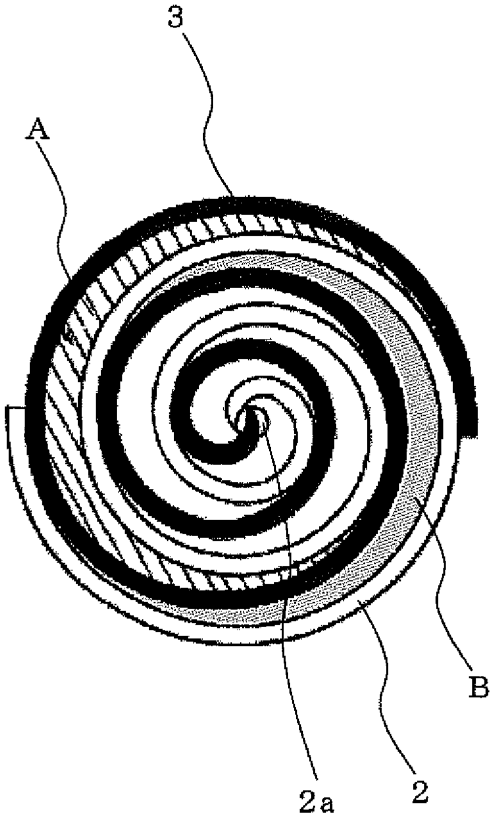
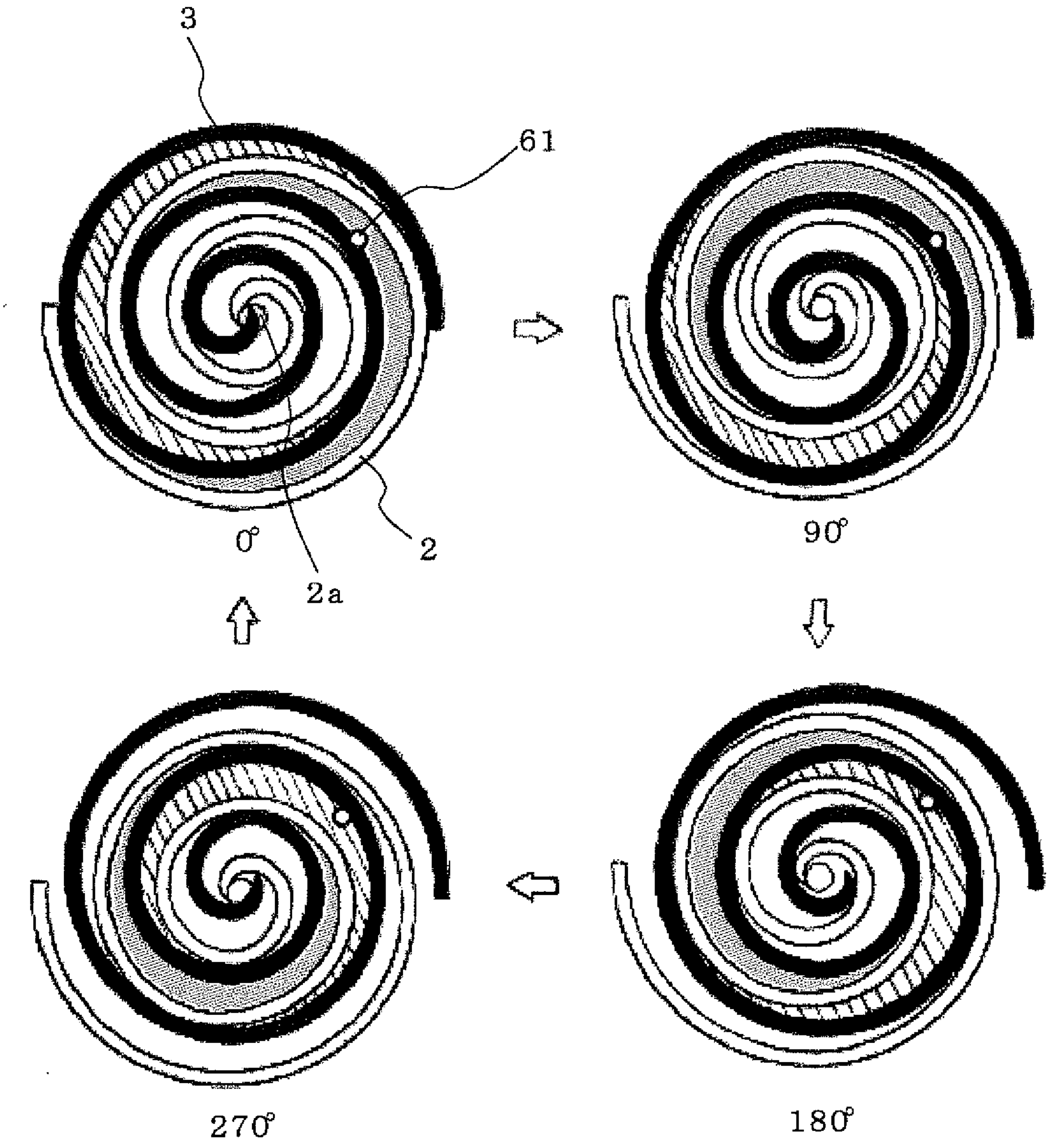
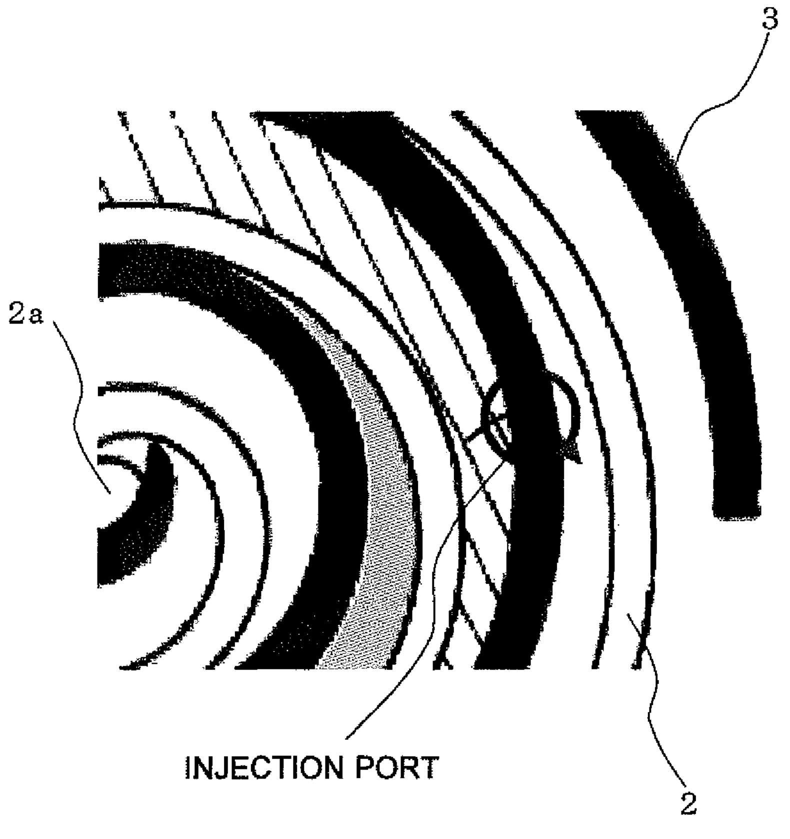


FIG. 7



F I G. 8



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/005330

A. CLASSIFICATION OF SUBJECT MATTER
F04C18/02(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
F04C18/02

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

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2011
Kokai Jitsuyo Shinan Koho	1971-2011	Toroku Jitsuyo Shinan Koho	1994-2011

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 Y	JP 2006-207593 A (Sanyo Electric Co., Ltd.), 10 August 2006 (10.08.2006), paragraphs [0031] to [0035]; fig. 1 to 6 (Family: none)	1,2 3,4
Y	JP 6-26474 A (Mitsubishi Heavy Industries, Ltd.), 01 February 1994 (01.02.1994), paragraph [0020]; fig. 1 (Family: none)	3
Y	JP 2000-161263 A (Mitsubishi Electric Corp.), 13 June 2000 (13.06.2000), paragraphs [0013], [0025]; fig. 3 (Family: none)	4

[×] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

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Date of the actual completion of the international search 21 December, 2011 (21.12.11)	Date of mailing of the international search report 10 January, 2012 (10.01.12)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2011/005330

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 1-147185 A (Mitsubishi Electric Corp.), 08 June 1989 (08.06.1989), entire text; all drawings (Family: none)	1-4
A	JP 2557734 B2 (Sanyo Electric Co., Ltd.), 27 November 1996 (27.11.1996), entire text; all drawings (Family: none)	1-4

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REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

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