Abstract of the Disclosure

A scroll compressor with high efficiency is provided according to the present invention. The scroll compressor compresses a refrigerant by meshing of an orbiting scroll (8) and a fixed scroll (7), wherein the orbiting scroll (8) includes a back pressure hole (35) which intermittently connects a compression chamber (13) and a back pressure chamber (18) per one orbit of the orbiting scroll (8), and the back pressure hole (35) communicates with the compression chamber (8) and also with the back pressure chamber (18) and shuts off the communication with the back pressure chamber (18) after the communication with the compression chamber (8) is shut off.

Fig. 1

Claims:

1. A scroll compressor, comprising:

a fixed scroll in which a spiral wrap is vertically provided on a base plate;

an orbiting scroll in which a spiral wrap is vertically provided on an end plate, the orbiting scroll meshing with the fixed scroll to form a compression chamber;

a discharge space to which a working fluid having been compressed in the compression chamber is discharged;

a back pressure chamber provided in a back surface of at least any one of the orbiting scroll and the fixed scroll to press at least one of both members of the orbiting scroll and the fixed scroll against the other one of the members; and

a back pressure hole formed in an end plate of at least any one of the fixed scroll and the orbiting scroll to provide communication between the compression chamber and the back pressure chamber to keep a pressure in the back pressure chamber at a pressure between a suction pressure and a discharge pressure, wherein

the compression chamber and the back pressure chamber intermittently communicate with each other through the back pressure hole per one orbit of the orbiting scroll, and

a communication port of the back pressure hole on a back pressure chamber side is blocked later than a communication port of the back pressure hole on a compression chamber side.

2. A scroll compressor, comprising:

a fixed scroll in which a spiral wrap is vertically provided on a base plate;

an orbiting scroll in which a spiral wrap is vertically provided on an end plate, the orbiting scroll meshing with the fixed scroll to form a compression chamber;

a discharge space to which a working fluid having been compressed in the compression chamber is discharged;

a back pressure chamber provided in a back surface of the end plate of the orbiting scroll to press the orbiting scroll against the fixed scroll; and

a back pressure hole formed in the end plate of the orbiting scroll to provide communication between the compression chamber and the back pressure chamber to keep a pressure in the back pressure chamber at a pressure between a suction pressure and a discharge pressure, wherein

the compression chamber and the back pressure chamber intermittently communicate with each other through the back pressure hole per one orbit of the orbiting scroll, and

a communication port of the back pressure hole on a back pressure chamber side is blocked later than a communication port of the back pressure hole on a compression chamber side.

3. The scroll compressor according to claim 1 or 2, wherein the communication port of the back pressure hole on the back pressure chamber side communicates with the back pressure chamber until the communication port of the back pressure hole on the compression chamber side is completely blocked.

4. The scroll compressor according to any one of claims 1 to 3, wherein as a structure for the intermittent communication between the compression chamber and the back pressure chamber through the back pressure hole, a cutout portion is provided in the end plate of the fixed scroll to communicate with the back pressure chamber so that the communication port of the back pressure hole on the back pressure chamber side that is provided in the orbiting scroll is caused to communicate with the cutout portion.

5. A refrigeration cycle apparatus for air-conditioning which is constituted by using the scroll compressor according to any one of claims 1 to 4.

6. A scroll compressor which compresses a refrigerant by meshing of an orbiting scroll and a fixed scroll, wherein

the orbiting scroll comprises a back pressure hole which intermittently connects a compression chamber and a back pressure chamber per one orbit of the orbiting scroll, and

the back pressure hole communicates with the compression chamber and also with the back pressure chamber, and shuts off the communication with the back pressure chamber after the communication with the compression chamber is shut off.

7. The scroll compressor according to claim 6, wherein timing of the communication is regulated by using a cutout portion provided in the fixed scroll.

8. A scroll compressor, substantially as herein described with reference to accompanying drawings and example.

9. A scroll compressor which compresses a refrigerant by meshing of an orbiting scroll and a fixed scroll, substantially as herein described with reference to accompanying drawings and example.

Dated this 19th day of January 2012

Of Anand & Anand Advocates
Agents for the applicants

HITACHI APPLIANCES, INC.
Application No.

7 Sheets
Sheet 1

ORIGINAL

FIG. 1

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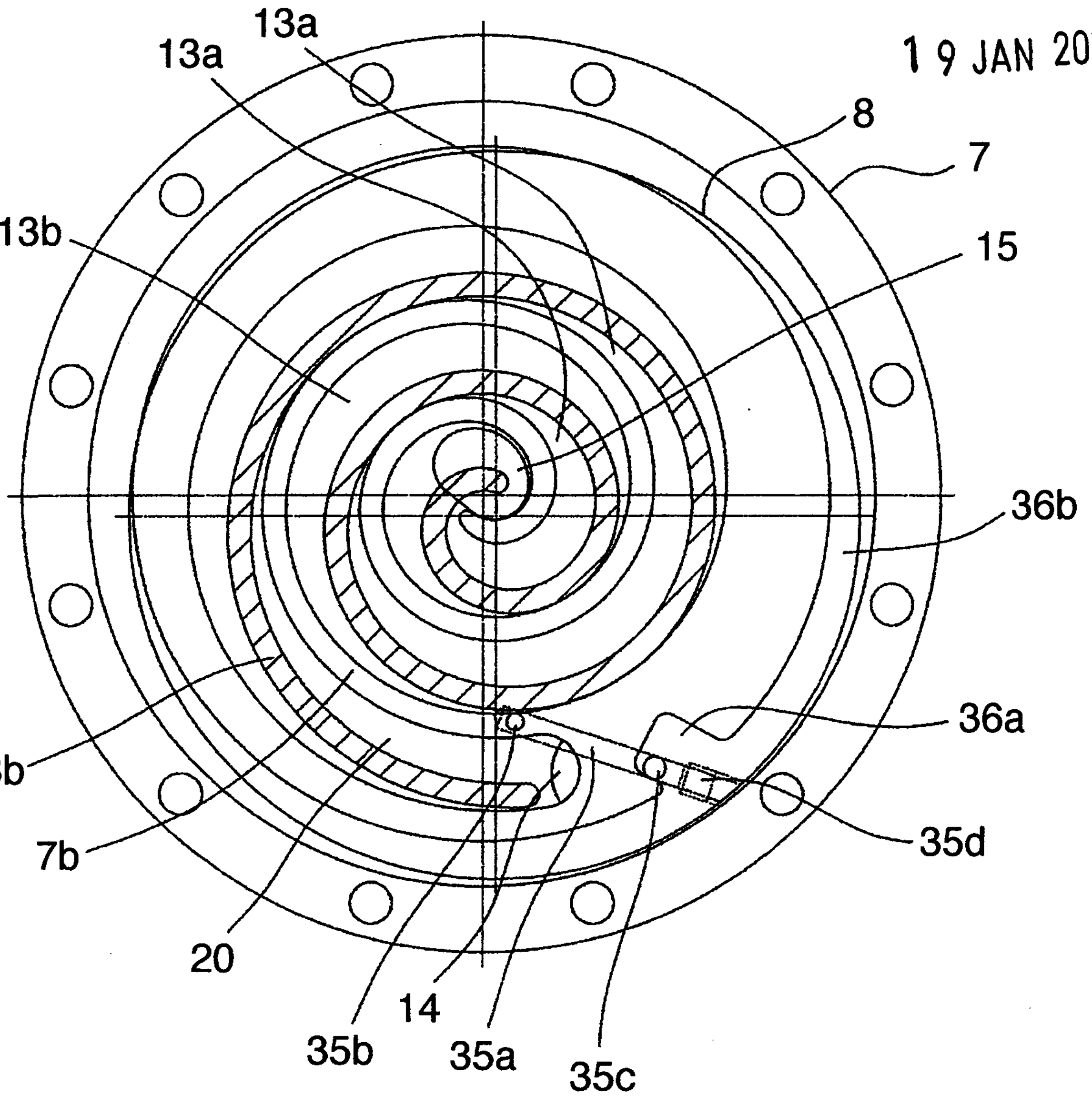

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FIG. 2

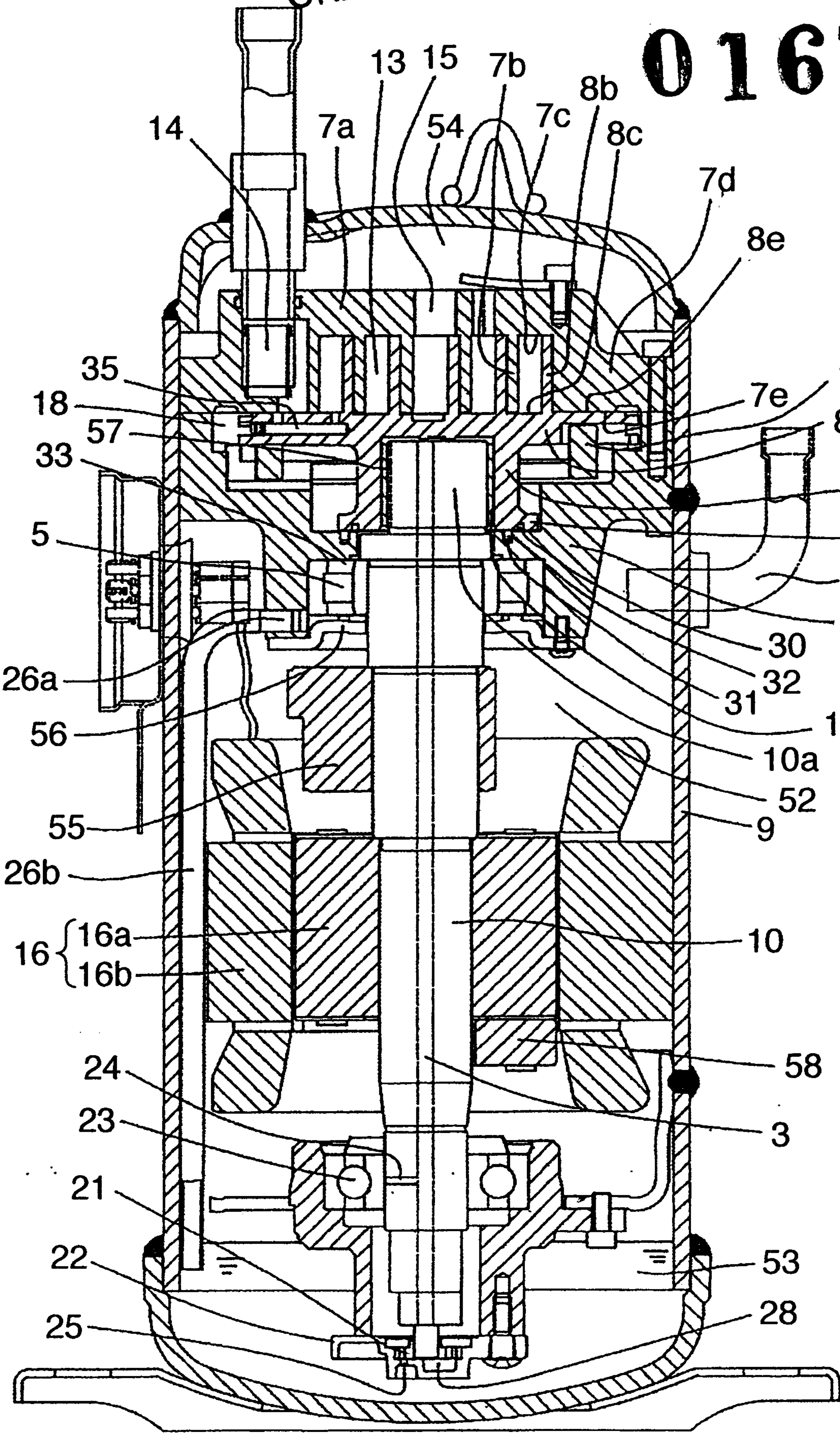

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FIG. 3

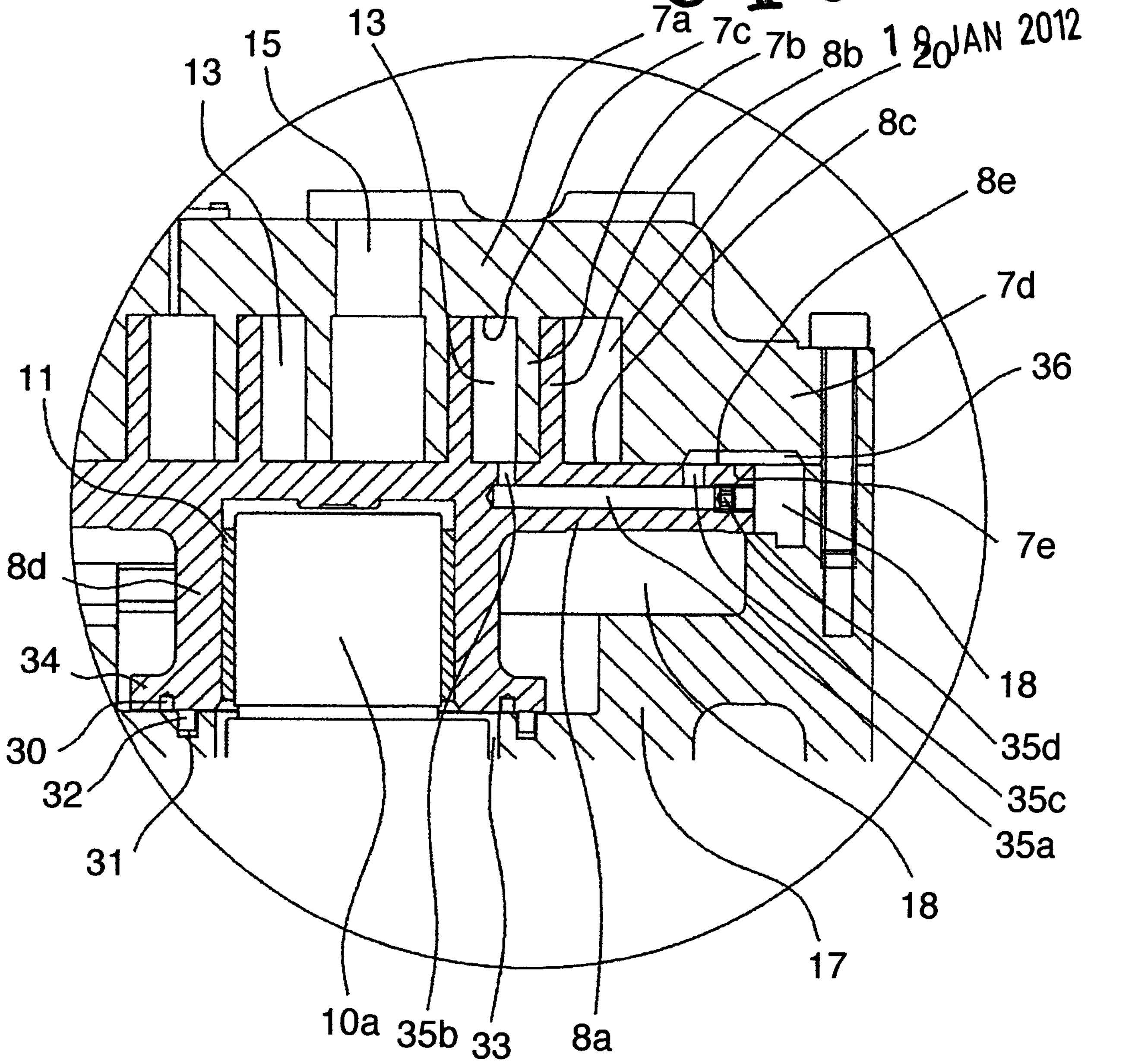

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FIG. 4

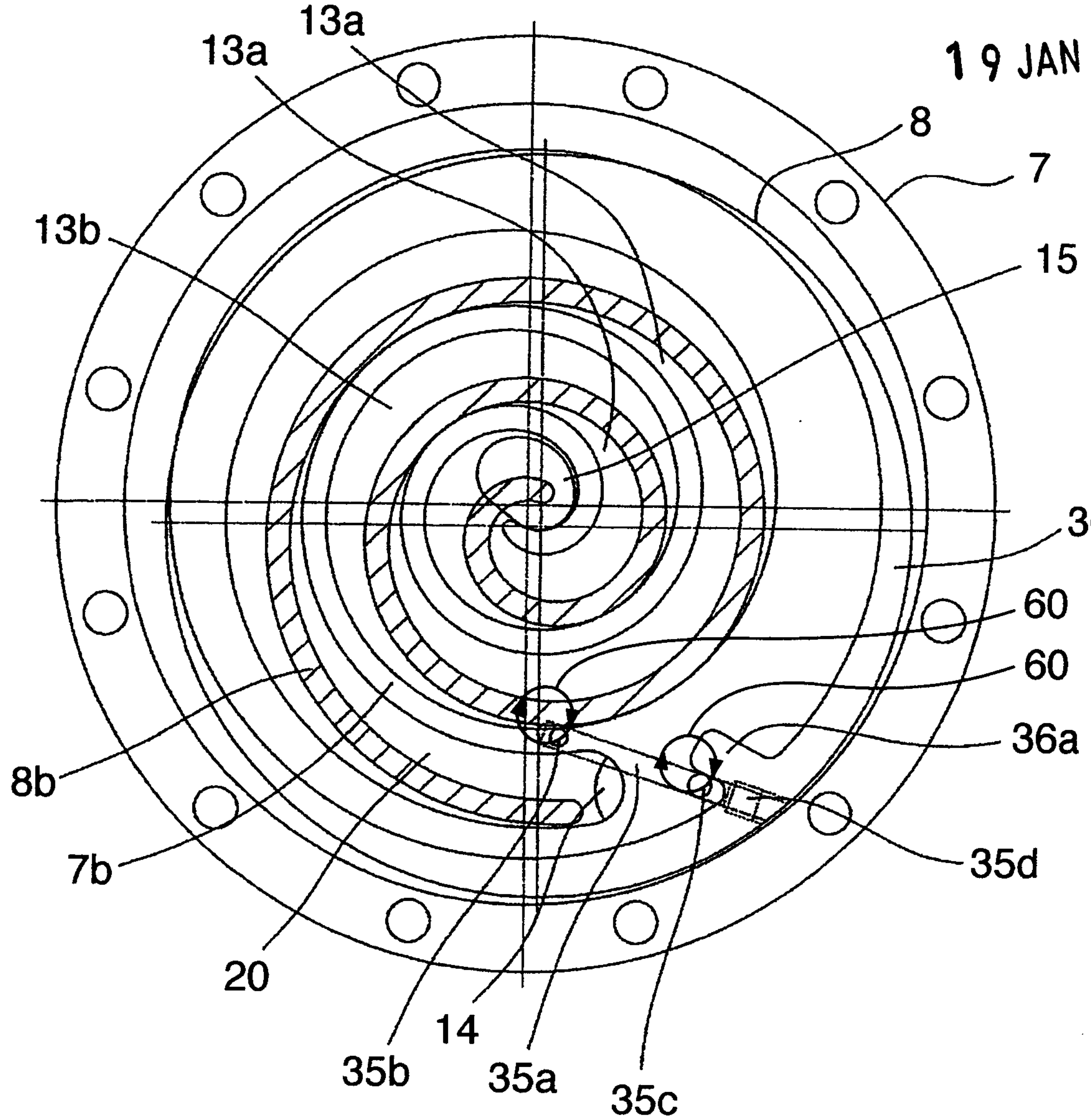

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FIG. 5

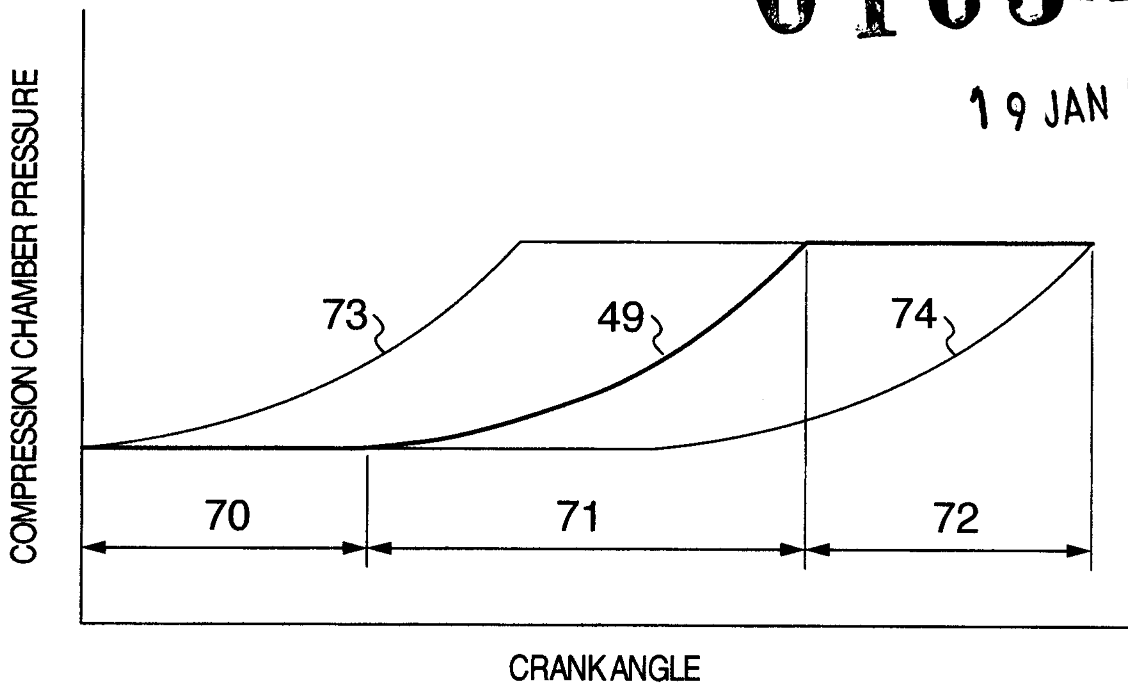

FIG. 6

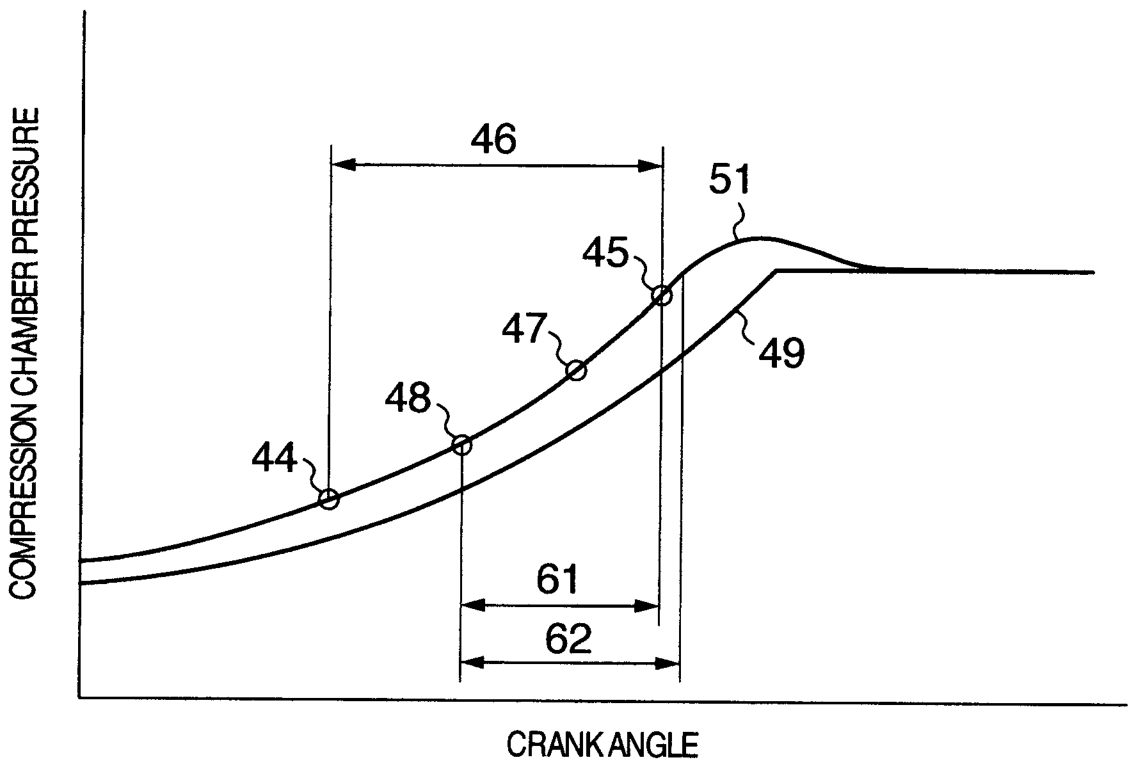

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FIG. 7

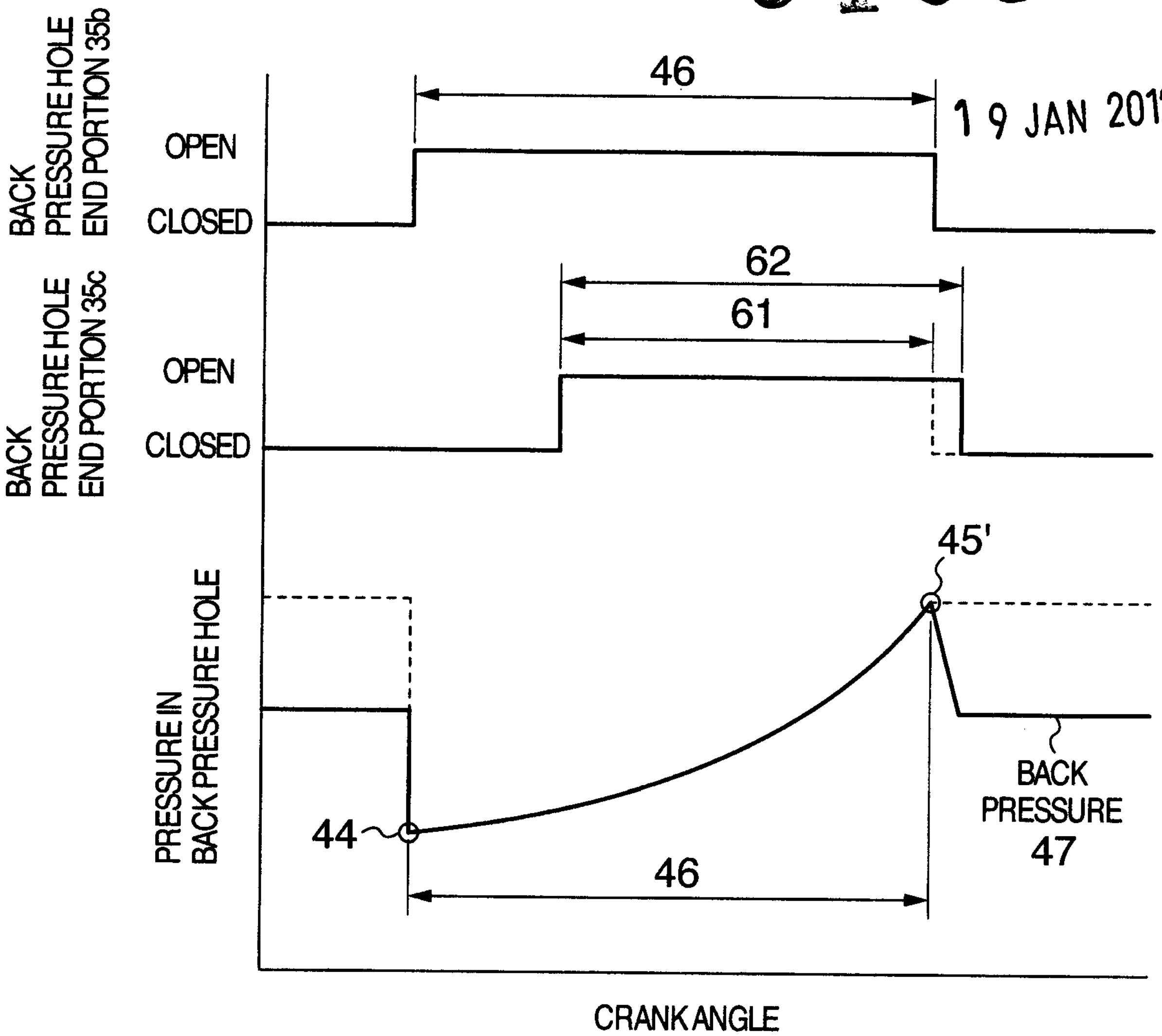

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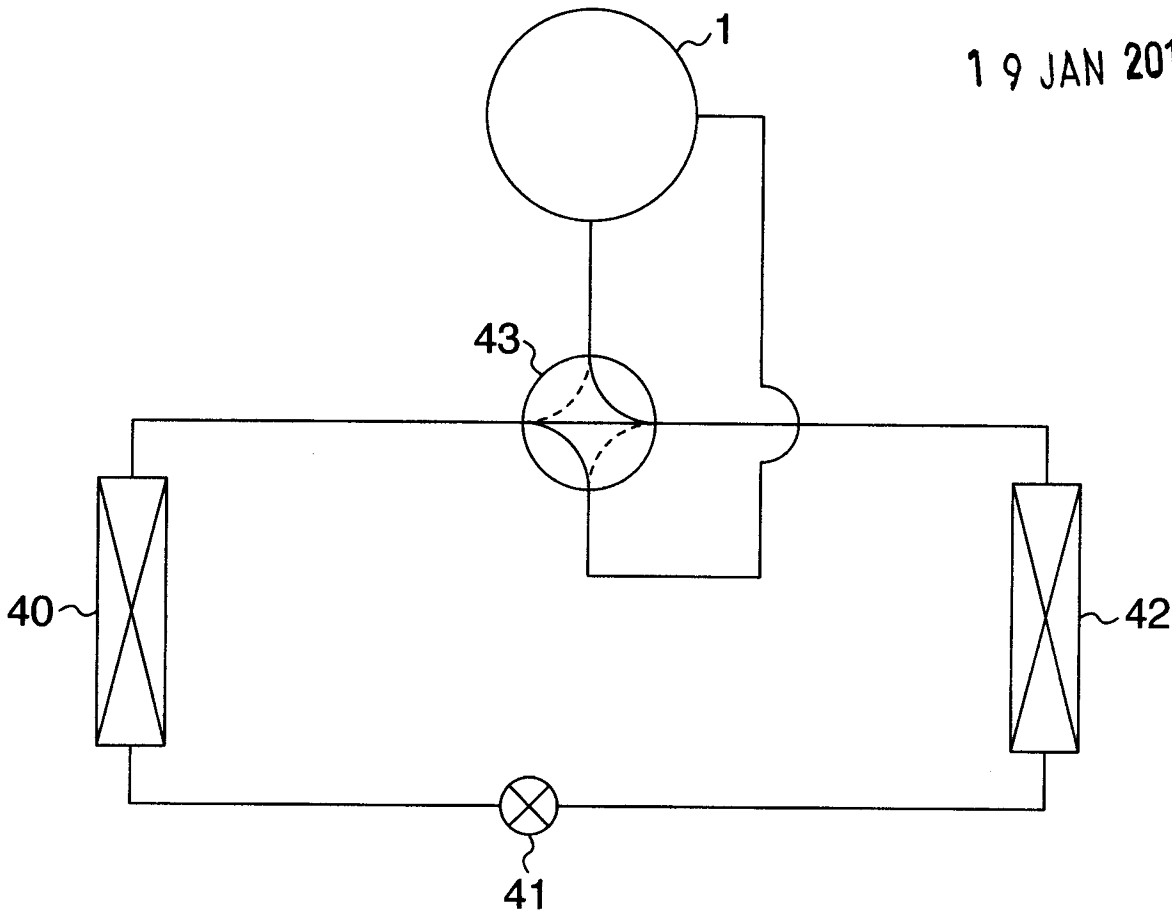
FIG. 8



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Background of the invention

(1) Field of the invention

The present invention relates to a scroll compressor which is preferable as a refrigerant compressor used in a refrigeration cycle for refrigeration, air-conditioning and the like, or a gas compressor for compressing air and other gases.

(2) Description of related art

As a background art of the present technical field, there is known a scroll compressor including a fixed scroll in which a spiral wrap is vertically provided on a base plate, an orbiting scroll in which a spiral wrap is vertically provided on an end plate and which orbiting scroll meshes with the fixed scroll to form a compression chamber, a discharge space to which a working fluid having been compressed in the compression chamber is discharged, a back pressure chamber which is provided at a back surface of at least any one of the orbiting scroll and the fixed scroll to press at least one of both members of the orbiting scroll and the fixed scroll against the other one, and a back pressure hole which is formed in an end plate of at least any one of the fixed scroll and the orbiting scroll to provide communication between the compression chamber and the back pressure chamber to keep the pressure in the back pressure chamber at a pressure between a suction pressure and a discharge pressure.

Further, JP-A-2010-106780 states that "A scroll compressor includes a fixed scroll, an orbiting scroll which meshes with the fixed scroll to form a compression chamber, a back pressure chamber which is provided at a back surface of an end plate of the orbiting scroll, a back pressure hole which is formed in the end plate of the orbiting scroll to provide communication between the compression chamber and the back pressure chamber, and a release mechanism which is provided at an end plate of the fixed scroll and discharges a working fluid in the compression chamber to a discharge space when the pressure in the compression chamber becomes higher than the pressure in the discharge space. A section 47 in which the compression chamber and the back pressure chamber communicate with each other by the back pressure hole in accordance with the orbiting movement of the orbiting scroll is configured so as not to overlap sections 44 and 45 in which the compression chamber and the discharge space communicate with each other by the release mechanism." (see the Abstract).

Brief summary of the invention

In the past, it has not been specifically taken into consideration that when the back pressure hole which intermittently provides communication between the compression chamber and the back pressure chamber completes communication between a compression chamber and a back pressure chamber and then communicates with the next low-pressure compression chamber, the gas and oil which has accumulated in the back pressure hole re-expand in the low-pressure compression chamber to cause thermal fluid loss.

An object of the present invention is to provide a scroll compressor with high efficiency.

The above object of the present invention is achieved by a scroll compressor including:

a fixed scroll in which a spiral wrap is vertically provided on a base plate

an orbiting scroll in which a spiral wrap is vertically provided on an end plate, which scroll meshes with the fixed scroll to form a compression chamber,

a discharge space to which a working fluid having been compressed in the compression chamber is discharged,

a back pressure chamber provided in a back surface of at least any one of the orbiting scroll and the fixed scroll to press at least one of both members of the orbiting scroll and the fixed scroll against another one of both members, and

a back pressure hole formed in an end plate of at least any one of the fixed scroll and the orbiting scroll, which hole provides communication between the compression chamber and the back pressure chamber to keep a pressure of the back pressure chamber at a pressure between a suction pressure and a discharge pressure, wherein

the compression chamber and the back pressure chamber intermittently communicate with each other via the back pressure hole during one orbit of the orbiting scroll, and

a communication port of the back pressure hole on a back pressure chamber side is blocked later than a communication port of the back pressure hole on a compression chamber side.

Further, the above described object of the present invention is achieved by a scroll compressor, including

a fixed scroll in which a spiral wrap is vertically provided on a base plate,

an orbiting scroll in which a spiral wrap is vertically provided on an end plate, which scroll meshes with the fixed scroll to form a compression chamber, a discharge space to which a working fluid having been compressed in the compression chamber is discharged,

a back pressure chamber provided in a back surface of the end plate of the orbiting scroll to press the orbiting scroll against the fixed scroll, and

a back pressure hole formed in the end plate of the orbiting scroll, which hole provides communication between the compression chamber and the back pressure chamber to keep a pressure of the back pressure chamber at a pressure between a suction pressure and a discharge pressure, wherein

the compression chamber and the back pressure chamber intermittently communicate with each other via the back pressure hole during one orbit of the orbiting scroll, and

a communication port of the back pressure hole on a back pressure chamber side is blocked later than a communication port of the back pressure hole on a compression chamber side.

Further, the above described object of the present invention is achieved by a scroll compressor which compresses a refrigerant by meshing of an orbiting scroll and a fixed scroll, wherein

the orbiting scroll has a back pressure hole which intermittently connects a compression chamber and a back pressure chamber during one orbit of the orbiting scroll, and

the back pressure hole communicates with the compression chamber and also with the back pressure chamber, and shuts off the communication with the back pressure chamber after the communication with the compression chamber is shut off.

According to the present invention, a scroll compressor with high efficiency can be obtained.

Other objects, features and advantages of the invention will become apparent from the following description of the embodiments of the invention taken in conjunction with the accompanying drawings.

Brief description of the several views of the drawing

Fig. 1 is a plane view showing a meshed state of a fixed scroll and an orbiting scroll which are one embodiment of the present invention;

Fig. 2 is an example of a vertical sectional view of a scroll compressor;

Fig. 3 is an example of an enlarged sectional view of a main part showing a back pressure hole portion in Fig. 2 by enlarging it;

Fig. 4 is a plane view showing a meshed state of a fixed scroll and an orbiting scroll having a conventional structure;

Fig. 5 is an example of an adiabatic compression diagram schematically showing a relationship between the crank angle and the compression chamber pressure in the scroll compressor;

Fig. 6 is an example of a P-V diagram schematically showing the relationship between the crank angle and the compression chamber pressure in the scroll compressor;

Fig. 7 is a diagram schematically showing pressure changes in the opening sections at both end portions of the back pressure hole and pressure changes in the back pressure hole; and

Fig. 8 is a conceptual diagram of a refrigeration cycle showing one embodiment of the present invention.

Detailed description of the invention

Hereinafter, an embodiment will be described by using the drawings.

Figs. 2 and 3 are vertical sectional views of a scroll compressor. As shown in the drawings, a fixed scroll (fixed scroll member) 7 has a disk-shaped base plate 7a, a wrap 7b which is vertically provided in a spiral shape on the base plate 7a, and a cylindrical support portion 7d which is located on an outer peripheral side of the base plate 7a and has an end plate surface 7e successively arranged with a tip end surface of the wrap 7b so as to surround the wrap 7b. Since the wrap 7b is likened to "tooth", the tip end surface of the wrap 7b is called a tooth tip, and a surface of the base plate 7a on which the wrap 7b is vertically provided is called a tooth bottom 7c since the surface of the base plate 7a is located in a space formed by the wrap 7b.

Further, a surface on which the support portion 7d is in contact with an end plate 8a of an orbiting scroll (orbiting scroll member) 8 forms the end plate surface 7e of the fixed scroll 7. The fixed scroll 7 has the support portion 7d fixed to a frame 17 by a bolt or the like, and the frame 17 integrated with the fixed scroll 7 is fixed to a case (sealed container) 9 by a fixing means such as welding.

The orbiting scroll 8 is disposed to be opposed to the fixed scroll 7, and is provided in the frame 17 to be capable of orbiting, with the wrap 7b of the fixed scroll and a wrap 8b of the orbiting scroll meshing with each other. The orbiting scroll 8 has a disk-shaped end plate 8a, the spiral wrap 8b which is vertically provided from a tooth bottom 8c which is a surface of the end plate 8a, and a boss portion 8d which is provided at a center of a back surface of the end plate 8a. Further, a surface of an outer peripheral portion of the end plate 8a, that is in contact with the fixed scroll 7, forms an end plate surface 8e of the orbiting scroll 8.

The case 9 has a sealed container structure internally accommodating a scroll portion consisting of the fixed scroll 7 and the orbiting scroll 8, a motor portion 16 (16a: rotor, 16b: stator), and a lubricant oil and the like. A shaft (rotary shaft) 10 which is fixed integrally with the rotor 16a of the motor portion 16 is rotatably supported at the frame 17 via a main bearing 5, and is coaxial with a center axis of the fixed scroll 7.

A crank portion 10a is provided at a tip end of the shaft 10, and is inserted in the boss portion 8d provided at the back surface of the orbiting scroll 8, and the orbiting scroll 8 is configured to be able to orbit with rotation of the shaft 10. An orbiting bearing 11 is disposed between the crank portion 10a and the boss portion 8d. A center axis of the orbiting scroll 8 is in a state eccentric by a predetermined distance with respect to the center axis of the fixed scroll 7. The wrap 8b of the orbiting scroll 8 is superposed on the wrap 7b of the fixed scroll 7 while being displaced by a predetermined angle in a circumferential direction. Reference numeral 12 designates an Oldham ring for making the orbiting scroll 8 perform orbiting movement relative to the fixed scroll 7 while restraining the orbiting scroll 8 so as not to rotate on its own axis.

Fig. 4 is a plane view showing a meshed state of a fixed scroll and an orbiting scroll having a conventional structure. As shown in the drawing, a plurality of crescent compression chambers 13 (13a, 13b) are formed between wraps 7b and 8b, and when the orbiting scroll 8 performs orbiting movement, the volumetric capacity of each of the compression chambers is continuously reduced as each of the compression chambers moves to a central portion. More specifically, the orbiting inner line side compression chamber 13a and the orbiting outer line side compression chamber 13b are formed on an inner line side and an outer line side of the orbiting scroll wrap 8b, respectively. Reference numeral 20 designates a suction chamber which is a space located halfway for suction of fluid. The suction chamber 20 becomes the compression chamber 13 from the point of time at which a phase of the orbiting movement of the orbiting scroll 8 advances to complete containment of the fluid.

A suction port 14 is provided in the fixed scroll 7 as shown in Figs. 2 and 4. The suction port 14 is formed by being bored at an outer peripheral side of the base plate 7a so as to communicate with the suction chamber 20. Further, a discharge port 15 is bored in the vicinity of a spiral center of the base plate 7a of the fixed scroll 7 so as to communicate with the compression chamber 13 on the innermost peripheral side.

When the shaft 10 is rotationally driven by the motor portion 16, the rotational drive is transmitted from a crank portion 10a of the shaft 10 to the orbiting scroll 8 through the orbiting bearing 11, and the orbiting scroll 8 performs orbiting movement with an orbiting radius of a predetermined distance around the center axis of the fixed scroll 7. The orbiting scroll 8 is restrained by the Oldham ring 12 so as not to rotate on its own axis at the time of the orbiting movement.

By the orbiting movement of the orbiting scroll 8, the compression chambers 13 formed between the respective wraps 7b and 8b continuously move to the center, and the volumetric capacities of the compression chambers 13 are continuously reduced in accordance with the movement. Thereby, the fluid (for example, a refrigerant gas which circulates in the refrigeration cycle) sucked from the suction port 14 is sequentially compressed in each of the compression chambers 13, and the compressed fluid is discharged from the discharge port 15 to a discharge space 54 at an upper portion of the case. The discharged fluid enters a motor chamber 52 in the case 9 from the discharge space 54, and is supplied from a discharge pipe 6 to the outside of the compressor, e.g., to a refrigerant cycle.

The lubricant oil is stored at the bottom of the case 9, and a positive displacement type or centrifugal type oil supply pump 21 is provided at a lower end of the shaft 10. The oil supply pump 21 is also rotated with rotation of the shaft, and the lubricant oil is sucked from a lubricant oil suction port 25 which is provided in an oil supply pump case 22, and is discharged from a discharge port 28 of the oil supply pump. The discharged lubricant oil is supplied to an upper portion through a through-hole 3 which is provided in the shaft. A part of the lubricant oil passes through a lateral hole 24 which is provided in the shaft 10, lubricates an accessory bearing 23, and returns to an oil reservoir 53 at the bottom portion of the case. The other most part of the lubricant oil passes through the through-hole 3 to reach an upper portion of the crank 10a of the shaft 10, and passes through an oil groove 57 which is provided in the crank 10a to lubricate the orbiting bearing 11. Subsequently, the lubricant oil lubricates the main bearing 5 which is provided at a lower portion of the orbiting bearing 11, and thereafter, passes through an oil drain hole 26a and an oil drain pipe 26b to return to the oil reservoir 53 at the bottom portion of the case.

Here, a space which is formed by the oil groove 57 and the orbiting bearing 11, and a space which accommodates the main bearing 5 (space which is formed by the frame 17, the shaft 10, a frame seal 56, an orbiting boss member 34 in a collar shape which is provided at the boss portion 8d of the orbiting scroll 8 and a seal member 32) are collectively called a first space 33. The first space 33 is a space having a pressure close to a discharge pressure. Most of the lubricant oil which flows into the first space 33 for lubrication of the main bearing 5 and the orbiting bearing 11 passes through the oil drain hole 26a and the oil drain pipe 26b to return to the bottom portion of the case. However, a part of the lubricant oil that is the minimum necessary amount required for lubrication of the Oldham ring 12, and lubrication and sealing of slide portions between the fixed scroll 7 and the orbiting scroll 8 enters a back pressure chamber 18 via an oil leaking means which will be described later between an upper end surface of the seal member 32 and an end surface of the orbiting boss member 34. The back pressure chamber 18 will be called a second space.

The seal member 32 is inserted in a circular groove 31 provided in the frame 17, together with a wave-shaped spring (not illustrated), and provides partition between the first space 33 which has the discharge pressure, and the back pressure chamber 18 which has a pressure between the suction pressure and the discharge pressure. The aforementioned oil leaking means includes, for example, a plurality of holes 30 which are provided in the orbiting boss member 34, and the aforementioned seal member 32. The aforementioned plurality of holes 30 perform circular motion across the seal member 32 in accordance with the orbiting movement of the orbiting scroll 8, and move between the first space 33 and the back pressure chamber 18. Thereby, the minimum necessary oil can be guided to the back pressure chamber 18 by storing the lubricant oil in the first space 33 in the holes 30, and intermittently transferring the lubricant oil to the back pressure chamber 18. Instead of the plurality of holes 30, a slit or the like may be provided to form the oil leaking means to the back pressure chamber.

When the back pressure becomes high, the lubricant oil which enters the back pressure chamber 18 passes through a back pressure hole 35 which provides communication between the back pressure chamber 18 and the compression chamber 13 to enter the compression chamber, after which, the lubricant oil is discharged from the discharge port 15, a part of it is discharged to the refrigeration cycle from the discharge pipe 6 together with the refrigerant gas, for example, and the remaining part is separated from the refrigerant gas in the case 9 and is stored in the oil reservoir 53 at the bottom of the case.

Since the oil supply amount which is necessary for the respective bearing portions and the oil supply amount which is necessary for the compression chamber can be independently controlled by providing the aforementioned first space 33, the back pressure chamber 18 and the oil leaking means as described above, it becomes possible to optimize the compression chamber oil supply amount to obtain the compressor with high efficiency.

Next, for the scroll compressor described above, details of the back pressure will be described. In the scroll compressor, the force in the axial direction occurs so as to separate the fixed scroll 7 and the orbiting scroll 8 from each other due to the compression action thereof. When a so-called breakaway phenomenon of the orbiting scroll 8 occurs, in which both the scrolls are separated from each other by the force in the axial direction, hermeticity of the compression chamber is worsened, and the efficiency of the compressor is reduced. Thus, the back pressure chamber 18 of which the pressure is between the discharge pressure and the suction pressure is provided at the back surface side of the end plate of the orbiting scroll 8, and the separating force is cancelled out by the back pressure while the orbiting scroll 8 is pressed against the fixed scroll 7. At this time, if the pressing force is too large, the slide loss of the end plate surface 8e of the orbiting scroll 8 and the end plate surface 7e of the fixed scroll 7 increases, and the compressor efficiency is reduced. That is, there is an optimal value for the back pressure, and if the back pressure is too small, the hermeticity of the compression chamber is worsened to increase thermal fluid loss, whereas if the back pressure is too large, the slide loss is increased. Accordingly, keeping the back pressure at the optimal value is important for enhancement of performance and enhancement of reliability of the compressor. In the present embodiment, the back pressure hole 35 is included to keep the back pressure in an optimal range.

The configuration of the back pressure hole 35 will be described using Figs. 3 and 4. In the end plate of the orbiting scroll 8, the back pressure hole 35 (35a, 35b, 35c) is provided in a U-shape. The back pressure hole 35 intermittently connects the compression chamber 13 and the back pressure chamber 18 while the orbiting scroll 8 orbits one time. A plug 35d is provided for closing an end portion of a passage 35a to form the U-shaped back pressure hole 35.

A cutout portion 36a which communicates with the back pressure chamber 18 is provided at the end plate surface 7e on the outer peripheral side of the fixed scroll 7. A back pressure chamber side communication port (end portion 35c) which is one communication port of the U-shaped back pressure hole 35 communicates with the back pressure chamber 18 by intermittently communicating with the aforementioned cutout portion 36a by orbiting movement shown in revolution loci 60 of Fig. 4, and the communication port is blocked by the end plate surface 7e of the fixed scroll 7 when the communication port does not communicate with the cutout portion 36a. A compression chamber side communication port (end portion 35b) which is the other communication port of the back pressure hole 35 intermittently communicates with the compression chamber 13 by orbiting movement, and when the communication port does not communicate with it, the communication port is blocked by the wrap 7b of the fixed scroll 7.

A section in which the back pressure chamber side communication port (end portion 35c) communicates with the back pressure chamber 18, and a section in which the compression chamber side communication port (end portion 35b) communicates with the compression chamber are generally different from each other, and only when both of them communicate with each other, the compression chamber 13 and the back pressure chamber 18 communicate with each other.

When the shape of the aforementioned cutout portion 36a, and the positions of both the end portions 35b and 35c of the back pressure hole 35 are determined, the section (communication section of the back pressure hole) in which the back pressure hole 35 provides communication between the compression chamber 13 and the back pressure chamber 18 is determined, and the pressure of the back pressure chamber 18 becomes the value corresponding to the compression chamber pressure in the communication section. More specifically, the timing of communication is regulated by using the cutout portion 36a.

This will be further described in detail by Figs. 5 and 6. First, the pressure change of the compression chamber of the scroll compressor will be described by Fig. 5. In the diagram of Fig. 5, the axis of abscissa represents a crank angle (phase of the orbiting movement of the orbiting scroll), whereas the axis of ordinates represents the pressure of the compression chamber at the time of adiabatic compression, and the diagram schematically shows the relationship therebetween. The diagram of Fig. 5 shows the compression chamber pressure of any one of the orbiting outer line side compression chamber 13b and the orbiting inner line side compression chamber 13a. When attention is paid to the compression chamber shown by a solid line 49 in the drawing, a section 70 is a suction section, a section 71 is a compression section, and a section 72 is a discharge section. Reference numerals 73 and 74 represent changes of the pressures of the compression chambers in the compression chambers which are formed before and after the compression chamber shown by reference numeral 49.

Next, by using Fig. 6, description is made by paying attention to only the compression chamber shown by reference numeral 49. Reference numeral 49 designates an adiabatic compression line, and the actual indication diagram expands upward as reference numeral 51 with respect to the adiabatic compression line 49 due to thermal fluid loss.

When explaining the conventional configuration as an example, the end portion 35b communicates with the compression chamber 13 in the section 46 from reference numerals 44 to 45, and the end portion 35c communicates with the back pressure chamber 18 in a section 61 from reference numerals 48 to 45. Consequently, the compression chamber 13 and the back pressure chamber 18 communicate with each other in the section 61 in which both the end portions provide communication. In the section 61, the compression chamber pressure varies from reference numerals 48 to 45, and the back pressure is set at a pressure 47 which is the average of the compression chamber pressures in this section while involving a little variation.

The above is the mechanism of generation of the back pressure, and the problem in the conventional configuration will be described hereinafter. In the conventional configuration, the back pressure can be kept to be optimal as described above, but much consideration has not been given to the fact that the U-shaped back pressure hole 35 has a so-called dead volume. More specifically, when consideration is given to the instant at which both of the end portion 35b and the end portion 35c are blocked after the back pressure hole 35 finishes providing communication between the compression chamber 13 and the back pressure chamber 18, the fluid flows from the end portion 35b side having the pressure 45 to the end portion 35c having the back pressure (pressure 47), and the inside of the back pressure hole 35 is filled with the pressure close to the pressure 45. Subsequently, when the end portion 35b communicates with the next compression chamber in accordance with the orbiting movement, the compression chamber pressure is 44, and therefore, the fluid in the back pressure hole 35 expands again from the pressure close to the pressure 45 to the pressure 44, so that thermal fluid loss occurs.

In contrast with this, the present embodiment expands the section 61 in the conventional configuration of Fig. 6 to a section 62 by changing the shape of the cutout portion 36a which is provided at the fixed scroll 7 as shown in Fig. 1. More specifically, the back pressure hole 35 communicates with the compression chamber 13 and also communicates with the back pressure chamber 18, and shuts off the communication with the back pressure chamber 18 after the communication with the compression chamber 13 is shut off. More specifically, even after the end portion 35b ends communication with the compression chamber 13, the end portion 35c communicates with the back pressure chamber 18. In other words, the end portions 35b and 35c of the back pressure hole 35 are provided to be in such a positional relationship that while the orbiting scroll 8 orbits one time, the back pressure hole 35 intermittently provides communication between the compression chamber 13 and the back pressure chamber 18, and the communication port of the back pressure hole 35 on the back pressure chamber 18 side is closed at a timing later than the communication port of the back pressure hole 35 on the compression chamber 13 side.

Thereby, the high pressure in the U-shaped back pressure hole 35 reduces to the back pressure 47 after both end portions are blocked, and re-expansion at the time when the end portion 35b communicates with the next chamber in accordance with the orbiting movement provides variation from the pressure 47 to the pressure 44, so that re-expansion loss can be reduced as compared with the conventional configuration.

The above content will be described again by Fig. 7. The upper portion of Fig. 7 shows the opening sections and the closed sections of the end portions 35b and 35c of the back pressure hole, and the lower portion of Fig. 7 shows the pressure in the back pressure hole. The solid line shows the opening section and the pressure change in the structure of the present embodiment (Fig. 1), and the broken line shows the opening section and the pressure change in the conventional structure (Fig. 4). In the conventional structure (Fig. 4), the pressure becomes 44 at the instant when the end portion 35b opens to the compression chamber (the starting point of the section 46), and the pressure in the back pressure hole also becomes high with increase in the pressure of the compression chamber. Even after the end portion 35c opens to the back pressure chamber 18 (the starting point of the section 61), the pressure increases, and the pressure becomes a pressure 45' which is a little lower than the pressure 45 at the end point of the sections 46 and the section 61. When the end portion 35b opens to the next compression chamber which has the pressure 44, the fluid in the back pressure hole expands again from the pressure 45' to the pressure 44.

In contrast with this, in the structure (Fig. 1) of the present embodiment, a section 62 is set so that the end portion 35c opens to the back pressure chamber 18 even after the section 46 ends, and therefore, the pressure in the back pressure hole temporarily rises to 45', and thereafter lowers to the back pressure 47. When the end portion 35c opens to the next compression chamber, the fluid in the back pressure hole expands again from the pressure 47 to the pressure 44, but as compared with the conventional structure (Fig. 4), the pressure can be reduced by the re-expansion amount from the pressure 45' to the pressure 47.

The effect of reduction by the re-expansion amount becomes larger when the volume of the back pressure hole 35 is larger. This is because when a volume of the back pressure hole 35 is set as V, and a swept volume (suction volume) of the compressor is set as Vth, the re-expansion loss is substantially proportional to V/Vth.

Further, the effect of reduction of the re-expansion amount becomes larger when the pressure in the back pressure hole 35 reduces more significantly. The estimation is as follows in a larger sense, though the estimation is rough. When the discharge pressure is set as Pd, the suction pressure is set as Ps, and the pressure in the back pressure hole 35 is assumed to re-expand by ΔP (45' to 44, or 47 to 44), the re-expansion loss is substantially proportional to $\Delta P/(Pd-Ps)$.

More specifically, the re-expansion loss is considered as the following expression.

Re-expansion loss $\propto (V/Vth) \times (\Delta P/(Pd-Ps))$

Accordingly, when the pressure in the back pressure hole 35 is decreased from 45' to 47, the re-expansion loss can be made smaller.

Further, by configuring a refrigeration cycle for air-conditioning as shown in Fig. 8 by using the compressor 1 as described above, a condenser 40, an expansion vale 41, an evaporator 42, and a four-way valve 43, it is possible to provide an air-conditioner which requires a small power consumption amount throughout a year and is easy to use with a wide operation range.

It should be further understood by those skilled in the art that although the foregoing description has been made on embodiments of the invention, the invention is not limited thereto and various changes and modifications may be made without departing from the spirit of the invention and the scope of the appended claims.