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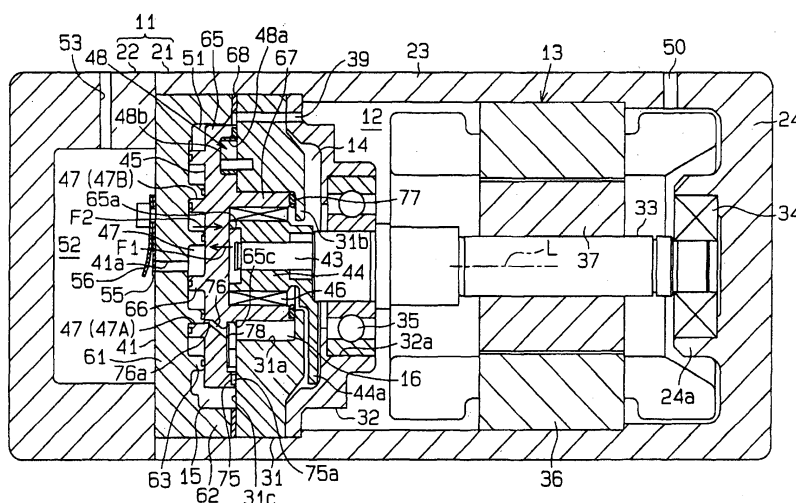
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(54) **Scroll compressor**

(57) A scroll compressor includes a fixed scroll member fixed to a housing and a movable scroll member engaging the fixed scroll member. Each scroll member has a base plate and a spiral wall. A compression chamber between the fixed and movable scroll members reduces in volume by orbiting the movable scroll member, thus compressing gas. A back pressure chamber is defined in the housing on a back surface side of the movable scroll base plate between the movable

scroll member and the a fixed wall of the housing. An introducing passage interconnects the back pressure chamber and a relatively high pressure region. A seal member on one of the movable scroll member and the fixed wall seals the back pressure chamber as being slidable on the other. The seal member includes a portion for lowering sealing performance, which interconnects the back pressure chamber and a relatively low pressure region.

**FIG. 1**



## Description

**[0001]** The present invention relates to a scroll compressor of a refrigeration cycle in a vehicle air conditioner for compressing refrigerant.

**[0002]** A scroll compressor of such type includes a fixed scroll member and a movable scroll member. The fixed scroll member has a spiral wall and a base plate, and is fixedly connected to a housing of the compressor. The movable scroll member has a spiral wall and a base plate, and is engaged with the spiral wall of the fixed scroll member. As the movable scroll member orbits, compression chambers defined between both the spiral walls progressively reduce in volume, thus compressing refrigerant gas.

**[0003]** Recently, carbon dioxide is employed as refrigerant for the refrigeration cycle. When carbon dioxide refrigerant is employed, pressure in the refrigeration cycle becomes much higher than that when fluorocarbon refrigerant is employed. Accordingly, in the scroll compressor, relatively large thrust load based upon pressure in the compression chambers is applied to the movable scroll member. Thus, the movable scroll member slides under relatively hard condition, so that reliability of the scroll compressor is deteriorated.

**[0004]** In order to solve such a problem, for example, as disclosed in Unexamined Japanese Patent Publication No. 2000-249086, the back surface of the movable scroll member is recessed to form a pocket for applying back pressure, and the pocket for applying back pressure is shut by a fixed wall provided in a housing of the compressor. Thus, a back pressure chamber is formed. A volume-reducing compression chamber communicates with the back pressure chamber through an introducing passage. Accordingly, force (force based upon the back pressure) that resists against force (thrust load) based upon pressure in the compression chambers is applied to the movable scroll member due to the pressure in the back pressure chamber, so that sliding resistance is reduced between the movable scroll member and the fixed wall. Additionally, the movable scroll member is pressed against the fixed scroll member, so that sealing performance of the compression chambers improve.

**[0005]** The pressure in the back pressure chamber is appropriately adjusted by variation in the amount of a clearance (passing cross-sectional area) between the movable scroll member and the fixed scroll wall. In other words, for example, as the pressure in the back pressure chamber rises, the clearance between the movable scroll member and the fixed wall increases. Accordingly, the amount of refrigerant gas delivered from the back pressure chamber to a relatively low pressure region through the clearance increases, so that an excessive rise in the pressure in the back pressure chamber is prevented. On the contrary, as the pressure in the back pressure chamber falls, the clearance between the movable scroll member and the fixed wall reduces. Accord-

ingly, the amount of refrigerant gas delivered from the back pressure chamber to the relatively low pressure region through the clearance reduces, so that undesirable reduction in the pressure in the back pressure chamber is prevented.

**[0006]** An unwanted feature is that in accordance with the Unexamined Japanese Patent Publication No. 2000-249086, the entire clearance between the movable scroll member and the fixed wall is utilized as a passage for delivering the refrigerant gas from the back pressure chamber to the relatively low pressure region. Accordingly, in order to optionally and appropriately adjust the pressure in the back pressure chamber by the variation in the amount of the clearance, for example, a facing surface of the movable scroll member and a facing surface of the fixed wall need be manufactured in high accuracy. As a result, cost for manufacturing the scroll compressor rises.

**[0007]** Particularly, when carbon dioxide refrigerant is employed, the pressure in the back pressure chamber is adjusted in a much higher range than that when fluorocarbon refrigerant is employed. Accordingly, in order to appropriately adjust the pressure in the back pressure chamber, the clearance between the movable scroll member and the fixed wall need be much narrower at the maximum. Thus, a rise in cost for manufacturing becomes a further serious problem. Therefore, there is a need for providing a scroll compressor that has a reasonable structure and optionally and appropriately adjusts pressure in a back pressure chamber.

## SUMMARY OF THE INVENTION

**[0008]** In accordance with the present invention, a scroll compressor has a housing, a fixed scroll member, a movable scroll member and a seal member. The housing includes a fixed wall, and defines a relatively high pressure region and a relatively low pressure region. The fixed scroll member has a base plate and a spiral wall extending from the base plate, and is fixedly connected to the housing. The movable scroll member has a base plate and a spiral wall extending from the base plate, and is engaged with the fixed scroll member. A compression chamber defined between the fixed scroll member and the movable scroll member progressively reduces in volume by orbiting the movable scroll member relative to the fixed scroll member, thus compressing gas. The back pressure chamber is defined in the housing on a back surface side of the base plate of the movable scroll member between the movable scroll member and the fixed wall. The back pressure chamber and the relatively high pressure region are interconnected through an introducing passage. A seal member is provided on one of the movable scroll member and the fixed wall for sealing the back pressure chamber as being slidable on the other of the movable scroll member and the fixed wall. The seal member includes a seal lowering portion for lowering sealing performance. The seal low-

ering portion interconnects the back pressure chamber and the relatively low pressure region.

**[0009]** Other aspects and advantages of the invention will become apparent from the following description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

#### BRIEF DESCRIPTION OF THE DRAWINGS

**[0010]** The features of the present invention that are believed to be novel are set forth with particularity in the appended claims. The invention together with objects and advantages thereof, may best be understood by reference to the following description of the presently preferred embodiments together with the accompanying drawings in which:

FIG. 1 is a longitudinal cross-sectional view of an electric compressor according to a preferred embodiment of the present invention;

FIG. 2 is a rear end view of a movable scroll member, which is detached from the scroll compressor, according to the preferred embodiment of the present invention;

FIG. 3A is a partially enlarged cross-sectional view around a seal member of FIG. 1;

FIG. 3B is a partially enlarged cross-sectional view illustrating a state when a passing cross-sectional area of a portion for lowering sealing performance becomes small;

FIG. 4 is a rear end view of a movable scroll member according to an alternative embodiment of the present invention; and

FIG. 5 is a partially enlarged cross-sectional view of a relevant portion of an electric compressor according to an alternative embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0011]** A preferred embodiment of the present invention will now be described with reference to FIGs. 1 through 3B. In the preferred embodiment, a scroll compressor according to the present invention is applied to an electric compressor for use in a refrigeration cycle of a vehicle air conditioner. Incidentally, carbon dioxide is employed as refrigerant of the refrigeration cycle. The left side and the right side of FIG. 1 respectively correspond to the front side and the rear side of the electric compressor.

**[0012]** As shown in FIG. 1, a housing 11 of the electric

compressor includes a first housing element 21 and a second housing element 22. The first housing element 21 and the second housing element 22 are fixedly connected with each other. The first housing element 21 has a cylindrical portion 23 and a bottom portion 24, which connects with the rear end of the cylindrical portion 23 (on the right side of FIG. 1). Thus, the first housing element 21 forms a cylinder with a bottom at one end and is formed by die-casting an aluminum alloy. The second housing element 22 forms a cylinder with a bottom on the front side (the left side of FIG. 1) and is formed by die-casting an aluminum alloy.

**[0013]** A cylindrical shaft support portion 24a extends from the center of an inner wall surface of the bottom portion 24 in the first housing element 21. A shaft support member 32, which has an insertion hole 32a formed through the center thereof, is fixedly connected to an opening end of the cylindrical portion 23 in the first housing element 21. A rotary shaft 33 is accommodated in the first housing element 21. The rear end (the right end) of the rotary shaft 33 is rotatably supported by the shaft support portion 24a of the first housing element 21 through a bearing 34. The front end (the left side) of the rotary shaft 33 is inserted through the insertion hole 32a of the shaft support member 32, and is rotatably supported by the shaft support member 32 through a bearing 35 in the insertion hole 32a.

**[0014]** A motor chamber 12 is defined in the housing 11 and is located on the rear side of FIG. 1 relative to the shaft support member 32. In the motor chamber 12, a stator 36 is provided on the inner circumferential surface of the cylindrical portion 23 of the first housing element 21. In the motor chamber 12, a rotor 37 is secured to the rotary shaft 33 so as to be located inside the stator 36. The stator 36 and the rotor 37 constitute the electric motor 13. The electric motor 13 integrally rotates the rotor 37 and the rotary shaft 33 by electric power externally supplied to the stator 36.

**[0015]** A fixed scroll member 41 is accommodated in the first housing element 21 and is located near the opening end of the cylindrical portion 23. The fixed scroll member 41 includes a disc-shaped base plate 61, a cylindrical outer circumferential wall 62 and a spiral wall 63. The outer circumferential wall 62 extends from the outer periphery of the base plate 61. The spiral wall 63 extends from the base plate 61 and is located inside the outer circumferential wall 62. In the first housing element 21, a disc-shaped center frame or a fixed wall 31 is arranged between the fixed scroll member 41 and the shaft support member 32. A through hole 31a is formed through the center of the center frame 31. An annular contact portion 31b is located at the opening end near the motor chamber 12 in the through hole 31a and protrudes inward.

**[0016]** The fixed scroll member 41 is connected to the outer periphery of the center frame 31 by the distal end surface of the outer circumferential wall 62. An annular shim 68 is interposed at a joint between the fixed scroll

member 41 and the center frame 31. The base plate 61 of the fixed scroll member 41, the outer circumferential wall 62 of the fixed scroll member 41 and the center frame 31 surround to define a scroll chamber 15 in the housing 11.

**[0017]** A crankshaft 43 is provided at the end surface of the rotary shaft 33 near the center frame 31. The crankshaft 43 is mostly arranged in the through hole 31 a of the center frame 31. A bushing 44 is fixedly fitted around the crankshaft 43. A movable scroll member 45 is accommodated in the scroll chamber 15 and is rotatably supported on the bushing 44 through a bearing 46 so as to face the fixed scroll member 41.

**[0018]** A balancer 44a is provided at the end of the bushing 44 near the shaft support member 32. The balancer 44a relieves imbalance on the rotary shaft 33 due to uneven arrangement of the movable scroll member 45 around an axis L of the rotary shaft 33. The balancer 44a is accommodated in a balancer chamber 14 outside the through hole 31 a. The balancer chamber 14 is defined between the shaft support member 32 and the center frame 31. The balancer chamber 14 communicates with the motor chamber 12 through a clearance of the bearing 35. Accordingly, the balancer chamber 14 has the same atmospheric pressure as that of the motor chamber 12.

**[0019]** The movable scroll member 45 includes a disc-shaped base plate 65 and a spiral wall 66 that extends toward the fixed scroll member 41. A boss 67 is provided near the center of a back surface of the base plate 65 and protrudes therefrom. The boss 67 is fitted around the bushing 44 through the bearing 46 in the through hole 31 a of the center frame 31. An annular tip seal 77 is provided at the distal end of the boss 67. In the through hole 31 a, the boss 67 slidably contacts with the contact portion 31 b of the center frame 31 by the tip seal 77. Accordingly, in the through hole 31 a, the tip seal 77 blocks communication between an inner space of the boss 67 communicating with the balancer chamber 14 and an outer space of the boss 67.

**[0020]** The fixed scroll member 41 and the movable scroll member 45 engage with each other by the respective spiral walls 63, 66 in the scroll chamber 15, while the distal end of the spiral wall 63 and the distal end of the spiral wall 66 contact with the base plate 65 of the movable scroll member 45 and the base plate 61 of the fixed scroll member 41, respectively. Accordingly, the base plate 61 and the spiral wall 63 of the fixed scroll member 41 and the base plate 65 and the spiral wall 66 of the movable scroll member 45 define compression chambers 47 in the scroll chamber 15.

**[0021]** A self-rotation blocking mechanism 48 is provided between the base plate 65 of the movable scroll member 45 and the center frame 31 facing the base plate 65. The self-rotation blocking mechanism 48 includes a plurality of cylindrical holes 48a and a plurality of pins 48b (only one of them is shown in FIG. 1). The cylindrical holes 48a are recessed in radially outer por-

tions of the back surface 65a of the base plate 65 in the movable scroll member 45. The pins 48b are buried in an end surface 31 c of the center frame 31 and are loosely fitted therein.

**[0022]** In the scroll chamber 15, a suction chamber 51 is defined between the outer circumferential wall 62 of the fixed scroll member 41 and the outermost circumferential portion of the spiral wall 66 of the movable scroll member 45. A suction passage 39 is formed in radially outer portions of the shaft support member 32, the shim 68 and the center frame 31 for interconnecting the suction chamber 51 and the motor chamber 12.

**[0023]** A suction port 50 is formed in the cylindrical portion 23 of the first housing element 21 and is located to correspond with the motor chamber 12. The suction port 50 connects with an external conduit, which further connects with an evaporator (not shown) of an external refrigerant circuit. The suction port 50 communicates with the motor chamber 12. Accordingly, relatively low pressure refrigerant gas from the external refrigerant circuit is introduced into the suction chamber 51 through the suction port 50, the motor chamber 12 and the suction passage 39.

**[0024]** In the housing 11, a discharge chamber 52 is defined between the second housing element 22 and the fixed scroll member 41. A discharge port 53 for communicating with the discharge chamber 52 is formed in the second housing element 22. The discharge port 53 connects with an external conduit, which further connects with a gas cooler (not shown) of the external refrigerant circuit. Accordingly, relatively high pressure refrigerant gas in the discharge chamber 52 is delivered to the external refrigerant circuit through the discharge port 53.

**[0025]** A discharge hole 41 a is formed through the center of the base plate 61 of the fixed scroll member 41. The compression chamber 47 near the center communicates with the discharge chamber 52 through the discharge hole 41 a. In the discharge chamber 52, a discharge valve 55 constituted of a reed valve is arranged on the base plate 61 of the fixed scroll member 41 for opening and closing the discharge hole 41 a. The opening degree of the discharge valve 55 is regulated by a retainer 56, which is fixedly arranged on the base plate 61 of the fixed scroll member 41.

**[0026]** As the rotary shaft 33 is rotated by the electric motor 13, the movable scroll member 45 orbits around the axis (the axis L of the rotary shaft 33) of the fixed scroll member 41 through the crankshaft 43. At the moment, the self-rotation of the movable scroll member 45 is blocked by the self-rotation blocking mechanism 48, so that only the orbital movement of the movable scroll member 45 is permitted. Due to the orbital movement of the movable scroll member 45, the compression chambers 47 reduce in volume as the compression chambers 47 move from the radially outer side of the spiral walls 63, 66 of the respective scroll members 41, 45 toward the center of the spiral walls 63, 66. Thus,

relatively low pressure refrigerant gas introduced from the suction chamber 51 to the compression chambers 47 is compressed. The compressed refrigerant gas is discharged to the discharge chamber 52 through the discharge hole 41 a by pushing away the discharge valve 55.

**[0027]** The operation for adjusting back pressure of the movable scroll member 45 will now be described.

**[0028]** As shown in FIG. 1, in the scroll chamber 15, a back pressure chamber 16 is located on the side of the back surface 65a of the base plate 65 of the movable scroll member 45. The base plate 65 and the boss 67 of the movable scroll member 45 and the center frame 31 surround to define the back pressure chamber 16. Communication between the back pressure chamber 16 and the balancer chamber 14 is blocked by the tip seal 77, which is interposed between the boss 67 of the movable scroll member 45 and the contact portion 31 b of the center frame 31.

**[0029]** As shown in FIGs. 2 and 3A, in the back surface 65a of the base plate 65 of the movable scroll member 45, an annular groove 65b for accommodating a seal is recessed in radially outer portion relative to the cylindrical recesses 48a so as to surround the cylindrical recesses 48a. An annular seal member 75 constituted of a tip seal is fitted in the groove 65b. The back surface 65a of the movable scroll member 45 slidably and elastically contacts with an end surface 31c of the center frame 31 by the seal member 75. Namely, the seal member 75 is interposed at a clearance CL between the back surface 65a of the movable scroll member 45 and the end surface 31c of the center frame 31. Communication between the back pressure chamber 16 and the suction chamber 51 through the entire clearance CL is blocked by the seal member 75.

**[0030]** Incidentally, a maximum distance of the clearance CL between the movable scroll member 45 and the center frame 31, that is, a thrust clearance between the movable scroll member 45 and the center frame 31, is adjusted in an appropriate distance in such a manner that a shim 68 having an appropriate thickness is selected from a plurality of shims 68 having different thicknesses and is assembled to the clearance CL when the electric compressor is manufactured.

**[0031]** As shown in FIGs. 1 and 2, an introducing passage 76 is formed in the base plate 65 of the movable scroll member 45 so as to extend through the base plate 65 in thickness. Two introducing passages 76 are provided. The back pressure chamber 16 and a volume-reducing (compressing) compression chamber 47A, which is a relatively high pressure region, are interconnected through one introducing passage 76. The back pressure chamber 16 and a volume-reducing compression chamber 47B, which is different from the compression chamber 47A, are interconnected through the other introducing passage 76. The introducing passages 76 are symmetrically located in the base plate 65 from each other with an angle of 180 degrees with respect to the

axis of the crankshaft 43, and respectively open to the corresponding compression chambers 47A, 47B.

**[0032]** A fixed throttle 76a is arranged in each of the introducing passages 76. In the movable scroll member 45, the back surface 65a of the base plate 65 forms two accommodating recesses 65c, with which the opening of each introducing passage 76 on the side of the back pressure chamber 16 communicates. A check valve 78 constituted of a reed valve is accommodated in each of the accommodating recesses 65c. The check valves 78 each permit refrigerant gas supplied from the compression chambers 47A, 47B to the back pressure chamber 16, and block the refrigerant gas returned from the back pressure chamber 16 to the compression chambers 47A, 47B.

**[0033]** As shown in FIGs. 2 and 3A, a portion 75a for lowering sealing performance (hereinafter, a seal lowering portion 75a) relative to the other portion is provided for the seal member 75. The seal lowering portion 75a is formed by splitting a portion of the annular seal member. The back pressure chamber 16 and the suction chamber 75, which is a relatively low pressure region, are interconnected through the seal lowering portion 75a of the seal member 75 in the clearance CL between the movable scroll member 45 and the center frame 31. Incidentally, in FIG. 2, dimensions of the seal lowering portion 75a (a split portion in the seal member 75) are exaggeratedly illustrated for easier understanding. Actually, the seal lowering portion 75a is formed by an extremely narrow clearance.

**[0034]** Incidentally, according to the present invention, a relatively high pressure region means a region where relatively high pressure refrigerant gas, which is compressed by the fixed scroll member 41 and the movable scroll member 45, exists, while a relatively low pressure region means a region where relatively low pressure refrigerant gas, which is yet to be compressed by the fixed scroll member 41 and the movable scroll member 45, exists.

**[0035]** As shown in FIG. 1, as pressure in the volume-reducing compression chambers 47A, 47B rises to exceed pressure in the back pressure chamber 16 due to operation of the electric compressor, the check valve 78 opens so that the relatively high pressure refrigerant gas in the volume-reducing compression chambers 47A, 47B is introduced into the back pressure chamber 16 through the respective introducing passages 76. Accordingly, the pressure in the back pressure chamber 16 rises so that force (back pressure force) F1 urging the movable scroll member 45 toward the fixed scroll member 41 is applied based upon the pressure in the back pressure chamber 16. On the other hand, force (thrust load) F2 based upon the pressure in the compression chambers 47 is applied to the movable scroll member 45 toward a direction to leave the fixed scroll member 41. Accordingly, a position of the movable scroll member 45 relative to the center frame 31 is determined in accordance with a balance between the force F1 and

the force F2.

**[0036]** As exaggeratedly shown in FIG. 3A, for example, as the force F1 becomes greater than the force F2 ( $F1 > F2$ ) due to an increase in the pressure in the back pressure chamber 16, the movable scroll member 45 is displaced in a direction in which the back surface 65a leaves the end surface 31 c of the center frame 31. Accordingly, sliding resistance between the back surface 65a of the movable scroll member 45 and the end surface 31 c of the center frame 31 is reduced. In addition, when the force F1 becomes greater than the force F2 ( $F1 > F2$ ), the movable scroll member 45 is pressed against the fixed scroll member 41 so that sealing performance of the compression chambers 47 improves.

**[0037]** As the movable scroll member 45 leaves the center frame 31 to increase the clearance CL between the movable scroll member 45 and the center frame 31, the passing cross-sectional area of refrigerant gas increases at the seal lowering portion 75a of the seal member 75. Accordingly, the amount of refrigerant gas delivered from the back pressure chamber 16 to the suction chamber 51 increases so that the pressure in the back pressure chamber 16 falls to reduce the force F1.

**[0038]** As exaggeratedly shown in FIG. 3B, as the force F1 becomes smaller than the force F2 ( $F1 < F2$ ) due to a reduction in the pressure in the back pressure chamber 16, the movable scroll member 45 is displaced in a direction in which the back surface 65a approaches the end surface 31 c of the center frame 31. Accordingly, sliding resistance between the movable scroll member 45 and the fixed scroll member 41 is reduced.

**[0039]** As the movable scroll member 45 approaches the center frame 31 to reduce the clearance between the movable scroll member 45 and the center frame 31, the passing cross-sectional area of refrigerant gas reduces at the seal lowering portion 75a of the seal member 75. Accordingly, the amount of refrigerant gas delivered from the back pressure chamber 16 to the suction chamber 51 reduces so that the pressure in the back pressure chamber 16 rises to increase the force F1.

**[0040]** Thus, the movable scroll member 45 varies the clearance CL (distance) between the back surface 65a and the end surface 31 c of the center frame 31 in such a manner that the force F1 based upon the pressure in the back pressure chamber 16 becomes an appropriate magnitude in a correspondence with the force F2 based upon the pressure in the compression chambers 47. The passing cross-sectional area of the seal lowering portion 75a is thereby autonomously adjusted. Incidentally, in the preferred embodiment, in order to enhance compression efficiency by improving sealing performance of the compression chambers 47, the adjustment of the pressure in the back pressure chamber 16 is predetermined in such a manner that a state, where the force F1 applied to the movable scroll member 45 slightly exceeds the force F2, is maintained for a relatively long time.

**[0041]** According to the preferred embodiment, the

following advantageous effects are obtained.

(1) The movable scroll member 45 varies the clearance CL between the movable scroll member 45 and the center frame 31 in such a manner that the force F1 based upon the pressure in the back pressure chamber 16 becomes an appropriate magnitude in a correspondence with the force F2 based upon the pressure in the compression chambers 47. Thus, the passing cross-sectional area of the seal lowering portion 75a of the seal member 75 is autonomously adjusted. In comparison to a prior art in which an entire clearance CL between the movable scroll member 45 and the center frame 31 is utilized as a passage for delivering refrigerant gas from the back pressure chamber 16 to the suction chamber 51, the surfaces 31 c and 65a respectively facing the movable scroll member 45 and the center frame 31 need not be manufactured in high accuracy. Accordingly, the pressure in the back pressure chamber 16 is appropriately adjusted without an increase in cost for manufacturing the electric compressor.

(2) The seal lowering portion 75a for lowering sealing performance of the seal member 75 is formed by splitting a portion of the annular seal member 75. Accordingly, the seal lowering portion 75a is easily formed in the seal member 75.

(3) The shim 68 is interposed at a joint between the fixed scroll member 41 fixed to the housing 11 and the center frame 31 also fixed to the housing 11 for adjusting a thrust clearance between the movable scroll member 45 and the center frame 31. For example, in comparison to the shim 68 interposed at a sliding portion between the movable scroll member 45 and the center frame 31, the leakage of refrigerant gas at a portion where the shim 68 is interposed is prevented in the preferred embodiment. This leads to improving compression efficiency of the electric compressor.

(4) The shaft support member 32, by which the rotary shaft 33 is supported through the bearing 35, is independently provided from the center frame 31, on which the movable scroll member 45 slides. The balancer chamber 14 is defined between the shaft support member 32 and the center frame 31, and the balancer 44a is accommodated in the balancer chamber 14. For example, in comparison to a structure in which the shaft support member 32 is integrated with the center frame 31 as one component and the balancer 44a is accommodated in the back pressure chamber 16 (This embodiment is not a departure from the present invention.), sealing of the back pressure chamber 16 becomes easy.

In other words, in a state of a comparative example, the rotary shaft 33 is partially located in the

back pressure chamber 16, so that the back pressure chamber 16 need be sealed by a lip seal. The lip seal, in view of its characteristic, tightly fastens the rotary shaft 33 for performing desirable sealing performance. As a result, power loss of the rotary shaft 33 increases, and appropriate seal of the back pressure chamber 16 and a reduction in power loss are not performed at the same time.

Incidentally, in the above comparative example, as disclosed in the Unexamined Japanese Patent Publication No. 2000-249086, a pocket for back pressure is recessed in the back surface 65a of the movable scroll member 45, and the back pressure chamber is formed by covering the pocket for applying back pressure with the center frame 31. Thus, the rotary shaft 33 need not be sealed by the lip seal. However, in this state, since the suction pressure is partially applied to the back surface of the movable scroll member 45 other than the pressure in the back pressure chamber, it becomes complicated to appropriately set function for adjusting back pressure. Additionally, the pocket for applying back pressure need be recessed in the movable scroll member 45, so that cost for manufacturing increases.

The relatively high pressure region includes two volume-reducing compression chambers 47A, 47B. Two introducing passages 76 are provided. One compression chamber 47A and the back pressure chamber 16 are interconnected through one introducing passage 76, while the other compression chamber 47B and the back pressure chamber 16 are interconnected through the other introducing passage 76. Thus, relatively high pressure refrigerant gas is supplied from two compression chambers 47A, 47B to the back pressure chamber 16, so that the inclination of the movable scroll member 45 due to a reduction in pressure in the compression chambers 47A, 47B by supplying the relatively high pressure refrigerant gas is prevented.

Namely, for example, when one compression chamber 47A only supplies relatively high pressure gas to the back pressure chamber 16 (this embodiment is not a departure from the present invention), pressure in the compression chamber 47A is reduced by supplying the relatively high pressure refrigerant gas to the back pressure chamber 16, while pressure in the other compression chamber 47B, which is located on a side opposite to the compression chamber 47A relative to the axis (the axis of the crankshaft 43) of the movable scroll member 45, is not reduced. Accordingly, force applied to the movable scroll member 45 based upon pressure in the compression chambers 47A, 47B becomes imbalance on each side relative to the axis, so that the movable scroll member 45 tends to incline relative to the axis of the movable scroll member 45.

(6) Carbon dioxide is employed as refrigerant for the refrigeration cycle. As described in the prior art, when carbon dioxide refrigerant is employed, passing cross-sectional area of a refrigerant gas passage between the back pressure chamber 16 and the suction chamber 51 need be much narrower at the maximum than that when fluorocarbon refrigerant is employed. Such a setting is easily handled by partially lowering sealing performance of the seal member 75 with low cost.

The present invention is not limited to the embodiment described above but may be modified into the following alternative embodiments.

In alternative embodiments to the above preferred embodiment, the balancer chamber 14 is defined as a relatively low pressure region, while the tip seal 77 for separating the balancer chamber 14 from the back pressure chamber 16 is defined as a seal member. As shown in FIG. 4, the tip seal 77 is partially split to form a seal lowering portion 77a for lowering sealing performance, and the back pressure chamber 16 and the balancer chamber 14 are interconnected through the seal lowering portion 77a.

In this state, as the operation being described with reference to FIGs. 1 and 4, for example, as the force F1 becomes greater than the force F2 ( $F1 > F2$ ) due to a rise in the pressure in the back pressure chamber 16, the movable scroll member 45 is displaced in a direction in which the distal end surface of the boss 67 leaves the contact portion 31 b of the center frame 31. Accordingly, a clearance between the distal end surface of the boss 67 and the contact portion 31 b of the center frame 31 increases, so that the passing cross-sectional area for refrigerant gas increases at the seal lowering portion 77a of the tip seal 77. The amount of refrigerant gas delivered from the back pressure chamber 16 to the balancer chamber 14 increases, and the pressure in the back pressure chamber 16 falls to reduce the force F1.

As the force F1 becomes smaller than the force F2 ( $F1 < F2$ ) due to a reduction in the pressure in the back pressure chamber 16, the movable scroll member 45 is displaced in a direction in which the distal end of the boss 67 approaches the contact portion 31 b of the center frame 31. Accordingly, a clearance between the distal end surface of the boss 67 and the contact portion 31 b of the center frame 31 reduces, so that the passing cross-sectional area for refrigerant gas reduces at the seal lowering portion 77a of the tip seal 77. The amount of refrigerant gas delivered from the back pressure chamber 16 to the balancer chamber 14 reduces, and the pressure in the back pressure chamber 16 rises to increase the force F1.

According to another embodiment, the same advantageous effects, such as appropriate adjust-

ment of pressure in the back pressure chamber 16 with a relatively low-cost structure, are obtained.

As shown in FIG. 5, in addition to the structure described in the preferred embodiment, the back pressure chamber 16 and a relatively low pressure region (the balancer chamber 14) are interconnected not through the seal lowering portion 75a but through another passage 81. A differential pressure regulating valve 82 is arranged in the passage 81 for opening when differential pressure between the back pressure chamber 16 and the balancer chamber 14 is equal to or greater than a predetermined value. Incidentally, the differential pressure regulating valve 82 includes a spherical valve body 82a, a coil spring 82b and a spring seat 82c. The pressure in the back pressure chamber 16 and the pressure in the balancer chamber 14 are respectively applied to the front side and the rear side of the valve body 82a. The coil spring 82b urges the valve body 82a in a direction to close the valve.

As described in the preferred embodiment, the passing cross-sectional area of the seal lowering portion 75a is adjusted in response to a balance between the force F1 based upon the pressure in the back pressure chamber 16 and the force F2 based upon the pressure in the compression chambers 47. Namely, in the embodiment of FIG. 5, the pressure in the back pressure chamber 16 is adjusted by utilizing two valves (the seal lowering portion 75a and the differential pressure regulating valve 82) each having different characteristic. Accordingly, a region where only one of the valves 75a and 82 cannot appropriately adjust pressure may be mutually covered by combination with the other of the valves 82 and 75a. Thus, the pressure in the back pressure chamber 16 is further appropriately adjusted.

In the preferred embodiment, one portion of the annular seal member 75 is split to form the seal lowering portion 75a. In alternative embodiments, a plurality of portions of a seal member, such as two, three, four, five or six portions, is split to form portion for lowering sealing performance at plural portions of the seal member.

In the preferred embodiment, the seal lowering portion 75a is formed by partially splitting the annular seal member 75. In alternative embodiments, the annular shape of the seal member is maintained, while a groove is partially formed in the seal member. Thus, a seal lowering portion for lowering sealing performance is formed.

In the preferred embodiment, two volume-reducing compression chambers 47A, 47B independently communicate with the back pressure chamber 16 through the respective introducing passages 76. In alternative embodiments, two introducing passages 76, which respectively extend from two compression chambers 47A, 47B, are integrated on the way and the integrated one introducing passage

communicates with the back pressure chamber 16. Thus, only one portion of the movable scroll member 45 (the base plate 65) is recessed to form the accommodating recess 65c, and the only one check valve 78 is required. Accordingly, cost for manufacturing the electric compressor is reduced.

In the preferred embodiment, relatively high pressure refrigerant gas is introduced from the volume-reducing compression chambers 47A, 47B to the back pressure chamber 16. In alternative embodiments, the compression chamber 47 near the center (the compression chamber 47 completes compression) or the discharge chamber 52 is defined as a relatively high pressure region, while the upstream portion of the introducing passage 76 communicates with the relatively high pressure region, so that the high pressure refrigerant gas, which is higher in pressure than the refrigerant gas in the volume-reducing compression chambers 47A, 47B, is introduced to the back pressure chamber 16.

In the preferred embodiment, a scroll compressor is embodied as the electric compressor. The scroll compressor is not limited to the electric compressor. In alternative embodiments, a scroll compressor driven by an engine of a vehicle, a hybrid type scroll compressor having an electric motor and an engine as drive sources, may be employed.

Therefore, the present examples and embodiments are to be considered as illustrative and not restrictive, and the invention is not to be limited to the details given herein but may be modified within the scope of the appended claims.

A scroll compressor includes a fixed scroll member fixed to a housing and a movable scroll member engaging the fixed scroll member. Each scroll member has a base plate and a spiral wall. A compression chamber between the fixed and movable scroll members reduces in volume by orbiting the movable scroll member, thus compressing gas. A back pressure chamber is defined in the housing on a back surface side of the movable scroll base plate between the movable scroll member and the a fixed wall of the housing. An introducing passage interconnects the back pressure chamber and a relatively high pressure region. A seal member on one of the movable scroll member and the fixed wall seals the back pressure chamber as being slidable on the other. The seal member includes a portion for lowering sealing performance, which interconnects the back pressure chamber and a relatively low pressure region.

## Claims

1. A scroll compressor having a housing (11), a fixed scroll member (41) and a movable scroll member

(45), the housing including a fixed wall (31) and defining a relatively high pressure region (47, 47A, 47B, 52) and a relatively low pressure region (14, 51), the fixed scroll member having a base plate (61) and a spiral wall (62) extending from the base plate, the fixed scroll member being fixedly connected to the housing, the movable scroll member having a base plate (65) and a spiral wall (66) extending from the base plate, the movable scroll member being engaged with the fixed scroll member, whereby a compression chamber (47) is defined between the fixed scroll member and the movable scroll member, the compression chamber progressively reducing in volume by orbiting the movable scroll member relative to the fixed scroll member, thus compressing gas, **characterized in that** a back pressure chamber (16) is defined in the housing on a back surface (65a) side of the base plate of the movable scroll member between the movable scroll member and the fixed wall, **in that** an introducing passage (76) interconnects the back pressure chamber and the relatively high pressure region, **in that** a seal member (75) is provided on one of the movable scroll member and the fixed wall for sealing the back pressure chamber as being slidable on the other of the movable scroll member and the fixed wall, and **in that** the seal member includes a seal lowering portion (75a) for lowering sealing performance, which interconnects the back pressure chamber and the relatively low pressure region.

2. The scroll compressor according to claim 1, wherein the seal member has an annular shape, the seal lowering portion being formed by partially splitting the seal member.
3. The scroll compressor according to any one of claims 1 and 2, wherein the movable scroll member is accommodated in a scroll chamber (15), which is defined by connecting the fixed scroll member and the fixed wall at a joint, **characterized in that** a shim (68) is interposed at the joint between the fixed scroll member and the fixed wall for adjusting a thrust clearance (CL) between the movable scroll member and the fixed wall.
4. The scroll compressor according to any one of claims 1 through 3, comprising a rotary shaft (33), a shaft support member (32) and a balancer (44a), **characterized in that** the rotary shaft includes a crankshaft (43) for supporting the movable scroll member, **in that** the shaft support member is fixedly connected to the fixed wall on a side opposite to the movable scroll member in the housing and rotatably supports the rotary shaft, a balancer chamber (14) being defined between the fixed wall and the shaft support member, and **in that** the balancer is provided for the crankshaft and is accommodated in the

balancer chamber.

5. The scroll compressor according to any one of claims 1 through 4, wherein the back pressure chamber communicates with the relatively low pressure region through a passage (81) other than the seal lowering portion, **characterized in that** a differential pressure regulating valve (82) is arranged in the passage for opening the passage when pressure differential between the back pressure chamber and the relatively low pressure region is equal to or higher than a predetermined value.
6. The scroll compressor according to any one of claims 1 through 5, wherein the relatively high pressure region includes two volume-reducing compression chambers (47A, 47B), which respectively communicate with the back pressure chamber through the introducing passage.
7. The scroll compressor according to claim 6, wherein two volume-reducing compression chambers respectively communicate with the back pressure chamber through the respective independent introducing passages.
8. The scroll compressor according to any one of claims 1 through 7, wherein the introducing passage is formed in the base plate of the movable scroll member.
9. The scroll compressor according to any one of claims 1 through 8, wherein carbon dioxide is employed as refrigerant of the refrigeration cycle.
10. The scroll compressor according to any one of claims 1 through 9, wherein the compressor is driven by an electric motor (13).

FIG. 1

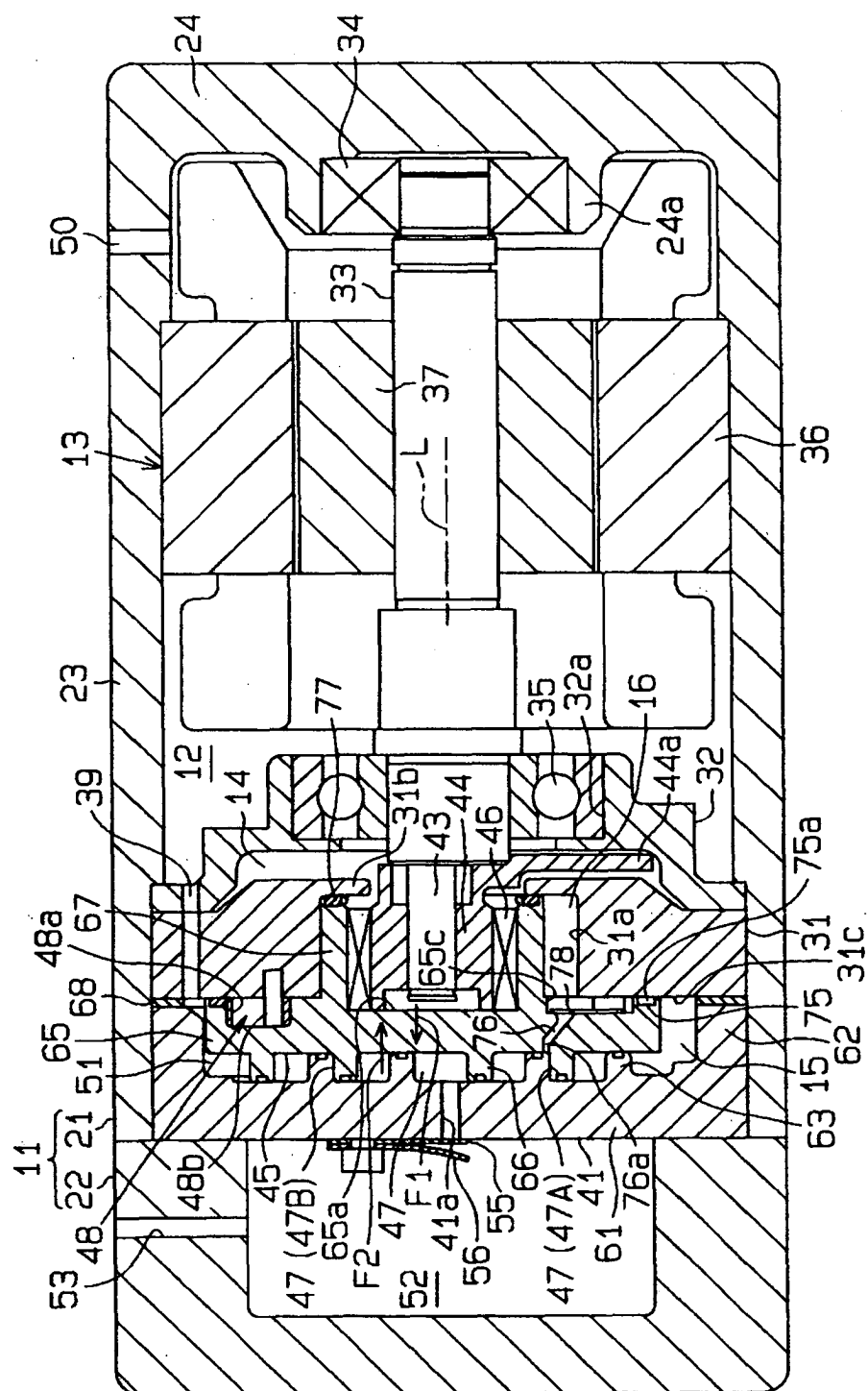


FIG. 2

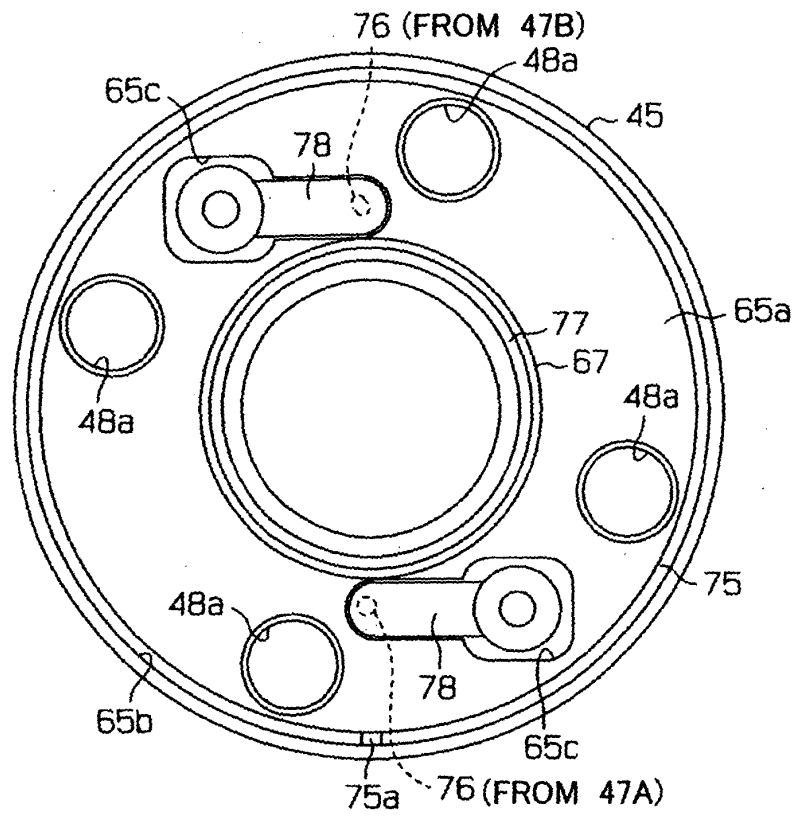


FIG. 3A

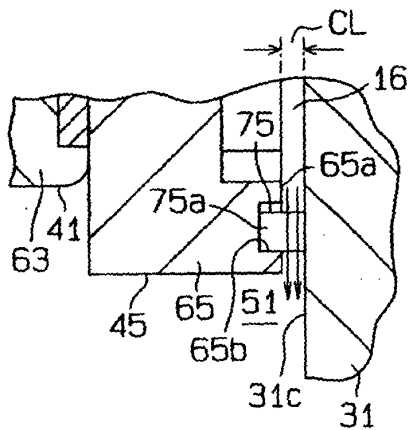


FIG. 3B

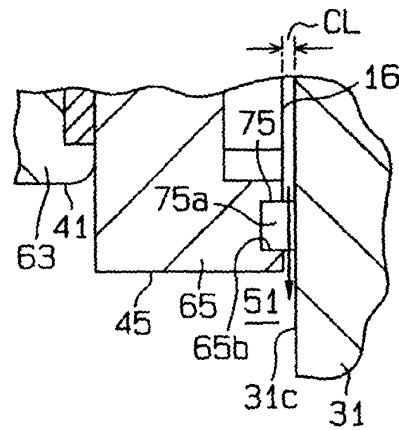


FIG. 4

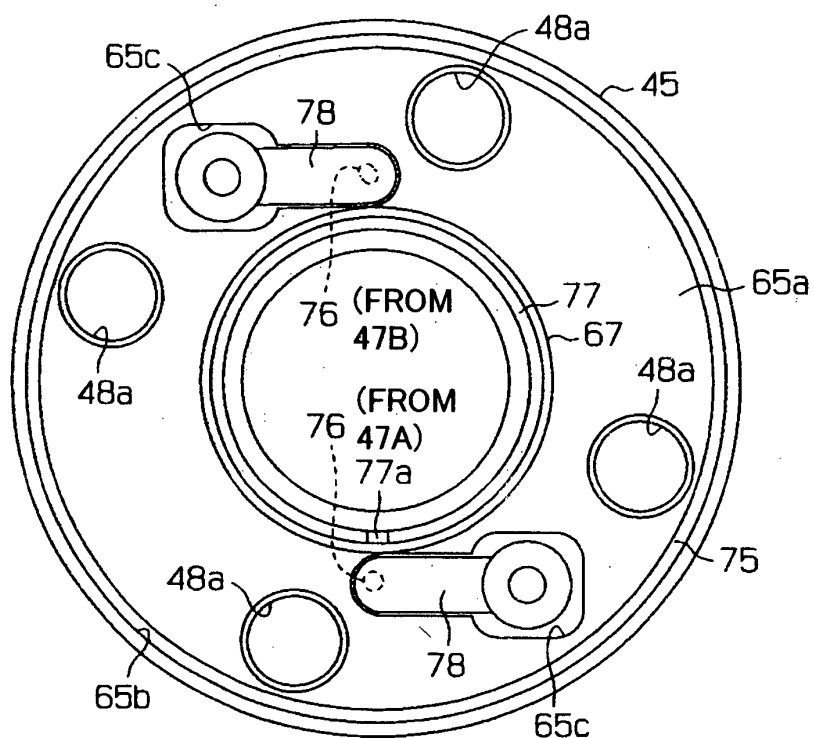
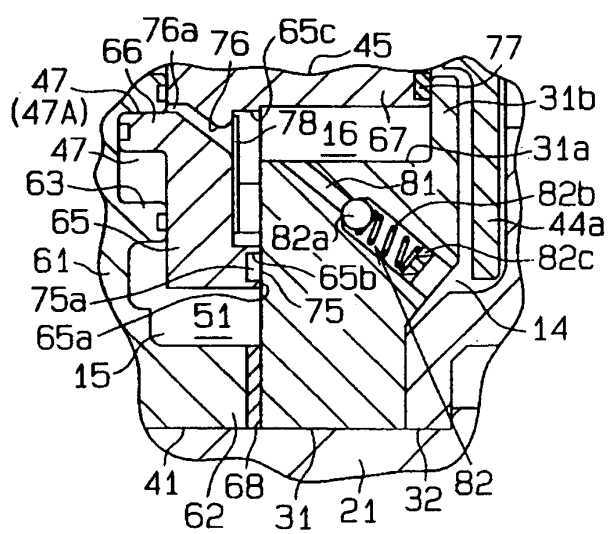


FIG. 5





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