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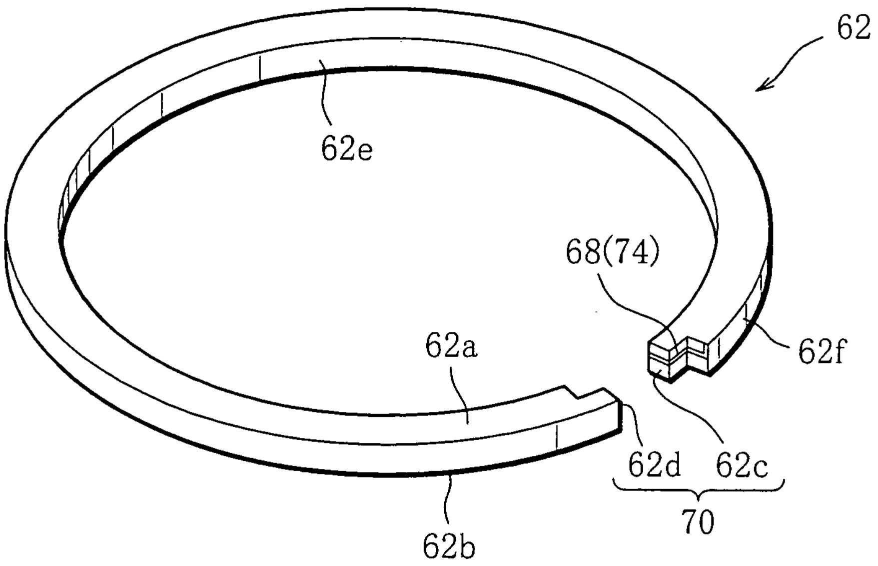
(54) **Fluid machine**

(57) There is provided a seal ring (62) that is supported by a frame (18) concentrically with the axis of a rotary shaft (16), has an abutment joint (70) formed when opposite circumferential end surfaces (62c and 62d) contact each other due to circumferential elongation of the ring which is caused by thermal expansion, and slidingly contacts the back surface (50) of a movable scroll (34) to separate an oil passage (52). The seal ring has depressurizing means that depressurizes a high-pressure chamber (72) and creates an intermediate-pressure chamber (76) of lower pressure than the high-pressure chamber and of higher pressure than a low-pressure chamber (42). The depressurizing means is formed in the abutment joint.

FIG. 3



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Description

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a fluid machine, and more specifically, to a fluid machine suitable to a refrigeration airconditioner and a heat-pump water heater.

Description of the Related Art

[0002] A fluid machine of this type, such as a scroll compressor, is provided in its housing with a scroll unit for carrying out a sequence of processes including suction, compression and discharge of working fluid. This unit is constructed of a fixed scroll and a movable scroll that are engaged with each other. When the movable scroll moves in an orbital motion about the axis of the fixed scroll along a frame fixed to the housing, the capacity of the space formed by both the scrolls is reduced, and the above-mentioned processes are carried out.

[0003] In this connection, a technology of forming an oil passage for lubricating oil within an end plate of the movable scroll, providing the end plate with throttle means that narrows down the oil passage, and thereby creating a depressurized back-pressure chamber on the side of the back surface of the end plate of the movable scroll (see Unexamined Japanese Patent Publication No. 2003-42080; hereinafter, referred to as "Document 1"). This allows the movable scroll to smoothly move in an orbital motion, and makes it possible to properly supply the lubricating oil to the unit. The compressor is then improved in compression performance.

[0004] There is another publicly known technology, according to which the oil passage is formed between the back surface of the end plate of the movable scroll and the frame, and the oil passage is separated by a seal ring that slidingly contacts the back surface of the movable scroll. A groove is carved out of the upper end surface of the seal ring and is used as throttle means to create the back-pressure chamber (see Unexamined Japanese Patent Publication No. 7-51950; hereinafter referred to as "Document 2").

[0005] However, Document 1 requires to prepare components for constructing the throttle means and to produce the oil passage and the throttle means inside the end plate, and therefore has the problem that the components and machining cost of the compressor are increased.

[0006] According to Document 2, the groove is formed in the upper end surface of the seal ring that slidingly contacts the back surface of the movable scroll. The process of forming the groove produces burr, which might hamper the orbital motion of the movable scroll. In order to remove the burr, it is necessary to add a burr removal process into the production process of the compressor, which complicates the production process of the compressor.

SUMMARY OF THE INVENTION

[0007] The present invention has been made in light of the above-mentioned problems. It is an object of the invention to provide a fluid machine including a compressor with reliability and productivity that are improved by easily and inexpensively forming a back-pressure chamber on a back surface side of an end plate of a movable scroll without hindering an orbital motion of the movable scroll.

[0008] In order to achieve the above object, the fluid machine of the invention has a rotary shaft that extends within a housing and is rotatably fitted into the housing; a scroll unit that carries out a sequence of processes including suction, compression and discharge of working fluid, the scroll unit being installed in the housing and provided with a fixed scroll formed integrally with the housing and a movable scroll that is driven by the rotary shaft to move in an orbital motion about an axis of the fixed scroll; a frame that is accommodated in the housing, supports the movable scroll so that the scroll may move in an orbital motion, and forms an oil passage located between the frame and a back surface of the movable scroll to supply lubricating oil from a high-pressure chamber located on an axis side of the rotary shaft, in which discharge pressure of the working fluid acts, toward a low-pressure chamber on an outer side of the rotary shaft, in which suction pressure of the working fluid acts; a seal ring that is supported by the frame concentrically with the axis of the rotary shaft, provided with an abutment joint that is so formed that opposite circumferential end surfaces are brought into contact with each other due to circumferential elongation that is caused by thermal expansion, and slidingly contacts the back surface of the movable scroll to separate the oil passage; and depressurizing means that is provided to the seal ring, depressurizes the high-pressure chamber, and forms as an oil passage an intermediate-pressure chamber of intermediate pressure which has a lower pressure than the high-pressure chamber and a higher pressure than the low-pressure chamber. The depressurizing means is formed in the abutment joint of the seal ring.

[0009] According to the fluid machine, the depressurizing means can be easily formed when the seal ring is machined to produce the abutment joint. Therefore, the intermediate-pressure chamber can be easily and inexpensively produced on the back surface side of the movable scroll.

[0010] Since the depressurizing means is formed in the abutment joint, the orbital motion of the movable scroll is smoothly carried out without being hindered by the depressurizing means. Therefore, the reliability of the fluid machine is retained, and at the same time, the productivity of the machine is improved.

[0011] In a preferable aspect of the fluid machine, the depressurizing means is formed of a groove produced in at least one of the circumferential end surfaces of the seal ring so as to extend from an inner circumferential surface to an outer circumferential surface of the seal ring. The groove forms an oil flow channel that is a part of the oil passage by the circumferential end surfaces contacting each other. By narrowing down the lubricating oil passage in the oil flow channel, the intermediate-pressure chamber is created on the side of the outer circumferential surface of the seal ring.

[0012] According to the above-described structure, the circumferential end surfaces are brought into contact with each other by causing the thermal expansion of the seal ring, and the groove is made to function as the oil flow channel in which the oil passage is narrowed down. In other words, by using the thermal expansion of the seal ring and an orifice effect of the groove, the intermediate-pressure chamber can be created on the back surface side of the movable scroll through the fairly simple machining that merely makes the groove in one of the circumferential end surfaces of the seal ring. Accordingly, the components and the complicated machining for forming the intermediate-pressure chamber are not necessary. This greatly improves the productivity of the fluid machine.

[0013] In a preferable aspect of the fluid machine, the seal ring is formed by injection-molding an engineering plastic.

[0014] By so doing, the groove that forms the depressurizing means of the seal ring is upgraded in machining accuracy and strength, and accordingly, the reliability and productivity of the fluid machine are further improved.

[0015] In a preferable aspect of the fluid machine, the working fluid is a refrigerant consisting of carbon dioxide.

[0016] In the above-described structure, the fluid machine operates at high temperature in a high rotation region, so that the seal ring is exposed to the high temperature and is brought into sliding contact with the back surface of the movable scroll on severe conditions. On the other hand, an increase in action of thermal expansion of the seal ring makes it possible to create the oil flow channel that is airtight. Furthermore, since the oil flow channel does not hamper the orbital motion of the movable scroll, the fluid machine is more effectively improved in reliability and productivity.

BRIEF DESCRIPTION OF THE DRAWINGS

[0017] The present invention will become more fully understood from the detailed description given hereinbelow and the accompanying drawings which are given by way of illustration only, and thus, are not limitative of the present invention, and wherein:

FIG. 1 is a longitudinal section of a sealed-type compressor according to one embodiment of the present invention;

FIG. 2 is an enlarged view of a substantial part of FIG. 1;

FIG. 3 is a perspective view of a seal ring shown in FIGS. 1 and 2; and

FIG. 4 shows a part of FIG. 2, which is added with a through hole of lubricating oil.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] One embodiment of the present invention will be described below with reference to the attached drawings.

[0019] FIG. 1 shows a sealed-type compressor as one example of a fluid machine of the invention. The compressor 1 is installed in a refrigeration circuit of a refrigeration airconditioner and of a heat-pump water heater or the like. The circuit includes a path through which a carbon dioxide refrigerant (hereinafter, referred to as refrigerant) that is one example of working fluid circulates. The compressor 1 takes in the refrigerant from the path, and after compressing the refrigerant, discharges the refrigerant toward the path.

[0020] The compressor 1 has a housing 2, which includes a body 4. An upper lid 6 and a lower lid 8 are airtightly fitted to upper and lower ends of the body 4 to seal the body 4. Discharge pressure of the refrigerant acts within the body 4. The body 4 is connected with a suction pipe 10 for sucking the refrigerant that is taken in from the circuit. A discharge pipe 12 for sending the compressed refrigerant of the housing 2 to the circuit is connected to a proper position of the upper lid 6.

[0021] An electric motor 14 is accommodated in the body 4. Disposed in the motor 14 is a rotary shaft 16. The rotary shaft 16 is driven by supplying electricity to the motor 14. An upper part of the rotary shaft 16 is rotatably supported by a spindle frame (frame) 18 with a bearing 17 interposed therebetween. The spindle frame 18 is integrally fixed to the housing 2.

[0022] A lower part of the rotary shaft 16 is rotatably supported by a secondary axis frame 22 with a bearing 20 interposed therebetween. An oil pump 24 is mounted onto the lower part of the rotary shaft 16. The pump 24 sucks lubricating oil stored in an oil storage chamber 26 that is formed on an inner side of the lower lid 8. The sucked lubricating oil flows up through an oil supply passage 28 that is pierced through the rotary shaft 16 along an axial direction thereof. The lubricating oil is then supplied from an upper end of the rotary shaft 16 to the motor 14, a scroll unit 30, and the like, to be used for lubricating various sliding parts, bearings, etc., and for sealing up sliding surfaces. In this connection, the refrigerant discharge pressure acts on an oil level of the lubricating oil in the storage chamber 26, and this contributes the rising of the lubricating oil in the oil supply passage 28. In a proper position of the secondary shaft frame 22, there is formed a lead-in opening 32 of the lubricating oil. The lubricating oil supplied to the sliding parts in the compressor 1 passes through the lead-in opening 32 to be stored in the oil storage chamber 26.

[0023] The unit 30 is disposed above the motor 14 in the body 4 and carries out a sequence of processes including the suction, compression and discharge of the refrigerant.

[0024] The unit 30 is formed of a movable scroll 34 and a fixed scroll 36. The movable scroll 34 has an end plate 38. A spiral wrap is integrally formed in the end plate 38 so as to extend toward an end plate 40 of the fixed scroll 36. In the end plate 40 of the fixed scroll 36, too, there is integrally formed a spiral wrap extending toward the end plate 38.

[0025] The spiral wraps suck the refrigerant from a suction chamber (low-pressure chamber) 42 communicating with the suction pipe 10 formed on the side of an outer circumference of the end plate 38, thereby forming a compression chamber in consort with each other. The compression chamber is reduced in capacity as it moves toward the center of the spiral wrap due to the orbital motion of the movable scroll 34 in relation to the fixed scroll 36. The movable scroll 34 is prevented from making a rotation by a rotation-blocking pin, not shown.

[0026] A boss 44 is formed in a lower surface of the end plate 38 to provide the orbital motion of the movable scroll 34. The boss 44 is rotatably supported by an eccentric shaft 48 with a bearing 46 interposed therebetween. The eccentric shaft 48 is integrally formed in the upper part of the rotary shaft 16. A given gap (oil passage) 52 that allows the orbital motion of the movable scroll 34 is secured in between a back surface 50 of the movable scroll 34 and the spindle frame 18. Due to rotation of the rotary shaft 16, the movable scroll 34 moves in an orbital motion above the spindle frame 18.

[0027] The fixed scroll 36 is fixed to the spindle frame 18. The end plate 40 separates the compression chamber and the discharge chamber 54 from each other. A back-pressure regulation valve 55 is built into an outer circumferential portion of the fixed scroll 36, the valve 55 being capable of regulating the back pressure of the back surface 50 of the movable scroll 34, that is, the pressure of the gap 52.

[0028] A discharge hole 56 communicating with the compression chamber is pierced through the end plate 40 to be located in a proper position in a central part of the fixed scroll 36. The discharge'hole 56 is opened/closed by a discharge valve 58 placed on the side of the back surface of the fixed scroll 36. The discharge valve 58 is covered with a discharge head 60. The discharge head 60 reduces the noise produced when the discharge valve 58 is opened.

[0029] With the compressor 1, the movable scroll 34 moves in an orbital motion along with the rotation of the rotary shaft 16. Due to the orbital motion of the movable scroll 34, the refrigerant of the suction chamber 42 is sucked into the unit 30. As the capacity of the compression chamber is reduced, the refrigerant is compressed. After a high-pressure refrigerant that has been compressed is discharged into the discharge hole 56 and circulated through the housing 2, the refrigerant is delivered from the discharge chamber 54 to the outside of the compressor through the discharge pipe 12.

[0030] The high-pressure lubricating oil that has been pumped up by the pump 24 correlatively with the action of the refrigerant discharge pressure is supplied from the upper end of the rotary shaft 16 to the unit 30, and the bearings 17, 20 and 46, etc. The lubricating oil subsequently flows down in the housing 2 and enters the storage chamber 26 through the lead-in opening 32 to be stored therein.

[0031] More specifically, as illustrated in FIG. 2 in an enlarged scale, after flowing out of the oil supply passage 28 and lubricating the bearing 46, the lubricating oil flows down along the rotary shaft 16 while lubricating the bearing 17 as shown by arrows. At the same time, the lubricating oil flows into the gap 52 of between the back surface 50 of the movable scroll 34 and the spindle frame 18, and is then supplied to the unit 30 through the suction chamber 42. The gap 52 is used as an oil-conducting channel that directs the lubricating oil coming from the oil supply passage' 28 to the unit 30. The lubricating oil, after flowing through the gap 52, is sucked into the unit 30 together with the low-pressure refrigerant that is supplied in the suction chamber 42. The lubricating oil is subsequently compressed and discharged from the discharge hole 56 in a state contained in the high-pressure refrigerant.

[0032] The gap 52 is separated by a seal ring 62. An upper surface 62a of the ring 62 slidingly contacts the back surface 50 of the movable scroll 34 through the entire circumference. A lower surface 62b is supported by the spindle frame 18 concentrically with an axis of the rotary shaft 16.

[0033] To be concrete, a depression is made in an upper surface 18a of the spindle frame 18 to provide an annular groove 64, and the ring 62 is loosely fitted into the annular groove 64. Preferably, an elastic body 66 such as a leaf spring is set between the annular groove 64 and the lower surface 62b. Accordingly, the ring 62 is urged against the back surface 50, which makes it possible to surely and continuously make the upper surface 62a slidingly contact the back surface 50.

[0034] The ring 62 is made of a plastic material such as PTFE (polytetrafluoro-ethylene), and is preferably injection-molded from an engineering plastic material, such as PPS (polyphenylene sulfide), PEEK (polyether ether ketone), PI (polyimide), PES (polyethersulfone), and PEI (polyetherimide).

[0035] Referring to FIG. 3 perspectively showing the ring 62, the ring 62 has circumferential end surfaces 62c and 62d facing each other in a circumferential direction of the ring 62. The circumferential end surfaces 62c and 62d are located away from each other with a given initial gap, and each have a radially stepped portion complementary to the other.

[0036] In the circumferential end surface 62c, a depression is made from an inner circumferential surface

62e of the ring 62 to an outer circumferential surface 62f of the ring 62 substantially parallel to the upper surface 62a to provide a groove 68. The groove 68 further extends from the outer circumferential surface 62f to the upper surface 62a. In short, the groove 68 is formed in a substantially L shape in the circumferential direction of the ring 62.

[0037] When the ring 62 is exposed to a high-temperature atmosphere during the operation of the compressor 1, the ring 62 is thermally expanded in the circumferential direction thereof. The circumferential end surfaces 62c and 62d are brought into contact with each other, thereby forming an abutment joint 70 of the ring 62. The initial gap between the circumferential end surfaces 62c and 62d at room temperature is previously set at such distance that allows the circumferential elongation of the ring 62 which is caused by thermal expansion.

[0038] Since the circumferential end surfaces 62c and 62d have their respective radially stepped portions complementary to each other, when a space (high-pressure chamber) 72 in the ring 62, which communicates with the oil supply passage 28 from the side of the inner circumferential surface 62e, becomes high in pressure, the inner circumferential surface 62e is urged by inner pressure of the space 72 toward the inner circumferential surface 64a of the annular groove 64. Consequently, airtightness of the space 72 is secured.

[0039] The ring 62 separates the gap 52 so that the gap 52 is airtight and thereby forms the space 72 during the operation of the compressor 1. When the circumferential end surfaces 62c and 62d are in contact with each other, the groove 68 functions as a through hole (oil flow channel) 74 for leaking the lubricating oil from the space 72.

[0040] As illustrated in FIG. 4 in an enlarged scale, the through hole 74 is formed once the groove 68 is covered with the circumferential end surface 62d simultaneously with the formation of the abutment joint 70. Since the groove 68 is preliminarily made at given width and depth, the passage sectional area of the through hole 74 can be adjusted. The high-pressure lubricating oil in the space 72 is depressurized and made to flow into a space (intermediate-pressure chamber) 76 located on the side of the outer circumferential surface 62f.

[0041] The through hole 74 serves as a diaphragm that supplies the depressurized lubricating oil from the space 72 to the space 76. In addition, the back-pressure regulation valve 55 is set at given pressure, so that the space 76 is created in the gap 52 as a back-pressure chamber of the movable scroll 34, which has a lower pressure than the space 72 of a high-pressure atmosphere, and has a higher pressure than the suction chamber 42 of a low-pressure atmosphere (depressurizing means).

[0042] As described above, in the compressor 1 according to the embodiment, the gap 52 produced in between the back surface 50 of the movable scroll 34 and the spindle frame 18 is separated by the ring 62 having the abutment joint 70. The groove 68 is made in the circumferential end surface 62c forming the abutment joint 70 so as to extend from the inner circumferential surface 62e of the ring 62 to the outer circumferential surface 62f. The groove 68 functions as the through hole 74 of the lubricating oil when the circumferential end surfaces 62c and 62d are brought into contact with each other due to the thermal expansion of the ring 62. As a result, the lubricating oil passage in the gap 52 is narrowed down.

[0043] By using the thermal expansion of the ring 62 and the orifice effect of the groove 68, namely the through hole 74, it is possible to create the space 76 of intermediate pressure on the side of the back surface 50 by the fairly simple machining that only produces the groove 68 in the circumferential end surface 62c. Accordingly, the back-pressure chamber of intermediate pressure can be inexpensively and easily formed without requiring new components and complicated machining. This greatly improves the productivity of the compressor 1.

[0044] Since the groove 68 is produced in the circumferential end surface 62c forming the abutment joint 70, the sliding contact of the upper surface 62a of the ring 62 with respect to the back surface 50 can be smoothly performed through substantially the entire circumference, and the orbital motion of the movable scroll 34 is not hindered. This makes it possible to easily and inexpensively form the back-pressure chamber of intermediate pressure and yet to secure the reliability of the compressor 1.

[0045] If the ring 62 is made by injection-molding an engineering plastic, the machining accuracy and strength of the groove 68, and therefore those of the through hole 74 are upgraded. Consequently, the compressor 1 is further improved in reliability and productivity.

[0046] This is the end of the descriptions about the one embodiment of the invention. However, the invention is not limited to the above-described embodiment, and various modifications can be made without deviating from the gist of the invention.

[0047] For instance, the embodiment forms the groove 68 in the circumferential end surface 62c. What is important is to obtain the through hole 74, so that the groove 68 may be formed in the circumferential end surface 62d or in both the circumferential end surfaces 62c and 62d.

[0048] In the embodiment, the groove 68 is formed in a substantial L shape as viewed in the circumferential direction of the ring 62. However, the groove 68 may be a straight-line depression that extends from the inner circumferential surface 62e to the outer circumferential surface 62f in parallel with the back surface 50 of the movable scroll 34, or may be a straight-line depression that slants upward from the inner circumferential surface 62e to the outer circumferential surface 62f, as long as the through hole 74 opens into the space 76.

[0049] If the groove 68 is formed parallel with the back surface 50 or on a slant, it is not necessary at all to machine the upper end surface 62 of the ring 62. As a result, the sliding contact of the ring 62 with the back surface 50 of the movable scroll 34 becomes smoother, which further enhances the reliability of the compressor 1.

[0050] Although the embodiment uses carbon dioxide as refrigerant, the refrigerant is not limited to carbon dioxide. When the refrigerant is carbon dioxide, the compressor 1 operates at higher pressure in a higher rotation region, so that the ring 62 is exposed to higher temperature and slidingly contacts the back surface 50 on more severe conditions, as compared to the case where the refrigerant is another substance. According to the above-described structure, however, the increase in the thermal expansion of the ring 62 makes it possible to achieve the through hole 74 that is more airtight. Whether the groove 68 is formed into an L-shaped line or a straight line parallel with the back surface 50 or an upwardly slant line, the through hole 74 is only slightly opened or is not opened at all in the upper end surface 62a of the ring 62. Therefore, the reliability and productivity of the compressor 1 are further improved.

[0051] Needless to say, the fluid machine of the invention can be used not only as the sealed-type compressor for a refrigeration circuit which is installed into a vehicle airconditioner but also as a compressor of any other type than the sealed type or expansion machine, which is used in various fields.

Claims

1. A fluid machine (1) comprising:

a rotary shaft (16) that extends within a housing (2) and is rotatably fitted into the housing (2);
a scroll unit (30) that carries out a sequence of processes including suction, compression and discharge of working fluid, the scroll unit (30) being installed in the housing (2) and provided with a fixed scroll (36) formed integrally with the housing (2) and a movable scroll (34) that is driven by the rotary shaft (16) to move in an orbital motion about an axis of the fixed scroll (36);
a frame (18) that is accommodated in the housing (2), supports the movable scroll (34) so that the movable scroll (34) may move in an orbital motion, and forms an oil passage (52) between the frame (18) and a back surface (50) of the movable scroll (34) to supply lubricating oil from a high-pressure chamber (72) located on an axis side of the rotary shaft (16), in which discharge pressure of the working fluid acts, toward a low-pressure chamber (42) on an outer side of the rotary shaft (16), in which suction pressure of the working fluid acts;
a seal ring (62) that is supported by the frame (18) concentrically with the axis of the rotary shaft (16), provided with an abutment joint (70) that is so formed that opposite circumferential end surfaces (62c and 62d) are brought into contact with each other due to circumferential elongation that is caused by thermal expansion, and slidingly contacts’the back surface (50) of the movable scroll (34) to’separate the oil passage (52); and
depressurizing means that is provided to the seal ring (62), depressurizes the high-pressure chamber (72), and forms as the oil passage (52) an intermediate-pressure chamber 76) of intermediate pressure which has a lower pressure than the high-pressure chamber (72) and a higher pressure than the low-pressure chamber (42), **characterized in that**:

the depressurizing means is formed in the abutment joint (70) of the seal ring (62).

2. The fluid machine (1) according to claim 1, **characterized in that**:

the depressurizing means is formed of a groove (68) produced in at least one of the circumferential end surfaces (62c and 62d) of the seal ring (62) so as to extend from an inner circumferential surface (64e) to an outer circumferential surface (62f) of the seal ring (62); and
the groove (68) is formed as an oil flow channel (74) serving as a part of the oil passage (52) due to the circumferential end surfaces (62c and 62d) contacting each other, and the oil passage (52) is narrowed down in the oil flow channel (74) to create the intermediate-pressure chamber (76) on the side of the outer circumferential surface of the seal ring (62).

3. The fluid machine (1) according to either one of claims 1 and 2, **characterized in that**:

the seal ring (62) is formed by injection-molding an engineering plastic.

4. The fluid machine (1) according to any one of claims 1 to 3, **characterized in that**:

the working fluid is a refrigerant consisting of carbon dioxide.

FIG. 1

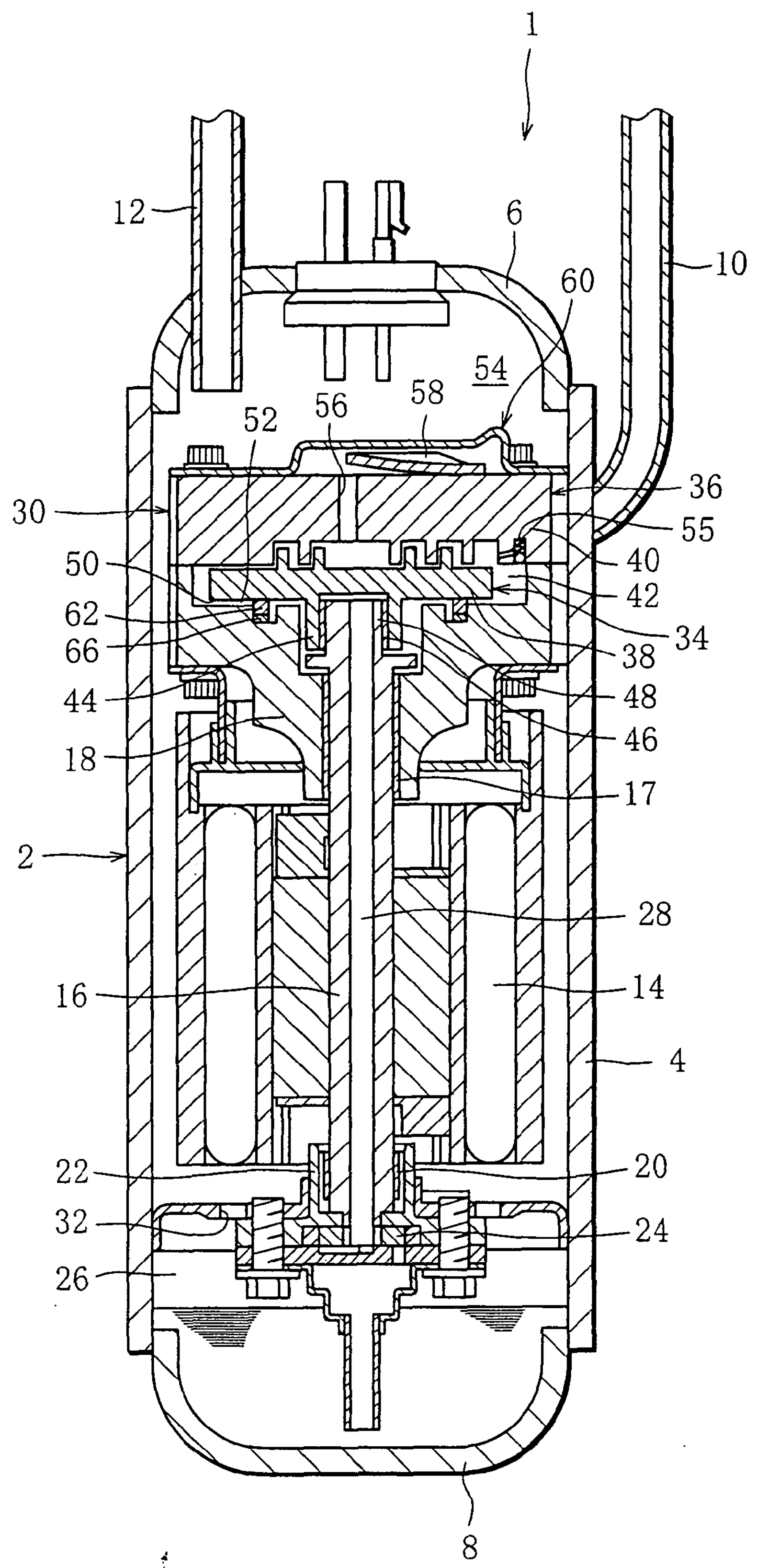
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FIG. 2

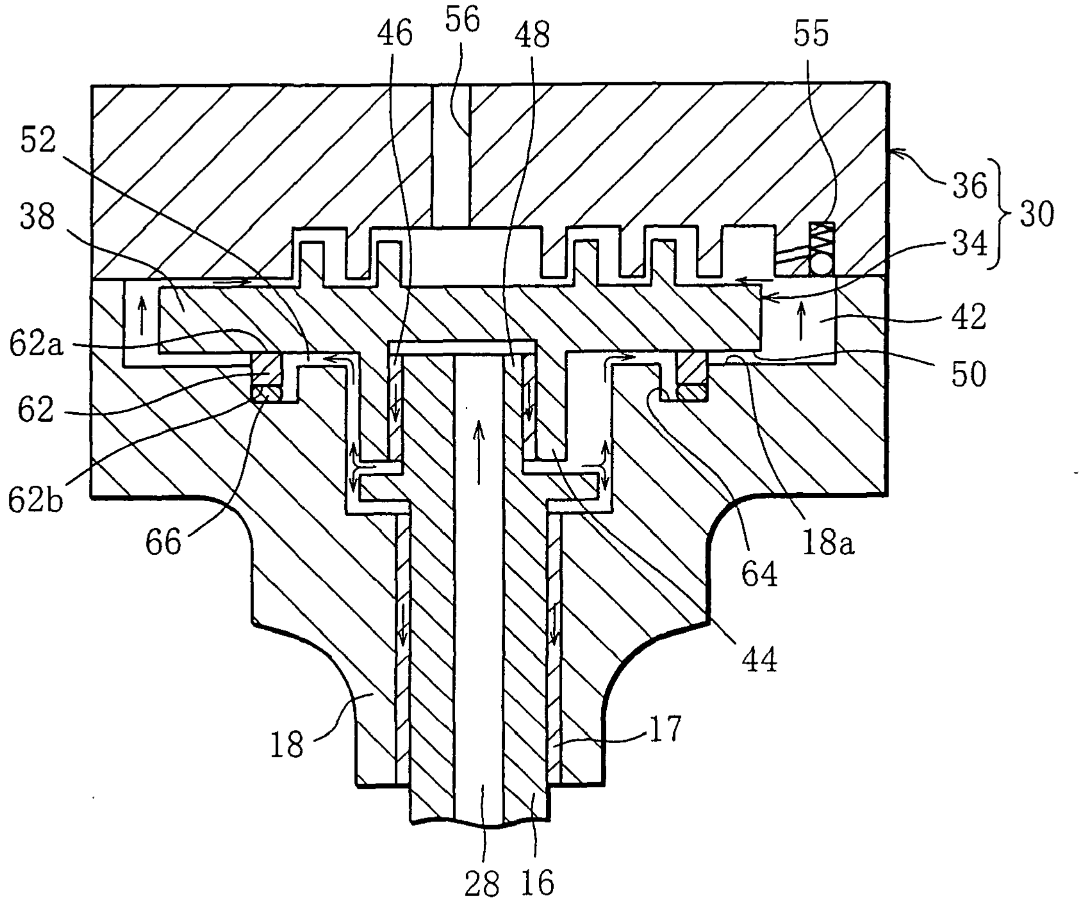


FIG. 3

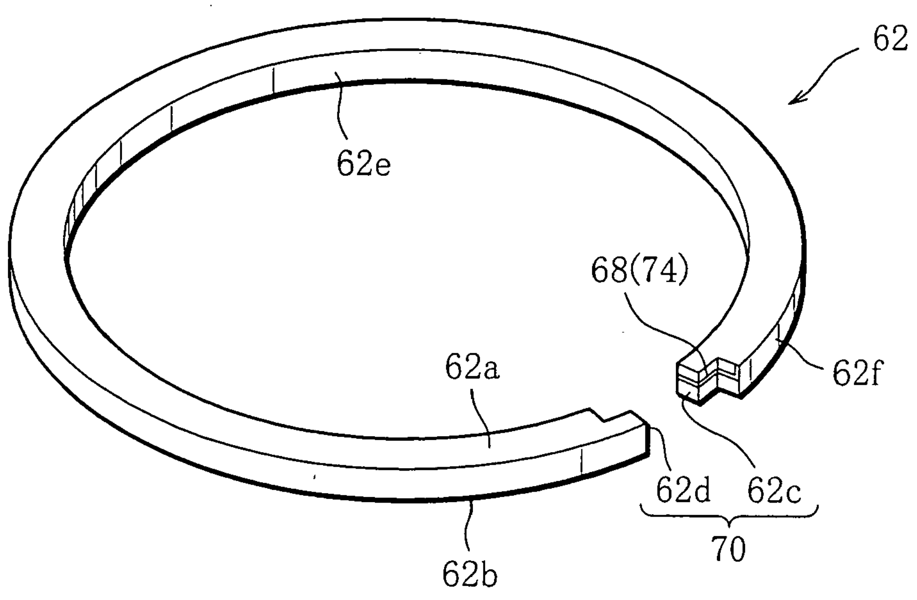
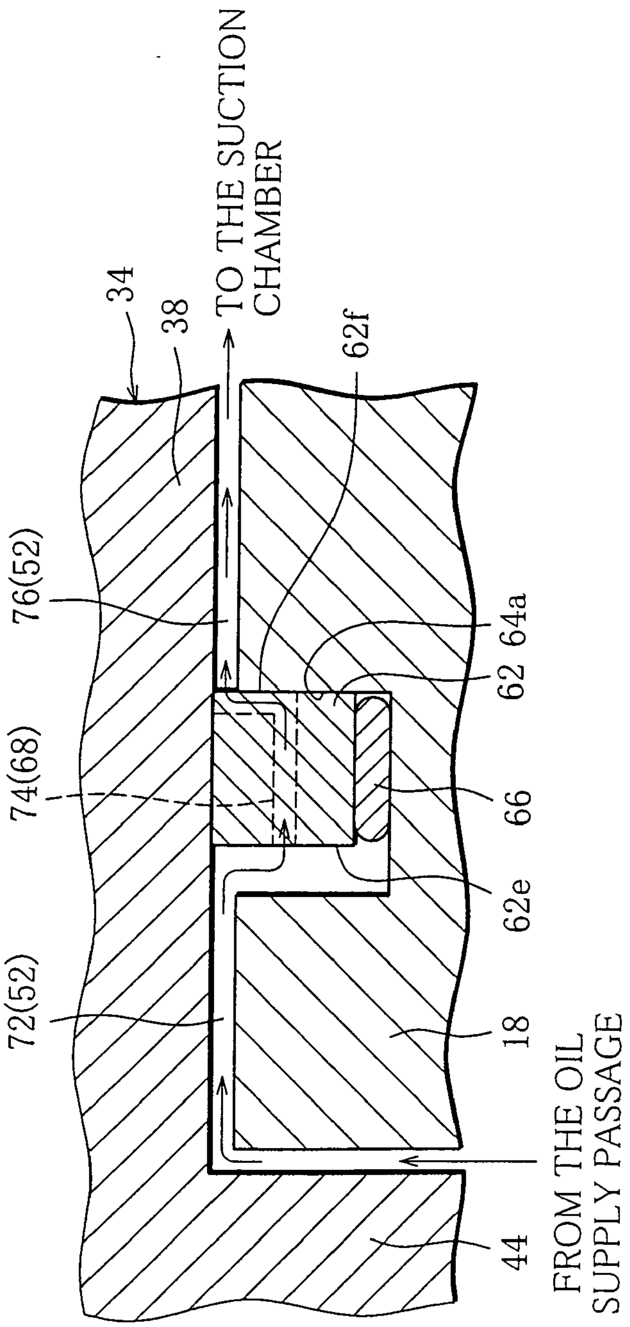


FIG. 4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FROM THE OIL SUPPLY PASSAGE

REFERENCES CITED IN THE DESCRIPTION

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