

(19)



(11)

**EP 3 301 302 B1**

(12)

**EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:

**05.04.2023 Bulletin 2023/14**

(51) International Patent Classification (IPC):

**F04C 18/02** <sup>(2006.01)</sup>      **F04C 29/02** <sup>(2006.01)</sup>  
**F04C 15/00** <sup>(2006.01)</sup>      **F04C 23/00** <sup>(2006.01)</sup>  
**F04C 28/08** <sup>(2006.01)</sup>

(21) Application number: **16859450.5**

(52) Cooperative Patent Classification (CPC):

**F04C 18/02; F04C 15/0092; F04C 18/0215;**  
**F04C 23/008; F04C 28/08; F04C 29/02;**  
**F04C 29/021; F04C 29/028**

(22) Date of filing: **23.09.2016**

(86) International application number:

**PCT/JP2016/078051**

(87) International publication number:

**WO 2017/073213 (04.05.2017 Gazette 2017/18)**

**(54) SCROLL COMPRESSOR AND AIR-CONDITIONING DEVICE**

SPIRALVERDICHTER UND KLIMATISIERUNGSVORRICHTUNG

COMPRESSEUR À VOLUTES ET DISPOSITIF DE CLIMATISATION

(84) Designated Contracting States:

**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB  
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO  
PL PT RO RS SE SI SK SM TR**

• **TAKASU, Yogo**

**Tokyo 108-8215 (JP)**

• **TAKAHASHI, Kazuki**

**Tokyo 108-8215 (JP)**

• **TATEISHI, Taichi**

**Tokyo 108-8215 (JP)**

• **YAMASHITA, Takuma**

**Tokyo 108-8215 (JP)**

• **KANAI, Akihiro**

**Tokyo 108-8215 (JP)**

(30) Priority: **30.10.2015 JP 2015213691**

(43) Date of publication of application:

**04.04.2018 Bulletin 2018/14**

(74) Representative: **Cabinet Beau de Loménie**

**158, rue de l'Université**

**75340 Paris Cedex 07 (FR)**

(73) Proprietor: **Mitsubishi Heavy Industries Thermal Systems, Ltd.**

**Tokyo 108-8215 (JP)**

(72) Inventors:

• **SATO, Hajime**

**Tokyo 108-8215 (JP)**

• **KIMATA, Yoshiyuki**

**Tokyo 108-8215 (JP)**

(56) References cited:

**JP-A- H03 138 473      JP-A- H05 141 201**

**JP-A- 2011 257 033      JP-A- 2012 058 807**

**EP 3 301 302 B1**

Note: Within nine months of the publication of the mention of the grant of the European patent in the European Patent Bulletin, any person may give notice to the European Patent Office of opposition to that patent, in accordance with the Implementing Regulations. Notice of opposition shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

## Description

### Technical Field

**[0001]** The present invention relates to a scroll compressor which compresses a fluid and an air-conditioning device.

### Background Art

**[0002]** For example, as a compressor of an air-conditioning device, there is a scroll compressor (PTL 1). JP H05-141201 A discloses a scroll compressor according to the preamble of claim 1.

### Citation List

#### Patent Literature

**[0003]** [PTL 1] International Publication No. WO 2012/147145

### Summary of Invention

#### Technical Problem

**[0004]** A scroll compressor includes a fixed scroll and an orbiting scroll and the orbiting scroll orbits while being fitted to the fixed scroll to compress a fluid. There is a scroll compressor in which a pressure in a housing in which the fixed scroll and the orbiting scroll are accommodated is lower than a discharge pressure, and in this scroll compressor, a force in a direction away from the fixed scroll is applied to the orbiting scroll by compressing a fluid. A thrust bearing for supporting this force is installed. However, in the thrust bearing, a friction loss is caused when the orbiting scroll orbits, and there is a possibility that efficiency of the scroll compressor is decreased due to the friction loss.

**[0005]** An object of the present invention is to prevent an efficiency of a scroll compressor from decreasing.

#### Solution to Problem

**[0006]** According to an aspect of the present invention, there is provided a scroll compressor, including: a housing; a partitioning member which divides an interior space of the housing into a first chamber and a second chamber; a scroll compression mechanism which includes a fixed scroll and an orbiting scroll disposed in the first chamber and compresses a refrigerant between the fixed scroll and the orbiting scroll to cause the compressed refrigerant to flow into the second chamber; a rotary shaft which is a rod-shaped member, includes an oil supply passage which extends in a longitudinal direction of the rod-shaped member and through which lubricant oil passes, and causes the orbiting scroll disposed on an outlet side of the oil supply passage to orbit; a back pressure cham-

ber which is disposed on the rotary shaft side of the orbiting scroll and into which the lubricant oil flowing out from the oil supply passage flows; an oil drain passage through which the lubricant oil flowing into the back pressure chamber passes; and a flow control mechanism which changes a flow rate of the lubricant oil flowing through the oil drain passage.

**[0007]** In the scroll compressor of the present invention, the pressure in the back pressure chamber increases by changing the flow rate of the lubricant oil flowing out from the inside of the back pressure chamber through the oil drain passage, and a force from the orbiting scroll toward the fixed scroll is generated on a rear surface of the orbiting scroll. A portion of a force which is applied to the orbiting scroll and is in a direction away from the fixed scroll is canceled out by the force generated on the rear surface of the orbiting scroll, and thus, a loss due to a friction generated when the orbiting scroll orbits in a thrust bearing is decreased. As a result, it is possible to prevent efficiency of the scroll compressor from decreasing.

**[0008]** The flow control mechanism changes, as described in the independent claim 1, the flow rate of the lubricant oil flowing through the oil drain passage based on an orbital speed of the orbiting scroll. In this way, the force from the orbiting scroll toward the fixed scroll can be adjusted according to the orbital speed.

**[0009]** The flow control mechanism increases the flow rate of the lubricant oil flowing through the oil drain passage when the orbital speed of the orbiting scroll is high compared to when the orbital speed of the orbiting scroll is low. The scroll compressor includes an oil supply pump which supplies the lubricant oil to the back pressure chamber. However, in a case where the flow rate of the lubricant oil flowing out from the inside of the back pressure chamber through the oil drain passage decreases, energy for driving the oil supply pump increases. The flow rate of the lubricant oil flowing through the oil drain passage increases when the orbital speed of the orbiting scroll is high, and thus, energy for driving the oil supply pump is prevented from increasing.

**[0010]** The flow control mechanism increases the flow rate of the lubricant oil flowing through the oil drain passage in a case where the orbital speed of the orbiting scroll is larger than a threshold value compared to a case where the orbital speed of the orbiting scroll is equal to or smaller than the threshold value, and the threshold value is equal to or larger than an orbital speed equivalent to a case where the scroll compressor is operated with a capacity of 1/2 of a rated operation and may be equal to or smaller than an orbital speed equivalent to a case where the scroll compressor is operated with the capacity of the rated operation. Accordingly, it is possible to effectively prevent the efficiency of the scroll compressor from decreasing.

**[0011]** The flow control mechanism may change the flow rate of the lubricant oil flowing through the oil drain passage based on at least one of a pressure of the re-

frigerant and a temperature of the lubricant oil. Accordingly, a change in an environment where the scroll compressor is used can be considered when the force from the fixed scroll toward the orbiting scroll is decreased, and thus, it is possible to adjust the force which is applied to the orbiting scroll and is in the direction away from the fixed scroll according to the change in the environment.

**[0012]** A passage sectional area of the oil drain passage may be larger than a passage sectional area of the oil supply passage. According to this structure, a pressure loss of the oil drain passage can be smaller than a pressure loss of the oil supply passage, and thus, it is possible to increase the pressure in the back pressure chamber by the flow control mechanism.

**[0013]** The scroll compressor may further include a bypass passage through which the lubricant oil in the back pressure chamber flows to bypass the flow control mechanism, in which a passage sectional area of the bypass passage may be smaller than the passage sectional area of the oil supply passage. According to this structure, it is possible to adjust the pressure in the back pressure chamber when the oil drain passage is closed.

**[0014]** The scroll compressor may further include a bypass passage through which the lubricant oil in the back pressure chamber flows to bypass the flow control mechanism, in which the bypass passage may include a member provided with a passage having a passage sectional area which is smaller than the passage sectional area of the oil drain passage. According to this structure, it is possible to adjust the pressure in the back pressure chamber when the oil drain passage is closed.

**[0015]** The scroll compressor may further include a positive-displacement oil supply pump which supplies the lubricant oil to the back pressure chamber via the oil supply passage. By using the positive-displacement pump, it is possible to relatively easily increase the pressure of the lubricant oil in the back pressure chamber even in a case where an oil discharge flow path is narrowed.

**[0016]** The flow control mechanism may set the flow rate of the lubricant oil flowing through the oil drain passage to be larger than 0 while the orbiting scroll orbits. The lubricant oil can be supplied to a sliding portion such as a slide bush or a thrust bearing during the operation of the scroll compressor, and thus, the sliding portion can be lubricated.

**[0017]** According to another aspect of the present invention, there is provided an air-conditioning device, including: a condenser which condenses a refrigerant; an evaporator which evaporates the refrigerant condensed by the condenser; and a scroll compressor which compresses the refrigerant evaporated by the evaporator. The air-conditioning device of the present invention includes the scroll compressor of the present invention, and thus, it is possible to prevent the efficiency from decreasing.

#### Advantageous Effects of Invention

**[0018]** Therefore, according to the present invention, it is possible to prevent the efficiency of the scroll compressor from decreasing.

#### Brief Description of Drawings

#### **[0019]**

Fig. 1 is an overall sectional view showing a scroll compressor according to a first embodiment.

Fig. 2 is a diagram showing a relationship between an opening degree of a valve included in the scroll compressor according to the first embodiment and an orbital speed of an orbiting scroll included in the scroll compressor.

Fig. 3 is a partial sectional view of the scroll compressor according to a second embodiment.

Fig. 4 is a diagram showing a relationship between efficiency of the scroll compressor and a magnitude of increasing a pressure in a back pressure chamber.

Fig. 5 is a partial sectional view of a scroll compressor according to a first modification example of the second embodiment.

Fig. 6 is a partial sectional view of a scroll compressor according to a second modification example of the second embodiment.

Fig. 7 is a partial sectional view of a scroll compressor according to a third modification example of the second embodiment.

Fig. 8 is a partial sectional view of a scroll compressor according to a fourth modification example of the second embodiment.

Fig. 9 is a view showing an example of an air-conditioning device according to a third embodiment.

#### Description of Embodiments

**[0020]** Hereinafter, aspects for embodying the invention (hereinafter, appropriately referred to as embodiments) will be described in detail with reference to the drawings. The present invention is not limited to the embodiments.

#### 45 First Embodiment

**[0021]** Fig. 1 is an overall sectional view showing a scroll compressor 1 according to a first embodiment. Fig. 1 shows the scroll compressor 1 which compresses a sucked fluid, in the present embodiment, a refrigerant, and discharges the compressed refrigerant. In addition, for example, the scroll compressor 1 is provided in a refrigerant flow path through which the refrigerant which is the fluid circulates in an air-conditioning device or a refrigerator.

**[0022]** As shown in Fig. 1, the scroll compressor 1 includes a motor 5 which is a drive device of the scroll compressor 1 and a scroll compression mechanism 7

which is driven by the motor 5 in an interior space of a housing 3.

**[0023]** The housing 3 includes a tubular housing main body 3a which vertically extends, a bottom portion 3b which closes a lower end of the housing main body 3a, and a cover portion 3c which closes an upper end of the housing main body 3a. The housing 3 is a pressure container whose entirety is sealed. A suction pipe 9 through which the refrigerant is introduced into the housing 3 is provided on the side portion of the housing main body 3a.

**[0024]** A discharge pipe 11 through which the refrigerant compressed by the scroll compression mechanism 7 is discharged is provided on the upper portion of the cover portion 3c. In the housing 3, a discharge cover 13 is provided between the housing main body 3a and the cover portion 3c, and the interior space of the housing 3 is divided into a low-pressure chamber 3A which is a first chamber positioned below the discharge cover 13 which is a partitioning member and a high-pressure chamber 3B which is a second chamber positioned above the discharge cover 13. Even in a case where the discharge cover 13 is not provided in the housing 3, the fixed scroll 33 and the upper bearing 21 function as the partitioning member. The discharge cover 13 includes an opening hole 13a through which the low-pressure chamber 3A and the high-pressure chamber 3B communicate with each other. A discharge reed valve 13b which opens and closes the opening hole 13a is provided in the discharge cover 13. An oil reservoir in which the lubricant oil is stored is formed on the bottom in the housing 3.

**[0025]** The motor 5 includes a stator 15 and a rotor 17. The stator 15 is fixed to an inner wall surface at an approximately intermediate portion in a vertical direction of the housing main body 3a. The rotor 17 is rotatably provided to the stator 15. A rotary shaft 19 is disposed above and below the rotor 17 in the longitudinal direction. Power is supplied to the motor 5 from the outside of the housing 3 to rotate the rotor 17, and thus, the rotor 17 and the rotary shaft 19 are rotated.

**[0026]** The rotary shaft 19 is a rod-shaped member which causes an orbiting scroll 35 of the scroll compression mechanism 7 to orbit. The rotary shaft 19 is provided such that end portions protrude upward and downward from the rotor 17, and an upper end portion of the rotary shaft 19 is rotatably supported on the housing main body 3a by an upper bearing 21 and a lower end portion thereof is rotatably supported on the housing main body 3a by a lower bearing 23 about an axis CE extending in the vertical direction. The axis CE is a longitudinal direction of the rotary shaft 19 which is a rod-shaped member.

**[0027]** In the rotary shaft 19, an eccentric pin 25 which protrudes upward along an eccentricity LE eccentric to the axis CE is formed on an upper end of the rotary shaft 19. The scroll compression mechanism 7 is connected to the upper end of the rotary shaft 19 having the eccentric pin 25. Detailed configurations of the eccentric pin 25 will be described later. The rotary shaft 19 and the eccentric pin 25 has an oil supply passage 27 which extends up

and down, that is, in the longitudinal direction of the rotary shaft 19 on the insides of the rotary shaft 19 and the eccentric pin 25. In the present embodiment, the oil supply passage 27 penetrates the rotary shaft 19 from one end toward the other end. The oil supply passage 27 and the rotary shaft 19 are provided such that lower ends thereof reach the oil reservoir, and an oil supply pump 29 is provided on the lower end of the rotary shaft 19. The oil supply pump 29 is driven by the rotary shaft 19. The oil supply pump 29 feeds the lubricant oil stored in the oil reservoir to the oil supply passage 27 of the rotary shaft 19 according to the rotation of the rotary shaft 19. The lubricant oil fed by the oil supply pump 29 passes through the oil supply passage 27 and flows out from an outlet 27H which is provided on the end portion on the scroll compression mechanism 7 side.

**[0028]** In the present embodiment, the oil supply pump 29 increases a flow rate of the discharged lubricant oil according to an increase in a rotational speed of the rotary shaft 19, that is, a rotational speed of the motor 5. For example, the oil supply pump 29 is a positive-displacement pump and a centrifugal pump. However, the present invention is not limited to this. Preferably, by using the positive-displacement pump as the oil supply pump 29, it is possible to relatively easily increase the pressure of the lubricant oil in the back pressure chamber 50 even in a case where an oil drain passage 21c is narrowed.

**[0029]** The upper end portion of the rotary shaft 19 penetrates the upper bearing 21, and thus, the upper bearing 21 rotatably supports the rotary shaft 19. In the upper bearing 21, a recessed portion 21a is formed on an upper surface of the upper bearing 21 to surround an upper end portion of the rotary shaft 19 penetrating the upper bearing 21. A slide bush 37 described later is accommodated in the recessed portion 21a, and the lubricant oil fed via the oil supply passage 27 by the oil supply pump 29 is stored in the recessed portion 21a.

**[0030]** In the upper bearing 21, a notch 21b is formed on a portion of an outer periphery to have a gap between an inner wall surface of the housing main body 3a of the housing 3 and the upper bearing 21, and the oil drain passage 21c which communicates with the notch 21b and the recessed portion 21a is formed. A cover plate 31 is provided below the notch 21b of the upper bearing 21.

The cover plate 31 is provided to extend in the vertical direction. The cover plate 31 is formed such that both side ends are curved toward the inner wall surface of the housing main body 3a so as to cover the vicinity of the notch 21b, and is formed such that a lower end of the cover plate 31 is gradually bent toward the inner wall surface of the housing main body 3a. The lubricant oil excessively stored in the recessed portion 21a flows to the recovery passage 51 through the oil drain passage 21c. The lubricant oil flowing through the recovery passage 51 is returned to a bottom oil reservoir in the housing 3.

**[0031]** In the interior space of the housing 3, the scroll compression mechanism 7 is disposed above the upper

bearing 21 in the low-pressure chamber 3A below the discharge cover 13, and includes a fixed scroll 33, an orbiting scroll 35, and a slide bush 37.

**[0032]** In the fixed scroll 33, a spiral fixed wrap 33b is formed on an inner surface (lower surface in Fig. 1) of the fixed end plate 33a fixed to the interior space of the housing 3. A discharge hole 33c is formed at the center portion of the fixed end plate 33a.

**[0033]** In the orbiting scroll 35, a spiral movable wrap 35b is formed on an inner surface (upper surface in Fig. 1) of a movable end plate 35a facing the inner surface of the fixed end plate 33a in the fixed scroll 33. In addition, the movable wrap 35b of the orbiting scroll 35 and the fixed wrap 33b of the fixed scroll 33 mesh with each other with their phases shifted from each other, and thus, a compression chamber which is portioned by the fixed end plate 33a, the movable end plate 35a, the fixed wrap 33b, and the movable wrap 35b is formed.

**[0034]** In the orbiting scroll 35, a cylindrical boss 35c to which the eccentric pin 25 of the rotary shaft 19 is connected and an eccentric rotation of the eccentric pin 25 is transmitted is formed on the outer surface (lower surface in Fig. 1) of the movable end plate 35a. The boss 35c is disposed on the outlet 27H side of the oil supply passage 27 included in the rotary shaft 19. In the present embodiment, the outlet 27H of the oil supply passage 27 faces the movable end plate 35a of the orbiting scroll 35. The orbiting scroll 35 is revolved while being prevented from rotating on the basis of the eccentric rotation of the eccentric pin 25 by a rotation prevention mechanism 39 such as an Oldham link disposed between the outer surface of the movable end plate 35a and the upper bearing 21.

**[0035]** The slide bush 37 is accommodated in the recessed portion 21a of the above-described upper bearing 21, is interposed between the eccentric pin 25 of the rotary shaft 19 and the boss 35c of the orbiting scroll 35, and transmits the rotation of the eccentric pin 25 to the orbiting scroll 35. Hereinafter, the recessed portion 21a in which the slide bush 37 is accommodated is appropriately referred to as a bush chamber 21a. The slide bush 37 is provided to be slidable in a radial direction of the eccentric pin 25 to maintain meshing between the movable wrap 35b of the orbiting scroll 35 and the fixed wrap 33b of the fixed scroll 33.

**[0036]** In the present embodiment, a space formed by a rear surface 35ab of the orbiting scroll 35, that is, a surface facing the upper bearing 21 of the movable end plate 35a, the bush chamber 21a, and the upper bearing 21 is referred to as a back pressure chamber 50. The back pressure chamber 50 is disposed between the orbiting scroll 35 and the upper bearing 21 which rotatably supports the rotary shaft 19 on the orbiting scroll 35 side. The lubricant oil passing through the oil supply passage 27 from the outlet 27H of the oil supply passage 27 included in the rotary shaft 19 flows into the bush chamber 21a forming the back pressure chamber 50. That is, the lubricant oil flowing out from the oil supply passage 27

flows into the back pressure chamber 50. The lubricant oil flowing into the back pressure chamber 50 passes through the above-described oil drain passage 21c and is discharged from the back pressure chamber 50.

**[0037]** In the scroll compression mechanism 7, by the revolution of the orbiting scroll 35, a low-pressure refrigerant introduced into the low-pressure chamber 3A in the housing 3 via the suction pipe 9 is compressed while being sucked into the compression chamber between the fixed scroll 33 and the orbiting scroll 35. The compressed high-pressure refrigerant is discharged from the discharge hole 33c of the fixed scroll 33 to the outer surface side of the fixed end plate 33a, and the discharge reed valve 13b of the discharge cover 13 is opened by the pressure of the refrigerant. Accordingly, the refrigerant flows from the opening hole 13a into the high-pressure chamber 3B and is discharged to the outside of the housing 3 via the discharge pipe 11.

**[0038]** During an operation of the scroll compressor 1, a pressure in the low-pressure chamber 3A is the same as a suction pressure which is a pressure by which the scroll compression mechanism 7 sucks the refrigerant, the orbiting scroll 35 of the scroll compression mechanism 7 receives a force in a direction away from the fixed scroll 33 by the refrigerant during compression of the refrigerant. Hereinafter, this force is appropriately referred to as a thrust force. This force is supported by a thrust bearing 40 installed on the upper surface of the upper bearing 21. This thrust force is applied to the thrust bearing 40, and thus, when the orbiting scroll 35 orbits, a loss is caused by a friction between the rear surface 35ab of the orbiting scroll 35 and the thrust bearing 40. Hereinafter, the loss caused by the friction is appropriately referred to as a thrust loss.

**[0039]** During the operation of the scroll compressor 1, the scroll compressor 1 causes the lubricant oil passing through the oil supply passage 27 of the rotary shaft 19 to flow into the back pressure chamber 50, and restrains a flow rate of the lubricant oil flowing out from the back pressure chamber 50 through the oil drain passage 21c, that is, a flow rate of the lubricant oil passing through the oil drain passage 21c. In this way, the pressure of the lubricant oil in the back pressure chamber 50 is larger than the suction pressure of the scroll compression mechanism 7, that is, the pressure in the low-pressure chamber 3A, and thus, the thrust force applied to the scroll compression mechanism 7 is decreased by the lubricant oil in the back pressure chamber 50. As a result, in the scroll compressor 1 in which the scroll compression mechanism 7 is disposed in the low-pressure chamber 3A, the thrust loss decreases.

**[0040]** After the lubricant oil supplied to the back pressure chamber 50 passes through the oil drain passage 21c, the lubricant oil is returned to an oil reservoir 3bt in the bottom portion 3b, which closes the lower end of the housing main body 3a, through the recovery passage 51. The lubricant oil in the oil reservoir 3bt is sucked by the oil supply pump 29 and passes through the oil supply

passage 27, and thereafter, the lubricant oil flows into the back pressure chamber 50 from the outlet 27H. The recovery passage 51 is a passage which is connected to the oil drain passage 21c and the oil supply pump 29 side of the housing main body 3a. In the present embodiment, the recovery passage 51 is disposed outside the housing 3. However, the recovery passage 51 may be disposed inside the housing 3.

**[0041]** The oil reservoir 3bt is disposed on the side to which gravity is applied. In the present embodiment, a lower portion of the scroll compressor 1 is the oil reservoir 3bt side, that is, the bottom portion 3b side, and an upper portion of the scroll compressor 1 is the cover portion 3c side. This is similarly applied to the following embodiments.

**[0042]** In the present embodiment, a flow control mechanism is provided in the recovery passage 51. The flow control mechanism is a mechanism which changes the flow rate of the lubricant oil flowing through the oil drain passage 21c, and in the present embodiment, is a valve 52. In the present embodiment, the valve 52 has a mechanism which changes an area of a portion through which the lubricant oil passes. In the present embodiment, as an example of the valve 52, there is an on/off valve or a flow regulating valve. Opening, closing, and an opening degree of the valve 52 are controlled by a control device 53. Accordingly, for example, an electromagnetic valve is used as the valve 52. For example, the control device 53 is a computer having a processor and a memory. The control device 53 may be a control device of the air-conditioning device on which the scroll compressor 1 is mounted or may be a dedicated device for controlling the operation of the valve 52.

**[0043]** The flow rate of the lubricant oil flowing through the recovery passage 51 is changed by opening or closing the valve 52 or adjusting the opening degree thereof, and thus, it is possible to change the flow rate of the lubricant oil flowing through the oil drain passage 21c connected to an upstream side in a flow direction of the lubricant oil flowing through the recovery passage 51. In the present embodiment, the valve 52 is provided in the recovery passage 51. However, the valve 52 may be provided in the oil drain passage 21c. In the present embodiment, the valve 52 may be provided between an inlet of the oil drain passage 21c and an inlet of the oil supply pump 29. In addition, the valve 52 may be provided between the inlet of the oil drain passage 21c and an outlet of the recovery passage 51.

**[0044]** In a case where the valve 52 closes or the opening degree of the valve 52 becomes smaller than that of the current state, the flow rate of the lubricant oil flowing through the oil drain passage 21c also becomes smaller than that of the current state. Accordingly, the lubricant oil in the back pressure chamber 50 increases, and the inside of the back pressure chamber 50 is filled with the lubricant oil. Therefore, the pressure in the back pressure chamber 50 increases, the orbiting scroll 35 receives a force in a direction away from the upper bearing 21, that

is, a force from the orbiting scroll 35 toward the fixed scroll 33, by the pressure from the back pressure chamber 5. Hereinafter, this force is appropriately referred to as an anti-thrust force. This anti-thrust force is applied in a direction opposite to that of the thrust force, and thus, decreases the thrust force. That is, in a case where the flow rate of the lubricant oil flowing through the oil drain passage 21c is smaller than that of the current state, the thrust force decreases, and thus, a thrust loss decreases. As a result, the efficiency of the scroll compressor 1 is prevented from decreasing.

**[0045]** In a case where the inside of the back pressure chamber 50 is filled with the lubricant oil by decreasing the flow rate of the lubricant oil flowing through the oil drain passage 21c, the surplus of the lubricant oil flows to a portion between the upper bearing 21 and the orbiting scroll 35. The lubricant oil flows into the compression chamber along with the refrigerant, an oil film is formed inside the scroll compression mechanism 7 to improve sealing performance, and thus, it is possible to suppress a decrease in efficiency of the scroll compressor 1. That is, the lubricant oil flowing to the portion between the upper bearing 21 and the orbiting scroll 35 from the back pressure chamber 50 improves the sealing performance of the refrigerant in the scroll compression mechanism 7. Accordingly, in a case where the valve 52 is closed or the opening degree of the valve 52 is smaller than that of the current state, the thrust loss is decreased, and performance of sealing the refrigerant in the scroll compression mechanism 7 is improved. As a result, the efficiency of the scroll compressor 1 is further prevented from decreasing.

**[0046]** In the scroll compressor 1, the anti-thrust force is generated by changing the flow rate of the lubricant oil flowing through the oil drain passage 21c, that is, the flow rate of the lubricant oil flowing out from the back pressure chamber 50, and thus, the thrust force is decreased and the thrust loss is decreased. The anti-thrust force is increased by decreasing the flow rate of the lubricant oil flowing through the oil drain passage 21c. In the present embodiment, the anti-thrust force is generated by setting the flow rate of the lubricant oil flowing through the oil drain passage 21c to 0, that is, by completely closing the valve 52. However, in order to generate the anti-thrust force, the flow rate of the lubricant oil flowing through the oil drain passage 21c may not be set to 0. For example, in the present embodiment, while the orbiting scroll 35 orbits, the valve 52 may increase the flow rate of the lubricant oil flowing through the oil drain passage 21c to be greater than 0. The lubricant oil can be reliably supplied to a sliding portion such as a bearing, and thus, it is possible to reliably lubricate the sliding portion.

**[0047]** In the present embodiment, a passage sectional area of the oil drain passage 21c is not limited. However, the passage sectional area may be equal to or larger than a passage sectional area of the oil supply passage 27 included in the rotary shaft 19. In this way, a pressure loss of the oil drain passage 21c can be smaller than a

pressure loss of the oil supply passage 27, and thus, it is possible to reliably increase the pressure in the back pressure chamber 50 by the valve 52. In addition, when the valve 52 is fully open, it is possible to reliably discharge the lubricant oil in the back pressure chamber 50 from the oil drain passage 21c.

**[0048]** In the present embodiment, the valve 52 changes the flow rate of the lubricant oil flowing through the oil drain passage 21c based on the orbital speed of the orbiting scroll 35, that is, the rotational speed of the motor 5. For example, in a case where the orbital speed of the orbiting scroll 35 is larger than a threshold value, the valve 52 increases the flow rate of the lubricant oil flowing through the oil drain passage 21c compared to a case where the orbital speed is equal to or smaller than the threshold value. That is, in the case where the orbital speed of the orbiting scroll 35 is equal to or smaller than the threshold value, the valve 52 decreases the flow rate of the lubricant oil flowing through the oil drain passage 21c compared to the case where the orbital speed of the orbiting scroll 35 is larger than the threshold value. In the present embodiment, the flow rate of the lubricant oil flowing through the oil drain passage 21c becomes 0. In this way, in the case where the orbital speed of the orbiting scroll 35 is larger than the threshold value, the flow rate of the lubricant oil flowing through the oil drain passage 21c increases, and thus, drive power of the oil supply pump 29 is prevented from increasing. In addition, it is possible to prevent rising of the oil caused by an excessive increase in the flow rate of the lubricant oil flowing to the orbiting scroll 35. As a result, the efficiency of the scroll compressor 1 is prevented from decreasing. In addition, an amount of the lubricant oil flowing to the portion between the upper bearing 21 and the orbiting scroll 35 from the inside of the back pressure chamber 50 decreases, and thus, an amount of the lubricant oil included in the refrigerant also decreases. The threshold value of the orbital speed is set to 1/2 of the maximum orbital speed of the orbiting scroll 35. However, the present invention is not limited to this, and the threshold value may be 1/3 or 1/4 thereof. In addition, the threshold value may be an orbital speed which is most frequently used in the scroll compressor 1. Preferably, the threshold value of the orbital speed may be equal to or larger than an orbital speed equivalent to a case where the scroll compressor 1 is operated with capacity of 1/2 of a rated operation or may be equal to or smaller than an orbital speed equivalent to a case where the scroll compressor 1 is operated with capacity of the rated operation. In a case where the threshold value is set to this range, the efficiency of the scroll compressor 1 is effectively prevented from decreasing.

**[0049]** In a case where the orbital speed of the orbiting scroll 35 is relatively low, the sealing performance of the scroll compression mechanism 7 decreases. By decreasing the flow rate of the lubricant oil flowing through the oil drain passage 21c in the case where the orbital speed of the orbiting scroll 35 is equal to or smaller than

the threshold value, the amount of the lubricant oil flowing to the portion between the upper bearing 21 and the orbiting scroll 35 from the inside of the back pressure chamber 50 increases, and thus, the sealing performance of the scroll compression mechanism 7 is improved. As a result, the efficiency of the scroll compression mechanism 7 is prevented from decreasing.

**[0050]** For example, the scroll compressor 1 is used in an air-conditioning device. In general, in the air-conditioning device, a period in which the air-conditioning device is operated under a condition of a lower output than the rated operation is longer than the period of the rated operation, preventing efficiency under such conditions from decreasing leads to preventing the efficiency from decreasing throughout the year. In the condition of a lower output than the output of the rated operation, the orbital speed of the orbiting scroll 35 of the scroll compressor 1 is lower than the orbital speed of the orbiting scroll 35 when the rated operation is performed. In the case where the orbital speed of the orbiting scroll 35 is equal to or smaller than the threshold value, the valve 52 is closed to decrease the flow rate of the lubricant oil flowing through the oil drain passage 21c. Accordingly, it is possible to prevent the efficiency of the scroll compressor 1 from decreasing. As a result, the scroll compressor 1 prevents the efficiency of the air-conditioning device from decreasing in a period in which the air-conditioning device is operated under a condition of a lower output than the output of the rated operation, and thus, it is possible to prevent the efficiency from decreasing throughout the year.

**[0051]** In this way, when the rotational speed of the orbiting scroll 35 is low, the valve 52 decreases the flow rate of the lubricant oil flowing through the oil drain passage 21c compared to when the rotational speed of the orbiting scroll 35 is high, and thus, it is possible to prevent the efficiency of the scroll compressor 1 from decreasing.

**[0052]** Fig. 2 is a diagram showing a relationship between the opening degree of the valve 52 included in the scroll compressor 1 according to the first embodiment and the orbital speed of the orbiting scroll 35 included in the scroll compressor 1. As shown in Fig. 2, in the valve 52, the opening degree is changed as the orbital speed of the orbiting scroll 35 increases, and in the present embodiment, the opening degree may increase. That is, the flow rate of the lubricant oil flowing through the oil drain passage 21c may increase as the orbital speed of the orbiting scroll 35 increases. In the example shown in Fig. 2, the opening degree of the valve 52 increases in a range of the orbital speed from N1 to N2. In this way, the flow rate of the lubricant oil flowing through the oil drain passage 21c can be optimally adjusted in the entire operation region of the scroll compressor 1, and thus, it is possible to further prevent the efficiency of the scroll compressor 1 from decreasing.

**[0053]** The flow rate of the lubricant oil flowing through the oil drain passage 21c may be changed based on at least one of the pressure of the refrigerant and the tem-

perature of the lubricant oil in addition to the orbital speed of the orbiting scroll 35. As the pressure of the refrigerant, a pressure difference between the discharge pressure of the refrigerant discharged from the scroll compressor 1 and the suction pressure of the refrigerant sucked into the scroll compressor 1 can be used. The pressure difference of the refrigerant increases as the rotational speed of the orbiting scroll 35 increases. Accordingly, for example, it is possible to increase the opening degree of the valve 52, that is, it is possible to increase the flow rate of the lubricant oil flowing through the oil drain passage 21c as the pressure difference of the refrigerant increases.

**[0054]** In a case where the temperature of the lubricant oil increases, viscosity of the lubricant oil decreases, and thus, the lubricant oil easily flows through the oil drain passage 21c. For example, the opening degree of the valve 52 decreases, that is, the flow rate of the lubricant oil flowing through the oil drain passage 21c decreases as the temperature of the lubricant oil increases. In this way, even in a case where the viscosity of the lubricant oil decreases and the flow rate of the oil supply pump 29 decreases, it is possible to more reliably decrease the thrust force. For example, the temperature of the lubricant oil is the temperature of the lubricant oil in the oil reservoir 3bt.

**[0055]** In the present embodiment, in the scroll compressor 1, the valve 52 can change the flow rate of the lubricant oil flowing through the oil drain passage 21c based on at least one of the rotational speed of the orbiting scroll 35, the pressure of the refrigerant, and the temperature of the lubricant oil. In the present embodiment, preferably, the flow rate of the lubricant oil flowing through the oil drain passage 21c is changed based on the rotational speed of the orbiting scroll 35, and the flow rate of the lubricant oil flowing through the oil drain passage 21c is changed based on at least one of the pressure of the refrigerant and the temperature of the lubricant oil.

**[0056]** In the present embodiment, one oil drain passage 21c may be provided, and the number of the oil drain passages 21c may not be limited. In a case where the scroll compressor 1 includes a plurality of oil drain passages 21c, the valve 52 is provided in each of the oil drain passages 21c, and the opening, the closing, or the opening degree of the valve 52 may be adjusted based on at least one of an operation conditions and an environment condition of the scroll compressor 1. Accordingly, the thrust force can be decreased in the entire operation region of the scroll compressor 1, a change in the environment where the scroll compressor 1 is used can be considered in the decrease of the thrust force, and thus, it is possible to further prevent the efficiency of the scroll compressor 1 from decreasing.

**[0057]** In the present embodiment, the flow rate of the lubricant oil flowing through the oil drain passage 21c may be adjusted based on the pressure of the lubricant oil in the back pressure chamber 50. For example, the opening degree of the valve 52 may be changed such

that the pressure of the lubricant oil in the back pressure chamber 50 becomes a predetermined value. In this way, in the scroll compressor 1, even in a case where an operation state is changed, the anti-thrust force having a constant magnitude is generated, and thus, it is possible to decrease the thrust loss. For example, as the pressure in the back pressure chamber 50, a value which is detected by a pressure sensor provided in the oil drain passage 21c can be used.

**[0058]** In the present embodiment, the recovery passage 51 is disposed outside the housing 3. According to this configuration, the valve 52 is easily provided in the recovery passage 51. In addition, preferably, a degree of freedom in the disposition of the valve 52 is improved. The recovery passage 51 and the valve 52 may be disposed inside the housing 3.

**[0059]** Hereinbefore, in the first embodiment, by restraining the flow rate of the lubricant oil flowing out through the oil drain passage 21c from the inside of the back pressure chamber 50 disposed on the rear surface of the movable end plate 35a of the orbiting scroll 35, that is, on the rear side of the surface on which the movable wrap 35b is formed, the pressure in the back pressure chamber 50 increases, and thus, the anti-thrust force is generated. In the first embodiment, a portion of the thrust force is canceled out by the anti-thrust force generated, and thus, the thrust loss decreases, and the efficiency of the scroll compressor 1 is prevented from decreasing. The configuration described in the first embodiment can be appropriately applied to the following embodiments.

#### Second Embodiment

**[0060]** Fig. 3 is a partial sectional view of the scroll compressor 1a according to a second embodiment. The scroll compressor 1a includes a bypass passage 21d through which the lubricant oil in the back pressure chamber 50 flows to bypass the valve 52 which is the flow control mechanism. In the present embodiment, the bypass passage 21d is a passage branching off from the oil drain passage 21c, and the lubricant oil flowing out from the oil drain passage 21c bypasses the valve 52 and flows through the bypass passage 21d. Other structures are similar to those of the scroll compressor 1 of the first embodiment.

**[0061]** In the scroll compressor 1a, the oil drain passage 21c and the bypass passage 21d are provided in the upper bearing 21. The bypass passage 21d is provided inside the housing 3. The valve 52 which is the flow control mechanism is not provided in the bypass passage 21d. Similarly to the first embodiment, the recovery passage 51 in which the valve 52 is provided is disposed outside the housing 3. The recovery passage 51 penetrates the housing 3 and is connected to the oil drain passage 21c. A sectional shape of the bypass passage 21d is not limited, and for example, may be any one of a circular shape, an elliptical shape, or a polygonal shape.

This is similarly applied to the following.

**[0062]** A portion of the lubricant oil flowing through the oil drain passage 21c branches off to flow through the bypass passage 21d, and thereafter, flows to the inside of the housing main body 3a of the housing 3. The lubricant oil flowing out from the bypass passage 21d passes through a passage 54 between the cover plate 31 and the inside of the housing main body 3a, and thereafter, flows into the oil reservoir 3bt shown in Fig. 1. As described above, the lubricant oil passing through the recovery passage 51 and the valve 52 flows into the housing main body 3a, and thereafter, flows into the oil reservoir 3bt shown in Fig. 1.

**[0063]** A passage sectional area of the bypass passage 21d is smaller than a passage sectional area of the oil supply passage 27 included in the rotary shaft 19 and a passage sectional area of the oil drain passage 21c. The bypass passage 21d is provided in the oil drain passage 21c, and thus, the lubricant oil in the oil drain passage 21c flows through the bypass passage 21d when the valve 52 is closed. Accordingly, compared to a case where the bypass passage 21d is not provided, it is possible to decrease the pressure in the back pressure chamber 50.

**[0064]** Fig. 4 is a diagram showing a relationship between efficiency  $\eta$  of the scroll compressor 1a and a magnitude  $\Delta P$  of increasing the pressure in the back pressure chamber 50. It is possible to adjust the pressure in the back pressure chamber 50 when the valve 52 is closed by changing the passage sectional area of the bypass passage 21d. As shown in Fig. 4, as an example, the passage sectional area of the bypass passage 21d is adjusted such that the magnitude  $\Delta P$  of increasing the pressure in the back pressure chamber 50 by the lubricant oil supplied into the back pressure chamber 50 from the oil supply pump 29 is from 0.02 MPa to 0.5 MPa or from 0.05 MPa to 0.3 MPa. The pressure in the back pressure chamber 50 is adjusted by adjusting the passage sectional area of the bypass passage 21d, and thus, it is possible to maximize the efficiency  $\eta$  of the scroll compressor 1a.

**[0065]** In the present embodiment, the bypass passage 21d penetrates the upper bearing 21 from the motor 5 side toward the oil drain passage 21c. However, the bypass passage 21d may be an orifice or a capillary.

#### First Modification Example

**[0066]** Fig. 5 is a partial sectional view of a scroll compressor 1b according to a first modification example of the second embodiment. The scroll compressor 1b has a structure similar to that of the scroll compressor 1a according to the second embodiment except that the bypass passage 21e has a first bypass passage 21e1 and a second bypass passage 21e2. Other structures are similar to those of the scroll compressor 1a according to the second embodiment.

**[0067]** The first bypass passage 21e1 extends in a di-

rection parallel to the axis CE of the rotary shaft 19 from the oil drain passage 21c. The second bypass passage 21e2 extends through the inside of the upper bearing 21 toward the outside of the rotary shaft 19 in the radial direction and is open to the surface of the upper bearing 21. The first bypass passage 21e1 is connected to the second bypass passage 21e2. According to this structure, a portion of the lubricant oil flowing through the inside of the oil drain passage 21c branches off to flow through the bypass passage 21e and flows into the housing main body 3a of the housing 3. The flow of the lubricant oil thereafter is similar to that of the scroll compressor 1a according to the second embodiment.

#### Second Modification Example

**[0068]** Fig. 6 is a partial sectional view of a scroll compressor 1c according to a second modification example of the second embodiment. The scroll compressor 1c has a structure similar to that of the scroll compressor 1a according to the second embodiment except that the bypass passage 21f is provided in a pipe 55 which connects the upper bearing 21 and the outside of the housing main body 3a of the housing 3 to each other. Other structures are similar to those of the scroll compressor 1a according to the second embodiment.

**[0069]** In the scroll compressor 1c, the pipe 55 is disposed between the recovery passage 51 and the oil drain passage 21c. The pipe 55 connects the recovery passage 51 and the oil drain passage 21c to each other. The bypass passage 21f is a hole which penetrates a side portion 55S of the pipe 55. According to this structure, a portion of the lubricant oil flowing through the inside of the oil drain passage 21c branches off to flow through the bypass passage 21f and flows into the housing main body 3a of the housing 3. The flow of the lubricant oil thereafter is similar to that of the scroll compressor 1a according to the second embodiment. The bypass passage 21f of the scroll compressor 1c can be formed by only drilling the side portion 55S of the pipe 55, and thus, the bypass passage 21f is easily manufactured.

#### Third Modification Example

**[0070]** Fig. 7 is a partial sectional view of a scroll compressor 1d according to a third modification example of the second embodiment. The scroll compressor 1d has a structure similar to that of the scroll compressor 1a according to the second embodiment. However, in the scroll compressor 1d, a member 56 having a through-hole 56H is attached to the bypass passage 21g. The bypass passage 21g of the third modification example penetrates the upper bearing 21 from the back pressure chamber 50 to the surface on the outside of the upper bearing 21 in the radial direction. In the present modification example, the bypass passage 21g is open to a portion of the notch 21b which is formed on a portion of the outer periphery of the upper bearing 21.

**[0071]** The member 56 is a rod-shaped member, and for example, is a bolt. The member 56 is screwed to a female screw formed on a side of the bypass passage 21g opposite to the back pressure chamber 50 and is attached to the bypass passage 21g. The through-hole 56H included in the member 56 penetrates the member 56 in a longitudinal direction of the member 56. A sectional shape of the through-hole 56H is not limited to a circular shape and may be an elliptical shape or a polygonal shape. The lubricant oil passing through the bypass passage 21g flows through the through-hole 56H. In this way, the through-hole 56H is a passage through which a liquid, in the present modification example, the lubricant oil flows. The member 56 includes a passage through which the lubricant oil flows.

**[0072]** The lubricant oil flowing out from the bypass passage 21g passes through the through-hole 56H of the member 56 and flows from the portion of the notch 21b of the upper bearing 21 into the housing main body 3a of the housing 3 without passing through the valve 52. In this way, the lubricant oil flowing out from the bypass passage 21g bypasses the valve 52 and flows into the housing main body 3a of the housing 3.

**[0073]** A passage sectional area of the through-hole 56H is smaller than a passage sectional area of the bypass passage 21g. Accordingly, a pressure loss of the through-hole 56H is larger than a pressure loss of the bypass passage 21g, and thus, the pressure in the back pressure chamber 50 can be increased when the valve 52 is closed, compared with only the bypass passage 21g. By exchanging members 56 with different passage sectional areas of the through-hole 56H, it is possible to change the pressure in the back pressure chamber 50 when the valve 52 is closed, and thus, the anti-thrust force is easily adjusted.

**[0074]** The bypass passages 21d, 21e, and 21f of the second embodiment, the first modification example, and the second modification example branch off from the oil drain passage 21c. However, in the present modification example, the oil drain passage 21c and the bypass passage 21g are provided at positions of the upper bearing 21 different from each other in the circumferential direction. In this way, the bypass passage 21g may not branch off from the oil drain passage 21c as long as the bypass passage 21g can cause the lubricant oil in the back pressure chamber 50 to flow through the bypass passage 21g to bypass the valve 52. In a case where the positions of the oil drain passage 21c and the bypass passage 21g are different from each other in the circumferential direction of the upper bearing 21, degrees of freedom in the depositions of the recovery passage 51 and the valve 52 are improved.

#### Fourth Modification Example

**[0075]** Fig. 8 is a partial sectional view of a scroll compressor 1e according to a fourth modification example of the second embodiment. The scroll compressor 1e has

a structure similar to that of the scroll compressor 1d according to the third modification example except that a member 57 having grooves 57S is attached to a bypass passage 21h branching off from the oil drain passage 21c. The bypass passage 21h of the third modification example penetrates the upper bearing 21 from the back pressure chamber 50 to the surface on the outside of the upper bearing 21 in the radial direction. In the present modification example, the bypass passage 21h is open to the portion of the notch 21b formed on a portion of the outer periphery of the upper bearing 21.

**[0076]** The member 57 is a rod-shaped member and includes the grooves 57S on the side surface. The grooves 57S are spirally formed on the surface of the member 57. The member 57 is inserted into the bypass passage 21h from an opening portion of the bypass passage 21h on the notch 21b side. The grooves 57S of the member 57 spirally extend from a first end portion of the member 57 to a second end portion thereof. The number of grooves 57S is not limited. The lubricant oil that has passed flows to a portion between the grooves 57S and the bypass passage 21h and flows out from the opening portion of the bypass passage 21h on the notch 21b side. In this way, the grooves 57S are a passage through which a liquid, in the present modification example, the lubricant oil flows. The member 57 is a passage through which the lubricant oil flows.

**[0077]** The lubricant oil flowing out from the bypass passage 21h passes through the grooves 57S of the member 57 and flows from the portion of the notch 21b of the upper bearing 21 into the housing main body 3a of the housing 3 without passing through the valve 52. In this way, the lubricant oil flowing out from the bypass passage 21h bypasses the valve 52 and flows into the housing main body 3a of the housing 3.

**[0078]** A passage sectional area of the groove 57S is smaller than a passage sectional area of the bypass passage 21h. Accordingly, a pressure loss of the groove 57S is larger than a pressure loss of the bypass passage 21h, and thus, the pressure in the back pressure chamber 50 can be increased when the valve 52 is closed, compared with only the bypass passage 21h. By exchanging the members 57 with different passage sectional areas of the groove 57S or adjusting an insertion depth of the member 57 into the bypass passage 21h, it is possible to change the pressure in the back pressure chamber 50 when the valve 52 is closed, and thus, the anti-thrust force is easily adjusted.

**[0079]** Hereinbefore, in the second embodiment and the modification examples thereof, in addition to the oil drain passage 21c of the first embodiment, the bypass passages 21d, 21e, 21f, 21g, and 21h are provided, through which the lubricant oil in the back pressure chamber 50 flows to bypass the valve 52 which is an example of the flow control mechanism. According to the bypass passages 21d, 21e, 21f, 21g, and 21h, the pressure in the back pressure chamber 50 can decrease compared to when the valve 52 is closed, and thus, the anti-thrust

force is easily adjusted. The configurations described in the second embodiment and the modification examples can be appropriately applied to the following embodiment.

### Third Embodiment

**[0080]** Fig. 9 is a view showing an example of an air-conditioning device 100 according to a third embodiment. The air-conditioning device 100 includes an outdoor unit 101 and an indoor unit 102. The outdoor unit 101 includes the scroll compressor 1 which is driven by a motor 111 and compresses a refrigerant and a condenser 104 which condenses the refrigerant compressed by the scroll compressor 1. The scroll compressor 1 is the scroll compressor of the first embodiment. However, the scroll compressor 1 may be those of the second embodiment and the modification examples thereof. The outdoor unit 101 further includes a blower 108 which blows air to the condenser 104. The blower 108 includes a motor 108M and an impeller 108B which is driven by the motor 108M. The scroll compressor 1 and the condenser 104 are connected to each other via a pipe 107A through which the refrigerant passes.

**[0081]** The indoor unit 102 includes an evaporator 105 which expands the refrigerant condensed by the condenser 104. The indoor unit 102 further includes a blower 109 which blows air to the evaporator 105 and an expansion valve 106 which evaporates a liquid refrigerant condensed by the condenser 104 and causes the refrigerant to flow into the evaporator 105. The blower 109 includes a motor 109M and an impeller 109B driven by the motor 109M. The condenser 104 and the evaporator 105 are connected to each other via a pipe 107B through which the refrigerant passes. The expansion valve 106 is installed in the middle of the pipe 107B. The evaporator 105 and the scroll compressor 1 are connected to each other via a pipe 107C through which the refrigerant passes.

**[0082]** The air-conditioning device 100 includes any one of the scroll compressors 1, 1a, 1b, 1c, 1d, and 1e of the first embodiment, the second embodiment, and the modification examples of the second embodiment. The scroll compressors 1, 1a, 1b, 1c, 1d, and 1e have high efficiency, and thus, the air-conditioning device 100 having any one thereof also has high efficiency. In the scroll compressors 1, 1a, 1b, 1c, 1d and 1e, the efficiency is prevented from decreasing when operating at a low rotational speed. Accordingly, it is possible to increase efficiency when the air-conditioning device 100 having any one thereof is operated at an intermediate period, for example, spring or autumn.

**[0083]** Hereinbefore, the embodiments are described. However, the embodiments are not limited by the contents described above. In addition, the above-described constituent elements include those which can be easily assumed by a person skilled in the art, substantially the same one, and so-called equivalents. The above-de-

scribed constituent elements can be appropriately combined. It is possible to perform at least one of various omission, substitution, and change of constituent elements within a range which does not depart from the scope of the invention, which is defined by the claims.

### Reference Signs List

#### [0084]

1, 1a, 1b, 1c, 1d, and 1e: scroll compressor  
 3: housing  
 3A: low-pressure chamber  
 3B: high-pressure chamber  
 3b: bottom portion  
 3c: cover portion  
 5: motor  
 7: scroll compression mechanism  
 13: discharge cover  
 19: rotary shaft  
 21: upper bearing  
 21a: recessed portion (bush chamber)  
 21c: oil drain passage  
 21d, 21e, 21f, 21g, and 21h: bypass passage  
 23: lower bearing  
 25: eccentric pin  
 27: oil supply passage  
 27H: outlet  
 29: oil supply pump  
 31: cover plate  
 33: fixed scroll  
 33a: fixed end plate  
 35: orbiting scroll  
 35a: movable end plate  
 39: rotation prevention mechanism  
 50: back pressure chamber  
 51: recovery passage  
 52: valve  
 54: passage  
 55: pipe  
 56, 57: member  
 56H: through-hole  
 57S: groove  
 100: air-conditioning device  
 104: condenser  
 105: evaporator  
 106: expansion valve

### Claims

1. A scroll compressor (1), comprising:
  - a housing (3) in which an interior space is divided into a first chamber (3A) and a second chamber (3B);
  - a scroll compression mechanism (7) which includes a fixed scroll (33) and an orbiting scroll

(35) disposed in the first chamber (3A) and compresses a refrigerant between the fixed scroll (33) and the orbiting scroll (35) to cause the compressed refrigerant to flow into the second chamber (3B);

a rotary shaft (19) which is a rod-shaped member, includes an oil supply passage (27) which extends in a longitudinal direction of the rod-shaped member and through which lubricant oil passes, and causes the orbiting scroll (35) disposed on an outlet side of the oil supply passage (27) to orbit;

a back pressure chamber (50) which is disposed on the rotary shaft (19) side of the orbiting scroll (35) and into which the lubricant oil flowing out from the oil supply passage (27) flows;

an oil drain passage (21c) through which the lubricant oil flowing into the back pressure chamber (50) passes to be discharged to the first chamber (3A);

a flow control mechanism (52) for changing a flow rate of the lubricant oil flowing through the oil drain passage (21c); and

an oil supply pump (29) which is installed in the oil supply passage (27) and supplies the lubricant oil stored in the first chamber (3A) to the back pressure chamber (50), **characterized in that**

the flow control mechanism (52) increases the flow rate of the lubricant oil flowing through the oil drain passage (21c) in a case where an orbital speed of the orbiting scroll (35) is larger than a threshold value compared to a case where the orbital speed of the orbiting scroll (35) is equal to or smaller than the threshold value, and the threshold value is equal to or larger than an orbital speed equivalent to a case where the scroll compressor is operated with a capacity of 1/2 of a rated operation and is equal to or smaller than an orbital speed equivalent to a case where the scroll compressor is operated with the capacity of the rated operation.

2. The scroll compressor according to claim 1 wherein the flow control mechanism (52) changes the flow rate of the lubricant oil flowing through the oil drain passage (21c) based on at least one of a pressure of the refrigerant and a temperature of the lubricant oil.
3. The scroll compressor according to any one of claims 1 to 2, wherein a passage sectional area of the oil drain passage (21c) is larger than a passage sectional area of the oil supply passage (27).
4. The scroll compressor according to any one of claims 1 to 3, further comprising:

a bypass passage (21d) through which the lubricant oil in the back pressure chamber (50) flows to bypass the flow control mechanism (52), wherein a passage sectional area of the bypass passage (21d) is smaller than the passage sectional area of the oil supply passage (27).

5. The scroll compressor according to claim 3 or 4, further comprising:

a bypass passage through which the lubricant oil in the back pressure chamber (50) flows to bypass the flow control mechanism (52), wherein the bypass passage includes a member provided with a passage having a passage sectional area which is smaller than the passage sectional area of the oil drain passage (21c).

6. The scroll compressor according to any one of claims 1 to 5, wherein the oil supply pump (29) is a positive-displacement pump.

7. The scroll compressor according to any one of claims 1 to 6, wherein the flow control mechanism (52) sets the flow rate of the lubricant oil flowing through the oil drain passage (21c) to be larger than 0 while the orbiting scroll (35) orbits.

8. An air-conditioning device (100), comprising:

a condenser (104) for condensing a refrigerant; an evaporator (105) for evaporating the refrigerant condensed by the condenser (104); and the scroll compressor according to any one of claims 1 to 7 for compressing the refrigerant evaporated by the evaporator (105).

#### Patentansprüche

1. Scrollverdichter (1), der Folgendes umfasst:

ein Gehäuse (3), bei dem ein Innenraum in eine erste Kammer (3A) und eine zweite Kammer (3B) geteilt ist;

einen Scrollverdichtungsmechanismus (7), der eine feste Spirale (33) und eine umlaufende Spirale (35) beinhaltet, die in der ersten Kammer (3A) angeordnet sind, und zwischen der festen Spirale (33) und der umlaufenden Spirale (35) ein Kältemittel verdichtet, um zu bewirken, dass das verdichtete Kältemittel in die zweite Kammer (3B) fließt;

eine Drehwelle (19), die ein stangenförmiges Element ist, einen Ölzufuhrkanal (27) beinhaltet, der sich in eine Längsrichtung des stangenförmigen Elements erstreckt und durch den Schmieröl geleitet wird, und bewirkt, dass die

umlaufende Spirale (35), die auf einer Auslassseite des Ölzufuhrkanals (27) angeordnet ist, umläuft;

eine Gegendruckkammer (50), die auf der Seite der Drehwelle (19) der umlaufenden Spirale (35) angeordnet ist und in die das Schmieröl fließt, das aus dem Ölzufuhrkanal (27) fließt;

einen Ölablasskanal (21c), durch den das Schmieröl, das in die Gegendruckkammer (50) fließt, geleitet wird, um zur ersten Kammer (3A) ausgegeben zu werden;

einen Flusssteuermechanismus (52) zum Ändern einer Durchflussrate des Schmieröls, das durch den Ölablasskanal (21c) fließt; und

eine Ölzufuhrpumpe (29), die im Ölzufuhrkanal (27) installiert ist und das in der ersten Kammer (3A) gespeicherte Schmieröl der Gegendruckkammer (50) zuführt, **dadurch**

**gekennzeichnet, dass**

der Flusssteuermechanismus (52) in einem Fall, in dem eine Umlaufgeschwindigkeit der umlaufenden Spirale (35) größer ist als ein Schwellwert, gegenüber einem Fall, in dem die Umlaufgeschwindigkeit der umlaufenden Spirale (35) gleich oder kleiner als der Schwellwert ist, die Durchflussrate des Schmieröls, das durch den Ölablasskanal (21c) fließt, erhöht, und der Schwellwert gleich oder größer ist als eine gleichwertige Umlaufgeschwindigkeit in einem Fall, in dem der Scrollverdichter mit einer Kapazität von 1/2 eines Nennbetriebs betrieben wird und gleich oder kleiner ist als eine gleichwertige Umlaufgeschwindigkeit in einem Fall, in dem der Scrollverdichter mit der Kapazität des Nennbetriebs betrieben wird.

2. Scrollverdichter nach Anspruch 1, wobei der Flusssteuermechanismus (52) die Durchflussrate des Schmieröls, das durch den Ölablasskanal (21c) fließt, auf Basis von mindestens einem von einem Druck des Kältemittels und einer Temperatur des Schmieröls ändert.

3. Scrollverdichter nach einem der Ansprüche 1 bis 2, wobei ein Kanalquerschnitt des Ölablasskanals (21c) größer ist als ein Kanalquerschnitt des Ölzufuhrkanals (27).

4. Scrollverdichter nach einem der Ansprüche 1 bis 3, der ferner Folgendes umfasst:

einen Bypasskanal (21d), durch den das Schmieröl in die Gegendruckkammer (50) fließt, um den Flusssteuermechanismus (52) zu umgehen, wobei ein Kanalquerschnitt des Bypasskanals (21d) kleiner ist als der Kanalquerschnitt des Ölzufuhrkanals (27).

5. Scrollverdichter nach Anspruch 3 oder 4, der ferner Folgendes umfasst:

einen Bypasskanal, durch den das Schmieröl in die Gegendruckkammer (50) fließt, um den Flusssteuermechanismus (52) zu umgehen, wobei der Bypasskanal ein Element beinhaltet, das mit einem Kanal versehen ist, der einen Kanalquerschnitt aufweist, der kleiner ist als der Kanalquerschnitt des Ölablasskanals (21c).

6. Scrollverdichter nach einem der Ansprüche 1 bis 5, wobei die Ölzufuhrpumpe (29) eine Verdrängerpumpe ist.

7. Scrollverdichter nach einem der Ansprüche 1 bis 6, wobei der Flusssteuermechanismus (52) die Durchflussrate des Schmieröls, das durch den Ölablasskanal (21c) fließt, derart einstellt, dass sie größer ist als 0, während die umlaufende Spirale (35) umläuft.

8. Klimaanlagevorrichtung (100), die Folgendes umfasst:

einen Verflüssiger (104), zum Verflüssigen eines Kältemittels;

einen Verdampfer (105) zum Verdampfen des vom Verflüssiger (104) verflüssigten Kältemittels; und

den Scrollverdichter nach einem der Ansprüche 1 bis 7 zum Verdichten des vom Verdampfer (105) verdampften Kältemittels.

### 35 Revendications

1. Compresseur à spirales (1) comprenant :

un boîtier (3) dans lequel un espace intérieur est divisé en une première chambre (3A) et en une seconde chambre (3B) ;

un mécanisme de compression à spirales (7) qui comprend une spirale fixe (33) et une spirale orbitale (35) disposées dans la première chambre (3A) et comprime un réfrigérant entre la spirale fixe (33) et la spirale orbitale (35) pour amener le réfrigérant comprimé à s'écouler dans la seconde chambre (3B) ;

un arbre rotatif (19) qui est un élément en forme de tige, comprend un passage d'alimentation en huile (27) qui s'étend dans une direction longitudinale de l'élément en forme de tige et à travers lequel l'huile de lubrification passe, et amène la spirale orbitale (35) disposée sur un côté de sortie du passage d'alimentation en huile (27) à décrire une orbite ;

une chambre de contre-pression (50) qui est disposée du côté de l'arbre rotatif (19) de la spirale

orbitale (35) et dans laquelle l'huile de lubrification sortant par le passage d'alimentation en huile (27) s'écoule ;

un passage de vidange d'huile (21c) à travers lequel l'huile de lubrification s'écoulant dans la chambre de contre-pression (50) passe pour être déchargée dans la première chambre (3A) ; un mécanisme de contrôle de débit (52) pour modifier un débit de l'huile de lubrification s'écoulant par le passage de vidange d'huile (21c) ; et

une pompe d'alimentation en huile (29) qui est installée dans le passage d'alimentation en huile (27) et amène l'huile de lubrification stockée dans la première chambre (3A) dans la chambre de contre-pression (50),

**caractérisé en ce que :**

le mécanisme de contrôle de débit (52) augmente le débit de l'huile de lubrification s'écoulant par le passage de vidange d'huile (21c) dans un cas dans lequel une vitesse orbitale de la spirale orbitale (35) est supérieure à une valeur de seuil, comparé à un cas dans lequel la vitesse orbitale de la spirale orbitale (35) est égale ou inférieure à la valeur de seuil, et

la valeur de seuil est égale ou supérieure à une vitesse orbitale équivalente à un cas dans lequel le compresseur à spirales est actionné avec une capacité de  $\frac{1}{2}$  d'un fonctionnement nominal et est égale ou inférieure à une vitesse orbitale équivalente à un cas dans lequel le compresseur à spirales est actionné avec la capacité de fonctionnement nominal.

2. Compresseur à spirales selon la revendication 1, dans lequel le mécanisme de contrôle de débit (52) modifie le débit de l'huile de lubrification s'écoulant par le passage de vidange d'huile (21c) sur la base d'au moins l'une parmi une pression du réfrigérant et une température de l'huile de lubrification.

3. Compresseur à spirales selon l'une quelconque des revendications 1 à 2, dans lequel une zone transversale de passage du passage de vidange d'huile (21c) est supérieure à une zone transversale de passage du passage d'alimentation en huile (27).

4. Compresseur à spirales selon l'une quelconque des revendications 1 à 3, comprenant en outre :

un passage de dérivation (21d) à travers lequel l'huile de lubrification dans la chambre de contre-pression (50) s'écoule pour bipasser le mécanisme de contrôle de débit (52), dans lequel une section transversale de passa-

ge du passage de dérivation (21d) est inférieure à la section transversale de passage du passage d'alimentation en huile (27).

5. 5. Compresseur à spirales selon la revendication 3 ou 4, comprenant en outre :

un passage de dérivation à travers lequel l'huile de lubrification dans la chambre de contre-pression (50) s'écoule pour bipasser le mécanisme de contrôle de débit (52), dans lequel le passage de dérivation comprend un élément prévu avec un passage ayant une section transversale de passage qui est inférieure à la section transversale de passage du passage de vidange d'huile (21c).

6. 6. Compresseur à spirales selon l'une quelconque des revendications 1 à 5, dans lequel la pompe d'alimentation en huile (29) est une pompe volumétrique.

7. 7. Compresseur à spirales selon l'une quelconque des revendications 1 à 6, dans lequel le mécanisme de contrôle de débit (52) règle le débit de l'huile de lubrification s'écoulant par le passage de vidange d'huile (21c) pour être supérieur à 0, alors que la spirale orbitale (35) décrit une orbite.

8. 8. Dispositif de climatisation (100) comprenant :

un condenseur (104) pour condenser un réfrigérant ;  
un évaporateur (105) pour faire évaporer le réfrigérant condensé par le condenseur (104) ; et le compresseur à spirales selon l'une quelconque des revendications 1 à 7 pour comprimer le réfrigérant évaporé par l'évaporateur (105).

FIG. 1

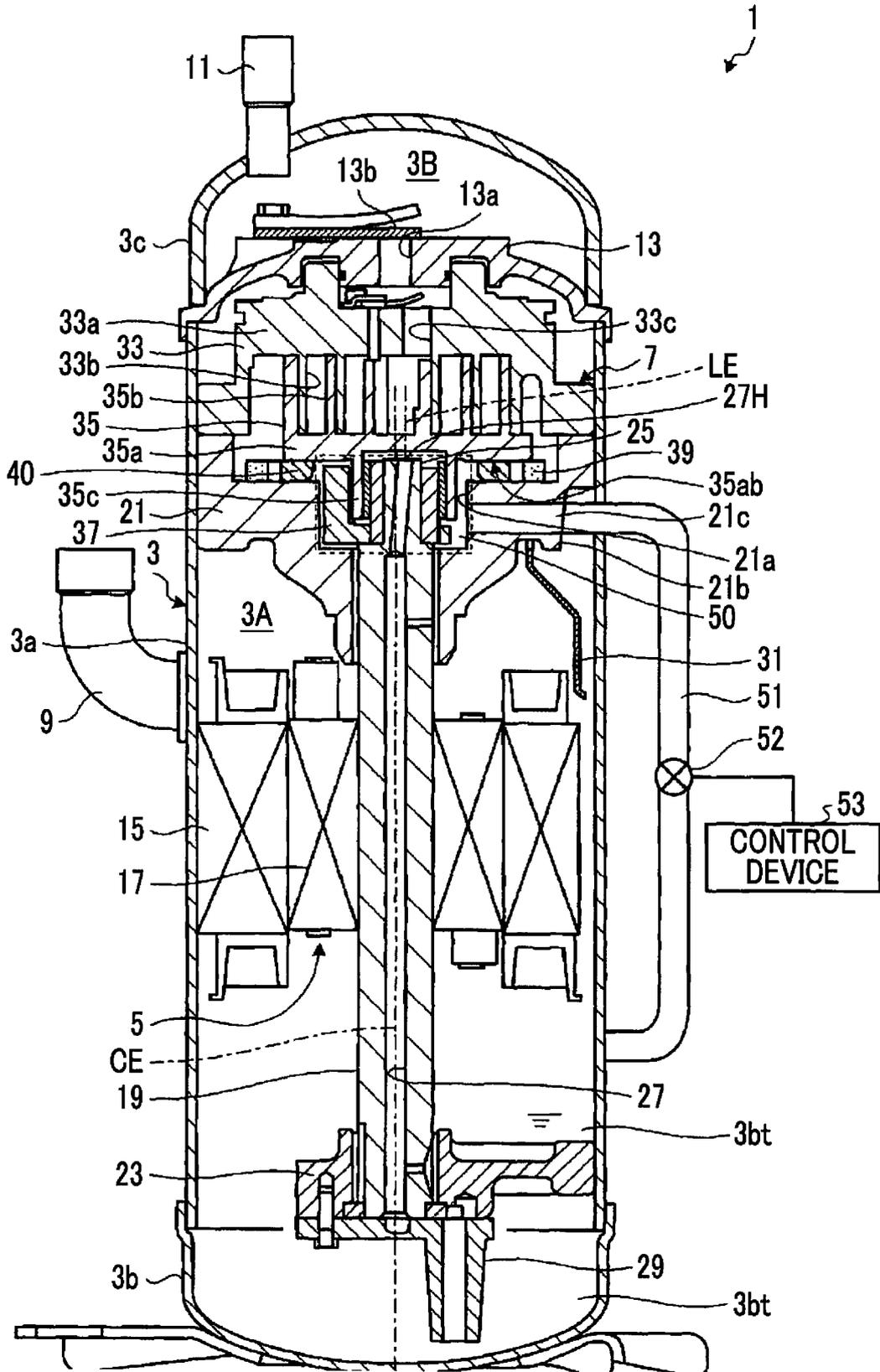


FIG. 2

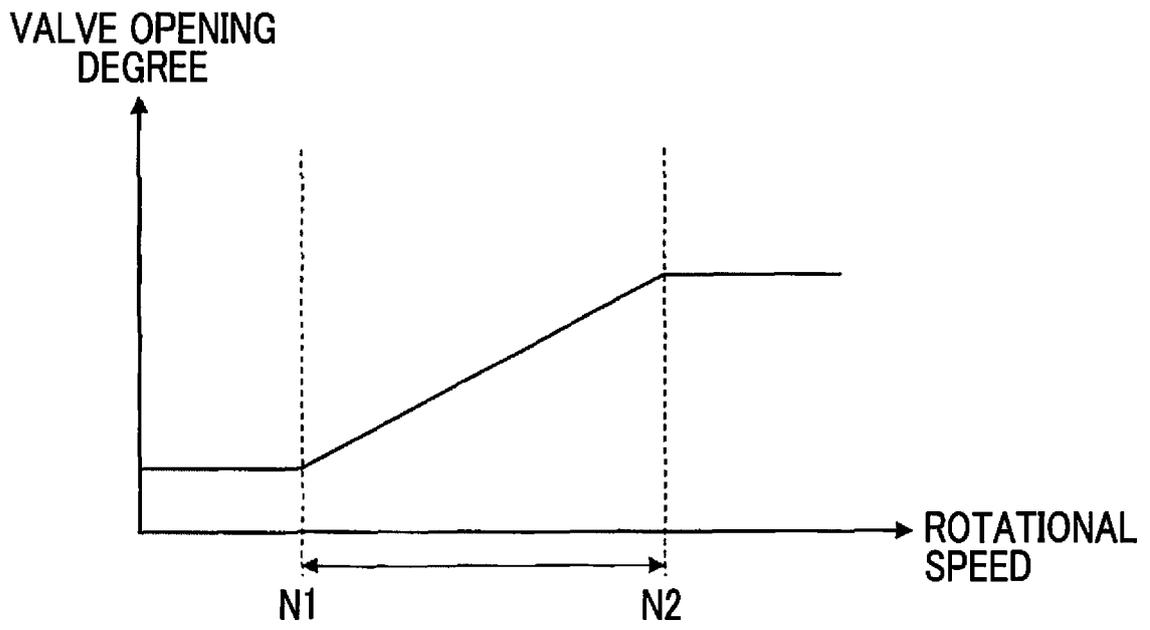


FIG. 3

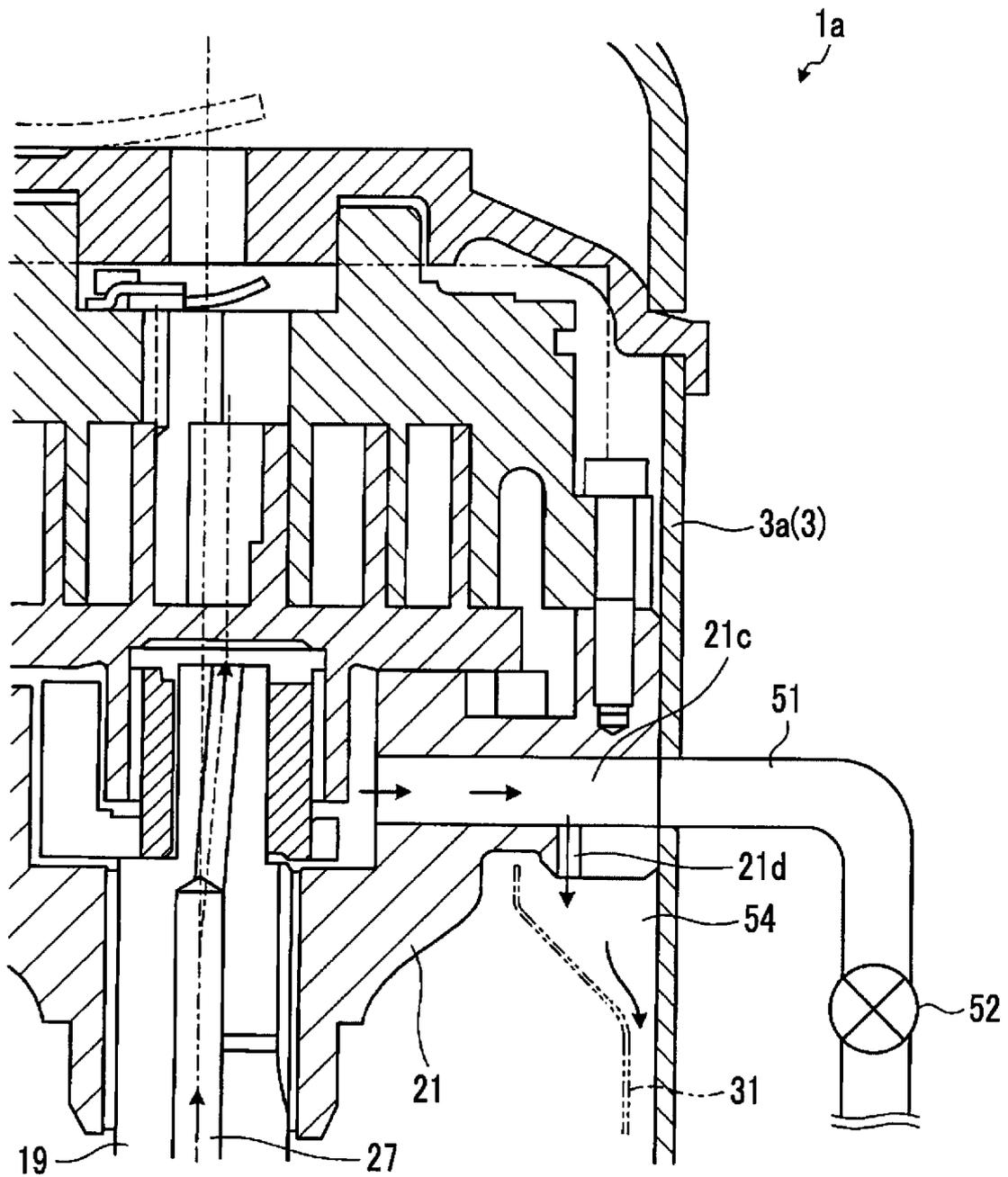


FIG. 4

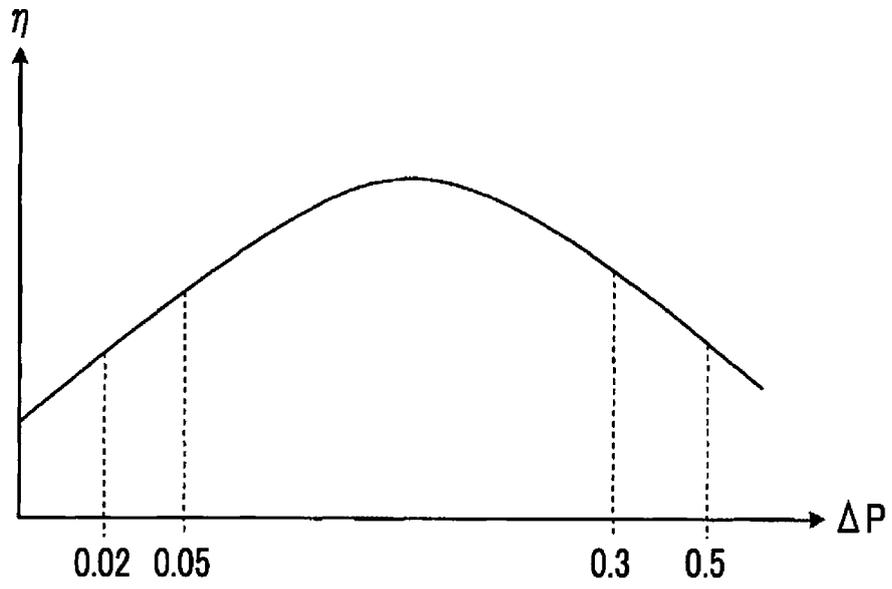


FIG. 5

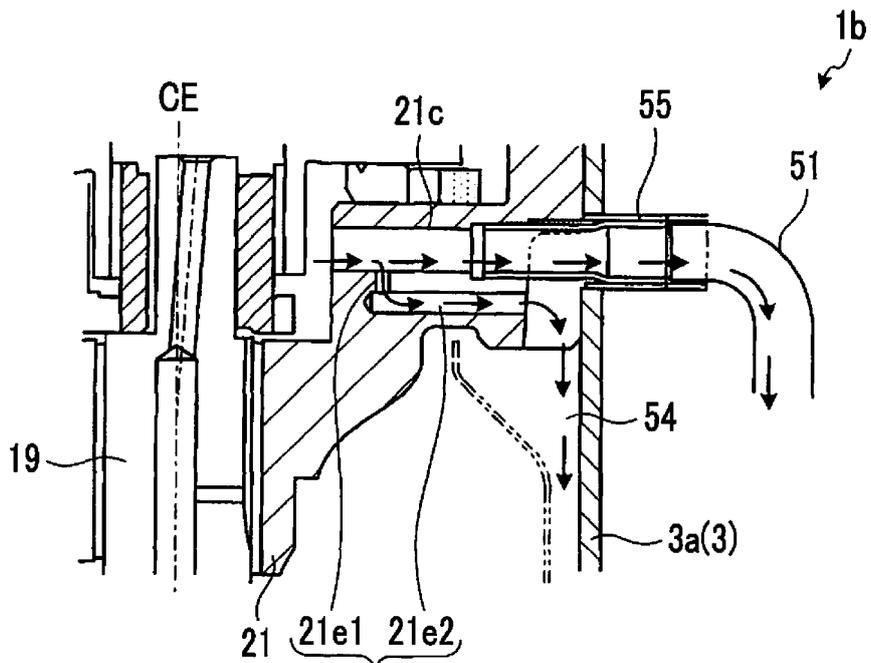


FIG. 6

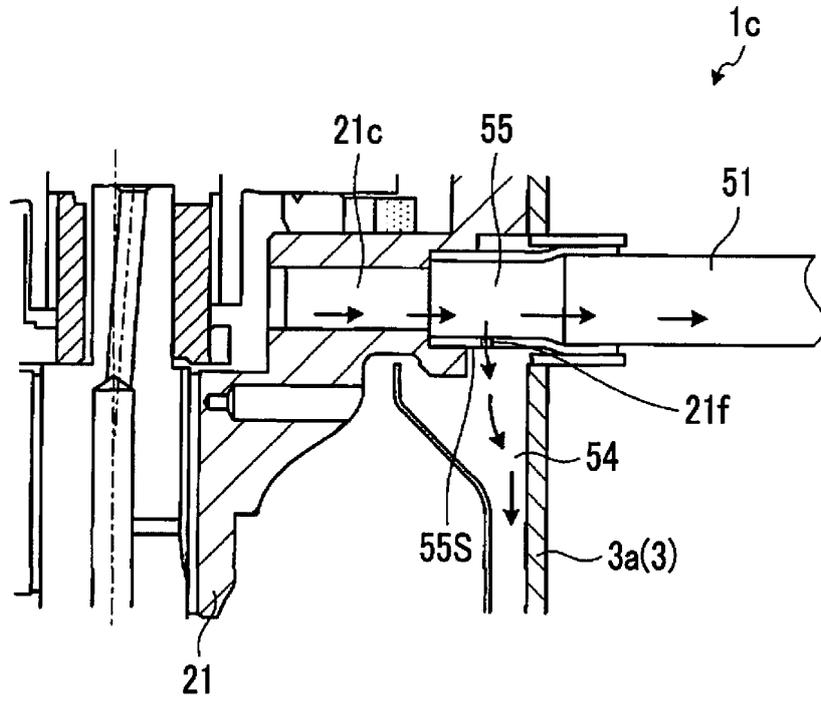


FIG. 7

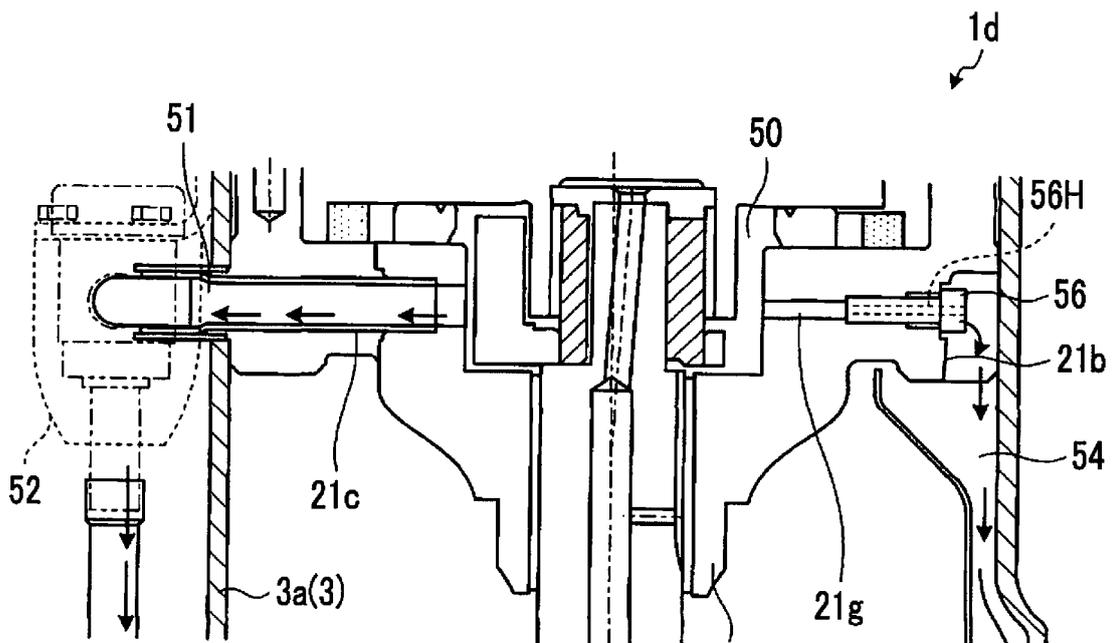


FIG. 8

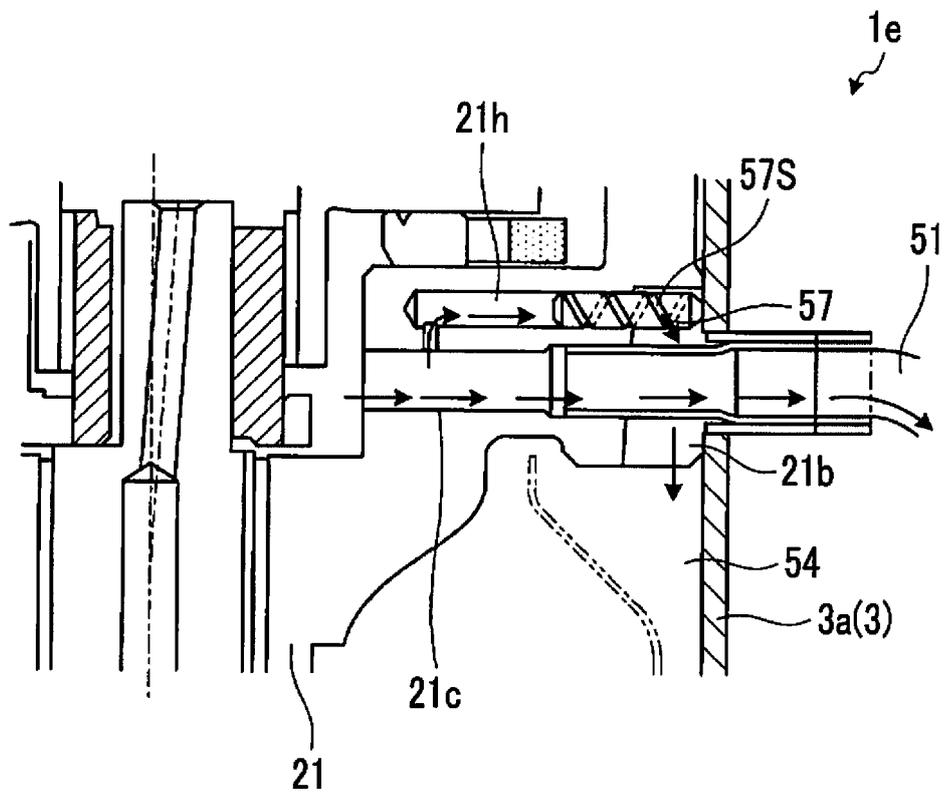
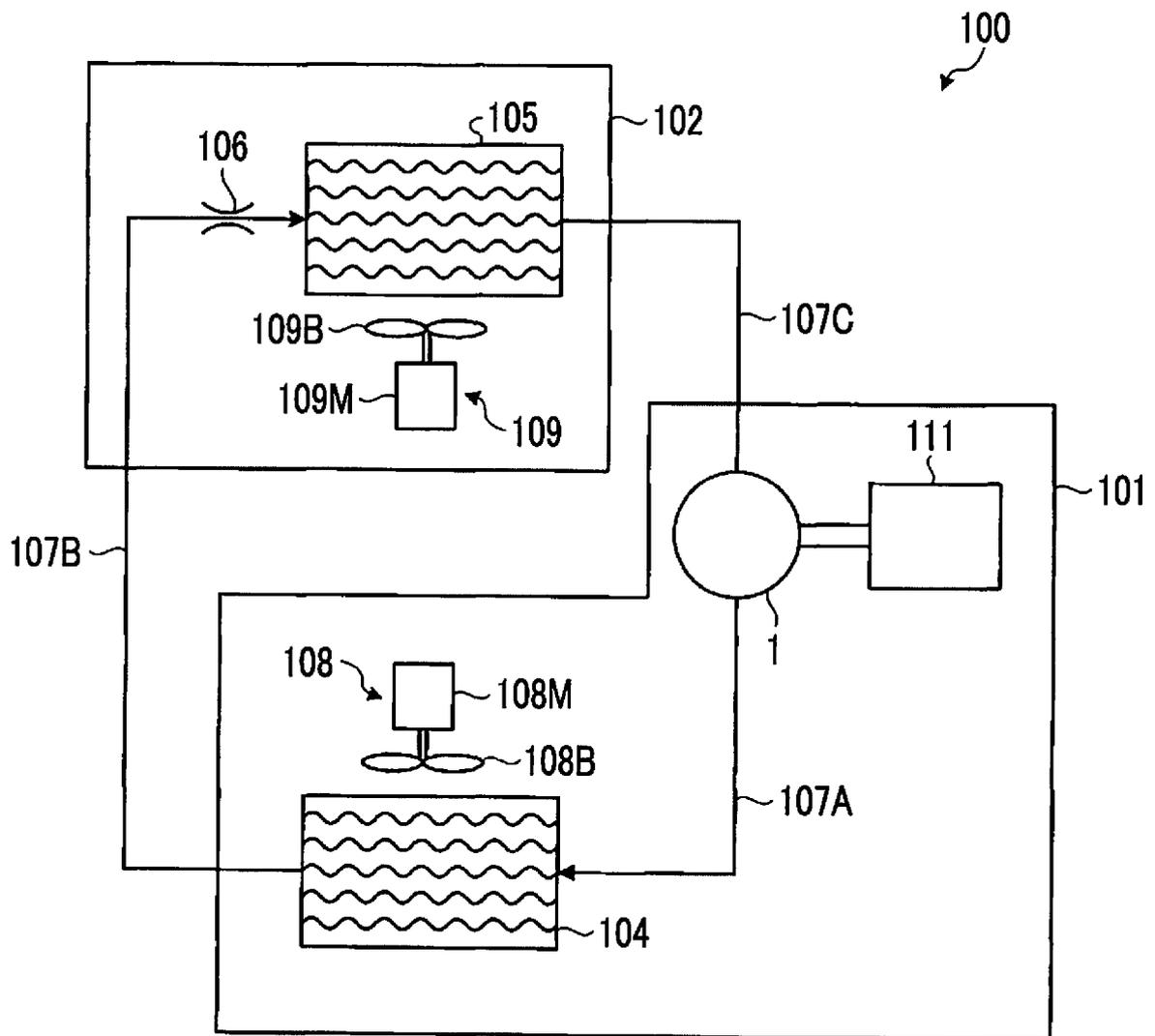


FIG. 9



**REFERENCES CITED IN THE DESCRIPTION**

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

**Patent documents cited in the description**

- JP H05141201 A [0002]
- WO 2012147145 A [0003]