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

(11) EP 2 161 454 A2

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
10.03.2010 Bulletin 2010/10

(51) Int Cl.:
F04C 18/356 *(2006.01)* ***F04C 23/00*** *(2006.01)*
F04C 29/00 *(2006.01)*

(21) Application number: **09169150.1**

(22) Date of filing: **01.09.2009**

(84) Designated Contracting States:
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 SE SI SK SM TR
Designated Extension States:
AL BA RS

(30) Priority: **03.09.2008 JP 2008226269**

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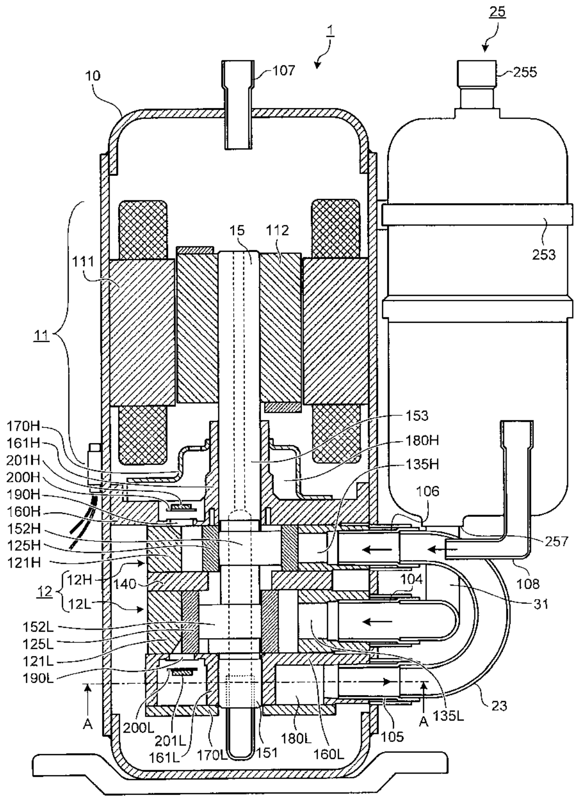
(54) **Injectible two-stage rotary compressor**

(57) An injectible two-stage compression rotary compressor (1) includes a compressor housing (10); a low-stage compressing section (12L) provided in the compressor house (10); a high-stage compressing section (12H) provided near the low-stage compressing section (12L); a motor (11) for driving the low-stage compressing section (12L) and the high-stage compressing section (12H); an accumulator (25) held at an outer side portion of the compressor housing (10); a low-pressure connecting pipe (31) connecting the accumulator (25) and the low-stage compressing section (12L); an intermediate connecting pipe (23) connecting the low-stage compressing section (12L) and the high-stage compressing section (12H) outside the compressor housing (10); and an intermediate suction pipe (108) for introducing a medium pressure injection refrigerant into the intermediate connecting pipe (23). The intermediate suction pipe (108) is connected to the intermediate connecting pipe (23) so that an outlet of the intermediate suction pipe (108) faces in a flowing direction of a medium pressure gas refrigerant in the intermediate connecting pipe (23).

FIG.1B



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Description

TECHNICAL FIELD

[0001] The present invention relates to an injectible two-stage compression rotary compressor used for a heat pump system utilizing an injection refrigerating cycle and specifically to a compressor where a medium pressure injection refrigerant, which is a high dryness wet refrigerant of a refrigerating cycle side, is introduced into an intermediate connecting pipe of a medium pressure gas refrigerant atmosphere.

BACKGROUND ART

[0002] A conventional two-stage compression rotary compressor includes a low-stage compressing section and a high-stage compressing section disposed in a sealed cylindrical compressor housing, a motor for driving the low-stage compressing section and the high-stage compressing section, and an accumulator disposed beside the compressor housing.

[0003] The compressor housing is provided with a first communication hole, a second communication hole, and a third communication hole in a line in a direction of a rotary shaft. In the second communication hole, a low-stage suction pipe connected to a suction side of the low-stage compressing section to draw in a low pressure refrigerant is disposed.

[0004] In the first communication hole, a low-stage discharge pipe connected to a discharge side of the low-stage compressing section to discharge a low-stage discharge refrigerant outside the compressor housing is disposed. In the third communication hole, a high-stage suction pipe connected to a suction side of the high-stage compressing section to draw in the low-stage discharge refrigerant is disposed.

[0005] The low-stage suction pipe and a lower portion of the accumulator are connected by a low-pressure connecting pipe. The low-stage discharge pipe and the high-stage suction pipe are connected by an intermediate connecting pipe. Into the intermediate connecting pipe, an injection refrigerant separated by a gas-liquid separator of a refrigerating cycle is injected via an intermediate suction pipe. An outlet of the intermediate suction pipe faces perpendicularly to a flow of a medium pressure gas refrigerant in the intermediate connecting pipe.

[0006] For example, Japanese Patent Application Laid-open No. 2006-152931 discloses a rotary compressor as described above.

[0007] Normally, pressure in the intermediate connecting pipe of the two-stage compression rotary compressor becomes medium due to the discharged refrigerant from the low-stage compressing section and then gradually reduces due to suction by the high-stage compressing section and pressure pulsation occurs in a cycle according to a rotational speed of the compressor.

[0008] When a discharge stroke of the low-stage compressing section ends, the low-stage compressing section and the intermediate connecting pipe are disconnected from each other. Because the high-stage compressing section is 180° out of phase, it is in a suction stroke at this time. Because the sum of a volume of the intermediate connecting pipe and a volume of the high-stage compressing section is the smallest at this time, pressure in the intermediate connecting pipe is the highest at this time. When phase further advances, the suction stroke of the high-stage compressing section proceeds and the volume increases and therefore the pressure in the intermediate connecting pipe reduces as a roller rotates. As a result, the pressure pulsation increases in the intermediate connecting pipe.

[0009] If the outlet of the intermediate suction pipe is connected to be perpendicular to the intermediate connecting pipe, the flow of the medium pressure gas refrigerant in the intermediate connecting pipe and a flow of the injection refrigerant discharged from the intermediate suction pipe become orthogonal to each other. Therefore, the pressure pulsation in the intermediate connecting pipe further increases, the pressure pulsation propagates into injection piping, and a pressure loss of the injection refrigerant increases. As a result, compression efficiency of the compressor is impaired.

DISCLOSURE OF INVENTION

[0010] It is an object of the present invention to at least partially solve the problems in the conventional technology.

[0011] According to an aspect of the present invention, an injectible two-stage compression rotary compressor used for a heat pump system utilizing an injection refrigerating cycle, includes a sealed cylindrical compressor housing in which first, second, and third communication holes are sequentially provided apart in an axial direction on an outer peripheral wall thereof; a low-stage compressing section provided within the compressor housing with one end of a low-stage suction pipe connected to a low-stage suction hole through the second communication hole and one end of a low-stage discharge pipe connected to a low-stage muffler discharge hole through the first communication hole; a high-stage compressing section provided near the low-stage compressing section within the compressor housing with one end of a high-stage suction pipe connected to a high-stage suction hole through the third communication hole and a high-stage muffler discharge hole communicating with an inside of the compressor housing; a motor for driving the low-stage compressing section and the high-stage compressing section; a sealed cylindrical accumulator held at an outer side portion of the compressor housing; a low-pressure connecting pipe connecting a bottom communication hole of the accumulator and the other end of the low-stage suction pipe; an intermediate connecting pipe connecting the other end of the low-stage discharge pipe and the other end of the high-stage suction pipe; and an intermediate suction pipe for introducing a medium pressure injection refrigerant into the intermediate connecting pipe, the medium pressure injection refrigerant being a wet refrigerant of the injection refrigerating cycle side. The intermediate suction pipe is connected to the intermediate connecting pipe so that an outlet of the intermediate suction pipe faces in a flowing direction of a medium pressure gas refrigerant in the intermediate connecting pipe.

[0012] The above and other objects, features, advantages and technical and industrial significance of this invention will be better understood by reading the following detailed description of presently preferred embodiments of the invention, when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF DRAWINGS

[0013]

FIG. 1A shows a basic structure of a refrigerating cycle of an air conditioner.
FIG. 1B is a vertical sectional view showing a first embodiment of an injectible two-stage compression rotary compressor of the air conditioner according to the present invention.
FIG. 1C is a cross sectional view of a low-stage compressing section and a high-stage compressing section of the two-stage compression rotary compressor.
FIG. 1D is a cross sectional view taken along line A-A of FIG. 1B.
FIG. 1E is a cross sectional view of a low-stage end plate.
FIG. 1F is a sectional view taken along line B-B of FIG. 1E.
FIG. 1G is a front view of a compressor housing.
FIG. 1H is a side view of the injectible two-stage compression rotary compressor in the first embodiment.
FIG. 1I is a vertical sectional view showing a variation of the injectible two-stage compression rotary compressor in the first embodiment.
FIG. 1J is a vertical sectional view showing another variation of the injectible two-stage compression rotary compressor in the first embodiment.
FIG. 2 is a side view of a second embodiment of the injectible two-stage compression rotary compressor of the air conditioner according to the invention.
FIG. 3 is a side view of a third embodiment of the injectible two-stage compression rotary compressor of the air conditioner according to the invention.

BEST MODE(S) FOR CARRYING OUT THE INVENTION

[0014] Embodiments of an injectible two-stage compression rotary compressor according to the present invention will be described below in detail with reference to the drawings. The invention is not limited to the embodiments.

First Embodiment

[0015] FIG. 1A shows a basic structure of a refrigerating cycle of an air conditioner, FIG. 1B is a vertical sectional view showing a first embodiment of an injectible two-stage compression rotary compressor of the air conditioner according to the invention, FIG. 1C is a cross sectional view of a low-stage compressing section and a high-stage compressing section of the two-stage compression rotary compressor, FIG. 1D is a cross sectional view taken along line A-A of FIG. 1B, FIG. 1E is a cross sectional view of a low-stage end plate, FIG. 1F is a sectional view taken along line B-B of FIG. 1E, FIG. 1G is a front view of a compressor housing, FIG. 1H is a side view of the injectible two-stage compression rotary compressor in the first embodiment, FIG. 1I is a vertical sectional view showing a variation of the injectible two-stage compression rotary compressor in the first embodiment, and FIG. 1J is a vertical sectional view showing another variation of the injectible two-stage compression rotary compressor in the first embodiment.

[0016] As shown in FIG. 1A, the refrigerating cycle (heat pump system) of the air conditioner in the first embodiment includes the injectible two-stage compression rotary compressor (hereafter simply referred to as the "compressor") 1, a condenser (radiator) 4, a first expansion mechanism section 7A, a second expansion mechanism section 7B, an evaporator (heat absorber) 9, and basic cycle piping 2 for connecting them in an annular shape.

[0017] The compressor 1 is the injectible two-stage compression rotary compressor including a low-stage compressing section 12L and a high-stage compressing section 12H. An intermediate suction pipe 108 (see FIG. 1B) for drawing in an injection refrigerant at medium pressure between condenser pressure and evaporator pressure is connected to an intermediate connecting pipe 23 for connecting the low-stage compressing section 12L and the high-stage compressing section 12H. The compressor 1 is a so-called inverter compressor having a motor with a rotational speed variable according to a power supply frequency.

[0018] The first expansion mechanism section 7A is a variable throttle mechanism for optimizing pressure of the condenser (radiator) 4 and pressure of the evaporator (heat absorber) 9 with outside air temperature and indoor set temperature. The second expansion mechanism section 7B is a variable throttle mechanism for optimizing an amount of the injection refrigerant. The basic cycle piping 2 connects the above devices in order and circulates the refrigerant.

[0019] The heat pump system of the air conditioner includes a branch pipe 5, injection piping 6, and an internal heat exchanger 8 as well. The branch pipe 5 is disposed in the basic cycle piping 2 and between the condenser (radiator) 4 and the first expansion mechanism section 7A to cause the refrigerant to branch into a basic cycle and an injection cycle.

[0020] The injection piping 6 connects the branch pipe 5 and the intermediate suction pipe 108 with the second expansion mechanism section 7B interposed therebetween. The internal heat exchanger 8 exchange heat between a basic cycle piping 2a disposed between the branch pipe 5 and the first expansion mechanism section 7A and an injection piping 6a disposed between the second expansion mechanism section 7B and the intermediate suction pipe 108.

[0021] In the heat pump system of the air conditioner, a four-way valve 3 for reversing a flowing direction of the refrigerant in the basic cycle is connected to the compressor 1 in order to provide for cooling and heating. If the four-way valve 3 is reversed, functions of the condenser (radiator) 4 and the evaporator (heat absorber) 9 are reversed. In FIG. 1A, the four-way valve 3 is in such a state that a heat exchanger connected between the four-way valve 3 and the branch pipe 5 functions as the condenser and therefore heating operation is carried out if the heat exchanger is disposed in an indoor unit.

[0022] The heat pump system of the air conditioner in the first embodiment is an example that is injectible only in the heating operation when the heat exchanger connected between the four-way valve 3 and the branch pipe 5 is disposed in the indoor unit. By adding changeover piping for reversely connecting the condenser (radiator) 4 and the evaporator (heat absorber) 9 to the first expansion mechanism section 7A on the basic cycle and to the internal heat exchanger 8 and the branch pipe 5, the system become injectible during cooling as well. Although flows of the basic cycle refrigerant and the injection refrigerant in the internal heat exchanger 8 are parallel flows in the heat pump system of the air conditioner in the first embodiment, it is also possible to install piping so that they become counterflows.

[0023] Next, with reference to FIG. 1A, the flow of the refrigerant during the heating operation in the heat pump system of the air conditioner in the first embodiment will be described. The high-temperature and high-pressure gas refrigerant discharged from the compressor 1 exchanges heat with air in the condenser (radiator) 4, dissipates heat, and becomes liquid. Here, part of the liquefied refrigerant branches at the branch pipe 5 and becomes the injection refrigerant flowing through the injection piping 6 and the rest of the refrigerant becomes the basic cycle refrigerant flowing through the basic cycle piping 2.

[0024] Pressure of the injection refrigerant flowing into the injection piping 6 is reduced in the second expansion mechanism section 7B to medium pressure Pm and the refrigerant is brought into a two-phase state at medium temperature and exchanges heat with the refrigerant flowing through the basic cycle piping 2a in the internal heat exchanger 8 when it flows through the injection piping 6a in the internal heat exchanger 8 to thereby absorb heat to obtain higher dryness. Then, the injection refrigerant meets discharged gas from the low-stage compressing section 12L and is drawn into the high-stage compressing section 12H in a generally gasified state.

[0025] On the other hand, the refrigerant flowing through the basic cycle piping 2 exchanges heat with the medium temperature injection refrigerant flowing through the injection piping 6a in the internal heat exchanger 8 when it flows through the basic cycle piping 2a in the internal heat exchanger 8 to thereby dissipate heat and be supercooled to a greater degree. Then, pressure of the refrigerant flowing through the basic cycle piping 2 is reduced in the first expansion mechanism section 7A and the refrigerant comes into a low temperature and low pressure two-phase state and exchanges heat with air in the evaporator (heat absorber) 9 to thereby absorb heat to come into a superheated state.

[0026] Then, the superheated refrigerant flows through the four-way valve 3 and a low-pressure connecting pipe 31 of the compressor 1 and is drawn into the low-stage compressing section 12L. The refrigerant drawn into the low-stage compressing section 12L is compressed in the low-stage compressing section 12L. After the refrigerant is discharged from the low-stage compressing section 12L, it meets the injection refrigerant and is drawn into the high-stage compressing section 12H.

[0027] The refrigerant drawn into the high-stage compressing section 12H is compressed in the high-stage compressing section 12H to high pressure that is final discharge pressure and discharged into a compressor housing 10 of the compressor 1. The refrigerant discharged into the compressor housing 10 of the compressor 1 is discharged outside the compressor housing 10 through a discharge pipe 107.

[0028] Next, the injectible two-stage compression rotary compressor 1 of the air conditioner of the first embodiment will be described. As shown in FIG. 1B, the compressor 1 of the first embodiment includes a compressing section 12 and a motor 11 for driving the compressing section 12 in the sealed cylindrical compressor housing 10.

[0029] A stator 111 of the motor 11 is fixed by shrink fitting to an inner peripheral face of the compressor housing 10. A rotor 112 of the motor 11 is disposed at a center of the stator 111 and is fixed by shrink fitting to a shaft 15 that mechanically connects the motor 11 and the compressing section 12.

[0030] The compressing section 12 includes the low-stage compressing section 12L and the high-stage compressing section 12H connected in series to the low-stage compressing section 12L and disposed above the low-stage compressing section 12L. As shown in FIGS. 1B and 1C, the low-stage compressing section 12L has a low-stage cylinder 121L and the high-stage compressing section 12H has a high-stage cylinder 121H.

[0031] In the low-stage cylinder 121L and the high-stage cylinder 121H, low-stage and high-stage cylinder bores 123L and 123H are formed, respectively, to be concentric with the motor 11. In the respective cylinder bores 123L and 123H, cylindrical low-stage and high-stage pistons 125L and 125H having smaller outside diameters than the bore diameters are disposed, respectively, to form compression spaces for compressing the refrigerant between the cylinder bore 123L and the low-stage piston 125L and between the cylinder bore 123H and the high-stage piston 125H, respectively.

[0032] In each of the cylinders 121L and 121H, a groove as high as the cylinder is formed to extend radially from the cylinder bore 123L or 123H. In the groove, a plate-shaped low-stage or high-stage vane 127L or 127H is fitted. Each of the vanes 127L and 127H is mounted, on its side facing the compressor housing 10, with a low-stage or high-stage spring 129L or 129H.

[0033] With repulsive forces of the springs 129L and 129H, tip ends of the vanes 127L and 127H are pushed against outer peripheral faces of the pistons 125L and 125H and the vanes 127L and 127H partition the compression spaces into low-stage and high-stage suction chambers 131L, 131H and low-stage and high-stage compression chambers 133L and 133H.

[0034] The cylinders 121L and 121H are provided with low-stage and high-stage suction holes 135L and 135H communicating with the suction chambers 131L and 131H to draw the refrigerant into the suction chambers 131L and 131H.

[0035] Between the low-stage cylinder 121L and the high-stage cylinder 121H, an intermediate partitioning plate 140 is disposed to partition the compression spaces into the space in the low-stage cylinder 121L and the space in the high-stage cylinder 121H. Below the low-stage cylinder 121L, a low-stage end plate 160L is disposed to close a lower side of the compression space in the low-stage cylinder 121L. Above the high-stage cylinder 121H, a high-stage end plate 160H is disposed to close an upper side of the compression space in the high-stage cylinder 121H.

[0036] On the low-stage end plate 160L, a lower bearing portion 161L is formed. A lower portion 151 of the shaft 15 is rotatably supported on the lower bearing portion 161L. On the high-stage end plate 160H, an upper bearing portion 161H is formed. A middle portion 153 of the shaft 15 is fitted in the upper bearing portion 161H.

[0037] The shaft 15 has eccentric low-stage crank portion 152L and high-stage crank portion 152H with a 180° phase shift from each other. The low-stage crank portion 152L retains the low-stage piston 125L of the low-stage compressing section 12L for rotation and the high-stage crank portion 152H retains the high-stage piston 125H of the high-stage compressing section 12H for rotation.

[0038] If the shaft 15 rotates, the low-stage and high-stage pistons 125L and 125H rotate while rolling on inner peripheral walls of the low-stage and high-stage cylinder bores 123L and 123H. Following the pistons 125L and 125H, the low-stage and high-stage vanes 127L and 127H reciprocate. Due to the motions of the low-stage and high-stage pistons 125L and 125H and the low-stage and high-stage vanes 127L and 127H, capacities of the low-stage and high-stage suction chambers 131L and 131H and the low-stage and high-stage compression chambers 133L and 133H continuously change and the compressing section 12 continuously draws in, compresses, and discharges the refrigerant.

[0039] Below the low-stage end plate 160L, a low-stage muffler cover 170L is disposed to form a low-stage muffler chamber 180L between the low-stage end plate 160L and the low-stage muffler cover 170L. A discharge portion of the low-stage compressing section 12L opens into the low-stage muffler chamber 180L. In other words, in the low-stage end plate 160L, a low-stage discharge hole 190L connecting the compression space in the low-stage cylinder 121L and the low-stage muffler chamber 180L is formed. In the low-stage discharge hole 190L, a low-stage discharge valve 200L for preventing backflow of the compressed refrigerant is disposed.

[0040] As shown in FIGS. 1D and 1E, the low-stage muffler chamber 180L is a single annular chamber and is part of an intermediate connecting passage connecting a discharge side of the low-stage compressing section 12L and a suction side of the high-stage compressing section 12H.

[0041] As shown in FIGS. 1E and 1F, on the low-stage discharge valve 200L, a low-stage discharge valve guard 201L for restricting a flexible valve opening amount of the low-stage discharge valve 200L is fixed together with the low-stage discharge valve 200L by a rivet 203. In an outer peripheral wall portion of the low-stage end plate 160L, a low-stage muffler discharge hole 210L for discharging the refrigerant in the low-stage muffler chamber 180L is formed. The low-stage muffler discharge hole 210L and the high-stage suction hole 135H are formed in the same direction on a circumference.

[0042] Above the high-stage end plate 160H, a high-stage muffler cover 170H is disposed to form a high-stage muffler chamber 180H between the high-stage end plate 160H and the high-stage muffler cover 170H. In the high-stage end plate 160H, a high-stage discharge hole 190H connecting the compression space in the high-stage cylinder 121H and the high-stage muffler chamber 180H is formed. In the high-stage discharge hole 190H, a high-stage discharge valve 200H for preventing backflow of the compressed refrigerant is disposed. On the high-stage discharge valve 200H, a high-stage discharge valve guard 201H for restricting a flexible valve opening amount of the high-stage discharge valve 200H is fixed together with the high-stage discharge valve 200H by a rivet.

[0043] The low-stage cylinder 121L, the low-stage end plate 160L, the low-stage muffler cover 170L, the high-stage cylinder 121H, the high-stage end plate 160H, the high-stage muffler cover 170H, and the intermediate partitioning plate 140 are fastened together by bolts (not shown). An outer peripheral portion of the high-stage end plate 160H of the compressing section 12 fastened together by the bolts is secured to the compressor housing 10 by spot welding. In this way, the compressing section 12 is fixed to the compressor housing 10.

[0044] As shown in FIG. 1G, in an outer peripheral wall of the cylindrical compressor housing 10, a first communication hole 101, a second communication hole 102, and a third communication hole 103 are formed in this order upward from a lower portion while spaced from each other in an axial direction. The first communication hole 101, the second communication hole 102, and the third communication hole 103 are formed in the same circumferential positions of the compressor housing 10.

[0045] As shown in FIGS. 1B and 1H, an accumulator 25 formed of a separate cylindrical sealed container is retained by an accumulator holder 251 and an accumulator band 253 in a circumferential position with a rightward phase shift from the front (the circumferential position where the first communication hole 101, the second communication hole 102, and the third communication hole 103 are formed) of an outer side portion of the compressor housing 10 in order to avoid interference with piping (described later).

[0046] To a center of a top portion of the accumulator 25, a system connecting pipe 255 connected to the refrigerating cycle side is connected. To a bottom communication hole 257 formed at a center of a bottom portion of the accumulator 25, the low-pressure connecting pipe 31 is connected. The low-pressure connecting pipe 31 has one end extending to an upper portion inside the accumulator 25 and the other end connected to the other end of a low-stage suction pipe 104.

[0047] To the low-stage muffler discharge hole 210L of the low-stage muffler chamber 180L, one end of a low-stage discharge pipe 105 is connected through the first communication hole 101. To the high-stage suction hole 135H of the high-stage cylinder 121H, one end of a high-stage suction pipe 106 is connected through the third communication hole 103. The other end of the low-stage discharge pipe 105 and the other end of the high-stage suction pipe 106 are connected by the intermediate connecting pipe 23 bent into a U shape in a two-dimensional manner. The low-pressure connecting pipe 31 is bent at right angles at two positions in a three-dimensional manner in order to avoid interference with the U-shaped intermediate communication pipe 23.

[0048] The intermediate communication passage connecting the discharge side of the low-stage compressing section 12L and the suction side of the high-stage compressing section 12H is formed of the low-stage muffler chamber 180L, the low-stage muffler discharge hole 210L, the intermediate connecting pipe 23, and the suction hole 135H of the high-stage compressing section 12H. To a U-shape upper portion (a downstream side) of the intermediate connecting pipe 23, the intermediate suction pipe 108 (described later) is connected.

[0049] A temperature sensor 240 for measuring temperature of the refrigerant discharged from the low-stage muffler chamber 180L is attached to an outer face of a portion of the intermediate connecting pipe 23 which is on an upstream side of a junction with the intermediate suction pipe 108 and is near the low-stage compressing section 12L.

[0050] The discharge portion of the high-stage compressing section 12H communicates with an inside of the compressor housing 10 via the high-stage muffler chamber 180H. In other words, the high-stage end plate 160H is provided with the high-stage discharge hole 190H connecting the compression space in the high-stage cylinder 121H and the high-stage muffler chamber 180H. In the high-stage discharge hole 190H, the high-stage discharge valve 200H for preventing backflow of the compressed refrigerant is disposed. The discharge portion of the high-stage muffler chamber 180H communicates with the inside of the compressor housing 10. To the top portion of the compressor housing 10, the discharge pipe 107 for discharging the high pressure refrigerant to the refrigerating side is connected.

[0051] Lubricating oil is encapsulated in the compressor housing 10 to a level of the high-stage cylinder 121H and is circulated through the compressing section 12 by a vane pump (not shown) inserted into a lower portion of the shaft 15 to lubricate sliding members and seal portions where minute gaps partition the compression space for the compressed refrigerant.

[0052] As shown in FIGS. 1B and 1H, as a structure characterizing the compressor 1 in the first embodiment, a tip end portion of the intermediate suction pipe 108 formed into the L shape is inserted into and connected (welded) to the upper portion of the intermediate connecting pipe 23 having a greater diameter than the intermediate suction pipe 108. An outlet at the tip end portion of the intermediate suction pipe 108 faces in substantially the same direction as a flowing direction of the medium pressure gas refrigerant in the intermediate connecting pipe 23. In this way, depending on conditions, it is possible to jet out the injection refrigerant having a higher flow rate than the medium pressure gas refrigerant to exert an ejector effect.

[0053] In other words, the injection refrigerant jetted out from the intermediate suction pipe 108 draws in the medium pressure gas refrigerant from the low-stage compressing section 12L and makes it easy to draw it into the high-stage compressing section 12H. As a result, a pressure loss of the medium pressure gas refrigerant can be reduced, suction pressure of the high-stage compressing section 12H can be increased, and efficiency of the compressor 1 can be enhanced.

[0054] FIG. 1I shows a variation of the compressor 1 in the first embodiment. In this variation, the outlet of the tip end portion of the intermediate suction pipe 108 inserted into the upper portion of the intermediate connecting pipe 23 is cut diagonally to be parallel to an inner wall of the intermediate connecting pipe 23. Because the tip end portion of the intermediate suction pipe 108 inserted into the intermediate connecting pipe 23 is cut, flow path resistance of the medium pressure gas refrigerant reduces, the pressure loss can be further reduced, and efficiency of the compressor 1 can be further enhanced.

[0055] FIG. 1J shows another variation of the compressor 1 in the first embodiment. In this variation, the outlet of the tip end portion of the intermediate suction pipe 108 formed into an L shape is inserted upward into a lower portion of the intermediate connecting pipe 23 and the intermediate suction pipe 108 and the intermediate connecting pipe 23 are connected (welded) to each other. The outlet of the tip end portion of the intermediate suction pipe 108, facing in substantially the same direction as the flowing direction of the medium pressure gas refrigerant in the intermediate connecting pipe 23, provides the ejector effect. In this way, it is possible to obtain similar effects to those of the above examples.

Second Embodiment

[0056] FIG. 2 is a side view of a second embodiment of the injectible two-stage compression rotary compressor of the air conditioner according to the invention. As a structure characterizing a compressor 1B in the second embodiment, the low-stage muffler discharge hole 210L (see FIG. 1E) is provided in a radial direction in a position with a leftward phase shift in a circumferential direction of the compressor housing 10 from the low-stage suction hole 135L (see FIG. 1C) and the high-stage suction hole 135H of the compressing section 12.

[0057] As shown in FIG. 2, the cylindrical compressor housing 10 is provided, in its outer peripheral wall, with the first communication hole 101, the second communication hole 102, and the third communication hole 103 in this order upward from a lower portion while spaced from each other in an axial direction. The second communication hole 102 and the third communication hole 103 are provided in the same circumferential position (front) of the compressor housing 10 and the first communication hole 101 is provided in a different circumferential position (a position displaced leftward) from the second communication hole 102 and the third communication hole 103.

[0058] The low-pressure connecting pipe 31 for introducing the low pressure refrigerant in the refrigerating cycle into the low-stage compressing section 12L via the accumulator 25 is connected to the low-stage suction hole 135L of the low-stage cylinder 121L with the second communication hole 102 and the low-stage suction pipe 104 interposed therebetween. The low-pressure connecting pipe 31 is bent into a shape of a quarter of a circle in a two-dimensional manner between the low-stage suction pipe 104 and the bottom communication hole 257 of the accumulator 25.

[0059] To the low-stage muffler discharge hole 210L of the low-stage muffler chamber 180L, one end of the low-stage discharge pipe 105 is connected through the first communication hole 101. To the high-stage suction hole 135H of the high-stage cylinder 121H, one end of the high-stage suction pipe 106 is connected through the third communication hole 103. The other end of the low-stage discharge pipe 105 and the other end of the high-stage suction pipe 106 are connected by the intermediate connecting pipe 23 bent into a U shape in a two-dimensional manner.

[0060] The first communication hole 101 is provided in the different circumferential position (the position displaced leftward) from the second and third communication holes 102 and 103 so that the low-pressure connecting pipe 31 and the intermediate connecting pipe 23 do not interfere with each other. The method of connecting the intermediate suction pipe 108 and the intermediate connecting pipe 23 is the same as that in the first embodiment (including the variation and the other variation).

[0061] In the compressor 1B in the second embodiment, the low-pressure connecting pipe 31 can be bent at one position into the arc shape in the two-dimensional manner, which facilitates working of low-pressure connecting pipe 31 and reduces cost. Moreover, duct resistance of the low-pressure connecting pipe 31 can be reduced, a suction pressure loss can be reduced, and compression efficiency of the compressor 1B can be enhanced.

Third Embodiment

[0062] FIG. 3 is a side view showing a third embodiment of the injectible two-stage compression rotary compressor of the air conditioner according to the invention. As a structure characterizing a compressor 1C in the third embodiment, the low-stage suction hole 135L (see FIG. 1C) of the compressing section 12 is provided in a radial direction in a position with a rightward phase shift in a circumferential direction of the compressor housing 10 from the low-stage muffler discharge hole 210L (see FIG. 1E) and the high-stage suction hole 135H.

[0063] As shown in FIG. 3, the cylindrical compressor housing 10 is provided, in its outer peripheral wall, with the first communication hole 101, the second communication hole 102, and the third communication hole 103 in this order upward from a lower portion while spaced from each other in an axial direction. The first communication hole 101 and the third communication hole 103 are provided in substantially the same circumferential position (front) of the compressor housing 10 and the second communication hole 102 is provided in a different circumferential position (a position displaced rightward) from the first communication hole 101 and the third communication hole 103 so that the low-pressure connecting pipe 31 and the intermediate connecting pipe 23 do not interfere with each other.

[0064] As shown in FIG. 3, the accumulator 25 formed of a separate cylindrical sealed container is retained by the accumulator holder 251 and the accumulator band 253 in a position with a rightward phase shift from the front (substantially the same circumferential position as the second communication hole 102) of an outer side portion of the compressor housing 10. To a center of a top portion of the accumulator 25, the system communication hole 255 connected to the refrigerating cycle side is connected. To the bottom communication hole 257 formed at a center of a bottom portion of the accumulator 25, the low-pressure connecting pipe 31 is connected. The low-pressure connecting pipe 31 has one end extending to an upper portion inside the accumulator 25 and the other end connected to the other end of the low-stage suction pipe 104.

[0065] The low-pressure connecting pipe 31 for introducing the low pressure refrigerant in the refrigerating cycle into the low-stage compressing section 12L via the accumulator 25 is connected to the low-stage suction hole 135L of the low-stage cylinder 121L with the second communication hole 102 and the low-stage suction pipe 104 interposed therebetween. The low-pressure connecting pipe 31 is bent into a shape of a quarter of a circle in a two-dimensional manner between the low-stage suction pipe 104 and the bottom communication hole 257 of the accumulator 25.

[0066] To the low-stage muffler discharge hole 210L of the low-stage muffler chamber 180L, one end of the low-stage discharge pipe 105 is connected through the first communication hole 101. To the high-stage suction hole 135H of the high-stage cylinder 121H, one end of the high-stage suction pipe 106 is connected through the third communication hole 103. The other end of the low-stage discharge pipe 105 and the other end of the high-stage suction pipe 106 are connected by the intermediate connecting pipe 23 bent into a U shape in a two-dimensional manner. The second communication hole 102 is provided in the different circumferential position (the position displaced rightward) from the first and third communication holes 101 and 103 so that the low-pressure connecting pipe 31 and the intermediate connecting pipe 23 do not interfere with each other.

[0067] As described above, in the rotary compressor 1C of the third embodiment, the first communication hole 101 and the third communication hole 103 in the compressor housing 10 are disposed in substantially the same circumferential position (front) of the compressor housing 10 and the second communication hole 102 is disposed in the different circumferential position (the position displaced rightward) from the first and third communication holes 101 and 103 so that the low-pressure connecting pipe 31 and the intermediate connecting pipe 23 do not interfere with each other.

[0068] As a result, similarly to the second embodiment, the low-pressure connecting pipe 31 can be bent at one position into the U shape in the two-dimensional manner, which can be facilitated working of the low-pressure connecting pipe 31 and reduced cost. Moreover, duct resistance of the low-pressure connecting pipe 31 can be reduced, a suction pressure loss can be reduced, and compression efficiency of the compressor 1C can be enhanced.

[0069] Because the pressure loss in the low-pressure connecting pipe 31 increases during high rotation operation of the motor 11 with the variable rotational speed, i.e., when a circulating refrigerant flow rate is large, it is possible to enhance the efficiency of the compressors 1B and 1C by bending the low-pressure connecting pipe 31 at one position to reduce the pressure loss as in the second and third embodiments.

[0070] In the embodiment of the injectible two-stage compression rotary compressor according to the present invention, the flow of the medium pressure gas refrigerant in the intermediate connecting pipe and a flow of the injection refrigerant jetted out from the outlet of the intermediate suction pipe are parallel to each other, which reduces pressure pulsation in the intermediate connecting pipe, reduces a suction loss in the high-stage compressing section, and enhances efficiency of the compressor.

[0071] Although the invention has been described with respect to a specific embodiment for a complete and clear disclosure, the appended claims are not to be thus limited but are to be construed as embodying all modifications and alternative constructions that may occur to one skilled in the art that fairly fall within the basic teaching herein set forth.

Claims

1. An injectible two-stage compression rotary compressor (1; 1B; 1C) used for a heat pump system utilizing an injection refrigerating cycle, the compressor (1; 1B; 1C) comprising:

   a sealed cylindrical compressor housing (10) in which first, second, and third communication holes (101, 102, 103) are sequentially provided apart in an axial direction on an outer peripheral wall thereof;

   a low-stage compressing section (12L) provided within the compressor housing (10) with one end of a low-stage suction pipe (104) connected to a low-stage suction hole (135L) through the second communication hole (102) and one end of a low-stage discharge pipe (105) connected to a low-stage muffler discharge hole (210L) through the first communication hole (101);

   a high-stage compressing section (12H) provided near the low-stage compressing section (12H) within the compressor housing (10) with one end of a high-stage suction pipe (106) connected to a high-stage suction hole (135H) through the third communication hole (103) and a high-stage muffler discharge hole communicating with an inside of the compressor housing (10);

   a motor (11) for driving the low-stage compressing section (12L) and the high-stage compressing section (12H);

   a sealed cylindrical accumulator (25) held at an

outer side portion of the compressor housing (10);
a low-pressure connecting pipe (31) connecting a bottom communication hole (257) of the accumulator (25) and the other end of the low-stage suction pipe (104);
an intermediate connecting pipe (23) connecting the other end of the low-stage discharge pipe (105) and the other end of the high-stage suction pipe (106); and
an intermediate suction pipe (108) for introducing a medium pressure injection refrigerant into the intermediate connecting pipe (23), the medium pressure injection refrigerant being a wet refrigerant of the injection refrigerating cycle side,

wherein the intermediate suction pipe (108) is connected to the intermediate connecting pipe (23) so that an outlet of the intermediate suction pipe (108) faces in a flowing direction of a medium pressure gas refrigerant in the intermediate connecting pipe (23).

2. The injectible two-stage compression rotary compressor (1B) according to claim 1,
wherein the second and third communication holes (102, 103) are provided in substantially the same circumferential position of the compressor housing (10),
the first communication hole (101) is provided in a different circumferential position from the second and third communication holes (102, 103),
the accumulator (25) is held in substantially the same circumferential position as the second and third communication holes (102, 103), and
the low-pressure connecting pipe (31) and the intermediate connecting pipe (23), each being bent in a two-dimensional manner, are provided so that interference between the low-pressure connecting pipe (31) and the intermediate connecting pipe (23) is avoided.

3. The injectible two-stage compression rotary compressor (1C) according to claim 1,
wherein the first and third communication holes (101, 103) are provided in substantially the same circumferential position of the compressor housing (10),
the second communication hole (102) is provided in a different circumferential position from the first and third communication holes (101, 103),
the accumulator (25) is held in substantially the same circumferential position as the second communication hole (102), and
the low-pressure connecting pipe (31) and the intermediate connecting pipe (23), each being bent in a two-dimensional manner, are provided so that interference between the low-pressure connecting pipe (31) and the intermediate connecting pipe (23) is avoided.

4. An injectible two-stage compression rotary compressor (1; 1B; 1C) according to any one of claims 1 to 3, adapted to variable rotational speed drive.

FIG.1A

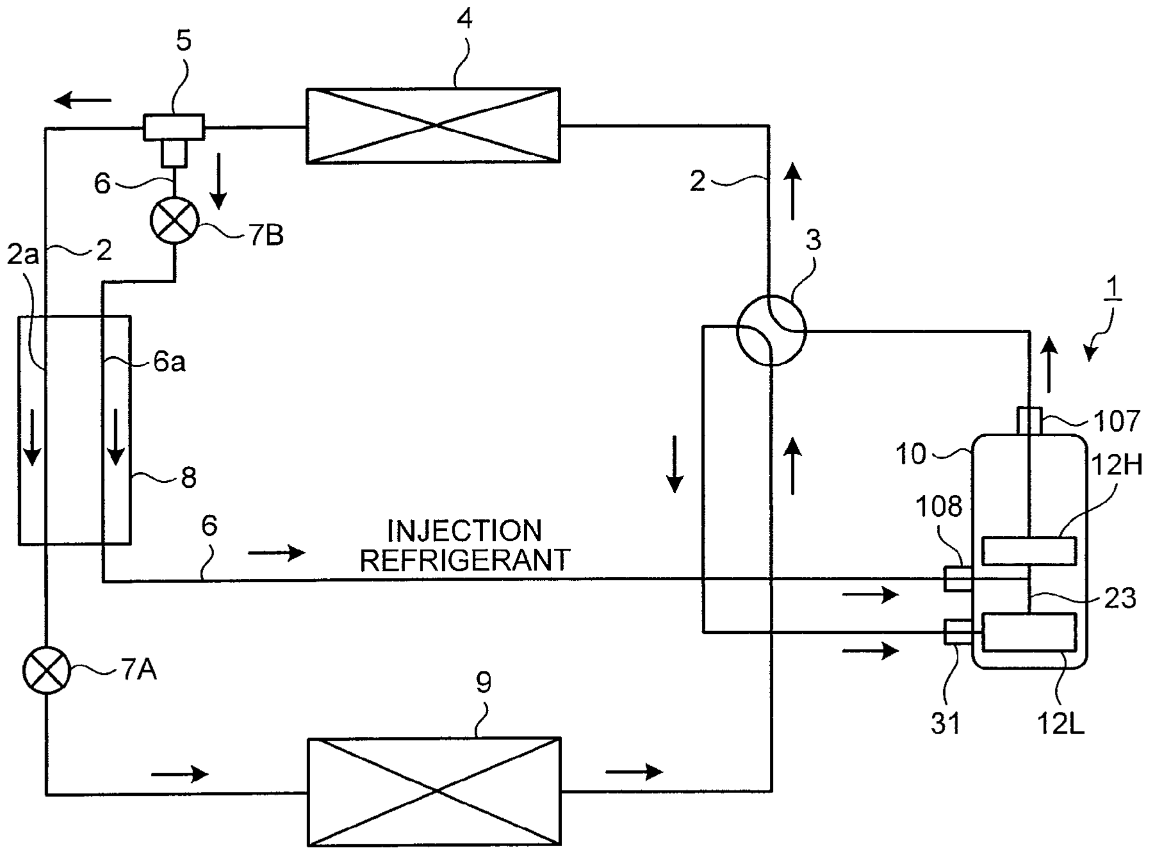

4
5
2
6
7B
2a
2
3
1
6a
107
10
12H
8
108
6
INJECTION
REFRIGERANT
23
7A
9
31
12L

FIG.1B

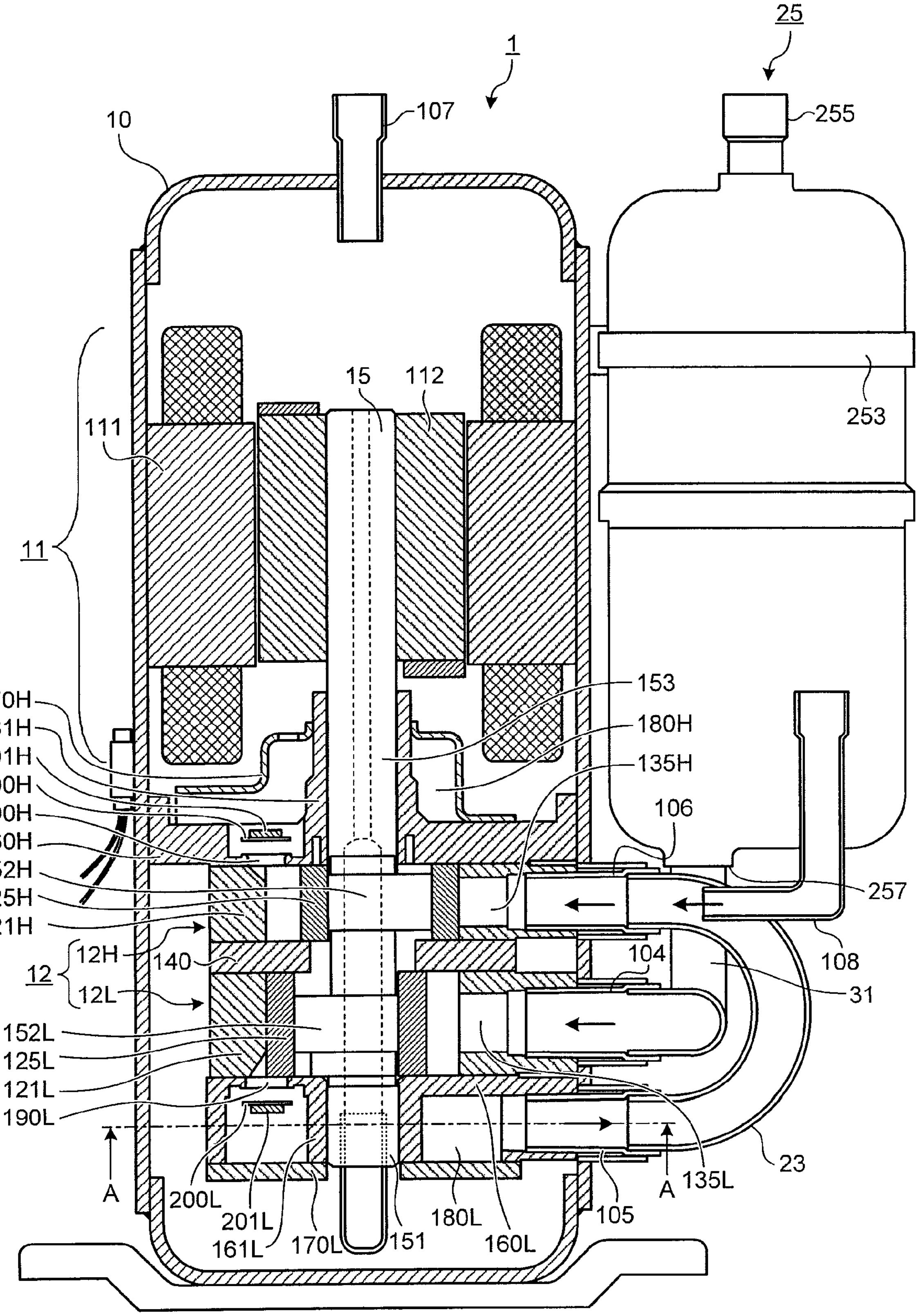

1
25
10
107
255
253
111
15
112
11
153
180H
135H
106
257
108
31
104
170H
161H
201H
200H
190H
160H
152H
125H
121H
12H
140
12
12L
152L
125L
121L
190L
A
200L
201L
161L
170L
151
180L
160L
105
135L
23

FIG.1C

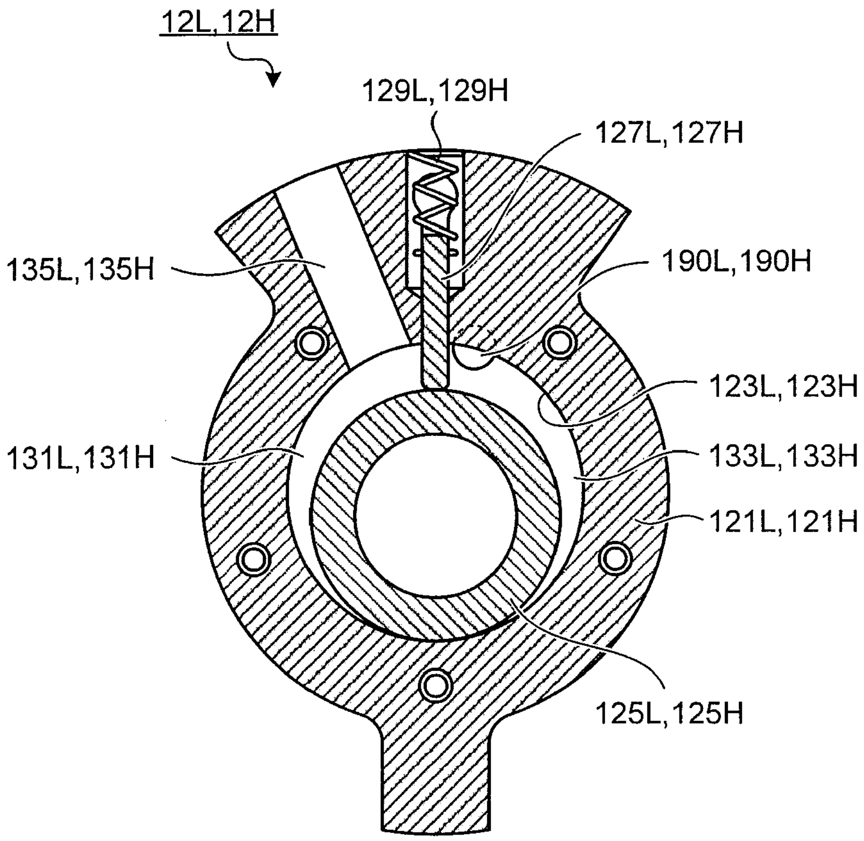

12L,12H
129L,129H
127L,127H
135L,135H
190L,190H
123L,123H
131L,131H
133L,133H
121L,121H
125L,125H

FIG.1D

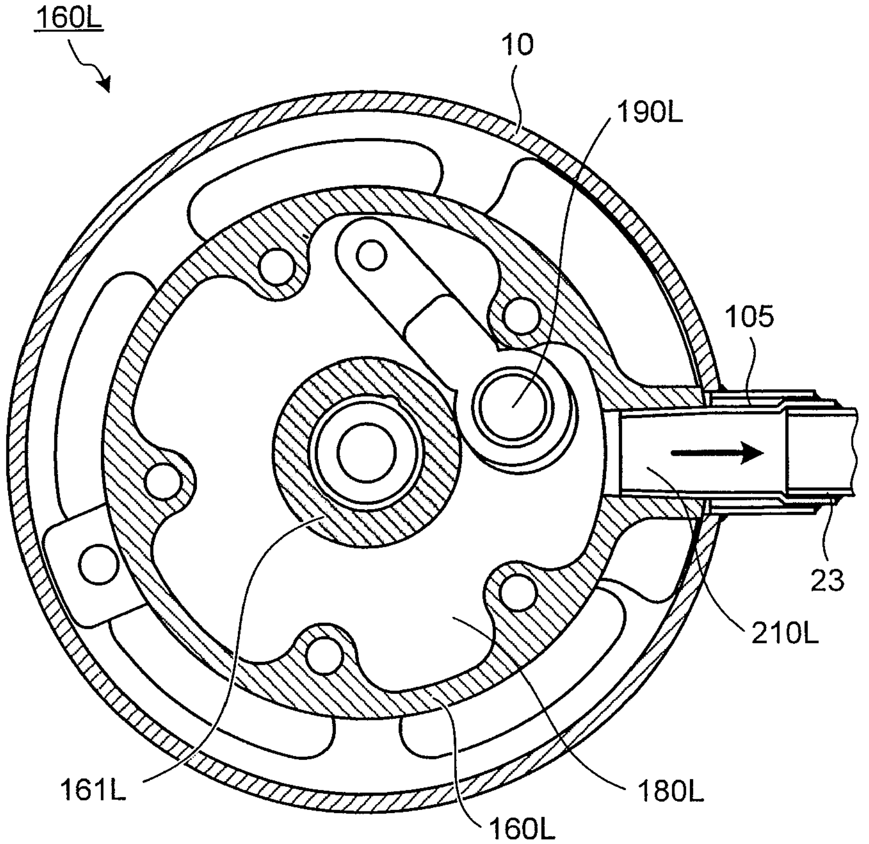


FIG.1E

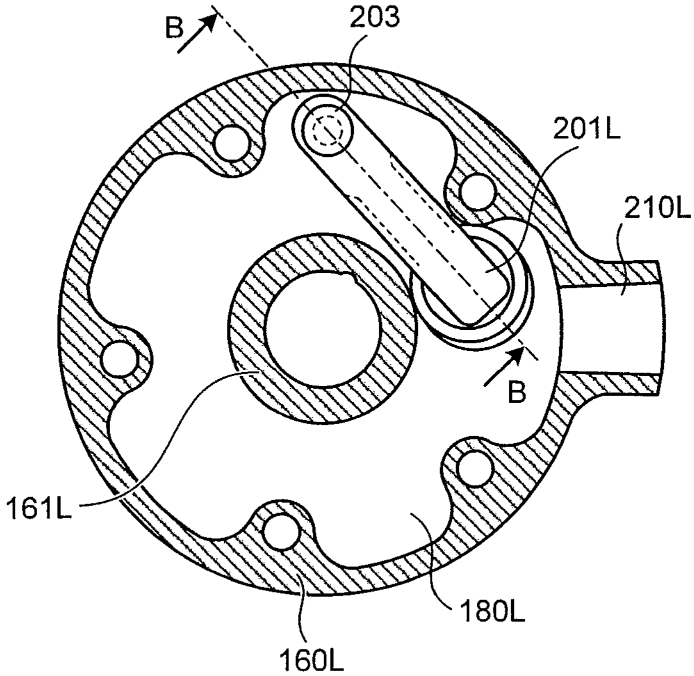


FIG.1F

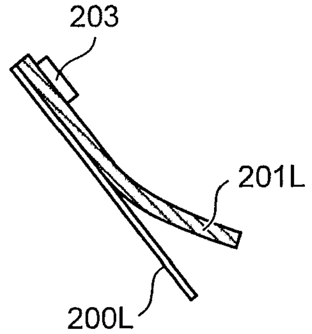


FIG.1G

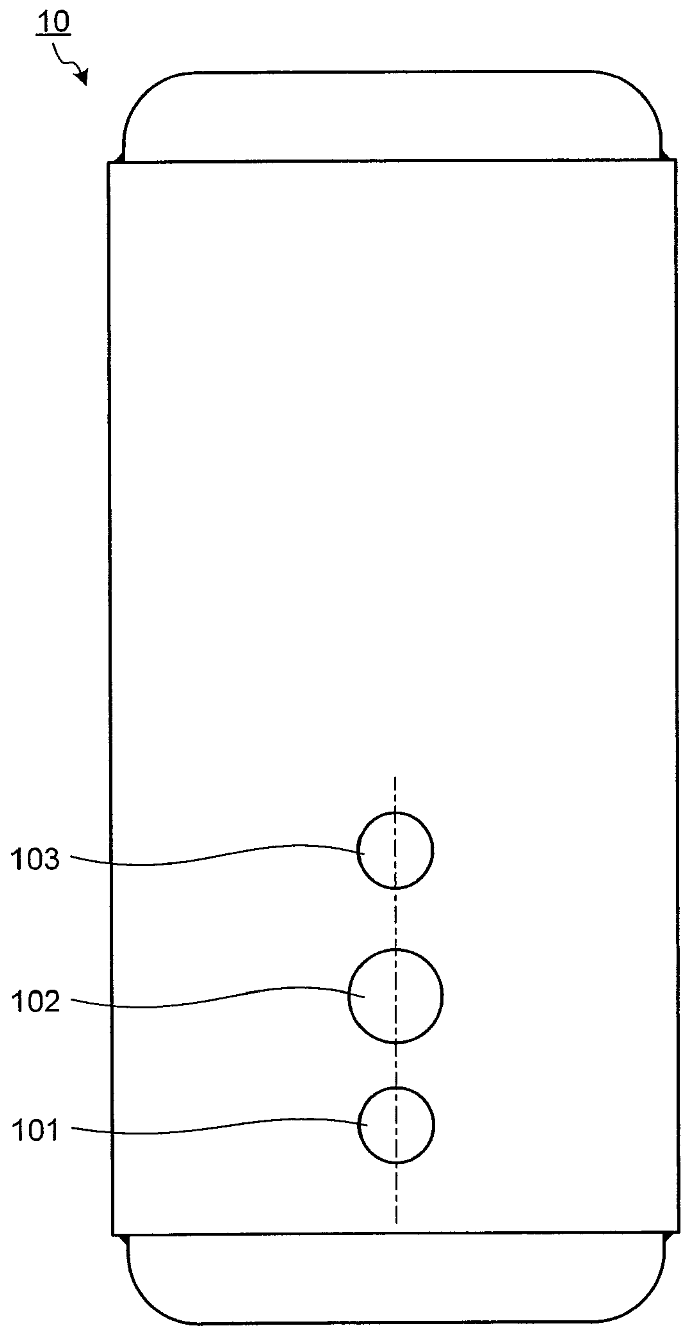


FIG.1H

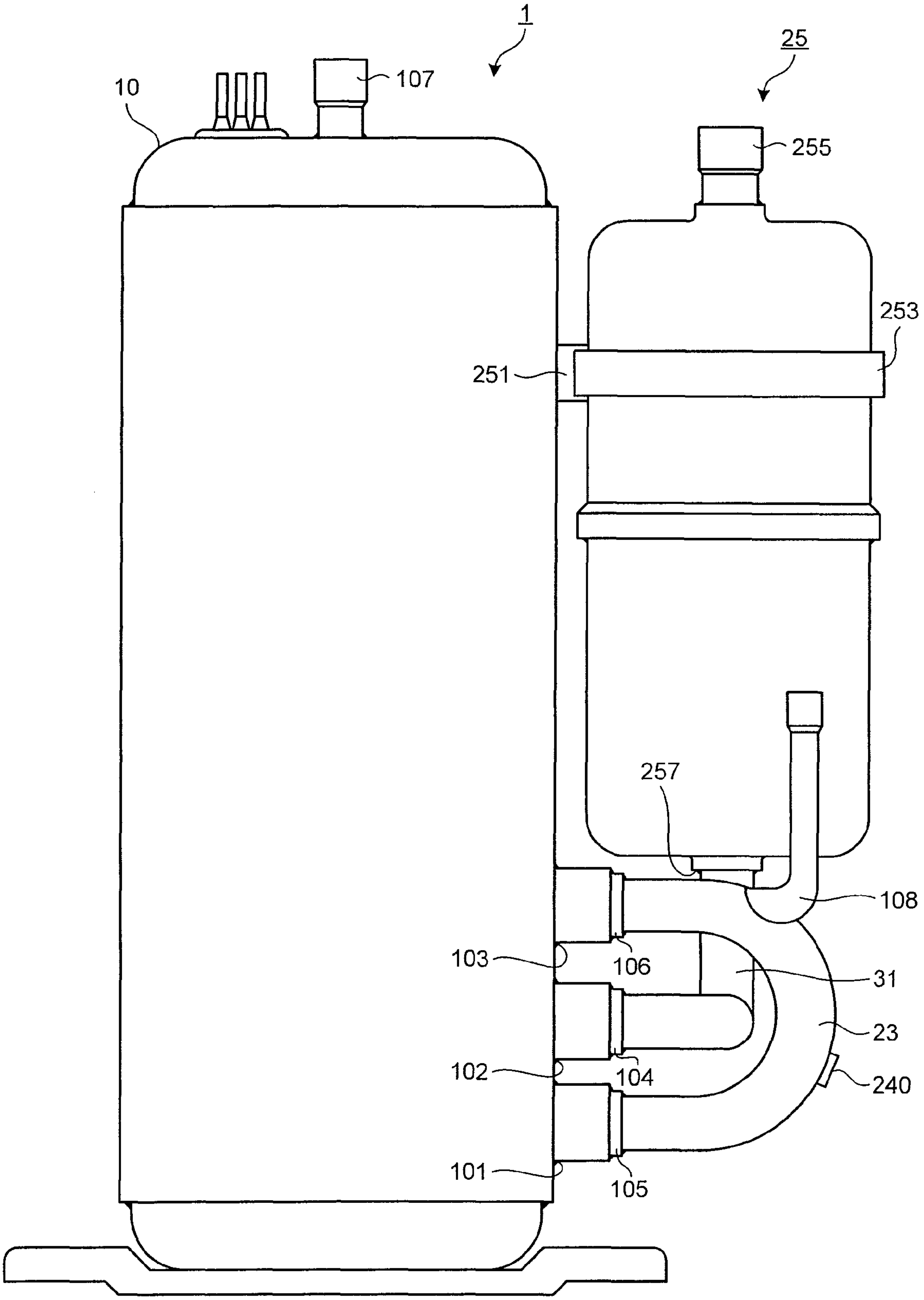
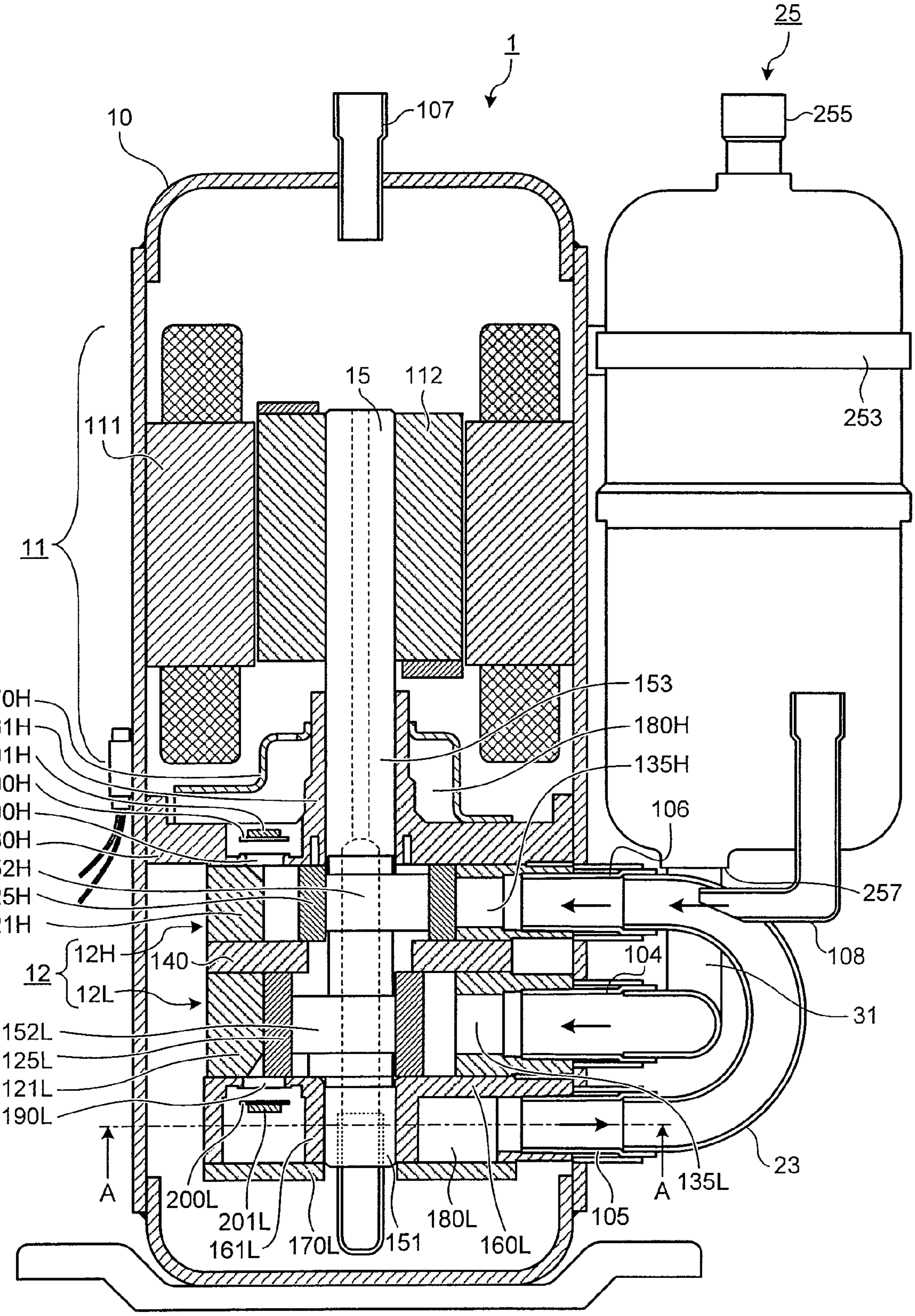


FIG.1I


25
1
107
255
10
15
112
111
253
11
153
170H
180H
161H
135H
201H
200H
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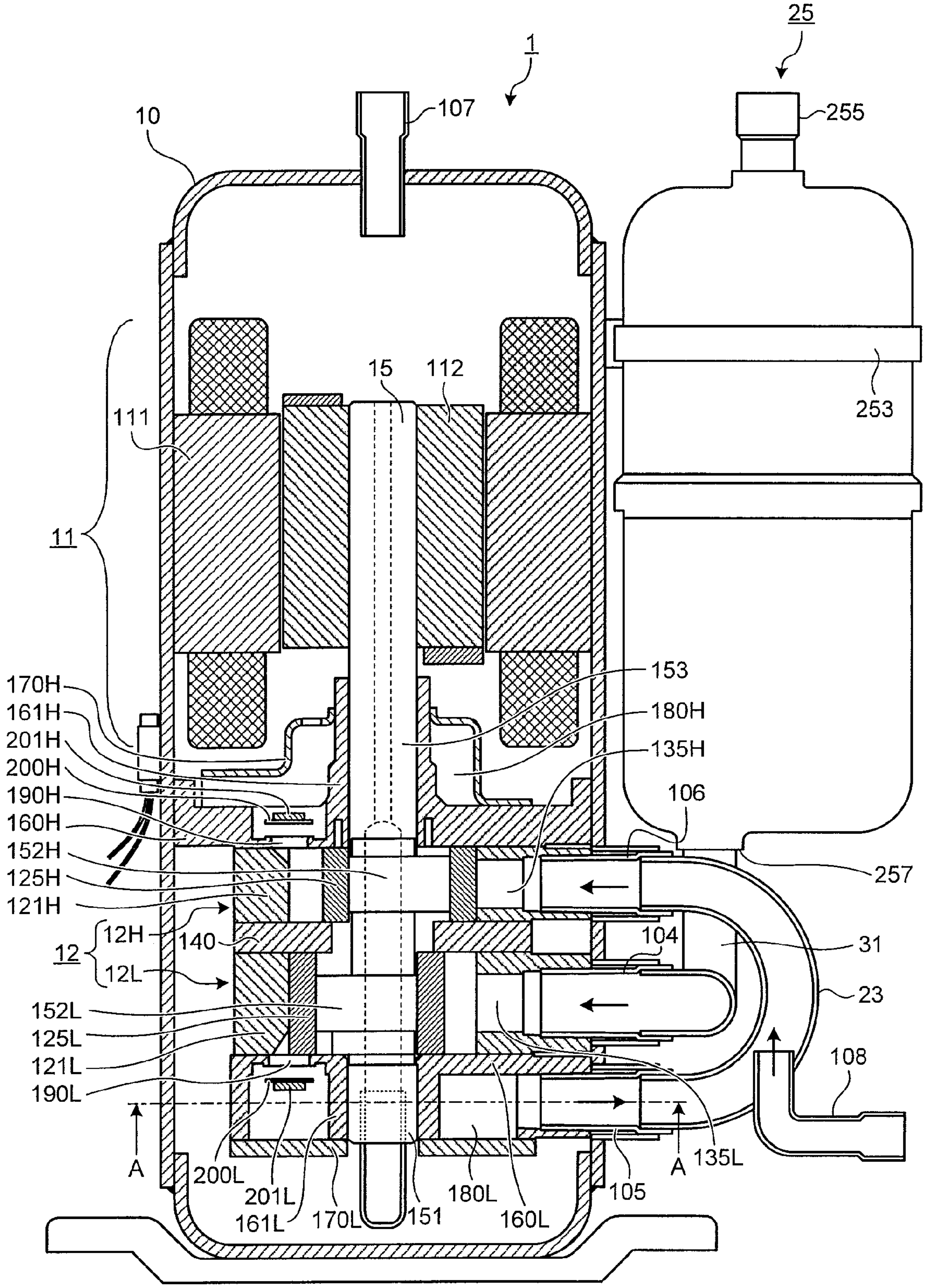
190H
160H
152H
257
125H
121H
108
12H
140
104
12
12L
31
152L
125L
121L
190L
23
A
200L
A
135L
201L
105
161L
170L
151
180L
160L

FIG.1J



25
1
107
10
255
11
111
15
112
253
170H
161H
201H
200H
190H
160H
152H
125H
121H
153
180H
135H
106
257
12
12H
12L
140
104
31
23
152L
125L
121L
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201L
161L
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151
180L
160L
105
A
135L

FIG.2

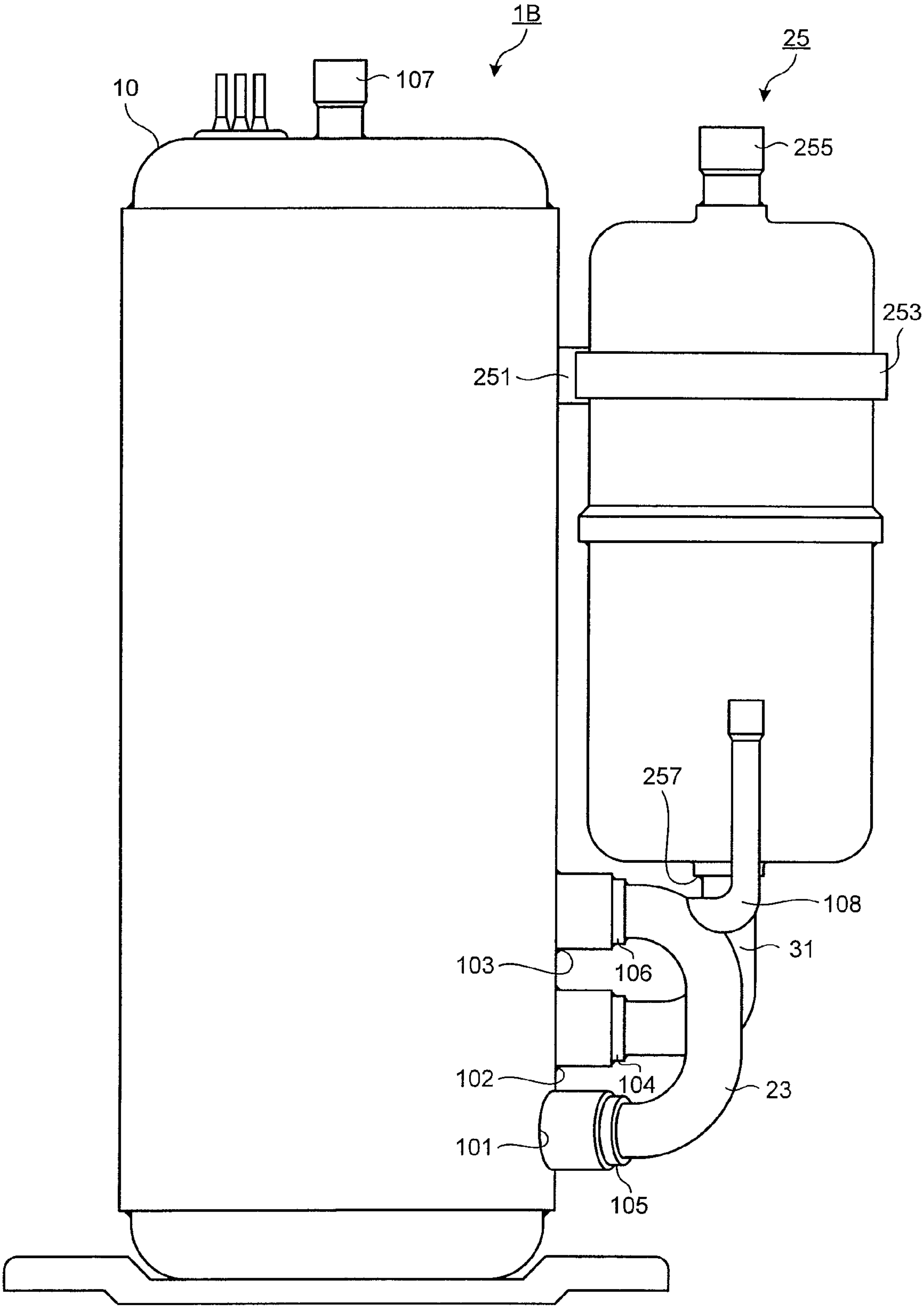
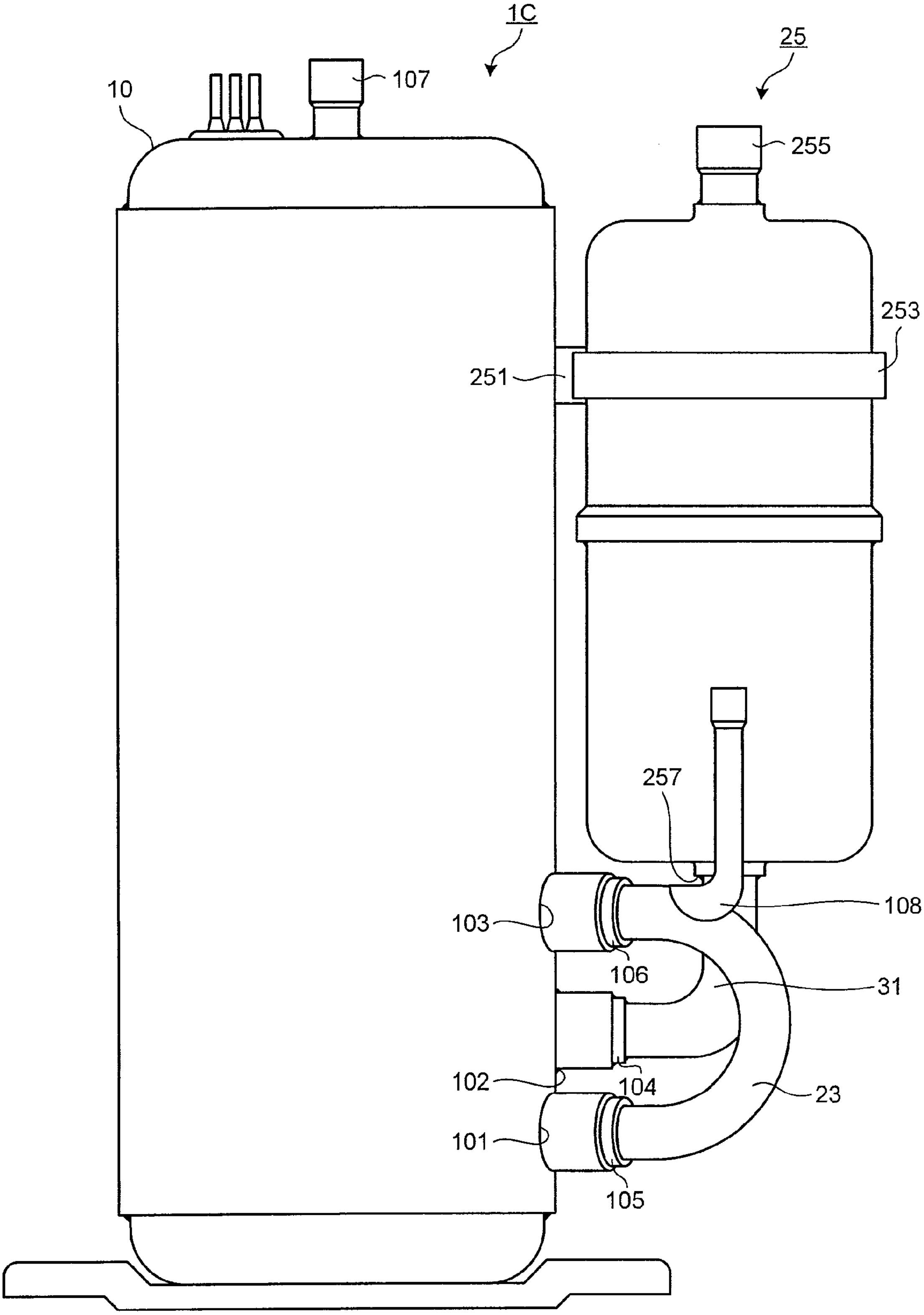


FIG.3



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Patent documents cited in the description

- JP 2006152931 A **[0006]**