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(54) **SCROLL COMPRESSOR**

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(57) **ABSTRACT**

In a scroll compressor according to the present invention, at least one injection port penetrating a second end plate of a fixed scroll at a position where the injection port is open to a first compression chamber or a second compression chamber in a compression stroke after the suction refrigerant is introduced and closed. Further, the discharge bypass port is disposed such that a volume ratio, which is a ratio of a suction volume to a discharge volume of the second compression chamber at which the refrigerant in the first compression chamber can be discharged, is smaller in the first compression chamber, which is one compression chamber having the large amount of the refrigerant injected from the injection port, than in the second compression chamber, which is the other compression chamber among the first compression chamber and the second compression chamber.

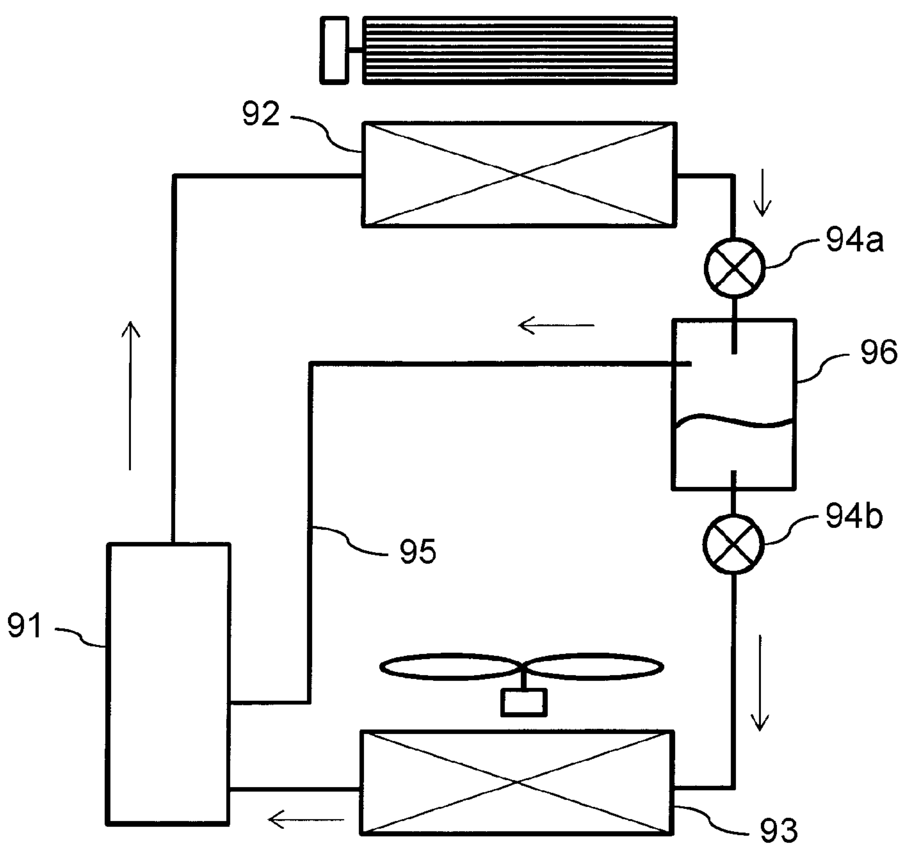


FIG. 1

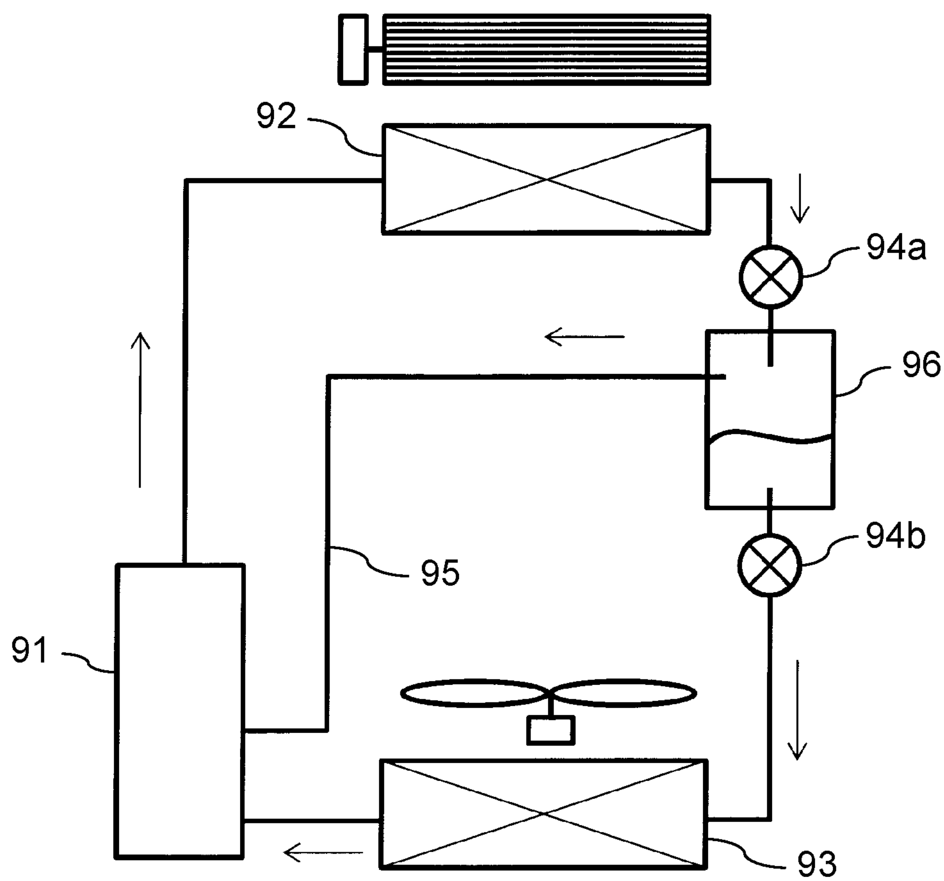


FIG. 2

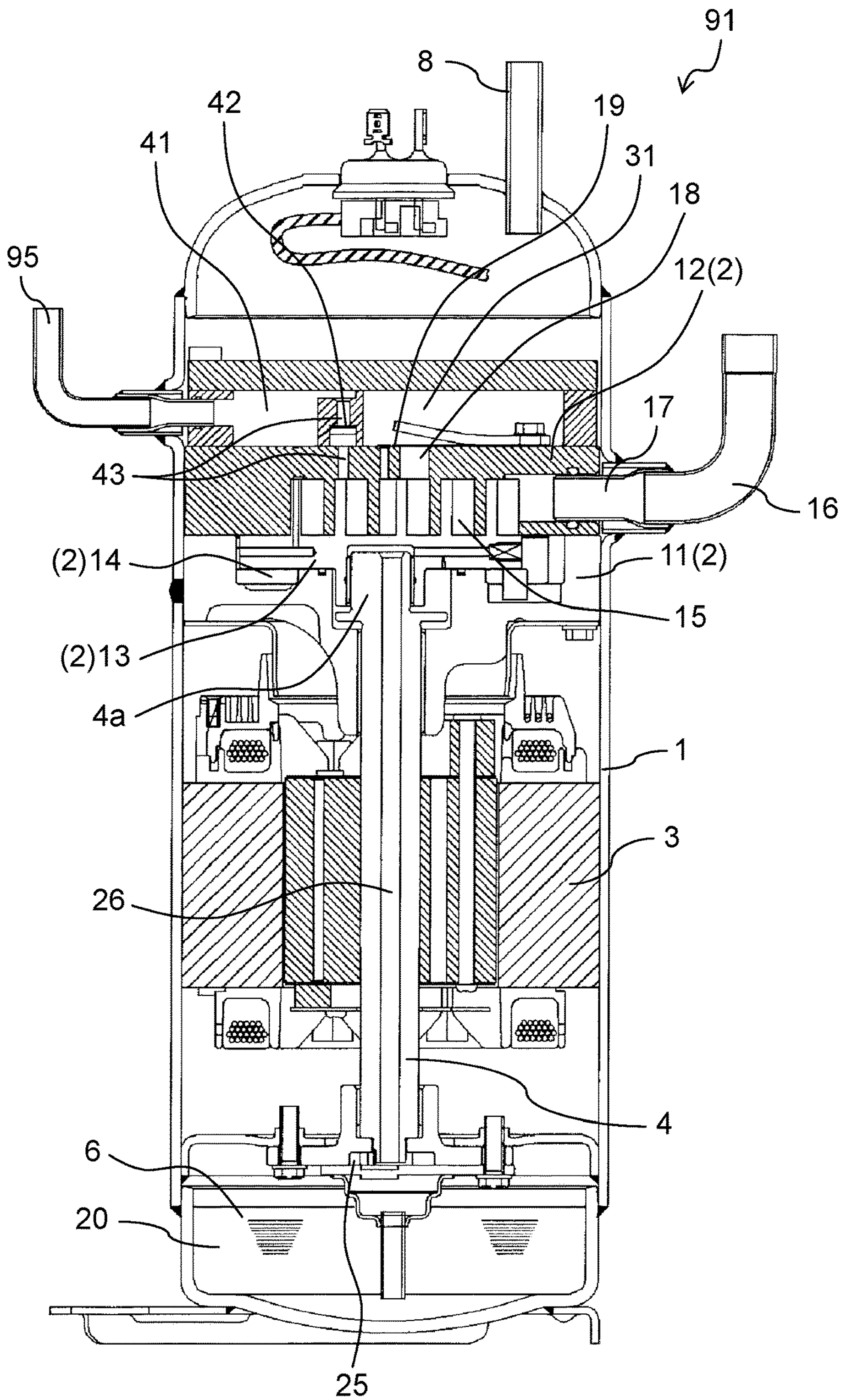
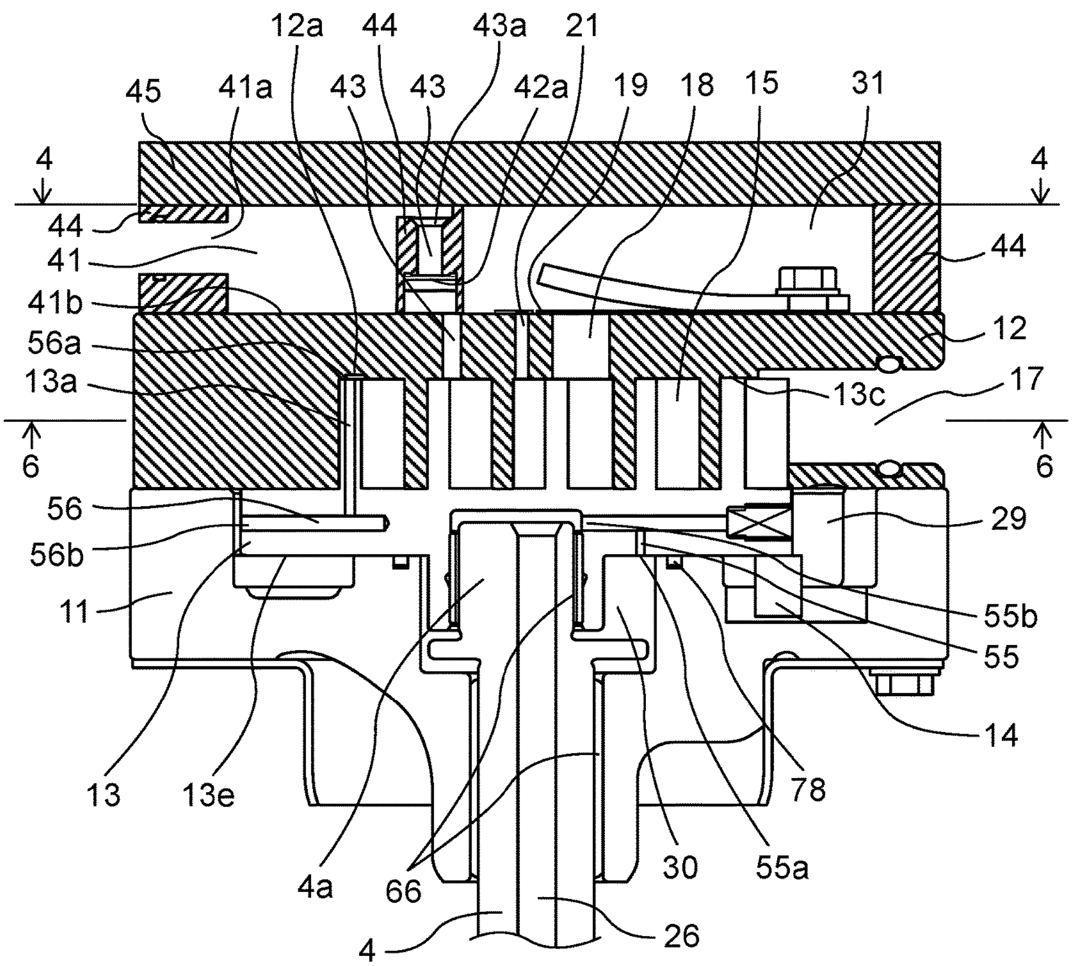


FIG. 3



12a
44
43a
21
45
41a
43
43
42a
19
18
15
31
4
4
44
41
44
41b
12
56a
17
13a
13c
6
6
56
29
56b
55b
11
55
14
13
13e
78
30
55a
4a
66
4
26

FIG. 4

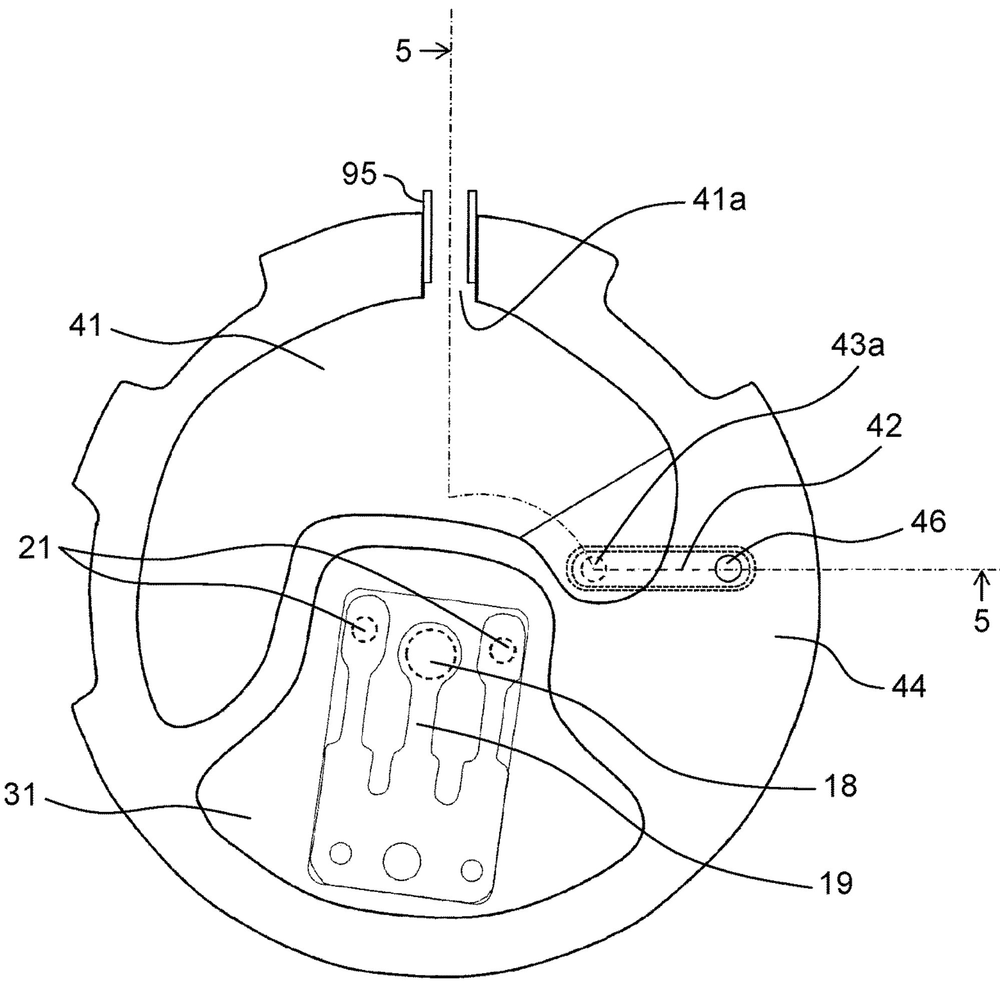

5
95
41a
41
43a
42
46
21
5
44
18
31
19

FIG. 5

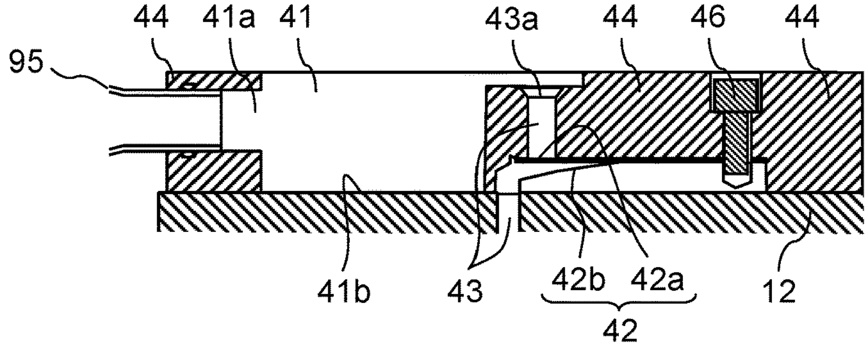

44
41a
41
43a
44
46
44
95
41b
43
42b
42a
12
42

FIG. 6

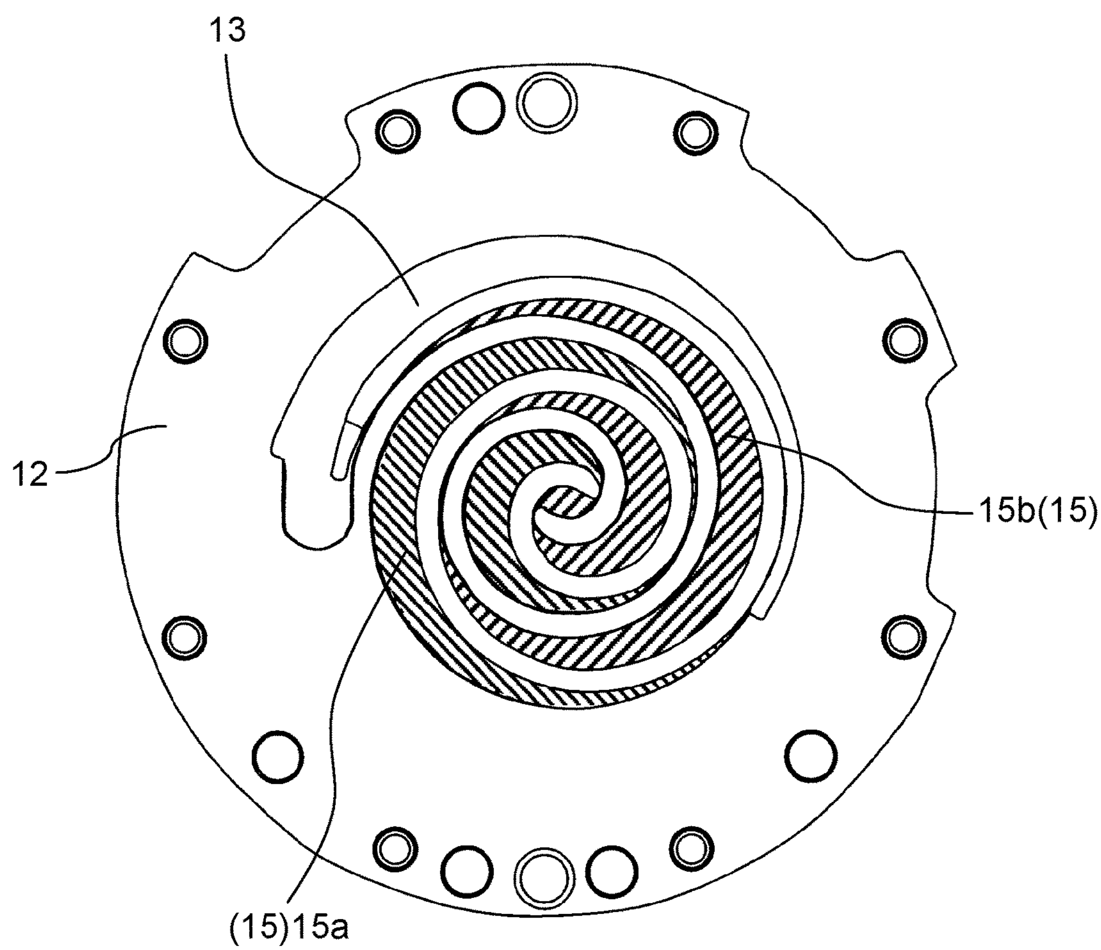
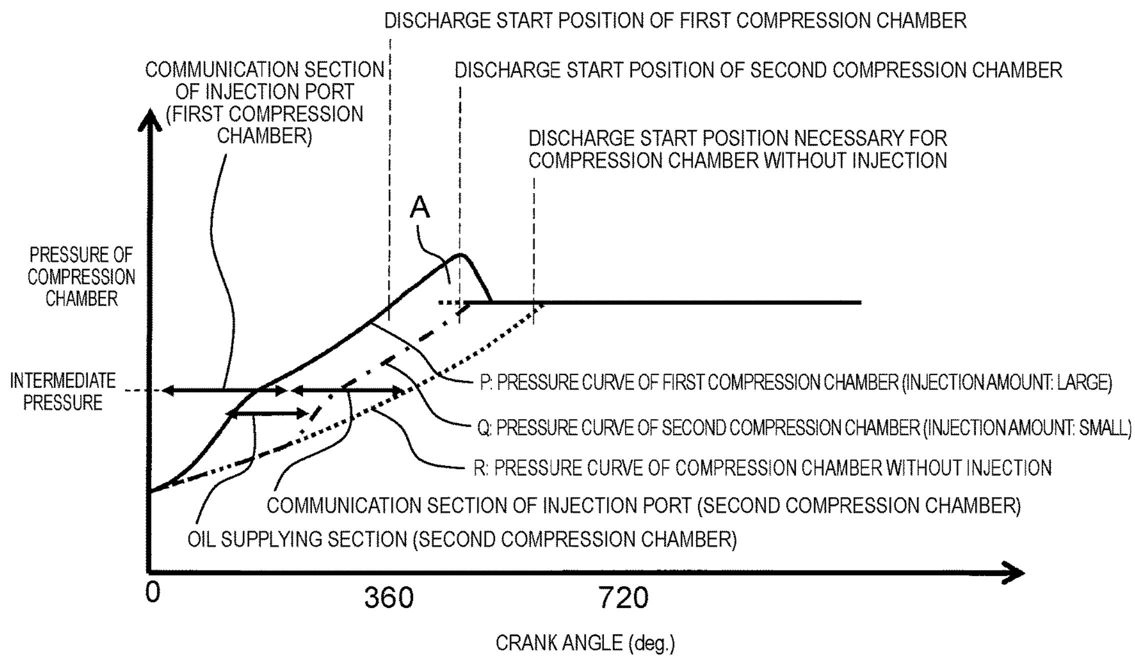


FIG. 7



DISCHARGE START POSITION OF FIRST COMPRESSION CHAMBER
COMMUNICATION SECTION OF INJECTION PORT (FIRST COMPRESSION CHAMBER)
DISCHARGE START POSITION OF SECOND COMPRESSION CHAMBER
DISCHARGE START POSITION NECESSARY FOR COMPRESSION CHAMBER WITHOUT INJECTION
A
PRESSURE OF COMPRESSION CHAMBER
INTERMEDIATE PRESSURE
P: PRESSURE CURVE OF FIRST COMPRESSION CHAMBER (INJECTION AMOUNT: LARGE)
Q: PRESSURE CURVE OF SECOND COMPRESSION CHAMBER (INJECTION AMOUNT: SMALL)
R: PRESSURE CURVE OF COMPRESSION CHAMBER WITHOUT INJECTION
COMMUNICATION SECTION OF INJECTION PORT (SECOND COMPRESSION CHAMBER)
OIL SUPPLYING SECTION (SECOND COMPRESSION CHAMBER)
0
360
720
CRANK ANGLE (deg.)

FIG. 8

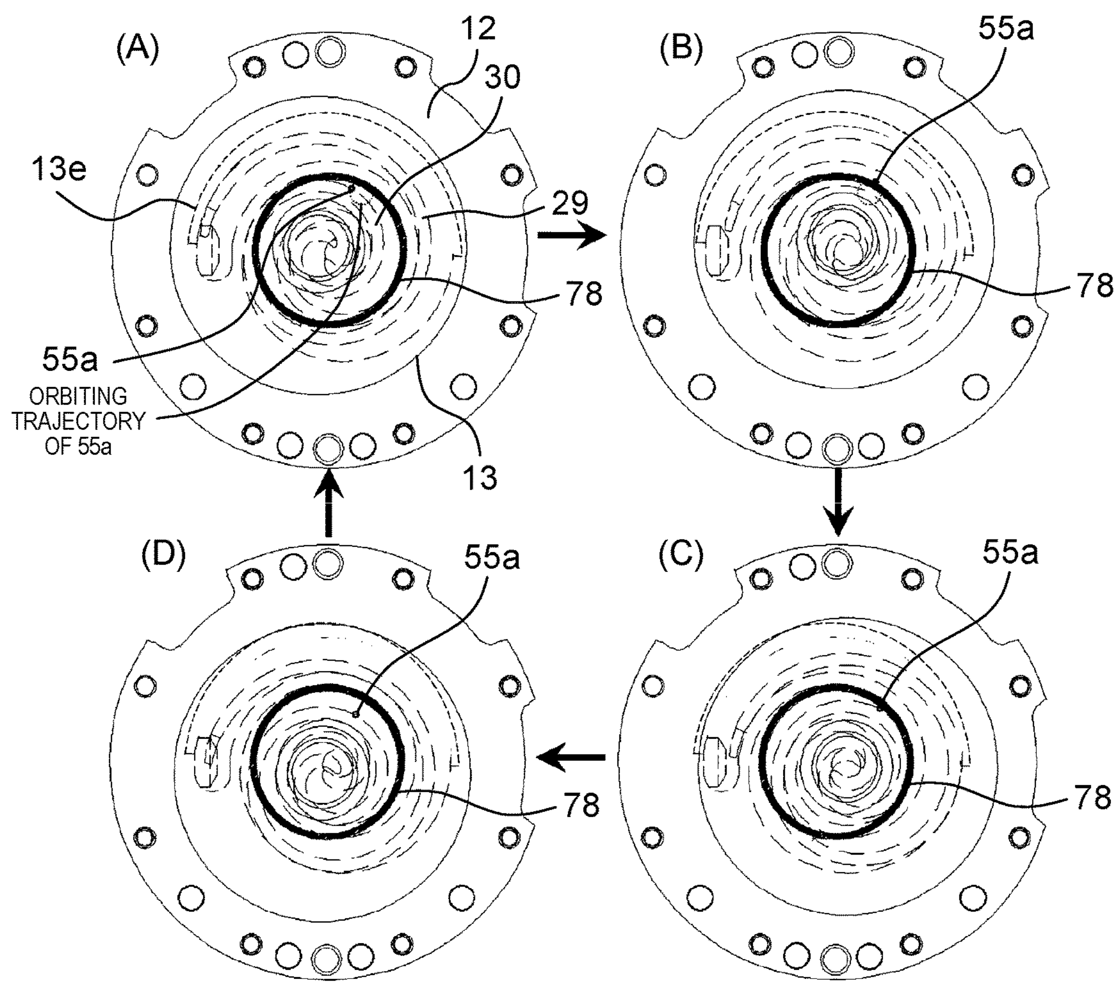

(A)
12
30
13e
29
78
55a
ORBITING TRAJECTORY OF 55a
13
(B)
55a
78
(C)
55a
78
(D)
55a
78

FIG. 9

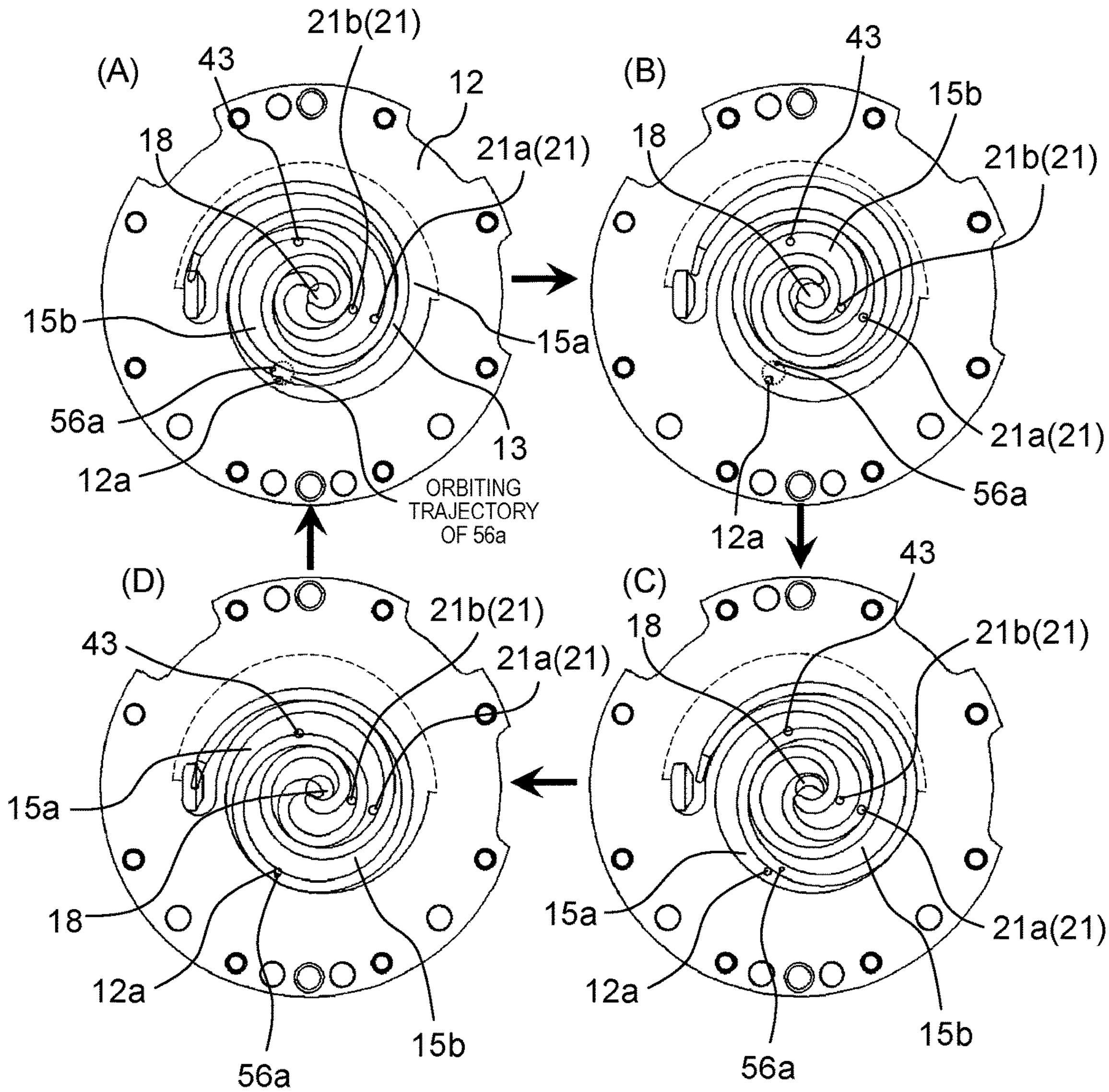
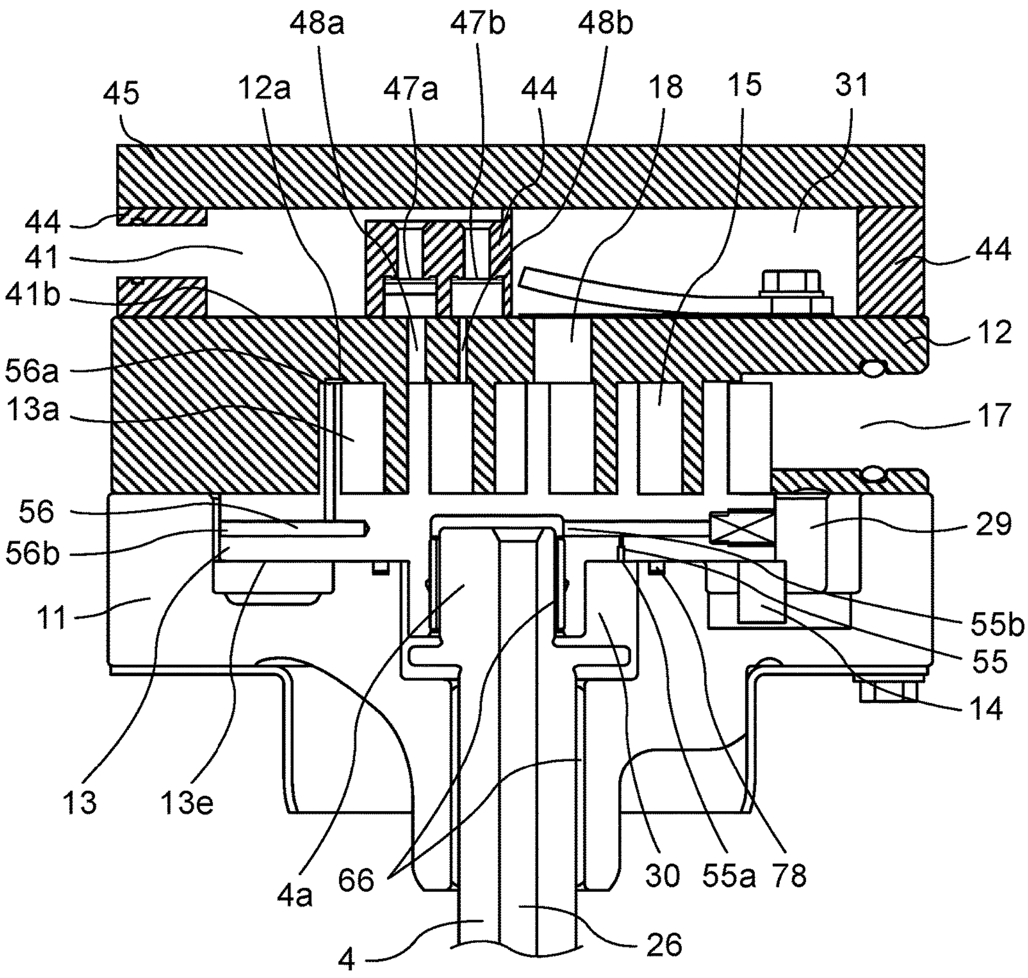

(A)
43
21b(21)
12
18
21a(21)
15b
15a
56a
13
12a
ORBITING TRAJECTORY OF 56a
(B)
43
15b
18
21b(21)
21a(21)
56a
12a
(C)
43
18
21b(21)
15a
21a(21)
12a
15b
56a
(D)
43
21b(21)
21a(21)
15a
18
12a
15b
56a

FIG. 10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47b
48b
45
12a
47a
44
18
15
31
44
41
44
41b
12
56a
13a
17
56
29
56b
55b
11
55
14
13
13e
4a
66
30
55a
78
4
26

SCROLL COMPRESSOR

TECHNICAL FIELD

[0001] The present invention relates to a scroll compressor particularly used for a refrigeration machine such as an air conditioner, a water heater, and a refrigerator.

BACKGROUND ART

[0002] In a refrigeration apparatus and an air conditioner, a compressor is used which sucks a gas refrigerant evaporated by an evaporator, compresses the gas refrigerant to a pressure required for condensation by a condenser, and sends high-temperature high-pressure gas refrigerant to a refrigerant circuit. Thus, a scroll compressor is provided with two expansion valves between the condenser and the evaporator and injects an intermediate-pressure refrigerant flowing between the two expansion valves to a compression chamber during a compression process, thereby aiming to reduce power consumption and improve capacity of a refrigeration cycle.

[0003] That is, the refrigerant circulating in the condenser is increased by the amount of the injected refrigerant. In the air conditioner, heating capacitor is improved. Further, since the injected refrigerant is in an intermediate pressure state, and power required for compression ranges from the intermediate pressure to the high pressure, a coefficient of performance (COP) can be improved and power consumption can be reduced, as compared to a case where the same function is provided without injection.

[0004] The amount of the refrigerant flowing in the condenser is equal to a sum of the amount of the refrigerant flowing in the evaporator and the amount of the injected refrigerant, and a ratio of the amount of the injected refrigerant to the amount of the refrigerant flowing in the condenser is an injection rate.

[0005] To increase an effect of injection, the injection rate may increase. Thus, the refrigerant is injected due to a pressure difference between the pressure of the injected refrigerant and the internal pressure of a compression chamber. To increase the injection rate, it is necessary to increase the pressure of the injected refrigerant.

[0006] However, when the pressure of the injected refrigerant increases, a liquid refrigerant is injected to the compression chamber, which causes a decrease in heating capacity and a decrease in reliability of the compressor.

[0007] In the refrigerant introduced into the compression chamber from an injection pipe, the gas refrigerant is preferentially extracted from a gas-liquid separator and is fed. However, when balance of intermediate pressure control is broken or when a transient condition is changed, in a state in which the liquid refrigerant is mixed with the gas refrigerant, the mixture is introduced from the injection pipe. In the compression chamber having many sliding parts, in order to keep a sliding state good, an appropriate amount of oil is fed and is compressed together with the refrigerant. However, when the liquid refrigerant is mixed, the oil in the compression chamber is washed by the liquid refrigerant. Thus, the sliding state deteriorates, components are worn or burned. Thus, it is important that the liquid refrigerant introduced from the injection pipe is not fed to the compression chamber as far as possible and only the gas refrigerant is guided to an injection port.

[0008] The intermediate pressure is controlled by adjusting an opening degree of the expansion valves respectively provided upstream or downstream of the gas-liquid separator, and an injected refrigerant is fed into the compression chamber by a pressure difference between the intermediate pressure and the internal pressure of the compression chamber in the compressor to which the injection pipe is finally connected. Therefore, when the intermediate pressure is adjusted high, the injection rate increases. Meanwhile, the higher the intermediate pressure, the smaller a gas-phase component ratio of the refrigerant flowing from the condenser via the upstream expansion valve to the gas-liquid separator. Thus, when the intermediate pressure excessively increases, the liquid refrigerant in the gas-liquid separator increases, and the liquid refrigerant flows into the injection pipe, resulting in a decrease in heating capacity and a decrease in reliability of the compressor.

[0009] Thus, a configuration which obtains a large amount of the injected refrigerant using the intermediate pressure as low as possible is desirable as the compressor, and a scroll type having a slow compression rate is suitable as a compression method.

[0010] In particular, a symmetric scroll compressor in which compression chambers having the same volume are formed at the same timing outside and inside a wrap of the orbiting scroll has a feature in which mechanical balance is excellent in a low vibration state due to symmetry of the compression chambers. Thus, the scroll compressor has been used for various fields such as air conditioning.

[0011] Meanwhile, regarding the injection, in the scroll compressor according to the related art, opening ranges of the injection port and the bypass port are disclosed (see, for example, PTL 1). Accordingly, the scroll compressor is provided which can cope with various operation modes including the injection with high performance.

CITATION LIST

Patent Literature

[0012] PTL 1: Japanese Patent No. 3764261

SUMMARY OF THE INVENTION

[0013] In the symmetric scroll compressor, a compression start timing of a first compression chamber formed outside a wrap of the orbiting scroll and a compression start timing of a second compression chamber formed inside the wrap of the orbiting scroll are equal to each other. Thus, it is difficult for one injection port to always send the same amount of the injected refrigerant to the first compression chamber and the second compression chamber.

[0014] Further, in PTL 1, a relationship between opening sections of the bypass port and the injection port is disclosed. However, a relationship between the amount of injection to the first compression chamber and the second compression chamber and the bypass port is not disclosed.

[0015] The present invention relates to a scroll compressor that can prevent an excessive compression operation due to a difference between injection amounts occurring in a symmetric scroll compressor, can cope with the operation even at a higher injection rate to maximize an original effect of an injection cycle, and can expand a capacity improvement amount.

[0016] The scroll compressor according to the present invention includes a fixed scroll including a first spiral wrap standing up from a first end plate of the fixed scroll and an orbiting scroll including a second spiral wrap standing up from a second end plate of the orbiting scroll, wherein the first spiral wrap of the fixed scroll is engaged with the second spiral wrap of the orbiting scroll to define a compression chamber between the fixed scroll and the orbiting scroll. Further, the compression chamber includes a first compression chamber on an outer wall side of the second spiral wrap of the orbiting scroll and a second compression chamber on an inner wall side of the second spiral wrap of the orbiting scroll, the suction volume of the first compression chamber is substantially equal to the suction volume of the second compression chamber. Further, the first end plate of the fixed scroll includes a central portion having a discharge port through which a refrigerant compressed in the compression chamber is discharged. The scroll compressor further comprises a discharge bypass port through which the refrigerant compressed in the compression chamber is discharged before the compression chamber communicates with the discharge port is provided. Further, the scroll compressor comprises at least one injection port through which an intermediate-pressure refrigerant is injected into the first compression chamber, the at least one injection port penetrating the first end plate of the fixed scroll at a position where the injection port is open to the first compression chamber or the second compression chamber during a compression stroke after a suction refrigerant is introduced and closed. Further, the scroll compressor comprises the discharge bypass port is disposed such that a volume ratio is smaller in one compression chamber of the first compression chamber and the second compression chamber, which has the large amount of the refrigerant injected from the injection port, than in the other compression chamber, the volume ratio of the suction volume to the discharge volume of the compression chamber at which the refrigerant in the compression chamber can be discharged.

[0017] In this way, as more injection is injected into a compression chamber having a small volume ratio, an injection rate increases, so that an effect of an injection cycle can be maximized, and efficiency improvement and capacity expansion effect can be obtained more than the related art.

BRIEF DESCRIPTION OF DRAWINGS

[0018] FIG. **1** is a diagram showing a refrigeration cycle including a scroll compressor according to a first embodiment of the present invention.

[0019] FIG. **2** is a longitudinal sectional view showing the scroll compressor according to the first embodiment of the present invention.

[0020] FIG. **3** is an enlarged view showing a main part of FIG. **2**.

[0021] FIG. **4** is a view taken along line **4-4** of FIG. **3**.

[0022] FIG. **5** is a view taken along line **5-5** of FIG. **4**.

[0023] FIG. **6** is a view taken along line **6-6** of FIG. **3**.

[0024] FIG. **7** is a graph showing an internal pressure of the compression chamber of the scroll compressor when an injection operation is not accompanied.

[0025] FIG. **8** is a diagram for illustrating a positional relationship between an oil supplying passage and a sealing member accompanying an orbiting movement of the scroll compressor according to the first embodiment of the present invention.

[0026] FIG. **9** is a diagram for illustrating an opening state of the oil supplying passage and an injection port accompanying the orbiting movement of the scroll compressor according to the first embodiment of the present invention.

[0027] FIG. **10** is a longitudinal sectional view showing a scroll compressor according to a second embodiment of the present invention.

DESCRIPTION OF EMBODIMENTS

First Embodiment

[0028] Hereinafter, a scroll compressor according to a first embodiment of the present invention will be described. The present invention is not limited to the following present embodiments.

[0029] FIG. **1** is a diagram showing a refrigeration cycle including the scroll compressor according to the first embodiment.

[0030] As illustrated in FIG. **1**, a refrigeration cycle device including the scroll compressor according to the present embodiment includes compressor **91** that is the scroll compressor, condenser **92**, evaporator **93**, expansion valves **94*a*** and **94*b***, injection pipe **95**, and gas-liquid separator **96**.

[0031] A refrigerant, which is a working fluid condensed by condenser **92**, is depressurized to an intermediate pressure by expansion valve **94*a*** on an upstream side, and gas-liquid separator **96** separates the refrigerant at the intermediate pressure into a gas-phase component (a gas refrigerant) and a liquid-phase component (a liquid refrigerant). The liquid refrigerant depressurized to the intermediate pressure further passes through expansion valve **94*b***, becomes a low-pressure refrigerant, and is guided to evaporator **93**.

[0032] The liquid refrigerant sent to evaporator **93** is evaporated by heat exchange and is discharged as the gas refrigerant or the gas refrigerant partially mixed with the liquid refrigerant. The refrigerant discharged from evaporator **93** is incorporated in the compression chamber of compressor **91**.

[0033] Meanwhile, the gas refrigerant separated by gas-liquid separator **96** and being at an intermediate pressure passes through injection pipe **95** and is guided to the compression chamber in compressor **91**. Although not illustrated, a closure valve or an expansion valve may be provided in injection pipe **95** and may be configured to adjust and stop the injection pressure.

[0034] Compressor **91** compresses a low-pressure refrigerant flowing from evaporator **93**, injects the refrigerant in gas-liquid separator **96** at an intermediate pressure to the compression chamber in a compression process to compress the refrigerant, and sends the high-temperature high-pressure refrigerant from a discharge tube to condenser **92**.

[0035] In a ratio of the liquid-phase component to the gas-phase component separated by gas-liquid separator **96**, as a pressure difference between an inlet-side pressure and an outlet-side pressure of expansion valve **94*a*** provided on the upstream side increases, the amount of the gas-phase component increases. Further, as a supercooling degree of the refrigerant at an outlet of condenser **92** decreases or a depletion degree thereof increases, the amount of the gas-phase component increases.

[0036] Meanwhile, the amount of the refrigerant sucked through injection pipe **95** by compressor **91** increases as the intermediate pressure increases. Thus, when the refrigerant of which the ratio of the gas-phase component is more than the ratio of the gas-phase component of the refrigerant separated by gas-liquid separator **96** is sucked from injection pipe **95**, the gas refrigerant in gas-liquid separator **96** is depleted, and the liquid refrigerant flows to injection pipe **95**. It is preferable that in order to maximize capacity of compressor **91**, the gas refrigerant separated by gas-liquid separator **96** is sucked from injection pipe **95** to compressor **91**. However, when the refrigerant escapes from this balanced state, the liquid refrigerant flows from injection pipe **95** to compressor **91**. Thus, even in this case, it is necessary that compressor **91** is configured to maintain high reliability.

[0037] FIG. **2** is a longitudinal sectional view showing the scroll compressor according to the present embodiment. FIG. **3** is an enlarged view showing a main part of FIG. **2**. FIG. **4** is a view taken along line **4-4** of FIG. **3**. FIG. **5** is a view taken along line **4-4** of FIG. **4**.

[0038] As illustrated in FIG. **2**, compressor **91** includes compression mechanism **2**, motor unit **3**, and oil reservoir **20** inside sealed container **1**.

[0039] Compression mechanism **2** includes main bearing member **11** fixed to sealed container **1** through welding or shrink fitting, fixed scroll (a compression chamber partitioning member) **12** fixed to main bearing member **11** through a bolt, and orbiting scroll **13** engaged with fixed scroll **12**. Shaft **4** is pivotally supported by main bearing member **11**.

[0040] Rotation restraining mechanism **14** such as an Oldham ring, which prevents rotation of orbiting scroll **13** and guides orbiting scroll **13** to perform a circular orbiting movement, is provided between orbiting scroll **13** and main bearing member **11**.

[0041] Orbiting scroll **13** is eccentrically driven by eccentric shaft portion **4***a* at an upper end of shaft **4** and circularly orbits by rotation restraining mechanism **14**.

[0042] Compression chamber **15** is formed between fixed scroll **12** and orbiting scroll **13**.

[0043] Suction pipe **16** penetrates sealed container **1** to the outside, and suction port **17** is provided at an outer circumferential portion of fixed scroll **12**. The working fluid (the refrigerant) sucked from suction pipe **16** is guided from suction port **17** to compression chamber **15**. Compression chamber **15** moves from an outer circumferential side to a central portion while the volume thereof is reduced. The working fluid that reaches a predetermined pressure in compression chamber **15** is discharged from discharge port **18** provided at a central portion of fixed scroll **12** to discharge chamber **31**. Discharge reed valve **19** is provided in discharge port **18**. The working fluid that reaches the predetermined pressure in compression chamber **15** pushes and opens discharge reed valve **19** to be discharged to discharge chamber **31**. The working fluid discharged to discharge chamber **31** is discharged to the outside of sealed container **1**.

[0044] Meanwhile, the working fluid at the intermediate pressure, guided from injection pipe **95**, flows to intermediate pressure chamber **41**, opens check valve **42** provided in injection port **43**, is injected into compression chamber **15** after working fluid is enclosed, and is discharged from discharge port **18** into sealed container **1** together with the working fluid sucked from suction port **17**.

[0045] Pump **25** is provided at a lower end of shaft **4**. Pump **25** is disposed such that a suction port thereof exists in oil reservoir **20**.

[0046] Pump **25** is driven by shaft **4** and can certainly pump up oil **6** in oil reservoir **20** provided at a bottom portion of sealed container **1** regardless of a pressure condition and an operation speed. Thus, a concern about shortage of oil **6** is alleviated. Oil **6** pumped up by pump **25** is supplied to compression mechanism **2** through oil supplying hole **26** formed in shaft **4**. Before and after oil **6** is pumped up by pump **25**, when foreign substances are removed from oil **6** by an oil filter or the like, the foreign substances can be prevented from being introduced into compression mechanism **2**, and reliability can be further improved.

[0047] The pressure of oil **6** guided to compression mechanism **2** is substantially the same as a discharge pressure of the scroll compressor and serves as a back pressure source for orbiting scroll **13**. Accordingly, orbiting scroll **13** stably exhibits a predetermined compression function without being separated from or colliding with fixed scroll **12**.

[0048] As illustrated in FIG. **3**, ring-shaped sealing member **78** is disposed on rear surface **13***e* of an end plate of orbiting scroll **13**.

[0049] High-pressure area **30** is formed inside sealing member **78**, and back-pressure chamber **29** is formed outside sealing member **78**. Back-pressure chamber **29** is set to a pressure between a high pressure and a low pressure. Since high-pressure area **30** and back-pressure chamber **29** can be separated from each other using sealing member **78**, application of the pressure from rear surface **13***e* of orbiting scroll **13** can be stably controlled.

[0050] As shown in FIG. **6** which is a view taken along line **6-6** of FIG. **3**, compression chamber **15** having fixed scroll **12** and orbiting scroll **13** includes first compression chamber **15***a* formed on an outer wall side of a wrap of orbiting scroll **13** and second compression chamber **15***b* formed on an inner wall side of the wrap.

[0051] Connection passage **55** from high-pressure area **30** to back-pressure chamber **29** and supply passage **56** from back-pressure chamber **29** to second compression chamber **15***b* are provided as an oil supplying passage from oil reservoir **20** illustrated in FIG. **3**. As connection passage **55** from high-pressure area **30** to back-pressure chamber **29** is provided, oil **6** can be supplied to a sliding portion of rotation restraining mechanism **14** and a thrust sliding portion of fixed scroll **12** and orbiting scroll **13**.

[0052] One first opening end **55***a* of connection passage **55** is formed on rear surface **13***e* of orbiting scroll **13** and travels between the inside and the outside of sealing member **78**, and the other second opening end **55***b* is always open to high-pressure area **30**.

[0053] Accordingly, intermittent oil supplying can be realized.

[0054] A part of oil **6** enters a fitting portion between eccentric shaft portion **4***a* and orbiting scroll **13** and bearing portion **66** between shaft **4** and main bearing member **11** so as to obtain an escape area by supply pressure or self weight, falls after lubricating each component, and returns to oil reservoir **20**.

[0055] In the scroll compressor according to the present embodiment, the oil supplying passage to compression chamber **15** is configured with passage **13***a* formed inside orbiting scroll **13** and recess **12***a* formed in a wrap side end plate of fixed scroll **12**. Third opening end **56***a* of passage **13***a* is formed at wrap tip end **13***c* and is periodically opened to recess **12***a* according to the orbiting movement. Further, fourth opening end **56***b* of passage **13***a* is always open to back-pressure chamber **29**. Accordingly, back-pressure chamber **29** and second compression chamber **15***b* can intermittently communicate with each other.

[0056] Injection port **43** for injecting the refrigerant at the intermediate pressure is provided to penetrate the end plate of fixed scroll **12**. Injection port **43** is sequentially open to first compression chamber **15***a* and second compression chamber **15***b*. Injection port **43** is provided at a position where injection port **43** is open during a compression process after the refrigerant is introduced into and closed in first compression chamber **15***a* and second compression chamber **15***b*.

[0057] Discharge bypass port **21** through which the refrigerant compressed in compression chamber **15** is discharged before discharge bypass port **21** communicates with discharge port **18** is provided in the end plate of fixed scroll **12**.

[0058] As illustrated in FIGS. **3** and **4**, compressor **91** according to the present embodiment is provided with intermediate pressure chamber **41** that guides an intermediate pressure working fluid fed from injection pipe **95** and before being injected into compression chamber **15**.

[0059] Intermediate pressure chamber **41** is formed with fixed scroll **12** that is a compression chamber partitioning member, intermediate pressure plate **44**, and intermediate pressure cover **45**. Intermediate pressure chamber **41** and compression chamber **15** face each other with fixed scroll **12** interposed therebetween. Intermediate pressure chamber **41** has intermediate pressure chamber inlet **41***a* into which the intermediate pressure working fluid flows and liquid reservoir **41***b* formed at a position lower than intermediate pressure chamber inlet **41***a* and injection port inlet **43***a* of injection port **43** through which the intermediate pressure working fluid is injected into compression chamber **15**.

[0060] Liquid reservoir **41***b* is formed on an upper surface of the end plate of fixed scroll **12**.

[0061] Intermediate pressure plate **44** is provided with check valve **42** that prevents backflow of the refrigerant from compression chamber **15** to intermediate pressure chamber **41**. In a section in which injection port **43** is open to compression chamber **15**, when the internal pressure of compression chamber **15** is higher than the intermediate pressure of injection port **43**, the refrigerant flows backward from compression chamber **15** to intermediate pressure chamber **41**. Thus, check valve **42** is provided to prevent the backflow of the refrigerant.

[0062] In compressor **91** according to the present embodiment, check valve **42** is configured with reed valve **42***a* lifted to compression chamber **15** side and causing compression chamber **15** and intermediate pressure chamber **41** to communicate with each other. Check valve **42** causes compression chamber **15** and intermediate pressure chamber **41** to communicate with each other only when the internal pressure of compression chamber **15** is lower than the pressure of intermediate pressure chamber **41**. By using reed valve **42***a*, the number of sliding portions in a movable portion becomes small, sealing performance can be maintained for a long time, and a flow passage area can be easily enlarged as needed. When check valve **42** is not provided or check valve **42** is provided in injection pipe **95**, the refrigerant in compression chamber **15** flows backward to injection pipe **95**, and unnecessary compression power is consumed. Check valve **42** according to the present embodiment is provided in intermediate pressure plate **44** close to compression chamber **15** to suppress the backflow from compression chamber **15**.

[0063] The upper surface of the end plate of fixed scroll **12** is located closer to intermediate pressure chamber inlet **41***a*, and the upper surface of the end plate of fixed scroll **12** is provided with liquid reservoir **41***b* in which the working fluid in a liquid-phase component is collected. Further, injection port inlet **43***a* is provided at a position higher than the height of intermediate pressure chamber inlet **41***a*. Thus, among the intermediate pressure working fluid, the working fluid in a gas-phase component is guided to injection port **43**. Since the working fluid in the liquid-phase component collected in liquid reservoir **41***b* is evaporated in the surface of fixed scroll **12** in a high-temperature state, it is difficult for the working fluid in the liquid-phase component to flow into compression chamber **15**.

[0064] Further, intermediate pressure chamber **41** and discharge chamber **31** are provided adjacent to each other through intermediate pressure plate **44**. It is possible to suppress an increase in the temperature of the high-pressure refrigerant of discharge chamber **31** while evaporation when the working fluid in the liquid-phase component flows into intermediate pressure chamber **41** is promoted. Thus, operation can be performed even in a high discharge pressure condition by that degree.

[0065] The intermediate pressure working fluid guided to injection port **43** pushes and opens reed valve **42***a* by a pressure difference between injection port **43** and compression chamber **15** and is joined to a low-pressure working fluid sucked by suction port **17** in compression chamber **15**. However, the intermediate pressure working fluid remaining in injection port **43** between check valve **42** and compression chamber **15** is repeatedly expanded and compressed again, which causes a decrease in efficiency of compressor **91**.

[0066] Thus, the thickness of valve stop **42***b* (see FIG. **5**) for regulating a maximum displacement of reed valve **42***a* is changed according to the lift regulation point of reed valve **42***a*, and the volume of injection port **43** downstream of reed valve **42***a* is small.

[0067] Further, reed valve **42***a* and valve stop **42***b* illustrated in FIG. **5** are fixed to intermediate pressure plate **44** through fixing member **46** having a bolt. A fixing hole of fixing member **46** provided in valve stop **42***b* is opened only to the insertion side of fixing member **46** without penetrating valve stop **42***b*. As a result, fixing member **46** is configured to be open only in intermediate pressure chamber **41**.

[0068] Accordingly, leakage of the working fluid between intermediate pressure chamber **41** and compression chamber **15** through a gap of fixing member **46** can be suppressed, so that the injection rate can be improved.

[0069] Intermediate pressure chamber **41** illustrated in FIG. **3** has a suction volume that is equal to or more than a suction volume of compression chamber **15** to be able to perform sufficient supplying to compression chamber **15** by an injection amount. Herein, the suction volume is the volume of compression chamber **15** at a time point when the working fluid guided from suction port **17** is introduced into and closed in compression chamber **15**, that is, at a time point when a suction process is completed, and is the total volume of first compression chamber **15***a* and second compression chamber **15***b*. In compressor **91** according to the present embodiment, intermediate pressure chamber **41** is provided to be spread on a flat surface of the end plate of fixed scroll **12** so as to expand the volume thereof. However, when a part of oil **6** enclosed in compressor **91** goes out from compressor **91** together with a discharge refrigerant, and returns to intermediate pressure chamber **41** through injection pipe **95** from gas-liquid separator **96**, if the amount of oil **6** remaining in liquid reservoir **41***b* is too large, oil **6** in oil reservoir **20** runs short. Thus, it is not appropriate that the volume of intermediate pressure chamber **41** is too large. Because of this, it is preferable that the volume of intermediate pressure chamber **41** is equal to or more than the suction volume of compression chamber **15**, and is equal to or less than a half of the oil volume of enclosed oil **6**.

[0070] FIG. **6** is a view taken along line **6-6** of FIG. **3**.

[0071] FIG. **6** is a view showing a state in which orbiting scroll **13** is engaged with fixed scroll **12** when viewed from rear surface **13***e* side of orbiting scroll **13**. As illustrated in FIG. **6**, in a state in which fixed scroll **12** and orbiting scroll **13** are engaged with each other, the number of winding of the spiral wrap of fixed scroll **12** is equal to the number of winding of the spiral wrap of orbiting scroll **13**.

[0072] Compression chamber **15** formed with fixed scroll **12** and orbiting scroll **13** includes first compression chamber **15***a* formed on an outer wall side of the wrap of orbiting scroll **13** and second compression chamber **15***b* formed on an inner wall side of the wrap of orbiting scroll **13**.

[0073] A timing when the working fluid is confined in first compression chamber **15***a* is substantially the same as a timing when the working fluid is confined in second compression chamber **15***b*, and compression of first compression chamber **15***a* and second compression chamber **15***b* simultaneously starts. Accordingly, a pressure balance between first compression chamber **15***a* and second compression chamber **15***b* is maintained, and behavior of orbiting scroll **13** is stabilized.

[0074] In FIG. **7**, R is a pressure curve showing the internal pressure of the compression chamber of the scroll compressor when an injection operation is not accompanied.

[0075] When the injection operation is not accompanied, pressure increasing rates of first compression chamber **15***a* and second compression chamber **15***b* according to a crank rotation angle are equal to each other. However, when the amounts of the injection to first compression chamber **15***a* and second compression chamber **15***b* differ from each other, the pressure increasing rates according to the amounts of the injection differ from each other.

[0076] FIG. **7** shows a difference in a compression rate due to a difference in the amount of the injection. The compression chamber where the amount of the injection is large reaches a discharge pressure in a short compression section from start of compression. In the present embodiment, since the amount of the refrigerant injected into first compression chamber **15***a* increases, the pressure increasing rate of first compression chamber **15***a* as indicated by pressure curve P is faster than the pressure increasing rate of second compression chamber **15***b* as indicated by pressure curve Q. In FIG. **7**, when discharge bypass port **21** is provided according to the internal pressure of the compression chamber having a small injection amount indicated by pressure curve Q, the internal pressure of the compression chamber having a large amount of the injection indicated by pressure curve P reaches the discharge pressure faster than the internal pressure indicated by pressure curve Q. However, even after the pressure reaches the discharge pressure, first compression chamber **15***a* that has been continuously compressed without an escape area is excessively compressed. After first compression chamber **15***a* communicates with discharge bypass port **21**, the excessive compression is alleviated. That is, an additional compression power corresponding to area A in the drawing is required. Thus, in the present invention, discharge bypass port **21** is provided at a position where first compression chamber **15***a* having a large amount of the injection can perform the discharge at an earlier timing than second compression chamber **15***b*.

[0077] That is, the internal pressure of the compression chamber having a large amount of the injection increases due to the injection refrigerant, and the pressure of the compression chamber having a low injection amount or without the injection increases slower than the other compression chamber. In other words, the compression chamber having a large amount of the injection is required to be brought in a dischargeable state at an earlier timing than the other compression chamber. However, in the symmetric scroll compression in which the amounts of the injection are necessarily different from each other, when the injection operation is performed without considering this fact, efficiency deteriorates. In the present embodiment, discharge bypass port **21** is provided at a position where first compression chamber **15***a* having a large amount of injection can perform discharge at an earlier timing than second compression chamber **15***b*. As a result, a volume ratio is defined by a ratio of a suction volume of the compression chamber to a volume of the compression chamber which communicates with the discharge port and discharge bypass port **21**. A volume ratio of first compression chamber **15***a* having a large injection amount is equal to or less than that of second compression chamber **15***b*.

[0078] As shown in FIG. **7**, an opening section of injection port **43** to second compression chamber **15***b* overlaps with at least a partial section of an oil supplying section from back-pressure chamber **29** to second compression chamber **15***b*. An overlapping section in which the oil supplying section overlaps with the opening section is a partial section of the second half of the oil supplying section. Injection port **43** is open to the second half of the oil supplying section, so that the opening section starts.

[0079] Further, a slope shape is provided at wrap tip end **13***c* of orbiting scroll **13** from a winding start portion that is a central portion to a winding end portion that is an outer circumferential portion based on a result obtained by measuring a temperature distribution during operation such that a wing height gradually increases. Accordingly, a dimensional change due to heat expansion is absorbed, and local sliding is easily prevented.

[0080] FIG. **8** is a diagram for illustrating a positional relationship between an oil supplying passage and a sealing member accompanying an orbiting movement of the scroll compressor according to the present embodiment.

[0081] FIG. **8** is a view illustrating a state in which orbiting scroll **13** is engaged with fixed scroll **12** when viewed from rear surface **13***e* side of orbiting scroll **13**, in which the phases of orbiting scroll **13** are sequentially shifted by 90 degrees.

[0082] First opening end **55***a* of connection passage **55** is formed on rear surface **13***e* of orbiting scroll **13**.

[0083] As illustrated in FIG. **8**, rear surface **13***e* of orbiting scroll **13** is partitioned into high-pressure area **30** on an inner side and back-pressure chamber **29** on an outer side by sealing member **78**.

[0084] In a state of FIG. **8**(B), since first opening end **55***a* is open to back-pressure chamber **29** that is an outer side of sealing member **78**, oil **6** is supplied.

[0085] In contrast, in FIGS. **8**(A), **8**(C), and **8**(D), since first opening end **55***a* is open to an inside of sealing member **78**, oil is not supplied.

[0086] That is, although first opening end **55***a* of connection passage **55** travels between high-pressure area **30** and back-pressure chamber **29**, oil **6** is supplied to back-pressure chamber **29** only when a pressure difference occurs between first opening end **55***a* and second opening end **55***b* of connection passage **55**. With this configuration, since the amount of the supplied oil can be adjusted at a rate of time when first opening end **55***a* travels between the inside and the outside of sealing member **78**, the passage diameter of connection passage **55** can be configured to be 10 times or more the size of the oil filter. Accordingly, since there is no risk that foreign substances are caught by passage **13***a* and passage **13***a* is blocked, the scroll compressor can be provided in which the back pressure can be stably applied and lubrication of the thrust sliding portion, rotation restraining mechanism **14** can be maintained in a good state, and high efficiency and high reliability can be realized. In the present embodiment, a case where second opening end **55***b* is always located in high-pressure area **30** and first opening end **55***a* travels between high-pressure area **30** and back-pressure chamber **29** has been described as an example. However, even when second opening end **55***b* travels between high-pressure area **30** and back-pressure chamber **29**, and first opening end **55***a* is always located in back-pressure chamber **29**, a pressure difference occurs between first opening end **55***a* and second opening end **55***b*. Thus, intermittent oil supplying can be realized and similar effects can be obtained.

[0087] FIG. **9** is a diagram for illustrating an opening state of the oil supplying passage and an injection port accompanying the orbiting movement of the scroll compressor according to the present embodiment.

[0088] FIG. **9** shows a state in which orbiting scroll **13** is engaged with fixed scroll **12**, in which the phases of fixed scroll **12** are sequentially shifted by 90 degrees.

[0089] As illustrated in FIG. **9**, intermittent communication is realized by periodically opening third opening end **56***a* of passage **13***a* formed in wrap tip end **13***c* to recess **12***a* formed in the end plate of fixed scroll **12**.

[0090] In a state of FIG. **9**(D), third opening end **56***a* is open to recess **12***a*. In this state, oil **6** is supplied from back-pressure chamber **29** to second compression chamber **15***b* through supply passage **56** or passage **13***a*. In this way, the oil supplying passage by third opening end **56***a* is provided at a position that is open to second compression chamber **15***b* during a compression stroke after the suction refrigerant is introduced and closed.

[0091] In contrast, in FIGS. **9**(A), **9**(B), and **9**(C), since third opening end **56***a* is not open to recess **12***a*, oil **6** is not supplied from back-pressure chamber **29** to second compression chamber **15***b*. Hereinabove, since oil **6** in back-pressure chamber **29** is intermittently guided to second compression chamber **15***b* through the oil supplying passage, a fluctuation in the pressure of back-pressure chamber **29** can be suppressed, and control can be performed to a predetermined pressure. Further, similarly, oil **6** supplied to second compression chamber **15***b* serves to improve the sealing property and the lubricity during the compression.

[0092] In FIG. **9**(C) showing a time point when first compression chamber **15***a* is closed, injection port **43** is open to first compression chamber **15***a*.

[0093] On the other hand, in a state of FIG. **9**(A) showing a state in which the compression is progressed, injection port **43** is open to second compression chamber **15***b*. Accordingly, even though the opening section of injection port **43** is substantially the same as a section between first compression chamber **15***a* and second compression chamber **15***b*, a larger amount of the injection refrigerant is sent to first compression chamber **15***a* that performs injection to the compression chamber having a low pressure immediately after the compression starts, and an increase in the pressure of first compression chamber **15***a* is quickened with respect to second compression chamber **15***b*. Further, in any compression chamber, since the injection refrigerant can be compressed without flowing back to suction port **17**, it is easy to increase the amount of a circulating refrigerant and it is possible to perform a highly efficient injection operation.

[0094] In this way, injection port **43** is provided at a position where injection port **43** is sequentially open to first compression chamber **15***a* and second compression chamber **15***b*. Further, injection port **43** is provided to penetrate the end plate of fixed scroll **12** at a position where injection port **43** is open to first compression chamber **15***a* during the compression stroke after the suction refrigerant is introduced and closed as illustrated in FIGS. **9**(C) and **9**(D) or at a position where injection port **43** is open to second compression chamber **15***b* during the compression stroke after the suction refrigerant is introduced and closed as illustrated in FIG. **9**(A) and FIG. **9**(B).

[0095] In FIG. **9**, the oil supplying section starts from FIG. **9**(C) to FIG. **9**(D). Injection port **43** is later open to second compression chamber **15***b* between FIG. **9**(A) and FIG. **9**(B), and the opening section of injection port **43** has an overlapping section between the opening section and the oil supplying section. In the present embodiment, the oil supplying section is the same as an opening of third opening end **56***a* to recess **12***a*. The pressure of back-pressure chamber **29** depends on the internal pressure of compression chamber **15** at an end of the oil supplying section, and the injection refrigerant is sent to compression chamber **15** from a middle of the oil supplying section. Thus, the pressure of back-pressure chamber **29** increases only during the injection operation, and it is possible to suppress destabilization of the behavior of orbiting scroll **13**. Further, the reason why start of the opening of injection port **43** to compression chamber **15** is not hastened until the first half of the oil supplying section is as follows. That is, when the internal pressure of compression chamber **15** increases due to the injection refrigerant from an early stage of the oil supplying section, the internal pressure of compression chamber **15** and the pressure of back-pressure chamber **29** become equal to each other before the oil is sufficiently supplied to compression chamber **15** from back-pressure chamber **29**. Thus, a possibility that a problem occurs in reliability of compressor that lacks oil supplying increases.

[0096] At least a part of the oil supplying section to compression chamber **15** is configured to overlap with an opening section of injection port **43**. Thus, application of the pressure from rear surface **13***e* to orbiting scroll **13** increases together with the internal pressure of compression chamber **15** during the oil supplying section as the intermediate pressure of the injection refrigerant increases. Therefore, orbiting scroll **13** is more stably pressed against fixed scroll **12**, so that stable operation can be performed while leakage from back-pressure chamber **29** to compression chamber **15** is reduced. Accordingly, the behavior of orbiting scroll **13** can more stably realize optimum performance, and can further improve an injection rate.

[0097] In FIG. **9**, at a central portion of the end plate of fixed scroll **12**, discharge port **18** through which the refrigerant compressed in the compression chamber is discharged is provided, and discharge bypass port **21***a* provided at a position communicating with first compression chamber **15***a* and discharge bypass port **21***b* provided at a position communicating with second compression chamber **15***b* are provided as discharge bypass port **21**.

[0098] First compression chamber **15***a* closes the suction refrigerant in a state of FIG. **9**(C), and discharge bypass port **21***a* is open to first compression chamber **15***a* in a state of FIG. **9**(D).

[0099] On the other hand, although second compression chamber **15***b* closes the suction refrigerant in a state of FIG. **9**(C), discharge bypass port **21***b* does not yet communicate with second compression chamber **15***b* in the states of FIG. **9**(D) and FIG. **9**(A) and communicates with second compression chamber **15***b* in a state of FIG. **9**(B).

[0100] Accordingly, even when first compression chamber **15***a* receives a larger amount of the injection refrigerant than that of second compression chamber **15***b*, first compression chamber **15***a* is not over-compressed, and an effect of the injection cycle can be exhibited.

[0101] In this way, even when discharge bypass port **21***a* communicating with first compression chamber **15***a* and discharge bypass port **21***b* communicating with second compression chamber **15***b* are provided, a volume ratio, which is a ratio of the suction volume to the discharge volume of compression chamber **15** at which the refrigerant in compression chamber **15** can be discharged, can be smaller in first compression chamber **15***a* than in second compression chamber **15***b*.

[0102] Therefore, even in a maximum injection state, an excessive increase in the pressure of first compression chamber **15***a* can be suppressed.

Second Embodiment

[0103] FIG. **10** is a longitudinal sectional view showing a scroll compressor according to a second embodiment of the present invention.

[0104] In the present embodiment, first injection port **48***a* that is open only to first compression chamber **15***a* and second injection port **48***b* that is open only to second compression chamber **15***b* are included. First injection port **48***a* is provided with first check valve **47***a*, and second injection port **48***b* is provided with second check valve **47***b*. Since the other configuration is the same as the configuration of the embodiment, the same reference numerals are designated, and description thereof will be omitted.

[0105] In the present embodiment, as the port diameter of first injection port **48***a* is more than the port diameter of second injection port **48***b*, the amount of the refrigerant injected from first injection port **48***a* into first compression chamber **15***a* is more than the amount of the refrigerant injected from second injection port **48***b* into second compression chamber **15***b*.

[0106] In this way, as first injection port **48***a* that is open only to first compression chamber **15***a* and second injection port **48***b* that is open only to second compression chamber **15***b* are provided, the amounts of the injection to first compression chamber **15***a* and second compression chamber **15***b* can be individually adjusted. In addition, the refrigerant can be always injected into first compression chamber **15***a* and second compression chamber **15***b* or can be simultaneously injected into first compression chamber **15***a* and second compression chamber **15***b*. Thus, it is effective to achieve a high injection rate under a condition in which a pressure difference in the refrigeration cycle is large. Further, since the degree of freedom in setting the oil supplying section from back-pressure chamber **29** increases, a pressure adjusting function can be effectively utilized in back-pressure chamber **29**, and addition of the pressure from rear surface **13***e* of orbiting scroll **13** can be stably controlled.

[0107] In the present embodiment, a case where first injection port **48***a* has a larger port diameter than second injection port **48***b* has been shown. However, with this configuration or instead of this configuration, the opening section in which first injection port **48***a* is open to first compression chamber **15***a* may be longer than the opening section in which second injection port **48***b* is open to second compression chamber **15***b*. Further, a pressure difference between the intermediate pressure in first injection port **48***a* and the internal pressure of first compression chamber **15***a* when first injection port **48***a* is open to first compression chamber **15***a* may be more than a pressure difference between the intermediate pressure in second injection port **48***b* and the internal pressure of second compression chamber **15***b* when second injection port **48***b* is open to second compression chamber **15***b*.

[0108] Further, in the present embodiment, first injection port **48***a* and second injection port **48***b* respectively open only to first compression chamber **15***a* and second compression chamber **15***b* have been described. However, using an injection port open to both first compression chamber **15***a* and second compression chamber **15***b* shown in the first embodiment or a combination of first injection port **48***a* and second injection port **48***b* respectively open only to first compression chamber **15***a* and second compression chamber **15***b* shown in the present embodiment, the amount of the injection into first compression chamber **15***a* may be more than the amount of the injection into second compression chamber **15***b*.

[0109] When R32 or carbon dioxide, in which the temperature of a discharged refrigerant is easy to be high, is used as a refrigerant that is a working fluid, an effect of suppressing an increase in the temperature of the discharged refrigerant is exhibited. Thus, deterioration of a resin material such as an insulating material of motor unit **3** (see FIG. **2**) can be suppressed, and a compressor that is reliable for a long time can be provided.

[0110] Meanwhile, when a refrigerant having a double bond between carbons or a refrigerant including the refrigerant and having a global warming potential (GWP; a global warming factor) of 500 or less is used, a refrigerant decomposition reaction is likely to occur at high temperatures. Thus, an effect for long-term stability of the refrigerant is exhibited according to the effect of suppressing the increase in the temperature of the discharge refrigerant.

[0111] As described above, in the scroll compressor according to the first disclosure, at the central portion of the first end plate of the fixed scroll, the discharge port through which the refrigerant compressed in the compression chamber is discharged is included, and the discharge bypass port through which the refrigerant compressed in the compression chamber is discharged before the compression chamber communicates with the discharge port is provided.

[0112] Further, at least one injection port through which an intermediate-pressure refrigerant is injected into the first compression chamber or the second compression chamber is provided to penetrate the end plate of the fixed scroll at a position where the injection port is open to the first compression chamber or the second compression chamber during the compression stroke after the suction refrigerant is introduced and closed. Further, the discharge bypass port is disposed such that a volume ratio is made smaller in one compression chamber among the first compression chamber and the second compression chamber, which has the large amount of the refrigerant injected from the injection port than in the other compression chamber, the volume ratio being a ratio of the suction volume to the discharge volume of the compression chamber at which the refrigerant in the compression chamber can be discharged.

[0113] According to the present disclosure, in the scroll compressor in which the discharge volume and the suction volume are equal to each other in the first compression chamber and the second compression chamber, the volume ratios of the first compression chamber and the second compression chamber are also equal to each other. However, as more injection to one compression chamber is performed, the internal pressure of the compression chamber reaches the discharge pressure in a shorter compression section of compression chamber than that of the other compression chamber. Even when the internal pressure of the compression chamber reaches the discharge pressure, if the dischargeable port and the compression chamber do not communicate with each other, excessive compression occurs. Not only an extra compression power is required, but also a force for separating the orbiting scroll from the fixed scroll is generated. Thus, compression motion deteriorates. The discharge bypass port is disposed such that the volume ratio is smaller in the one compression chamber having the large amount of the injected refrigerant than in the other compression chamber. Thus, even in a maximum injection state, an excessive increase in the pressure can be suppressed. That is, according to the present embodiment, the discharge bypass port early communicates with the compression chamber having the large amount of the injection, and the volume ratio is reduced. Thus, excessive compression can be prevented even during operation at a high injection rate, the injection cycle effect can be maximized, and efficiency improvement and capacity expansion effect can be obtained more than the related art.

[0114] According to a second disclosure, in the scroll compressor according to the first disclosure, the injection port is provided with a check valve which allows flow of the refrigerant to the compression chamber and suppresses flow of the refrigerant from the compression chamber.

[0115] According to the present disclosure, as the check valve and the compression chamber are provided close to each other, even when the internal pressure of the compression chamber increases to the intermediate pressure or more in a section in which the injection port is open to the compression chamber, the compression of the refrigerant in a space that is ineffective for compression, such as the injection pipe can be minimized, and the injection rate can be increased to a condition in which theoretical performance of the injection cycle can be exhibited to maximum.

[0116] According to a third disclosure, in the scroll compressor according to the first disclosure or the second disclosure, the oil reservoir in which the oil is stored is formed in the sealed container including the fixed scroll and the orbiting scroll therein, and the high-pressure area and the back-pressure chamber are formed on the rear surface of the orbiting scroll.

[0117] Further, the oil supplying passage through which the oil is supplied from the oil reservoir to the compression chamber passes through the back-pressure chamber, and the oil supplying passage through which the back-pressure chamber communicates with the first compression chamber and the second compression chamber is provided at a position open to the first compression chamber or the second compression chamber during the compression stroke after the suction refrigerant is introduced and closed.

[0118] Further, at least a partial section of the oil supplying section in which the oil supplying passage communicates with the first compression chamber or the second compression chamber overlaps with the opening section in which the injection port is open to the first compression chamber or the second compression chamber.

[0119] When the intermediate-pressure refrigerant is injected into the compression chamber, the pressure of the compression chamber more quickly increases than in a case where the intermediate-pressure refrigerant is not injected. Thus, a force for separating the orbiting scroll from the fixed scroll increases more than in the related art. According to the present disclosure, a force for pressing the orbiting scroll against the fixed scroll interlocks with the pressure of the compression chamber with which the oil supplying passage communicates. Therefore, as the intermediate-pressure refrigerant is injected into the compression chamber, the force for pressing the orbiting scroll against the fixed scroll increases, and stable operation can be performed while the orbiting scroll is not separated from the fixed scroll.

[0120] According to a fourth disclosure, in the scroll compressor according to the third disclosure, the overlapping section where the oil supplying section overlaps with the opening section is a part of the latter half of the oil supplying section.

[0121] According to the present disclosure, since the pressure of the back-pressure chamber interlocks with the internal pressure of the compression chamber in the second half of the overlapping section, the pressure of the back-pressure chamber can be set according to the internal pressure of the compression chamber in a state in which the injection is completed or in a state in which the injection is further performed.

[0122] Accordingly, under a condition in which a separation force of the orbiting scroll by the injection is large, the pressure of the back-pressure chamber is high and stable orbiting movement is possible. On the other hand, under a condition in which the injection amount is small, the pressure of the back-pressure chamber is low, and an excessive pressing force against the fixed scroll can be prevented.

[0123] According to a fifth disclosure, in the scroll compressor according to any one embodiment of the first disclosure to the fourth disclosure, at least one injection port is provided at a position where the injection port is sequentially open to the first compression chamber and the second compression chamber.

[0124] According to the present disclosure, since the injection port can be shared when the injection into both the first and second compression chambers is performed, miniaturization and a reduction in the number of components can be achieved, and the injection rate increases so that the injection cycle effect can be maximized. Further, in general, in the scroll compressor, compression start timings of the first compression chamber and the second compression chamber are different from each other by 180 degrees. Thus, immediately after start of the compression from one injection port even to any compression chamber, the injection port may be provided at a position where the injection is performed, and is suitable for realizing a high injection rate.

[0125] According to a sixth disclosure, in the scroll compressor according to any one embodiment of the first disclosure to the fourth disclosure, the injection port includes the first injection port that is open only to the first compression chamber and the second injection port that is open only to the second compression chamber. Further, one of the following configurations (1) to (3) is added.

[0126] (1) Further, the first injection port has a larger port diameter than the second injection port. (2) The opening section in which the first injection port is open to the first compression chamber is longer than the opening section in which the second injection port is open to the second compression chamber. (3) the pressure difference between the intermediate pressure in the first injection port and the internal pressure of the first compression chamber when the first injection port is open to the first compression chamber is more than the pressure difference between the intermediate pressure of the second injection port and the internal pressure of the second compression chamber when the second injection port is open to the second compression chamber.

[0127] According to the present disclosure, the amount of injection into the first compression chamber having a large volume and a slow pressure increase rate can be certainly increased, and efficient distribution of the amount of the injected refrigerant can be achieved.

INDUSTRIAL APPLICABILITY

[0128] The scroll compressor is useful for a refrigeration cycle apparatus, such as a hot water heater, an air conditioner, a water heater, and a refrigerator, in which an evaporator is used in a low temperature environment.

REFERENCE MARKS IN THE DRAWINGS

[0129] **1** SEALED CONTAINER
[0130] **2** COMPRESSION MECHANISM
[0131] **3** MOTOR UNIT
[0132] **4** SHAFT
[0133] **4***a* ECCENTRIC SHAFT PORTION
[0134] **6** OIL
[0135] **11** MAIN BEARING MEMBER
[0136] **12** FIXED SCROLL
[0137] **12***a* RECESS
[0138] **13** ORBITING SCROLL
[0139] **13***c* WRAP TIP END
[0140] **13***e* REAR SURFACE
[0141] **14** ROTATION RESTRAINING MECHANISM
[0142] **15** COMPRESSION CHAMBER
[0143] **15***a* FIRST COMPRESSION CHAMBER
[0144] **15***b* SECOND COMPRESSION CHAMBER
[0145] **16** SUCTION PIPE
[0146] **17** SUCTION PORT
[0147] **18** DISCHARGE PORT
[0148] **19** DISCHARGE REED VALVE
[0149] **20** OIL RESERVOIR
[0150] **21**, **21***a*, **21***b* DISCHARGE BYPASS PORT
[0151] **25** PUMP
[0152] **26** OIL SUPPLYING HOLE
[0153] **29** BACK-PRESSURE CHAMBER
[0154] **30** HIGH-PRESSURE AREA
[0155] **31** DISCHARGE CHAMBER
[0156] **41** INTERMEDIATE-PRESSURE CHAMBER
[0157] **41***a* INTERMEDIATE-PRESSURE CHAMBER INLET
[0158] **41***b* LIQUID RESERVOIR
[0159] **42** CHECK VALVE
[0160] **42***a* REED VALVE
[0161] **42***b* VALVE STOP
[0162] **43** INJECTION PORT
[0163] **43***a* INJECTION PORT INLET
[0164] **44** INTERMEDIATE-PRESSURE PLATE (INTERMEDIATE PRESSURE CHAMBER PARTITION MEMBER)
[0165] **45** INTERMEDIATE-PRESSURE COVER (INTERMEDIATE PRESSURE CHAMBER PARTITION MEMBER)
[0166] **46** FIXING MEMBER
[0167] **47***a* FIRST CHECK VALVE
[0168] **47***b* SECOND CHECK VALVE
[0169] **48** INJECTION PORT
[0170] **48***a* FIRST INJECTION PORT
[0171] **48***b* SECOND INJECTION PORT
[0172] **55** CONNECTION PASSAGE
[0173] **55***a* FIRST OPENING END
[0174] **55***b* SECOND OPENING END
[0175] **56** SUPPLY PASSAGE
[0176] **56***a* THIRD OPENING END
[0177] **56***b* FOURTH OPENING END
[0178] **66** BEARING PORTION
[0179] **78** SEALING MEMBER
[0180] **91** COMPRESSOR
[0181] **92** CONDENSER
[0182] **93** EVAPORATOR
[0183] **94***a*, **94***b* EXPANSION VALVES
[0184] **95** INJECTION PIPE
[0185] **96** GAS-LIQUID SEPARATOR

1. A scroll compressor comprising:
a fixed scroll including a first spiral wrap standing up from a first end plate of the fixed scroll; and
an orbiting scroll including a second spiral wrap standing up from a second end plate of the orbiting scroll,
wherein the first spiral wrap of the fixed scroll is engaged with the second spiral wrap of the orbiting scroll to define a compression chamber between the fixed scroll and the orbiting scroll,
the compression chamber includes:
a first compression chamber on an outer wall side of the second spiral wrap of the orbiting scroll; and

a second compression chamber on an inner wall side of the second spiral wrap of the orbiting scroll,

a suction volume of the first compression chamber is equal to a suction volume of the second compression chamber,

wherein the first end plate of the fixed scroll includes a central portion having a discharge port through which a refrigerant compressed in the compression chamber is discharged,

the scroll compressor further comprises:

a discharge bypass port through which the refrigerant compressed in the compression chamber is discharged before the compression chamber communicates with the discharge port is provided;

at least one injection port through which an intermediate-pressure refrigerant is injected into the first compression chamber and the second compression chamber, the at least one injection port penetrating the first end plate of the fixed scroll at a position where the injection port is open to the first compression chamber or the second compression chamber in a compression stroke after a suction refrigerant is introduced and closed, and

the discharge bypass port is disposed such that a volume ratio is made smaller in one of the first compression chamber and the second compression chamber having a large amount of the refrigerant injected from the injection port among the first compression chamber and the second compression chamber than in the other one of the first compression chamber and the second compression chamber, the volume ratio being a ratio of the suction volume to the discharge volume of the compression chamber at which the refrigerant in the compression chamber is able to be discharged.

2. The scroll compressor of claim **1**, wherein a check valve that allows flow of the refrigerant to the compression chamber and suppresses flow of the refrigerant from the compression chamber is provided in the injection port.

3. The scroll compressor of claim **1**,

wherein an oil reservoir in which oil is stored is formed in a sealed container including the fixed scroll and the orbiting scroll, a high-pressure area and a back-pressure chamber are formed on a rear surface of the orbiting scroll, an oil supplying passage through which the oil is supplied from the oil reservoir to the compression chamber passes through the back-pressure chamber, the oil supplying passage through which the back-pressure chamber communicates with the first compression chamber and the second compression chamber is provided at the position where the injection port is open to the first compression chamber and the second compression chamber during the compression stroke after the suction refrigerant is introduced and closed, and at least a partial section of an oil supplying section in which the oil supplying passage communicates with the first compression chamber or the second compression chamber overlaps with an opening section in which the injection port is open to the first compression chamber or the second compression chamber.

4. The scroll compressor of claim **2**,

wherein an oil reservoir in which oil is stored is formed in a sealed container including the fixed scroll and the orbiting scroll, a high-pressure area and a back-pressure chamber are formed on a rear surface of the orbiting scroll, an oil supplying passage through which the oil is supplied from the oil reservoir to the compression chamber passes through the back-pressure chamber, the oil supplying passage through which the back-pressure chamber communicates with the first compression chamber and the second compression chamber is provided at the position where the injection port is open to the first compression chamber and the second compression chamber during the compression stroke after the suction refrigerant is introduced and closed, and at least a partial section of an oil supplying section in which the oil supplying passage communicates with the first compression chamber or the second compression chamber overlaps with an opening section in which the injection port is open to the first compression chamber or the second compression chamber.

5. The scroll compressor of claim **3**, wherein an overlapping section where the oil supplying section overlaps with the opening section is defined as a partial section of the latter half of the oil supplying section.

6. The scroll compressor of claim **4**, wherein an overlapping section where the oil supplying section overlaps with the opening section is defined as a partial section of the latter half of the oil supplying section.

7. The scroll compressor of claim **1**, wherein at least one injection port is provided at a position where the injection port is sequentially open to the first compression chamber and the second compression chamber.

8. The scroll compressor of claim **1**, wherein as the injection port, a first injection port that is open only to the first compression chamber and a second injection port that is open only to the second compression chamber are provided, the first injection port has a larger port diameter than the second injection port, the opening section in which the first injection port is open to the first compression chamber is longer than the opening section in which the second injection port is open to the second compression chamber, or a pressure difference between an intermediate pressure in the first injection port and an internal pressure of the first compression chamber when the first injection port is open to the first compression chamber is more than a pressure difference between an intermediate pressure in the second injection port and an internal pressure of the second compression chamber when the second injection port is open to the second compression chamber.

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