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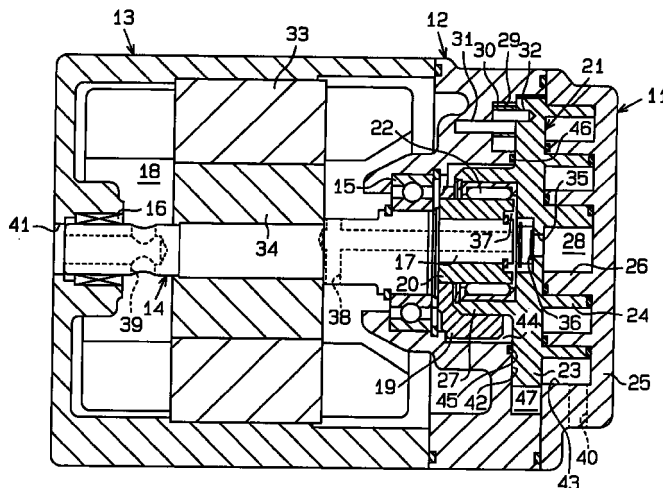
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(54) **Scroll-type compressor**

(57) A scroll-type compressor having an improved seal structure includes a stationary scroll (11) and a movable scroll (21). Gas is discharged to an inner zone (44) through a discharge port (35) in accordance with orbital movement of the movable scroll (21). The seal structure includes a seal member (46), which is located

between a movable base plate (23) and a radial projection (42). The seal member (46) substantially prevents gas that is discharged from the discharge port (35) from flowing radially from the zone (44). The seal member (46) is moved axially by the force of gas pressure.

Fig.1



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a scroll-type compressor, more particularly, to a sealing structure of scroll-type compressors.

[0002] Japanese Unexamined Patent Publication No. 4-175483 discloses a scroll-type compressor shown in Fig. 8. The compressor includes a movable scroll 61 and a stationary scroll 65. The scrolls 61, 65 each have a volute portion to compress refrigerant gas. The movable scroll 61 includes a base plate 62. A groove 63 is formed in the base plate 62 on the surface from which the volute portion extends. The groove 63 is filled with a filler 64. The filler 64 forms a seal between the stationary scroll 65 and the movable scroll 61.

[0003] Since the filler 64 is located in a surface of the base plate 62 that faces the stationary scroll 65, the area of contact between the scrolls 65 and 61 must be relatively large. Thus, if the sealing structure of the prior art publication is used in a scroll-type compressor that includes a discharge port formed in the movable scroll, the diameter of the base plate of the movable scroll will be relatively great, which will increase the overall size of the compressor.

[0004] If a discharge port is formed in the movable scroll, the discharge port communicates with a space that is defined adjacent to the movable scroll. Specifically, the space is defined at a side of the movable scroll that is opposite to the volute portion. Therefore, the pressure of the compressed refrigerant gas acts on the movable scroll. If excessive, the load of the pressure hinders smooth orbital motion of the movable scroll, which makes the movable scroll less reliable and reduces the life of the movable scroll.

SUMMARY OF THE INVENTION

[0005] Accordingly, it is a first objective of the present invention to provide a scroll type compressor having a sealing structure that has high sealing characteristics between a movable scroll and a stationary scroll and reduces the radial dimension of a scroll-type compressor in which a discharge port is formed in a movable scroll. A second objective of the present invention is to reduce excessive load acting on a side of the movable scroll opposite to a volute portion.

[0006] To achieve the foregoing and other objectives and in accordance with the purpose of the present invention, a scroll-type compressor is provided. The compressor includes a housing, a projection extending inward from the inner surface of the housing, a rotary shaft, an eccentric shaft, a stationary scroll, a movable scroll and a seal member. The rotary shaft is supported by the housing to rotate about its axis. The eccentric shaft extends from the rotary shaft. The axis of the eccentric shaft is offset from the axis of the rotary shaft.

The stationary scroll is fixed to the housing and includes a base stationary plate and a stationary volute portion extending from the base plate. The movable scroll includes a movable base plate and a movable volute portion extending from the movable base plate. The two volute portions cooperate to form a variable displacement pocket between the two scrolls. A discharge port is formed in the movable scroll. Rotation of the rotary shaft is converted into orbital movement of the movable scroll by the eccentric shaft. Gas is introduced into the pocket, compressed in the pocket and discharged to a discharge chamber, which is radially inside the projection, through the discharge port in accordance with the orbital movement of the movable scroll. The seal member substantially prevents gas that is discharged from the discharge port from flowing out from the discharge chamber radially inside the projection. The seal member is located between the movable base plate and the projection, and further inward than the outermost inner surface of the stationary scroll.

[0007] 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

[0008] 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 cross-sectional view illustrating a scroll-type compressor according to a first embodiment of the present invention;

Fig. 2 is a front view of a first seal member used in the compressor shown in Fig. 1;

Fig. 3 is an enlarged cross-sectional view showing the first seal when the seal is at a seal position;

Fig. 4 is a cross-sectional view illustrating a scroll-type compressor according a second embodiment;

Fig. 5 is an enlarged cross-sectional view showing a first seal and a second seal when the seals are at seal positions;

Fig. 6 is a cross-sectional view taken along line 6-6 of Fig. 4;

Fig. 7(a) is front view illustrating a seal member according to a third embodiment;

Fig. 7(b) is an enlarged view showing the seal member of Fig. 7(a) when the diameter of the seal is enlarged by a pressure difference; and

Fig. 8 is a partial cross-sectional view illustrating a prior art scroll-type compressor.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0009] A scroll-type compressor according to a first embodiment of the present invention will now be described with reference to Figs. 1 to 3.

[0010] As shown in Fig. 1, a stationary scroll 11 is secured to a center housing member 12. A motor housing member 13 is also secured to the center housing member 12. A rotary shaft 14 is supported by the center housing member 12 and the motor housing member 13 through radial bearings 15, 16. An eccentric shaft 17 is formed integrally with the rotary shaft 14. The inner wall of the motor housing member 13 and the center housing member 12 define a motor chamber 18.

[0011] A counterweight 19 and a bushing 20 are supported by the eccentric shaft 17. The rotary shaft 14, the eccentric shaft 17 and the bushing 20 rotate integrally. A movable scroll 21 is supported by the bushing 20 through a needle bearing 22. The movable scroll 21 includes a movable base plate 23 and a movable volute portion 24 that extends from the movable base plate 23. The stationary scroll 11 includes a stationary base plate 25 and a stationary volute portion 26 that extends from the stationary base plate 25. The volute portions 24, 26 engage each other. A boss 27 extends from the movable base plate 23 at the side opposite to the movable volute portion 24. The needle bearing 22 is accommodated in the boss 27. The base plates 23, 25 and the volute portions 24, 26 define pockets 28. As the movable scroll 21 orbits, each pocket 28 moves radially inward while its volume decreases.

[0012] Recesses 29, the number of which is four in this embodiment, are formed in a side of the center housing member 12 that faces the stationary scroll 11. The recesses 29 are arranged circumferentially. A ring 30 is located in each recess 29. Also, a fixed pin 31 is fixed in each recess 29. Movable pins 32 are fixed to the movable scroll 21. The number and the locations of the movable pins 32 correspond to those of the recesses 29. Each fixed pin 31 and the corresponding movable pin 32 are inserted into the corresponding ring 30. As the eccentric shaft 17 rotates, the movable scroll 21 orbits. At this time, the rings 30, the fixed pins 31 and the movable pins 32 prevent the movable scroll 21 from rotating about its own axis.

[0013] A stator 33 is fixed to the inner wall of the motor housing member 13. A rotor 34 is fixed to the rotary shaft 14 at a location corresponding to the stator 33. The stator 33 and the rotor 34 form an electric motor. When a current is supplied to the stator 33, the rotor 34 and the rotary shaft 14 rotate integrally.

[0014] A discharge port 35 is formed substantially in the center of the movable base plate 23. The movable base plate 23 also has a float valve 36 at a position corresponding to the discharge port 35. The discharge port 35 is connected to the interior of the boss 27, or a discharge chamber 37, through the float valve 36. A first

passage 38 is formed in the rotary shaft 14 in the vicinity of the bearing 15. Also, a second passage 39 is formed in the rotary shaft 14 in the vicinity of the bearing 16 to connect the motor chamber 18 to the exterior of the motor housing member 13. As the movable scroll 21 orbits, refrigerant gas is drawn into the pockets 28 from an inlet 40 formed in the stationary scroll 11. Then, the gas flows to the exterior of the motor housing member 13 through the discharge port 35, the first passage 38, the second passage 39 and the outlet 41.

[0015] As shown in Fig. 1, a projection 42 is formed in the center housing member 12 and extends radially inward from the inner surface of the center housing member 12. The projection 42 is adjacent to the movable scroll 21 and is on the opposite side of the movable base plate 23 from the movable volute portion 24. The projection 42 extends radially further inward than the outermost inner surface 43 of the stationary scroll 11. As shown in Figs. 1 and 3, an annular groove 45 is formed in a surface of the projection 42 that faces the movable scroll 21. The groove 45 has a rectangular cross section. A seal member 46, which is illustrated in Fig. 2, is located in the groove 45. The outer diameter D_S of the seal member 46 is slightly smaller than the outer diameter D_G of the annular groove 45. The radial dimension W_G of the groove 45 is slightly greater than the radial dimension W_S of the seal member 46. The axial dimension P of the groove 45 is slightly smaller than the axial dimension T of the seal member 46. Thus, the seal member 46 axially protrudes from the groove 45. The seal member 46 is movable in the groove 45 in the axial direction of the rotary shaft 14.

[0016] As shown in Fig. 1, the interior of the projection 42, or the space radially inside the seal member 46, is connected to the discharge chamber 37 through the bearing 22 and is exposed to the discharge pressure. Thus, the space in the projection 42 will be referred to as a high pressure chamber 44. The space that is between the projection 42 and the movable scroll 21 and the space outside the seal member 46 are exposed to a pressure that is close to the suction pressure. The spaces will therefore be referred to as a low pressure chamber 47. The pressure difference between the high pressure chamber 44 and the low pressure chamber 47 urges the seal member 46 to the position shown in Fig. 3, or to a seal position. If there is a space between the seal member 46 and the movable scroll 21, decompression created by airflow through the space causes the seal member 46 to approach the movable scroll 21. Then, the pressure of highly pressurized discharged gas applies a force shown by arrow G in Fig. 3, which urges the first seal member 46 against the outer wall of the groove 45 and against the movable scroll 21. Accordingly, the high pressure chamber 44 is sealed from the low pressure chamber 47.

[0017] The sealing structure of Figs. 1 to 3 has the following advantages.

(1) The projection 42 extends further inward than the outermost inner surface 43 of the stationary scroll 11, and the seal member 46 is attached to the projection 42. Therefore, the sealing structure sufficiently seals the high pressure chamber 44 and the low pressure 47 from each other. Also, the sealing structure allows the diameter of the movable scroll 21 to be reduced, which reduces the size of the scroll-type compressor.

(2) The seal member 46 is held at the seal position by the difference between the pressure in the high pressure chamber 44 and the pressure in the low pressure chamber 47. Therefore, the high pressure chamber 44 and the low pressure chamber 47 are properly sealed from each other.

(3) The groove 45, in which the seal member 46 is accommodated, is formed in the center housing member 12. Thus, the seal member 46 contacts the movable scroll 21 regardless of the position of the movable scroll 21. Therefore, the area on the projection 42 needed for sealing can be reduced.

(4) Refrigerant gas is supplied to the motor chamber 18 to cool the motor in the motor housing member 13.

(5) The passages 38, 39 are formed in the rotary shaft 14. Accordingly, the radial dimension of the compressor is reduced.

(6) The axial dimension P of the groove 45 is smaller than the axial dimension T of the seal member 46. The seal member 46 therefore functions as a buffer between the movable scroll 21 and the projection 42 and prevents seizing.

A second embodiment of the present invention will now be described with reference to Figs. 4 to 6. In addition to the seal member 46, the compressor of Figs. 4 to 6 has a second seal member 50 and a third seal member 48. The third seal member 48 prevents gas from flowing to the motor chamber 18 through the space between the rotary shaft 14 and the projection 42. The other structures are the same as those of the compressor of Figs. 1 to 3. Like or the same reference numerals are given to those components that are like or the same as the corresponding components of the embodiment of Figs. 1 to 3.

As shown in Fig. 4 and 5, the bushing 20 has an annular groove 49 in the surface facing the movable scroll 21. The second seal member 50 is fitted in the groove 49. The second seal member 50 moves axially relative to the groove 49. As shown in Fig. 5, the radial dimension of the groove 49 is slightly greater than that of the second seal member 50. The axial dimension of the groove 49 is

slightly smaller than that of the second seal member 50. The second seal member 50 protrudes from the groove 49. The third seal member 48 is located between the rotary shaft 14 and the inner wall of the projection 42 for sealing the motor chamber 18.

As shown in Fig. 6, the first and second seal members 46, 50 define an intermediate pressure chamber 51 between the high pressure chamber 44 and the low pressure chamber 47. The pressure in the intermediate pressure chamber 51 is between the pressures in the high and low pressure chambers 44, 47. The pressures of the chambers 44, 51, 47 decrease stepwise from the high pressure chamber 44 to the low pressure chamber 47. The first and second seal members 46, 50, through which gas leaks at a small flow rate, function as restrictions.

The high pressure chamber 44 communicates with the discharge port 35, and the pressure in the intermediate pressure chamber 51 is lower than that of the high pressure chamber 44. The pressure acting on the side of the movable scroll 21 facing the eccentric shaft 17 urges the movable scroll 21 toward the stationary scroll 11. That is, the stationary scroll 11 receives a load from the movable scroll 21. The load in this embodiment is smaller than that where there is no second seal member 50. Therefore, the movable scroll 21 smoothly orbits and wear on the movable scroll 21 is reduced.

In addition to advantages (1) to (4), the embodiment of Figs. 4 to 6 has the following advantages.

(7) The intermediate pressure chamber 51 is defined between the high pressure chamber 44 and the low pressure chamber 47, and the pressure in the intermediate pressure chamber 51 is lower than that of the high pressure chamber 44. Accordingly, the load acting on the movable scroll 21 is reduced. As a result, the movable scroll 21 smoothly orbits and wear is suppressed, which improves the reliability and extends the life of the compressor.

(8) The second seal member 50 is used to form the intermediate pressure chamber 51. Therefore, the second seal member 50 does not need to have a high sealing characteristics, which facilitates the forming of the seal member 50 and the groove 49.

(9) Two seal members, that is the first seal member 46 and the second seal member 50, are located between the high pressure chamber 44 and the low pressure chamber 47. Therefore, the high pressure chamber 44 is properly sealed from the low pressure chamber 47.

[0018] It should be apparent to those skilled in the art that the present invention may be embodied in many other specific forms without departing from the spirit or

scope of the invention. Particularly, it should be understood that the invention may be embodied in the following forms.

[0019] The diameter of each seal member 46, 50 may be adjustable. For example, each of the seal members 46, 50 may be replaced by a seal member that has a slant cut. A seal member 53 illustrated in Figs. 7(a) and 7(b) is an example of such a seal member. Two seal members 53 having different sizes are prepared to replace the seal members 46, 50. When installed, the cut portion 52 is deformed as shown in Fig. 7(b) by a pressure difference between the high pressure area and the low pressure area. The deformation permits the seal member 53 to contact the outer wall of the grooves 45, 49 and dimensional errors in the grooves 45, 49 are absorbed.

[0020] The seal member 53 may be formed by rubber that is treated to reduce friction.

[0021] The grooves 45, 49 may be formed in the side of the movable scroll 21 that is opposite to the movable volute portion 24.

[0022] In the embodiment of Figs. 4 to 6, two or more intermediate pressure chambers may be formed. In this case, the number of annular sealing members is also increased, which properly seals the high pressure chamber 44 from the low pressure chamber 47.

[0023] In the embodiment of Figs. 4 to 6, the second seal member 50 need not be located between the bushing and the movable scroll 21. For example, the diameter of the eccentric shaft 17 may be increased, and the second seal member 50 may be located between the eccentric shaft 17 and the movable scroll 21.

[0024] In the embodiments of Figs. 1 to 6, a passage for directly communicating the discharge chamber 37 with the exterior of the housing may be formed in the rotary shaft 14. In this case, the third seal member 48, which is located between the rotary shaft 14 and the center housing 12, may be omitted.

[0025] The first seal member 46 may be axially aligned with the outermost inner surface 43 of the stationary scroll 11. This structure also permits the size of the compressor to be reduced.

[0026] The third seal member 48 may be replaced with a lip seal. Alternatively, the third seal member 48 may be omitted and the bearing 15 may be replaced by a bearing with a seal.

[0027] The sealing structure of the present invention may be embodied in other types of scroll-type compressors, for example, in a scroll-type compressor that is driven by an engine.

[0028] 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 and equivalence of the appended claims.

[0029] A scroll-type compressor having an improved seal structure includes a stationary scroll (11)

and a movable scroll (21). Gas is discharged to an inner zone (44) through a discharge port (35) in accordance with orbital movement of the movable scroll (21). The seal structure includes a seal member (46), which is located between a movable base plate (23) and a radial projection (42). The seal member (46) substantially prevents gas that is discharged from the discharge port (35) from flowing radially from the zone (44). The seal member (46) is moved axially by the force of gas pressure.

Claims

1. A scroll-type compressor comprising:

a housing (12,13);
 a projection (42) extending inward from the inner surface of the housing;
 a rotary shaft (14), which is supported by the housing (12, 13) to rotate about its axis;
 an eccentric shaft (17) extending from the rotary shaft (14), the axis of the eccentric shaft (17) being offset from the axis of the rotary shaft (14);
 a stationary scroll (11) fixed to the housing, the stationary scroll (11) including a stationary base plate (25) and a volute stationary portion (26) extending from the base plate (25); and
 a movable scroll (21), which includes a movable base plate (23) and a movable volute portion (24) extending from the movable base plate (23), wherein the two volute portions (26, 24) cooperate to form a variable displacement pocket (28) between the two scrolls (11, 21), wherein a discharge port (35) is formed in the movable scroll (21), wherein rotation of the rotary shaft (14) is converted into orbital movement of the movable scroll (21) by the eccentric shaft (17), and wherein gas is introduced into the pocket (28), compressed in the pocket (28) and discharged to discharge chamber (37), which is radially inside the projection (42), through the discharge port (35) in accordance with the orbital movement of the movable scroll (21), **characterized by:**
 a seal member (46) for substantially preventing gas that is discharged from the discharge port (35) from flowing out from the discharge chamber (37), wherein the seal member (46) is located between the movable base plate (23) and the projection (42), and the seal member (46) is located further inward than the outermost inner surface of the stationary scroll (11).

2. The compressor according to claim 1, **characterized in that** the seal member (46) is urged toward a predetermined position by the difference between the pressure of a zone (47) radially outside the seal

member (46) and the pressure of a zone (44) radially inside the seal member (46).

and wherein the second seal member (50) is located between the bushing (20) and the movable scroll (21).

3. The compressor according to claim 2, **characterized in that** an annular groove (45) is formed in the projection (42) and faces the movable base plate (23), and the outer surface of the seal member (46) contacts the radially outer surface of the annular groove (45), wherein the seal member (46) is movable in the axial direction of the rotary shaft (14). 5 10
4. The compressor according to any one of claims 1 to 3, **characterized in that** the seal member (46) is annular. 15
5. The compressor according to any one of claims 1 to 4, **characterized in that** the diameter of the seal member (46) is variable. 20
6. The compressor according to any one of claims 1 to 5, **characterized in that** a passage (38, 39) is formed in the rotary shaft (14) to discharge gas to the outside of the compressor. 25
7. The compressor according to any one of claims 1 to 6, **characterized by** an electrical motor for rotating the rotary shaft (14), wherein the motor includes a motor chamber (18) defined in the housing (12, 13), a stator (33) fixed in the motor chamber (18) and a rotor (34) supported by the rotary shaft (14), and wherein gas discharged from the discharge port (35) flows through the motor chamber (18). 30
8. The compressor according to any one of claims 1 to 7, wherein the seal member is a first seal member (46), **characterized by:** 35
 - a second seal member (50), wherein the second seal member (50) is located radially inside the first seal member (46); 40
 - a low pressure zone (47) located outside the first seal member (46), wherein the pressure of the low pressure zone (47) is relatively low;
 - a high pressure zone (44) located inside the second seal member (50), the pressure of the high pressure zone (44) is relatively high; and 45
 - an intermediate pressure zone (51) defined between the first seal member (46) and the second seal member (50), wherein the intermediate pressure zone (51) is adjacent to the movable base plate (23), and the pressure of the intermediate pressure zone (51) is between the pressure of the high pressure zone (44) and the pressure of the low pressure zone (47). 50
9. The compressor according to claim 8, **characterized in that** a bushing (20) is located between the eccentric shaft (17) and the movable scroll (21), 55

Fig.1

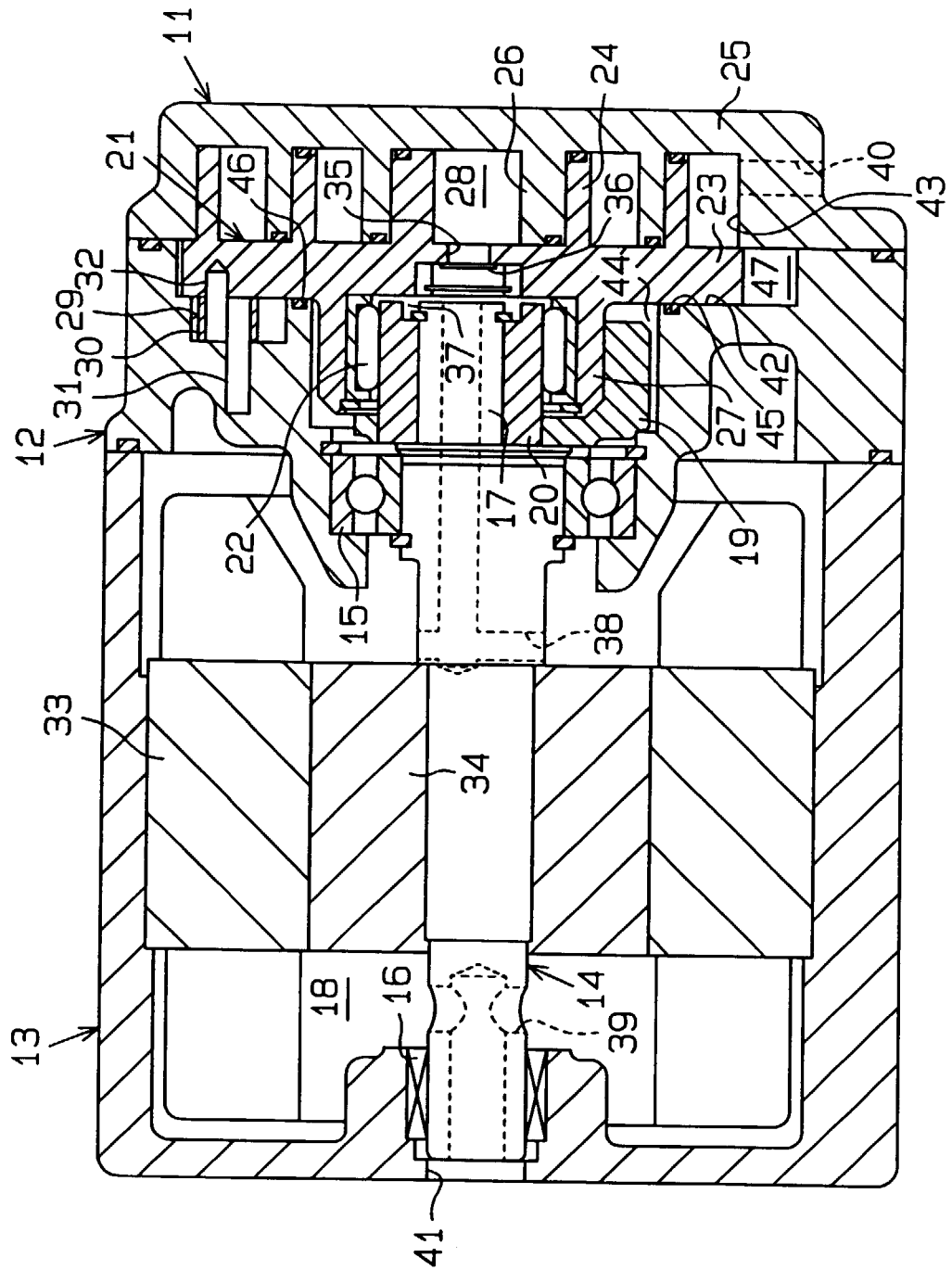


Fig. 2

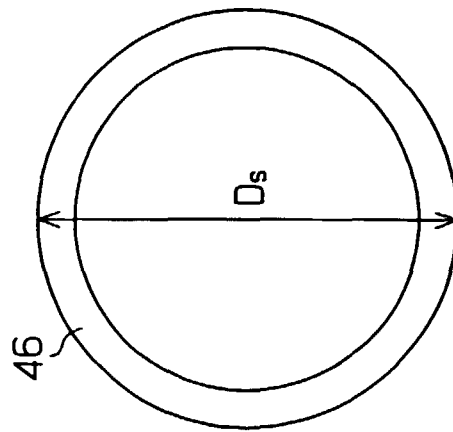


Fig. 3

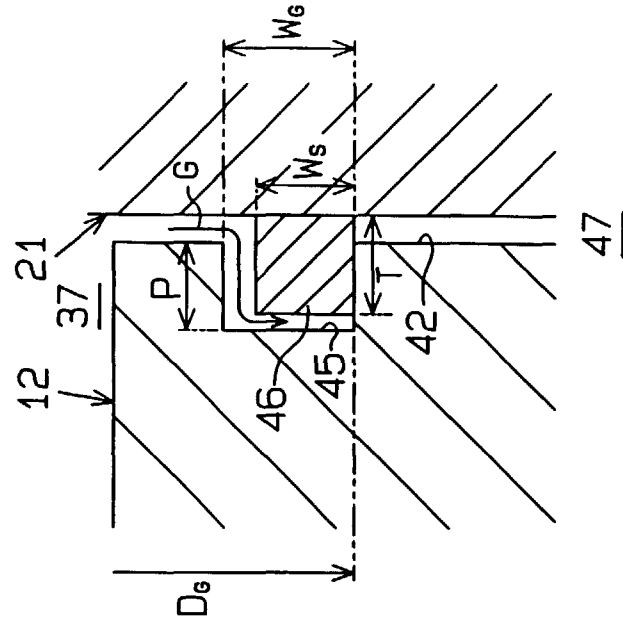


Fig. 4

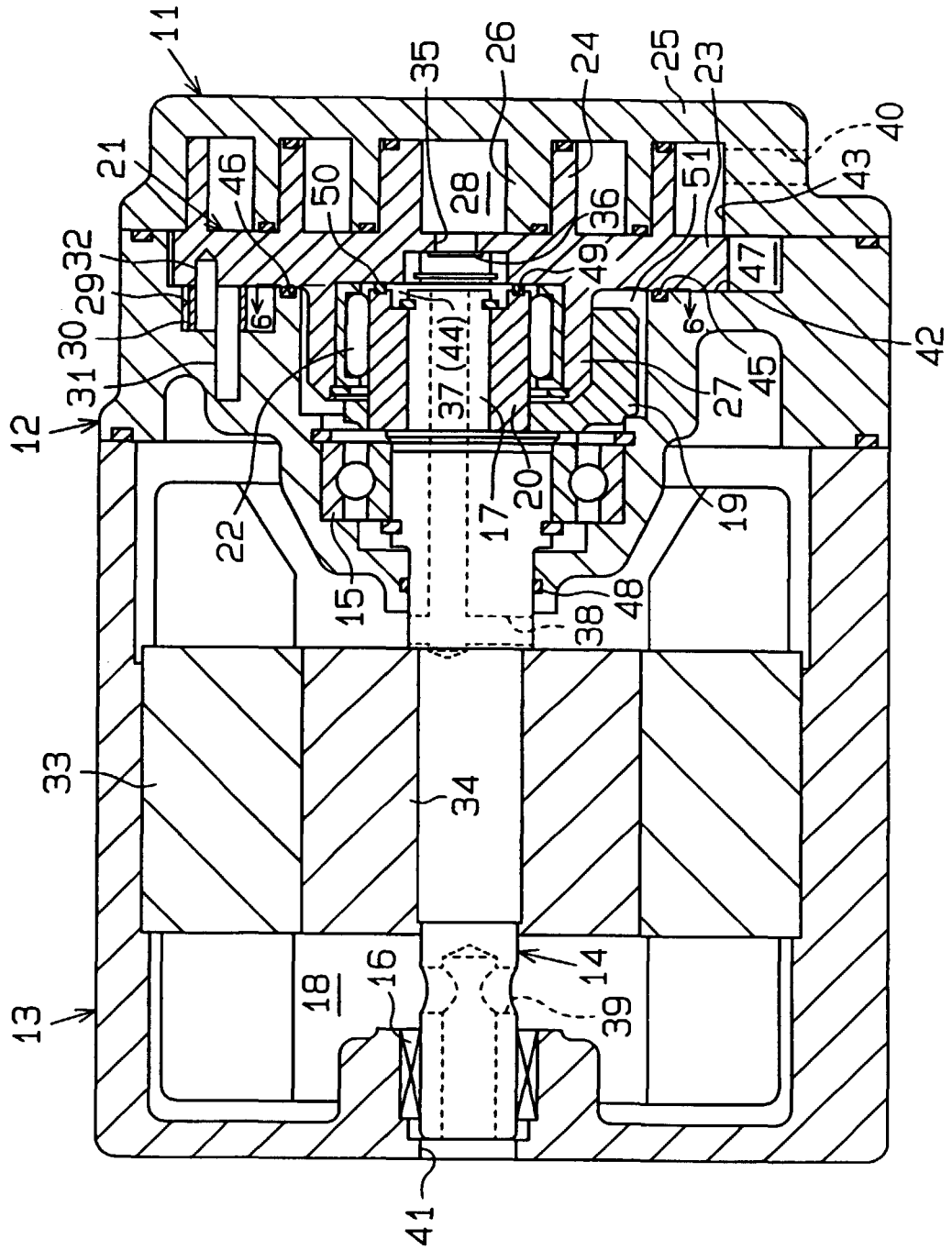


Fig. 5

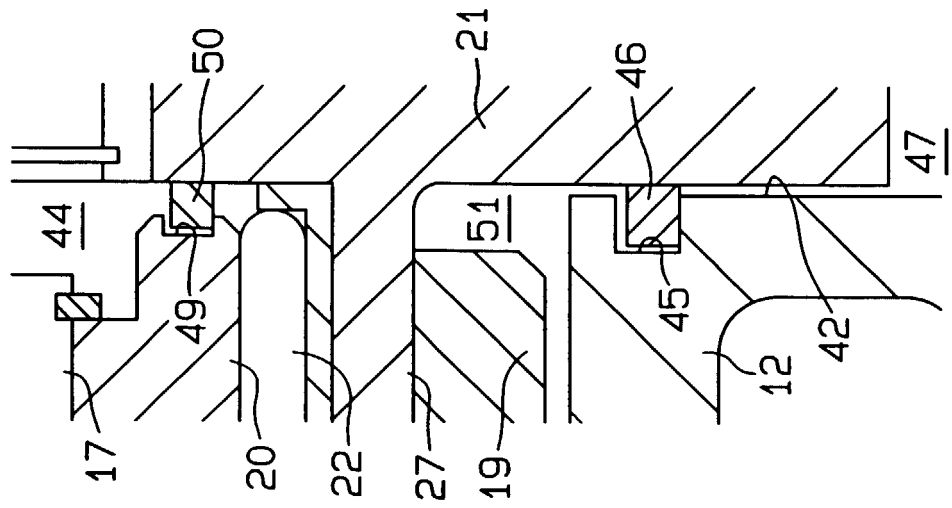


Fig. 6

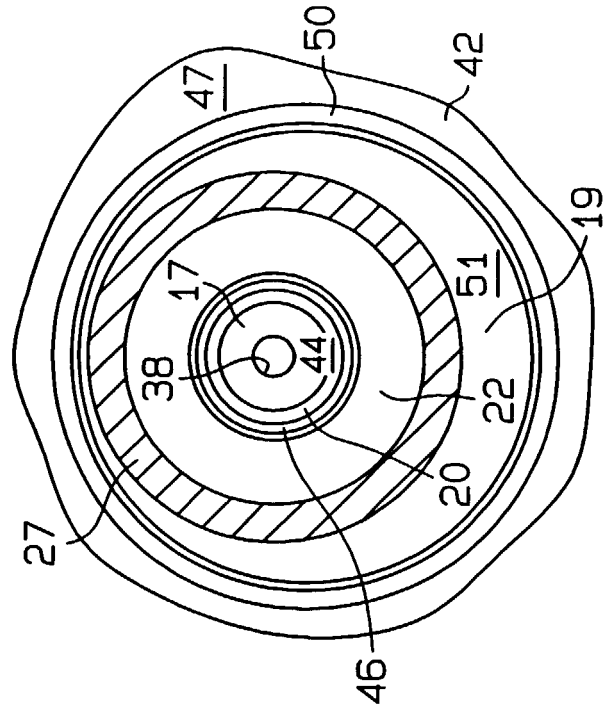


Fig. 7 (a)

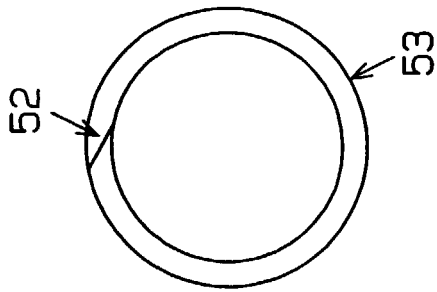


Fig. 7 (b)

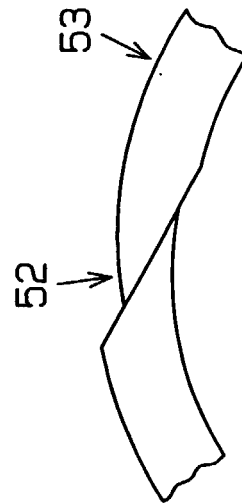


Fig. 8

